Stressor Identification

July 2018

Watonwan River Watershed Stressor Identification Report

A study of local stressors limiting the biotic communities in the Watonwan River Watershed

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

Authors

Erin Andrews, MPCA
Jacquelyn Bacigalupi, DNR
Kevin Mott, DNR

Contributors/acknowledgements

Paul Davis, MPCA
Chandra Henrich, MPCA
Kim Laing, MPCA
Joe Magee, MPCA
Melissa Markert, MPCA
Chuck Regan, MPCA
Tiffany Schauls, MPCA
Bryan Spindler, MPCA

Editing and graphic design

Ashley Ignatius, MPCA

Project dollars provided by the Clean Water Fund (from the Clean Water, Land and Legacy Amendment).

The MPCA is reducing printing and mailing costs by using the Internet to distribute reports and information to wider audience. Visit our website for more information.

MPCA reports are printed on 100% post-consumer recycled content paper manufactured without chlorine or chlorine derivatives.

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

This report is available in alternative formats upon request, and online at www.pca.state.mn.us.

Document number: wq-ws5-07020010a

Contents

Figures

Tables

Key Terms & Abbreviations

CADDIS	Causal Analysis/Diagnosis Decision Information System
DNR	Minnesota Department of Natural Resources
EPA	U.S. Environmental Protection Agency of the United States
MPCA	Minnesota Pollution Control Agency
SID	Stressor Identification
SOE	Strength of Evidence
TMDL	Total Maximum Daily Load
WRAPS	Watershed Restoration and Protection Strategy
DO	Dissolved Oxygen
IWM	Intensive Watershed Monitoring
SOE	Strength of Evidence
TSS	Total Suspended Solids
NRCS	National Resource Conservation Service
AUID	Assessment Unit Identification
LRVW	Limited Resource Value Water
BOD	Biological Oxygen Demand
pH	potential of hydrogen
EPT	Taxa Richness of Ephemeroptera, Plecoptera, Trichoptera
POET	Taxa Richness of Plecoptera, Odonata, Ephemeroptera and Trichoptera
MSHA	Minnesota Stream Habitat Assessment
HBI_MN	Hilsenhoff Biotic Index adapted for Minnesota by Chirhart
HSPF	Hydrological Simulation Program FORTRAN
TIV	Tolerance Indicator Values
Hrs	hours
ug/L	microgram per liter
C	Degrees Celsius
NA	Not Assessed
Cr	Creek
Fk	Fork
Lk	Lake
MU	Modified Use
GU	General Use
CL	Confidence Limit

IBI	Index of Biotic Integrity
Mg/L	Milligrams per liter
RR	Rock Riffle
GP	Glide Pool
N	Nitrogen
FIBI	Fish Index of Biotic Integrity
MIBI	Macroinvertebrate Index of Biotic Integrity
TP	Total Phosphorous

Executive summary

Over the past few years, the Minnesota Pollution Control Agency (MPCA) has substantially increased the use of biological monitoring and assessment as a means to determine and report the condition of the state's rivers and streams. This basic approach is to examine fish and aquatic macroinvertebrate communities and related habitat conditions at multiple sites throughout a major watershed. From these data, an Index of Biological Integrity (IBI) score can be developed, which provides a measure of overall community health. If biological impairments are found, stressors to the aquatic community must be identified.

Stressor identification is a formal and rigorous process that identifies stressors causing biological impairment of aquatic ecosystems and provides a structure for organizing the scientific evidence supporting the conclusions (Cormier et al. 2000). In simpler terms, it is the process of identifying the major factors causing harm to aquatic life. Stressor identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act.

This report summarizes stressor identification work in the Watonwan River Watershed. There were 30 reaches identified with biological impairment in the Watonwan River Watershed. The impairments in this report are organized by 10-digit Hydrologic Unit Code (HUC). There are six HUCs discussed in this report.

After examining many candidate causes for the biological impairments, the following stressors were identified as probable causes of stress to aquatic life:

- Dissolved oxygen (DO)
- Eutrophication
- Nitrogen
- Sediments
- Physical habitat
- Altered hydrology
- Longitudinal connectivity

In the Watonwan Watershed, there were 19 stream reaches with fish and macroinvertebrate impairments, 10 with fish only and the remaining 1 with macroinvertebrate impairment only. A summary of the stressors identified in each stream reach is found at the end of this document, in Table 6.1

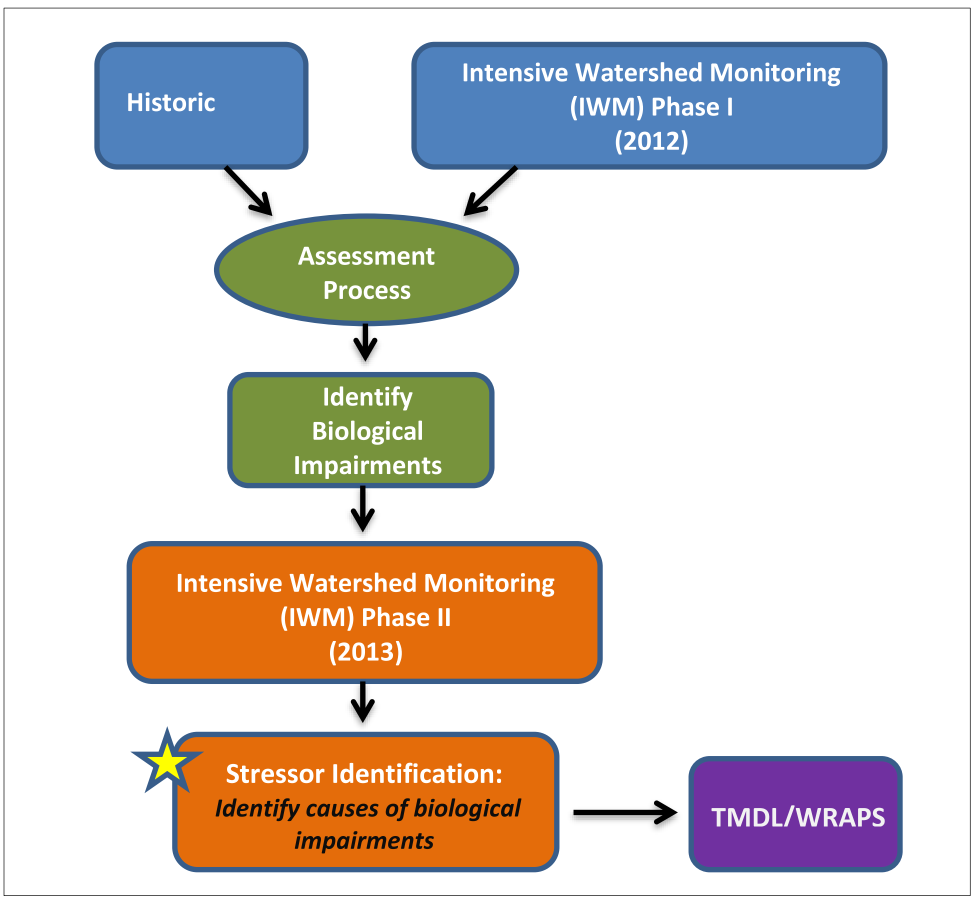
1. Introduction

1.1 Monitoring and assessment

Water quality and biological monitoring in the Watonwan River Watershed have been ongoing for four years. As part of the MPCA's Intensive Watershed Monitoring (IWM) approach, monitoring activities increased in rigor and intensity during the years of 2013-2014, and focused more on biological monitoring (fish and macroinvertebrates) as a means of assessing stream health. The data collected during this period, as well as historic data obtained prior to 2013, were used to identify stream reaches that were not supporting healthy fish and macroinvertebrate assemblages (Figure 1).

Once a biological impairment is discovered, the next step is to identify the source(s) of stress on the biological community. A Stressor Identification (SID) analysis is a step-by-step approach for identifying probable causes of impairment in a particular system. Completion of the SID process does not result in a finished Total Maximum Daily Load (TMDL) study. The product of the SID process is the identification of the stressor(s) for which the TMDL may be developed. In other words, the SID process may help investigators nail down excess fine sediment as the cause of biological impairment, but a separate effort is then required to determine the TMDL and implementation goals needed to restore the impaired condition.

Figure 1. Process map of Intensive Watershed Monitoring, Assessment, Stressor Identification and TMDL processes.

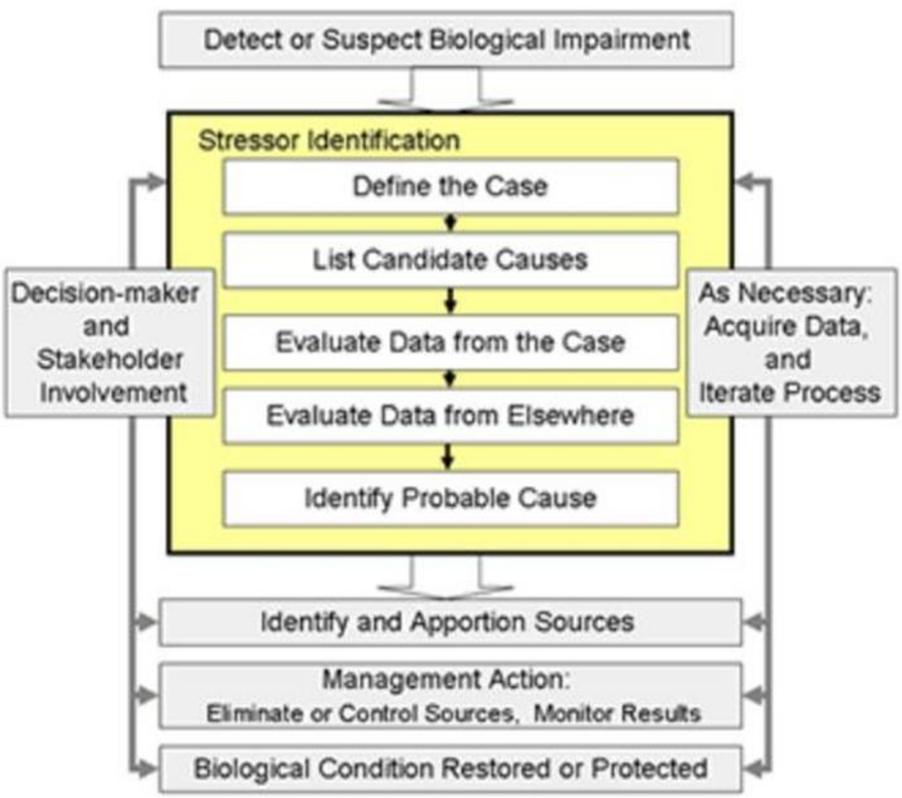


1.2 Stressor Identification Process

The MPCA follows the U. S. Environmental Protection Agency (EPA)'s process of identifying stressors that cause biological impairment, which has been used to develop the MPCA's guidance to stressor identification (Cormier et al. 2000; MPCA 2008). The EPA has also developed an updated, interactive web-based tool, the Causal Analysis/Diagnosis Decision Information System (CADDIS; EPA 2010). This system provides an enormous amount of information designed to guide and assist investigators through the process of Stressor Identification. Additional information on the Stressor Identification process using CADDIS can be found here: http://www.epa.gov/caddis/.

Stressor Identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act. SID draws upon a broad variety of disciplines and applications, such as aquatic ecology, geology, geomorphology, chemistry, land-use analysis, and toxicology. A conceptual model showing the steps in the SID process is shown in Figure 2. Through a review of available data, stressor scenarios are developed that aim to characterize the biological impairment, the cause, and the sources/pathways of the various stressors.

Figure 2. Conceptual model of Stressor Identification process (Cormier et al. 2000).



Strength of evidence (SOE) analysis is used to evaluate the data for candidate causes of stress to biological communities. The relationship between stressor and biological response are evaluated by considering the degree to which the available evidence supports or weakens the case for a candidate cause. Typically, much of the information used in the SOE analysis is from the study watershed (i.e., data from the case). However, evidence from other case studies and the scientific literature is also used in the SID process (i.e., data from elsewhere).

Developed by the EPA, a standard scoring system is used to tabulate the results of the SOE analysis for the available evidence (Table 8.1). A narrative description of how the scores were obtained from the evidence should be discussed as well. The SOE table allows for organization of all of the evidence, provides a checklist to ensure each type has been carefully evaluated and offers transparency to the determination process.

The existence of multiple lines of evidence that support or weaken the case for a candidate cause generally increases confidence in the decision for a candidate cause. The scoring scale for evaluating each type of evidence in support of or against a stressor is shown in Table 8.2. Additionally, confidence in the results depends on the quantity and quality of data available to the SID process. In some cases, additional data collection may be necessary to accurately identify the stressor(s) causing impairment. Additional detail on the various types of evidence and interpretation of findings can be found here: https://www.epa.gov/caddis-vol1/summary-tables-scores.

1.3 Common stream stressors

The five major elements of a healthy stream system are stream connections, hydrology, stream channel assessment, water chemistry and stream biology. If one or more of the components are unbalanced, the stream ecosystem may fail to function properly and is listed as an impaired water body. Table 1 lists the common stream stressors to biology relative to each of the major stream health categories.

Table 1. Common streams stressors to biology (i.e., fish and macroinvertebrates).

Stream Health	Stressor(s)	Link to Biology
Stream Connections	**Loss of Connectivity** • Dams and culverts • Lack of Wooded riparian cover • Lack of naturally connected habitats/causing fragmented habitats	Fish and macroinvertebrates cannot freely move throughout system. Stream temperatures also become elevated due to lack of shade.
Hydrology	**Altered Hydrology** **Loss of habitat due to channelization** **Elevated Levels of TSS** • Channelization • Peak discharge (flashy) • Transport of chemicals	Unstable flow regime within the stream can cause a lack of habitat, unstable stream banks, filling of pools and riffle habitat, and affect the fate and transport of chemicals.
Stream Channel Assessment	**Loss of Habitat due to excess sediment** **Elevated levels of TSS** • Loss of dimension/pattern/profile • Bank erosion from instability • Loss of riffles due to accumulation of fine sediment • Increased turbidity and or TSS	Habitat is degraded due to excess sediment moving through system. There is a loss of clean rock substrate from embeddedness of fine material and a loss of intolerant species.
Water Chemistry	**Low Dissolved Oxygen Concentrations** **Elevated levels of Nutrients** • Increased nutrients from human influence • Widely variable DO levels during the daily cycle • Increased algal and or periphyton growth in stream • Increased nonpoint pollution from urban and agricultural practices • Increased point source pollution from urban treatment facilities	There is a loss of intolerant species and a loss of diversity of species, which tends to favor species that can breathe air or survive under low DO conditions. Biology tends to be dominated by a few tolerant species.
Stream Biology	Fish and macroinvertebrate communities are affected by all of the above listed stressors	If one or more of the above stressors are affecting the fish and macroinvertebrate community, the IBI scores will not meet expectations and the stream will be listed as impaired.

1.4 Report format

This SID report follows a format to first summarize candidate causes of stress to the biological communities at the 8-digit HUC scale. Within the summary (Section 3), there is information about how the stressor relates broadly to the Watonwan River Watershed, water quality standards and general effects on biology. Section 4 is organized by impaired AUID (or candidate causes) and discusses the available data and relationship to fish and macroinvertebrate metrics in more detail.

2. Overview of Watonwan River Watershed

2.1 Background

The Watonwan River Watershed is the western most watershed in the Greater Blue Earth River Basin (GBERB). The Watonwan River, Blue Earth River and Le Sueur River make up the GBERB, which is a part of the greater Minnesota River Basin. The GBERB drains 2.3 million acres of land between Minnesota and Iowa (MPCA River Profile). The Watonwan River Watershed drains roughly 878 square miles of Blue Earth, Brown, Cottonwood, Jackson, Martin, and Watonwan counties. (DNR, 2014). St. James is the largest of 12 cities that lie within the watershed.

The watershed is heavily influenced by row crop agriculture, specifically corn and soybeans. Agriculture shaped the history of the watershed and now makes up 86% of its land use. Historically, 92.94% of the watershed's wetlands have been lost due to agricultural drainage and 76% of the watershed's waterways have been altered due to channelization for agricultural ditches.

The Watonwan River Watershed begins in Cottonwood County and flow east for 113 miles before joining with the Blue Earth River near the Rapidan Dam outside of Garden City. The Watonwan River consists of three branches: Watonwan River, South Fork Watonwan River and North Fork Watonwan River. Major tributaries contributing to the Watonwan River are Butterfield Creek, St. James Creek, Perch Creek and Willow Creek.

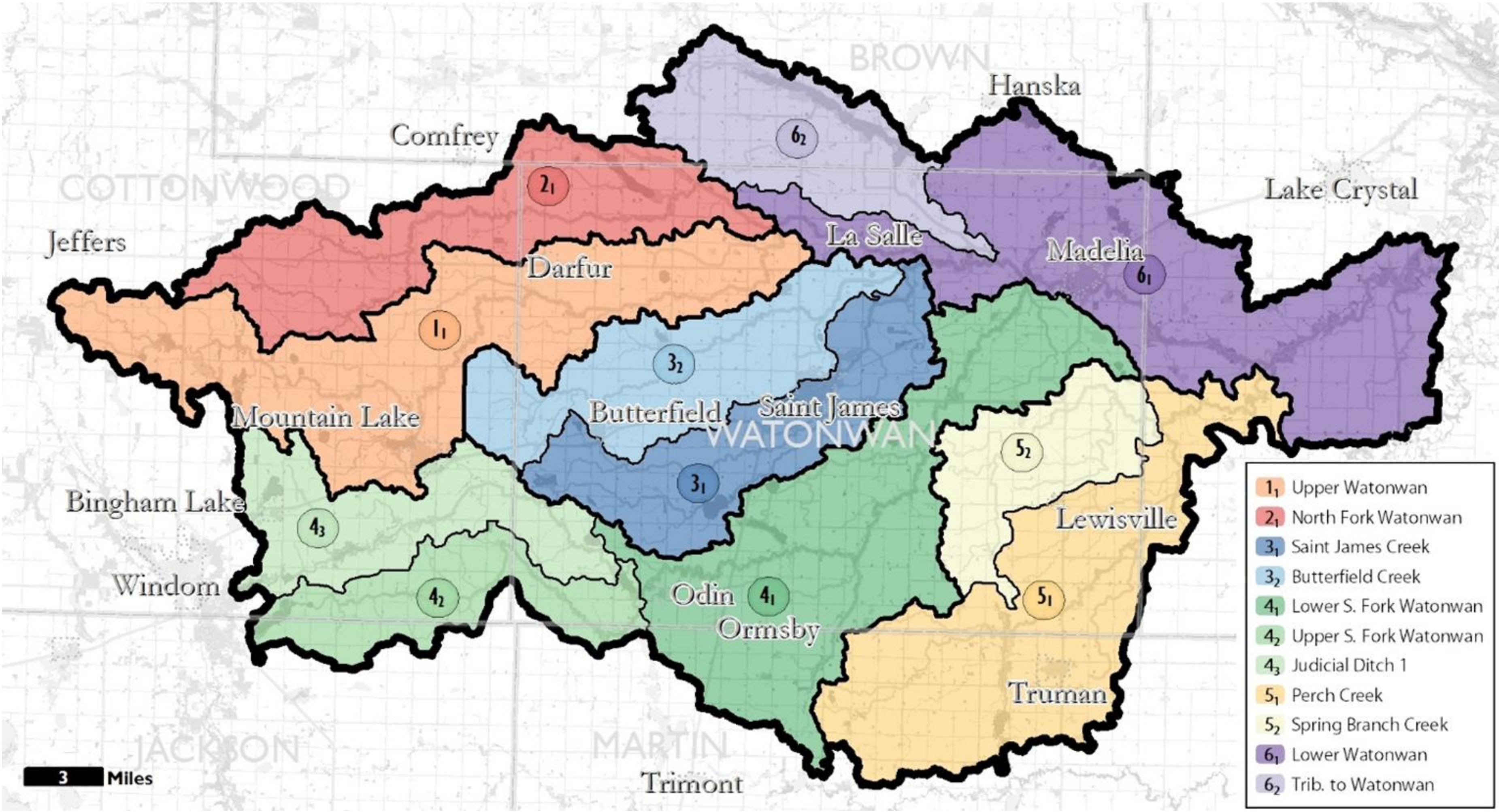
Creating the western boundary of the watershed is the Algona Moraine (a deposition of glacial debris), dividing the Watonwan River Watershed from the Des Moines River Watershed (DNR, 2014). Glacial till plains dominate the watershed with a mixture of clay, silt, sand and gravel. The now dry Lake Minnesota deposited a layer of clay on top of the glacial till (NRCS, 2007). In the eastern side of the watershed the geology shows a combination of till plains, glacial lake plains and moraines, resulting in poorly drained soil, which has contributed to intensive drain tiling in the watershed in an effort to increase agricultural production (NRCS, 2007).

Fishing is a popular recreational activity in the watershed, with walleye often caught on the mainstem Watonwan River. The Minnesota Department of Natural Resources (DNR) lists part of the Watonwan River as a State Water Trail encouraging canoers and kayakers to enjoy the nearly 30 miles of the Watonwan River's gentle currents from Madelia to Garden City.

2.1.1 Subwatersheds

Due to the watershed's overall size and the channelization network within the watershed, identifying the watershed's stressors required dividing the Watonwan River drainage into smaller subwatersheds to better characterize localized stressors. While there are some consistencies in physical and chemical stressors found throughout the Watonwan River Watershed, some stressors are acting more locally, driven by landscape characteristics specific to a certain region of the watershed. To address biological impairments within the Watonwan River, the watershed was organized in the same aggregated 12-digit HUC units used in the Watonwan River Monitoring and Assessment Report.

Figure 3. Map showing management units in the Watonwan River Watershed.



2.2 Monitoring Overview

Thirty-nine of the 72 established stream reaches in the watershed were assessed for aquatic life use, aquatic recreational use or both. Of the assessed streams, only five reaches fully supported aquatic life use; one of those five reaches also fully supported aquatic recreational use. All five of these AUIDs are modified use streams and are held to a lower standard for aquatic life integrity.

Throughout the watershed, a total of 30 AUIDs were non-supporting of aquatic life. Thirteen AUIDs do not support Aquatic recreation. Two limited resource value water (LRVW) AUIDs do not support reduced standards applicable to LRVW waters, due to extremely elevated bacteria levels.

No stream reaches underwent a list correction during assessments, new data available for comparison against old listings either still supported those listings or there were insufficient quantities of data to recommend changes to past impairment decisions.

The biological monitoring stations that led to aquatic life listing, and are included in this report, are mapped in Figure 4.

In addition to covering stressors of riverine impairments, this report also includes information regarding stressor identification of aquatic life impairments in the Watonwan River Watershed's lakes.

Six lakes were assessed with the Fish IBI Tools in the Watonwan River Watershed. Mountain, Bingham, and Long Lakes all had repeated nearshore surveys. St. James also had repeated nearshore and trapnet and gill net surveys, but only the 2009 survey was used for assessment.

This report will examine potential stressors for the five lakes with Fish IBI scores below the impairment threshold: Hanska, Mountain, Bingham, Fish (Jackson County), and Long (Watonwan County) Lakes (see figure below).

Figure 4. Map of monitoring stations and impairments in the Watonwan River Watershed.

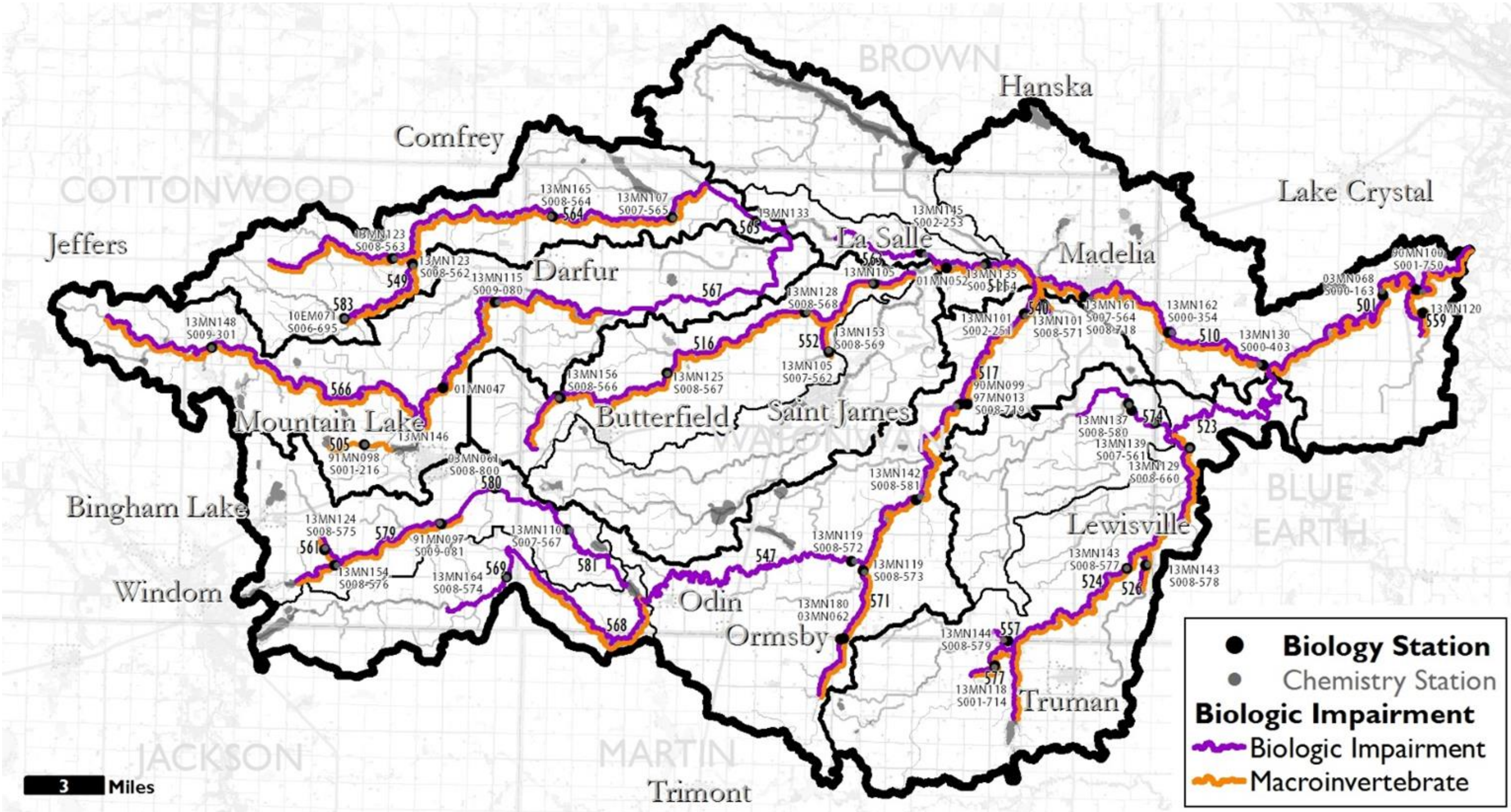
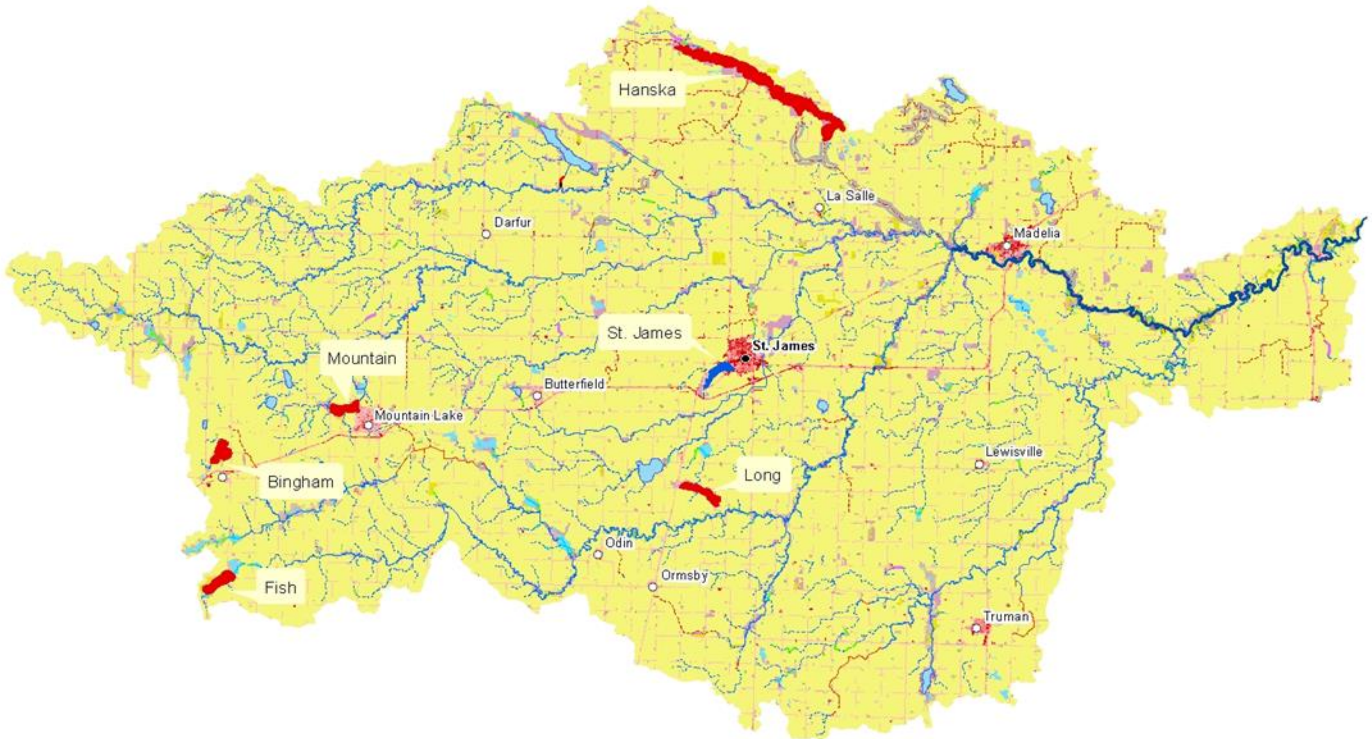


Figure 5. Map of lake aquatic life impairments in the Watonwan River Watershed.



2.3 Summary of biological impairments

The approach used to identify biological impairments includes assessment of fish and aquatic macroinvertebrates communities and related habitat conditions at sites throughout a watershed. The resulting information is used to develop an index of biological integrity (IBI). The IBI scores can then be compared to range of thresholds.

The fish and macroinvertebrates within each Assessment Unit Identification (AUID) were compared to a regionally developed threshold and confidence interval and utilized a weight of evidence approach. The water quality standards call for the maintenance of a healthy community of aquatic life. IBI scores provide a measurement tool to assess the health of the aquatic communities. IBI scores higher than the impairment threshold indicate that the stream reach supports aquatic life. Conversely, scores below the impairment threshold indicate that the stream reach does not support aquatic life. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of the waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, and land use, etc.

In the Watonwan River Watershed, 30 AUIDs are currently impaired for a lack of biological assemblage; 18 reaches were impaired for both fish and macroinvertebrates, 10 reaches for fish only impairments and one reach for a macroinvertebrate only impairment. Of the 30 impairments, seven were on modified reaches and 23 were on general use reaches (Table 2) In addition, five lakes are currently impaired for lack of fish assemblage (see table below).

Table 2. Biologically impaired AUIDs in the Watonwan River Watershed.

				Impairments	
10 Digit HUC	**Stream Name**	**AUID #**	**Reach Description**	**Biological**	**Water Quality**
Upper Watonwan	Unnamed Creek (Mountain Lake Inlet)	07020010-505	Headwaters to Mountain Lk	Macroinvertebrates (2015)	
Upper Watonwan	Watonwan River	07020010-566	Headwaters to T107 R33W S33, east line	Fish & Macroinvertebrates (2015)	Fecal Coliform & Turbidity (2006)
Upper Watonwan	Watonwan River	07020010-567	T107 R33W S34, west line to N Fk Watonwan R	Fish (2004)	Fecal Coliform & Turbidity (2006)
North Fork Watonwan River	Unnamed Creek	07020010-583	T106 R35W S1, west line to Unnamed cr	Fish & Macroinvertebrates (2015)	
North Fork Watonwan River	Unnamed Creek	07020010-549	Unnamed cr to N Fk Watonwan R	Fish & Macroinvertebrates (2015)	
North Fork Watonwan River	NF Watonwan River	07020010-564	Headwaters to T107 R32W S6, east line	Fish & Macroinvertebrates (2015)	*E coli* (2015), Turbidity (2006)

				Impairments	
10 Digit HUC	Stream Name	AUID #	Reach Description	Biological	Water Quality
North Fork Watonwan River	NF Watonwan River	07020010-565	T107 R32W S5, west line to Watonwan R	Fish (2015)	
St. James Creek	Unnamed Creek	07020010-552	CD 4 to Butterfield Cr	Fish & Macroinvertebrates (2015)	
St. James Creek	Butterfield Creek	07020010-516	Headwaters to St James Cr	Fish & Macroinvertebrates (2015)	*E coli* (2015) Turbidity (2008)
South Fork Watonwan	Unnamed Creek	07020010-561	Unnamed cr to JD 1	Fish & Macroinvertebrates (2015)	
South Fork Watonwan	JD 1	07020010-579	Headwaters to -94.9058 43.9095	Fish & Macroinvertebrates (2015)	
South Fork Watonwan	JD1	07020010-580	-94.9058 43.9095 to T105 R33W S7, east line	Fish (2006)	
South Fork Watonwan	JD1	07020010-581	T105 R33W S8, west line to Irish Lk	Fish (2015)	*E. coli* (2015)
South Fork Watonwan	South Fork Watonwan River	07020010-569	-94.9121 43.8594 to -94.8475 43.8813	Fish (2015)	
South Fork Watonwan	South Fork Watonwan River	07020010-568	-94.8475 43.8813 to Irish Lk	Fish & Macroinvertebrates	*E. coli* (2015)
South Fork Watonwan	South Fork Watonwan	07020010-547	Irish Lk to Willow Cr	Fish (2015)	Turbidity (2006)
South Fork Watonwan	Willow Creek	07020010-571	JD 4 to S Fk Watonwan R	Fish (2006), Macroinvertebrates (2015)	
South Fork Watonwan	South Fork Watonwan River	07020010-517	Willow Cr to Watonwan R	Fish & Macroinvertebrates (2015)	Fecal Coliform & Turbidity (2006)
South Fork Watonwan	Spring Brook	07020010-540	Unnamed ditch to S Fk Watonwan R	Fish & Macroinvertebrates (2015	
Perch Creek	Mink Creek	07020010-577	Unnamed cr to Perch Cr	Fish & Macroinvertebrates (2015)	
Perch Creek	Unnamed Creek	07020010-557	Unnamed cr to Perch Cr	Fish (2015)	

				Impairments	
10 Digit HUC	**Stream Name**	**AUID #**	**Reach Description**	**Biological**	**Water Quality**
Perch Creek	Perch Creek	07020010-524	Headwaters (Perch Lk 46-0046-00) to Spring Cr	Fish & Macroinvertebrates (2015)	Turbidity (2006)
Perch Creek	Unnamed Creek	07020010-526	T105 R30W S24, south line to Perch Cr	Fish & Macroinvertebrates (2015)	
Perch Creek	Spring Branch Creek	07020010-574	T106 R30W S22, west line to Perch Cr	Fish (2015)	*E. coli* (2015)
Perch Creek	Perch Creek	07020010-523	Spring Cr to Watonwan R	Fish (2015)	*E. coli* (2015)
Lower Watonwan	Watonwan River	07020010-563	T107 R31W S18, west line to Butterfield Cr	Fish (2015)	Fecal Coliform& Turbidity (2006)
Lower Watonwan	Watonwan River	07020010-511	Butterfield Cr to S Fk Watonwan R	Fish (2004), Macroinvertebrates (2015)	Fecal Coliform (2006) Turbidity (2006)
Lower Watonwan	Watonwan River	07020010-510	S Fk Watonwan R to Perch Cr	Fish & Macroinvertebrates (2015)	*E coli* (2015) Turbidity (2008)
Lower Watonwan	County Ditch 78	07020010-559	164th St to Watonwan R	Fish & Macroinvertebrates (2015)	
Lower Watonwan	Watonwan River	07020010-501	Perch Cr to Blue Earth R	Fish & Macroinvertebrates (2015)	Turbidity and Mercury (2002) Fecal coliform (1994)

Table 3. Biological assessment of lakes in the Watonwan River Watershed

D0W	Lake Name	County	Survey Year	Notes	DNR GIS Acres	Lake Type-IBI Tool	% Littoral	Fish IBI Score	Below Impairment Threshold	Above Impairment Threshold
08002600	Hanska	Brown	2012		1795	7	99	14	x	
17000300	Mountain	Cottonwood	2014	7/24/14 and 8/7/14 nearshore surveys	220	7	100	14, 14	x	
17000700	Bingham	Cottonwood	2010	8/23/10 and 9/13/2010 nearshore surveys	270	7	96	9, 9	x	
32001800	Fish	Jackson	2011		297	2*	50	36	x	
83004000	Long	Watonwan	2010	7/14/10 and 8/13/10 nearshore surveys	263	7	100	11, 12	x	
83004300	St. James	Watonwan	2009		203	7	100	39		x

*Note that Fish Lake is atypical of IBI Tool 2 lakes in that it is slightly shallower, further south and west, and more geographically isolated. The fish survey data from Fish Lake was also scored using the Tool 4 and 7 IBIs, the respective scores were below impairment thresholds for each of the Tool 4 and 7 tools.

The assessment process is a weight of evidence approach that takes biological response into account along with water chemistry, physical and exposure indicators when making decisions. An explanation for management decisions can be found in the Monitoring and Assessment Report.

Thirteen additional biological samples were collected in 2015 within the Watonwan River Watershed at seven unique stations. All seven stations were sampled for fish, while only six were sampled for macroinvertebrates (see table below). While a majority of the monitoring was conducted to gain additional information for SID investigations, one station was sampled as part of a random statewide study (EMAP) to better characterize water quality across the state of Minnesota.

Table 4. Biological stations sampled after initial IWM sampling including both for SID investigations and biological monitoring EMAP project.

Field Number	Site Location	Visit Date	Indicator Sampled	Project
01MN052	Downstream of CR 16, 5 mi. W of Madelia	8/11/2015	fish	SID
10EM071	Downstream of CSAH 9, 6 mi. NW of Mountain Lake	8/5/2015	fish	SID
10EM071	Downstream of CSAH 9, 6 mi. NW of Mountain Lake	8/6/2015	macroinvertebrates	SID
13MN105	Downstream of CSAH 27 (At 740th Ave), 2 mi. SW of La Salle	8/10/2015	fish	SID
13MN105	Downstream of CSAH 27 (At 740th Ave), 2 mi. SW of La Salle	8/26/2015	macroinvertebrates	SID
13MN118	Downstream of 240th St, 3 mi. W of Truman	7/15/2015	fish	SID
13MN118	Downstream of 240th St, 3 mi. W of Truman	8/26/2015	macroinvertebrates	SID
13MN133	Upstream of CSAH 1, 5 mi. Darfur	8/11/2015	fish	SID
13MN156	Downstream of 350th St, 2mi NW of Butterfield	7/15/2015	fish	SID
13MN156	Downstream of 350th St, 2mi NW of Butterfield	8/26/2015	macroinvertebrates	SID
15EM067	0.5 mi. downstream of CSAH 54, 2 mi. NW of Truman	7/7/2015	fish	EMAP
15EM067	0.5 mi. downstream of CSAH 54, 2 mi. NW of Truman	8/26/2015	macroinvertebrates	EMAP

Table 5. Fish classes with respective IBI thresholds and upper/lower confidence limits (CL) found in the Watonwan River Watershed.

Class	Class Name	GU IBI Thresholds	GU Upper CL	GU Lower CL	MU IBI Thresholds	MU Upper CL	MU Lower CL
1	Southern Rivers	39	50	28	NA	NA	NA
2	Southern Streams	45	54	36	35	44	26
3	Southern Headwaters	51	58	44	33	40	26
7	Low Gradient	40	50	30	15	25	5

Table 6. Macroinvertebrate classes with respective IBI thresholds and upper/ lower confidence limits (CL) found in the Watonwan River Watershed.

Class	Class Name	GU IBI Thresholds	GU Upper CL	GU Lower CL	MU IBI Thresholds	MU Upper CL	MU Lower CL
2	Prairie Forest Rivers	30.7	41.5	19.9	NA	NA	NA
5	Southern Streams RR	35.9	48.5	23.3	24	36.6	11.4
7	Prairie Streams GP	38.3	51.9	24.7	22	35.6	9.4

The purpose of stressor identification is to interpret the data collected during the biological monitoring and assessment process. Trends in the IBI scores can help to identify causal factors for biological impairments. The macroinvertebrate and fish IBI scores are shown in Table 7.

Table 7. Assessable Fish and macroinvertebrate IBI scores by biological station within AUID. Key to color-coding in table below.

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
Upper Watonwan River	07020010-505, Unnamed Creek (Mountain Lake Inlet)	91MN098	2001	**21.3**	3		
Upper Watonwan River	07020010-505, Unnamed Creek (Mountain Lake Inlet)	91MN098	2010	**35.6**	3	**9.1**	7
Upper Watonwan River	07020010-505, Unnamed Creek (Mountain Lake Inlet)	91MN098	2010			**14.7**	7
Upper Watonwan River	07020010-566, Watonwan River	13MN148	2013	**21.6**	7	Not sampled Insufficient Flow	
Upper Watonwan River	07020010-566, Watonwan River	13MN146	2013	**17.4**	2	**34.2**	7
Upper Watonwan River	07020010-566, Watonwan River	01MN047	2001	**24.8**	2	**32**	5
Upper Watonwan River	07020010-566, Watonwan River	01MN047	2013	**19.3**	2	**35.7**	5
Upper Watonwan River	07020010-566, Watonwan River	01MN047	2013	**37.6**	2		
Upper Watonwan River	07020010-566, Watonwan River	13MN115	2013	**25.5**	2	Not sampled Insufficient Flow	

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
Upper Watonwan River	07020010-567, Watonwan River	13MN166	2013	31.3	2	40.0	7
Upper Watonwan River	07020010-567, Watonwan River	97MN018	1997	49.9	2		
Upper Watonwan River	07020010-567, Watonwan River	13MN106	2013	32.5	2	43.0	7
North Fork Watonwan River	07020010-583, Unnamed Creek	10EM071	2010	59	3	26.5	5
North Fork Watonwan River	07020010-583, Unnamed Creek	10EM071	2013	45.1	3	16.3	5
North Fork Watonwan River	07020010-583, Unnamed Creek	10EM071	2015	47.2	3	25.3	5
North Fork Watonwan River	07020010-549, Unnamed Creek	13MN123	2013	42.1	3	36.4	7
North Fork Watonwan River	07020010-564, North Fork Watonwan River	13MN136	2013	49.1	3	9.8	7
North Fork Watonwan River	07020010-564, North Fork Watonwan River	13MN165	2013	30.3	2	47.5	7
North Fork Watonwan River	07020010-564, North Fork Watonwan River	13MN107	2013	28.4	2	40.6	7

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
North Fork Watonwan River	07020010-565, North Fork Watonwan River	13MN133	2013	29.6	2	37.6	7
North Fork Watonwan River	07020010-565, North Fork Watonwan River	13MN133	2015	63.2	2		
St. James Creek	07020010-552, Unnamed Creek	13MN153	2013	**0**	3	**4.9**	7
St. James Creek	07020010-516, Butterfield Creek	13MN156	2013	**33.5**	3	7.1	7
St. James Creek	07020010-516, Butterfield Creek	13MN156	2014	42.8	3	18.2	7
St. James Creek	07020010-516, Butterfield Creek	13MN156	2014	**28**	3	29.8	7
St. James Creek	07020010-516, Butterfield Creek	13MN156	2014	**28.4**	3		
St. James Creek	07020010-516, Butterfield Creek	13MN156	2015	**33.1**	3		
St. James Creek	07020010-516, Butterfield Creek	13MN125	2013	**43.5**	3	32.3	7
St. James Creek	07020010-516, Butterfield Creek	13MN125	2014	**42.6**	3	42.9	7
St. James Creek	07020010-516, Butterfield Creek	13MN125	2014	**35.6**	3		

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
St. James Creek	07020010-516, Butterfield Creek	13MN125	2014	**37.5**	3		
St. James Creek	07020010-516, Butterfield Creek	13MN128	2013	**32.2**	2	**31.2**	7
St. James Creek	07020010-516, Butterfield Creek	13MN128	2013	**48.9**	2	**33.9**	7
St. James Creek	07020010-516, Butterfield Creek	13MN128	2013	**52.5**	2		
St. James Creek	07020010-516, Butterfield Creek	13MN128	2014	**44.5**	2		
St. James Creek	07020010-516, Butterfield Creek	13MN128	2014	**51.5**	2		
St. James Creek	07020010-516, Butterfield Creek	13MN105	2013	**50.1**	2	**51.9**	7
St. James Creek	07020010-516, Butterfield Creek	13MN105	2013	**30**	2		
St. James Creek	07020010-516, Butterfield Creek	13MN105	2013	**20.5**	2		
St. James Creek	07020010-516, Butterfield Creek	13MN105	2014	**44**	2	**40.8**	7
St. James Creek	07020010-516, Butterfield Creek	13MN105	2014	**32**	2		
St. James Creek	07020010-516,	13MN105	2015	**35.8**	2	**22.3**	7

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
	Butterfield Creek						
South Fork Watonwan River	07020010-561, Spring Brook	13MN124	2013	NA	3	22.6	5
South Fork Watonwan River	07020010-561, Spring Brook	13MN124	2013	0	3	15.2	5
South Fork Watonwan River	07020010-579, Judicial Ditch 1	13MN154	2013	0	3	Not sampled, Insufficient flow	
South Fork Watonwan River	07020010-579, Judicial Ditch 1	13MN154	2013	0	3		
South Fork Watonwan River	07020010-579, Judicial Ditch 1	91MN097	2013	Non-reportable		17.2	5
South Fork Watonwan River	07020010-579, Judicial Ditch 1	91MN097	2014	2.5	2	29.8	5
South Fork Watonwan River	07020010-580, Judicial Ditch 1	03MN061	2003	0	2	11.4	7
South Fork Watonwan River	07020010-581, Judicial Ditch 1	13MN110	2013	38.4	2	42.1	5
South Fork Watonwan River	07020010-569, Spring Brook	13MN164	2013	23.4	3	Not sampled, Insufficient flow	
South Fork Watonwan River	07020010-568, South Fork Watonwan River	13MN109	2013	NA		29.9	5
South Fork Watonwan River	07020010-568, South Fork Watonwan River	13MN109	2014	32.3	2	25.2	5
South Fork Watonwan River	07020010-547, South Fork	13MN134	2013	25.1	2	35.7	7

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
	Watonwan River						
South Fork Watonwan River	07020010-547, South Fork Watonwan River	13MN134	2013			49.3	7
South Fork Watonwan River	07020010-571, Willow Creek	03MN062	2003	42.4	3		
South Fork Watonwan River	07020010-571, Willow Creek	13MN119	2013	27.3	2	35.2	7
South Fork Watonwan River	07020010-571, Willow Creek	13MN180	2013	5.3	3		
South Fork Watonwan River	07020010-517, South Fork Watonwan River	13MN142	2013	40.1	2	43	7
South Fork Watonwan River	07020010-517, South Fork Watonwan River	90MN099	2001	47.7	2		
South Fork Watonwan River	07020010-517, South Fork Watonwan River	90MN099	2002			54.9	7
South Fork Watonwan River	07020010-517, South Fork Watonwan River	90MN099	2010	59.7	2	41	7
South Fork Watonwan River	07020010-517, South Fork Watonwan River	90MN099	2010	59.9	2		
South Fork Watonwan River	07020010-517, South Fork Watonwan River	90MN099	2013	44.8	2	33.6	7

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
South Fork Watonwan River	07020010-517, South Fork Watonwan River	97MN013	1997	42.5	2		
South Fork Watonwan River	07020010-517, South Fork Watonwan River	13MN101	2013	43.9	2	34.8	7
South Fork Watonwan River	07020010-517, South Fork Watonwan River	13MN101	2014	39	2	49.9	7
South Fork Watonwan River	07020010-540, Spring Brook	13MN131	2013	38.9	3	33.5	7
Perch Creek	07020010-577, Mink Creek	13MN118	2013	28.3	3	36.4	7
Perch Creek	07020010-577, Mink Creek	13MN118	2015	31.1	3	Not sampled Insufficient Flow	
Perch Creek	07020010-557, Unnamed Creek (Judicial Ditch 72)	13MN144	2013	37.6	3	Not sampled Insufficient Flow	
Perch Creek	07020010-524, Perch Creek	13MN143	2013	0	2	39.4	7
Perch Creek	07020010-524, Perch Creek	13MN143	2014	59	2	Not sampled Insufficient Flow	
Perch Creek	07020010-524, Perch Creek	13MN129	2013	30.4	2	32.3	5
Perch Creek	07020010-526, Unnamed Creek	13MN158	2013	1.2	3	18.0	7
Perch Creek	07020010-574, Spring Branch Creek	13MN150	2013	15.7	7	29.7	7

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
Perch Creek	07020010-574, Spring Branch Creek	13MN137	2013	**20.1**	2	**40.1**	7
Perch Creek	07020010-574, Spring Branch Creek	13MN139	2013	**32.1**	2	**38.9**	7
Perch Creek	07020010-574, Spring Branch Creek	13MN139	2013	[redacted]		**37.7**	7
Perch Creek	07020010-523, Perch Creek	01MN015	2001	**43.7**	2	**39.2**	5
Perch Creek	07020010-523, Perch Creek	97MN011	1997	**42.9**	2	[redacted]	
Perch Creek	07020010-523, Perch Creek	97MN011	1998	**38.4**	2		
Perch Creek	07020010-523, Perch Creek	97MN011	2013	**41.2**	2	**40.7**	5
Lower Watonwan River	07020010-563, Watonwan River	13MN145	2013	**37.3**	2	**50.4**	7
Lower Watonwan River	07020010-563, Watonwan River	13MN145	2013	**36.5**	2	[redacted]	
Lower Watonwan River	07020010-511, Watonwan River	13MN135	2013	**50.5**	1	**35.1**	5
Lower Watonwan River	07020010-511, Watonwan River	13MN135	2013	**52.9**	1	[redacted]	
Lower Watonwan River	07020010-511, Watonwan River	01MN052	2001	**36.9**	1	**56.2**	7
Lower Watonwan River	07020010-511,	01MN052	2015	**28.1**	1	[redacted]	

	AUID & Reach	Station	Year	Fish IBI Score*	Fish Class	Macroinvertebrate IBI Score*	Macroinvertebrate Class
	Watonwan River						
Lower Watonwan River	07020010-510, Watonwan River	13MN161	2013	45	1	Not sampled, Insufficient flow	
Lower Watonwan River	07020010-510, Watonwan River	13MN161	2013	40.7	1		
Lower Watonwan River	07020010-510, Watonwan River	13MN162	2013	38.6	1	17.2	2
Lower Watonwan River	07020010-510, Watonwan River	13MN130	2013	41.8	1	14.4	2
Lower Watonwan River	07020010-559, County Ditch 78	13MN120	2013	53.5	3	38.2	7
Lower Watonwan River	07020010-501, Watonwan River	03MN068	2003	37.3	1	37.7	2
Lower Watonwan River	07020010-501, Watonwan River	03MN068	2013	37.5	1	16.0	2
Lower Watonwan River	07020010-501, Watonwan River	03MN068	2013	43.7	1	25.2	2
Lower Watonwan River	07020010-501, Watonwan River	90MN100	1990	NA	1		
Lower Watonwan River	07020010-501, Watonwan River	90MN100	2009	NA	1		

Table 8. Key to color-coded IBI scores.

≤ lower CL	> lower CL & ≤ Threshold	> threshold & ≤ upper CL	> upper CL	NA = Not available

IBI data utilized in the analysis of this report was collected from 54 unique stations over the years of 1990-2015. 90 fish visits and 63 macroinvertebrate visits produced IBI scores that could be utilized for stressor identification analysis in the Watonwan River Watershed.

Fish and macroinvertebrate IBI results were not always consistent within the same station or stream reach; there were instances where both indicators failed their respective IBI scores and others where one indicator met standards where the other did not. Overall, MIBI scores in the Watonwan River Watershed are worst in the upper reaches of the Watonwan River and in headwaters streams. Generally, most MIBI scores not meeting standards fall below the threshold but within lower confidence limits. Across the aggregated 10 subwatersheds, MIBI scores tend to improve moving downstream as stream size and drainage area increases. However, this does not hold true on the mainstem of the Watonwan River in its lowest reaches where conditions deteriorated moving towards the watershed's outlet. Fish results showed similar trends in most of the subwatersheds with lowest IBI scores observed in the headwaters with improvements made moving downstream. This did not hold true in the North Fork Watonwan subwatershed where standards were met in the headwaters, decreased moving downstream and then rose back within the lower confidence limits before joining the mainstem Watonwan. On the mainstem Watonwan, there was only one passing FIBI score in all of the visits at all of the stations. FIBI results were worst in the upper reaches and improved moving downstream but were still below the threshold but within lower confidence limits. Fish and macroinvertebrate IBI data will be discussed in more detail in Section 4 of the report.

3. Possible stressors to biological communities

A list of potential stressors to aquatic biological communities compiled by the EPA can be found here https://www.epa.gov/caddis-vol2/learn-about-stressors. This list serves two purposes. First, it can serve as a checklist for investigators to consider all possible options for impairment in the watershed of interest. Second, it can be used to identify potential stressors that can be eliminated from further evaluation. In some cases, the data may be inconclusive and limit the ability to confidently determine if a stressor is causing impairment to aquatic life. It is imperative to document if a candidate cause was suspected, but there was not enough information to make a scientific determination of whether or not it is causing harm to aquatic life. In this case, management decisions can include modification of sampling plans and future evaluation of the inconclusive case. Alternatively, there may be enough information to conclude that a candidate cause is not causing biological impairment and therefore can be eliminated. The inconclusive or eliminated causes will be discussed in more detail in the following section.

3.1 Eliminated causes

There were no causes eliminated from the Watonwan River Watershed.

3.2 Inconclusive causes (insufficient information)

Some candidate causes were not considered further due to the lack of understanding of the linkage between the potential stressor and the biological community; and/or there was not enough data available. The potential causes that were inconclusive across the Watonwan River Watershed were ammonia, conductivity, chloride and stream temperature.

Ammonia

Unionized ammonia concentrations were evaluated throughout the Watonwan River Watershed where data was available. For a majority of the watershed, unionized ammonia concentrations were well below standards. Elevated concentrations of unionized ammonia were identified on the mainstem Watonwan River in the early 1970s; however, more recent datasets from the mid-2000s show that concentrations have declined in recent years and are now meeting standards. However, there was not a large dataset available for analysis. One elevated concentration of unionized ammonia was identified within the Butterfield Creek system, while the dataset was limited within the reach, additional investigation is warranted to better characterized the potential stressor. Given the limited quantity of current information available, ammonia is generally an inconclusive stressor in the watershed at this time.

Chloride and conductivity

Chloride and conductivity concentrations were also evaluated throughout the Watonwan River Watershed where data was available. While concentrations were within normal ranges for much of the watershed, elevated conductivity readings were observed with the highest reading being 8340 ug/L on Butterfield Creek (AUID -516). Three reaches had specific conductance readings exceeding 1600 ug/L. While there was limited paired chloride data available, where data was present readings were well below the 230 mg/L standard. Additional investigation of these three reaches may be helpful in eliminating conductivity and chloride as a potential stressor within these reaches. Given the limited quantity of current information available, conductivity is generally an inconclusive stressor in the watershed at this time.

Stream temperature

Stream temperature data was reviewed across the watershed where data was available. Many of the warmwater stations had continuous temperature data collected from YSI sondes, or HOBO temperature loggers. The information in the table below summarizes the high-resolution temperature information available for warmwater reaches in the Watonwan Watershed. None of the data suggest a daily average that exceeds 30 degrees C, which is the current temperature standard. Some sites had short durations where the temperature was above 30 degrees C. Stream temperature should continue to be monitored in these areas, because stream temperature can influence other parameters and cause stress indirectly. The current information does not link temperature as a direct stressor in any warmwater stream in the Watonwan River Watershed. Due to the information summarized in this table, and discrete temperature measurements taken throughout the watershed, it can be concluded that temperature is an unlikely stressor to the warmwater systems of the Watonwan River and therefore each warmwater stream reach did not go through additional temperature related stressor analysis.

Table 9. Summary of available high-resolution temperature data for warmwater streams in the Watonwan River Watershed.

Site	AUID/Stream	Year Collected	Data Type	Dates	Maximum Temperature Recorded °C	Max Time >30°C	July Average Temperature	August Average Temperature
91MN098	-505 Unnamed Inlet to Mountain Lake	2015	YSI Sonde	7/31 - 8/6	21.9	NA	NA	NA
91MN098	-505 Unnamed Inlet to Mountain Lake	2016	YSI Sonde	8/23 - 9/7	26.58	NA	NA	NA
13MN161	-510 Watonwan River	2015	YSI Sonde	7/31 - 8/6	22.83	NA	NA	NA
13MN162	-510 Watonwan River	2013	HOBO	5/14 - 6/22 & 7/22 - 9/15	28.518	NA	20.87	22.25
13MN135	-511 Watonwan River	2013	HOBO	5/17 - 9/15	27.801	NA	22.28	21.74
13MN105	-516 Butterfield Creek	2015	YSI Sonde	7/23 - 7/30	28.29	NA	NA	NA
13MN128	-516 Butterfield Creek	2015	YSI Sonde	7/23 - 7/30	27.6	NA	NA	NA
13MN156	-516 Butterfield Creek	2015	YSI Sonde	7/24 - 7/30	25.95	NA	NA	NA

Site	AUID/Stream	Year Collected	Data Type	Dates	Maximum Temperature Recorded °C	Max Time >30°C	July Average Temperature	August Average Temperature
13MN125	-516 Butterfield Creek	2016	YSI Sonde	8/10 - 8/23	28.95	NA	NA	NA
13MN156	-516 Butterfield Creek	2016	YSI Sonde	8/10- 8/23	27.27	NA	NA	NA
13MN105	-516 Butterfield Creek	2013	HOBO	5/14 - 9/12	**30.419**	2.75 hrs	21.39	22.3
13MN125	-516 Butterfield Creek	2013	HOBO	5/16 - 8/27	29.89	NA	21.43	21.07
13MN128	-516 Butterfield Creek	2013	HOBO	5/16 - 7/25	28.965	NA	21.53	NA
13MN156	-516 Butterfield Creek	2013	HOBO	5/15 -9/15	**31.382**	4.5 hrs	21.12	21.47
13MN101	-517 South Fork Watonwan River	2013	HOBO	5/17 - 8/19	28.295	NA	22.44	20.14
97MN013	-517 Watonwan River	2015	YSI Sonde	7/31 - 8/6	25.38	NA	NA	NA
97MN011	-523 Perch Creek	2013	HOBO	5/13 - 7/25	**30.95**	6 hrs	24.2	NA
13MN143	-524 Perch Creek	2016	HOBO	7/31 -9/13	28.369	NA	22.35	22.29

Site	AUID/Stream	Year Collected	Data Type	Dates	Maximum Temperature Recorded °C	Max Time >30°C	July Average Temperature	August Average Temperature
13MN158	-526 Watonwan River	2015	YSI Sonde	8/10 - 8/17	**30.72**	2 hrs	NA	NA
13MN136	-546 Watonwan River	2015	YSI Sonde	7/31 - 8/6	27.48	NA	NA	NA
13MN123	-549 Unnamed Creek	2016	YSI Sonde	8/10 - 8/23	29.39	NA	NA	NA
13MN123	-549 Unnamed Creek	2016	HOBO	6/28 – 9/13	29.215	NA	20.75	21.57
13MN145	-563 Watonwan River	2013	HOBO	5/15 - 9/15	29.19	NA	22.2	22.09
13MN107	-564 North Fork Watonwan River	2013	HOBO	5/17 - 9/16	27.628	NA	21.53	21.35
13MN148	-566 Watonwan River	2016	YSI Sonde	8/23 - 9/7	25.39	NA	NA	NA
13MN106	-566 Watonwan River	2013	HOBO	5/16 - 7/13	29.065	NA	22.52	NA
13MN115	-566 Watonwan River	2016	HOBO	6/28 – 11/15	**30.976**	2 hrs	22.38	22.26

Site	AUID/Stream	Year Collected	Data Type	Dates	Maximum Temperature Recorded °C	Max Time >30°C	July Average Temperature	August Average Temperature
13MN148	-566 Watonwan River	2016	HOBO	6/28 – 11/15	28.345	NA	22.94	20.57
97MN018	-567 Watonwan River	2015	YSI Sonde	7/31 - 8/6	27.27	NA	NA	NA
13MN109	-568 South Fork Watonwan River	2013	HOBO	5/23 - 9/11	28.791	NA	21.61	21.09
13MN109	-568 Watonwan River	2015	YSI Sonde	7/16 - 7/23	28.64	NA	NA	NA
13MN109	-568 Watonwan River	2016	YSI Sonde	8/23 - 9/7	24.12	NA	NA	NA
13MN164	-569 Spring Brook	2016	YSI Sonde	8/23 - 9/7	23.75	NA	NA	NA
13MN164	-569 Watonwan River	2015	YSI Sonde	7/16 -7/23	**30.31**	1.75 hrs	NA	NA
13MN119	-571 Willow Creek	2016	HOBO	6/28 – 9/7	26.94	NA	19.88	20.42
13MN139	-574 Spring Branch Creek	2013	HOBO	5/13 - 9/15	**32.253**	8 hrs	21.8	23.17
91MN097	-579 Judicial Ditch 1	2016	HOBO	6/28 – 9/13	28.94	NA	22.03	22.24

Site	AUID/Stream	Year Collected	Data Type	Dates	Maximum Temperature Recorded °C	Max Time >30°C	July Average Temperature	August Average Temperature
03MN061	-580 Watonwan River	2015	YSI Sonde	8/10 - 8/17	**33.79**	7 .5 hrs	NA	NA
13MN110	-581 Watonwan River	2015	YSI Sonde	8/10 - 8/17	27.14	NA	NA	NA
10EM071	-583 Unnamed Creek	2016	YSI Sonde	8/10 - 8/23	29.71	NA	NA	NA

3.3 Summary of Candidate Causes in the Watonwan River Watershed

Eleven candidate causes were selected as possible drivers of biological impairments in the Watonwan River Watershed. The list of candidate causes was then narrowed down after initial data evaluation resulting in seven candidate causes for final analysis in this report. The seven remaining candidate causes are:

- Dissolved oxygen (DO)
- Eutrophication
- Nitrate
- Total suspended solids (TSS)
- Habitat
- Altered hydrology
- Connectivity

Background information specific to candidate causes/stressors in Minnesota can be found here. This information provides an overview of the pathway and effects of each candidate stressor considered in the biological stressor identification process with relevant data and water quality standards specific to Minnesota. The EPA has additional information, conceptual diagrams of sources and causal pathways, and publication references for numerous stressors on its CADDIS website.

3.3.1 Overview of dissolved oxygen in the Watonwan River Watershed

DO was measured at multiple locations in the Watonwan River Watershed. All biological monitoring stations had at least one point measurement collected during the biological sampling visits. Additional point measurements were gathered during SID investigations. Instantaneous (one moment in time) DO data was collected at many locations and used as an initial screening for low DO reaches. Because DO concentrations can vary significantly with changes in flow conditions and time of sampling, conclusions using instantaneous measurements need to be made with caution and are not completely representative of the DO regime at a given site. Where a potential low DO problem or biological response to low DO conditions was apparent, additional diurnal DO measurements were taken by deploying sondes (a submerged electronic sampling device) for roughly 1-2 week intervals during the late summer months. This continuous sampling provides a large quantity of measurements to reveal the magnitude and pattern of DO flux at a site, capturing daily minimum and maximum concentrations.

Continuous DO monitoring was collected at 17 unique locations from 2015-2016. Additionally, four stations had continuous DO monitoring collected in multiple years. Additional continuous DO monitoring was planned during the summer of 2016; however, consistent elevated flows throughout the summer were not conclusive for seeking low DO data at all desired stations in 2016.

Currently, there are not any reaches in the Watonwan River Watershed that are designated impaired for aquatic life due to low DO concentrations. However, low DO conditions do exist in the watershed and are having negative impacts on the fish and macroinvertebrate communities. Low DO was identified as a stressor to the macroinvertebrate community on a single reach in the Perch Creek subwatershed at Unnamed Creek (526). Low DO was an inconclusive stressor to one or both indicators on an additional 22 reaches in the Watonwan River Watershed.

High water conditions in the late summer of 2015 likely impeded the ability to identify all reaches with probable low DO conditions. Additional continuous DO monitoring in the watershed would be useful to better tease out other low DO stressors within the watershed.

This data showed for the most part that low DO conditions, along with high daily DO conditions were more often present in areas dominated by agriculture. High levels of phosphorus were frequently found in these reaches leading to increased productivity and eutrophication.

3.3.2 Overview of eutrophication in the Watonwan River Watershed

Grab samples for phosphorous were collected during all fish visits during biological sampling. Additional chemical data assisted in understanding the magnitude and duration of phosphorous concentrations under various conditions and are summarized in this report for each AUID. DO flux data was reviewed where continuous DO data was available. Continuous DO monitoring was collected at 31 different locations from 2012-2015. Additionally, two sites had continuous DO monitoring collected in multiple years.

Eutrophication was identified as a stressor on a single reach, Butterfield Creek (516), in the St. James Creek subwatershed. It was found to be an inconclusive stressor in all remaining reaches across the Watonwan River Watershed. Elevated phosphorous concentrations were identified across the watershed; however, limited response variable data was available to conclusively identify eutrophication as a stressor across much of the watershed.

High flow conditions during the summer of 2016 were not conducive to excessive plant and algal growth as one might typically expect in late summer months in streams with eutrophication issues. Future observations should be made on impaired reaches in the watershed to obtain this evidence as this additional information would be useful in better understanding potential eutrophication across the Watonwan River Watershed.

3.3.3 Overview of nitrogen in the Watonwan River Watershed

Nitrate data were collected at each biological station on the same date as fish sampling. Additional chemical data assisted in understanding the magnitude and duration of nitrate concentrations under various conditions and are summarized in this report for each AUID.

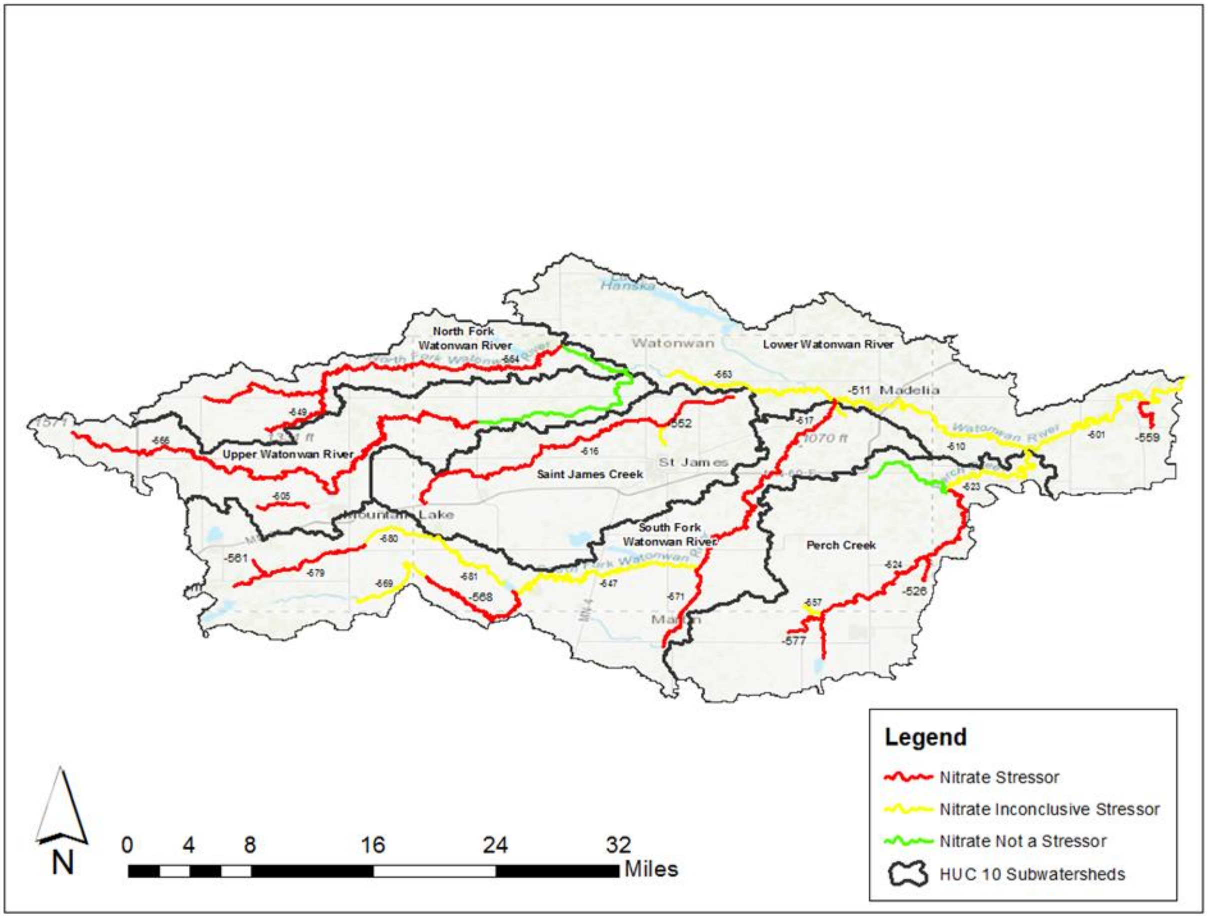
Nitrogen was identified as a stressor in 15 of the 30 impaired reaches covered in this report. Twelve additional reaches were identified as inconclusive to nitrate stress and require additional information to clarify potential stress in the reach. Nitrate stress was identified across all six subwatersheds but was not generally observed on the mainstem of the Watonwan River, rather the stressor was widespread in the headwaters reaches that feed the mainstem Watonwan.

Elevated nitrate concentrations coincide with widespread agriculture within the watershed. The transport of nitrate to streams in the watershed is largely sourced from agricultural lands, which are tile drained. The statewide nitrogen study (MPCA 2013) describes tile drainage as the largest pathway for nitrates to reach surface waters. This is further evidenced by the nitrate concentrations analyzed in the watershed, which show high concentrations in the spring months (May and June) when flows are higher and tiles are contributing more water and nitrate to the system. When flow is reduced in late summer, concentrations drop significantly.

Overall, fish lack strong biological response evidence in relation to elevated nitrate concentrations. Better metric relationships have been made with respect to macroinvertebrate impairment and nitrate concentration. In warmwater streams, fish lack a strong biological response to elevated nitrogen concentrations, but can show some response with the percentage of sensitive fish species compared to tolerant fish species. Macroinvertebrate metrics that often respond to elevated nitrate include, taxa count, the presence of sensitive Trichoptera (including non-hydropsychids), and intolerant taxa and individuals. In addition, there are tolerance values and metrics specific to nitrate that can be analyzed given the macroinvertebrate community composition. The percentage of nitrate tolerant individuals can indicate higher nitrate concentrations may exist.

Biological stress due to nitrate has been identified in multiple reaches in this watershed (see figure below).

Figure 6. Nitrate stress in the Watonwan River Watershed by biologically impaired reach.



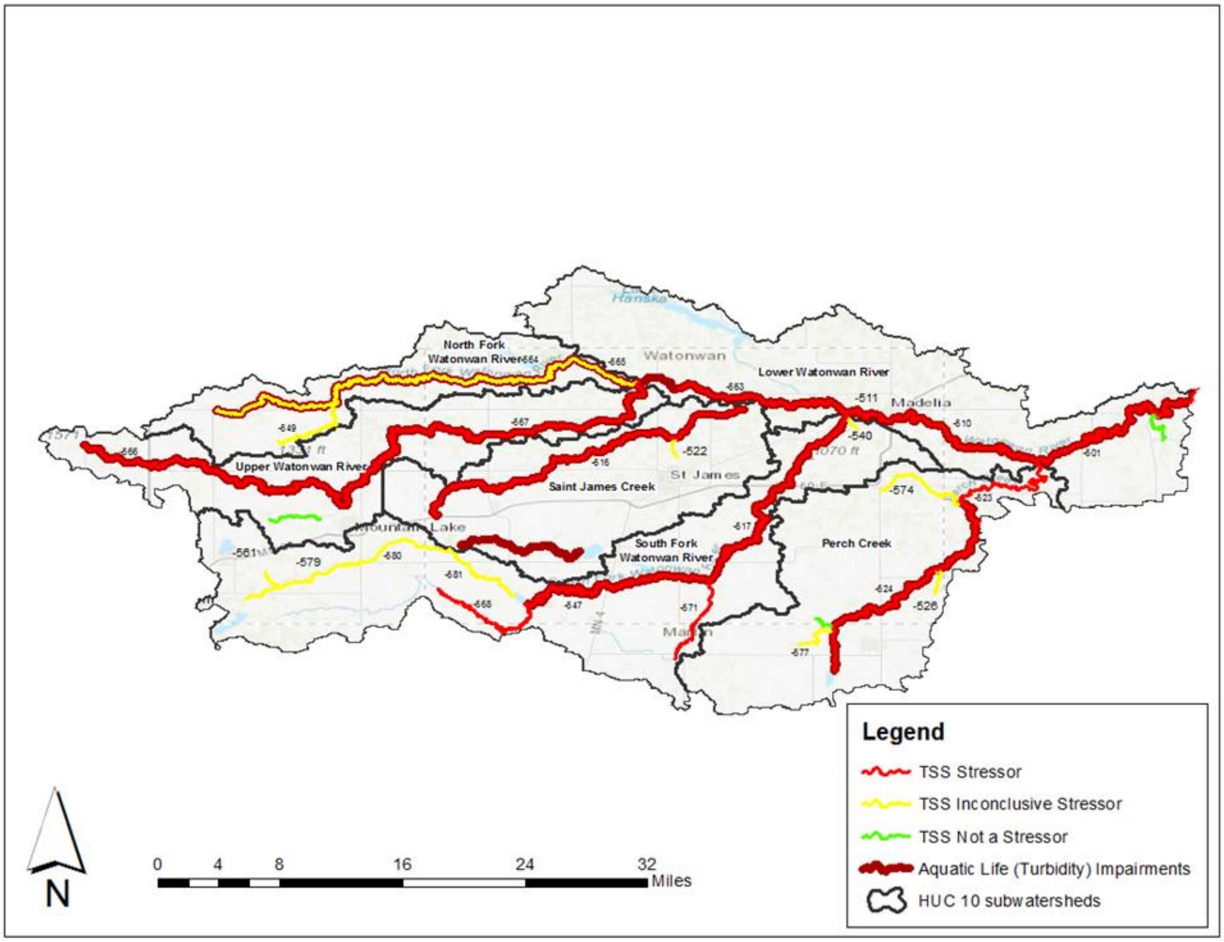
3.3.4 Overview of sediments in the Watonwan River Watershed

TSS and TSVS data were collected at each biological station on the same date as fish sampling. Secchi tube measurements were collected at all biological visits. Additional chemical data assisted in understanding the magnitude and duration of nitrate concentrations under various conditions and are summarized in this report for each AUID. Longitudinal secchi readings were collected during elevated flow events on reaches with identified elevated suspended sediment levels.

The macroinvertebrate and fish communities were analyzed and a TIV score was created for each site. The lower the score, the more sensitive the community is to TSS, as the score increases so does the TSS tolerance of the community. Fish and macroinvertebrates that are tolerant to TSS can also be tolerant of many other stressors, which is why multiple lines of evidence are used to support determination of stressors. Multiple biological metrics were analyzed for fish and macroinvertebrates to help determine if TSS may be impacting the communities.

There are currently 10 aquatic life impairments associated with excess levels of turbidity in the Watonwan River drainage. Overall, 13 reaches in the Watonwan were identified as being stressed by TSS and 14 were inconclusive in terms of TSS stress. TSS stress was most apparent in reaches with greater drainage area and more inconclusive in the headwaters reaches where TSS datasets were more limited.

Figure 7. TSS stress in the Watonwan River Watershed by biologically impaired reach.



3.3.5 Overview of physical habitat in the Watonwan River Watershed

Reviewing stream habitat characteristics within the Watonwan River Watershed is an essential tool when understanding and describing the biological communities and their conditions. Habitat was measured using the [Minnesota Stream Habitat Assessment (MSHA)] during the fish-sampling event. The MSHA is useful in describing the aspects of habitat needed to obtain an optimal biological community. It includes five subcategories: land use, riparian zone, substrate, cover, and channel morphology.

Stream habitats within the Watonwan River Watershed are generally a reflection of a heavily altered landscape by anthropogenic activities. While pockets of good habitat conditions exist where streams remain unaltered, natural reaches show signs of degradation by upstream channel modifications and landuse alterations. Habitat conditions were often lowest in areas dominated by agriculture. Increasing use of drain tile, animal pasturing and lack of riparian buffer are frequent causes of the poor habitat conditions.

All 30 impaired reaches described in this document found degraded habitat conditions to be stressors to their respective biological communities.

3.3.6 Overview of altered hydrology and connectivity in the Watonwan River Watershed

Many anthropogenic changes can alter stream channels and flow regime, while dams create impoundments, all of which can lead to a change in the habitat structure and connectivity of a stream system. Increasing discharge in a watershed and changes in discharge regulation can also have biological impacts. This all can affect plant, fish, and macroinvertebrate diversity and richness. The conceptual model for physical connectivity including Altered Hydrology as a candidate stressor can be found on the EPA CADDIS webpage here.

Altered hydrology and channelization are widespread across the Watonwan River Watershed, most extensive alteration is found in the headwaters reaches but is also present at least intermittently on within the Watonwan's major tributaries. Altered hydrology refers to any activity that alters the discharge patterns of a stream and local flow characteristics associated with structural habitat changes. In the Watonwan, altered hydrology encompasses multiple aspects including factors such as stream channelization, tile drainage, impoundments and perched culverts. These varying factors can have varying impacts to the biological community, and are explained further in each stream section.

Data collected to analyze potential altered hydrology concerns in the watershed included: site visits and observations made at up and downstream road crossings, review of altered water course layer and aerial imagery, analysis of photographs taken during low flow conditions by the biological monitoring crew in the fall of 2012 to determine if altered hydrological conditions may have contributed to intermittent flow or dry stream reaches and review of flow data where present.

Twenty-one reaches within the watershed were identified as being limited by altered hydrology stress in the watershed while nine were found to be inconclusive. Altered hydrology stress was most prevalent in higher up in the watershed in headwaters reaches where low or no flow conditions were identified during the fall of 2012. The collection of additional flow data at reaches where altered hydrology was deemed inconclusive to better understand the potential of altered hydrology to be impacting these reaches and provide additional evidence for the stressor.

Connectivity refers to the physical connections in a stream that have been disrupted. For the purposes of this report, connectivity refers to the longitudinal connections, like dams or perched culverts, which can also affect the flow regime and limit natural biological migrations that are critical to the life cycles of some fish and mussel taxa.

Data analyzed to determine potential longitudinal connectivity concerns in the watershed included: desktop reconnaissance of aerial imagery, observations made at road crossings to identify potential high and low flow barriers due to culverts, rock dams and human made structures that may limit fish passage, review of fish species lists at all biological visits to identify known migratory taxa and comparison of species lists to up and downstream reaches and analysis of mussel taxa lists collected by DNR across the watershed to identify potential barriers as many mussel taxa are reliant on migratory fish to complete their life cycles.

Six reaches were identified in the watershed as being stressed due to longitudinal connectivity; an additional 11 were inconclusive and will require additional field investigation under late summer low flow conditions to better understand whether or not potential barriers due to road crossings and culverts are present.

High flows during the late summer and fall of 2016 limited the ability to conduct culvert surveys and make observations during low flow culvert observations that may be useful in better understanding the potential for under or oversized culverts or misplaced culverts to be limiting fish passage and longitudinal connectivity during periods of high or low flow. Additional investigation within the watershed should include these surveys to better characterize the potential of connectivity stress where inconclusive determinations were made during this study.

Figure 8. Altered Hydrology stress in the Watonwan River Watershed by biologically impaired reach.

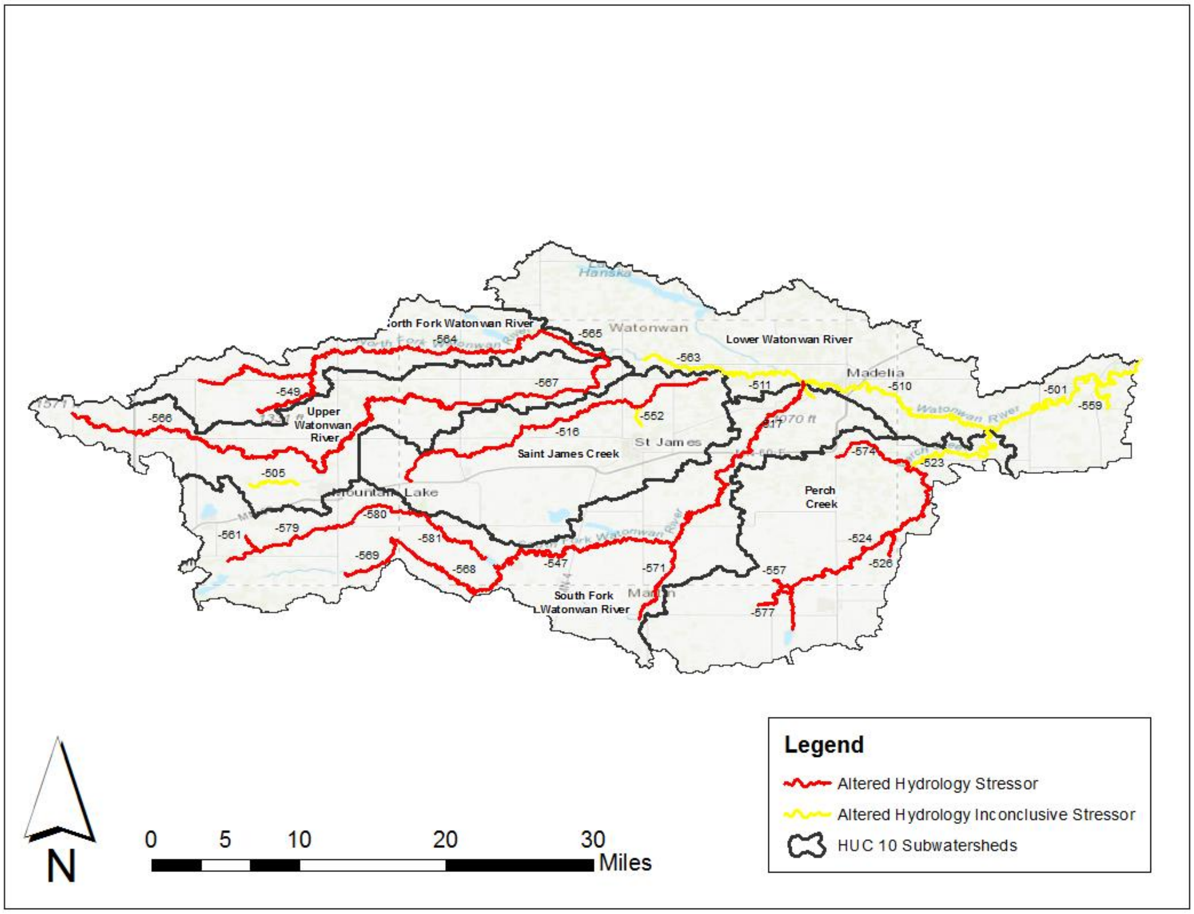
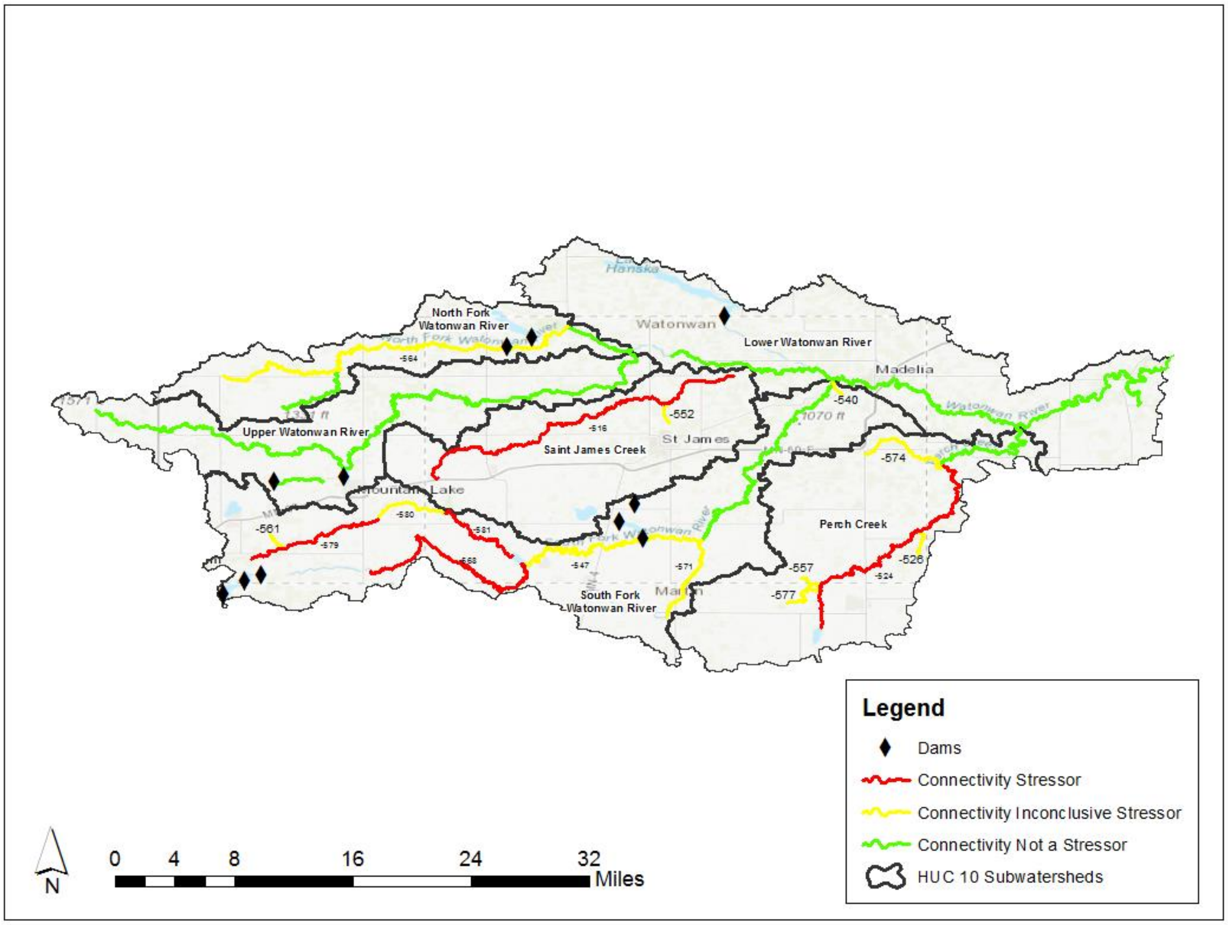


Figure 9. Connectivity stress in the Watonwan River Watershed by biologically impaired reach.



Increasing precipitation and climate change may also be a factor contributing to Altered Hydrology issues. Despite a rising trend in precipitation over the last 20 years across much of Minnesota, rainfall in the central region, where the Watonwan River is located, has not risen at a statistically significant rate over the last 20 years ((MPCA, 2016). The past 100 years of precipitation, though have shown a significant rising trend (p=0.001) that matches similar trends throughout Minnesota for the same period (MPCA, 2016).

Figure 10. Precipitation trends in south central Minnesota (1995-2014) with five-year running average.

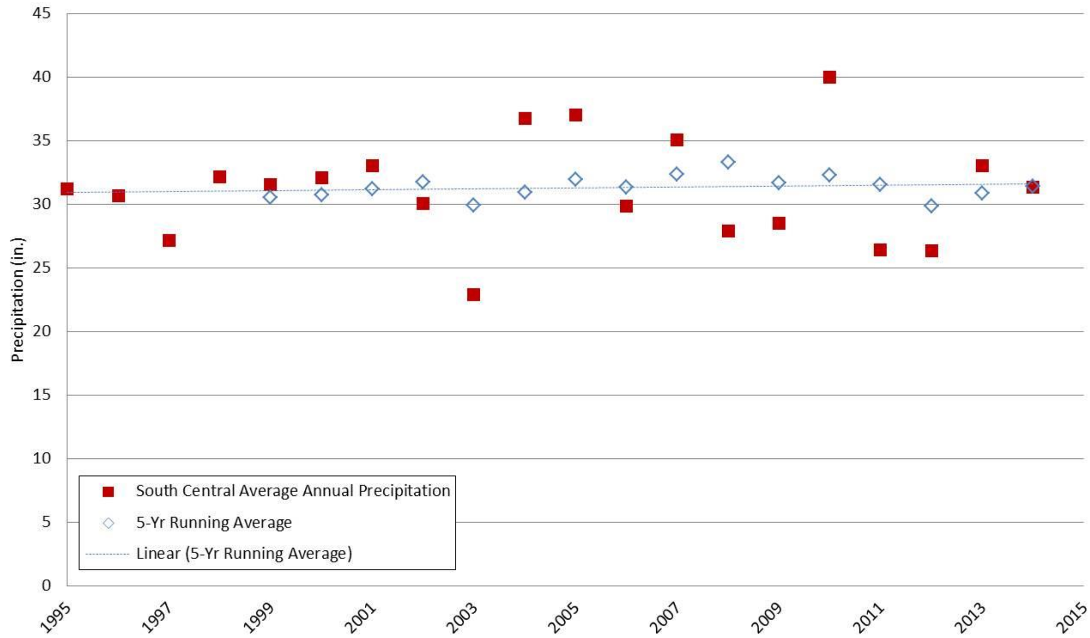
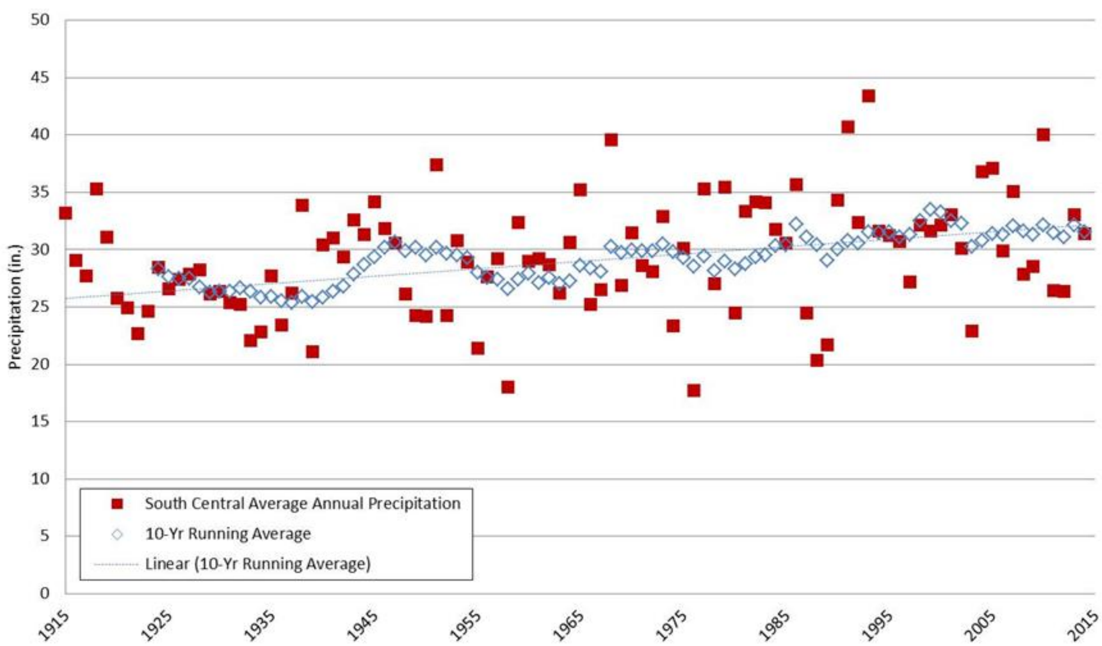
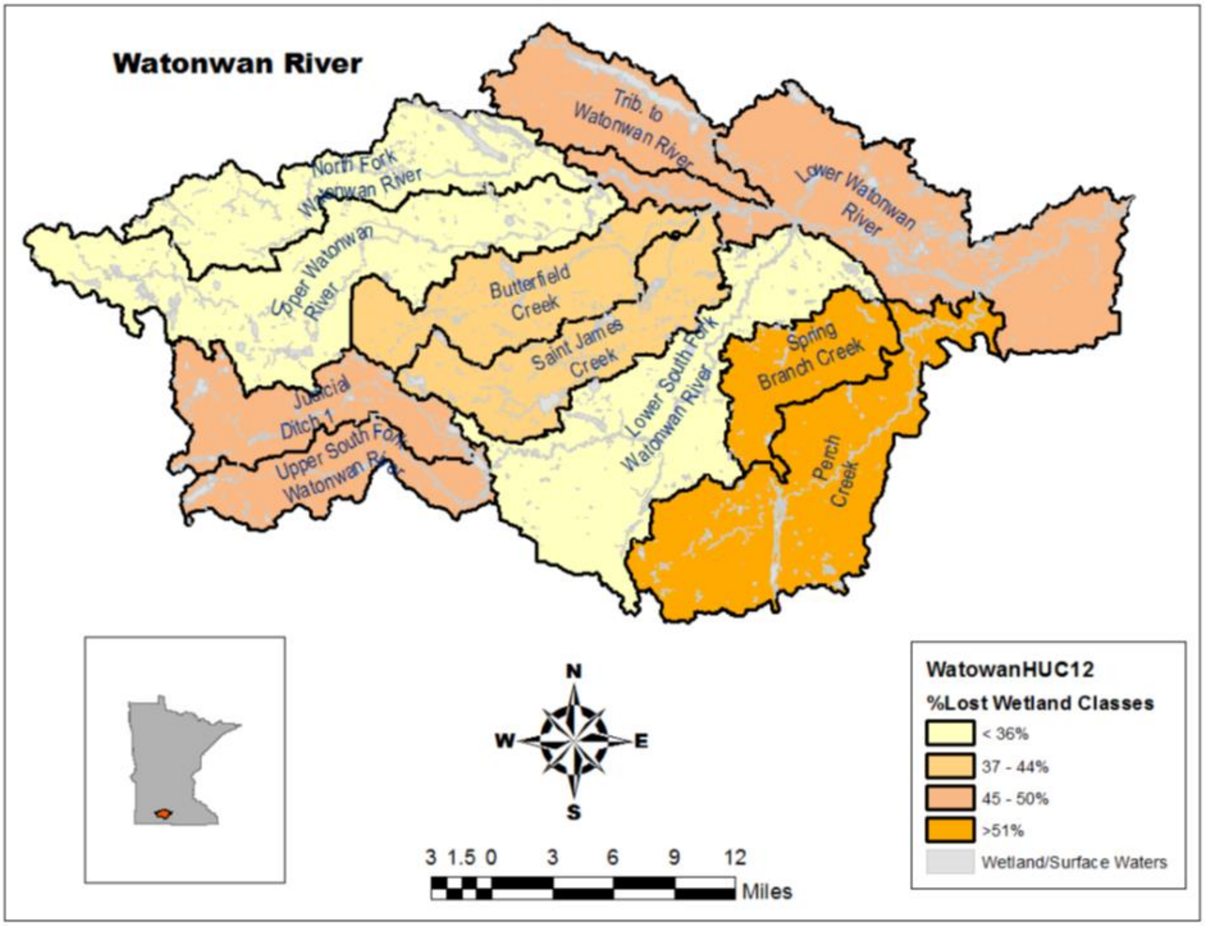


Figure 11. Precipitation trends in south central Minnesota (1915-2014) with 10-year running average.



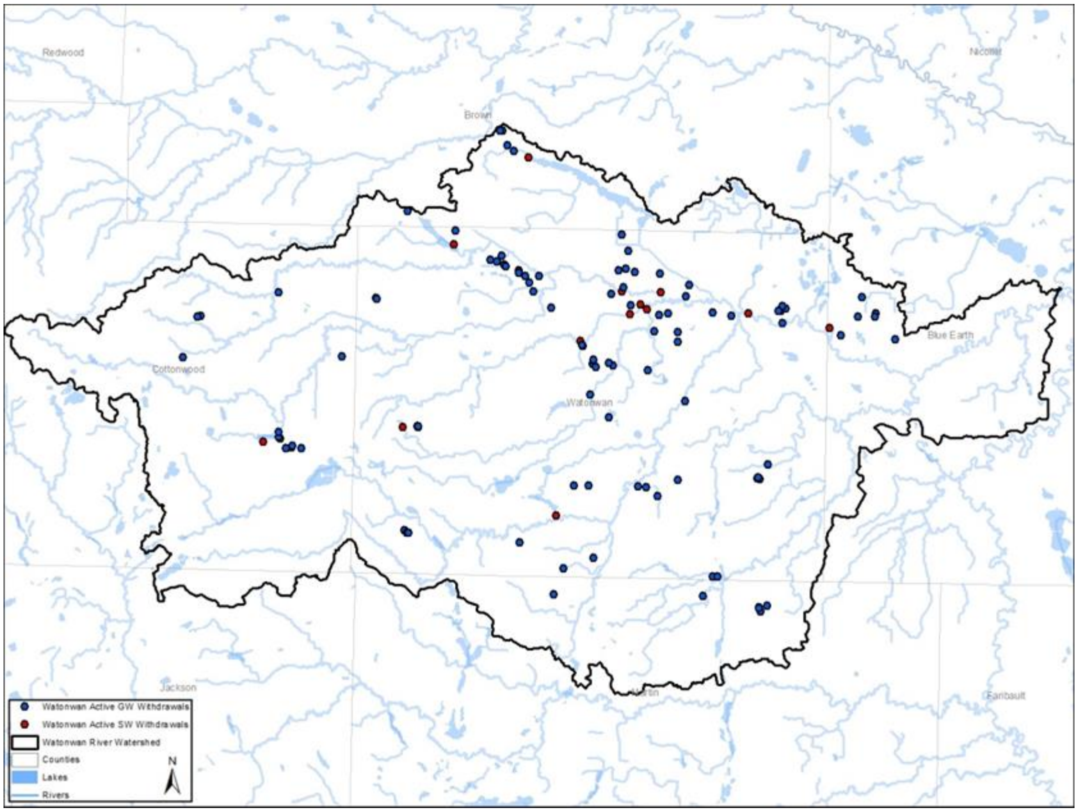
Loss of water storage on the landscape can also contribute to altered hydrology stress in a watershed. The figure below provides estimates of wetland loss in the Watonwan River drainage. Wetland loss in the landscape is significant because it reduces the amount of water that can potentially be stored on the landscape. This in turn increase stream flows during storm events as water that would have been otherwise held back by wetlands has more ready access to the watersheds drainage systems, which leads to stream bed scouring and stream bank erosion.

Figure 12. Estimated historic wetland loss in each HUC12 subwatershed, based on analysis of SSURGO drainage class data selected on "Very Poorly" and "Poorly" drained soil map units.



In addition to loss of water storage in the Watonwan River Watershed, there has been a rise of high capacity groundwater withdrawals across the drainage, which is also likely contributing to low flow conditions observed during the fall of 2012. There are currently 110 active permitted groundwater withdrawals and 14 active permitted surface water withdrawals within the Watonwan River Watershed (Figure 13) (MPCA, 2016).

Figure 13. Active permitted groundwater and surface water withdrawals in the Watonwan River Watershed.



From 1994 to 2013, groundwater withdrawals within the Watonwan River Watershed exhibit a very significant increasing trend (p=0.001) (Figure 14), while surface water withdrawals exhibit a statistically significant trend (p=0.01) (Figure 15) (MPCA, 2016). Efforts to better manage groundwater withdrawals in the watershed are needed especially during drought periods to maintain sufficient baseflow in the Watonwan River drainage for the health of aquatic biological communities.

Figure 14. Total annual groundwater withdrawals in the Watonwan River Watershed (1994-2013).

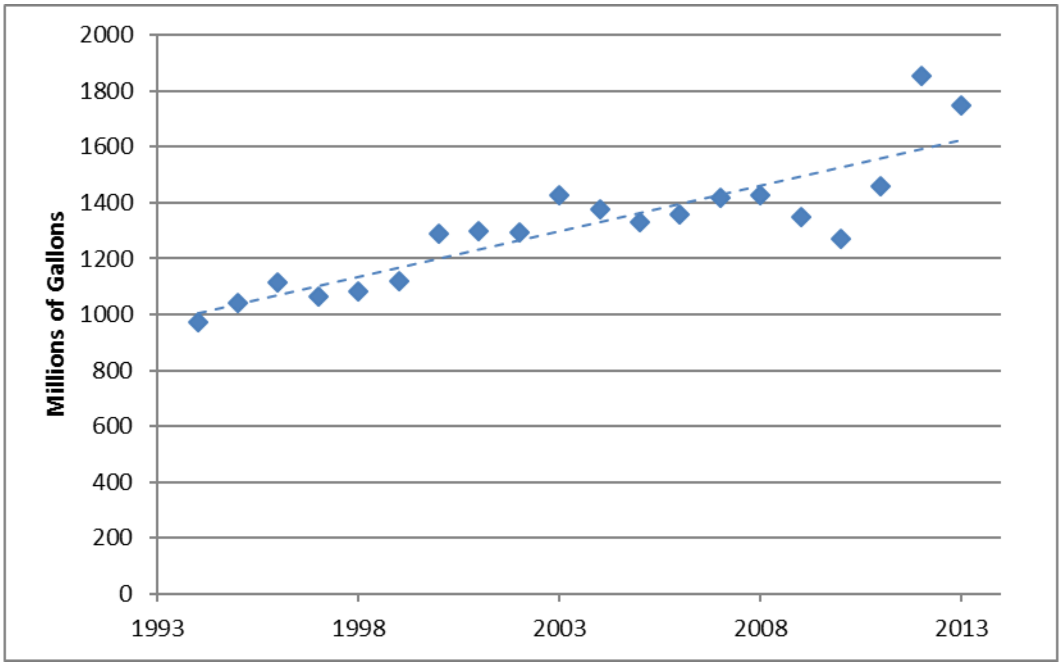
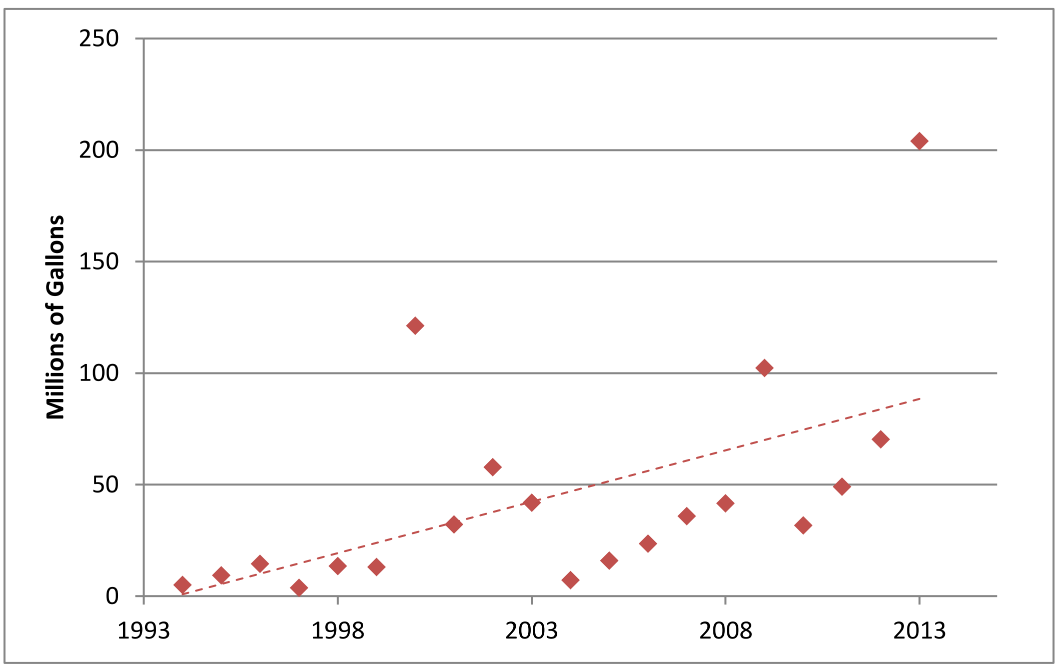


Figure 15. Total annual surface water withdrawals in the Watonwan River Watershed (1994-2013).



Tying into wetland losses, and increases in groundwater withdrawals, mean summer flows have decreased significantly from 1993-2013 at the monitoring station on the lower Watonwan River near Garden City (July at p=0.10 and August at p=0.01) (Figure 16) (MPCA, 2013). In contrast, mean annual discharge has not decreased at a statistically significant rate but mean summer flows have decreased significantly over that time period (July at p=0.10 and August at p=0.01) (Figure 17) (MPCA, 2016). This indicates that the annual water budget of the Watonwan River is moving through the watershed earlier in the year increasing stream flows and power in the spring months, contributing to increased erosion and sedimentation while flows diminish in the late summer months leaving stream water levels at unhealthy levels for biological communities.

Figure 16. Mean monthly discharge for July and August, Watonwan River near Garden City (1993-2013).

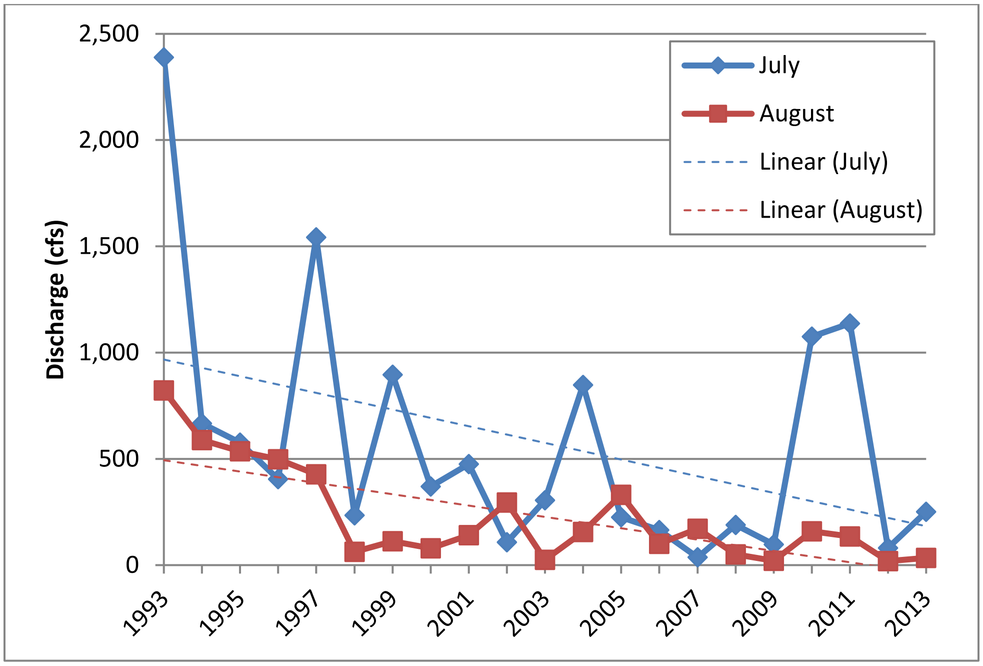
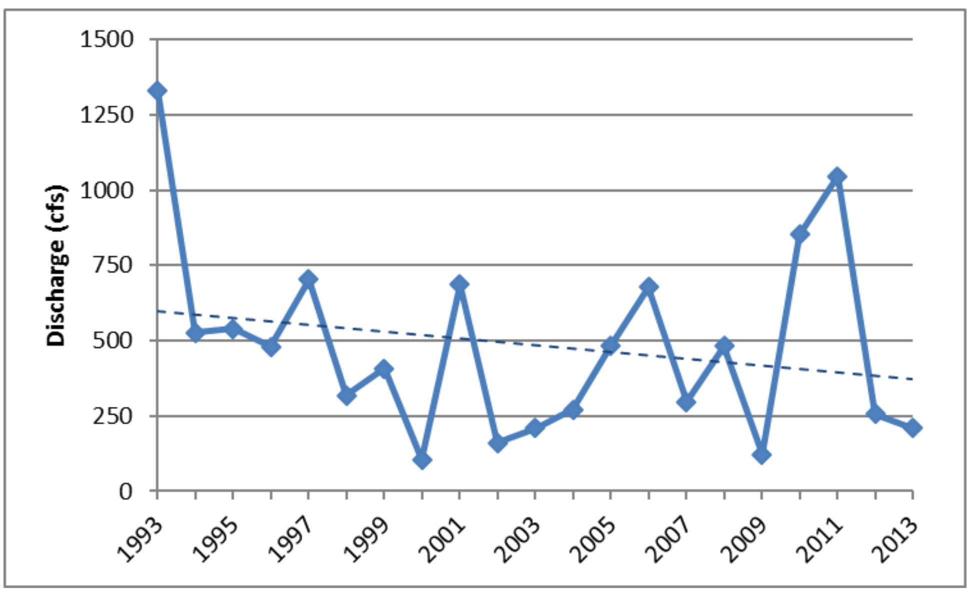


Figure 17. Mean annual discharge, Watonwan River near Garden City (1993-2013).

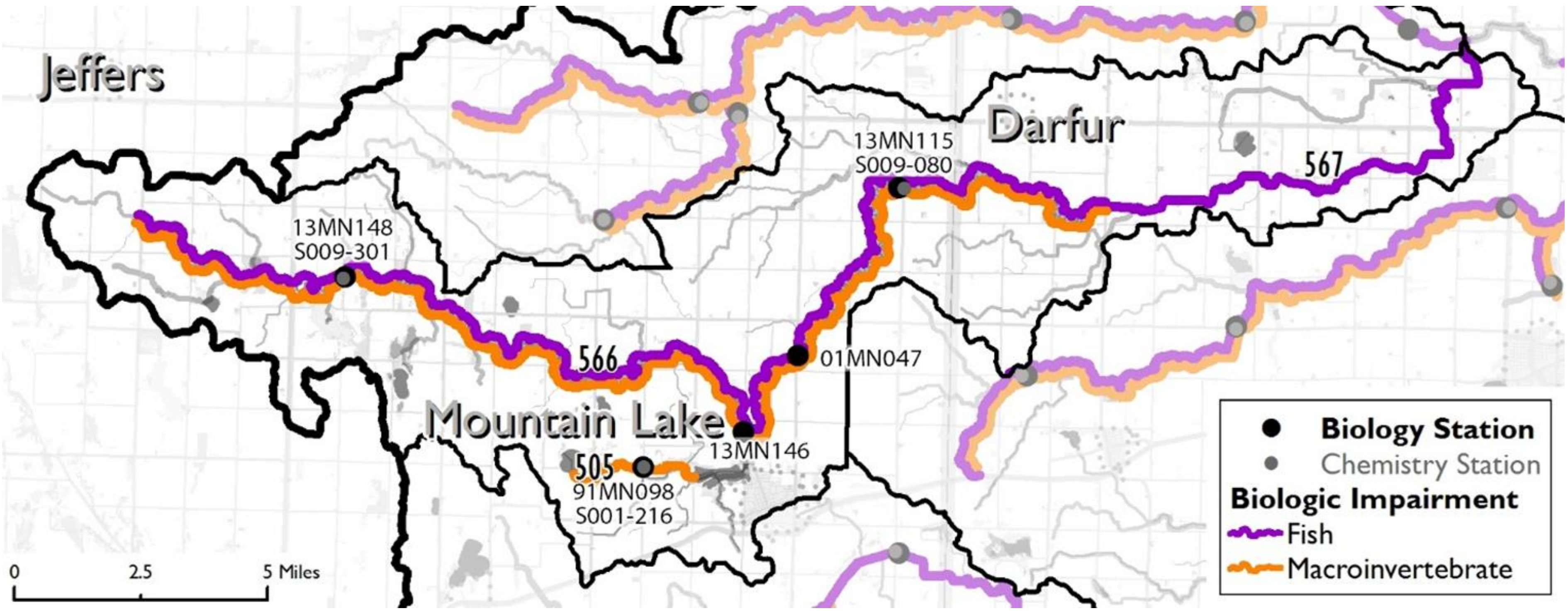


4. Evaluation of Candidate Causes of Stream Investigations organized by AUID

Upper Watonwan River

The Upper Watonwan HUC 10 watershed includes the headwaters of the Watonwan River. The Watonwan River flows west to east starting near Jeffers and flowing past Mountain Lake and Darfur before its confluence with the North Fork of the Watonwan River.

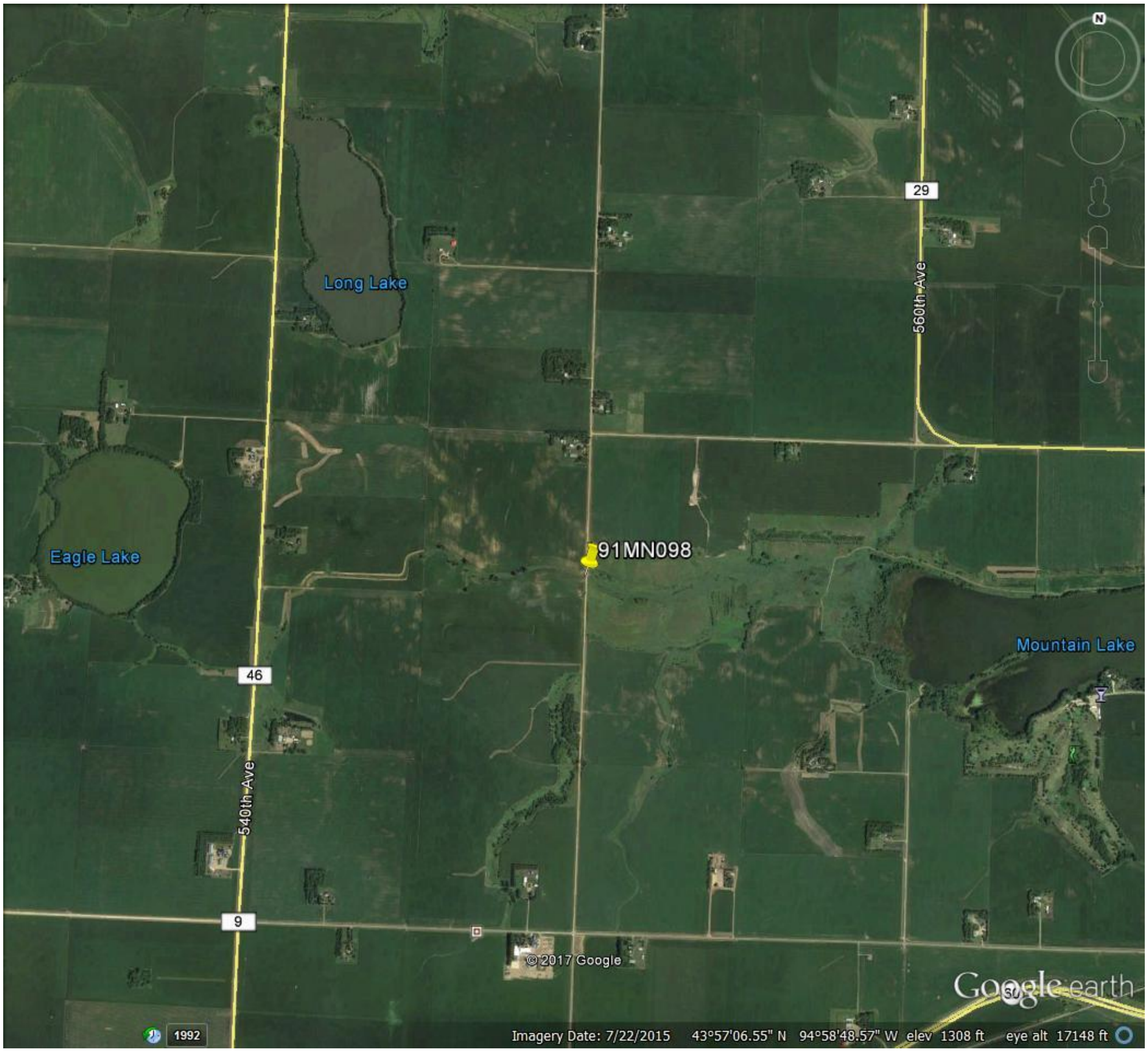
Figure 18. Biological impairment map of the Upper Watonwan River subwatershed.



4.1 Unnamed Creek (Mountain Lake Inlet) -505

Unnamed Creek (07020010-505) begins at the outlet of Eagle Lake and flows 3.2 stream miles east ultimately discharging to Mountain Lake. This reach is classified as modified use warmwater 2Bm. The reach is impaired for aquatic life for macroinvertebrate assemblage.

Figure 19. Google Earth image of Unnamed Creek (Mountain Lake Inlet) (-505).



4.1.1 Biological communities

91MN098 is the only biological station within the reach. Macroinvertebrates were sampled twice in 2010, scoring 14.7 and 9.1 respectively; both visits were below the threshold but within the lower confidence interval for modified use for the Southern Headwaters Class.

Both samples fell well below standards for overall species counts, quantities of clinger (ClingerCh) and collector filterer taxa, lacked intolerant taxa (Intolerant2Ch) and had low richness of POET and non-hydropsychid Trichoptera taxa (TrichopteraChTxPct) (see graph below). Both communities were hyper dominated by Micropsecta followed by Thienemannimyia. Additional abundant species in the samples included Physa (snails) and Oligochaete (worms).

91MN098 was sampled for fish in 2009 and 2010; results were just above modified use standards. The fish community was hyper-dominated by fathead minnows and lacked sensitive taxa (Sensitive). Some lake species were present (see table below).

Figure 20. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 91MN098, Unnamed Creek (Mountain Lake Inlet).

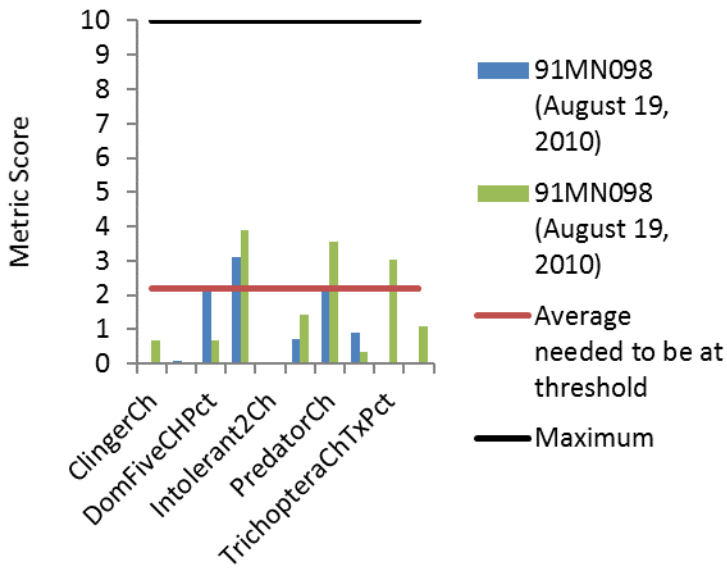
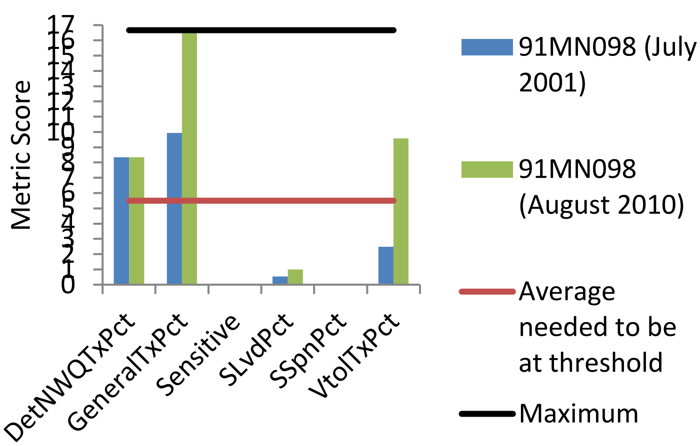


Figure 21. Fish metrics of the Southern Headwaters Class IBI for station 91MN098, Unnamed Creek (Mountain Lake Inlet).



4.1.2 Data evaluation for each Candidate Cause

Dissolved oxygen

There were four DO measurements collected during biological sampling at 91MN098 on August 12, 1991, July 30, 2001, July 9, 2009 and August 11, 2010. Two values were just above the 5 mg/L standard at 5.5 mg/L and 5.7 mg/L respectively. There were seven additional measurements taken in 2016 that ranged from 7.54 mg/L to 11.46 mg/L.

Low DO readings suggested a potential for low DO within the reach. At station 91MN098, a YSI sonde was deployed from July 31 to August 6, 2015 (see graph below). No values were recorded below the low DO standard during the deployment, nor were any elevated DO readings observed. DO flux ranged from 0.61 mg/L to 1.08 mg/L (see graph below). Additional continuous DO monitoring was performed at station 91MN098 in 2016; again, no DO standard or DO flux violations were recorded.

Figure 22. Diurnal DO results for station 91MN098 July 31 - August 6, 2015.

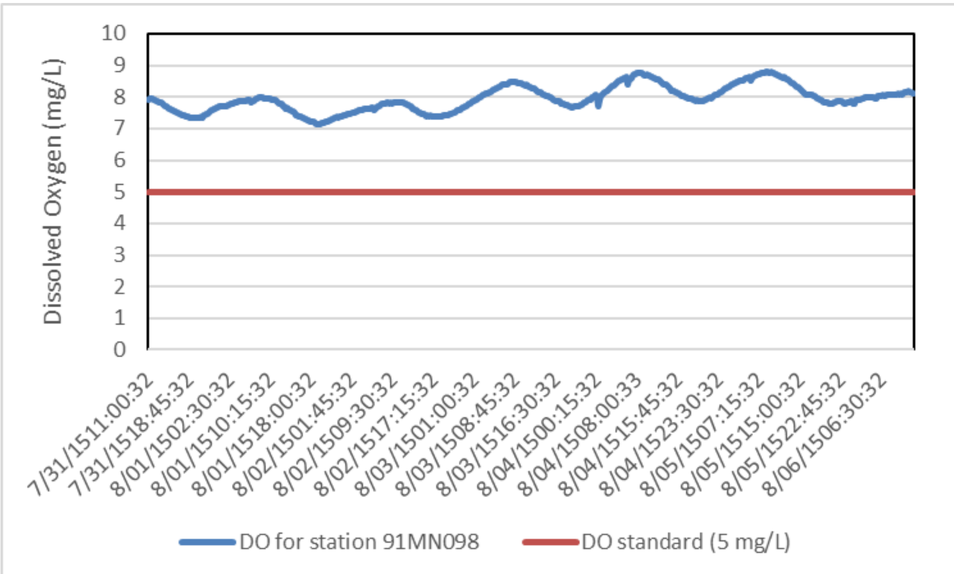


Figure 23. Daily DO Flux results for station 91MN098 July 31 - August 6, 2015.

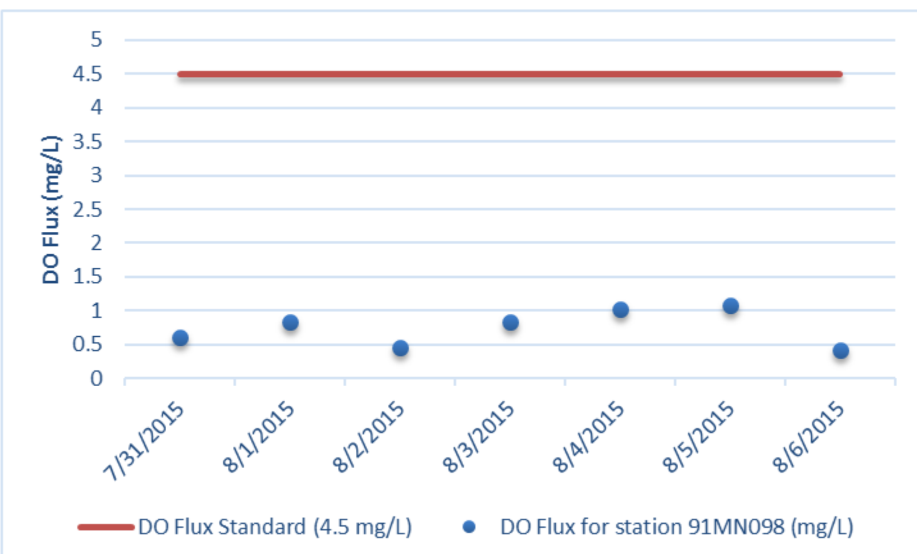


Figure 24. Diurnal DO results for station 91MN098 August 10-24, 2016.

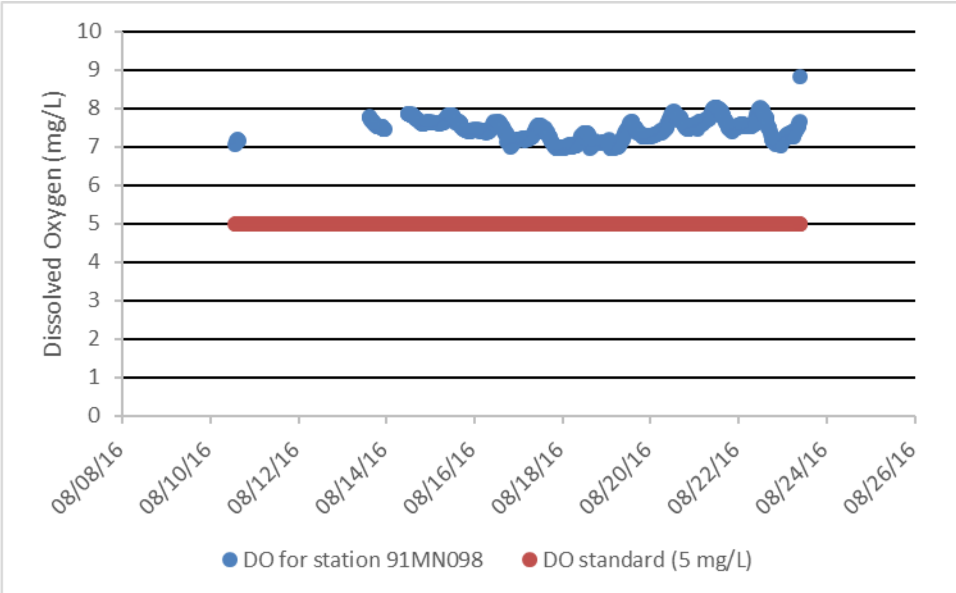
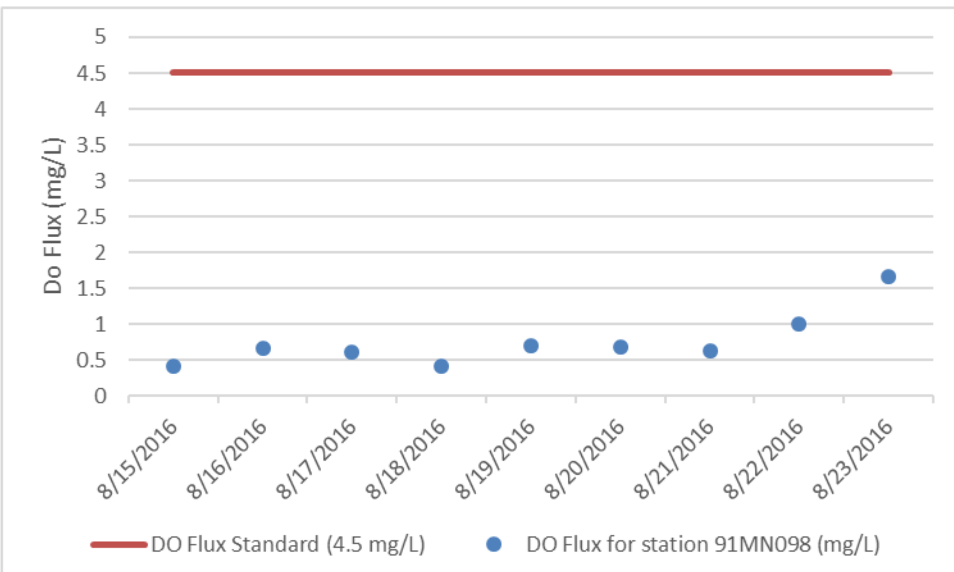


Figure 25. Daily DO Flux results for station 91MN098 August 10-24, 2016.



Additional continuous DO monitoring was conducted at station 91MN098 in 2016. However, equipment malfunctions resulted in missing data from several days during the deployment. DO values ranged from 6.95 mg/L to 8.82 mg/L during deployment, all values were above the low DO standard and below the DO flux standard.

There is not strong metric evidence that the macroinvertebrate community is impacted by low DO stress (see table below). The DO index metric score was above the class average needed to meet the prairie streams class threshold at both visits. The HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score was well below the average at both visits, which implies that macroinvertebrates are not being limited by low DO concentrations. While there were quantities of low DO intolerant taxa and EPT taxa, there were low numbers of low DO tolerant taxa; this could indicate other stressors are having a greater impact on the macroinvertebrate community at this time.

Table 10. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
91MN098 (2010)	**20.00**	**2.00**	3.10	6.51	**1.00**	**0.61**	6.00	6.38
91MN098 (2010)	**22.00**	**1.00**	3.91	6.57	**1.00**	**0.64**	6.00	15.54
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to increased DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Fish are not impaired within the reach, but sometimes fish metric data can be useful in better understanding stressors within the reach (see table below). However, the utility of the fish metric data is limited due to the low taxa counts collected. The fish community shows a somewhat mixed response to low DO stress. Unlike the macroinvertebrates, the DO Index score fell below the average needed to meet the threshold within the southern headwaters class. There was an abundance of generally tolerant taxa. There was also an absence of generally sensitive taxa and low DO sensitive taxa, as well as low quantities of late maturing individuals, which may signal DO stress. While there were few DO tolerant taxa, low DO tolerant individuals dominated the reach.

Due to a lack of chemical data and limited biological metric response, DO is not a likely stressor in the reach at this time.

Table 11. Fish metrics that respond to low DO stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
91MN098 (2001)	**0.00**	**0.50**	**98.51**	**6.19**	**0.00**	**0.00**	3.00	**99.00**
91MN098 (2010)	**0.00**	**3.75**	**92.88**	**6.21**	**0.00**	**0.00**	3.00	**99.25**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*6.02*	*14.39*	*19.30*	*6.89*	*0.11*	*0.11*	*3.94*	*36.89*
Expected response to increased DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

There were two phosphorous samples collected during the fish visits, both samples were at or above the southern region eutrophication standard of 0.15 mg/L. Eight additional samples were gathered in 2015 and 2016, two of those values were above the standard. Phosphorous concentrations ranged from

0.061 mg/L to 0.436 mg/L, with an average concentration of 0.185 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have impacts that are more direct on biology than phosphorus. Two chlorophyll a samples were collected during 2015 with values ranging from 6.7 ug/L to 21.7 ug/L, below the southern eutrophication standard of 35 ug/L. One BOD reading value was collected in May of 1991, the reading was at 0.7 mg/L, below the southern regional standard of 3 mg/L. DO grab sample results ranged from 5.5 mg/L to 11.46 mg/L suggesting potential for high DO fluctuations in the reach. However, continuous DO monitoring in 2016 showed a low DO flux, peaking at 1.5 mg/L during the August deployment; this could infer that eutrophication is not a likely stressor within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values collected on the reach in 1991, 2015 and 2016 ranged from 7.35 to 8.05. Filamentous algae was observed during SID visits but was not overly abundant. Abundant algal growth in a reach can be indicative of nutrient enrichment. The tributary is sourced by Eagle Lake, which is impaired for aquatic recreation (nutrients).

The macroinvertebrate community metrics show some potential response to eutrophication stress (see table below). Within the community, there were low counts of collector-filterer taxa, collector gatherer taxa, EPT taxa and a complete absence of intolerant taxa. There was also a high percentage of tolerant taxa.

Table 12. Macroinvertebrate metrics that respond to eutrophication stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
91MN098 (2010)	**20.00**	**0.00**	**6.00**	**1.00**	**0.00**	**90.00**
91MN098 (2010)	**22.00**	**1.00**	**8.00**	**2.00**	**0.00**	**95.46**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

While fish are not impaired within the reach, sometimes fish metric data can be useful in better understanding the reach's stressors (see table below). However, few species were captured across the visits at 91MN098; this must be considered when looking at fish metric data, as the results may appear skewed. Present metric data shows some potential response to eutrophication stress at nearly all visits but shows mixed results during the 2009 visit. All visits lacked sensitive and intolerant taxa, darters and simple lithophilic spawners. There was also an abundance of tolerant individuals at nearly all visits except the 2009 visit. A positive relationship exists between eutrophication and omnivorous fish. Elevated quantities of omnivorous fish were identified across all four visits in the reach.

Metrics tied to eutrophication are associated with multiple stressors; as such, negative response to eutrophication stress metrics is not a direct indication of eutrophication stress. Strong chemical and response indicator data is needed to confirm biological stress metrics.

Despite an apparent metric response in both fish and macroinvertebrate data, and high phosphorous levels there is no response variable chemical dataset to confirm that low DO conditions, nor elevated DO flux, BOD or Chlorophyll a levels exist within the reach to corroborate nutrient enrichment as a stressor. As such, eutrophication is an inconclusive stressor at this time until additional information is available to prove otherwise.

Table 13. Fish metrics that respond to eutrophication stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
91MN098 (1991)	**0.00**	**0.00**	**0.00**	**100.00**	**100.00**	**1.00**	**0.00**
91MN098 (2001)	**0.00**	**0.00**	**0.00**	**98.51**	**98.51**	**4.00**	**0.00**
91MN098 (2009)	**0.00**	**0.00**	**0.00**	**66.67**	55.56	**3.00**	**0.00**
91MN098 (2010)	**0.00**	**0.00**	**0.00**	**92.88**	**92.88**	**4.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	6.02	10.56	30.09	19.80	76.70	10.03	0.52
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

Nitrate samples were collected during fish visits in 2001 and 2010. Nitrate concentrations ranged from 8.9 mg/L at the July 30, 2001 visit to 4.9 mg/L at the August 8, 2010 visit. An additional 41 samples were collected in 1991, 2015 and 2016, during the months of February thru September. Nitrate concentrations ranged from 3 mg/L in March of 1991 to 28 mg/L in April of 1991, with an overall average of 16.73 mg/L. Twenty-six values were above 15 mg/L and were collected from April thru August; however, a majority of the high readings were taken in 1991. In the 11 readings taken since 1991, only three samples have been equal or greater than 15 mg/L for nitrates. The tributary is sourced by Eagle Lake, which is impaired for aquatic recreation (nutrients).

The macroinvertebrates in this reach show a mixed response to nitrate stress (see table below). A low number of nitrate tolerant taxa may be related to an overall low taxa count, thus potentially explaining the mixed results observed. The nitrate index score ranged from 4.07 to 4.12 above the average for the Prairie Streams GP modified class suggesting that the present community is tolerant to elevated nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) and decreased intolerant and Trichoptera taxa, all of which are lacking in this reach. Additionally, the number of nitrate tolerant individuals (92.3%) are much higher than average.

Table 14. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Date sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (date fish visit)
91MN098 (no invert visit)													8.90 (7/30/2001)
91MN098 (8/19/2010)	**22.00**	**1.00**	**8.00**	**1.00**	**0.00**	**95.45**	**0.00**	**0.00**	**4.12**	**0.00**	16.00	**92.30**	4.90 (8/11/2010)
91MN098 (8/19/2010)	**20.00**	**0.00**	**6.00**	**2.00**	**0.00**	**90.00**	**1.00**	**0.30**	**4.07**	**0.00**	15.00	**92.70**	4.90 (8/11/2010)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.00*	*11.57*	*4.84*	*0.11*	*87.94*	*1.99*	*0.66*	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

A table showing fish metric response to nitrate is not included in this section because fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate.

Chemical evidence indicates high N values routinely occur during spring runoff months; the macroinvertebrate community is responding negatively to elevated concentrations of nitrates in the water column as observed in the metric table above; as such nitrates are currently a stressor to the macroinvertebrate community.

Suspended sediment

Two TSS samples were collected on the reach at one biological station in 2001 and 2010 during fish visits, neither sample exceeded the southern regional standard of 65 mg/L. Fifty-seven TSS samples were collected on the reach in 1991, 15 of these samples exceeded the TSS standard. In 2015 and 2016, nine additional TSS samples were collected as part of SID investigations, two samples exceeded TSS standards. Ten secchi transparency measurements were collected on the reach during SID investigations in 2015 and 2016, values ranged from 8 cm to > 100 cm, with only one value falling below the 10 cm southern Minnesota transparency standard during an extreme rainfall event in June 2016.

There was mixed negative response in the macroinvertebrate community with regards to TSS stress related metrics within the reach (see table below). The TSS Index score for the station fell below the average for the Prairie Streams GP Class, suggesting that macroinvertebrates are not likely to be stressed by elevated TSS levels. While there was an absence of TSS intolerant taxa, there were below average quantities of TSS tolerant taxa; limited quantities of intolerant taxa could be explained by other stressors. There were below average quantities of collector-filterer (Collector-filtererPct) and plecoptera taxa (PlecopteraPct), indicating potential stress.

Table 15. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Date sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
91MN098 (8/11/2010)	**0.65**	**0.00**	13.13	**0.00**	**0.00**	7.00	19.29
91MN098 (8/11/2010)	**0.00**	**0.00**	11.45	**0.00**	**0.00**	4.00	10.33
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.00*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Fish are not impaired within the reach, but sometimes fish metric data can be useful in better understanding stressors within the reach (see table below). The TSS Index score for the fish community was high indicating potential for TSS stress within the reach; however, there was an absence of TSS Tolerant taxa within the reach. There were also no riffle dwelling taxa, simple lithophilic spawners or benthic feeders, which are all sensitive to sedimentation and presence of sediment in the water column suggesting possible stress. Fish metric results are mixed and inconclusive. However, the utility of the fish metric data is limited due to the low taxa counts collected.

Table 16. Fish metrics that respond to high TSS stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
91MN098 (2001)	**0.00**	**1.00**	**0.00**	**0.00**	**1.49**	**1.49**	**0.00**	**0.00**	**0.00**
91MN098 (2010)	**0.00**	3.38	**0.00**	**0.00**	**4.50**	**7.13**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*31.38*	*1.01*	*21.54*	*0.52*	*4.91*	*15.11*	*22.62*	*6.02*	*15.69*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

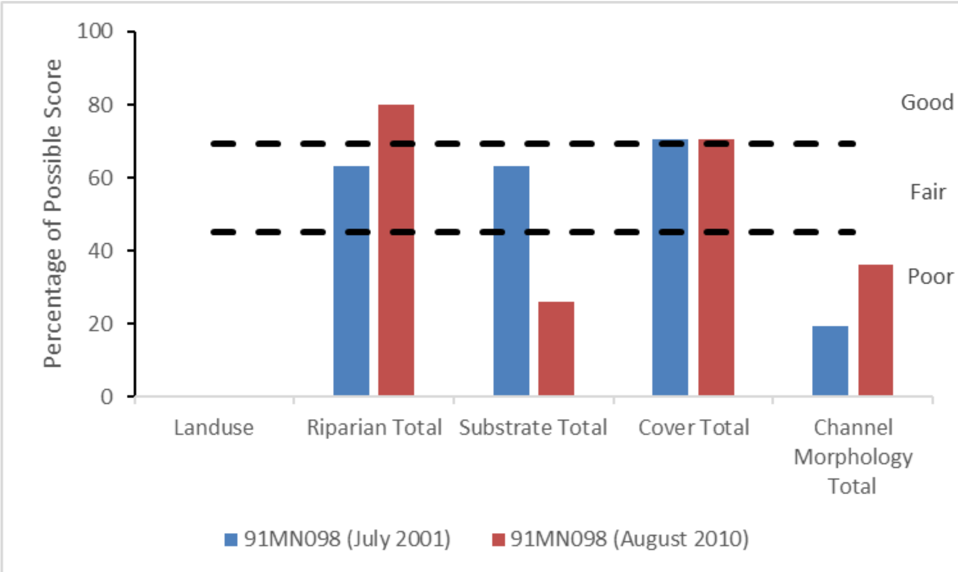
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
91MN098 (2001)	**23.41**	**0.00**	**0.00**	0.00	0.00
91MN098 (2010)	**24.27**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*17.35*	*0.04*	*0.01*	*0.66*	*5.36*
Expected response to TSS stress	↑	↓	↓	↑	↑

Due to low TSS index scores in the macroinvertebrate results, a low percentage of TSS tolerant individuals, limited metric response and a limited recent chemical dataset indicating problems, the macroinvertebrates present do not indicate that TSS is a likely stressor in the reach.

Habitat

There were two qualitative habitat surveys conducted on the reach at biological station 91MN098, one in 2001 and one in 2010 (see graph below). The average MSHA score was 44.75, hovering between fair and poor. Row crop agriculture is the dominant landuse along the reach. The reach is entirely channelized along its length with narrow (5-10 meter) grass buffers within the biological station and upstream and extensive buffers downstream of the biological station (see photo below). Limited erosion was observed within the site but cutting is evident just downstream of the station where the culvert has become perched. The stream channel type is ubiquitous in nature at 100% run with limited depth variability and a dominance of fine substrates and limited diversity of coarse substrates. Instream habitat cover was classified as extensive consisting of instream macrophytes and overhanging vegetation.

Figure 26. Percentage of MSHA subcategory scores for station 91MN098 in Unnamed Creek (Mountain Lake Inlet).



There was a mixed response to degraded habitat stress within the macroinvertebrate community in the reach (see table below). While there appears to be lower than average quantities of clinger taxa, there were sufficient quantities of climbing taxa in both samples, which confirms the abundance of macrophytes and overhanging vegetation observed during the fish visit. Both visits had above average burrower and legless taxa, which can thrive where there is an abundance of fine sediments and limited coarse substrates. This is also apparent in the low quantities of clinger taxa, as they require coarse substrates or woody debris.

Table 17. Macroinvertebrate metrics that respond to degraded habitat stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Date sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
91MN098 (8/11/2010)	**10.39**	60.39	**9.09**	**1.30**	**95.78**	**19.81**
91MN098 (8/11/2010)	**8.23**	70.43	**5.49**	**0.61**	**98.78**	**15.24**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.07*	*18.46*	*38.49*	*30.93*	*43.48*	*21.94*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Fish are not impaired within the reach, but sometimes fish metric data can be useful in better understanding stressors within the reach (see table below). Fish taxa in the reach were dominated by pioneering species. There was a complete absence of riffle dwelling taxa, benthic insectivores, simple lithophilic spawners, piscivore taxa and darters, all of which require a variety of complex habitats that are not present in the reach indicating that degraded habitat could be a likely stressor in the reach. However, low fish taxa counts observed within the reach make utilizing metric data difficult for determining stressors as the information can produce false positives for potential stressors due to the limited dataset. Fish data should be considered as supporting evidence of habitat stress within the reach.

Biological metric data in conjunction with qualitative habitat data demonstrates that limited available habitat is stressing the biota at this time.

Table 18. Fish metrics that respond to degraded habitat stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
91MN098 (2001)	**98.51**	**0.00**	**0.00**	**0.00**	**95.52**	**0.00**	**0.00**	**0.00**
91MN098 (2010)	**92.88**	**0.00**	**0.00**	**0.00**	**92.88**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*46.70*	*1.97*	*57.98*	*10.59*	*32.54*	*22.62*	*10.91*	*32.54*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

Figure 27. Station 91MN098 (June 15, 2016) wide riparian grass corridor.

Altered hydrology/Longitudinal connectivity

There are no fish impairments within the reach; however, there are two known connectivity barriers. At the outlet of Eagle Lake there is a barrier, and there is a low flow barrier on downstream side of CR 99 downstream of biological station 91MN098 due to down cutting. As macroinvertebrates are not impacted by connectivity – connectivity is not a stressor within the reach at this time.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 3.2 mile long reach of the Unnamed Creek (Mountain Lake Inlet) is 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, while stream bank erosion was limited within the reach, an abundance of fine sediments and undercut banks were identified. Insufficient information is available to determine whether or not alteration is a leading stressor in the reach at this time.

In 2012, southwestern Minnesota experienced a significant drought and low flow conditions were observed across the Watonwan River Watershed. There were no photographs taken within the reach during that time. Low flow conditions observed in 2012, are likely the result of altered flow conditions due to extensive wetland drainage in the watershed and extensive systems of tile drainage, reducing water storage on the landscape and resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months. However, conditions observed in the Watonwan system may have also been influenced by extreme climatic conditions from the drought. Photographic evidence of low flow conditions at Unnamed Creek (Mountain Lake Inlet) would be beneficial in better understanding the potential of the stressor in this system.

Presence of lake species within the reaches fish community including black bullhead, yellow perch and bluegill sunfish could be an indication of low flow conditions within the reach, as lake taxa prefer more lentic conditions and do not require moving water. It could also be a result of the biological station residing between two lakes, Eagle Lake upstream and Mountain Lake downstream. In addition, low quantities of long-lived fish taxa and an absence of riffle dwelling species could also indicate potential for low flow conditions within the reach (see table below).

Altered hydrology is an inconclusive stressor in the reach at this time. While there is anecdotal evidence to suggest potential for stress within the reach there is no direct lines of evidence linking a declining macroinvertebrate community to altered hydrology stress.

Table 19. Fish metrics that respond to altered hydrology stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
91MN098 (2001)	**98.51**	**1.49**	**0.00**
91MN098 (2010)	**92.88**	**4.50**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*46.70*	*4.91*	*22.62*
Expected response to Altered Hydrology stress	↑	↓	↓

Figure 28. Biological station 91MN08 (May 24, 2016) barrier downstream side of culvert.

4.1.3. AUID Summary

The macroinvertebrate community within Unnamed Creek (Mountain Lake Inlet) is stressed by elevated levels of nutrients (N) and degraded habitat conditions. The stream is fed by Eagle Lake, impaired for aquatic recreation (nutrients), the lake along with surrounding row crop agricultural landuse in the reaches watershed acts as likely sources for elevated nutrient concentrations observed within the reach. Macroinvertebrate metric data show a clear response to nitrate stress through extremely high quantities of nitrate tolerant taxa and an absence of macroinvertebrate taxa that are sensitive high nitrogen concentrations. Habitat within the stream is ubiquitous in nature. Only run channel type exists within the biological station. The stream is shallow and laden with fine sediments, and few habitat types are available to biota. The macroinvertebrate community is responding to these physical habitat limitations with great quantities of burrowing taxa (often found in embedded riffles) and legless macroinvertebrates, which tolerate poor habitat conditions. There is also a lack of sensitive EPT taxa, which are indicative of good habitat characteristics. Present conditions are common in modified channelized reaches with riparian zones dominated by row crop agriculture as was observed within the reach.

Eutrophication and altered hydrology are inconclusive stressors within the reach. While the reach is fed by a lake impaired for excess nutrients and elevated phosphorous concentration were detected in the reach, there was limited response variable data to corroborate potential for biological stress. Available DO flux data was not above standards and a limited chlorophyll a dataset was well below standards. No BOD data was available and photographs did not indicate an overabundance of plant or algal growth. Additional chemical data collection and response variable data is needed to rule out eutrophication stress. While extensive wetland drainage and cropland drainage through drain tiles are known to be abundant in the watershed and stress metrics in the fish community suggest potential low flow conditions in the watershed there is no direct evidence suggesting that low flow conditions are inhibiting the macroinvertebrate community in the reach.

Low DO and elevated TSS were ruled out as potential stressors within the reach. There was limited metric response by macroinvertebrates with regards to potential DO stress, and continuous sonde deployment in 2015 and 2016 did not indicate the presence of low DO conditions within the reach. Similar findings were found with regards to TSS, while elevated TSS levels were observed in 1991, recent datasets indicate elevated TSS concentrations only on occasion and especially during extreme rainfall events, in addition macroinvertebrate metric response to TSS stress was limited to metrics which are influenced by several stressors.

Table 20. Summary of stressor determinations for Unnamed Creek (Trib. to Mountain Lake) (505).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Unnamed Creek (Mountain Lake Inlet)	07020010-505	--	o	●	--	●	o	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

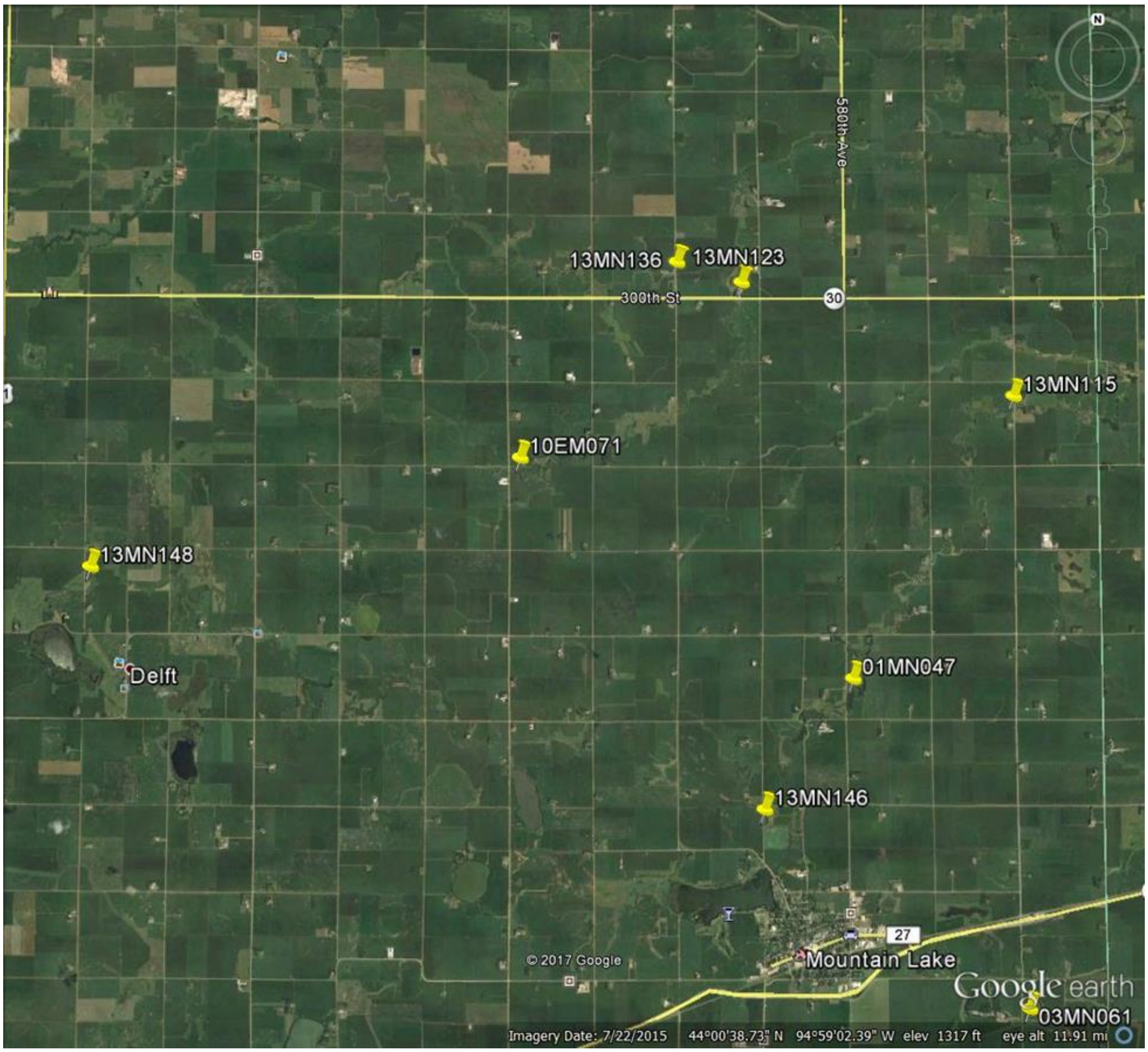
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1 Watonwan River -566

Watonwan River (07020010-566) is the headwaters reach of the mainstem Watonwan River. It begins 2 miles south of Jeffers and flows east 47 river miles, ending 2 miles east of Co. Hwy 124 where the next downstream Watonwan River reach (07020010-567) begins. Throughout its course it gains the outflow from Mountain Lake. This reach is classified as general use warmwater 2B. This reach is currently impaired for aquatic life, for degraded fish and macroinvertebrate communities (2015), high levels of turbidity (2006) and for aquatic recreation for high levels of fecal coliform bacteria (2006).

Figure 29. Google Earth image of Watonwan River (-566).



4.1.1 Biological communities

There are four biological stations on this AUID. There were six fish visits and three macroinvertebrate visits. All FIBI results were below the GU threshold and lower confidence interval (see table below). FIBI scores are lower at the upstream two stations and generally higher at the two downstream stations. Tolerant taxa were abundant at all stations and across all visits, resulting in a zero metric score for tolerant percent. All visits also had low quantities of sensitive taxa and early maturing individuals. There were 12 to 15 species across all visits and individual counts were not dramatically low (see graphs below). The most abundant fish taxa observed at biological stations within the reach include tolerant taxa, including creek chub, sand shiner, bluntnose minnow, bigmouth shiner and fathead minnow.

All macroinvertebrate results were below their respective thresholds but within lower confidence limits. Most abundant macroinvertebrate taxa observed include Physa, Ploypedilum, Tricorythodes, Dubiraphia and Cheumatopsyche. A low presence of predator taxa and low HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) index scores were observed at both stations sampled. Station 13MN146 also had low quantities of collector filterer and intolerant taxa. Station 01MN047 also had low quantities of Plecoptera and Trichoptera taxa and an abundance of tolerant taxa (see graphs below).

Macroinvertebrates were not sampled at station 13MN148 in August of 2013 due to insufficient flow conditions in the reach due to a dry streambed. While there was a macroinvertebrate visit at station 13MN115, the sample went missing during processing and as such, no data was available for assessment.

Table 21. Summarized fish and macroinvertebrate IBI data, organized downstream to upstream.

Station Number	Fish Visit Date	Fish IBI	FIBI GU Threshold	FIBI confidence Limits	Macroinvertebrate Visit Date	Macroinvertebrate IBI	MIBI GU Threshold	MIBI confidence
13MN148	08-Jul-13	22	55	7	8/13/2013	None -DRY	x	x
13MN146	12-Jun-13	17	50	9	8/14/2013	34.2	41	14
01MN047	8/13/2001	24.8	50	9	9/11/2001	32	37	13
01MN047	12-Jun-13	21	50	9	8/14/2013	35.7	37	13
01MN047	28-Aug-13	38	50	9	x	x	x	x
13MN115	15-Jul-13	25	50	9	8/14/2013	None -MIA	x	x

Figure 30. Fish metrics of the Southern Headwaters Class IBI for station 13MN148, Watonwan River.

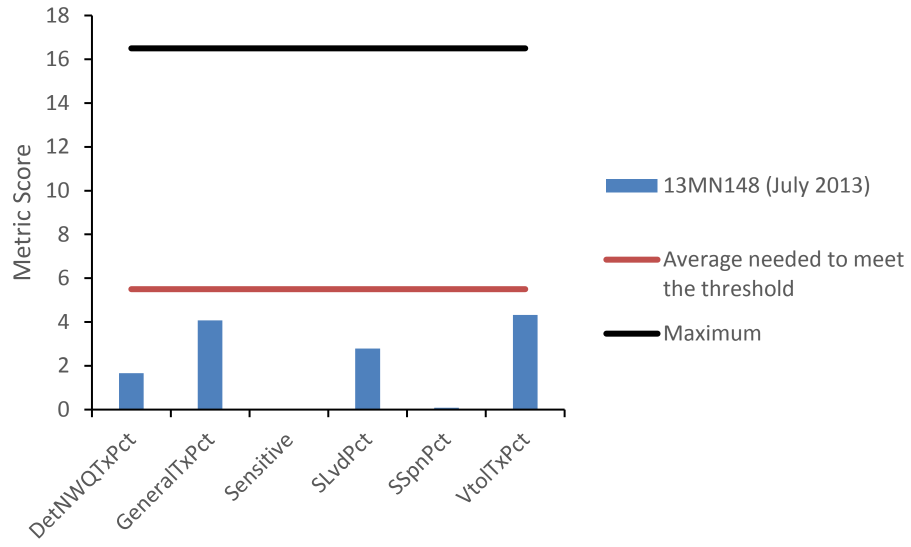


Figure 31. Fish metrics of the Southern Streams Class IBI for station 13MN146 and 01MN047, Watonwan River.

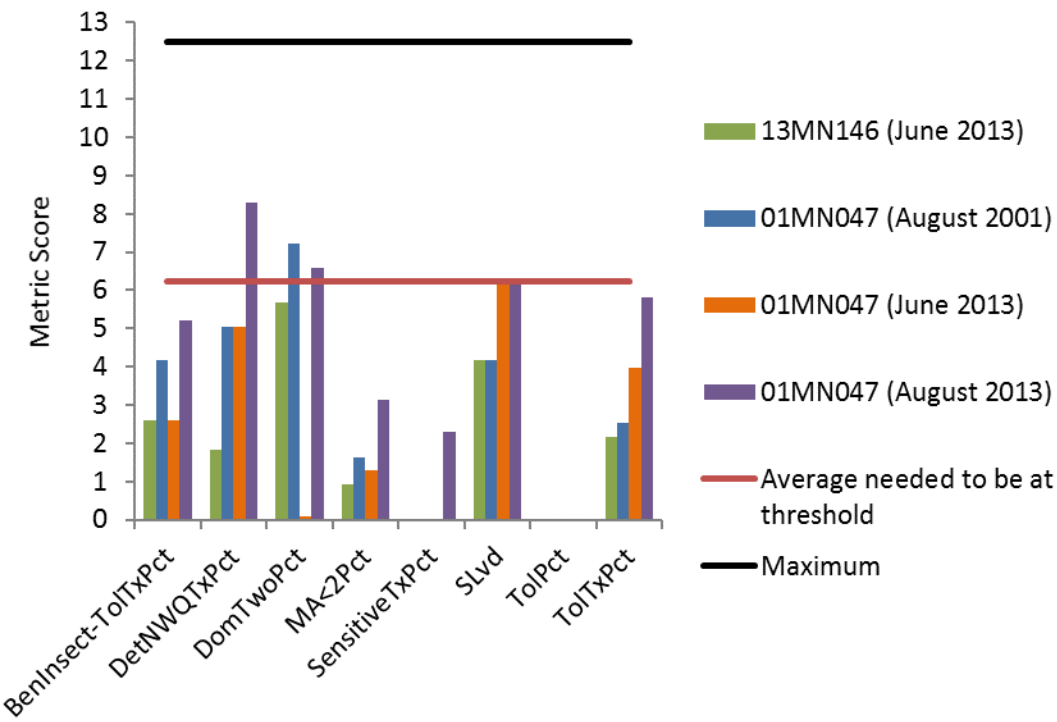


Figure 32. Fish metrics of the Southern Streams Class IBI for station 13MN115, Watonwan River.

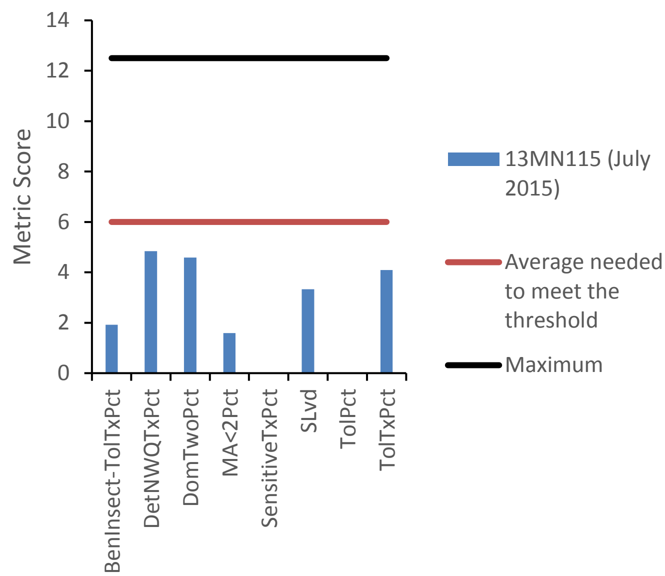


Figure 33. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN146, Watonwan River.

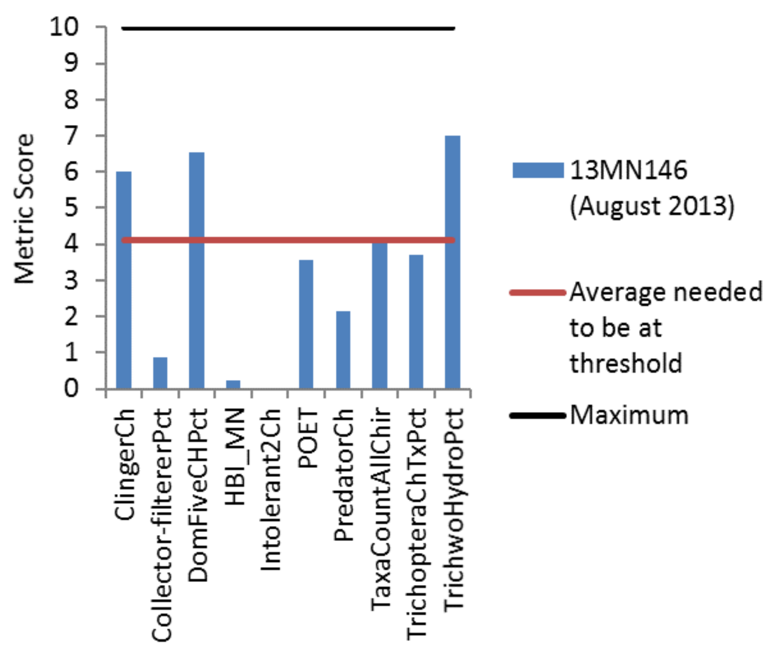
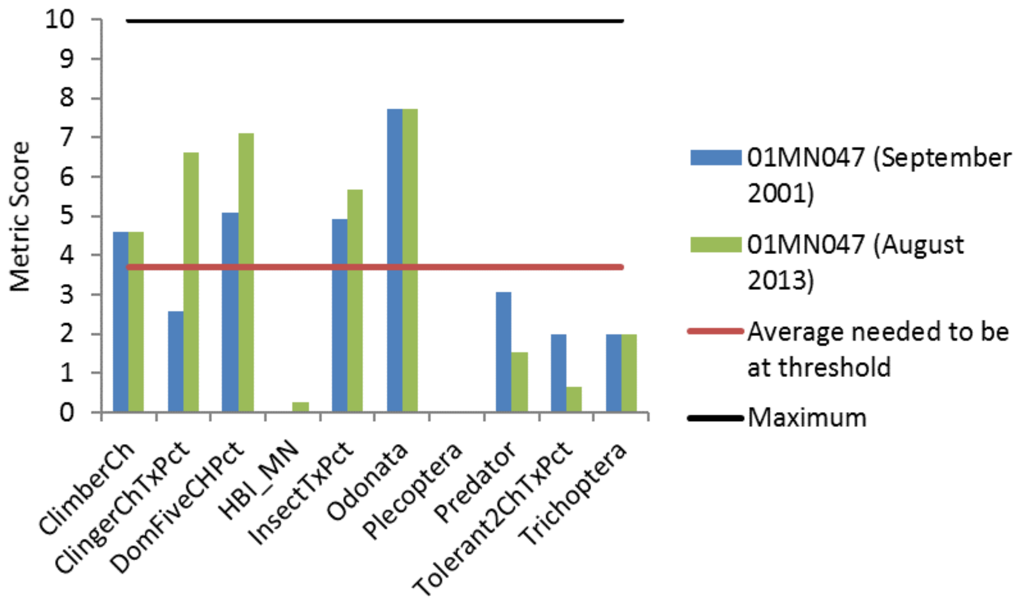


Figure 34. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 01MN047, Watonwan River.



4.1.2 Data evaluation for each Candidate Cause

Dissolved oxygen

Nine DO readings were collected during the biological visits at four stations. Values ranged from 5.34 mg/L at 13MN115 on August 14, 2013 at 10:04 am to 13.48 mg/L at 13MN148 on July 8, 2013 at 4:45 PM. Two values were above 10 mg/L. There was no DO monitoring on the reach prior to biological sampling. Eleven additional samples were gathered across the stations in 2014 and 2016. No samples fell below the 5 mg/L DO standard, while two were above 10 mg/L.

A continuous monitoring YSI sonde was deployed at station 13MN148 in 2016 from August 23 to September 7 (see graph below). DO values below the 5 mg/L standard were recorded every day during the 15-day deployment. On three days DO levels did not rise above 5 mg/L. There were no violations of the DO Flux eutrophication standard during deployment (see graph below). Daily DO flux ranged from 1.47 mg/L to 4.07 mg/L.

There are two large wetlands upstream of biological station 13MN148 what may be contributing to the low DO conditions observed (see aerial photo below).

Figure 35. Diurnal DO results for station 13MN148 August 23 - August 6, 2016.

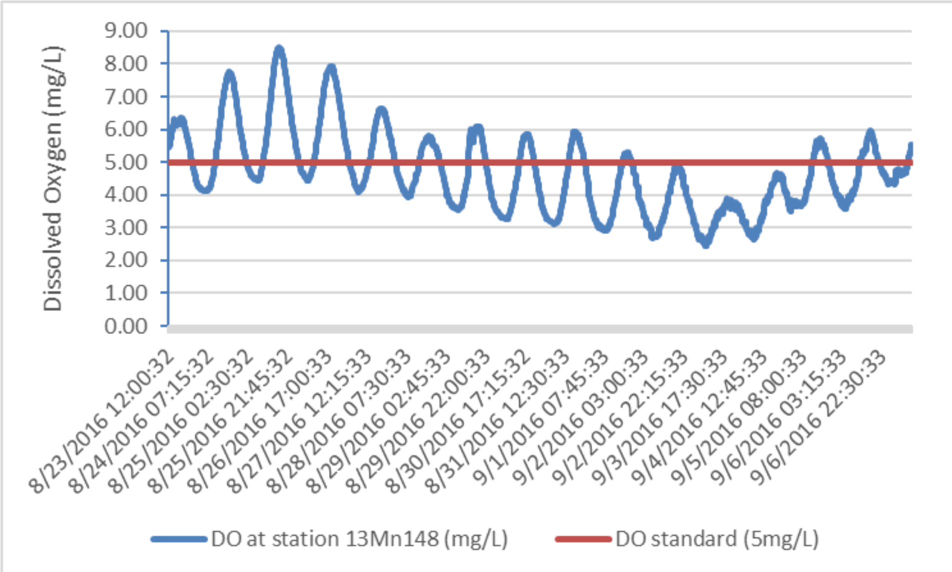
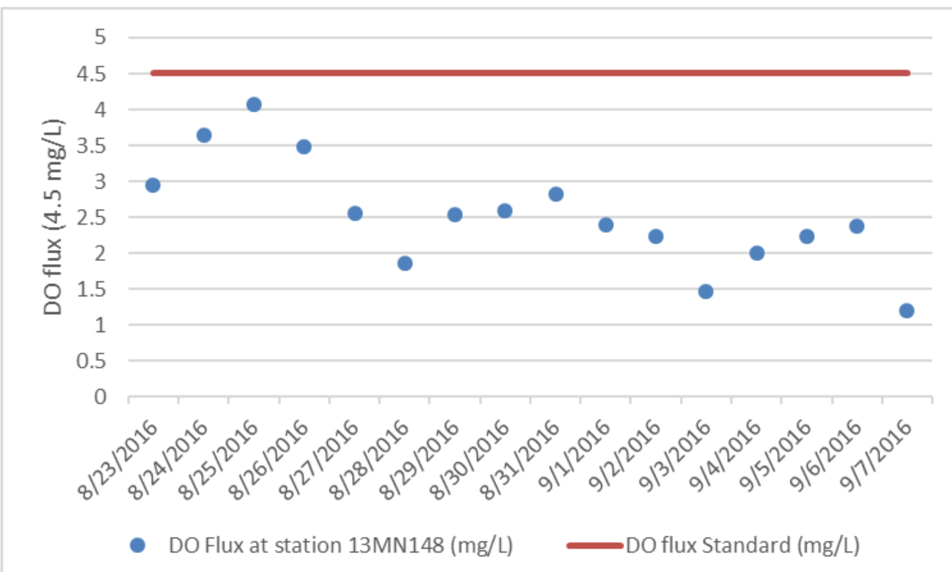


Figure 36. Diurnal DO flux results for station 13MN148 August 23 - August 6, 2016.



There was a mixed response to low DO metrics within the macroinvertebrate community (see table below). All stations were near their respective threshold for the DO Index score, suggesting that low DO is not a likely stressor within the reach. While all HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) metrics exceeded their class' averages. There were also low quantities of DO Intolerant taxa and EPT taxa across all of the visits. There were higher than average quantities of DO tolerant taxa at both visits on station 01MN047 but only the 2001 visit from station 01MN047 had greater than average quantities of DO tolerant individuals.

Table 22. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
01MN047 (2001)	**42.00**	**11.00**	**8.50**	**7.00**	**4.00**	**3.86**	**8.00**	**11.20**
01MN047 (2013)	**43.00**	**12.00**	**8.30**	7.09	**5.00**	**12.11**	**7.00**	9.90
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
13MN146 (2013)	**33.00**	**7.00**	**8.80**	6.51	**2.00**	**1.97**	5.00	11.59
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Within the fish community there was a mixed response to the low DO metrics as well (see table below). The DO Index score at all but one station (13MN146) hovered near their classes respective threshold, suggesting that low DO may not be a major stressor to the fish community. There was a complete absence of DO sensitive taxa across all visits and an absence of generally sensitive species at nearly all visits. All stations had fewer than average quantities of late maturing individuals. There was an abundance of generally tolerant fish but only one station, 01MN047 had greater than average quantities of DO tolerant species, but only during the 2001 visit and only one station 13MN148 had above average quantities of DO tolerant individuals.

While there is chemical evidence to suggest low DO conditions could be a potential stressor in the reach, there was limited metric response from the biological communities. Due to discrepant data DO is currently an inconclusive stressor within the reach. Additional investigation in understanding the extent of DO stress within the entire reach would be useful. 2016 was a higher water year in the Watonwan River Watershed compared to 2013, suggesting that under low flow conditions DO stress could be more pronounced. Late summer biological visits, when low DO conditions typically occur, could also provide additional information to better understand potential for low DO stress within the reach.

Table 23. Fish metrics that respond to low DO stress in Unnamed Creek (Mountain Lake Inlet) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN148 (2013)	**0.00**	**3.39**	**83.05**	6.85	**0.00**	**0.00**	**4.00**	**28.81**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*0.70*	*4.10*	*3.40*	*21.20*
13MN146 (2013)	**0.00**	**6.86**	**98.53**	7.29	**0.00**	**0.00**	2.00	4.41
01MN047 (2001)	**0.00**	**3.97**	**86.64**	**7.11**	**0.00**	**0.00**	**7.00**	17.69
01MN047 (2013)	**0.00**	**7.76**	**93.88**	**7.08**	**0.00**	**0.00**	2.00	1.22
01MN047 (2013)	**0.32**	**17.36**	**80.39**	**7.16**	**0.00**	**0.00**	4.00	4.82
13MN115 (2013)	**0.00**	**9.63**	**79.06**	**7.11**	**0.00**	**0.00**	4.00	6.50
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.9*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

There were six phosphorous samples collected at four biological stations on the reach, all values were below the southern streams eutrophication standard of 0.15 mg/L. Five additional phosphorous samples were collected in 2016 at station 15MN115, only one visit exceeded the standard.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. No chlorophyll a samples were collected within this reach. There was one BOD sample collected on the reach at EQUIS station S001-216 on May 9, 1991, the reading was 0.7 mg/L below the southern regional standard of 3 mg/L. DO grab samples collected on the reach ranged from 5.34 to 13.48 mg/L suggesting potential for high DO fluctuations in the reach. However, continuous DO monitoring at biological station 13MN148 in 2016 did not provide evidence that daily DO flux exceeds standards. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values on the reach ranged from 7.6 – 8.26. An abundance of filamentous algae was also identified in the reach, at station 13MN148 in 2013; prolific algae is a likely indication of an overabundance of nutrient availability within the reach (see photo below).

The macroinvertebrate community has a mixed response to eutrophication stress within this reach (see table below). There was an absence of intolerant taxa and an abundance of tolerant taxa at both stations. While taxa counts for collector-filterer, collector-gatherer and EPT taxa were all below the average threshold needed to meet biocriteria at station 01MN047, results were only marginally below the class average and do not give a clear indication of eutrophication stress. Results were only marginally better than the threshold at nearly all the same metrics from station 13MN146.

Table 24. Macroinvertebrate metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN146 (2013)	**33.00**	**2.00**	13.00	7.00	**0.00**	**93.94**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*3.90*	*12.80*	*6.50*	*0.10*	*85.40*
01MN047 (2001)	**42.00**	**6.00**	**13.00**	**11.00**	**0.00**	**90.70**
01MN047 (2013)	**43.00**	**7.00**	**15.00**	**12.00**	**0.00**	**85.71**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Fish metrics show some response to eutrophication stress within the reach (see table below). All samples lacked intolerant and sensitive taxa and had elevated percentages of tolerant taxa. All visits also had low quantities of simple lithophilic spawners. The darter count was below the threshold needed to meet their respective biocriteria at all but two visits. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were only identified at biological station 13MN148 while all other visits fell below the statewide average for Class 2 Southern Streams. This suggests that potential eutrophication stress may be more pronounced in the upstream reaches compared to lower sections of the reach.

Table 25. Fish metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN148 (2013)	**0.00**	**10.17**	**5.08**	**30.51**	**83.05**	12.00	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*14.71*	*1.95*	11.50	1.60
13MN146 (2013)	**0.00**	**0.49**	**19.12**	10.78	**98.53**	**12.00**	**0.00**
01MN047 (2001)	**0.00**	**8.30**	**9.75**	9.39	**86.64**	**15.00**	**0.00**
01MN047 (2013)	**0.00**	**0.41**	**18.37**	8.98	**93.88**	**12.00**	**0.00**
01MN047 (2013)	**0.32**	14.79	**19.94**	15.43	**80.39**	**12.00**	**0.00**
13MN115 (2013)	**0.00**	14.44	**9.39**	4.81	**79.06**	**13.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*16.53*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Figure 37. Biological station 13MN148 (July 8, 2013) filamentous algae.

While there is photographic evidence of elevated nutrients in the reach and some metric evidence suggesting eutrophication is a potential stressor, there is limited chemical evidence to corroborate the stressor. Biological metric data for eutrophication is not strong evidence as many of the metrics can respond to multiple stressors within a reach. As such, eutrophication is currently an inconclusive stressor. Additional chemistry collection and response variable data should be gathered to better define conditions that are producing nuisance algal blooms in the reach that may be limiting biological communities.

Nitrate

Nitrate samples were collected during six fish visits on four stations. Nitrate concentrations ranged from 0.06 mg/L at 01MN047 on August 28, 2013 to 12 mg/L at 13MN146 on June 12, 2013. An additional five samples were collected in 2016 during the stressor identification investigation during the months of February, May and June. Nitrate concentrations ranged from 14 mg/L to 18 mg/L. The overall average of nitrate concentrations across all samples was 10.85 mg/L. Only four readings were above 15 mg/L.

The macroinvertebrates in this reach show a consistent indication that they are impacted by elevated levels of nitrates (see table below). The nitrate index score ranged from 3.88 to 4.1, while the average for Southern Streams RR meeting impairment threshold is 2.9 and the average for Prairie Rivers meeting the impairment threshold is 3.2. This suggests that overall the community present is quite tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) which was observed at two of three visits. High nitrate levels also generally result in a decreased quantity of intolerant and Trichoptera taxa, which also occurred in this reach. Nitrate tolerant taxa were marginally above average at the 2001 visit at 01MN047 and much higher than average during the 2013 visit and at 13MN146. A high percentage of nitrate tolerant individuals was observed across all visits.

Table 26. Macroinvertebrate metrics that respond to nitrate stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria.

Bold indicates metric value indicative of stress. (There was no macroinvertebrate sample for 13MN115 because the sample went missing. 13MN148 did not have an invertebrate sample collected due to insufficient flow).

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Date Sample Collected
13MN148 (2013)													8.00 (7/8/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*2.60*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
13MN146 (2013)	**33.00**	**2.00**	**13.00**	**7.00**	**0.00**	**93.90**	**2.00**	4.64	**4.10**	**0.00**	**23.00**	**82.50**	12.00 (6/12/2013)
01MN047 (2001)	**42.00**	6.00	13.00	11.00	**0.00**	**85.71**	**4.00**	**3.29**	**4.04**	**2.00**	**19.00**	**76.90**	1.70 (8/13/2001)
01MN047 (No Invert Visit)													10.00 (6/12/2013)
01MN047 (2013)	**43.00**	7.00	15.00	11.00	**0.00**	**90.70**	**4.00**	**4.69**	**3.88**	**0.00**	**26.00**	**77.00**	0.06 (8/28/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
13MN115 (2013) (Invert Sample Missing)													6.60 (7/15/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*2.60*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Macroinvertebrates are better indicators of nitrate stress than fish; however, fish metrics that do respond to nitrate stress also indicate potential for stress (see table below). There were low quantities of sensitive and darter taxa and an abundance of tolerant taxa, all of which indicate stress, but could be indications of other stressors in the reach.

Table 27. Fish metrics that respond to nitrate stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN148 (2013)	**0.00**	**10.17**	**83.05**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*
13MN146 (2013)	**0.00**	**0.49**	**98.53**	**0.00**
01MN047 (2001)	**0.00**	**8.30**	**86.64**	**0.00**
01MN047 (2013)	**0.00**	**0.41**	**93.88**	**0.00**
01MN047 (2013)	**0.32**	**14.79**	**80.39**	**0.00**
13MN115 (2013)	**0.00**	**14.44**	**79.06**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*18.65*	*11.68*	*44.85*	*4.97*
Expected response to Nitrate stress	↓	↓	↑	↓

Strong macroinvertebrate metric data indicating nitrate stress in addition to high nitrate levels observed during chemical data collection confirm that nitrate is a stressor within the reach.

Suspended Sediment

Six TSS samples were collected along the reach during fish visits at four unique biological stations in 2001 and 2013; no samples exceeded the southern regional TSS standard of 65 mg/L. No additional TSS samples were collected on the reach apart from biological visits discussed earlier prior to 2013. The present turbidity impairment on the reach is a carry forward impairment from parent WID -514, there was insufficient information to reassess turbidity in 2015. There were 659 transparency tube readings collected on this reach from 2001-2016, 52 of these readings were below the 10 cm standard, a majority of exceedances occurred prior to biological sampling. Three of six TSS samples collected in 2016 as part of SID investigations exceeded the regional TSS standards.

A negative response to all TSS stress related metrics suggests that elevated TSS levels are a likely stressor to the macroinvertebrate community within the reach (see table below). All three fish visits had TSS Index scores above their respective class averages; this signals that the macroinvertebrate community has an abundance of TSS tolerant taxa. There was also an absence of TSS intolerant taxa collected during visits. Collector-filterer taxa counts were low and Plecoptera taxa were absent in the reach. These taxa require clear conditions for foraging and are sensitive to high TSS concentrations.

Table 28. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN146 (2013)	**3.64**	**0.00**	**18.94**	**0.00**	**0.00**	**12.00**	**59.93**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.7*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
01MN047 (2001)	**6.29**	**0.00**	**18.41**	**0.00**	**0.00**	**15.00**	**54.01**
01MN047 (2013)	**20.31**	**0.00**	**19.39**	**0.00**	**0.00**	**14.00**	**55.90**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.4*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was a mixed response to TSS related stress within the fish community (see table below). Only three of six visits has TSS Index scores above their respective averages. Elevated TSS scores indicate a high potential for TSS stress. This inconsistency could reveal isolated stress conditions at station 13MN148 and 13MN146 and only occasional stress observed at 01MN047 or it could represent periodic instability within the reach. Interestingly, nearly all taxa related metrics, which indicate TSS stress, were below their respective thresholds. No intolerant taxa were identified within the reach and only one station produced sensitive taxa. There were low counts of benthic feeders, centrarchids, herbivores, long-lived taxa and simple lithophilic spawners and riffle dwellers. High levels of suspended sediment limit these fish and their ability to occupy these niches. TSS tolerant taxa counts were near or just above average at all visits.

Recent TSS measurements collected on the reach corroborate historic transparency data, confirming high TSS levels occur within the reach. The macroinvertebrates are responding negatively to TSS stress, while metric data within the fish community is less defined. Additional chemistry data collection to obtain sufficient data to assess TSS on the reach would solidify TSS stress in the reach.

Table 29. Fish metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

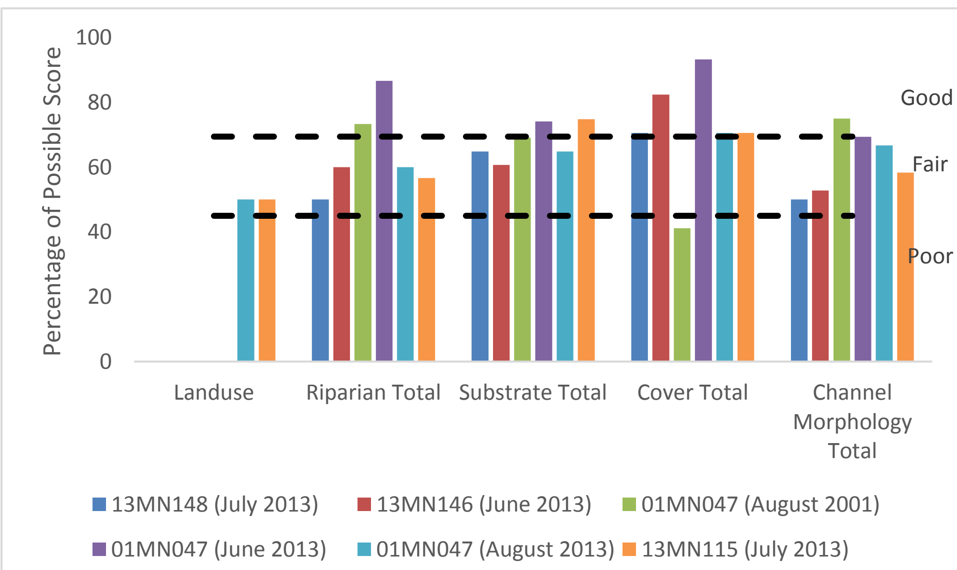
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN148 (2013)	**16.95**	**0.00**	**5.08**	**0.00**	**1.69**	**10.17**	**5.08**	**0.00**	**3.39**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
13MN146 (2013)	**7.35**	**0.00**	**6.86**	**0.00**	**0.98**	**0.98**	**6.86**	**0.00**	**6.86**
01MN047 (2001)	**18.77**	**0.00**	**9.39**	**0.00**	**3.97**	**9.03**	**9.39**	**0.00**	**3.25**
01MN047 (2013)	**8.98**	**1.63**	**8.57**	**0.00**	**2.04**	**2.04**	**8.57**	**0.00**	**7.76**
01MN047 (2013)	**29.58**	**0.96**	**14.47**	**0.00**	**3.54**	**18.33**	**14.79**	**0.32**	**14.47**
13MN115 (2013)	**21.30**	**0.96**	**6.86**	**0.00**	**6.14**	20.58	**6.86**	**0.00**	**4.45**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN148 (2013)	**20.88**	**0.00**	**0.00**	**2.00**	0.01
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
13MN146 (2013)	**23.96**	**0.00**	**0.00**	**3.00**	**42.00**
01MN047 (2001)	18.37	**0.00**	**0.00**	1.00	3.25
01MN047 (2013)	**20.38**	**0.00**	**0.00**	2.00	0.002
01MN047 (2013)	17.50	**0.00**	**0.00**	1.00	0.00
13MN115 (2013)	18.77	**0.00**	**0.00**	1.00	0.01
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.05*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

There were six qualitative habitat surveys conducted on this reach on four unique biological stations (see graph below). Stations 13MN148, 13MN146 and 13MN115 were each surveyed once in 2013, while station 01MN047 was surveyed once in 2001 and twice in 2013. Dominant landuse surrounding the reach is row crop agriculture. There are many small to moderately sized feedlots (swine, bovine and goat) within the confines of the watershed which encompasses this reach and two larger swine facilities approaching 1000 animal units. The small community of Delft lies in the central portion of the reach, further downstream effluent from the community of Mountain Lake joins the stream downstream of biological station 13MN146. The extent of riparian buffers vary along the reach with more extensive buffers observed in natural unaltered reaches, whereas smaller buffers are more apparent alongside channelized portions of the reach. Better channel development scores were observed in the lower two biological stations (01MN047 and 13MN115) versus the upstream two stations (13MN148 and 13MN146), riffles were not observed at upstream station 13MN148 but were identified within downstream stations. Bank erosion was more pronounced at the upstream most biological station on the reach, 13MN148, and was light at lower stations. Coarse substrates also appeared to be more prevalent moving downstream in the reach (see photos below). Embeddedness of coarse substrates was observed across the reach, with increased levels observed at the two mid stations (13MN146 and 01MN047). Stream stability scores were lowest in the upstream reach and increased moving downstream. Instream habitat cover was generally moderate across all MSHA surveys.

Figure 38. Percentage of MSHA subcategory scores for station 13MN148, 13MN146, 01MN047 and 13MN115 in Watonwan River.



All habitat stress metrics in the reach indicate a high likelihood that the fish community is stressed by degraded habitat conditions within the reach (see table below). All visits had an abundance of tolerant and pioneering taxa. All visits also had low quantities of piscivores, lithophilic and simple lithophilic spawners, 'darter, sculpin, sucker' taxa, riffle dwellers and benthic insectivores, which is a reflection of the absence or degradation of particular habitat niches which these taxa rely on.

Table 30. Fish metrics that respond to degraded habitat stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN148 (2013)	**83.05**	**0.00**	**11.86**	**10.17**	**66.10**	**5.08**	**11.86**	**5.08**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*31.00*
13MN146 (2013)	**98.53**	**0.49**	**27.45**	**0.49**	**23.53**	**6.86**	**0.49**	**19.12**
01MN047 (2001)	**86.64**	**0.00**	**51.62**	**8.30**	**53.79**	**9.39**	**9.39**	**9.75**
01MN047 (2013)	**93.88**	**0.00**	**32.65**	**0.41**	**75.10**	**8.57**	**0.41**	**18.37**
01MN047 (2013)	**80.39**	**0.96**	**48.23**	**14.79**	**68.49**	**14.79**	**15.11**	**19.94**
13MN115 (2013)	**79.06**	**0.96**	**30.57**	**14.44**	**70.88**	**6.86**	**14.44**	**9.39**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to habitat stress metrics within the macroinvertebrate community within the reach (see table below). While all visits had lower than average quantities of clinger and EPT taxa; there were above or near average quantities of sprawler, climber and burrowing taxa. An abundance of legless and burrower taxa indicates a prevalence of fine sediments within the reach, which is direct result of stream bank erosion observed within the reach (see photos below). An abundance of climber taxa indicate abundant overhanging vegetation. Low quantities of clinger taxa indicate limited availability of coarse substrates and woody debris; which is especially detrimental to communities in the RR class. This indicates that particular habitat types that burrowing, climbing, legless insects and sprawling species reside in are abundant while others which are more critical to the class are lacking. Limited habitat diversity and complexity can have direct negative implications on biological diversity within the reach.

Observational evidence from fair MSHA habitat scores including poor substrate conditions in conjunction with a clear metric response indicating limited habitat diversity implies that degraded habitat conditions are stressing both fish and macroinvertebrates within the reach.

Table 31. Macroinvertebrate metrics that respond to degraded habitat stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN146 (2013)	8.28	45.70	**22.52**	**26.16**	**61.59**	21.19
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
01MN047 (2001)	**14.67**	40.72	**23.65**	**17.07**	**67.67**	**12.58**
01MN047 (2013)	**8.13**	29.69	**34.06**	**39.38**	**51.25**	21.88
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

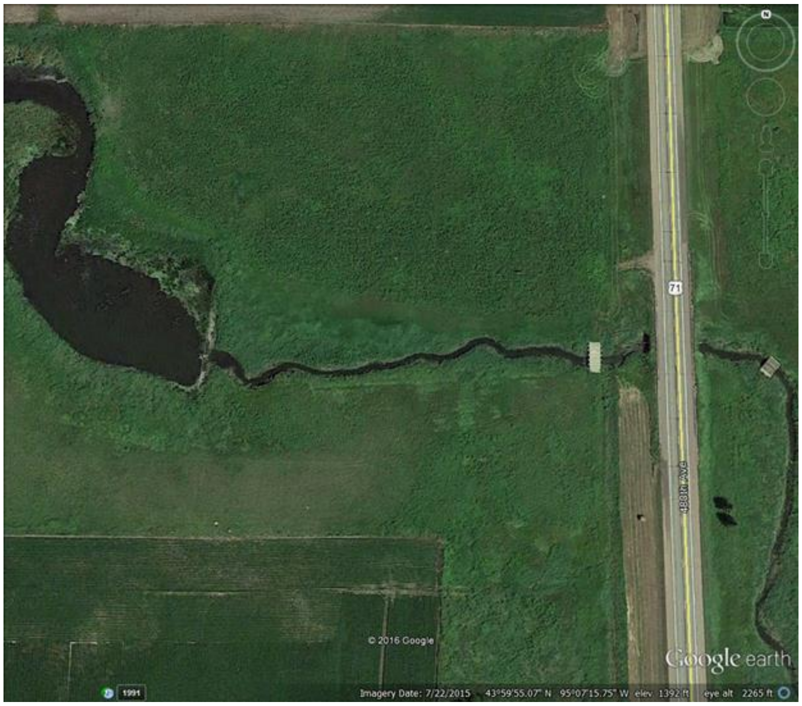
Figure 39. Biological station 13MN146 (June 12, 2013) stream bank erosion (left); biological station 13MN148 (July 8, 2013) stream bank erosion (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. Aerial photography indicated that there is a potential fish barrier upstream of biological station 13MN148 (see photo below). However, there were no fish community samples taken upstream of the potential barrier so it is unknown as to whether or not the barrier may be impacting the fish community within the reach.

Only four of 19 mussel species were identified within the reach during DNR mussel surveys from 1999-2003, *Anodontoides ferussacianus* (Cylindrical papershell), *Lampsilis siliquoidea* (Fatmucket), *Pyganodone giandis* (Giant Floater) and *Toxolasma parvum* (Lilliput). Many mussel taxa are dependent on migratory fish species to complete their life cycles, presence of mussel taxa within the reach could indicate that longitudinal connectivity is not a likely stressor within the reach; however, many mussel taxa identified further downstream in the watershed were not observed within this reach.

Figure 40. Fish barrier upstream of biological station 13MN148.



A comparison of fish diversity of biological stations across the reach and within the next downstream reach suggests that it is unlikely that unknown fish barriers (perched culverts, etc.) are impacting the fish community within the two reaches (-567 and -566).

Evidence of an old beaver dam was identified at biological station 13MN148 during SID investigations, the dam had been breached and did not appear to be causing any limitations to stream connectivity.

Three known migratory fish species were captured within the reach, black bullhead, central stoneroller and walleye (see table below). Central stoneroller were observed at all biological stations within the WID, while walleye and black bullhead were only observed at a single station. Blackside darter and shorthead redhorse, also migratory taxa, were observed within the next downstream WID. Presence of migratory fish taxa within the reach serves as additional evidence suggesting that connectivity is not be a likely stressor within the reach at this time.

Table 32. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Taxa names in blue are taxa typically found in lakes.

	13MN148	13MN146	01MN047	13MN115	13MN166	97MN018	13MN106
WID	-566	-566	-566	-566	-567	-567	-567
Fish Taxa							
bigmouth shiner	X	x	X	x	x	x	x
black bullhead			X			x	
black crappie						x	
blacknose dace	x	x	X	x	x	x	x
blackside darter						x	
bluntnose minnow	x	x	X	x	x		x
brassy minnow			X				x
central stoneroller	x	x	X	x	x		x
common carp	x	x	X			X	
common shiner		x	X	x	x	X	x
creek chub	x	x	X	x	x	X	x
fathead minnow	x	x	X	x			
green sunfish			X		x	x	
hybrid sunfish						x	
johnny darter	x	x	X	x	x	x	x
largemouth bass			X	x	x	x	x
northern hogsucker							x
northern pike							
orange spotted sunfish						x	
sand shiner	x	x	X	x	x	x	x
shorthead redhorse						x	
slenderhead darter							x
spotfin shiner							x
Stonecat			X				
tadpole madtom	x		X			x	
walleye		x				x	
white sucker	x	x	X	x	x	x	x
yellow bullhead	x		X	x			
yellow perch			X	x	x	x	x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 47.14 mile long reach of the Unnamed Creek (Mountain Lake Inlet) is 53% natural and 47% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. DNR conducted a geomorphology survey within the reach identifying it as deeply incised C4 channel, with a high sediment supply and high potential for erosion. The stream is highly sensitive to disturbance and buffers are generally lacking leading to stream bank instability; those which are present are helping provide some stability to a system that would decline at a faster rate in their absence. According to CADDIS, bank erosion and instability and undercut banks are site evidence that Altered Hydrology is a potential stressor, all of which were observed within the reach.

Presence of fish taxa that are typically seen in lakes could be an additional indication of low flow stress, black bullhead, largemouth bass, yellow bullhead and yellow perch are all taxa that inhabit lakes and were all identified at least one station on the reach. There was also few long-lived individuals within the community and a low percentage of taxa that require riffles, which are also indications of potential altered hydrology stress (see table below).

Table 33. Fish metrics that respond to altered hydrology stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	LlvdPct	RifflePct	TolPct
13MN148 (2013)	**1.69**	**5.08**	**83.05**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*4.50*	*26.20*	*70.64*
13MN146 (2013)	**0.98**	**6.86**	**98.53**
01MN047 (2001)	**3.97**	**9.39**	**86.64**
01MN047 (2013)	**2.04**	**8.57**	**93.88**
01MN047 (2013)	**3.54**	**14.79**	**80.39**
13MN115 (2013)	**6.14**	**6.86**	**79.06**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*13.60*	*30.20*	*44.85*
Expected response to Altered Hydrology stress	↓	↓	↑

Low flow conditions were observed on the reach in the fall of 2012 and 2013 (see photos below). In 2012, southwestern Minnesota was experiencing a significant drought; low flow conditions observed that year might have been influenced by extreme climatic conditions. In 2013, Low flow conditions also inhibited the ability of macroinvertebrate samples to be collected at station 13MN148. Baseflow concerns appear to be a continuous problem in the reach, and are only exacerbated by extreme climatic events.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

While longitudinal connectivity is not a likely stressor in the reach, low flow conditions observed in 2012 and 2013 provide strong evidence that altered hydrology is stressing the biological communities within the reach.

Figure 41. Biological station 13MN146 (September 12, 2012) low flow (left); biological station 01MN047 (September 13, 2013) low flow (right).

4.1.3. AUID Summary

Elevated concentrations of nitrate, degraded habitat conditions and altered hydrology are stressing biological communities in the reach. Elevated concentrations of nitrogen were observed within the reach during spring sampling when agricultural runoff and drain tile flow is most prevalent; an abundance of nitrate tolerant individuals within the reach, high nitrate index scores, in addition to low quantities of nitrate intolerant taxa confirm nitrate stress in the reach. Fair MSHA results in conjunction with biologic metric response confirm habitat stress within the reach. Limited habitat diversity is limiting biological communities. A prevalence of stream bank erosion on the reach has limited the availability of coarse substrates to sensitive taxa in the reach like lithophilic spawners, EPT and clinger taxa and increased the prevalence of taxa that can thrive in degraded conditions including burrower, legless and pioneering taxa. Evidence of low flow conditions during the fall of 2012 and the summer of 2013 demonstrate persistent base flow concerns on the reach. Fish metrics also showed potential influence to low flow conditions with few long-lived and riffle dwelling taxa and the presence of lake taxa. Many observed stressors within the reach can be linked back to altered hydrology. Historic channelization and agricultural inputs via tile drainage have altered natural stream hydrology, by creating a system designed to move water off the landscape quickly, resulting in degraded habitat conditions, seasonally high nitrate concentrations and low late summer flows, which can contribute to abundant algal growth and seasonally eliminate vital aquatic habitat via dry streambeds.

Macroinvertebrates in the reach are also stressed by suspended sediments. Elevated TSS levels were identified historically on the parent reach, while there was insufficient chemistry data to reassess TSS in the reach in 2015; new data collected indicates elevated TSS levels persist, especially after rainfall events. An abundance of TSS tolerant macroinvertebrate taxa in the reach in conjunction with high TSS index score point to elevated TSS concentrations and stress to the macroinvertebrates within the reach. Additional chemistry collection to bolster the recent chemical dataset for assessment could help solidify TSS stress in the reach.

Low DO and eutrophication are inconclusive stressors in the reach at this time. Continuous sonde data from 2016 at the upstream most station shows low DO conditions can be persistent within the reach; however, there is limited biological metric data to infer low DO conditions are a driving stressor within the reach. An upstream wetland may be a source of low DO observed. Additional investigation to understand the extent and cause of low DO conditions could be useful as well as efforts to obtain a macroinvertebrate sample at 13MN148, where low conditions were observed, as well as later summer fish samples when low DO conditions are more likely to occur. Phosphorous collection within the reach was sparse and produced limited evidence of elevated P concentrations, sufficient response variable information was not available to confirm the potential eutrophication problems within the reach. However, photographic evidence of abundant algae in the reach suggests the potential for elevated P concentrations to exist, as does a negative response from biological metrics, especially at station 13MN148 which could indicate potential isolated stress within the reach. Additional evidence to confirm elevated P concentrations would be useful in better defining the potential of stressor as well as obtaining corroborating response variable information.

Suspended sediments were an inconclusive stressor to the fish community in the reach. Despite chemical evidence of high TSS conditions occurring within the reach and historic transparency data, there was an inconsistent response to TSS stress metrics and a limited presence of TSS tolerant taxa within the reach. Additional information is needed to confirm or refute TSS stress to the fish community. However, any efforts to lower TSS concentrations in the reach to improve the macroinvertebrate community would also likely benefit the fish community.

An absence of barriers between biological stations in the reach, in conjunction with presence of migratory fish taxa and mussel taxa that rely on fish movement to complete their life cycle, suggests that longitudinal connectivity is not a likely stressor within the reach.

Table 34. Summary of stressor determinations for Watonwan River (566).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Watonwan River	07020010-566	o	o	●	o/●	●	●	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

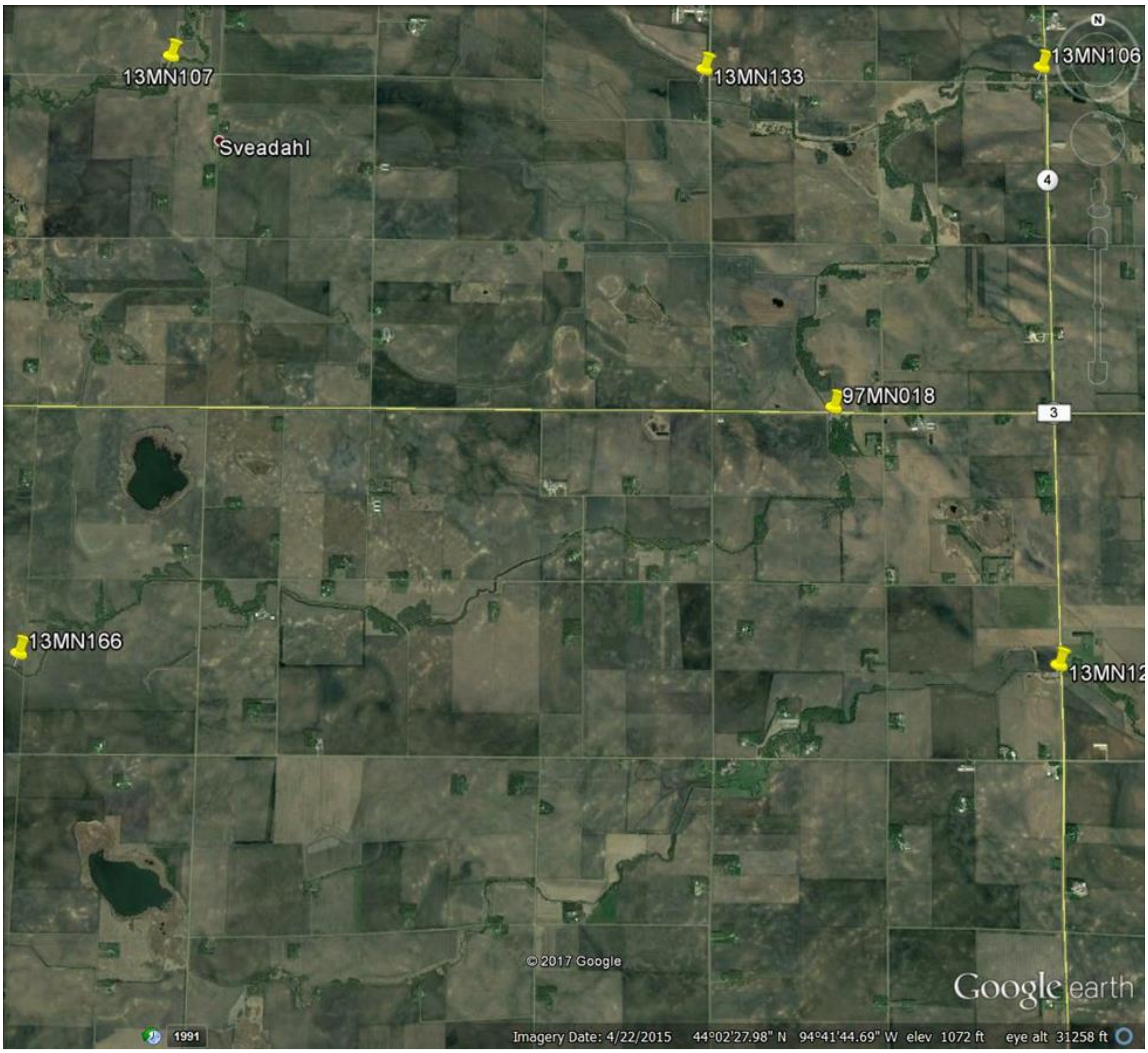
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1 Watonwan River -567

Reach (07020010-567) is the continuation of the mainstem Watonwan River, starting at the end of reach (07020010-566) 2 miles east of Co. Hwy 124 and flowing 12.3 miles northeast, ending before its confluence with the North Fork Watonwan River downstream of Twp. Hwy 77, approximately 3 miles east of Sveadahl. Classification for this reach is modified warmwater Class 2Bm. This reach is impaired for aquatic life, for lacking fish assemblage and excessive levels of turbidity, and aquatic recreation for high levels of fecal coliform bacteria.

Throughout its course, this reach gains the flow of two Unnamed Creeks (07020010-555 and 07020010-556). Reach -555 meets modified aquatic life use standards while reach – 556 not assessed for aquatic biology.

Figure 42. Google Earth image of Watonwan River (-567).

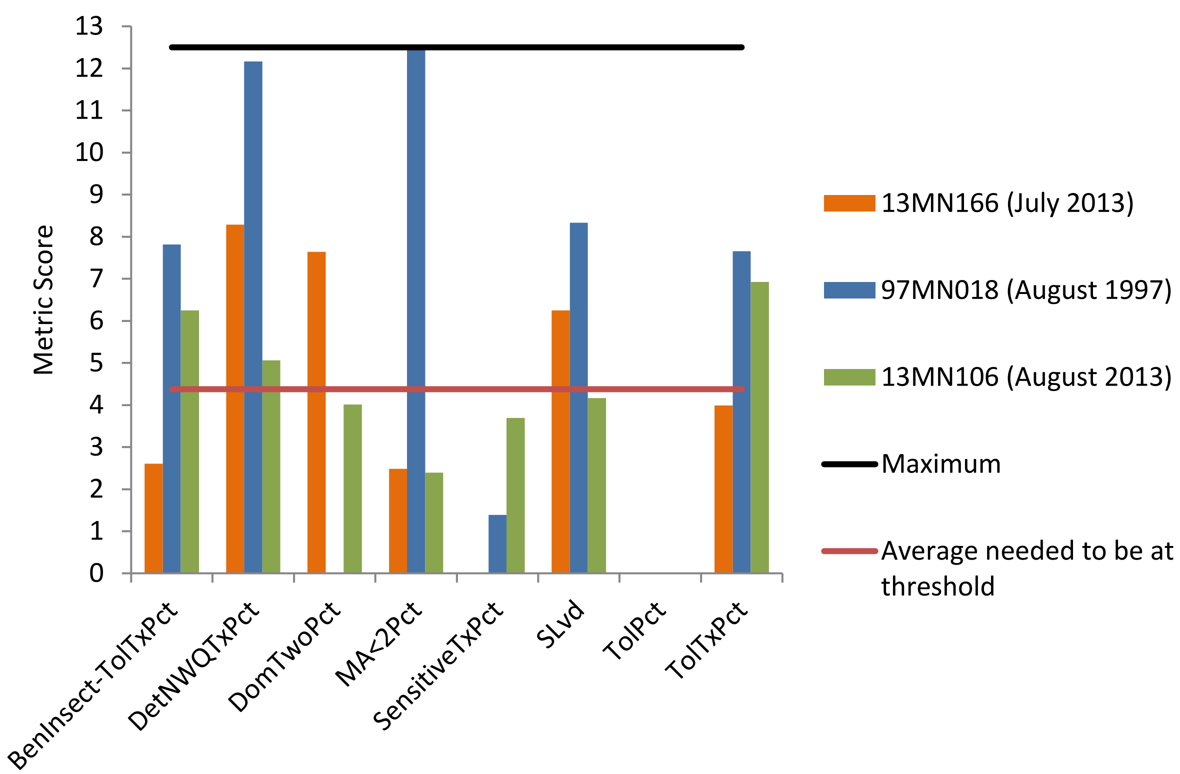


4.1.1 Biological communities

This reach has three biological monitoring stations. Stations 13MN166 and 13MN106 were each visited in 2013, while 97MN018 was visited once in 1997. FIBI scores at 2013 visits scored below the threshold (35) and lower confidence limits while the 1997 visit scored within lower confidence limits. This suggests that conditions may have degraded in the reach overtime (see graph below). The dominant species across all three stations are tolerant of degraded conditions and included: bluntnose minnow, bigmouth shiner, sand shiner and black bullhead. All visits had zero values for the tolerant percent metric (TolPct) and had low quantities of sensitive taxa (SensitiveTxPct).

Macroinvertebrates were sampled at 13MN166 and 13MN106 in 2013 and met aquatic life use standards, scoring very near the impairment threshold.

Figure 43. Fish metrics of the Southern Streams Class IBI for station 13MN166, 97MN018 and 13MN106, Watonwan River.



4.1.2 Data evaluation for each Candidate Cause

Dissolved oxygen

There were four DO measurements collected during the biological visits at two stations within the reach. DO values ranged from 7.25 mg/L on July 16, 2013 at 8:13am at station 13MN166 to 10.79 mg/L on August 15, 2013 at 11:34 am at station 13MN106. Twenty-one additional DO samples were collected from 2013 – 2016, values ranged from 8.01 mg/L to 12.61 mg/L (see graph below). No values were below the low DO standard of 5 mg/L. In 2015, a YSI sonde was placed at station 97MN018 to monitor continuous DO within the reach. All readings were above the 5 mg/L DO standard. The DO flux eutrophication standard of 4.5 mg/L was exceeded on two days during the end of deployment (see graph below). DO flux readings ranged from 2.82 mg/L to 5.44 mg/L with an average DO flux of 3.86 mg/L.

Figure 44. Diurnal DO results for station 97MN018 July 31 - August 16, 2015.

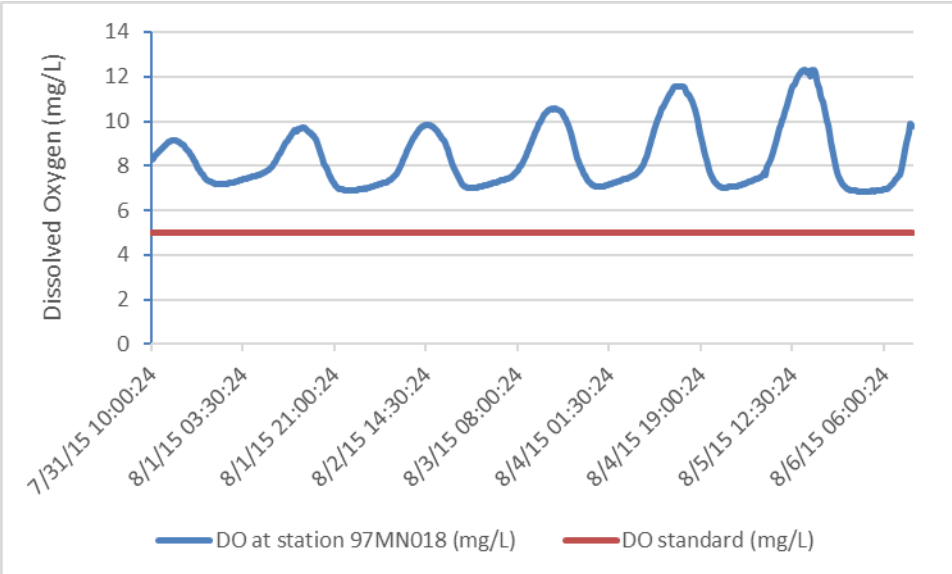
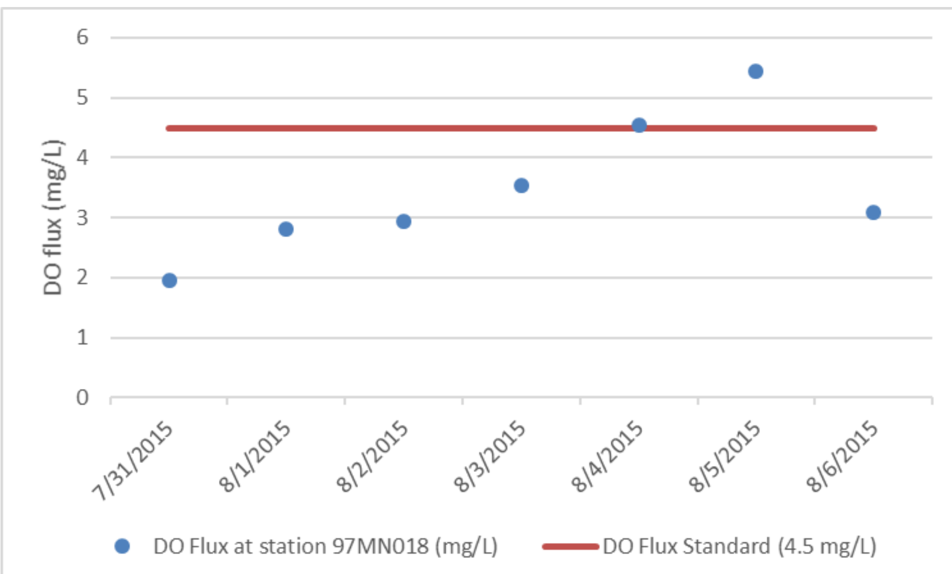


Figure 45. Daily DO Flux results for station 97MN018 July 31 - August 16, 2015.



The macroinvertebrate community does not appear to be responding to low DO stress (see table below). The DO Index score was above the average needed to meet the threshold for the prairie streams class at both visits. There were greater than average quantities of low DO intolerant taxa and individuals as well as lower than average quantities of low DO tolerant taxa and individuals, indicating that the community is not likely impacted by low DO stress.

Table 35. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN166 (2013)	**34.00**	10.00	**8.20**	7.05	4.00	6.60	4.00	15.84
13MN106 (2013)	**31.00**	10.00	**8.30**	6.91	6.00	15.19	5.00	20.25
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish community is showing a mixed signal to low DO stress metrics (see table below). Fish metrics from station 97MN018 show a greater probability for low DO stress that what was observed at stations 13MN166 and 13MN106. The DO index score is below the average needed to meet the threshold only at 97MN018; there was also a higher than average quantity of DO tolerant taxa at this station, not observed at the other sites. All stations showed an absence of DO sensitive taxa and few to no generally sensitive taxa. The percentage of generally tolerant taxa was high across all visits but high numbers of DO tolerant individuals were not observed at any of the three stations; this could mean that stress observed may be a result of a different stressor. Results indicate a potential isolated low DO stress at station 97MN018; however, more recent data on the reach could also indicate a potential change in DO conditions in the reach over time for the better.

Lack of chemical evidence to indicate low flow conditions exist in additional to very limited DO metric response from the fish and macroinvertebrates indicate that low DO is not a likely stressor in the reach at this time.

Table 36. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN166 (2013)	**0.00**	**12.48**	**90.20**	**7.16**	**0.00**	**0.00**	3.00	8.32
97MN018 (1997)	**0.30**	**11.68**	**88.02**	**6.30**	**0.00**	**0.00**	**8.00**	**83.83**
13MN106 (2013)	**0.12**	**11.50**	**78.94**	7.24	**0.00**	**0.00**	3.00	10.96
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*8.38*	*27.98*	*46.38*	*6.78*	*0.1*	*1.08*	*5.5*	*54.58*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

Phosphorous values collected during the fish visits were below the southern regional eutrophication standard of 0.15 mg/L. Phosphorous monitoring on the reach in 2015 produced one additional sample showing similar results. A chlorophyll a sample was also taken in 2015 of 34.2 ug/L, just below the southern eutrophication standard of 35 ug/L. Values of DO samples collected on the reach range from 7.25 mg/L to 12.61 mg/L indicating potential for elevated DO flux. During continuous sonde deployment in 2015 the DO flux eutrophication standard of 4.5 mg/L was exceeded on two days during the end of deployment. DO flux readings ranged from 2.82 mg/L to 5.44 mg/L with an average DO flux of 3.86 mg/L. There were no BOD samples collected on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values on the reach ranged from 7.26 to 9.00. Twenty-five samples were collected from 2013-2016, 2 samples were above 8.5.

Macroinvertebrate metrics show somewhat discrepant results in this reach with response to eutrophication stress (see table below). The communities had an abundance of tolerant taxa, an absence of intolerant taxa and a limited quantity of collector-filterer taxa. While a greater signal was present at station 13MN106, results were less defined at 13MN166 where the collector-gatherer count was just above the class average needed to meet biocriteria. Eutrophication stress metrics are general in nature and are not direct indicators of eutrophication stress and may be responding to other stressors within the reach.

Table 37. Macroinvertebrate metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN166 (2013)	34.00	**2.00**	16.00	10.00	**0.00**	79.41
13MN106 (2013)	**31.00**	**3.00**	**11.00**	10.00	**0.00**	83.87
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to stress	↓	↓	↓	↓	↓	↑

The fish community showed a more consistent response to general eutrophication stress metrics (see table below). All samples had a high percentage of tolerant taxa, an absence of intolerant taxa, and limited sensitive taxa. Both darter and simple lithophilic spawner counts were below the average threshold needed to meet biocriteria for the southern streams class. However, these metrics are very general indicators of stress and do not directly implicate eutrophication as a stressor in the reach and could be an indication of other stressors present. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous taxa were only observed at the mid station of the reach in the early mid ‘90s. This could suggest a reduction of eutrophication across the reach in more recent years or a potential isolated source of eutrophication stress within the reach.

Table 38. Fish metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN166 (2013)	**0.00**	**1.21**	**13.42**	7.11	**90.20**	**12.00**	**0.00**
97MN018 (1997)	**0.30**	**4.79**	**11.98**	**84.13**	**88.02**	20.00	**0.00**
13MN106 (2013)	**0.12**	**5.60**	**8.76**	5.42	**78.94**	**15.00**	**0.00**
Statewide average for Class 2 Southern Streams that are meeting the FIBI Modified Use Threshold (35.0)	*8.38*	*13.57*	*26.17*	*25.1*	*46.38*	*14.52*	*0.86*
Expected response to stress	↓	↓	↓	↑	↑	↓	↓

Eutrophication is an inconclusive stressor to the biota on the reach at this time. While response variable metrics suggest potential for eutrophication stress, including elevated chlorophyll a concentrations and elevated DO flux, there is limited phosphorous data present in the reach and at present there are no results that rise above the present standard.

Nitrate

There were two fish visits with nitrate concentration data in 2013. Nitrate concentrations were 7.1 mg/L at 13MN166 on July 16, 2013 and 1.2 mg/L on August 1, 2013. There were 75 additional samples collected in 2000, 2001, 2002, 2013, 2015 and 2016. Samples were collected from May thru September. Nitrate concentrations ranged from 0.2 mg/L on in August and September of 2000, 2002 and 2013 to 18.3 mg/L on July 1, 2013, with an average concentration of 8.36. Only 3 nitrate samples were above 15 mg/L and occurred in June and early July. Nitrate concentrations appear to be above normal background conditions in the reach but do not appear as high as observed on other reaches within the watershed.

Fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate. The macroinvertebrates in this reach are not impaired, but respond to some metrics that indicate potential nitrate stress (see table below). The nitrate specific metrics show better than average Trichoptera taxa, at one of the two reaches, and above average percentages of non-hydropsychid trichoptera at both reaches. The nitrate index score ranged from 3.98 to 4.11, while the average for the Prairie Streams GP MU Class meeting impairment threshold is 3.2. This suggests that overall the community present is somewhat tolerant to high nitrate concentrations. This can also be seen with the high percentage of nitrate tolerant individuals, while the nitrate tolerant taxa count is only three taxon above the class' average. Nitrate intolerant taxa were below the threshold at both stations but this could be caused by other potential stressors. While nitrate in this reach is not a stressor to the fish community, the macroinvertebrates are signaling nitrate stress, even though they are not impaired at this time. Reductions in nitrate are necessary before the macroinvertebrates also become impaired.

Table 39. Macroinvertebrate metrics that respond to nitrate stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Date fish sample)
13MN166 (2013)	**34.00**	**2.00**	16.00	**8.00**	**0.00**	**79.41**	**2.00**	5.28	**3.98**	1.00	**21.00**	**82.80**	7.10 (7/16/2013)
13MN106 (2013)	**31.00**	**3.00**	**11.00**	**10.00**	**0.00**	**83.87**	5.00	3.16	**4.11**	**0.00**	**21.00**	**88.30**	1.20 (8/1/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*	*2.60*	*2.40*	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Two TSS samples were collected at two biological stations during fish visits in 2013, neither sample was above the southern regional TSS standard of 65 mg/L. Seventy TSS samples were collected on the reach from 2000 -2002 and in 2013, 33 of these readings were above the TSS standard. Samples collected in the early 2000s, identified exceedances in 2000 and 2002, and attributed to a 2006 turbidity impairment (samples were collected from April to September). Samples collected in 2013 were part of intensive watershed monitoring efforts and were collected twice per month from May thru September and did not produce any exceedances. Two additional TSS samples were collected in 2015 as part of SID investigations; neither sample was above the regional TSS standard. Twenty-one transparency measurements were collected in the watershed from 2013 to 2016, ranging from 6 cm to 100 cm. Only two readings fell below the southern Minnesota standard of 10 cm.

A majority of fish metric data indicates that TSS is a likely stressor in the reach (see table below). The TSS Index score was above the Southern Streams Class average indicating a likely potential for TSS stress. All taxa related metrics responded negatively to TSS stress. There were low quantities of benthic feeders, centrarchids, herbivores, intolerant and sensitive species, long-lived taxa, simple lithophilic spawners and riffle dwelling species. While TSS intolerant taxa were absent, TSS tolerant taxa were abundant at biological station 13MN106 but not at 13MN166 or 97MN018.

Table 40. Fish metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN166 (2013)	**8.86**	**2.82**	**7.65**	**0.00**	**8.19**	**9.40**	**7.65**	**0.00**	**7.11**
97MN018 (1997)	**8.98**	**0.30**	**6.29**	**0.00**	**9.58**	**9.88**	**7.19**	**0.30**	**7.49**
13MN106 (2013)	**11.87**	**2.98**	**6.33**	**0.00**	**9.07**	**14.61**	**6.39**	**0.12**	**5.48**
Statewide average for Class 2 Southern Streams that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*17.98*	*0.86*	*21.25*	*28.69*	*19.54*	*8.38*	*16.15*
Expected response to stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN166 (2013)	**19.78**	0.00	0.00	1.00	11.10
97MN018 (1997)	**24.83**	0.00	0.00	**4.00**	0.01
13MN106 (2013)	**22.93**	0.00	0.00	2.00	**39.00**
Statewide average for Class 2 Southern Streams that are meeting the FIBI Modified Use Threshold (35.0)	*19.64*	*0.00*	*0.00*	*2.70*	*28.19*
Expected response to TSS stress	↑	↓	↓	↑	↑

A majority of the macroinvertebrate related TSS stress metrics within the reach responded negatively, indicating potential stress as well (see table below). The TSS Index score at both stations on the reach was greater than the Prairie Streams GP average, indicating that elevated TSS levels are likely influencing the macroinvertebrate community. While TSS intolerant taxa were present in the reach, their numbers were low. Similarly TSS tolerant taxa numbers were below average for the class; however, they comprised a greater percentage of the overall community, also indicating stress. Plecoptera and collector-filterer taxa counts were also low in the reach, both taxon require high water clarity for foraging, low quantities of these taxa are indicative of TSS stress.

A majority of evidence suggests that TSS is a likely stressor in the reach.

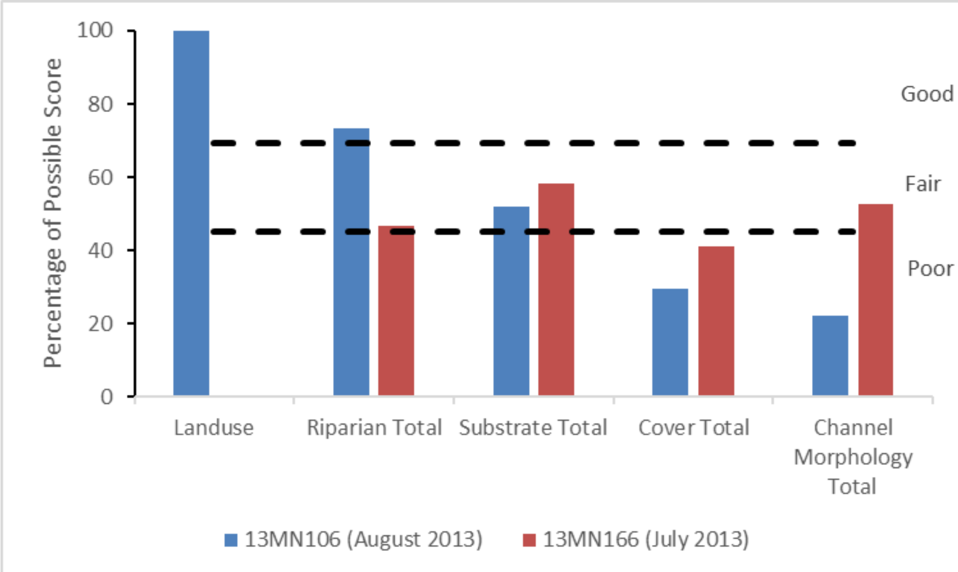
Table 41. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN166 (7/16/2013)	**4.95**	**0.00**	**19.65**	1.00	**0.33**	**11.00**	**50.83**
13MN106 (8/1/2013)	**6.96**	**0.32**	**18.12**	2.00	**0.63**	9.00	**57.59**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.02*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Habitat

Two qualitative habitat surveys were conducted on this reach at two unique biological stations, 13MN166 and 13MN106 both sampled in 2013 (see graph below). MSHA scores were slightly higher at the upstream station versus the downstream station; 13MN166 had a fair score (48.7), while 13MN106 had a poor score (43). The surrounding landuse for the reach was dominated by row crop agriculture. A few small cattle and large swine operations dot the adjacent landscape. Along its course the reach is mostly channelized, a few small stretches have retained their natural character. Riparian buffers vary in size throughout the reach, with larger buffers observed where the adjacent riparian zone is heavily wooded and smaller buffers seen where grass buffer strips with scattered trees line the stream banks. Limited instream habitat cover was available to the biota at either reach. Natural channel progression was limited at the biological stations; the downstream station was 100% run, and the upstream station was 85% run. Fine sediments dominated both stations while what coarse substrates were present were severely embedded. Greater amounts of bank erosion were observed at the upstream station 13MN166 (see photos below). While sediment deposition was apparent at station 13MN106, (see photo below). Overall channel stability was moderate at both stations which can likely be attributed to past ditching efforts within the reach.

Figure 46. Percentage of MSHA subcategory scores for station 13MN106 and 13MN166 in Watonwan River.



A majority of habitat related stress metrics within the reach indicate that the fish community is likely stressed by degraded habitat conditions within the reach (see table below). At all visits there were above average quantities of tolerant taxa. There were limited quantities of piscivores, lithophilic and simple lithophilic spawners, 'darter, sculpin, sucker' taxa, riffle dwelling species and benthic insectivores, suggesting that limited habitat diversity is available within the reach. While there were low quantities of pioneering species present at two stations visited, their absence is negated by other stronger habitat related metrics in the reach, which are showing an impact.

Table 42. Fish metrics that respond to degraded habitat stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN166 (2013)	**90.20**	**2.82**	**29.53**	**1.21**	**47.65**	**7.65**	**1.21**	**13.42**
97MN018 (1997)	**88.02**	**1.50**	**12.57**	**5.39**	2.40	**7.19**	**5.69**	**11.98**
13MN106 (2013)	**78.94**	**2.98**	**12.17**	**5.66**	12.96	**6.39**	**5.66**	**8.76**
Statewide average for Class 2 Southern Streams that are meeting the FIBI Modified Use Threshold (35.0)	*46.38*	*8.02*	*35.59*	*16.45*	*23.58*	*19.54*	*19.05*	*26.17*
Expected response to stress	↑	↓	↓	↓	↑	↓	↓	↓

The macroinvertebrate community in the reach shows an abundance of burrowing and legless taxa and below average numbers of clinger taxa (see table below). Abundance of burrowing taxa are consistent with the prevalence of fine sediments identified in the reach and low quantities of clinger taxa are consistent to the fact that limited coarse substrates and woody debris were available. Riffle dwelling taxa and simple lithophilic spawners are also limited within the reach, also likely to poor substrates. Limited coarse substrate availability is likely connected to stream bank erosion and sedimentation in the reach (see photos below), which in turn is increasing TSS levels in the reach.

Fish and macroinvertebrate metrics show habitat diversity is lacking in the reach. Habitat observations made within the reach corroborate limiting conditions that are stressing the biota. As such, habitat is a stressor to the fish community within the reach.

Table 43. Macroinvertebrate metrics that respond to degraded habitat stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN166 (7/16/2013)	**19.80**	24.10	**15.51**	31.02	**65.35**	29.70
13MN106 (8/1/2013)	**25.95**	39.24	**18.99**	21.21	**75.95**	**11.39**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 47. Biological station 13MN106 (August 1 2013) sediment (left); biological station 13MN166 (August 15, 2013) stream bank erosion (middle); biological station 13MN166 (July 16, 2013) stream bank erosion.

Altered hydrology/Longitudinal connectivity

There are no documented dams or fish barriers within the reach. A comparision of fish diversity of biological stations across the reach and the next downstream reach suggests that it is unlikely that unknown fish barriers (perched culverts, etc.) are impacting the fish community within the two reaches (-567 and -566) as similar assemblages are found throughout the biological stations.

Only five of 19 mussel species looked at during DNR mussel surveys from 1999-2003 were identified within the reach, including: *Anodontoides ferussacianus* (Cylindrical papershell), *Lasmigona companata* (White heelsplitter), *Lampsilis siliquoidea* (Fatmucket), *Pyganodone giandis* (Giant Floater) and

Toxolasma parvum (Lilliput). Many mussel taxa are dependent on migratory fish species to complete their life cycles, presence of mussel taxa within the reach could indicate that longitudinal connectivity is not a likely stressor within the reach.

Seven known migratory fish species were captured within the reach, including: black bullhead, blackside darter, central stoneroller, shorthead redhorse, slenderhead darter, walleye and white sucker (see table below). White sucker were observed at all three stations along the WID, central stonerollers were observed at two stations, while slenderhead darter, shorthead redhorse, black bullhead and blackside darter were only observed at a single station. Presence of migratory fish taxa within the reach serves as additional evidence suggesting that connectivity is not a likely stressor within the reach.

Preponderance of evidence suggests longitudinal connectivity is not a stressor at this time.

Table 44. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Taxa in blue are considered lake species.

Field Number	13MN148	13MN146	01MN047	13MN115	13MN166	97MN018	13MN106
WID	-566	-566	-566	-566	-567	-567	-567
bigmouth shiner	x	x	x	x	x	x	x
black bullhead			x			x	
black crappie						x	
blacknose dace	x	x	x	x	x	x	x
blackside darter						x	
bluntnose minnow	x	x	x	x	x		x
brassy minnow			x				x
central stoneroller	x	x	x	x	x		x
common carp	x	x	x			x	
common shiner		x	x	x	x	x	x
creek chub	x	x	x	x	x	x	x
fathead minnow	x	x	x	x			
green sunfish			x		x	x	
hybrid sunfish						x	
johnny darter	x	x	x	x	x	x	x
largemouth bass			x	x	x	x	x
northern hogsucker							x
northern pike							
orange spotted sunfish						x	
sand shiner	x	x	x	X	x	x	x
shorthead redhorse						x	
slenderhead darter							x
spotfin shiner							x
stonecat			x				
tadpole madtom	x		x			x	
walleye		x				x	
white sucker	x	x	x	X	x	x	x
yellow bullhead	x		x	X			
yellow perch			x	X	x	x	x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 12.31 mile long reach of the Watonwan River is 100% modified. A majority of the next upstream reach of the Watonwan River -566 is natural; however, there are large portions of its very headwaters that are also heavily altered. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that Altered Hydrology is a potential stressor, while only bank erosion and reduced stability was observed at the biological sites, sedimentation appears to be a concern within the reach.

Presence of fish taxa that are typically seen in lakes could be an additional indication of low flow stress. Black bullhead, black crappie, largemouth bass, yellow bullhead and yellow perch are all taxa that inhabit lakes and were all identified at least one station on the reach. There was also few long-lived individuals within the community and a low percentage of taxa that require riffles, which are also indications of altered hydrology stress (see table below).

Table 45. Fish metrics that respond to altered hydrology stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	RifflePct	LlvdPct	TolPct
13MN166 (2013)	**7.65**	**8.19**	**90.20**
97MN018 (1997)	**7.19**	**9.58**	**88.02**
13MN106 (2013)	**6.39**	**9.07**	**78.94**
Statewide average for Class 2 Southern Streams that are meeting the FIBI Modified Use Threshold (35.0)	*19.54*	*21.25*	*46.38*
Expected response to Altered Hydrology stress	↓	↓	↑

Low flow conditions were observed on the reach in the fall of 2012. In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on its biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Evidence suggests that low flow conditions are causing altered hydrology stress within the reach.

Figure 48. Biological Station 13MN103 (September. 12, 2012) low flow.

4.1.3 AUID Summary

Elevated concentrations of TSS, degraded habitat and altered hydrology are stressing fish communities within the reach.

A turbidity impairment was identified within the reach in 2006. Both fish and macroinvertebrate communities exhibit evidence of TSS related stress with limited presence of taxa groups that can persist under turbid conditions, including: simple lithophilic spawners, riffle dwellers, benthic insectivores, perciforms, plecoptera and collectorer filterer taxa. Evidence of stream bank erosion in the reach seen in photos above; indicate prevalence of sediment loading during runoff events.

Biology in the channelized reach were held to modified use standards in the reach due to degraded habitat conditions. The MSHA stream habitat survey revealed a ubiquitous stream channel with little depth variability or natural channel progression, dominated by fine substrates and lacking cover. What coarse substrates were available were severely embedded and bank erosion was prevalent in the reach.

Past channelization in the reach in addition to limited natural riparian zones are likely contributing to elevated TSS concentrations, as peak flow events, exacerbated by stream straightening and contributions by tile drainage, are scouring unprotected stream banks, supplying the river with large amounts of sediment covering present coarse substrates and limiting available habitat to coarse substrate and riffle dwelling obligates.

Low flows identified in the reach during the fall of 2012 provides additional evidence that baseflow within the reach is unstable. Presence of lake dwelling taxa and a small quantity of long-lived taxa are also indicators of altered hydrology stress.

Eutrophication is an inconclusive stressor. At present, there are no phosphorous readings that rise above the southern region eutrophication standard. However, elevated DO flux and chlorophyll a readings were detected during SID investigations, suggesting for potential for elevated P concentrations to exist. Additional P data collection could reveal high P concentrations eluded to by response variable indicators.

Low DO, nitrates and longitudinal connectivity are not stressing the fish in the reach at this time. Grab samples and continuous sonde deployment did not produce any evidence that low DO conditions exist within the watershed. Low DO tolerant taxa were not abundant across the reach and Low DO Index scores were near their respective averages.

Fish communities are not responsive of elevated nitrogen concentrations. High nitrate concentrations were identified within the reach during the spring months when agricultural runoff is greatest. The macroinvertebrate community, while not impaired, showed signs of nitrate related stress. As the MIBI is only marginally above the standard efforts should be made to reduce nitrate concentrations within the reach before they fall below impairment thresholds.

There are no known barriers in the reach to limit fish passage. Presence of diverse mussel taxa and migratory fish taxa are also indications that fish are moving freely within the reach and are not limited by structural barriers.

Table 46. Summary of stressor determinations for Watonwan River (567).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
Watonwan River	07020010-567	--	o	--	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

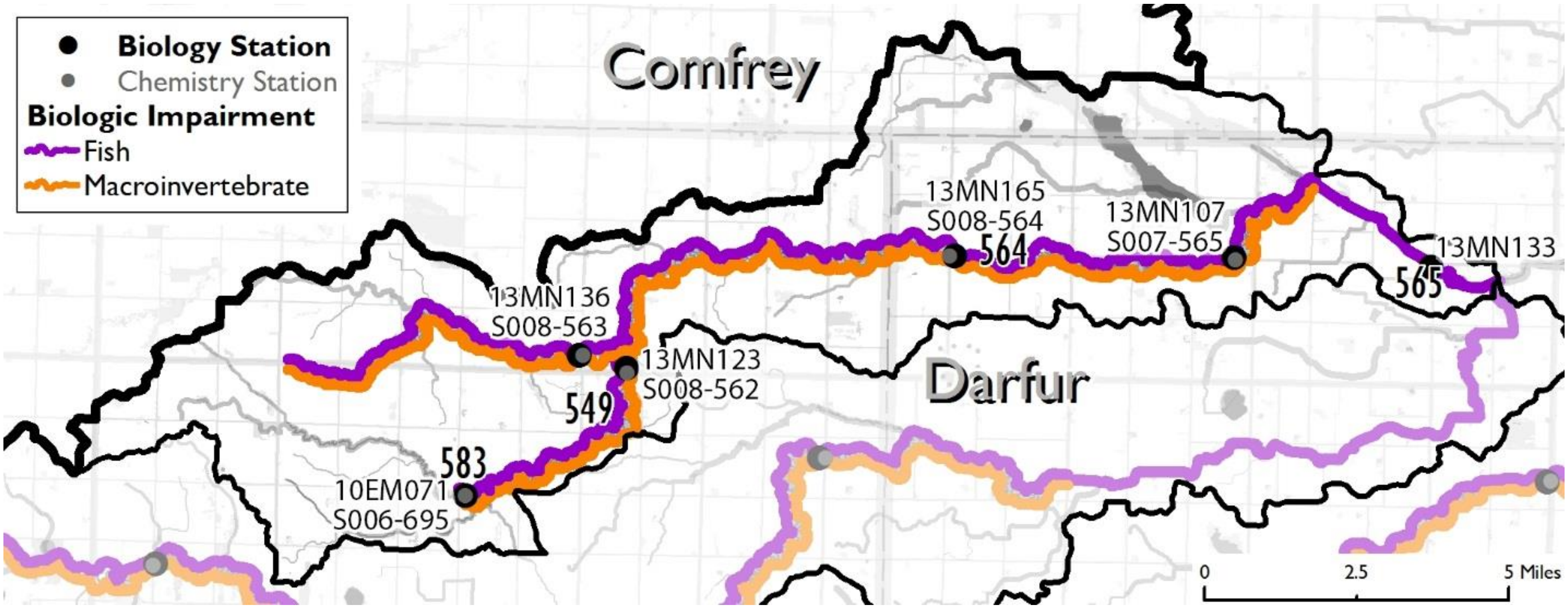
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

North Fork Watonwan River

The North Fork of the Watonwan River flows west to east. It begins eight miles east of Jeffers, several miles north of the headwaters of the mainstem Watonwan River. It joins the mainstem Watonwan about four miles west of La Salle.

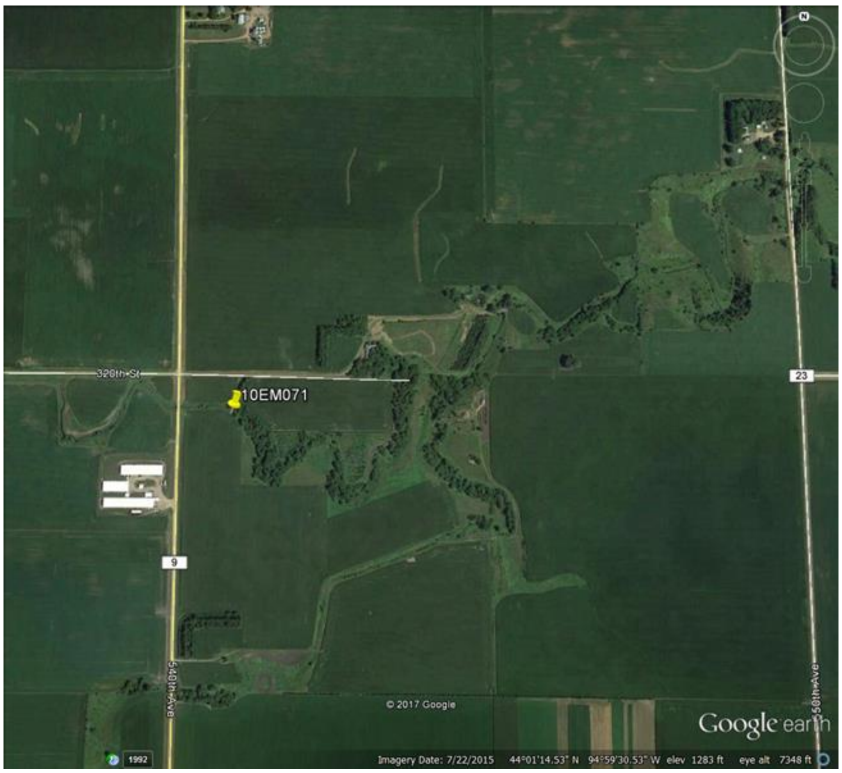
Figure 49. Biological impairment map of the North Fork Watonwan River subwatershed.



4.1 Unnamed Creek -583

Reach (07020010-583) is an upstream section of Unnamed Creek (07020010-549). This reach begins downstream of 540th Ave and flows only 0.8 miles before transitioning to downstream reach (07020010-549). This reach is classified as general use warmwater 2Bg. This reach is impaired for aquatic life due to lacking fish and macroinvertebrate communities (2015).

Figure 50. Google Earth image of Unnamed Creek (-583).



4.1.1 Biological communities

One biological monitoring station located on reach, 10EM071, was sampled in 2010, 2013 and 2015 for both assemblages. The FIBI at the initial visit in 2010 scored 59, above the threshold (55) but within lower confidence limits, while the following two visits scored below the threshold but within lower confidence limits, 45.1 and 47.2 respectively. Diversity dropped from 14 taxa in 2010 to 7 taxa at following visits. All visits lacked sensitive taxa. There was an increase in the very tolerant taxa percent metric and the general taxa percent metric when comparing the 2010 visit to the 2013 visit (see graph below).

The MIBI scores were below the threshold (MIBI: 37), while the first (MIBI: 26.5) and third (MIBI: 25.3) visits were within lower confidence limits while the second (MIBI: 16.3) visit was below lower confidence limits. From visit 1 to visit 2, there was a complete loss of trichoptera, but trichoptera were found again in visit 3. There was also a drop in the insect (InsectTxPct) and clinger taxa percent (ClingerChTxPct) (see graph below). Physa hyper dominated the sample at the second visit, explaining the lower overall MIBI score compared to the initial and final visits. The third visit was dominated by Physella taxa.

Figure 51. Fish metrics of the Southern Headwaters Class IBI for station 10EM071, Unnamed Creek.

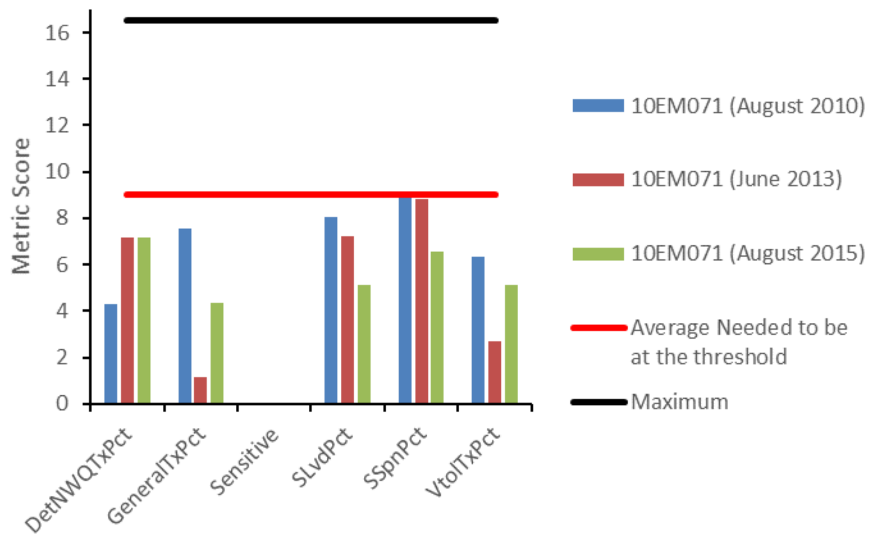
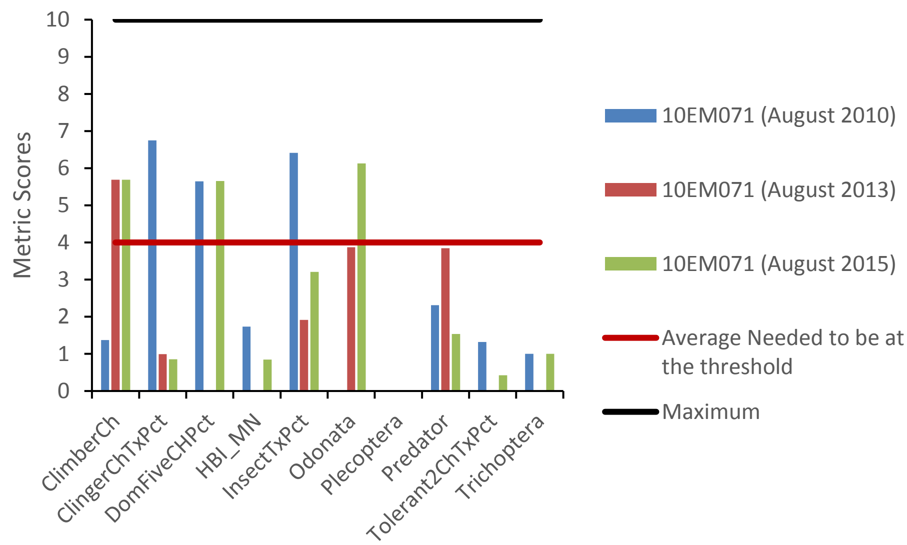


Figure 52. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 10EM071, Unnamed Creek.



4.1.2 Data evaluation for each Candidate Cause

Dissolved oxygen

There were five DO measurements collected on this reach during biological sampling in 2010, 2013 and 2015. Two values were elevated with the highest reading 15.46 mg/L on August 13, 2013 at 3:00 PM, suggesting a potential for high DO flux and low DO. Seven additional samples were collected in 2016, 3 were above 10 mg/L. A YSI sonde was deployed at the biological station 10EM071 from August 10 to 23, 2016 (see graph below). During the deployment, the DO level never fell below the 5 mg/L DO standard ranging from 5.2 mg/L to 11.64 mg/L. The DO flux ranged from 1.8 mg/L to 4.94 mg/L, with an average of 3.41 mg/L daily flux (see graph below). Only one value was above the river eutrophication standard of 4.5 mg/L for DO flux.

Figure 53. Diurnal DO results for station 10EM071, August 11-23, 2016.

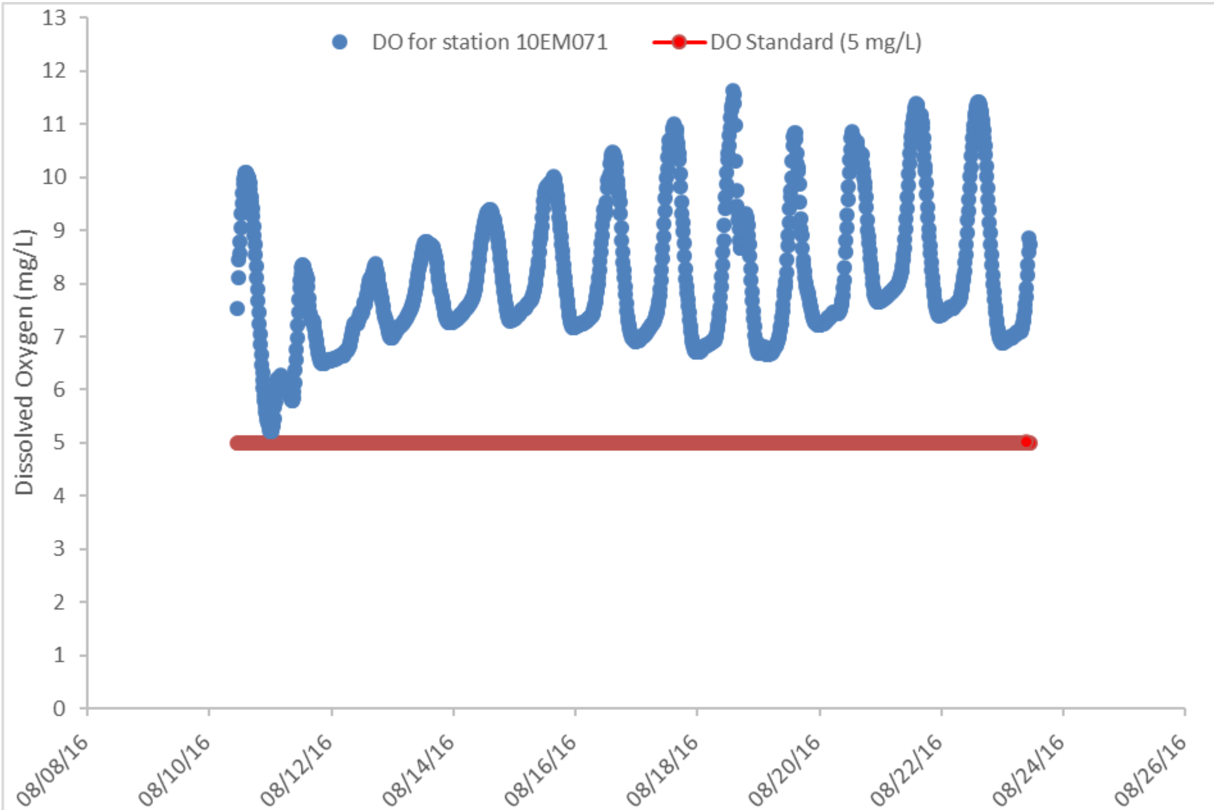
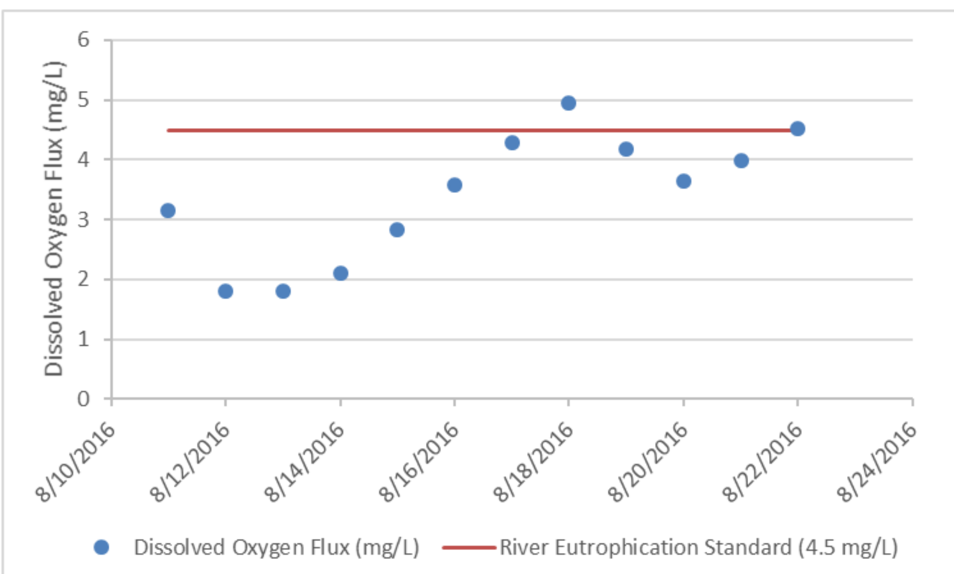


Figure 54. Daily DO flux results for station 10EM071, August 11-23, 2016.



There was a mixed response to low DO stress in the macroinvertebrate metrics (see table below). The Low DO Index score was above the average needed to meet the threshold for the Southern Streams RR Class, implying that low DO stress is not likely stressing macroinvertebrates within the reach. There were few EPT taxa identified in the reach and there were low quantities of low DO tolerant taxa; however, there were also few DO tolerant taxa, suggesting that other stressors may be responsible for the degraded conditions observed.

Table 47. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
10EM071 (2010)	32.00	**5.00**	**7.80**	7.19	**5.00**	**16.30**	**5.00**	5.11
10EM071 (2013)	31.00	**4.00**	**9.40**	**6.46**	**2.00**	**2.53**	**7.00**	8.86
10EM071 (2015)	**36.00**	**7.00**	**8.10**	7.45	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Similar to the macroinvertebrates there was a mixed response to low DO stress within the fish metrics (see table below). All low DO index scores were above the average needed to meet the threshold for the Southern Headwaters Class, suggesting that low DO is not a likely stressor for the fish community. While sensitive taxa were, absent in the reach, and there were few late maturing individuals within the reach; there were also few DO tolerant taxa.

At present there is no chemical dataset available to confirm low DO conditions occur within the reach. Neither fish nor macroinvertebrate metrics show a strong case for low DO stress. 2016 sonde data showed DO dropped to just above the standard 5 mg/L during deployment. As 2016 was a high water year, this may indicate for potential for low DO conditions to occur is still possible. While DO is not a stressor in the reach efforts to improve potential low DO conditions would be beneficial to biological communities.

Table 48. Fish metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
10EM071 (2010)	**0.00**	**4.80**	**82.19**	7.24	**0.00**	**0.00**	**5.00**	3.82
10EM071 (2013)	**0.00**	**0.00**	61.11	7.29	**0.00**	**0.00**	1.00	1.11
10EM071 (2015)	**0.00**	**0.00**	**79.05**	7.46	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

During all three fish visits phosphorous concentrations were low, with concentrations ranging from 0.041 mg/l to 0.088 mg/L. Five additional samples were taken at the biological station in 2016, two of these samples had TP values above 0.150 mg/L, the southern region eutrophication standard. There were no chlorophyll a or BOD samples collected. DO grab samples collected on the reach range from 6.68 mg/L to 15.46 mg/L, indicated potential for high DO flux in the reach. In 2016 continuous DO monitoring indicated that high DO flux appears to be a concern within the reach (see graph above). The DO flux ranged from 1.8 mg/L to 4.94 mg/L, with an average of 3.41 mg/L daily flux. One value was above the river eutrophication standard of 4.5 mg/L for DO flux. High DO flux is a response to increased macrophyte respiration as a result of a nutrient rich environment that is conducive to growing algae and plant material. Presence of filamentous algae was noted in 2015 during the fish visit and during SID investigations (see photo below). As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.41 – 8.13 in the reach.

Figure 55. Biological station 10EM071 (August 23, 2016) filamentous algae.

Eutrophication metrics for macroinvertebrates suggest potential for nutrient stress (see table below). There were fewer collector-filterers and collector-gatherers than similar stations meeting the biocriteria. There were no intolerant taxa and a high percentage of tolerant taxa at two of the three sampling events.

Table 49. Macroinvertebrate metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
10EM071 (2010)	**32.00**	**4.00**	**11.00**	**5.00**	**0.00**	**87.50**
10EM071 (2013)	**31.00**	**1.00**	**9.00**	**4.00**	**0.00**	**100.00**
10EM071 (2015)	**37.00**	**4.00**	**13.00**	**6.00**	**0.00**	69.44
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Fish results show more discrepancies across the three visits (see table below). This was seen in the quantities of darter, simple lithophilic spawners and abundance of tolerant species. However, all visits lacked sensitive and intolerant taxa. While there does appear to be some negative response to eutrophication metrics, it is not clear whether or not this could be a result of other stressors as these metrics are general in nature. A positive relationship exists between eutrophication and omnivorous fish. Across all three visits, omnivore percentages were well below the southern headwaters average suggesting that the fish in the reach are not showing a strong response to eutrophication stress within the reach.

While data collection during SID shows high P concentrations are possible within the reach, the dataset is very small. Elevated levels of DO flux and algae presence also potentially indicate eutrophication could be a potential stressor; however, additional chemical data is needed to strengthen evidence that the stressor is persistent in the reach. While there is some biological metric response in the fish and macroinvertebrate communities, eutrophication stress metrics are general in nature and could be indications of other stressors in the reach. As present data is insufficient, eutrophication is an inconclusive stressor at this time.

Table 50. Fish metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	Omnivorect	TolPct	TaxaCount	IntolerantPct
10EM071 (2010)	**0.00**	**5.09**	**25.19**	3.82	**82.19**	14.00	**0.00**
10EM071 (2013)	**0.00**	**0.00**	57.78	1.11	61.11	**7.00**	**0.00**
10EM071 (2015)	**0.00**	11.75	**30.79**	0.00	**79.05**	**7.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*14.71*	*1.95*	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

Stream water chemistry data was limited to data gathered during biological monitoring visits and stressor identification investigations. Eight samples were collected from 2010 to 2016. The range of nitrate concentrations spanned from 2.1 mg/L in August 2015 to a maximum of 30 mg/L on June 18, 2013 during a fish visit. High values (above 15 mg/L) were observed at six visits, all occurring during the months of February, May and June. Elevated nitrate readings correspond with the June fish visit but not with August visits as would be expected.

Nearly all macroinvertebrate nitrate metrics responded adversely to nitrate tolerance metrics for the Southern Streams RR average (see table below). Nitrate Index score values ranged from 3.9 to 5.6, higher than the Southern Streams RR class average of 2.9. There was also a high percentage of nitrogen tolerant individuals observed across all stations, and generally elevated quantities of nitrate tolerant taxa when compared to Southern Streams RR class' averages. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) and decreased intolerant taxa, both which are lacking in this reach.

Table 51. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Date Fish Visit)
10EM071 (2010)	**32.00**	**4.00**	**11.00**	**5.00**	**0.00**	**87.50**	**3.00**	**1.28**	**3.90**	**0.00**	**22.00**	**80.80**	8.80 (8/4/2010)
10EM071 (2013)	**31.00**	**1.00**	**9.00**	**4.00**	**0.00**	**100.00**	**2.00**	**1.58**	**4.90**	**0.00**	**19.00**	**91.80**	30.00 (6/8/13)
10EM071 (2015)	**36.00**	**4.00**	13.00	**6.00**	**0.00**	**91.66**	**3.00**	**0.33**	**5.60**	**0.00**	**25.00**	**86.00**	2.10 (8/5/2015)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish metrics suggest potential for nitrate related stress; however, discrepancies exist (see table below). There was an absence of sensitive and intolerant taxa, an abundance of tolerant taxa at two of three visits and low quantities of darters at two of three visits. As fish nitrate stress metrics are less poignant metrics, macroinvertebrates metric information should be given more clout when making stress determinations for nitrate related stress.

Elevated Nitrate concentration during spring months show a connection of high nitrate levels to agricultural runoff. Macroinvertebrate nitrate stress metric data strongly suggests nitrate stress is having impacts in the reach. There was an abundance of nitrate tolerant individuals and taxa and nitrate index scores well above class averages. Evidence points to nitrate as a stressor within the reach.

Table 52. Fish metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
10EM071 (8/4/2010)	**0.00**	**5.09**	**82.19**	**0.00**
10EM071 (6/8/13)	**0.00**	**0.00**	61.11	**0.00**
10EM071 (8/5/2015)	**0.00**	11.75	**79.05**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*
Expected response to Nitrate stress	↓	↓	↑	↓

Suspended sediment

There were three TSS readings collected during biological sampling in 2010, 2013 and 2015, all readings were below the 65 mg/L southern regional standard. Six additional readings were gathered during SID investigations in 2015 and 2016; only one reading was above the standard at 74 mg/L. Four secchi readings collected during biological visits show values ranging from 75 cm to greater than 100 cm.

TSS metric data within the reach suggests that TSS is a likely stressor to the macroinvertebrate community within the reach (see table below). TSS Index scores were above the Southern Streams RR Class average at all visits within the reach; suggesting potential for TSS related stress to impact the macroinvertebrate community. There were below average quantities of intolerant taxa and above average quantities of TSS tolerant individuals. Taxa metrics show an absence of Plecoptera taxa and below average quantities of collector-filterer taxa.

Table 53. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
10EM071 (8/4/2010)	**24.60**	**0.00**	**16.17**	**0.00**	**0.00**	6.00	**40.90**
10EM071 (6/8/13)	**0.32**	**0.00**	**18.26**	**0.00**	**0.00**	**13.00**	**76.58**
10EM071 (8/5/2015)	**9.48**	**0.00**	**17.24**	**0.00**	**0.00**	10.00	**36.81**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There were mixed results to TSS stressors within the fish community on the reach (see table below). TSS Index Scores were below the Southern Headwaters Class average, suggesting that it is not likely that elevated TSS levels are impacting the fish community. While TSS intolerant taxa were, absent from the reach, so too were TSS tolerant taxa. Nearly all TSS taxa related metrics suggest that elevated TSS levels are having an affect on the fish community, most recent visits show below average numbers for all metrics in the table below suggesting likelihood for stress.

While macroinvertebrate data suggests that TSS is a likely stressor there is little chemical data available to verify that elevated TSS levels are a consistent issue within the reach. Additional TSS data should be gathered during storm events to bolster the chemical dataset before a determination can be made whether or not TSS is stressing biological communities. As such TSS is an inconclusive stressor in the reach at this time.

Table 54. Fish metrics that respond to high TSS stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

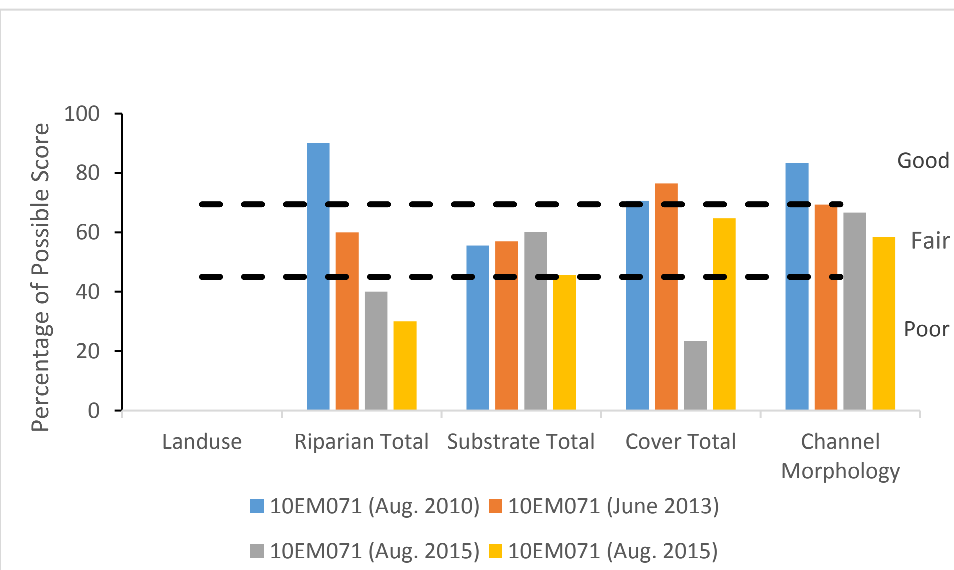
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
10EM071 (2010)	**22.39**	1.27	**17.05**	**0.00**	**3.05**	**8.14**	**17.05**	**0.00**	**3.05**
10EM071 (2013)	**11.11**	**0.00**	**11.11**	**0.00**	**0.00**	**0.00**	**11.11**	**0.00**	**0.00**
10EM071 (2015)	**20.63**	**0.00**	**8.89**	**0.00**	**0.00**	**11.75**	**8.89**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
10EM071 (2010)	13.48	**0.00**	**0.00**	0.00	0.00
10EM071 (2013)	13.05	**0.00**	**0.00**	0.00	0.00
10EM071 (2013)	13.73	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

The MSHA score at station 10EM071 has declined from a good status during the initial visit in 2010 to a more marginal quality in subsequent visits in 2013 and 2015, suggesting that conditions have deteriorated in recent years (see graph below). Prominent landuse within the watershed is row crop agriculture; there are a handful of moderately sized swine and bovine feedlots in the upstream watershed ranging from 61 – 973 animal units. The largest is 1/10th of a mile upstream of the site. The reach has retained its natural character despite channelization occurring both up and downstream of the site. The stream has good channel development, sinuosity, depth variability and substrate diversity within the site. Declines in the habitat score were observed in the riparian zone and in channel morphology, including an increase in stream bank erosion (see photo below) and coarse substrate embeddedness and a reduction in stream shading, riparian width and instream cover. While the channel stability of the station has remained moderate across all visits; it is likely that as the quality continues to deteriorate so too will stream bank stability.

Figure 56. Percentage of MSHA subcategory scores for stations 10EM071 in Unnamed Creek.



A majority of habitat metric data suggests that degraded habitat conditions are a likely stressor within the reach (see table below). There was an abundance of tolerant taxa at all visits. While there were above average quantities of relative percent lithophilic spawners, there were below average quantities of 'darter, sculpin, sucker' taxa, riffle dwelling taxa, benthic insectivores and piscivores , all of which indicate stress. In addition, there were above average quantities of pioneering species, which are less sensitive to disturbance, suggesting that other stressors had pushed out original inhabitants making way for more tolerant taxa to take their place.

Table 55. Fish metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric values indicative of stress.

Station (Year sampled)	TolPct	LithFrimPct	DarterSculpSucPct	RifflePct	BenInsect-TolPct	PiscivorePct	PioneerPct	SLithopPct
10EM071 (2010)	**82.19**	84.99	**5.09**	**17.05**	**5.34**	**0.00**	**52.93**	**25.19**
10EM071 (2013)	**61.11**	90.00	**0.00**	**11.11**	**0.00**	**0.00**	**28.89**	57.78
10EM071 (2015)	**79.05**	61.59	**11.75**	**8.89**	**11.75**	**0.00**	**38.10**	**30.79**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*20.40*	*5.24*	*19.02*	31.50
Expected response to Habitat stress	↑	↓	↓	↓	↓	↓	↑	↓

There were mixed results when looking at the macroinvertebrate community with regards to habitat stress (see table below). Metric results showed fewer than average Clinger and EPT taxa within the reach and above average quantities of legless taxa, which are more tolerant of disturbed conditions. Low quantities of clinger taxa suggest limited availability of coarse substrates and woody debris in the reach. While climbing taxa were abundant, this could be a testament to an abundance of overhanging vegetation within the reach. Discrepant results suggest that vulnerable habitats exist within the reach, whose absence and degradation are likely stressing the biological communities.

Preponderance of evidence shows that degraded habitat conditions are having negative impacts to biological communities within the reach.

Table 56. Macroinvertebrate metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
10EM071 (8/4/2010)	4.79	28.44	**41.21**	**32.27**	**61.02**	22.05
10EM071 (6/8/13)	**6.01**	72.15	**9.18**	**5.38**	**84.81**	**6.01**
10EM071 (8/5/2015)	**7.84**	37.58	**24.84**	**4.25**	**86.28**	19.61
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 57. Biological station 10EM071 (August 4, 2010) raw stream banks.

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. Aerial photography below suggests potential for localized beaver activity, which could be inhibiting connectivity within the stream. Fish communities at 10EM071 and downstream station 13MN123 are very similar, suggesting that longitudinal connectivity is not a major concern for the reach (see table below). Three known migratory fish taxa were identified on the reach: black bullhead, central stoneroller and white sucker (see table below). No known mussel surveys have been conducted on this reach. If fish taxa lists drastically differ during future sampling events, additional investigation of beaver activity and longitudinal connectivity in the reach may be warranted.

Longitudinal connectivity is not a likely stressor to the fish community.

Table 57. Taxa comparison of biological stations along reach.

Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Taxa in bold are known migratory fish species. Taxa in bold are known migratory fish species. Taxa in blue are known lake species.

Field Number	10EM071	13MN123
WID	-583	-549
Fish Species		
bigmouth shiner	x	x
black bullhead	x	x
blacknose dace	x	x
bluegill	x	
bluntnose minnow	x	x
central stoneroller	x	x
common shiner	x	x
creek chub	x	x
johnny darter	x	x
white sucker	x	x
yellow bullhead		x
yellow perch	x	

Figure 58. Google Earth image downstream of biological station 10EM071, potential beaver activity.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 0.79 mile long reach of the Unnamed Creek is 44% modified and 56% natural. Upstream of the reach the stream is 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion and instability and undercut banks are site evidence that Altered Hydrology is a potential stressor, all of which were identified at the biological station.

During the fall of 2012, on downstream WID -549 biological station 13MN123 had a dry stream bed, it is then also likely that further upstream, at station 10EM071, low flow conditions were also present. See photograph in altered hydrology section for AUID -549. In 2012, southwestern Minnesota experienced a significant drought, low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Three lake taxa were identified during fish sampling events: black bullhead, bluegill and yellow perch. Presence of lake taxa in riverine conditions suggest potential for altered hydrologic stress as these species thrive in non-lotic conditions. Low quantities of long-lived taxa and low percentages of riffle dwelling species also suggest that altered hydrological conditions may be impacting the fish community (see table below).

Table 58. Fish metrics that respond to altered hydrology stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
10EM071 (2010)	**82.19**	**3.05**	**17.05**
10EM071 (2013)	**61.11**	**0.00**	**11.11**
10EM071 (2015)	**79.05**	**0.00**	**8.89**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*
Expected response to Altered Hydrology stress	↑	↓	↓

Altered hydrology is a likely stressor within the reach at this time, additional photographic evidence showing low flow conditions within the reach would be beneficial to strengthen evidence for this stressor.

4.1.3. AUID Summary

The fish and macroinvertebrate community within the reach is being stressed by, elevated nitrate, poor habitat and Altered Hydrology. Elevated nitrate concentrations (max of 30 mg/L) are also stressing macroinvertebrates as seen by high percentages of nitrate tolerant macroinvertebrates and an absence of nitrate intolerant taxa. Elevated nitrate concentrations were observed during spring months, when contributions from drain tiles are at their peak. As noted in the statewide nitrogen study, nitrate reaches waterways through surface runoff, tile drainage, and leaching to groundwater, with tile drainage being the largest pathway (MPCA, 2013). Insufficient habitat within the reach is likely due to an increase in stream bank erosion leading to the embeddedness of coarse substrates and higher quantities of legless macroinvertebrates (which can tolerate embeddedness and poor habitat) and reduced clinger numbers, which need coarse substrates or woody debris. Reduced habitat conditions can be linked to landuse modifications within the watershed, including channel straightening and drain tiling, which have direct impacts on stream hydrology and instream habitat. Low flow conditions observed upstream of the reach in 2012 provides additional evidence of altered hydrology stress and concern about maintaining base flow within the reach.

TSS and eutrophication are inconclusive stressors within the reach. TSS chemistry data violations was limited to one reading above the standard, of only a handful of measurements gathered, while macroinvertebrate metrics indicated some potential for TSS related stress, fish metrics were less clear. Further investigation is needed to determine if elevated TSS levels are having an impact on biology within the reach.

Limited elevated phosphorous and response variable data is available to implicate eutrophication stress in the reach. Additional data collection is needed to better understand the extent of high P conditions in the reach and the frequency of elevated DO flux. Additional chlorophyll a and BOD collection could also help in better understanding the potential of the stressor.

DO and longitudinal connectivity were ruled out as potential stressors within the reach. Available chemical data did not indicate DO levels falling below the low DO standard; however, a continuous reading of just above 5 mg/L suggests that low DO may be a potential concern during lower water years. However, biological metrics did not respond dramatically to low DO stress. There are no known fish barriers within the reach. Presence of migratory fish taxa within the reach in addition to fish communities similar to downstream station 13MN123 indicate that longitudinal connectivity is not a likely stressor to the fish community at present.

Table 59. Summary of stressor determinations for Unnamed Creek (583).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Unnamed Creek	07020010-583	--	o	●	o	●	●	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

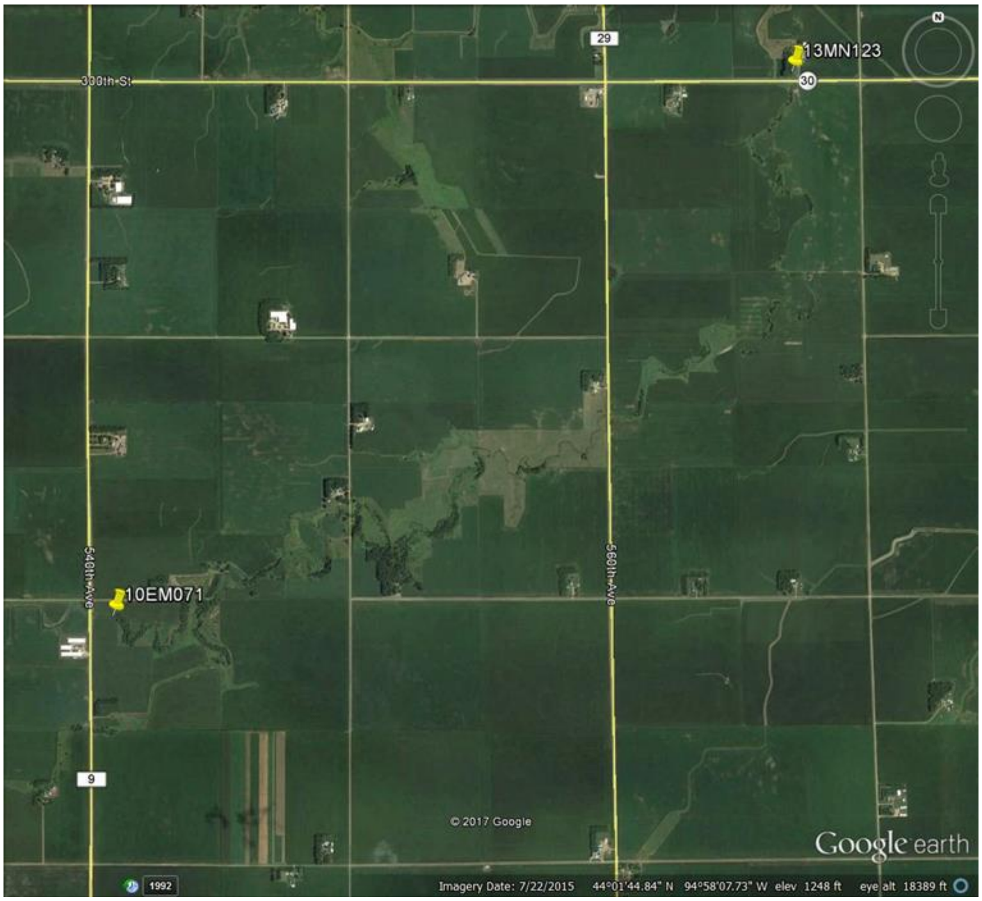
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1 Unnamed Creek -549

Reach (07020010-549) is a continuation of Unnamed Creek (07020010-583) and a tributary of the North Fork Watonwan River (07020010-564). The reach starts upstream of 550th Ave and flows northeast nearly seven stream miles before discharging to the North Fork Watonwan downstream of MN Hwy 30. The reach is classified as general use warmwater 2Bg. This reach is impaired for aquatic life for degraded fish and macroinvertebrate communities (2015).

Figure 59. Google Earth image of Unnamed Creek (-549).



4.1.1. Biological communities

A single station exists on this reach, 13MN123. The site was sampled in 2013 for fish and macroinvertebrates. The FIBI scored 42.1, below the threshold (FIBI: 55) and lower confidence limits. The fish community lacked sensitive (Sensitive) and generalist taxa (GeneralTxPct) (see graph below).

The MIBI score was 36.4 below the threshold (MIBI: 41) but within lower confidence limits. The community was hyper dominated by Physa taxa and lacked intolerant species (Intolerant2Ch) and collector-filterers (Collectorer-filtererPct). The HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) metric score was also low (see graph below).

Figure 60. Fish metrics of the Southern Headwaters Class IBI for station 13MN123, Unnamed Creek.

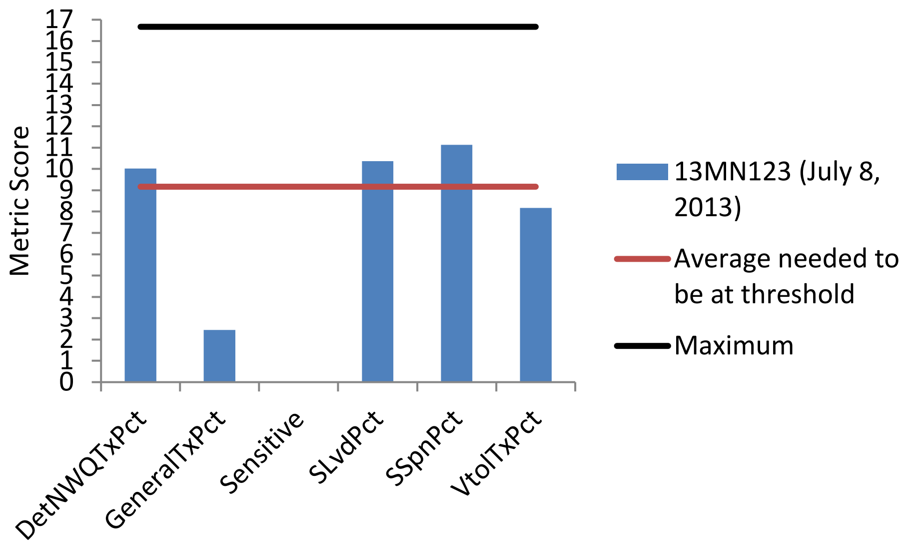
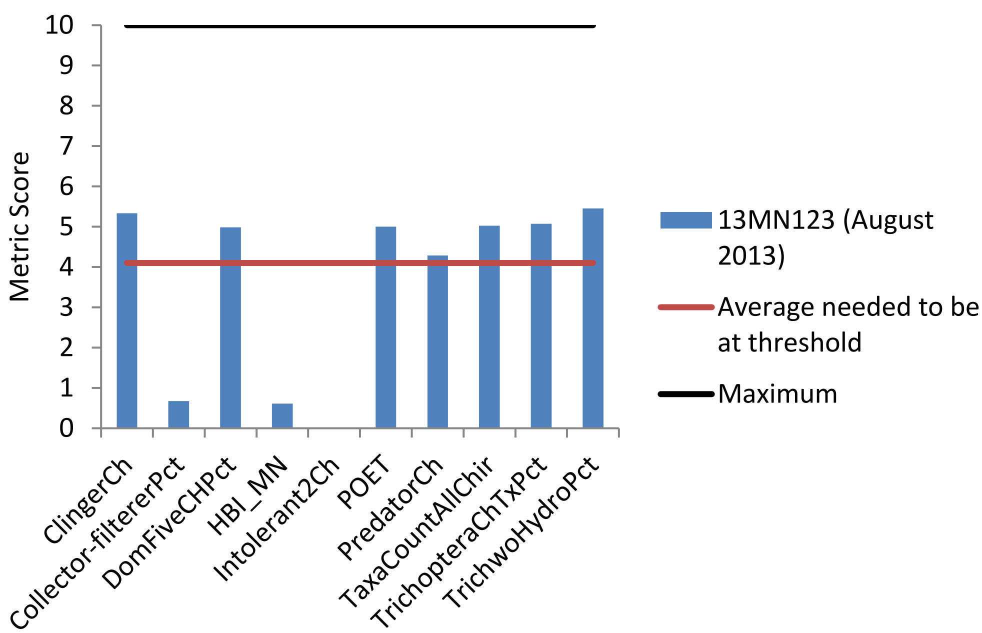


Figure 61. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN123, Unnamed Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Two DO samples were collected during the biological visits. Sample values were 14.42 mg/L on July 8, 2013 at 2:23pm and 11.91 mg/L on August 13, 2013 at 4:38pm. Eight additional DO samples were taken in 2016; no readings fell below the 5 mg/L standard. Four readings were above 10 mg/L, the highest reading was 12.82 mg/L on February 22, 2016 at 2:23pm.

Afternoon high DO readings observed during biological sampling prompted additional continuous DO monitoring in 2016 (see graph below). A YSI sonde was deployed on August 10 - 23, 2016. All recorded DO values were above the 5 mg/L DO standard and fell below the daily DO flux eutrophication standard of 4.5 mg/L (see graph below).

Figure 62. Diurnal DO results for station 13MN123 August 10-23, 2016.

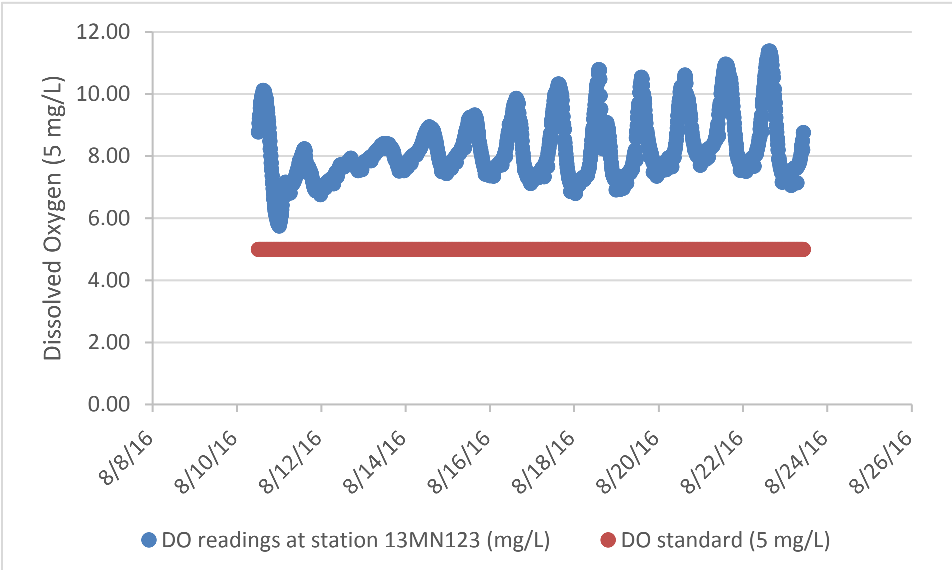
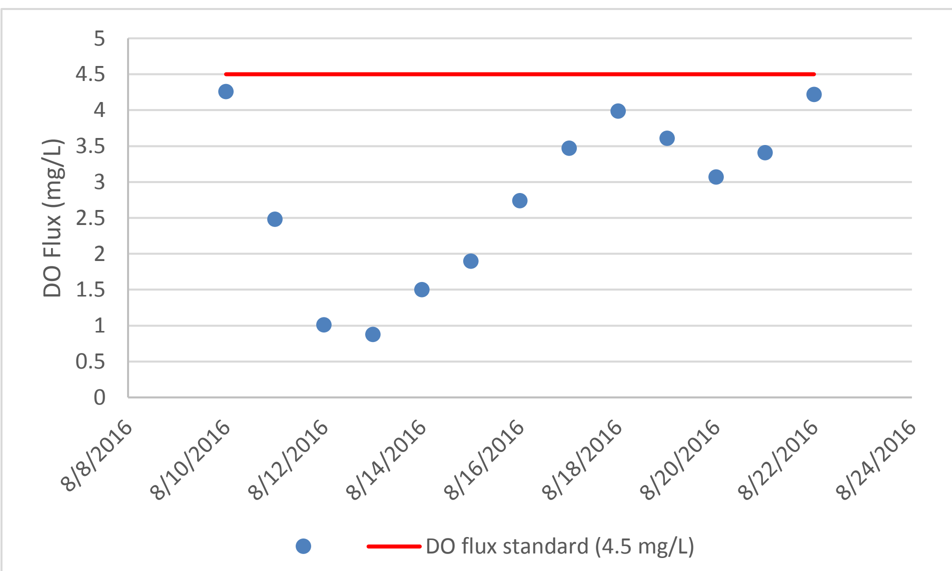


Figure 63. Daily DO Flux results for station 13MN123 August 10-23, 2016.



The macroinvertebrate community within the reach does not show an overwhelming response to low DO metrics (see table below). The Low DO Index score was below the average for the Southern Streams GP Class, suggesting that low DO is not likely affecting the macroinvertebrates at the site. While low DO intolerant taxa were not abundant at the site, neither were DO tolerant taxa.

Table 60. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN123 (2013)	**36.00**	**7.00**	**8.70**	6.74	**2.00**	**0.63**	7.00	8.86
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Similar to the macroinvertebrates, the fish community shows little response to low DO stress metrics (see table below). The low DO Index score for the site was above the average for the Southern Headwaters Class, suggesting low DO stress is unlikely. While there were no sensitive species identified in the fish sample; this could be explained by other stressors in the reach. There were also below average quantities of DO tolerant taxa, suggesting that low DO conditions are not present.

Available chemistry and biological metric data does not suggest low DO conditions are impacting biological communities at this time.

Table 61. Fish metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN123 (2013)	**0.00**	**1.25**	66.88	7.25	**0.00**	**0.00**	2.00	1.25
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*0.70*	*4.10*	*3.40*	*21.2*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

The phosphorous concentration collected during the fish visit was below the southern region eutrophication standard of 0.15 mg/L. Five additional phosphorous samples were collected in 2015, three of these samples exceeded the standard. Phosphorous concentrations ranged from 0.022 mg/L to 0.415 mg/L, with an average concentration of 0.155 mg/L. There were no chlorophyll-a or BOD samples collected on this reach. Across sampling efforts DO values ranged from 8.7 mg/L to 12.82 mg/L. While high afternoon DO readings were identified in the reach, DO flux data collected in 2016 does not indicate elevated levels of DO flux. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.09 – 8.3 in the reach.

Macroinvertebrate metrics indicate potential for eutrophication stress (see table below). There were fewer collector-filterers and collector-gatherers than the average of similar stations meeting the biocriteria. There were no intolerant taxa and a high percentage of the taxa in the sample were tolerant.

Table 62. Macroinvertebrate metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN123 (2013)	**36.00**	**2.00**	**11.00**	**7.00**	**0.00**	**86.11**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community metrics also shows some possible eutrophication stress (see table below). There was an absence of both intolerant and sensitive taxa and darter counts were low. However, the percentage of tolerant fish was below the southern headwaters class average and the percentage of simple lithophilic spawners was above average, indicating that the fish community may be responding to another stressor. A positive relationship exists between eutrophication and omnivorous fish. Omnivore quantities at the biological station were below the southern headwaters class average suggesting that eutrophication is not a primary stressor to the fish community at this time.

Table 63. Fish metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN123 (2013)	**0.00**	**4.38**	41.88	2.50	66.88	**10.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*14.71*	*1.95*	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While elevated phosphorous levels appear within the reach and biological metric data suggests potential for eutrophication stress, there is insufficient evidence to determine whether or not eutrophication is a stressor at this time. Eutrophication stress metrics are general in nature and could be indicators of other stressors in the reach. There were no violations the DO flux standard during continuous sonde deployment, and there was no evidence of problematic algal growth or abundance of aquatic macrophytes within the reach. Additional chemical evidence to understand the extent of elevated P conditions in addition to positive response variable data is needed to further tease out stressor potential. Therefore, eutrophication is an inconclusive stressor at this time.

Nitrate

Stream chemistry data for this reach was limited to data collected during the biological monitoring visits and stressor identification investigations. Eight samples were collected over the years of 2013, 2015 and 2016, during the months of February, May, June, July and August. Nitrate concentration values ranged from 4.1 mg/L on August 27, 2015 to a maximum value of 25 mg/L on June 16, 2015, with an average reading of 20 mg/L. High values (above 15 mg/L) were observed at all but one visit when the minimum value was recorded. Six of the values greater than 15 mg/L were taken during the months of May, June and July.

The macroinvertebrates in this reach show a somewhat mixed response to elevated nitrate concentrations (see table below). The nitrate index score was 4.5, while the average for modified Prairie Streams GP class meeting impairment threshold is 3.2. This suggests that the macroinvertebrate community is generally tolerant of nigh nitrate concentrations. High levels of nitrate tolerant taxa and the percentage of nitrate tolerant individuals within the community were also above the average for the Prairie Streams GP class. A response was not observed in the quantity of Trichoptera taxa nor in the non-hydropsychid Trichoptera individual percentages, low quantities in both metrics often correlate with increased nitrate concentrations. While there were three Trichoptera taxa, there were only a few individuals present which undermines the importance of looking at the taxa and their abundance. The non-hydropsychid Trichoptera individual percentages were only just above the average. An abundance of snails in the reach probably has inflated the Nitrate Index Score and the percentage of nitrate tolerant individuals.

Table 64. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish visit date)
13MN123 (2013)	**36.00**	**2.00**	**11.00**	**7.00**	**0.00**	**86.11**	3.00	2.85	**4.50**	**1.00**	**25.00**	**87.00**	20.00 (7/8/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*0.00*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish metrics suggest potential for nitrate related stress; however, discrepancies exist (see table below). There was an absence of sensitive and intolerant taxa, and low quantities of darters within the reach. There was also a below average quantity of tolerant individuals within the reach. As fish nitrate stress metrics are less poignant than macroinvertebrate nitrate metrics, macroinvertebrates metric information should be given more clout when making stress determinations for nitrate related stress.

Table 65. Fish metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN123 (2013)	**0.00**	**4.38**	66.88	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*
Expected response to Nitrate stress	↓	↓	↑	↓

Elevated nitrate concentrations along with positive metric response from the macroinvertebrate community indicates that elevated nitrate is stressing the macroinvertebrate community within the reach.

Suspended sediment

One TSS sample was collected during the fish visit in 2013; the reading was below the southern regional TSS standard of 65 mg/L. There were no TSS samples gathered prior to 2013. Additional monitoring TSS monitoring was conducted in 2015 and 2016 for SID investigations, two of seven samples exceeded the standard. Twelve secchi transparency readings were gathered in 2013, 2015 and 2016, values raged from 4 cm to greater than 100 cm, only one value fell below the 10 cm southern standard.

There were discrepant results with regards to TSS stress metrics within the macroinvertebrate community on the reach (see table below). The TSS index score was just above the average for the Prairie Streams GP Class, suggesting that TSS is not a likely stressor to the macroinvertebrate community. While there is an absence of TSS intolerant taxa within the reach, there were also not TSS tolerant taxa present. There were below average quantities of collector-filterer taxa, quantities of these taxa can decline in turbid conditions as visibility within the water column is limited; however, their absence can also be attributed to degraded habitat conditions. Given the present dataset, it is unlikely that TSS is stressing the macroinvertebrate community within the reach.

Table 66. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN123 (7/8/2013)	**2.85**	**0.00**	**16.79**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The fish community within the reach showed a response to TSS stress (see table below). The TSS Index score was above the average for the Southern Headwaters Class, suggesting that TSS is likely stressing the fish. There were also elevated quantities of TSS tolerant taxa and individuals with the sample. Low quantities of centrarchids, lithophilic and simple lithophilic spawners, perciformes and riffle dwelling species. There were also low quantities of intolerant and sensitive species, but this could be explained by other stressors.

Table 67. Fish metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN123 (2013)	28.13	**0.00**	**23.75**	**0.00**	**0.00**	**4.38**	**23.75**	**0.00**	**1.25**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

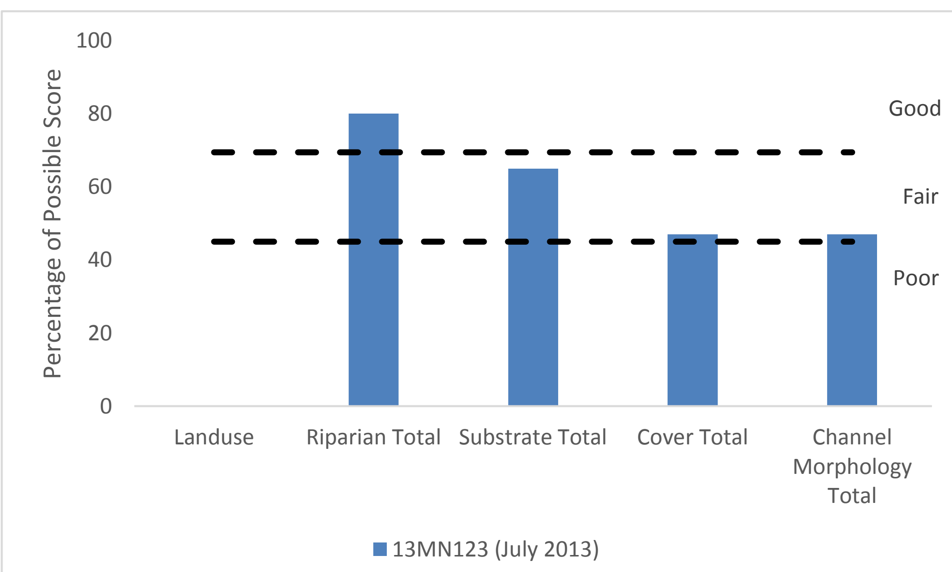
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN123 (2013)	**14.35**	**1.00**	**0.32**	**12.00**	**61.71**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

There was a limited chemical dataset implicating TSS as a stressor in the reach. Macroinvertebrates within the reach did not show a strong response to TSS stress while the fish community did. TSS stress is presently an inconclusive stressor for the fish community and an unlikely stressor for the macroinvertebrate community. Additional investigation is warranted to further understand the potential stressor.

Habitat

The MSHA score for 13MN123 was fair (54.55) (see graph below). Landuse within the watershed is predominately row crop agriculture, scattered feedlots are present within the watershed's headwaters. The reach scored well in riparian categories with a moderate riparian width, little current bank erosion and heavy shading by mature trees. Within the reach there is active livestock access to the stream, which appears to be causing sedimentation (see photo). The instream zone provides little habitat cover, limited substrate variability, lightly embedded coarse substrates and limited channel development (85% run, only 5% riffle). The stream reach is channelized resulting in poor sinuosity. Just downstream of Hwy 30, both stream banks have been stabilized by riprap, indicating that stream stability control measurements have been implemented in recent years (see photo below).

Figure 64. Percentage of MSHA subcategory scores for stations 13MN123 in Unnamed Creek.



There was mixed response to habitat stress within the fish community (see table below). While there were below average numbers of tolerant taxa at the site, piscivore, riffle dwelling and benthic insectivore taxa were below the average for the Southern Headwaters Class. Inversely, lithophilic and simple lithophilic spawner and pioneering taxa were near or within their respective averages.

Table 68. Fish metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SlithopPct
13MN123 (2013)	**66.88**	**0.00**	**69.38**	4.38	23.13	**23.75**	**4.38**	41.88
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*	*37.79*	*28.33*	*14.22*	31.50
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

A majority of metric evidence suggests that habitat is likely stressing the macroinvertebrate community (see table below). There were above average quantities of burrower and legless taxa, both of which are abundant when limited habitat is available. Clinger and sprawler taxa were also deficient within the reach and further corroborate a lack of diversified habitat within the reach. While climber taxa were abundant, their prevalence may be because overhanging vegetation was the most abundant habitat within the reach.

Table 69. Macroinvertebrate metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN123 (2013)	**10.13**	66.77	**9.81**	**6.01**	**89.56**	**9.81**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 65. Biological station 13MN123 (July 8, 2013) livestock trampling (left); bank stabilization efforts riprapping (right).

Evidence in the reach suggests habitat conditions are marginal. Abundance of fine sediments, lack of habitat diversity and limited natural channel development is inhibiting biological communities within the reach. While evidence of stress is stronger in the macroinvertebrate habitat stress metrics, fish appear to be limited by the low quantity of riffles within the reach and an absence of habitat for carnivorous piscivore taxa. Degraded habitat conditions are stressing the biological communities within the reach.

Altered hydrology/Longitudinal connectivity

There are no known dams or perched culverts downstream of 13MN123 to the next downstream biological monitoring station (13MN165) on the North Fork Watonwan River. A little over a mile downstream from the site there appears to be a beaver dam, which may be limiting stream connectivity to the North Fork Watonwan (see photos below).

Five unique fish species captured at 13MN165 were not captured at 13MN123; one species captured at 13MN123 was not seen at 13MN165. Small differences in species lists may be attributed to stream order and do not necessarily imply longitudinal connectivity concerns. Three known migratory fish taxa were collected on the reach: black bullhead, central stoneroller and white sucker (see table below). No known mussel surveys have been conducted on the reach. Preponderance of evidence suggests longitudinal connectivity is not presently a stressor on the reach.

Table 70. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Taxa in bold are known migratory fish species. Taxa in blue are known lake species.

Field Number	13MN123	13MN165
WID	-549	-564
Fish Taxa		
bigmouth buffalo		x
bigmouth shiner	X	x
black bullhead	X	x
blacknose dace	X	x
blackside darter		x
bluntnose minnow	X	x
central stoneroller	X	x
common carp		x
common shiner	X	x
creek chub	X	x
johnny darter	X	x
northern pike		x
sand shiner		x
tadpole madtom		x
white sucker	X	x
yellow bullhead	X	x
yellow perch	X	

Figure 66. Google Earth images, approximately one-mile downstream of biological station 13MN123 there appears to be a beaver dam which may be limiting stream connectivity to the North Fork Watonwan River.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 6.93 mile long reach of Unnamed Creek is 82% natural and 18% modified. Upstream of the reach, its headwaters is predominately 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. While there are no known dams along the reach, aerial photographs reveal potential beaver activity. Additional investigation of beaver activity may be warranted if diversity within the reach declines in the future (see photo below). According to CADDIS, bank erosion and instability and undercut banks are site evidence that Altered Hydrology is a potential stressor. While stream bank erosion is presently limited at the site, heavily riprapped stream banks are evidence of past concerns (see photo below), undercut banks and reduced stream channel stability were also identified at the biological station.

Two taxa commonly found in lakes were present at the station; their presence could infer low flow conditions are common within the reach and could imply altered hydrology may be stressing the fish within the reach. The absence of long-lived taxa and below average quantities of riffle dwelling individuals is additional evidence that low flows may be stressing fish communities in the reach (see table below).

Table 71. Fish metrics that respond to altered hydrology stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN123 (2013)	66.88	**0.00**	**23.75**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*
Expected response to Altered Hydrology stress	↑	↓	↓

During the fall of 2012, biological station 13MN123 had a dry streambed (see photo). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Low flow evidence suggests that altered hydrology is a likely stressor within the reach at this time.

Figure 67. Biological station 13MN123 (September 13, 2012) low flow.

Figure 68. Biological station 13MN123 (August 27, 2015) culvert filled with sediment vegetation growing (left); (May 1, 2015) drain tile culvert caving in (right).

4.13 AUID Summary

The biology within the reach is being stressed by elevated nitrate concentrations, degraded habitat and altered hydrology. Elevated nitrate concentrations were identified within the reach with a maximum concentration of 25 mg/L documented. Highest nitrate concentrations were observed in May and June, when drain tiles contribute significantly to stream flows. As noted in the statewide nitrogen study, nitrate reaches waterways through surface runoff, tile drainage, and leaching to groundwater, with tile drainage being the largest pathway (MPCA, 2013). Macroinvertebrate nitrate stress metrics indicated an abundance of nitrate tolerant taxa within the reach and a community dominated by tolerant snails.

Degraded habitat conditions are also limiting the macroinvertebrate community within the reach. Available habitat in the reach is dominated by overhanging vegetation and scattered woody debris, benefiting climbing taxa at the detriment of sprawlers and clingers. An abundance of legless and burrowing taxa is also evident that limited habitat diversity is present. There was an abundance of fine sediment which may be a contribution of local livestock trampling and bank instability in the upstream reaches or past in reach instability seen in photos via heavy riprapping of stream banks in the reach. Fish metrics indicate that the fish community is not as severely stressed by habitat as macroinvertebrates in the reach. Riffle taxa and predatory taxa appear to be most limited, only 5% of the reach was riffle habitat and limited habitat cover was available to potential predatory taxa. Reduced habitat conditions can be linked to landuse modifications within the watershed, including channel straightening and drain tiling, which have direct impacts on stream hydrology and instream habitat.

While a majority of the stream reach is natural its headwaters is predominately modified. Upstream drainage efforts including channelization, wetland draining and tile drainage have led to instable base flow conditions in the reach, observed in the fall of 2012 where flow was reduced to a trickle. Inconsistent flow conditions are detrimental to biological communities.

TSS was an inconclusive stressor to the fish community and an unlikely stressor for the macroinvertebrate community. There was limited TSS data available within only two readings above the standard during high flow events. Macroinvertebrate metrics showed little indication of TSS stress. There was an abundance of TSS tolerant taxa within the fish community and an elevated TSS Index Score suggesting that elevated TSS conditions are inhibiting the fish community. Additional chemical sampling could be useful at better understanding the potential extent of TSS stress within the reach.

Eutrophication stress is an inconclusive stressor. While there were a few elevated phosphorous concentrations recorded during investigations, continuous DO measurements did not produce any daily DO flux numbers above the standard. There was also limited evidence of algal or macrophyte production within the reach. There was a mixed response within biological metrics which are general in nature and do not solely implicate eutrophication stress. Additional investigation would be valuable in better understanding the relationship between the biology and elevated phosphorous conditions within the reach.

Dissolved oxygen (DO) and longitudinal connectivity were ruled out as stressors within the reach. There was no chemical evidence that low DO conditions exist within the reach and there limited biological metric response to indicate a problem. No dams or fish barriers were identified within the reach and presence of migratory fish taxa often indicate longitudinal connectivity in a reach is intact.

Table 72. Summary of stressor determination for Unnamed Creek (549).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Unnamed Creek	07020010-549	--	o	●	o	●	●	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

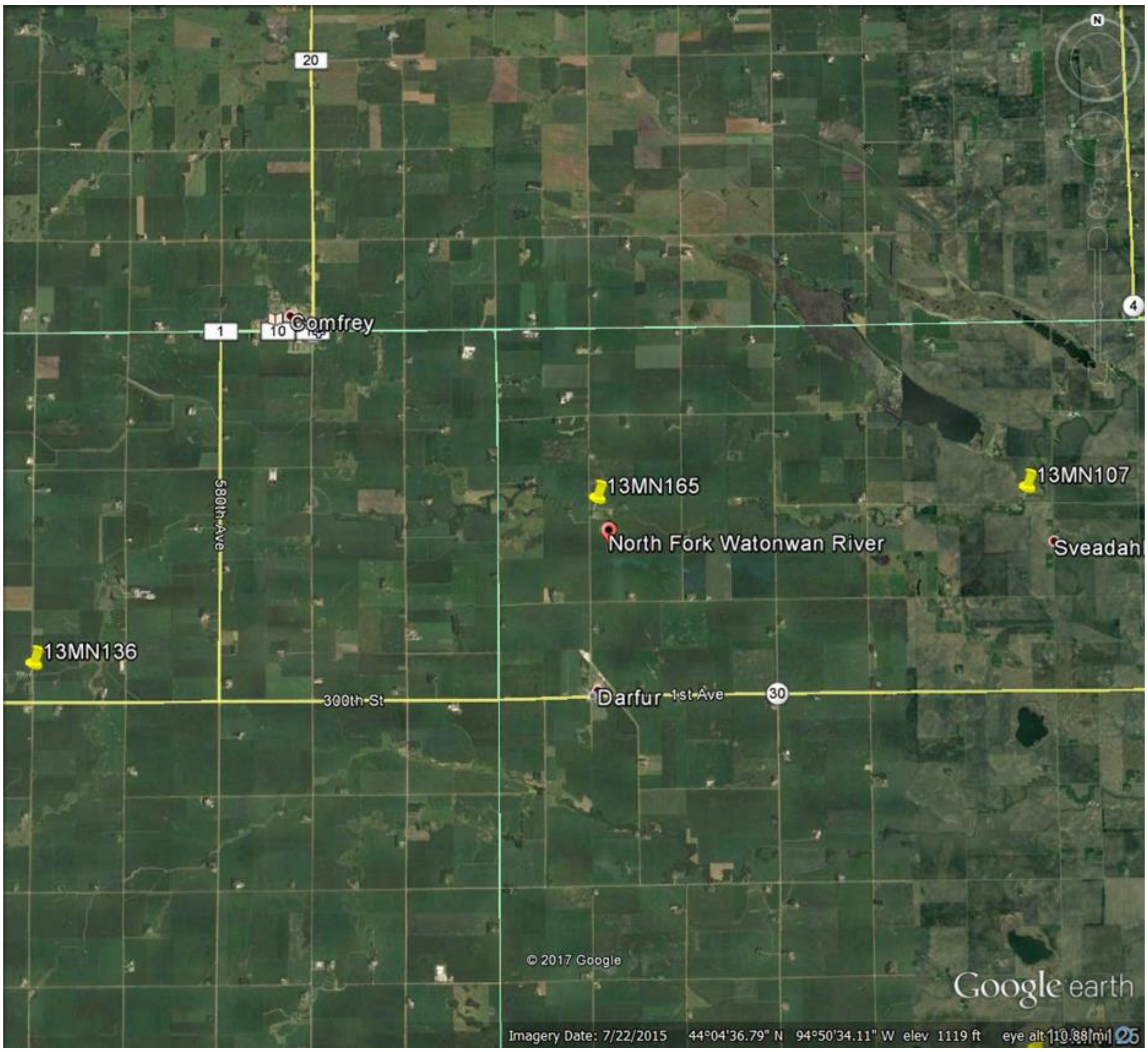
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1 North Fork Watonwan River -564

Reach (07020010-564) is the headwaters reach of the North Fork Watonwan River. The reach starts near the stream's headwaters upstream of 520th Ave., a couple miles north of Delft, and continues nearly the entire length of the North Fork Watonwan River, approximately 35 river miles, to downstream reach (07020010-565) at Twp. Hwy 137. This reach is classified as general use warmwater 2Bg. This reach is impaired for aquatic life, for lacking fish and macroinvertebrate assemblage (2015) and for excessive levels of turbidity (2006) and for aquatic recreation for high levels of *E. coli* bacteria (2015).

Throughout its course, the reach gains the flow of Unnamed Creek (07020010-549) and the outflow of Wood Lake.

Figure 69. Google Earth image of North Fork Watonwan River (-564).



4.1.1 Biological communities

There were three biological stations on this reach. All three stations were also sampled for macroinvertebrates in 2013. The upstream most station 13MN136 had the lowest MIBI score at 9.8 falling below the threshold (MIBI: 41) and well below lower confidence limits. The sample was dominated by Physa taxa. Downstream, 13MN107 scored just below the threshold while 13MN165 scored above. Physa were also the predominate taxa at 13MN165 but were not overwhelmingly so. All three stations scored a zero for the Intolerant2Ch metric (Taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN TVs). They also all fell below the average needed to meet the threshold for the following metrics: HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota), TricopteraChTxPct (percentage of trichoptera taxa) and TrichwoHydroPct (Relative abundance (%) of non-hydropsychid Trichoptera). The worst scoring station, 13MN136, also had low taxa counts and a more disproportionate community overall, lacking clinger (ClingerCh), collector-filterer (Collectorer-filtererPct), POET and Trichoptera taxa (TrichopteraChTxPct) (see graph below).

Each station was sampled once for fish in 2013 (13MN107, 13MN136, 13MN165). All sites scored below the GU threshold, two sites scored below the lower confidence limit as well (13MN107, 13MN165). Station 13MN136 is in the Southern Headwaters class. The station lacked sensitive taxa and had below average generalist taxa counts. The top three quantities of taxa collected were blacknose dace, central stoneroller and johnny darter. The next two downstream stations, 13MN165 and 13MN107, are in the Southern Streams Class. 13MN165 was hyper dominated bluntnose minnow, a tolerant species. However, the sample was overall more diverse than 13MN107, with 16 species compared to 10 at 13MN107. 13MN165 also produced a significantly greater quantity of individuals compared to 13MN107. Both stations scored a zero for the tolerant percent metric (TolPct), indicating high numbers of tolerant taxa. They also both scored below the average threshold for relative abundance of tolerant species (TolTxPct), relative abundance of benthic insectivores (BenInsect-TolTxPct), relative abundance of two most abundant taxa (DomTwoPct) and relative abundance (%) of individuals with a female mature age greater or equal to two years (MA<2Pct) (see graph below).

Figure 70. Fish metrics of the Southern Streams Class IBI for station 13MN165 and 13MN107, North Fork Watonwan River.

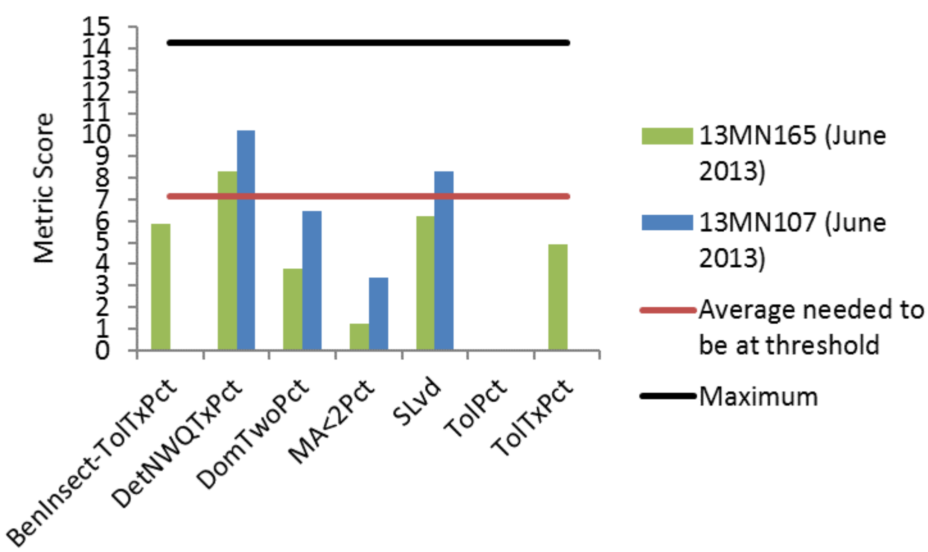


Figure 71. Fish metrics of the Southern Headwaters Class IBI for station 13MN136, North Fork Watonwan River.

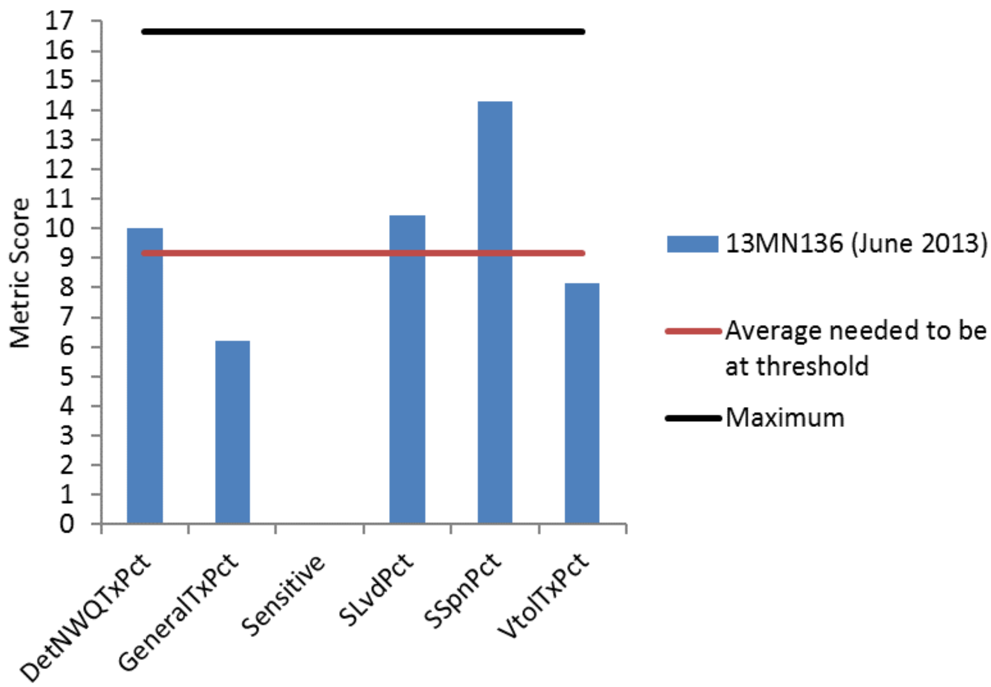
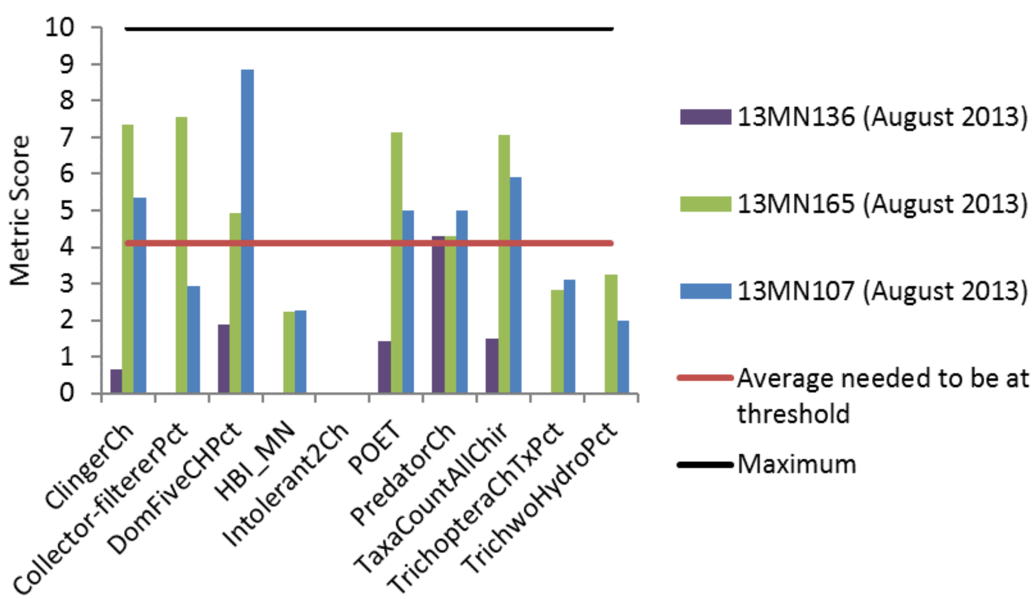


Figure 72. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN136, 13MN165 and 13MN107, North Fork Watonwan River.



4.1.2 Data evaluation for each Candidate Cause

Dissolved oxygen

Six DO readings were gathered during the biological monitoring visits at three stations along the reach. No low DO violations were observed. Three readings above 10 mg/L were recorded with a high reading of 13.44 mg/L at station 13MN136 at 3:25 pm on June 17, 2013. Thirty-seven additional DO samples were collected from 2013 - 2016, no values fell below the 5 mg/L standard, while 8 were above 10 mg/L with a high value of 12.61 mg/L was recorded at 13MN107 on February 22, 2016 at 1:16pm.

High DO readings prompted additional DO sampling at 13MN136 using a YSI sonde to record continuous DO measurements from July 31 – August 6, 2015 (see graph below). Low diurnal DO values always fell just above the 5 mg/L standard with the lowest reading reaching 5.09 mg/L. DO flux exceeded river eutrophication standards three times, the highest flux observed was 5.08 mg/L (see graph below). The average DO flux observed was 4.58 mg/L.

Figure 73. Diurnal DO results for station 13MN136, July 31 – August 6, 2015.

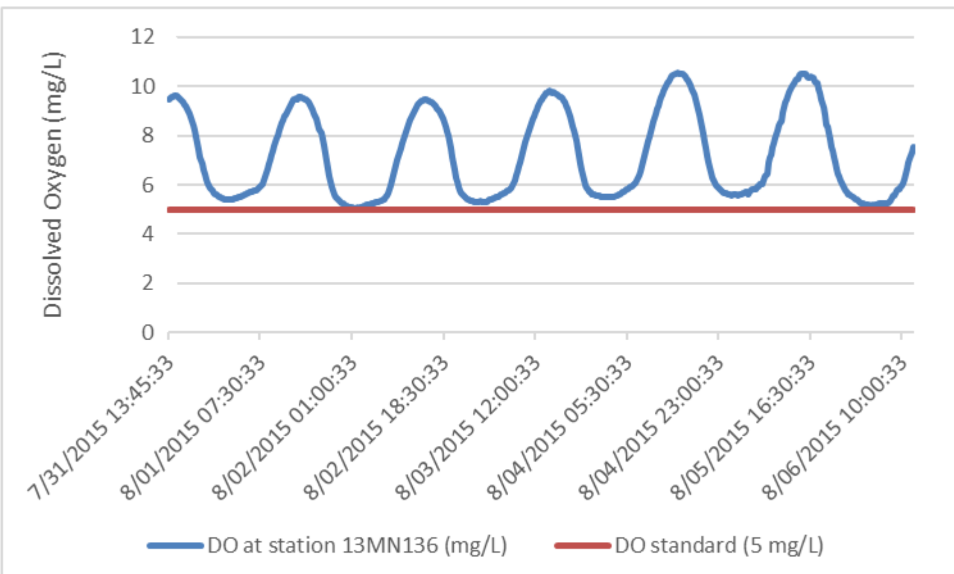
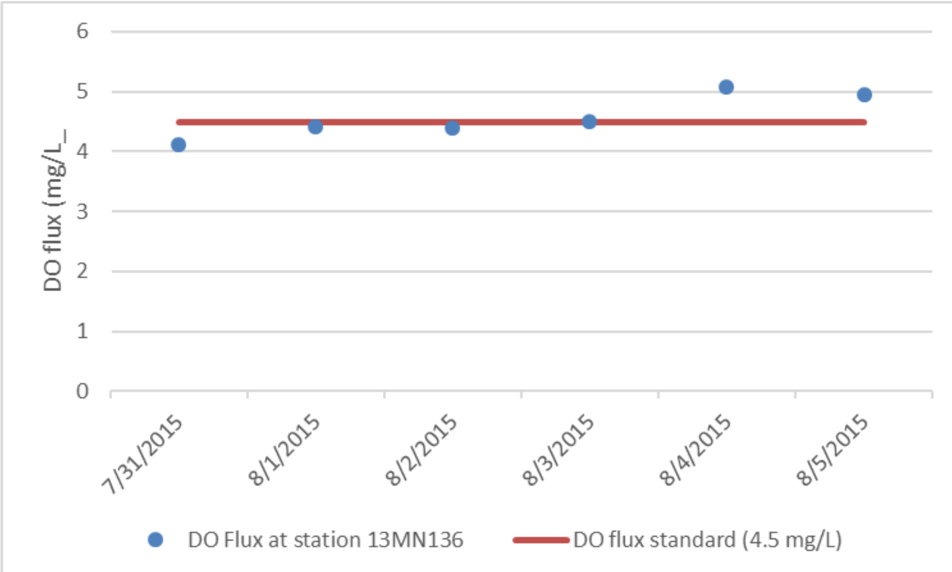


Figure 74. Daily DO Flux results for station 13MN136, July 31 – August 6, 2015.



There was a mixed response to low DO stress at the biological stations across the reach (see table below). The greatest response was observed at station 13MN136. At this station, there was a high quantity of low DO tolerant taxa and an above average number of low DO tolerant individuals. There was also a low abundance of low DO tolerant taxa, individuals and EPT taxa, suggesting potential for low DO stress. HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) scores were also above average at all stations. Stations 13MN107 and 13MN165 did not show any additional response to DO stress. It is possible there is localized low DO stress isolated at station 13MN136, but additional information would be needed to confirm that hypothesis as observed stress could be related to other stressors.

Table 73. Macroinvertebrate metrics that respond to low DO stress in North Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN136 (2013)	**24.00**	**1.00**	**9.20**	6.46	**1.00**	**0.32**	**9.00**	**27.13**
13MN165 (2013)	43.00	11.00	**8.20**	7.16	5.00	9.88	4.00	2.78
13MN107 (2013)	39.00	12.00	**8.20**	6.98	6.00	12.62	5.00	7.26
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish communities within the reach show a mixed response to low DO stress (see table below). All stations lacked DO sensitive taxa and generally sensitive taxa, but this could be attributed to other stressors in the reach. All stations showed high percentages of tolerant individuals, but generally had lower than average or near average quantities of DO tolerant taxa and individuals except for station 13MN107. This suggests that other stressors are contributing to the high numbers of tolerant taxa observed. All stations also hovered around their respective average DO Index scores, suggesting that low DO is not a driving stressor in the reach. Unlike the macroinvertebrate community, the fish at station 13MN136 are not showing isolated signs of low DO stress but this could be because fish are able to leave the reach and seek refuge during periods of low DO.

Table 74. Fish metrics that respond to low DO stress in North Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN136 (2013)	**0.00**	**2.65**	**76.18**	7.31	**0.00**	**0.00**	2.00	0.05
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
13MN165 (2013)	**0.00**	**5.52**	**75.80**	**7.12**	**0.00**	**0.00**	**5.00**	4.25
13MN107 (2013)	**0.00**	**10.26**	**97.44**	**7.05**	**0.00**	**0.00**	3.00	**23.07**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

At this time, low DO is an inconclusive stressor within the reach. While there was no chemical evidence to suggest DO concentrations fall below the 5 mg/L standard, levels were near the standard during every day of continuous sonde deployment in 2016 suggested that low diurnal DO flux could be a reality in low flow conditions. Biological metric data shows a potential for low DO stress in the macroinvertebrate community at station 13MN136. Additional investigation is needed to better understand potential of the stressor within the reach.

Eutrophication

Phosphorous concentrations collected during the fish visits at all three biological stations were all below the southern region eutrophication standard of 0.15 mg/L. An additional 15 phosphorous samples were collected on the reach at biological stations 13MN107, 13MN136 during 2015 and 2016; three of these readings were above the standard. Overall concentrations ranged from 0.021 mg/L to 0.768 mg/L, with an average concentration of 0.13 mg/L. Chlorophyll a was collected three times in 2015 and was low 1.48 ug/L to 5.32 ug/L, below the southern eutrophication standard of 35 ug/L. Evidence of abundant plant growth was identified in the reach (see photo below) and could be a sign of elevated nutrients in the reach. There were no BOD samples collected on the reach. Do concentrations from grab samples ranged from 6.39 mg/L to 13.44 mg/l indicating potential for elevated DO flux in the reach. Continuous

DO monitoring indicated exceedances of DO flux in the reach, exceeding river eutrophication standards three times. High DO flux is a response to increased macrophyte respiration as a result of a nutrient rich environment that is conducive to growing algae and plant material. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.59 – 9.58 in the reach.

The macroinvertebrate community suggests a potential for eutrophication stress, especially at the upstream most station 13MN136 (see table below). There were fewer collector-filterers than the average of similar stations meeting the biocriteria. Collector-gatherer numbers showed discrepant results across the three stations. There were no intolerant taxa and high percentage of the taxa in the sample were tolerant.

Table 75. Macroinvertebrate metrics that respond to eutrophication stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

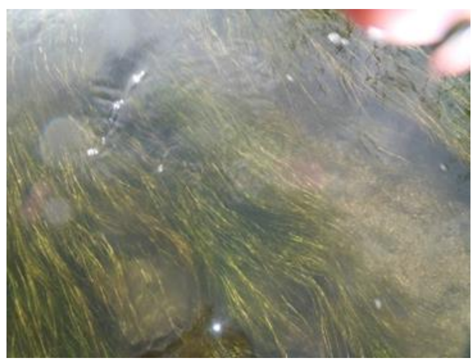
Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN136 (2013)	**24.00**	**0.00**	**6.00**	**1.00**	**0.00**	**87.50**
13MN165 (2013)	**43.00**	**4.00**	16.00	**11.00**	**0.00**	**86.05**
13MN107 (2013)	**39.00**	**5.00**	**13.00**	**12.00**	**0.00**	**82.05**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Fish community results were more mixed in response to eutrophication stress (see table below). All visits had an absence of sensitive and intolerant taxa and high percentages of tolerant species. Only biological station 13MN107 had both low numbers of darters and simple lithophilic spawners. A positive relationship exists between eutrophication and omnivorous fish. The two upstream most stations has below average quantities of omnivore taxa while the downstream most station had above average quantities of omnivores, this suggests that eutrophication could be a greater form of stress in the downstream portions of the reach and less of a concern further upstream in the reach.

Table 76. Fish metrics that respond to eutrophication stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN136 (2013)	**0.00**	17.35	35.00	2.94	**76.18**	**10.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.500	31.50	14.71	72.80	11.50	1.60
13MN165 (2013)	**0.00**	20.59	**20.59**	7.64	**75.80**	**16.00**	**0.00**
13MN107 (2013)	**0.00**	**0.00**	**7.69**	**30.77**	**97.44**	**10.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.9*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Figure 75. Biological station 13MN136 (June 17, 2013) filamentous algae (left); abundant vegetation (right).



Elevated P concentrations were identified on the reach but the dataset was small. Response variable data was limited to DO flux above the standard during a YSI deployment in 2016. Chlorophyll a readings were below the standard. While biological metrics suggest potential for eutrophication stress, metrics are generic in nature and may be indicating other stressors in the reach. Evidence of abundant plant growth in the reach suggests potential for eutrophication. Additional chemical evidence and response variable data is needed to better understand potential for eutrophication stress within the reach, as such eutrophication is an inconclusive stressor at this time.

Nitrate

During the three fish sampling events nitrogen concentrations ranged from 14 mg/L to 27 mg/L respectively. All sampling events occurred in June of 2013. Thirty additional samples were collected on this reach from 2013 to 2016 at the biological stations. These samples were collected from the months of May to September, with two visits from February of 2016. The nitrate concentration ranged from

0.29 mg/L in late September to 27 mg/L in June of 2016. Seventeen of the thirty samples were above 15 mg/L. The average nitrate concentration of all 33 samples was 15.65 mg/L.

There is a mixed response to the nitrate stressor in the macroinvertebrate community, but overwhelmingly data indicates that macroinvertebrates are responding to nitrate stress (see table below). The Nitrate tolerant Index Score ranged from 4 to 4.5 above the Prairie Stream Class threshold of 3.2, indicating general tolerance to high nitrate concentrations. The nitrate specific metrics show better than average Trichoptera taxa at two of three stations; trichoptera are generally sensitive to nitrate stress. However, there are very tolerant hydropsychids within the reach, including Cheumatopsyche, suggesting that Trichoptera taxa counts are not significant in determining nitrate stress within this reach. Two of three stations have quantities of nitrate tolerant taxa above the Prairie Streams GP class threshold. The percentage of nitrate tolerant individuals is above the threshold at all stations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). An absence of sensitive caddisflies in the reach also supports the case for nitrate stress.

Fish are not good indicators of elevated nitrate stress; however, general stress related metrics could be indications of nitrate related stress in the reach. Sensitive or intolerant fish taxa were absent in the reach while tolerant taxa were abundant. While darter numbers were within class averages at two stations they were absent at 13MN107.

Elevated nitrate concentrations in conjunction with strong macroinvertebrate stress metric data suggest that nitrates are stressing the macroinvertebrate community within the reach. Elevated nitrate concentrations in the reach are likely delivered to the stream via agricultural and drain tile runoff during heavy spring rain events before crop canopies have closed.

Table 77. Macroinvertebrate metrics that respond to nitrate stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L)
13MN136 (2013)	**24.00**	**0.00**	**6.00**	**1.00**	**0.00**	**87.5**	**0.00**	**0.00**	**4.50**	**1.00**	16.00	**74.80**	27.00 (6/17/2013)
13MN165 (2013)	43.00	**4.00**	16.00	**9.00**	**0.00**	**86.04**	2.00	**1.23**	**4.18**	**0.00**	**23.00**	**76.50**	15.00 (6/11/2013)
13MN107 (2013)	39.00	**5.00**	**13.00**	**8.00**	**0.00**	**82.05**	2.00	**0.63**	**4.00**	**0.00**	**23.00**	**79.80**	14.00 (6/11/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*0.00*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Three TSS samples were collected during the fish visits in 2013; no samples exceeded the southern region TSS standard of 65 mg/L. In 2013, 11 additional TSS samples were taken on the reach as part of IWM monitoring at biological station 13MN107, the downstream most station in the reach, one was above the standard. In 2015 and 2016 during SID investigations, 18 additional TSS samples were collected, and four were above the standard, a majority of samples were collected after rain events, half were collected above the confluence of -549 and the other half were collected at the pour point site on the reach, 13MN107. Six secchi tube readings were gathered in 2016 as part of SID investigations after rainfall events, readings ranged from 5 cm to 26 cm, only one value was below the 10 cm southern regional standard. A turbidity impairment on the reach was identified in 2006 and is a carry forward impairment from parent AUID -513. Recent TSS and STUBE data met the standard during 2015 assessments; however, the dataset not strong enough to pursue a delisting.

There was a response to TSS stress within the macroinvertebrate community within the reach (see table below). The TSS Index scores were above the average for the Prairie Streams GP Class across the reach, suggesting high potential for elevated TSS to affect the macroinvertebrates. TSS intolerant taxa were absent in the reach, but this could be explained by other stressors. An abundance of TSS tolerant individuals were captured across the reach.

Table 78. Macroinvertebrate metrics that respond to high TSS stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN136 (6/17/2013)	**11.36**	0.32	**17.69**	**0.00**	**0.00**	6.00	**70.35**
13MN165 (6/11/2013)	28.70	**0.00**	**19.21**	**0.00**	**0.00**	**17.00**	**65.74**
13MN107 (6/11/2013)	**0.00**	**0.00**	**21.69**	**0.00**	**0.00**	**15.00**	**72.56**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Fish at the downstream station, 13MN107, appear to be more vulnerable to TSS stress metrics than other stations on the reach (see table below). The TSS Index Score was above the class average only at station 13MN107, indicating potential for isolated TSS to the fish community within the reach. While TSS intolerant taxa and sensitive taxa were absent across the reach, only two stations had above average quantities of TSS tolerant taxa, and only 13MN107 had above average quantities of TSS tolerant individuals. There was an absence of centrarchids across the reach and below average quantities of riffle dwelling taxa and simple lithophilic spawners. Evidence suggests that TSS concentrations may accumulate downstream in this system, causing potential problems for the fish community.

Table 79. Fish metrics that respond to high TSS stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN136	42.06	**0.00**	24.41	**0.00**	**0.00**	17.35	**24.41**	**0.00**	**2.65**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
13MN165 (2013)	**29.09**	**0.00**	**7.01**	**0.00**	**0.85**	20.59	**7.01**	**0.00**	**5.13**
13MN107 (2013)	**2.56**	**0.00**	**2.56**	**0.00**	23.08	**0.00**	**2.56**	**0.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN136	13.54	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
13MN165 (2013)	16.65	**0.00**	**0.00**	**3.00**	1.27
13MN107 (2013)	**28.35**	**0.00**	**0.00**	**4.00**	**64.10**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Despite recent chemical data suggesting the historic turbidity impairment is not as severe as in the past, macroinvertebrate communities continue to show signs of elevated TSS stress as do the fish at station 13MN107. Erosion in the reach (see photos below) suggest there is still an abundant sediment supply to the reach during periods of high flow. Lack of recent chemical data response to confirm the persistence of turbidity issues within the reach could infer that the aftermath of past turbidity issues including degraded habitat conditions may be a stronger stressor within the reach. Until sufficient data is collected to delist TSS within the reach, TSS will remain an inconclusive stressor to biological communities.

Figure 76. Biological station 13MN107 (June 11, 2013) stream bank erosion (left); stream bank erosion (right).

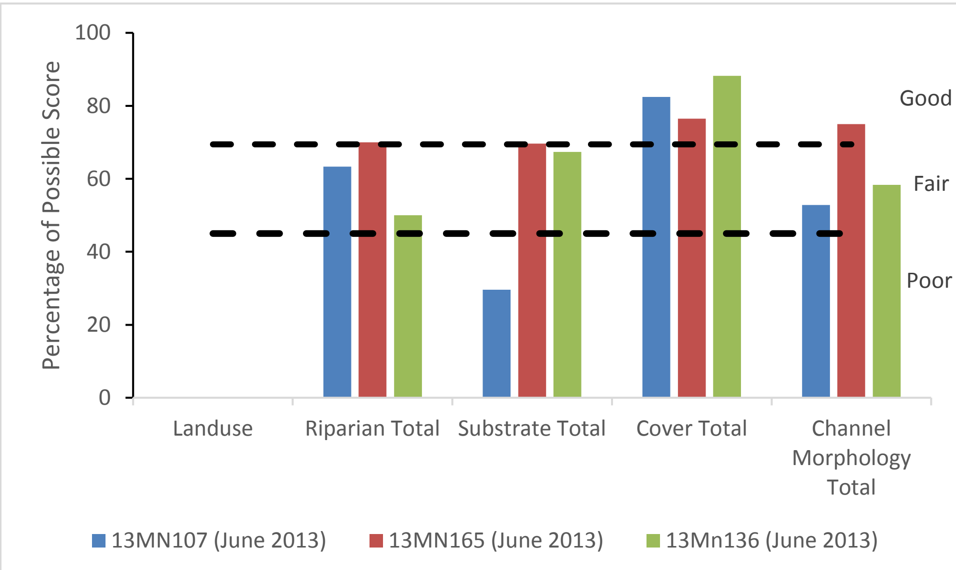
Figure 77. Biological station 13MN165 (June 11, 2013) stream bank erosion.

TSS stress is likely an isolated stressor on the reach with most profound metric response observed at station 13MN107. Above photographic evidence shows eroding banks which are likely contributors to elevated sediment levels observed.

Habitat

There were three qualitative habitat surveys conducted within the reach on three biological stations (13MN136, 13MN165 and 13MN107) in 2013 (see graph below). MSHA scores ranged from fair to good, ranging from 50.5 at the downstream most station (13MN107) to 69.3 at the mid station (13MN165). Surrounding landuse along the reach was dominated by row crop agriculture; however, a fair number of swine and cattle operations are scattered throughout the reach's watershed. A majority of the reach has been channelized, riparian buffers appear narrow where trees do grow along the river's banks; some stretches have wide riparian buffers while others are very limited. Instream habitat cover for biota ranged from moderate to extensive across the stations. Natural channel development was fair to good across the reaches. Stream bank erosion was identified at all three biological stations with greater amounts observed at the two downstream most stations (13MN165 and 13MN107). Diverse streambed substrates were identified at the upstream most two stations (13MN136 and 13MN165), but less than 4 were identified at the downstream most station (13MN107), where fine sediments were dominant and the embeddedness of coarse substrates was also greatest (Severe). Stream channel stability was rated moderate to moderate high at all stations, with lowest ratings observed at the downstream most station where sedimentation and erosion were more apparent.

Figure 78. Percentage of MSHA subcategory scores for stations 13MN107, 13MN165 and 13MN136 in Unnamed Creek.



A majority of habitat stress related metrics responded negatively for the fish community at the two downstream most stations (see table below). There was an abundance of tolerant taxa across the reach. There were limited quantities of piscivores and riffle dwelling species across the reach, While low quantities of lithophilic and simple lithophilic spawners were observed at the downstream most stations. This suggests that riffle habitat and coarse substrates are lacking within the reach as are refuge for predatory taxa. An abundance of pioneering taxa at the two upstream most station could also indicate habitat distress and pioneering taxa numbers are generally higher in more disturbed reaches. A preponderance of evidence at the site suggests that it is likely that the fish community is being stressed by degraded habitat conditions, especially at the downstream most station.

Table 80. Fish metrics that respond to degraded habitat stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN136 (2013) Headwaters	**76.18**	**0.00**	71.18	17.35	**42.06**	**24.41**	17.65	35.00
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	31.50
13MN165 (2013) Streams	**75.80**	**0.21**	**29.94**	**20.59**	**70.28**	**7.01**	22.51	**20.59**
13MN107 (2013) Streams	**97.44**	**0.00**	**15.38**	**0.00**	2.56	**2.56**	**0.00**	**7.69**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

The macroinvertebrate community shows a mixed response to habitat related stress metrics. All stations had fewer than average sprawler species and above average quantities of legless taxa. Abundance of legless taxa infer limited structure availability for organisms to adhere to. Quantities of burrower taxa were low and all stations had above average climber taxa. Abundant climber taxa could be attributed to the abundance of macrophytes or overhanging vegetation within the reach, especially seen in station 13MN136. Low quantities of burrowing taxa can be an indication of more diverse substrate types within a reach; however, this was not true at 13MN107. Low quantities of clinger taxa were seen at the upstream and downstream station. As only overhanging and instream macrophytes were sampled at 13MN136, it is not surprising that few clinger taxa were found as they thrive on coarse substrates and woody debris. Only woody debris was sampled at station 13MN107 so one would expect a higher clinger taxa percentage than what was observed.

As macroinvertebrates met their respective standards at station 13MN165; as such, it is not likely that habitat conditions are stressed at that station (see table below). The upstream most station had the lowest IBI score on the reach has a reasonably high MSHA score that is likely overinflated by choking macrophyte growth in the reach identified by SID photographs during the fish sampling. This sample was hyper dominated by snails, explaining the large legless individual percent observed. MSHA observations indicate habitat conditions are most degraded at the downstream most station where the river is lower gradient allowing fine sediments to accumulate on the streambed, filling in riffle and pool habitats.

Metrics suggests that degraded habitat issues vary by station, while the downstream most station has abundant fine sediments and few riffles, the upstream station is hyper dominated by macrophyte habitat. Lack of habitat diversity is an isolated stressor on the reach but may not be the primary stressor driving impairment observed.

Table 81. Macroinvertebrate metrics that respond to degraded habitat stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN136 (6/17/2013)	3.50	82.80	**5.10**	**1.27**	**87.58**	**5.73**
13MN165 (6/11/2013)	4.32	41.67	44.44	**35.19**	**58.95**	**6.17**
13MN107 (6/11/2013)	5.99	24.92	**29.97**	50.47	**36.59**	**13.57**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. At 650th Ave. there is a perched culvert, this is likely to be a barrier at low flows as well as high flows as the culvert is "inverted" and there is no sediment siting in the culvert, only algae. Despite the barrier along the reach all sampling events produced 10+ unique fish species. There were 5 species identified below the barrier at station 13MN133 that were not observed upstream, one of these taxa, shorthead redhorse is a known migratory fish species. There were also nine taxa identified upstream of the barrier on WID 564 that were not observed downstream of the barrier on WID 565, two of these taxa are known migratory fish species.

Only three of 19 mussel species were identified within the reach during DNR surveys from 1999-2003, Anodontoides ferussacianus (Cylindrical papershell), Lampsilis siliquoidea (Fatmucket), Pyganodone giandis (Giant Floater). Many mussel taxa are dependent on migratory fish species to complete their life cycles, presence of mussel taxa within the reach could indicate that longitudinal connectivity is not a likely stressor. However, seven additional mussel taxa were identified on the next downstream WID that were not observed in -564, this could indicate the present barrier is having some effect on biological communities.

While some migratory fish taxa are present within the reach, other migratory taxa identified downstream of the reach and potential barriers were not identified within the reach (see table below). As such, insufficient information is available to conclude whether longitudinal connectivity is stressing the biological community with the reach.

Table 82. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN136	13MN165	13MN107	650th Ave	13MN133
WID	-564	-564	-564		-565
Fish Taxa					
bigmouth buffalo		x	x		x
bigmouth shiner	x	x	x		x
black bullhead	x	x	x		x
blacknose dace	x	x	x		
blackside darter		x			
bluntnose minnow	x	x			x
central stoneroller	x	x	x		
common carp		x	x		x
common shiner	x	x	x		
creek chub	x	x	x		
hybrid sunfish					x
johnny darter	x	x			
northern pike		x			x
orange spotted sunfish			x		
Pumpkinseed					x
sand shiner		x	x		x
shorthead redhorse					x
spotfin shiner					x
tadpole madtom	x	x			
white sucker	x	x			x
yellow bullhead		x			
yellow perch					x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 34.89 mile long reach of the North Fork Watonwan River is 61% natural and 39% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that Altered Hydrology is a potential stressor, all of which were identified at the biological stations.

Presence of fish taxa that are typically seen in lakes can be an additional indication of low flow stress, black bullhead and yellow bullhead are both taxa that inhabit lakes and were all identified at least one station on the reach. There was also few long-lived individuals at stations 13MN136 and 13MN165 and a low percentage of taxa that require riffles at all stations, which are also indications of altered hydrology stress (see table below).

Table 83. Fish metrics that respond to altered hydrology stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN136 (2013)	**76.18**	**0.00**	**24.41**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*70.64*	*4.50*	*28.33*
13MN165 (2013)	**75.8**	**0.85**	**7.01**
13MN107 (2013)	**97.44**	23.08	**2.56**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Low flow conditions were observed on the reach at station 13MN107 in the fall of 2012. In 2012, southwestern Minnesota experienced a significant drought, low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months. Low flows can result in degraded habitat conditions, seasonally high nitrate concentrations and low late summer flows contributing to macrophyte growth and diurnal DO swings.

The evidence suggests that it is likely that stream alteration is causing stress to the biological community on the reach at this time.

Figure 79. Biological station 13MN107 (September 12, 2012) low flow (left); intermittent flow (right).

4.1.3 AUID Summary

The macroinvertebrate community in the North Fork Watonwan River is being stressed by elevated nitrate, degraded habitat and altered hydrology.

Available nitrate stress metric data shows a consistent response to elevated nitrogen concentrations in the macroinvertebrate community. There was an abundance of nitrate tolerant taxa within the reach. The maximum concentration collected on the reach was 27 mg/L. Elevated readings were identified during the spring months and are likely a result of land application of nutrients and tile drainage. As noted in the statewide nitrogen study, nitrate reaches waterways through surface runoff, tile drainage, and leaching to groundwater, with tile drainage being the largest pathway (MPCA, 2013).

Degraded habitat conditions were most pronounced at the downstream station in the reach where lower gradient conditions have allowed fine sediments to blanket the stream bottom, filling in riffle and pool habitat, limiting the presence of lithophilic spawners and riffle dwelling taxa. While the MSHA habitat score at the upstream station suggests better habitat conditions compared to the downstream most station, photographic evidence reveals that choking macrophytes are likely limiting the macroinvertebrate community in the reach as diverse habitat availability is limited at this station. Habitat concerns vary across the reach and appear to be influenced by nutrients and high flows that bring sediment loading.

Stream bank erosion is prevalent across the reach and provides the stream with a high sediment supply, as seen in photographs of eroding banks. Many observed stressors within the reach can be linked back to altered hydrology, historic channelization and agricultural inputs via tile drainage. Past channel modifications and changes to stream hydrology via tile drainage have designed a system to move water off the landscape quickly, resulting in degraded habitat conditions, seasonally high nitrate concentrations and low late summer flows contributing to macrophyte growth and diurnal DO swings.

DO was an inconclusive stressor on the reach for biological station 13MN136. While there were no DO readings observed below the 5 mg/l standard, continuous DO monitoring on the reach showed DO concentrations just above standard during the diurnal swing every day during deployment, suggesting that potential for low DO stress is likely. A marginal metric response to low DO stress was only observed at the upstream most station. Additional continuous DO monitoring may be warranted to better understand the potential stressor.

Eutrophication is also an inconclusive stressor within the reach. While elevated P concentrations were identified within the reach, the dataset was limited, and there was little response variable data to corroborate the stressor. Elevated DO flux concentrations suggest potential for stress, as does abundant vegetation in the reach; however, additional information is needed to better understand the stressor's extent and potential.

TSS is also an inconclusive stressor in the reach. Recent TSS data collected during intensive watershed monitoring does not agree with past data collection that attributed to a turbidity listing on the reach in 2006. However, insufficient data was available to lead to a delisting during 2015 assessments. There is still high erosion potential and sediment supply within the reach. Macroinvertebrate metric data still suggests elevated TSS stress across the reach as do the fish at 13MN107 in the lower reach. This response could be a result of past elevated TSS conditions and resulting habitat concerns within the reach and may not reflect present TSS conditions. Additional data collection to determine if TSS should be delisted would helpful in understanding the present potential for TSS stress within the reach.

Longitudinal connectivity is an inconclusive stressor in the reach. A barrier has been identified within the reach; however, some migratory taxa are found above and below the barrier while others are only found below the barrier. Insufficient information is available to determine potential stress at this time.

Table 84. Summary of stressor determinations for North Fork Watonwan River (564).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
North Fork Watonwan River	07020010-564	o	o	●	o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

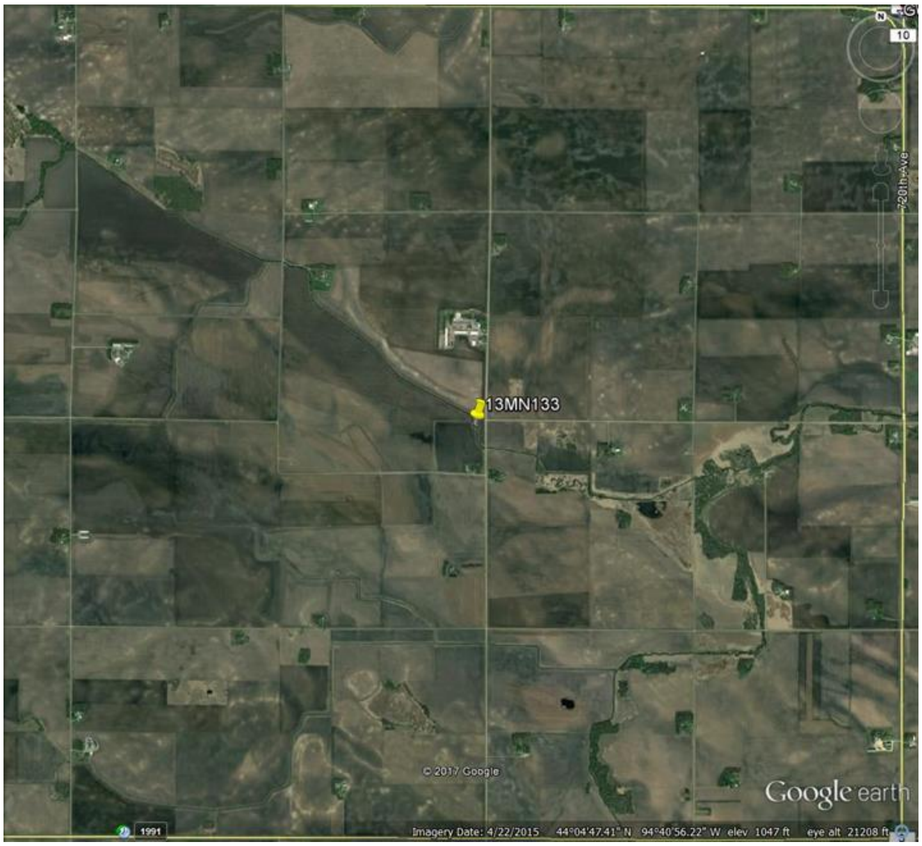
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1 North Fork Watonwan River -565

Reach (07020010-565) is the terminal reach for the North Fork Watonwan River, starting at reach (07020010-564) at Twp. Hwy 137 and flowing southeast 4.3 river miles to its confluence with the mainstem Watonwan River (07020010-512) at CR 14, 6 miles north of St. James. This reach is classified as modified use warmwater 2Bm. This reach is impaired for aquatic life for a degraded fish community.

Figure 80. Google Earth image of North Fork Watonwan River (-565).



4.1.1 Biological communities

One biological station occurs on this reach, 13MN133. It was sampled in 2013 for both indicators. Fish were sampled a second time in 2015. The 2013 visit had an FIBI score of 29.6 while the 2015 visit scored above upper confidence limits for the general use threshold at 63.2. The biggest difference in the overall samples included date of sample, June (2013) and August in (2015) and the presence of two additional species in 2015 that are generally more sensitive: tadpole madtom and stonecat. The dominant species in both samples were all generally tolerant due to degradation. The second sampling event also had greater quantities of later maturing individuals (MA<2Pct) and benthic insectivores (BenInsec-TolTxPct).

Macroinvertebrates were sampled once in 2013 and scored above the modified threshold and met standards. The MIBI score fell just below the general use threshold at 37.6. There was an absence of collector filterer taxa (Collectorer-filtererPct) within the reach, a zero score for the HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) and an absence of intolerant taxa (Intolerant2Ch).

Figure 81. Fish metrics of the Southern Streams Class IBI for station 13MN133, North Fork Watonwan River.

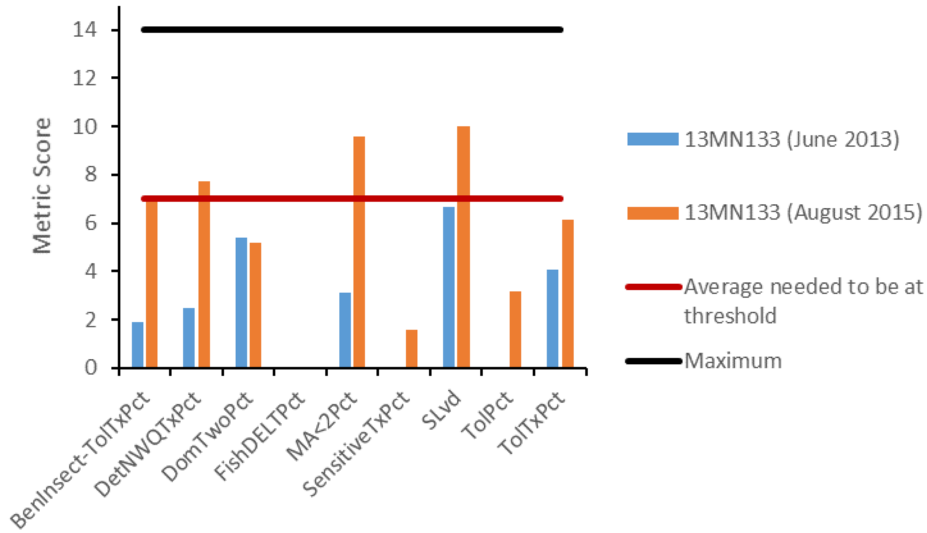
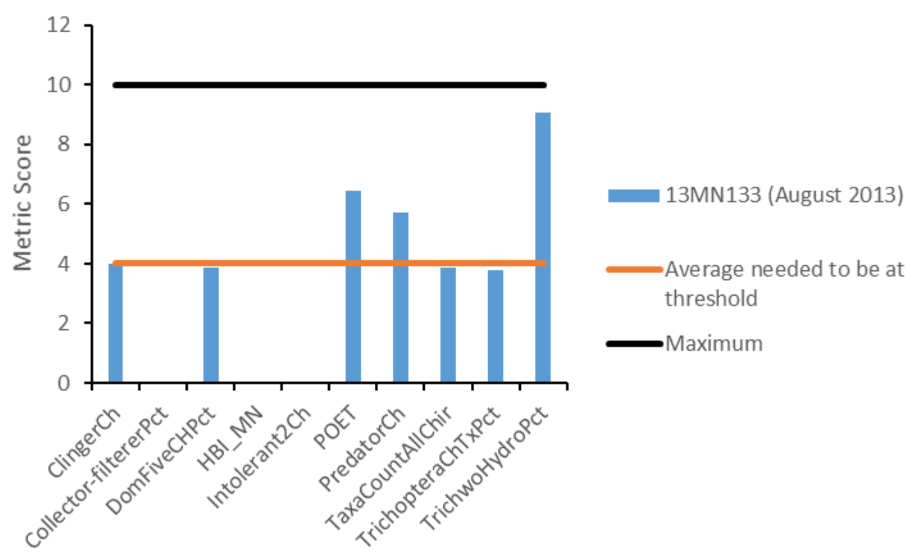


Figure 82. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN133, North Fork Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

During the biological sampling at 13MN133, three DO measurements were collected. A reading below the 5 mg/L standard was observed on August 11, 2015 of 3.19 mg/L at 8:24 am. An additional reading in August of 2013 was just above the standard at 5.68 mg/L at 10:10am, while the remaining value was within the normal range. Six additional DO samples were collected in 2016, ranging from 7.26 mg/L to 12.65 mg/L.

Fish communities appear to be showing some response to low DO stress metrics (see table below). There was a complete absence of DO sensitive taxa, a low percentage of generally sensitive individuals and an abundance of DO tolerant taxa while numbers of low DO sensitive individuals were below average. While there were low quantities of late maturing individuals in the initial visit, the 2015 visit produced much greater quantities.

Table 85. Fish metrics that respond to low DO stress in North Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN133 (2013)	**0.00**	**19.61**	**76.47**	7.00	**0.00**	**0.00**	**6.00**	33.33
13MN133 (2015)	**2.11**	53.68	**60.00**	**6.68**	**0.00**	**0.00**	**8.00**	52.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*8.38*	*27.98*	*46.38*	*6.89*	*0.1*	*1.08*	*5.5*	*54.58*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrate community is not impaired, looking at metric data from both assemblages in the reach can be beneficial in understanding stressors in the reach (see table below). Macroinvertebrate community data show only a marginal response to DO stress. While there was a low percentage of DO tolerant individuals collected, there was a higher than average quantity of low DO intolerant taxa. Quantities of low DO tolerant taxa were near average while the percentage of low DO tolerant individuals was low

Table 86. Macroinvertebrate metrics that respond to low DO stress in North Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN133 (2013)	**32.00**	11.00	**8.90**	6.97	3.00	1.54	8.00	12.92
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Low DO is an inconclusive stressor at this time, limited chemical data is available within the reach but available data suggests potential for low DO conditions exist. Fish metric data show potential for low DO stress as there us an abundance of DO tolerant taxa present within the reach. Additional DO data collection especially continuous DO monitoring would be beneficial in better understanding the potential of the stressor.

Eutrophication

Phosphorous data collected during two fish visits fell below the southern regional eutrophication standard of 0.15 mg/L. Of five additional samples collected in 2016 at the biological station, three exceeded standards. Phosphorous concentrations ranged from 0.102 mg/L to 0.417 mg/L across all visits with an average reading of 0.18 mg/L. There were no chlorophyll a or BOD samples collected within the reach. DO measurements in the reach ranged from 3.19 mg/L to 12.65 mg/L indicating potential for high DO flux in the reach. High DO flux is a response to increased macrophyte respiration as a result of a nutrient rich environment that is conducive to growing algae and plant material. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.55 – 8.04 in the reach.

The fish community metrics indicated potential eutrophication stress (see table below). Darter counts were low as was the percentage of tolerant taxa. Intolerant species were absent. The initial visit had a low percentage of simple lithophilic spawners while the second visit was above southern streams averages, indicating discrepant results. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were observed within the reach during both visits suggesting that eutrophication may be stressing the fish community in the reach.

Table 87. Fish metrics that respond to eutrophication stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN133 (2013)	**0.00**	**0.00**	**3.92**	**29.41**	**76.47**	**13.00**	**0.00**
13MN133 (2015)	**2.11**	**5.26**	38.95	**52.63**	**60.00**	**14.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*33.59*	*3.22*	*11.57*	*25.10*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Macroinvertebrates are not impaired within the reach; however, looking at metric data from both indicators can be useful in understanding potential stress within the reach (see table below). Macroinvertebrate metrics also show potential response to eutrophication stress. There was a high percentage of tolerant taxa and low quantities of collector-filterer and collector-gatherer taxa compared to the southern streams class average. There was also an absence of intolerant taxa. In contrast, there were above average quantities of EPT taxa, which are sensitive to disturbed conditions.

Table 88. Macroinvertebrate metrics that respond to eutrophication stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN133 (2013)	**32.00**	**1.00**	**11.00**	11.00	**0.00**	**93.75**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

While there was some biological metric response to eutrophication stress within the reach, biological metrics used for eutrophication stress are general stress metrics and may be responding to other stressors in the reach and should only be used as supplementary evidence to stress. Phosphorous concentrations were elevated in the reach in the limited dataset available; however, there was no response variable data available to confirm potential problems within the reach. Eutrophication is an inconclusive stressor in the reach until additional chemistry and response variable information is gathered to better understand the potential of stress within the reach.

Nitrate

Water chemistry data for this reach was limited to data collected during biological monitoring visits and information gathered during stressor identification investigations. Eight nitrate samples were gathered from 2013 to 2016 during the months of February, May, June and August. Nitrate concentrations ranged from 0.11 mg/L in August of 2015 to 21 mg/L in May and June of 2016, the average observed was 15.33 mg/L. High nitrate values at or above 15mg/L were observed during four visits in May and June. Elevated levels above natural background levels were also observed during the February sample in 2016 and the June sampling event in 2013 corresponding to the fish visit.

Table 89. Fish metrics that respond to nitrate stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN133 (2013)	**0.00**	**0.00**	**76.47**	**0.00**
13MN133 (2015)	**2.11**	**5.26**	**60.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*8.38*	*13.57*	*46.38*	*0.86*
Expected response to Nitrate stress	↓	↓	↑	↓

Fish often do not show strong response to increased nitrate concentrations. Available fish metrics that respond to nitrate stress are very general and are likely indicators of other stressors in the reach (see table above). There were few darters present in the reach; however, this too could be explained by absence of riffles in the reach and limited availability of coarse substrates in the reach.

Macroinvertebrate stress metrics indicate that the macroinvertebrate community is responding negatively to elevated concentrations of nitrates (see table below). The Nitrate Index score was above the statewide average for the Prairie Streams GP Class, suggesting potential for stress. There was also an abundance of nitrate tolerant taxa and individuals in the reach, indicating stress. Evidence suggests nitrate is impacting the macroinvertebrate community and should be reduced to prevent further degradation and potential future impairment.

Table 90. Macroinvertebrate metrics that respond to nitrate stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L)
13MN133 (2013)	**32.00**	**1.00**	**11.00**	**9.00**	**0.00**	**93.75**	**2.00**	8.39	**4.30**	**0.00**	**23.00**	**84.60**	13.00 (6/12/2013)
13MN133 (2015)													0.11 (8/11/2015)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.00*	*11.57*	*4.84*	*0.11*	*87.94*	***1.99***	***0.66***	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Two TSS samples were taken during biological sampling visits in 2013 and 2015; neither sample exceeded the 65 mg/L southern regional TSS standard. Five of six TSS samples collected in 2016 during SID investigations exceeded the standard. No additional TSS data was collected on the reach prior to biological monitoring visits.

There was a mixed response to TSS stress within the fish community between fish visits (see table below). The TSS Index score was above the average for the Southern Headwaters Class for both visits, which indicates potential for stress. Elevated numbers of TSS tolerant taxa and individuals were also identified within the reach during the 2013 visit. Taxa metrics show that during the 2013 visit there were below average quantities of benthic feeders, herbivores, perciformes, riffle dwelling species and simple lithophilic spawners, all of which indicate potential stress. Benthic feeders require clear water to collect food. Herbivores have difficulty finding food as well because turbid waters can prevent the establishment of macrophytes in a stream reach due to lack of light for photosynthesis and difficulty getting established because of continual sedimentation in the reach. Riffle dwelling species like lithophilic spawners require clear coarse substrates for spawning and as such are not likely to be found in turbid waters. However, there were above average quantities of centrarchids and long-lived individuals. While there were below average quantities of sensitive and intolerant taxa, this could be explained by other stressors within the reach. However, the 2015 visit performed much better with only low quantities of centrarchids, intolerant taxa and sensitive taxa suggesting yearly variation in the reach.

Table 91. Fish metrics that respond to high TSS stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN133 (2013)	**3.92**	1.96	**1.96**	**0.00**	37.25	**9.80**	**3.92**	**0.00**	**3.92**
13MN133 (2015)	49.47	**0.00**	37.89	**0.00**	15.79	18.95	40.00	**2.11**	37.89
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*31.38*	*1.01*	*21.54*	*0.52*	*4.91*	*15.11*	*22.62*	*6.02*	*15.69*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN133 (2013)	**28.67**	0.00	**0.00**	**4.00**	**71.00**
13MN133 (2015)	**17.65**	0.00	**0.00**	**2.00**	2.11
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*17.35*	*0.04*	*0.01*	*0.66*	*5.36*
Expected response to TSS stress	↑	↓	↓	↑	↑

While macroinvertebrates aren't impaired within the reach, looking at all available indicator data is useful in better understanding potential stress in the reach (see table below). TSS stress metrics in the reach indicate that TSS is a likely stressor for the macroinvertebrate community at station 13MN133. The TSS Index score was above the Prairie Streams GP Class average, suggesting that TSS stress is likely. There was an absence of TSS Intolerant Taxa and an abundance of TSS tolerant taxa and individuals. Additional taxa metrics show an absence of collectorer-filterer taxa and limited plecoptera taxa as well. An absence of collector-filtered taxa within the reach could indicate that turbid conditions are persistent in the reach and do not provide adequate visibility for macroinvertebrate that rely on site to collect nourishment. Limited plecoptera taxa in the reach is indicative of limited availability of riffles and coarse substrates, likely due to erosion and instream sedimentation.

Table 92. Macroinvertebrate metrics that respond to high TSS stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN133 (2013)	**0.00**	**0.31**	**23.40**	**0.00**	**0.00**	**14.00**	**74.77**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.00*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

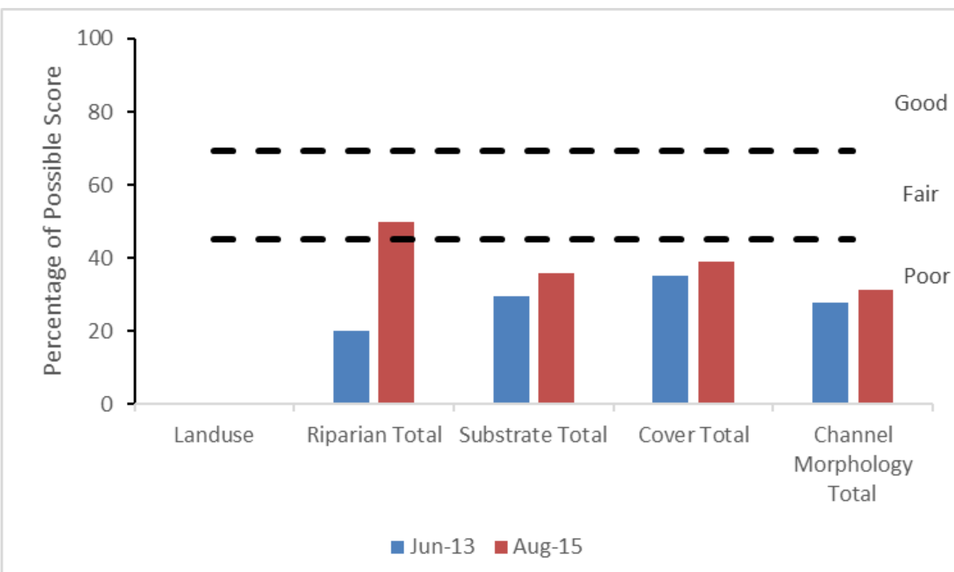
Biological metrics indicate a high potential for TSS stress within the reach; however, limited TSS chemistry data is available in the reach to corroborate the stressor. While upstream reach is impaired for turbidity, insufficient data was presented for delisting, despite the fact that more recent data suggests improving conditions. As such, TSS is an inconclusive stressor until additional investigation of TSS concentrations in the reach is obtained to better character the potential stressor.

Habitat

Two qualitative habitat surveys were conducted at biological station 13MN133 in 2013 and 2015 (see graph below). MSHA habitat ratings were poor at both visits with an average score of 31. Landuse in the surrounding watershed is predominately comprised of row crop agriculture with one large bovine facility near the stream reach (2750 bovine). The reach is predominately channelized with narrow to very narrow riparian buffers. At the biological station, row crop came right up to the stream edge contributing to the stream bank instability observed at the reach (see photo). Stream substrates were dominated by fine sediments (sand and silt) and present coarse substrates were moderately to severely embedded. Instream natural channel progression was limited pools and runs, with moderate depth variability. Sparse stream habitat cover for biota was observed within the reach.

Figure 83. Biological station 13MN133 (June 12, 2013) lack of riparian buffer (left); riprao utilized to stabilize failing stream banks (right).

Figure 84. Percentage of MSHA subcategory scores for stations 13MN133 in North Fork Watonwan River.



There was a mixed response to degraded habitat stress within the reach in the fish community, with greater response observed during the initial visit (see table below). Tolerant taxa were abundant within the reach. Quantities of lithophilic spawners, 'darter, sculpin, sucker' taxa and piscivore taxa were below the Southern Headwaters Modified Class average, suggesting stress and corroborating absence of riffles in the reach and limited available coarse substrates and available habitat. However, there were below average quantities of pioneering species, typically numbers of pioneering species are elevated within a reach as they are the first to move into new habitats when other taxa have been pushed out. Quantities of riffle dwelling taxa, benthic insectivores and simple lithophilic spawners varied between visits, suggesting year-to-year sampling variability as flows appeared similar between visits. Two taxa in the reach, tadpole madtom and stonecat likely inflated FIBI scores during the second visit. Their presence in the reach is surprising given such poor habitat conditions present and are likely a fluke.

Table 93. Fish metrics that respond to degraded habitat stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LithFrimPct	DarterSculpSucPct	RifflePct	BenInsect-TolPct	PiscivorePct	PioneerPct	SLithopPct
13MN133 (2013)	**76.47**	**3.92**	**1.96**	**3.92**	**1.96**	**1.96**	1.96	**3.92**
13MN133 (2015)	**60.00**	**41.05**	**5.26**	40.00	12.63	**1.05**	23.16	38.95
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*46.70*	57.98	10.59	22.62	10.91	1.97	*32.54*	*30.09*
Expected response to Habitat stress	↑	↓	↓	↓	↓	↓	↑	↓

While the macroinvertebrate community is no impaired within the reach, sometimes looking at all indicator data can assist in better understanding potential stressors in a reach (see table below). Similar to the fish community there were mixed results in the habitat stress metric data. Despite an abundance of fine sediment in the reach and severely embedded coarse substrates, there was not an abundance of burrower and legless taxa. Sufficient quantities of climber taxa can be attributed to the abundance of overhanging vegetation in the reach. The abundance of clinger taxa is surprising considering woody debris and coarse substrates were not prevalent in the reach.

Table 94. Macroinvertebrate metrics that respond to degraded habitat stress in North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN133 (2013)	4.04	38.20	**20.19**	46.89	40.06	30.75
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Observed degraded habitat conditions in conjunction with a poor response to many habitat metrics indicate habitat is stressing the fish within the reach.

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. At 650th Ave. there is a perched culvert, this is likely to be a barrier at low flows as well as high flows as the culvert is “inverted”, and there is no sediment siting in the culvert, only algae. Despite the barrier along the reach all sampling events produced 15 unique fish species, only five fish species found below the potential barrier were not found upstream. Eight species identified upstream of the barrier were not observed downstream of the barrier within the reach. This could be a fluke or due to habitat limitations at the station 13MN133 that are not as pronounced in the upstream reaches. There were four migratory fish taxa identified within the reach and one identified upstream of the barrier not seen within the reach (see table below).

Ten of 19 mussel species were identified within the reach during 1999-2003 DNR mussel surveys. The following taxa were identified: *Anodontoides ferusseicianus* (Cylindrical papershell), *Fusconai flava* (Wabash pigtoe), *Lamsitis cardium* (Plain Pocketbook), *Lasmigona complanata* (White heelsplitter), *Lasmigona compressa* (Creek heelsplitter), *Leptodea fragillis* (Fragile Papershell), *Lampsili siliquoidea* (Fatmucket), *Pyganodon grandis* (Giant Floater), *Potamilus ohiensis* (Pink Papershell) and *Stophitus undulates* (Creeper). Many mussel taxa are dependent on migratory fish species to complete their life cycles, presence of mussel taxa within the reach could indicate that longitudinal connectivity is not a likely stressor.

Evidence suggests that it is unlikely that longitudinal connectivity is limiting the fish community at this time.

Table 95. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Taxa in blue are known lake species.

Field Number	13MN136	13MN107	13MN165	650th Ave	13MN133
WID	-564	-564	-564		-565
Fish Species					
bigmouth buffalo		x	x		x
bigmouth shiner	x	x	x		x
black bullhead	x	x	x		x
blacknose dace	x	x	x		
blackside darter			x		x
bluntnose minnow	x		x		x
central stoneroller	x	x	x		
common carp		x	x		x
common shiner	x	x	x		
creek chub	x	x	x		
hybrid sunfish					x
johnny darter	x		x		
northern pike			x		x
orange spotted sunfish		x			
Pumpkinseed					x
sand shiner		x	x		x
shorthead redhorse					x
spotfin shiner					x
tadpole madtom	x		x		
white sucker	x		x		x
yellow bullhead			x		
yellow perch					x

Figure 85. .Biological station 13MN133 (May 2, 2016) drainage in same field with center pivot irrigator (left); drain tile (right).

The Altered Watercourses GIS layer for Minnesota streams indicates that the 4.34 mile long reach of the North Fork Watonwan River is 100% modified. A majority of the upstream reach of the North Fork Watonwan River was natural; however, nearly 40% was modified. Modified channels often lead to bank erosion and instability. Altered hydrology also leads to the reduction of habitat by limiting a streams ability to push fine sediment through a system, which can cover coarse substrates limiting habitat availability for biotic communities. According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were identified at the biological station.

The DNR conducted a geomorphology survey near the biological station on this reach identifying the reach as a G4c channel. Here the North Fork is deeply incised and vertically entrenched, leading to bank and bed erosion commonly seen in ditches. Narrow riparian buffers are also leading to stream widening (DNR, 2014).

Two lake species were identified on the reach during biological sampling, black bullhead and yellow perch. Presence of fish taxa that are typically seen in lakes could be an additional indication of low flow stress. There were sufficient quantities of long-lived individuals during the 2013 visit but a low quantity of riffle taxa, which is not surprising as there were no riffles identified within the reach. Mysteriously the quantity of taxa that require riffles increased during then 2015 visit (see table below).

Table 96. Fish metrics that respond to altered hydrology stress in the North Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN133 (2013)	**76.47**	37.25	**3.92**
13MN133 (2015)	**60.00**	**15.79**	40.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*46.70*	4.91	22.62
Expected response to Altered Hydrology stress	↑	↓	↓

In the photograph above at station 13MN133, a drain tile pump was recorded draining water off agricultural land in the Watonwan while center pivot irrigators are placed on the same fields. Wetland drainage and extensive systems of tile drainage within the watershed to remove water from agricultural fields have reduced water storage on the landscape resulting in increased peak flows during storm events. Evidence of drain tile usage in conjunction with center pivot irrigation systems are an extreme indication of altered hydrology, spring rain events are quickly discharged to the North Fork Watonwan during storm events and the water table is bring drained by the irrigators, impacting baseflow during periods of dry weather when crops require water. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and limiting flow in the drier late summer months.

Sufficient evidence exists to implicate altered hydrology as a stressor in the reach.

4.1.3 AUID Summary

The fish community in the North Fork Watonwan is stressed by degraded habitat conditions and altered hydrology. The MSHA habitat surveys identified poor habitat conditions within the reach, which attributed to the biological communities being judged against modified use standards. Absence of riffles and diverse habitat cover, limited coarse substrates, in stream sedimentation and unstable banks all attributed to negative responses to habitat stress metrics in the fish community including low quantities of darters, riffle dwelling taxa, lithophilic spawners, piscivores and benthic insectivores. Altered hydrology relates to degraded habitat conditions observed within the reach. Historic stream channelization and intensive agricultural practices including tile drainage have led to intensified flows during storm events, leading to ubiquitous stream channels laden with fine sediments and limited depth variability and sparse cover for biota. Center pivot irrigators add to stress by depleting the water table during dry periods removing potential baseflow from the reach further stressing biota.

Low DO, eutrophication, suspended sediment and habitat were inconclusive stressors within the reach. A limited DO dataset produced one DO measurement below the low DO standard, fish exhibited response to low DO stress metrics. Limited data was available to determine eutrophication stress, while elevated phosphorous concentrations were present within the reach, there was no DO flux information available or other response variable indicator data nor was their extensive algal or macrophyte growth which can help build or refute a case for the stressor. Additional continuous DO monitoring of the site could lead to better understanding of the potential for low DO stress and diurnal DO swings within the reach. Additional paired phosphorous and response variable data would also be useful in understand eutrophication potential within the reach. Elevated TSS concentrations were limited to grab samples during high flow events. An upstream turbidity impairment indicates past issues with turbidity on the North Fork Watonwan River; however, more recent data indicates conditions may be improving but are not abundant enough to delist. Both biological indicators show a negative response to TSS stress metrics. Despite degraded habitat conditions observed within the site, there was little metric response to disturbed habitat related metrics for both fish and macroinvertebrate taxa. Stream bank erosion and fine sediments were abundant within the reach and limited habitat was available for biological communities.

While fish do not generally respond to nitrate stress, the macroinvertebrate community , while not impaired macroinvertebrates responded negatively to nitrate stress metrics, with an abundance of nitrate tolerant individuals. Elevated nitrogen concentrations were identified within the reach with the highest concentrations observed during the spring months when stream flow contributions from drain tiles are highest. The highest value documented was 21 mg/L. Efforts should be made to reduce nitrogen concentrations in the reach to prevent the macroinvertebrate community from future impairment.

Longitudinal connectivity is not stressing the fish community in the reach. There was an abundance of mussel taxa in the reach (10 taxa) and four known migratory fish taxa identified.

Table 97. Summary of stressor determinations for North Fork Watonwan River (565).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
North Fork Watonwan River	07020010-565	o	o	--	o	●	●	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

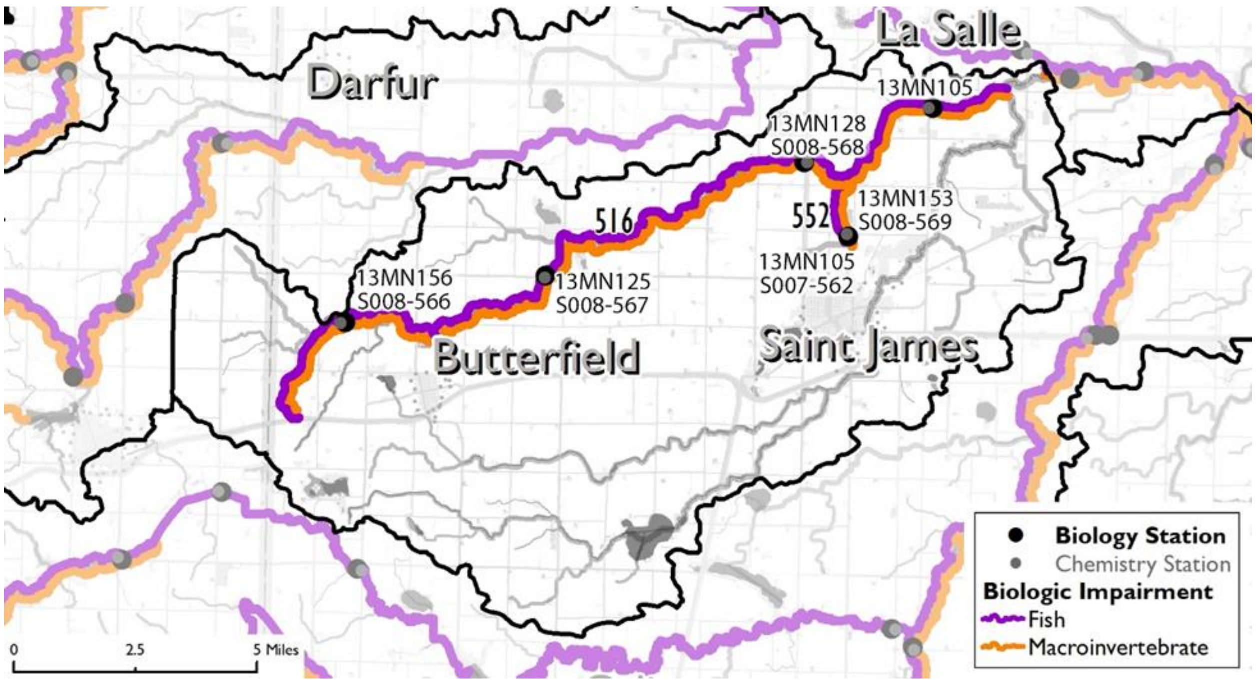
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

St. James Creek

The St. James Creek Watershed, includes St. James Creek and its primary tributary Butterfield Creek. Butterfield Creek begins southwest of Butterfield and flows northeast towards La Salle. St. James Creek begins south of Butterfield and flows in a northeast direction past the community of St. James and north towards La Salle. Butterfield Creek joins St. James Creek south of La Salle before joining the mainstem Watonwan River.

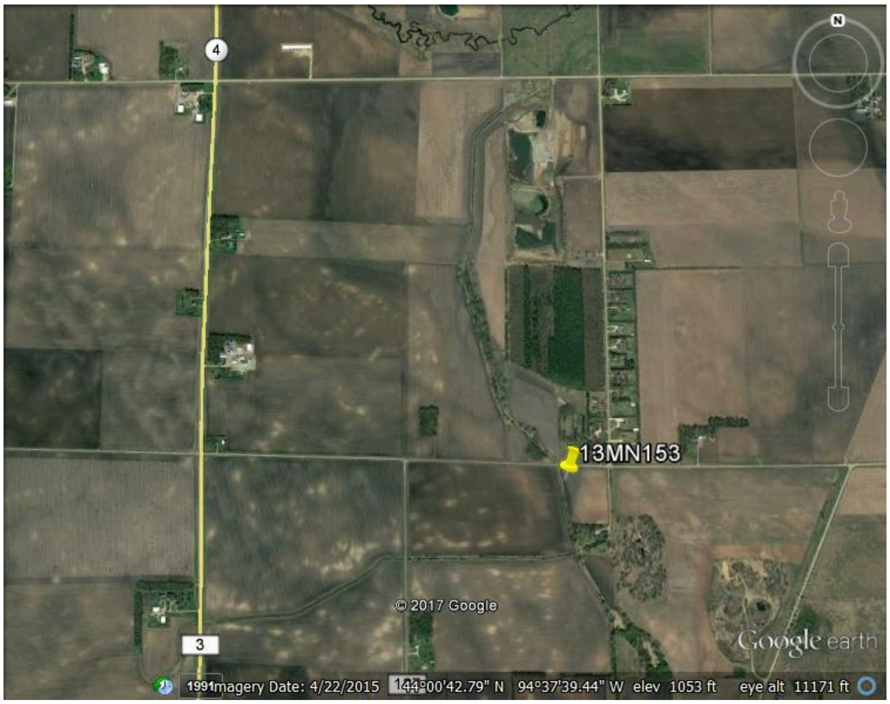
Figure 86. Biological impairment map of the St. James Creek subwatershed.



4.1 Unnamed Creek -552

Unnamed Creek (07020010-552) is a tributary of Butterfield Creek (07020010-516). It begins 1 mile north of St. James at Co. Hwy 127 and flows north 1.5 stream miles to its confluence with Butterfield Creek downstream of Co. Hwy 116. This reach is classified as modified use warmwater. This reach is impaired for aquatic life for both fish and macroinvertebrate assemblages (2015).

Figure 87. Google Earth image of Unnamed Creek (-552).



4.1.1 Biological communities

There is one biological station on this reach. Station 13MN153 was sampled for fish and macroinvertebrates in 2013. The macroinvertebrate IBI scored 4.9, scoring well below the threshold and lower confidence interval. The sample was overwhelmingly dominated by a single taxon, Physa (269 individuals) (snails), followed by Dicrotendipes (15 individuals) (nonbiting midges, bloodworms) and Oligochaeta (14 individuals) (worms). The MIBI scored a zero for 8 of 10 metrics (see graph below).

The fish also scored well below standards with an IBI score of zero. Only three blacknose dace were captured. Low capture rates resulted in low end scoring (see graph below).

Figure 88. Fish metrics of the Southern Headwaters Class IBI for station 13MN153, Unnamed Creek.

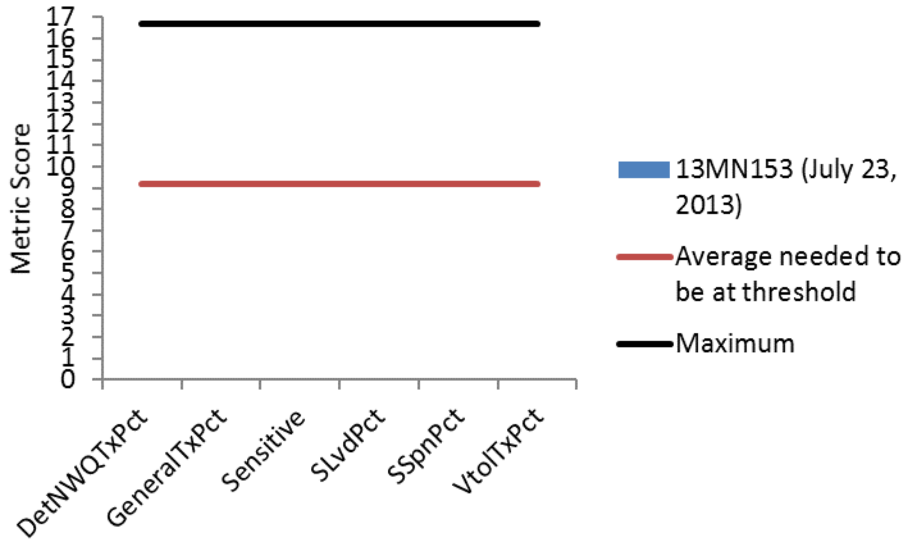
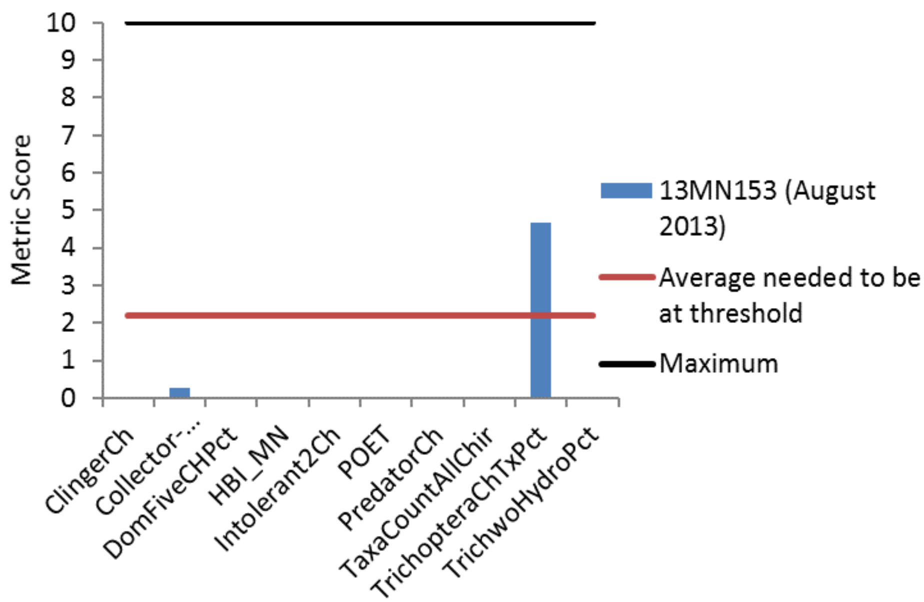


Figure 89. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN153, Unnamed Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Two DO measurements were collected at the biological station in 2013; samples were collected in the late afternoon on July 23 and August 14 and were 10.88 mg/l and 11.5 mg/L respectively.

The macroinvertebrate community shows a mixed response to low DO stress (see table below). The low DO Index score was slightly below the average for the Prairie Streams GP modified class, indicating that low DO stress is unlikely in the reach. There was an absence of low DO intolerant taxa and few DO tolerant taxa, indicating potential for stress or a result of the overall low taxa count.

Table 98. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN153 (2013)	**13.00**	**2.00**	0.00	**6.35**	**0.00**	**0.00**	4.00	6.37
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Only blacknose dace were captured during the fish visit so metric data may not provide sufficient information for determining stress, as such the table was omitted from the report. The fish community showed a similar mixed response to low DO stress. While 100% of the community was considered tolerant, and there was an absence of DO sensitive taxa; there was also an absence of DO tolerant taxa and the low DO Index score was only marginally below the average needed to meet the Southern Headwaters modified class average.

Insufficient information is available to make a stressor assessment at this time.

Eutrophication

Only one sample was collected on this reach for phosphorous during the fish visit on July 23, 2013, results were 0.066 mg/L. This lone sample was below the river eutrophication standard for the Southern Region. No chlorophyll a or BOD samples were collected. Only two DO grab samples were collected in the reach, ranging from 10.88 mg/l and 11.5 mg/L. Photographic evidence (below) suggests potential for eutrophication stress due to an overabundance of stream macrophyte growth within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.19 – 8.72 in the reach. Additional chemical data collection would be useful to better understand potential for eutrophication stress within the reach.

Macroinvertebrate results suggest possible eutrophication stress (see table below). There was a lower number of collector-filterers, collector-gatherers and EPT taxa than the average of visits meeting the biocriteria. Also 100% of the taxa present were tolerant. There were also very low taxa counts.

There is little utility in the metric information for the fish community as only a single species was captured during the visit. As such, the table has been omitted from the report. Only three blacknose dace were captured which are a tolerant taxa.

Additional chemistry data collection is needed in determining potential for exposure to high levels of eutrophication within this reach as well as response indicator data to confirm high P levels are causing problems in the reach, as would additional biological sampling to better understand potential stressors in the reach. Insufficient information is available to make a stressor assessment at this time.

Table 99. Macroinvertebrate metrics that respond to eutrophication stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN153 (2013)	**13.00**	**2.00**	**6.00**	**2.00**	**0.00**	**100.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Figure 90. Biological station 13MN153 (July 23, 2013) dense macrophytes.

Nitrate

A single grab sample for nitrate was collected during the fish visit on July 23, 2013 of 8.4 mg/L. There are no additional nitrate stream chemistry data is available for this reach. This single reading suggests nitrogen levels are elevated above normal background levels.

The macroinvertebrates in this reach show a mixed response to elevated nitrate concentrations (see table below). There is a low overall abundance of nitrate tolerant taxa within the reach; the number is half as low as the average for the Prairie Streams GP class. However, the percentage of nitrate tolerant individuals is very high at 93.3%, more than 30 points above the class' average at 59.7%. The nitrate index score was 5.06, while the average for modified Prairie Streams meeting impairment threshold is 3.2, indicating a high potential for stress. There was also an absence of nitrate intolerant taxa and a limited presence of trichoptera and EPT taxa, which are sensitive to nitrate pollution.

Fish are not often impacted by elevated nitrate stress. As only three blacknose dace were captured in the reach, metric data, which are very general stress metrics, have little utility in determining stress.

While a nitrate exposure signal appears to be present in the reach when looking at the macroinvertebrate community, additional water chemistry data collection for nitrates should be gathered in spring months in conjunction with rainfall events to better understand nitrate exposure within the reach and potential impacts of this stressor.

Table 100. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (date fish visit)
13MN153 (2013)	**13.00**	**2.00**	**6.00**	**2.00**	**0.00**	**100.00**	**1.00**	**0.00**	**5.06**	**0.00**	9.00	**93.30**	8.40 (7/23/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.00*	*11.57*	*4.84*	*0.11*	*87.94*	***1.99***	***0.66***	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

During the biological sampling on Unnamed Creek, the TSS concentration was 50 mg/L, below the standard for the southern region, 65 mg/L. There were no additional samples collected within the reach.

The macroinvertebrate community showed a negative to response to nearly all the metrics associated with TSS stress (see table below). The TSS index score was greater than that of the average of similar stations meeting the criteria. There was a complete absence of TSS intolerant taxa. While there was an abundance in the percentage of TSS tolerant individuals (86.31 %), the number of TSS tolerant taxa was low a testament to the low diversity in the reach. There were also low quantities of collector-filterer taxa and an absence of Plecoptera taxa (stoneflies); low numbers of these taxa infer turbid conditions as collector and filter taxa require clear water to locate food and stoneflies live in clear fast moving water.

The utility of the fish metric data is limited due to the low taxa count collected, a single tolerant species.

While the macroinvertebrate metric data suggests potential for stress in the reach, limited chemical data to corroborate the stressor will result in an assessment of inconclusive at this time. Additional chemical data would be useful in further clarifying the potential for TSS stress within the reach and a fish sample with greater diversity is needed to better understand potential stressors in the reach.

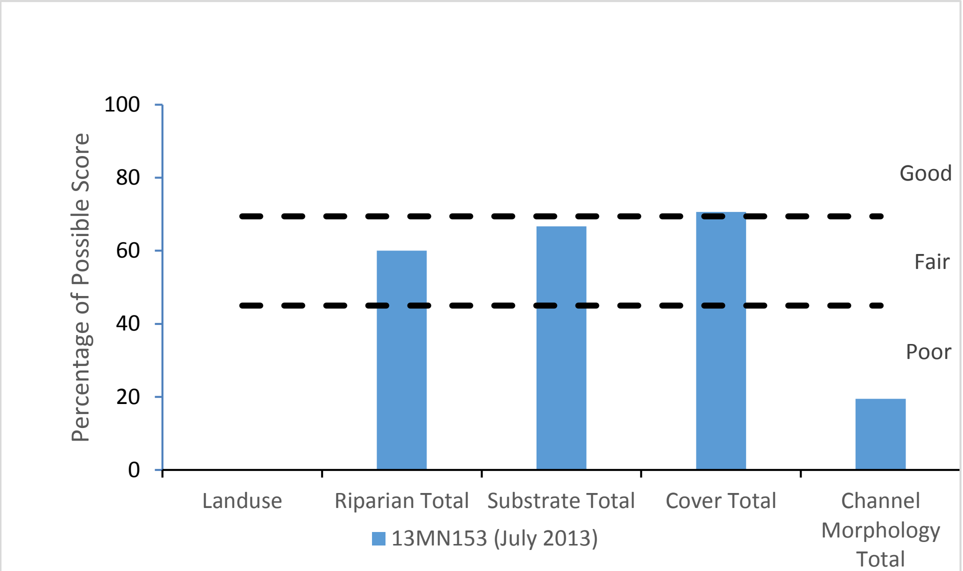
Table 101. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN153 (7/23/2013)	**1.27**	**0.00**	**17.83**	**0.00**	**0.00**	3.00	**86.31**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.00*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to stress	↓	↓	↑	↓	↓	↑	↑

Habitat

The MSHA at station 13MN153 was poor (46); which is reflective of the streams modified use classification (see graph below). Landuse in the watershed is predominately comprised of row crop agriculture; a small residential portion of the northern range of the municipality of St. James also lies within its boundaries, which attributed to a zero score for landuse metrics. Within the reach, there is a narrow natural riparian zone of 5-10 m dominated by reed canary grass which provides some shade to the small tributary. There was no observed bank erosion. Substrates are limited to sand and gravel, which shows some indication of embeddedness. While habitat cover was noted as extensive, cover types were limited to overhanging vegetation and emergent macrophytes, an indication of dense macrophytes (seen in photograph above) suggest that the extensive ranking was likely over inflated and cover should have been listed as choking vegetation only. A low channel morphology metrics score can be attributed to a ubiquitous stream channel (100% run), an absence of sinuosity and limited depth variability. Channel modifications within the reach are likely decreasing the stability of the stream bed load.

Figure 91. Percentage of MSHA subcategory scores for stations 13MN153, in Unnamed Creek.



The macroinvertebrate community showed almost universal negative response to habitat stress related metrics within the reach (see table below). There was an abundance of legless and burrowing taxa, indicating a prevalence of fine sediment within the reach and limited coarse substrates. Clinger and sprawling taxa were nearly absent, consistent with limited habitat diversity noted in the MSHA. Large quantities of climbing taxa were noted and are typical in a reach dominated by overhanging vegetation and macrophytes.

The utility of the fish metric data is limited due to the low taxa count collected, a single tolerant species, blacknose dace. As such, the table was omitted from the report.

Degraded conditions and limited habitat diversity identified during biological visits, in addition to a negative response in the macroinvertebrate community to degraded habitat metrics is an indication of habitat stress within the reach.

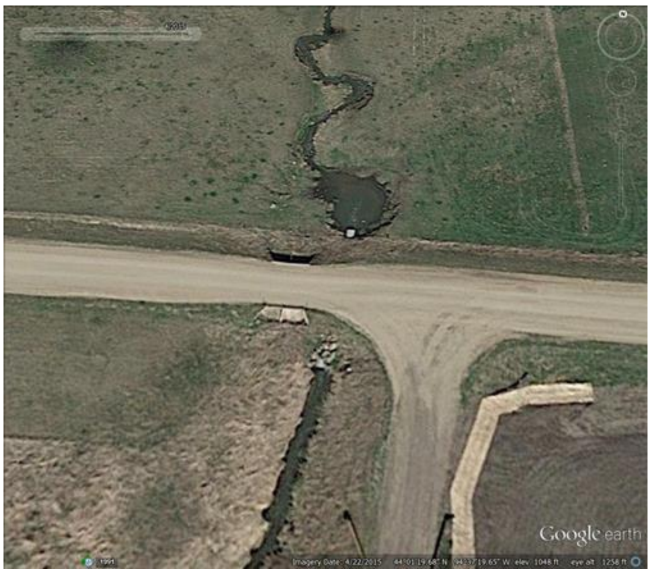
Table 102. Macroinvertebrate metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN153 (7/23/2013)	**10.51**	87.58	**0.64**	**0.64**	**99.36**	**0.96**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. Aerial maps indicate a potential for a high flow fish barrier at CR 116, the last road crossing before the stream joins Butterfield Creek. An undersized culvert appears to be causing a large scour on the downstream side of the road, which can be seen in the aerial photo below. Increases in flow through small openings can be challenging for migrating fish species to navigate and can pose as a barrier to longitudinal connectivity. No migratory fish species were captured during fish sampling; however, only one fish taxa was captured during the visit. No known mussel surveys have been conducted on the reach. Longitudinal connectivity is an inconclusive stressor at this time; additional on the ground investigation could help determine if indeed the culvert limits fish passage.

Figure 92. Google Earth image downstream of biological station 13MN153 at last road crossing before the stream joins Butterfield Creek. Culvert appears undersized and may act as fish barrier during eriods of higher flow.



The Altered Watercourses GIS layer for Minnesota streams indicates that the 1.49 mile long reach of the Unnamed Creek is 100% modified. Upstream of the reach the stream is also 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. While the reach is having substrate stability issues, stream bank erosion was not observed at the biological station.

Conditions observed are likely the result of past channel modifications, tile drainage and inputs from upstream storm water from St. James. Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow in the drier late summer months creating perfect conditions for more tolerant taxa to thrive.

There is no photographic evidence suggesting intermittent flows or dry channel beds during periods of low flow. No lake species were captured during the fish visit; however, only one species was captured during the visit.

While it is likely that past channel modifications, tile drainage and drained wetlands are likely contributing to degraded conditions observed in the watershed, altered hydrology is an inconclusive stressor within the reach. Additional metric evidence, pictorial evidence and investigation is needed to better understand the stressor in the reach.

4.1.3. AUID Summary

The fish and macroinvertebrates within unnamed creek are stressed by degraded stream habitat conditions. This modified (channelized) stream reach has many negative habitat characteristics that are stressing the macroinvertebrate community. The adjacent land use and poor substrate, with a lack of any rock or woody debris, and abundance of aquatic macrophytes and overhanging vegetation favor degraded biological communities. An abundance of find sediment are also inhibiting biological potential. Conditions observed are likely the result of past channel modifications, tile drainage and inputs from upstream storm water from St. James.

Inconclusive stressors within the reach include low DO, eutrophication, elevated nitrates, elevated TSS levels, altered hydrology and longitudinal connectivity. Insufficient chemistry datasets were available on the reach to make stressor determinations for the aforementioned metrics. Metric information suggests potential for TSS and nitrate stress within the macroinvertebrate community as high levels of TSS tolerant and nitrate tolerant individuals were identified. Additional chemistry monitoring, including continuous DO monitoring would be useful in better understanding potential DO flux within the reach, as an abundance of stream macrophytes suggests potential for diurnal DO swings. Nitrogen measurements should be taken in the spring months to determine whether or not potential inputs from stream tiles are causing the elevated metric response seen in the macroinvertebrate community and to better understand duration of stress. Additional fish monitoring would be useful in better understanding the impacts of stressors on the fish community within the reach. Limited data is available to understand potential of fish barriers and potential longitudinal connectivity stress in the reach. Aerial photography indicates potential for a high flow barrier in the downstream culvert within the reach. Additional investigation will be needed to determine if the culvert is in fact limiting fish passage during periods of high or low flows. Investigation of the potential impacts of the storm water within the community of St. James on the reach would be useful in better understanding if storm flows are inhibiting the biology within the reach.

Table 103. Summary of stressor determinations for Unnamed Creek (552).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
Unnamed Creek	07020010-552	o	o	o	o	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

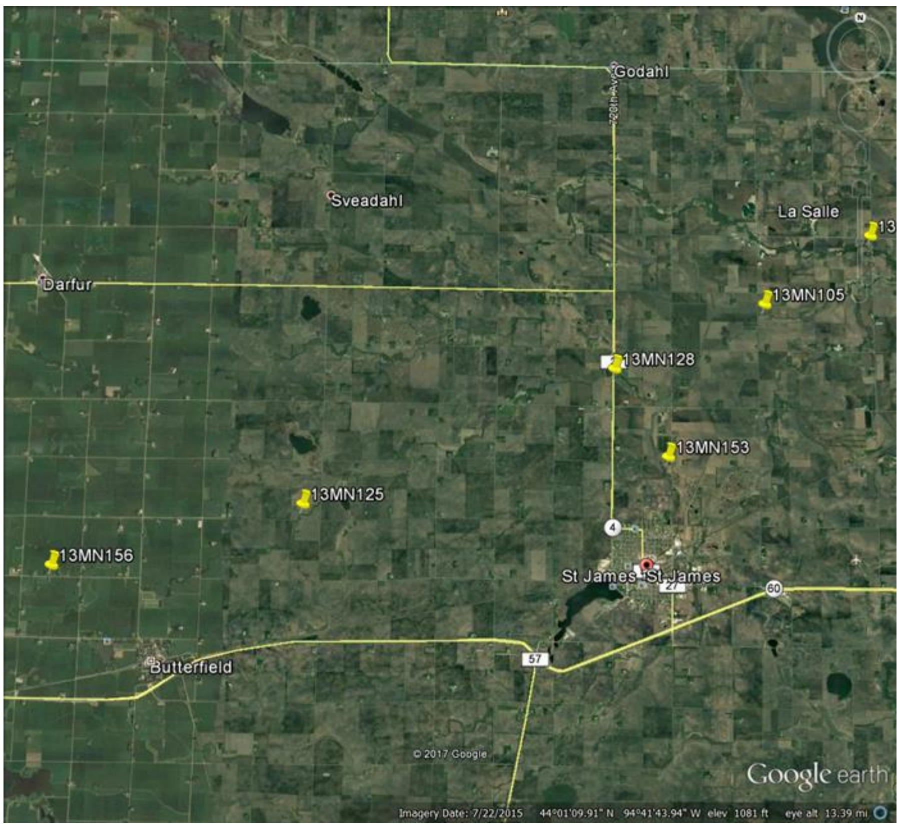
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Butterfield Creek -516

Butterfield Creek (07020010-516) stretches 25 river miles from the creek's headwaters northwest of the community of Butterfield east to its confluence with St. James Creek (07020010-515) at Twp. Rd. 74. This reach is classified as general use warmwater 2Bg. This reach is impaired for aquatic life, for both fish and macroinvertebrate communities (2015), and excess levels of turbidity (2008) and for aquatic recreation for high levels of *E.coli* bacteria (2015).

Throughout its course, it gains the flow of Unnamed Creek (07020010-552).

Figure 93. Google Earth image of Butterfield Creek (-516).



4.1.1. Biological communities

There are four biological stations on this reach. There were eighteen visits from four stations sampled in 2013 and 2014 for fish. Fifteen of 18 visits scored below the threshold with an 83% exceedance rate), twelve of these also scored below the lower confidence interval. The abundance of fish visits in the reach can be attributed to a study by MPCA staff to better characterize the impacts of the 2012 flood within the Watonwan River Watershed.

Station 13MN156 was sampled seven times; however, only five visits were reportable, (June 11, 2014 and May visit were not, because sampling occurred outside the index period in May and the early June sample in 2014 was limited by a cold spring limiting spring fish migrations). All visits scored below the threshold and lower confidence interval. Blacknose dace, white sucker and creek chub were the dominant species across nearly all visits; however, one visit was hyper-dominated by brook stickleback. All four of these species are tolerant.

Station 13MN125 was sampled seven times, but only four visits were assessable (June 11, 2014, July 10, 2013 and May 23, 2013 were not). All visits scored below threshold and lower confidence interval. All visits were dominated by tolerant taxa (see graph below).

Station 13MN128 was sampled eight times, but only five visits were assessable (May 29, 2013, May 27, 2013, July 1, 2014 were not). One visit was below the threshold and lower confidence interval; two visits were below the threshold but within lower confidence limits; and two visits were above the threshold but within upper confidence limits). Both passing scores occurred in August. All visits lacked sensitive taxa and quantities of benthic insectivores were low (see graph below).

Station 13MN105 was sampled nine times, but only six visits were assessable (May 28, 2014, July 1, 2014 and June 12, 2014 visits were not). Four visits scored below the threshold and lower confidence interval; one scored below the threshold but within lower confidence limits; and one scored above the threshold but within lower confidence limits. The passing visit was in July 2013. All visits lacked sensitive taxa and the count of benthic insectivores was low (see graph below).

There were eight biological invert visits on four stations (13MN105, 13MN125, 13MN128, 13MN156), sampled in 2013 and 2014. Site 13MN156 scored below the GU threshold below the lower confidence interval on both visits. Site 13MN105 scored at or above the GU threshold, within the upper confidence limit, on both visits, but the 2014 visit had a very different looking invert community composition. Site 13MN125 scored below the GU threshold in 2013, and above the GU threshold in 2014, both visits were within the confidence interval. Site 13MN128 scored below the GU threshold on both visits, within the lower confidence limit. All site visits had very abundant nitrogen tolerant taxa. Collector filterer (Collectorer-filtererPct) numbers were low across all visits. All but one station visit had low scores for HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) and intolerant taxa richness (Intolerant2Ch) as well (see graph below).

Figure 94. Fish metrics of the Southern Streams Class IBI for station 13MN128 and 13MN105, Butterfield Creek.

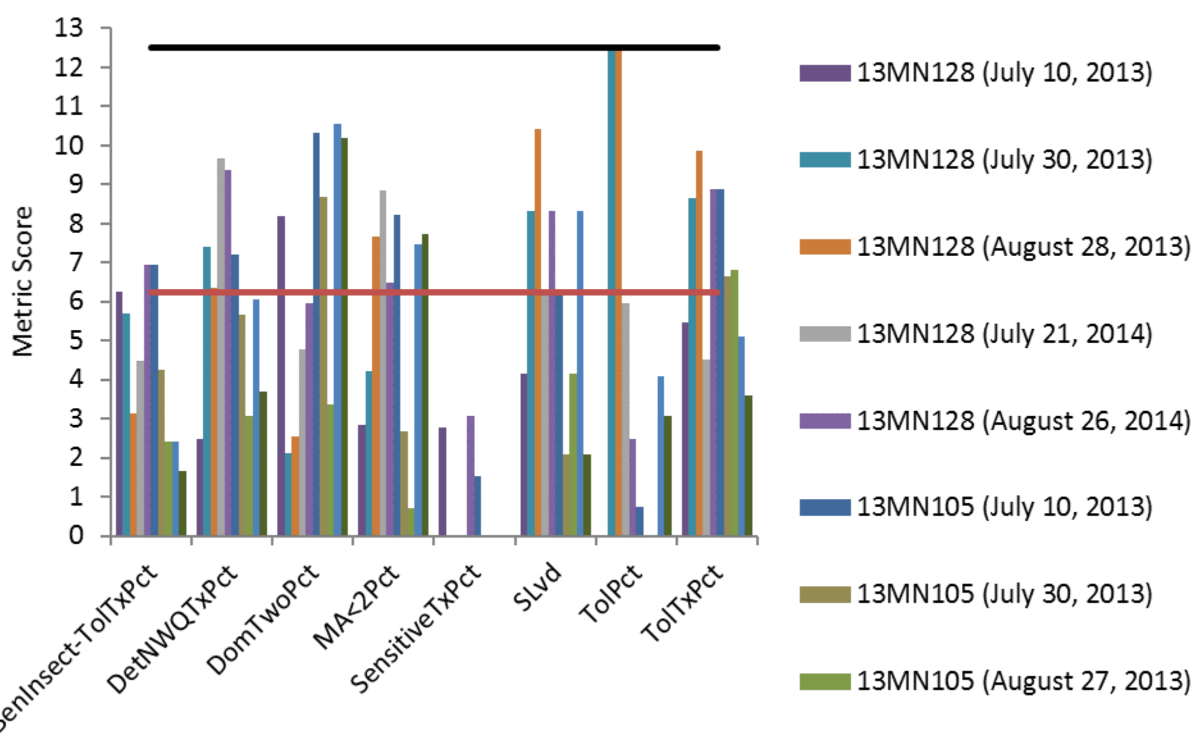


Figure 95. Fish metrics of the Southern Streams Class IBI for station 13MN156 and 13MN125, Butterfield Creek.

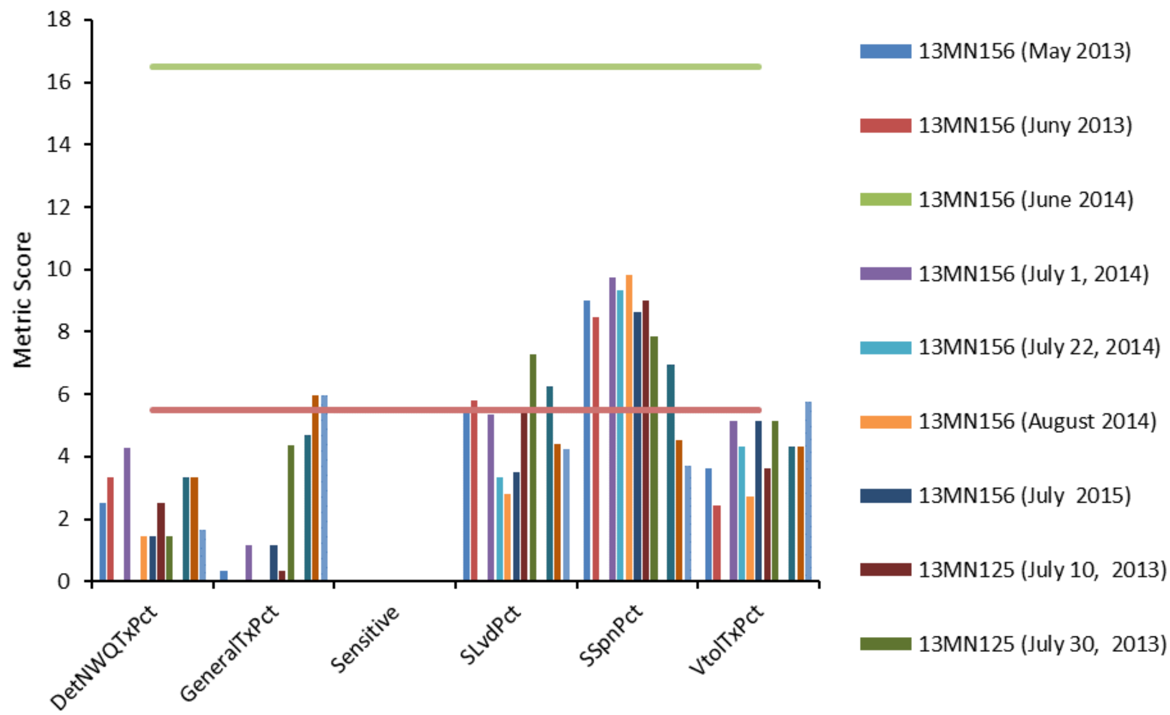
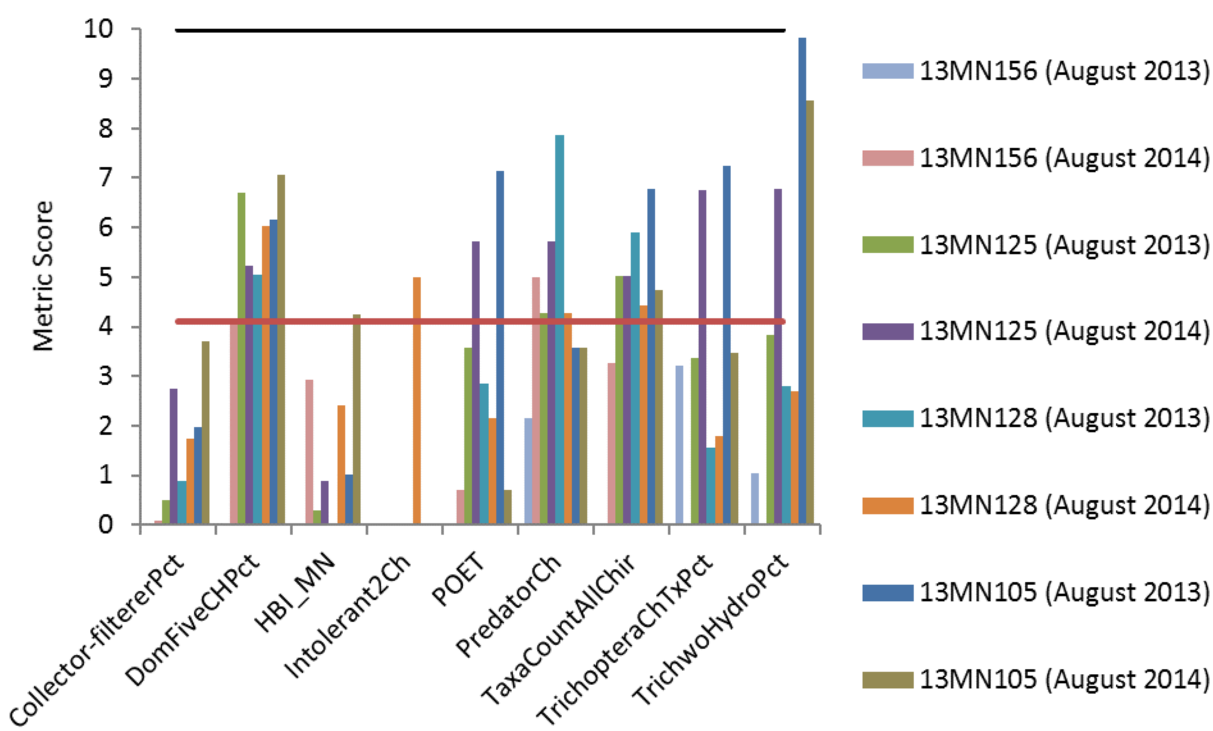


Figure 96. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN156, 13MN125, 13MN128 and 13MN105, Butterfield Creek.



4.1.2. Data evaluation for each Candidate Cause

Unionized ammonia

There were seven instances of paired NH_4, pH and stream temperature data during biological visits at station 13MN125. Unionized ammonia calculations were completed for all visits, while all visits fell below the class 2B standard of 40 ug/L for ammonia; one reading was elevated on June 11, 2014 with a concentration of 33 ug/L. No fish were captured during fish sampling on June 11, 2014. Additional investigation to better understand duration of potential elevated concentrations of unionized ammonia would be useful to better characterize the stressor and its potential to impact the aquatic community.

Conductivity

Specific conductance is an indication of the amount of dissolved minerals or total dissolved solids in the water. Elevated conductivity can be toxic to biological organisms through effects on osmoregulation.

A total of 46 specific conductance measurements were collected from 2013 to 2016. The highest conductivity reading observed within the greater Watonwan River Watershed was observed on Butterfield Creek at 8340 µg/cm on September 24, 2013. Six additional readings above 1000 µg/cm were observed within the reach at multiple locations in 2013 and 2016. Two of the elevated readings had paired chloride data readings, ranging from 21.2 to 29.2 mg/L at station S007-562, neither of which were near the standard (230 mg/L). Elevated conductivity may not be caused by only elevated chloride but can serve as a surrogate or indicator for ions in the water, such as chloride. The chloride data from this stream reach did not once exceed the standard, topping out at 42.4 mg/L in May 2013. However, the samples during the winter months were minimal compared to other times of the year.

From a biological standpoint, sunfish based assemblages can increase due to elevated chloride levels (Centrarchidae). Sunfish were not prevalent in overabundance within the reach, while each of the four stations had at least one visit with either green or orange spotted sunfish, these taxa were not represented at most visits and where they were present their numbers were not large.

Chloride and conductivity related stress can also result in reduced overall taxa richness of macroinvertebrate communities, decreases in mayfly (Ephemeroptera) percentages, mayfly taxa richness and EPT taxa (see table below). A response was seen among most of these conductivity stress metrics within the macroinvertebrate community (table below) which may be suggestive of chloride related stress but could also be a result of other stressors.

Table 104. . Macroinvertebrate metrics that respond to low conductivity stress in Butterfield Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	TaxaCount	EphemeropteraCh	EphemeropteraPct	EPT
13MN156 (2013)	**12.00**	**0.00**	**0.00**	**1.00**
13MN156 (2014)	**18.00**	**1.00**	**1.00**	**1.00**
13MN156 (2015)	**16.00**	**0.00**	**0**	**2.00**
13MN125 (2013)	**21.00**	**5.00**	**9.18**	**6.00**
13MN125 (2014)	**23.00**	**6.00**	26.76	**7.00**
13MN128 (2013)	**21.00**	**3.00**	**8.64**	**4.00**
13MN128 (2014)	**19.00**	**3.00**	**2.82**	**4.00**
13MN105 (2013)	**23.00**	7.00	33.01	11.00
13MN105 (2014)	**14.00**	**1.00**	**0.32**	**3.00**
13MN105 (2015)	**17.00**	**1.00**	**0.64**	**3.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*33.59*	*6.19*	*24.69*	*8.90*
Expected response to high Conductivity stress	↓	↓	↓	↓

While the macroinvertebrate community does indicate potential for response to elevated conductivity levels, findings could be the result of cumulative stress within the reach. The observed conductivity values >1000 µg/cm are concerning. Conductivity/chloride is inconclusive in this reach due to the lack of connecting biological information, but monitoring should continue to ensure that both chloride and conductivity are at suitable levels in this reach.

Dissolved oxygen

During biological monitoring 41 DO samples were collected across four stations from 2013-2015. While DO data from the upstream most station, 13MN156, did not show any violations, observed values ranged from 5.16 mg/L on July 15, 2015 at 9:08 am to 14.08 mg/L on June 11, 2014 at 12:10 pm, suggesting potential for high swings in DO flux and low pre 9am DO readings. Mid station 13MN125 did not have any DO readings below the 5 mg/L standard but did have three readings above 10 mg/L, with the highest being 12.74 mg/L on July 30, 2013 at 6:00pm. Only one violation below the 5 mg/L standard was observed at mid station 13MN128 of 3.27 mg/L on August 28, 2013. The highest value recorded at this station was 13.99 mg/L. This along with low DO readings suggests potential for DO and DO flux standard violations within the reach. DO readings at the downstream most station, 13MN105, fell within the normal range. Forty-seven additional DO samples were collected from 2013 – 2016; there were no violations below the 5 mg/L standard observed. Thirteen values were recorded over 10 mg/L, with the highest value recorded at 12.63 mg/L at 1:38PM on February 22, 2016.

A combination DO readings just above and below 5 mg/L in conjunction with elevated readings observed across the reach led to additional DO investigations on the reach in 2015 and 2016 (see graphs below). Continuous DO monitoring with YSI sondes was conducted longitudinally at three biological monitoring stations on the reach in late July of 2015: 13MN156, 13MN128 and 13MN105. Data from the upstream most station produced four consecutive diurnal swings below the 5 mg/L standard and 1 day of high DO flux at 5.16 mg/L (see graph below).

Figure 97. Diurnal DO results for station 13MN156, July 27 - 30, 2015.

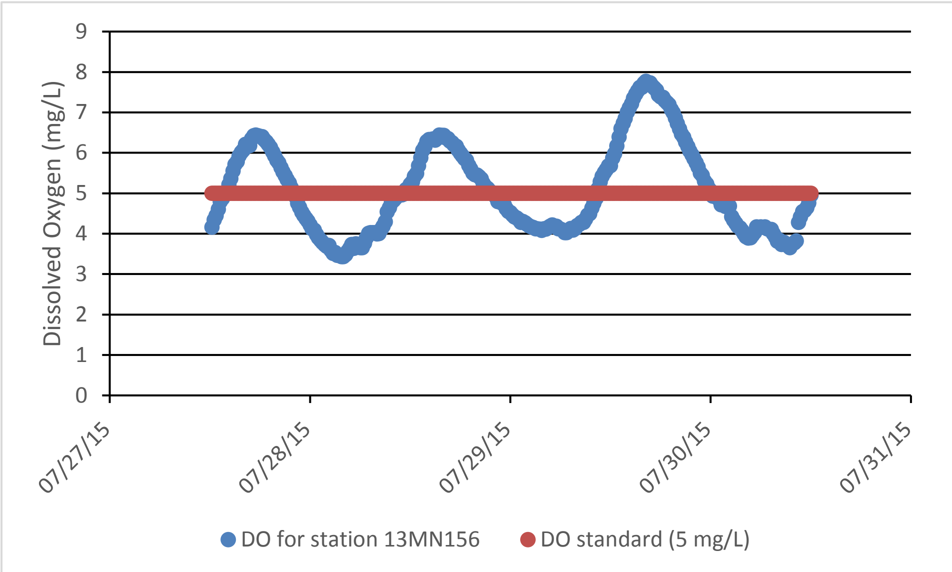
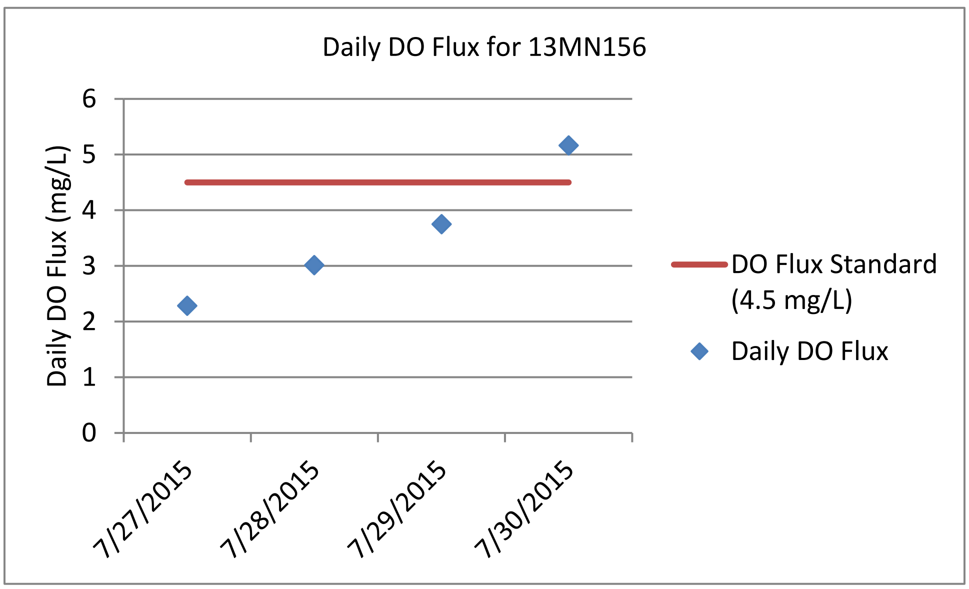


Figure 98. Daily DO Flux results for station 13MN156, July 27 - 30, 2015.



Mid station 13MN128 did not have any violations below the 5 mg/L DO standard; however, the 4.5 mg/L daily DO flux standard was exceeded every day (see graphs below). DO flux ranged from 4.53 mg/L to 7.44 mg/L with an average flux of 6.05 mg /L.

Figure 99. Diurnal DO results for station 13MN128, July 23 - 30, 2015.

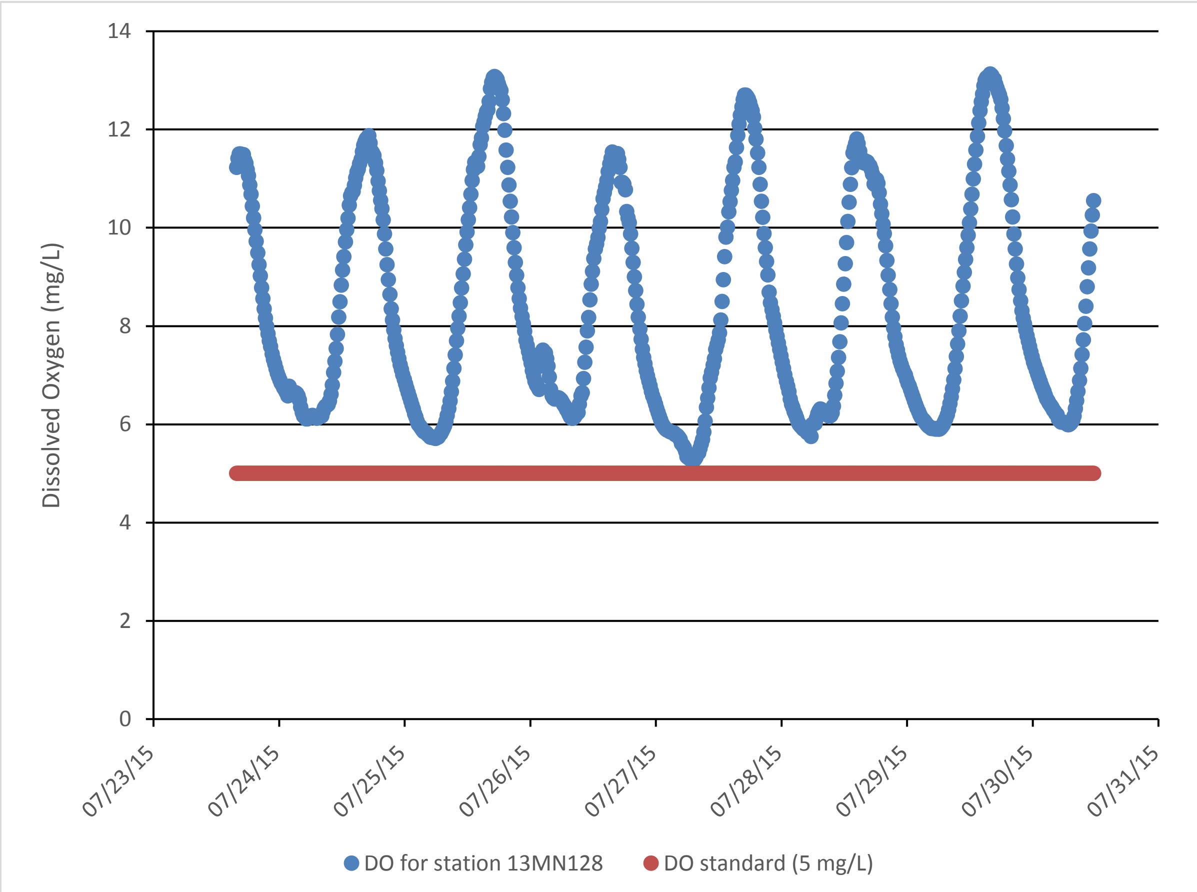
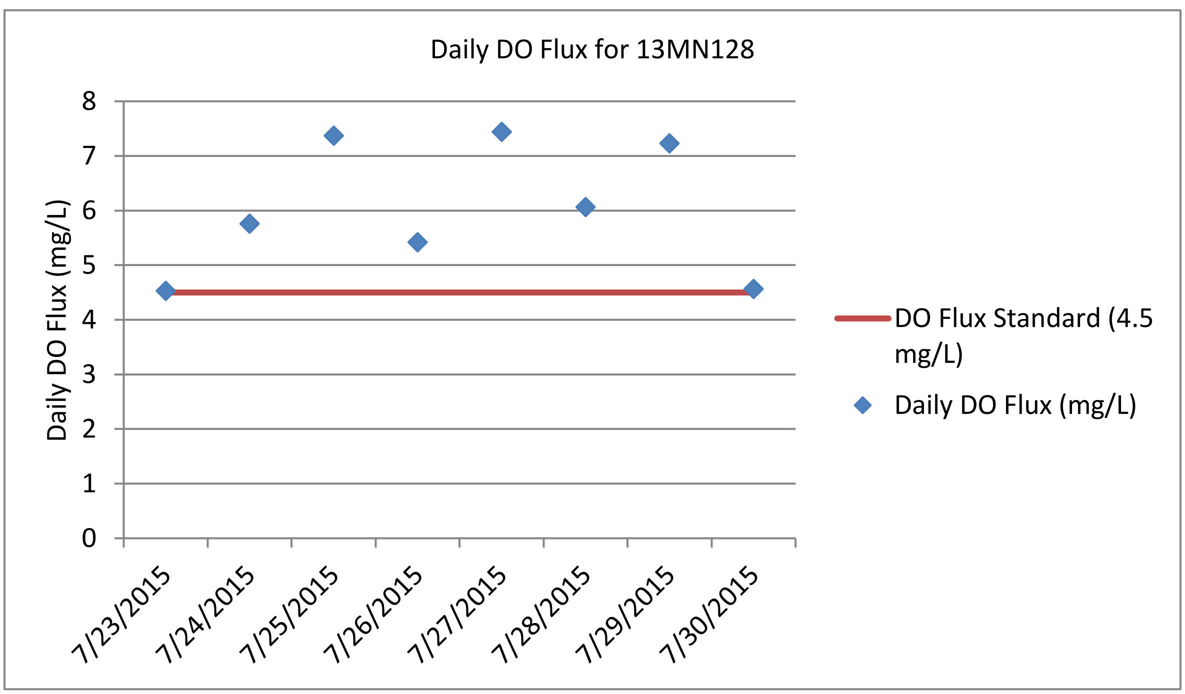


Figure 100. Daily DO Flux results for station 13MN128, July 23 - 30, 2015.



The downstream most station, 13MN105, showed similar results to 13MN105, with no low DO violations but near daily exceedances of the 4.5 mg/L DO flux standard. DO flux ranged from 4.19 mg/L to 8.34 mg/L with an average of 5.80 mg/L (see graphs below).

Figure 101. Diurnal DO results for station 13MN105, July 23 - 30, 2015.

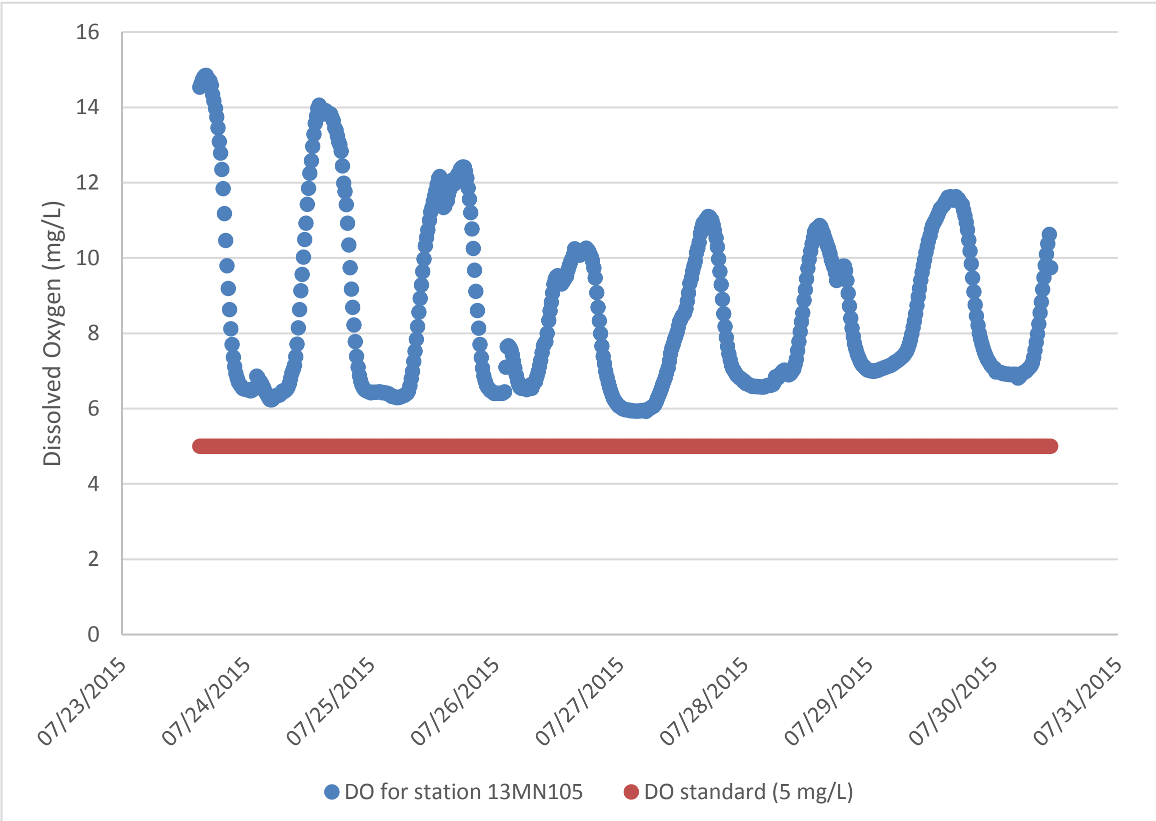
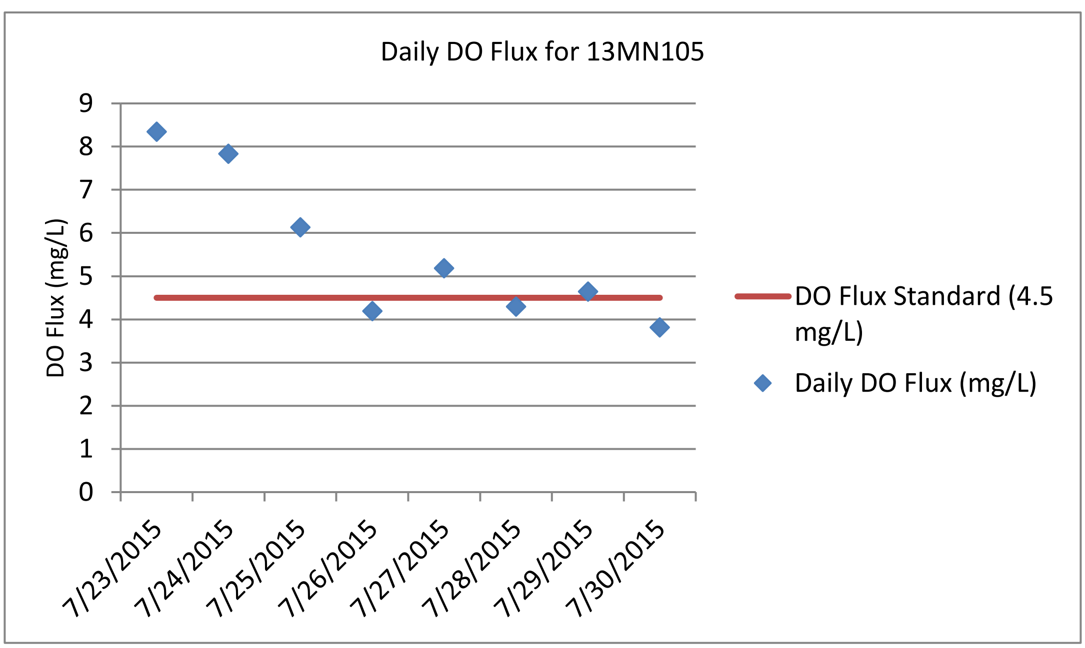


Figure 102. Daily DO Flux results for station 13MN105, July 23 - 30, 2015.



A follow up continuous DO monitoring study occurred in 2016 on station 13MN156 from August 10 – 23, no violations of standards were observed (see graphs below). DO flux values ranged from 1.97 mg/L to 4.45 mg/L. High water levels observed in 2016 may explain differences observed at station 13MN156 when comparing 2015 data to 2016 data.

Figure 103. Diurnal DO results for station 13MN156, August 10-23, 2016.

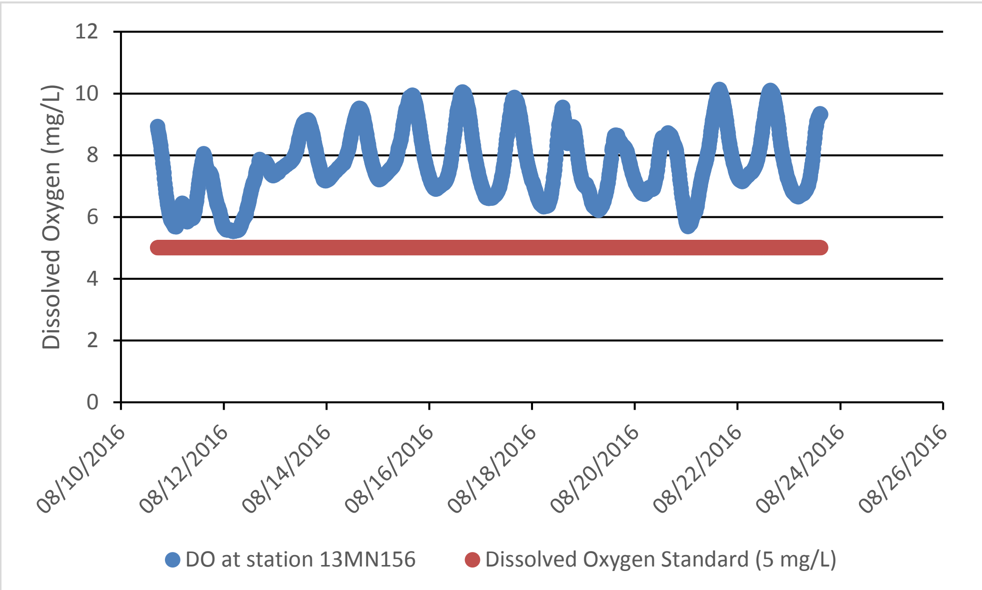
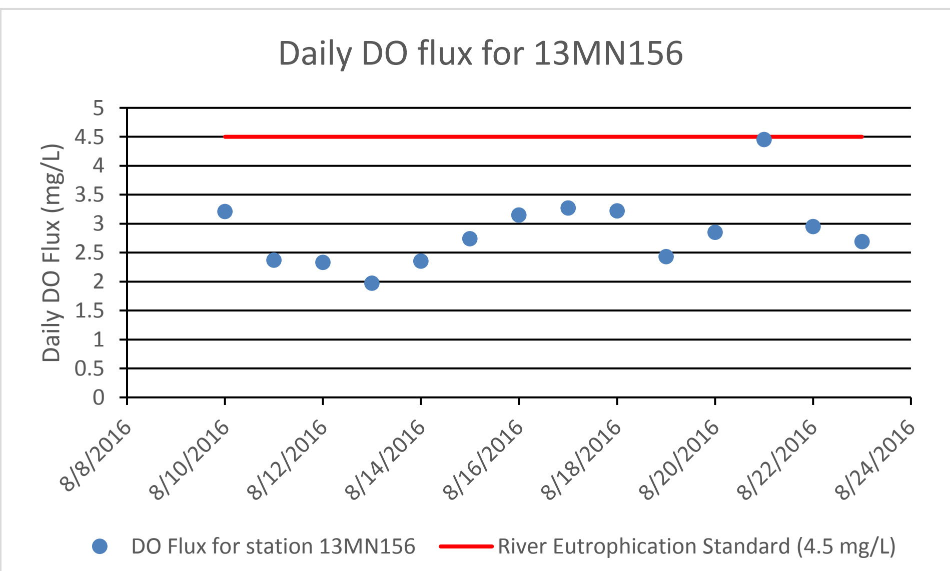


Figure 104. Daily DO Flux results for station 13MN156, August 10-23, 2016.



There was a mixed response to low DO stress within the macroinvertebrate community (see table below). There were discrepancies within the same site over different years, and there were discrepancies across different sites within the reach. Three of the four stations had one visit with above average quantities of low DO tolerant taxa. EPT taxa numbers were low across all but two visits, indicating that the stream is stressed, but the response could be due to other stressors. Varying results were also seen in Low DO Index score values, suggesting that potential low DO stress within the reach can vary by year, time of year and location.

Table 105. Macroinvertebrate metrics that respond to low DO stress in Butterfield Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN156 (2013)	**19.00**	**1.00**	**9.60**	**5.40**	**0.00**	**0.00**	**10.00**	**30.67**
13MN156 (2014)	**30.00**	**1.00**	7.19	6.70	**0.00**	**0.00**	8.00	7.58
13MN156 (2015)	**30.00**	**2.00**	7.46	**6.29**	1.00	**2.80**	7.00	8.70
13MN125 (2013)	**36.00**	**7.00**	**8.80**	6.56	**2.00**	**1.58**	8.00	10.76
13MN125 (2014)	**36.00**	10.00	**8.60**	6.76	4.00	**3.33**	**10.00**	17.33
13MN128 (2013)	**34.00**	**4.00**	**9.10**	**6.03**	0.00	**0.00**	7.00	**25.31**
13MN128 (2014)	39.00	**4.00**	**8.14**	6.56	3.00	**1.99**	**13.00**	20.86
13MN105 (2013)	42.00	12.00	8.60	6.90	7.00	**4.21**	7.00	14.24
13MN105 (2014)	**35.00**	**3.00**	7.57	**5.70**	**1.00**	**0.63**	**11.00**	**41.46**
13MN105 (2015)	**29.00**	**3.00**	**8.04**	6.82	2.00	**0.96**	6.00	17.52
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish community low DO metric results showed similar inconsistencies within the dataset (see table below). Low DO Index scores were below their respective class thresholds during some visits but not others, indicating potential for stress. Abundant quantities of low DO tolerant taxa were observed at multiple visits at 13MN156, 13MN128, 13MN105 and only a single visit at 13MN125.

Inconsistencies within the dataset for both fish and macroinvertebrates indicate that low DO stress is an inconclusive stressor at this time. Measures taken to limit observed dips below the standard would likely benefit biology within the reach.

Table 106. Fish metrics that respond to low DO stress in Butterfield Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress. (Non-reportable sites removed).

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN156 (7/11/2013)	**0.00**	32.26	**91.94**	7.22	**0.00**	**0.00**	**4.00**	11.29
13MN156 (7/1/2014)	**0.00**	**4.14**	**99.31**	**6.95**	**0.00**	**0.00**	**4.00**	**24.14**
13MN156 (7/22/2014)	**0.00**	**7.80**	**100.00**	**6.65**	**0.00**	**0.00**	3.00	**42.55**
13MN156 (8/26/2014)	**0.00**	**8.00**	**100.00**	**6.30**	**0.00**	**0.00**	2.00	**58.00**
13MN156 (7/15/2015)	**0.00**	**8.24**	**98.35**	**6.29**	**0.00**	**0.00**	3.00	19.00
13MN125 (7/30/2013)	**0.00**	37.50	**82.09**	7.29	**0.00**	**0.00**	0.00	0.00
13MN125 (7/1/2014)	**0.00**	**7.84**	**90.20**	7.18	**0.00**	**0.00**	2.00	11.76
13MN125 (8/26/2014)	**0.00**	**5.17**	**81.03**	7.18	**0.00**	**0.00**	3.00	6.90
13MN125 (7/22/2014)	**0.00**	**8.41**	**86.92**	**6.99**	**0.00**	**0.00**	**4.00**	**28.97**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
13MN128 (7/10/2013)	**1.27**	**6.72**	**75.95**	**7.14**	**0.00**	**0.00**	2.00	15.19
13MN128 (7/30/2013)	**0.00**	**6.67**	21.01	**6.99**	**0.00**	**0.00**	4.00	**27.73**
13MN128 (8/28/2013)	**0.00**	33.33	17.33	**6.83**	**0.00**	**0.00**	4.00	**49.33**
13MN128 (7/21/2014)	**0.00**	46.98	52.51	**7.01**	**0.00**	**0.00**	**5.00**	**40.45**
13MN128 (8/26/2014)	**0.78**	37.50	65.63	**7.13**	**0.00**	**0.00**	3.00	**25.00**
13MN105 (7/10/2013)	**0.48**	44.74	**72.25**	**7.17**	**0.00**	**0.00**	**5.00**	**20.10**
13MN105 (7/30/2013)	**0.00**	**12.77**	**80.55**	7.25	**0.00**	**0.00**	**9.00**	15.31
13MN105 (8/27/2013)	**0.00**	**2.54**	**84.77**	7.28	**0.00**	**0.00**	4.00	6.09
13MN105 (7/21/2014)	**0.00**	39.47	**59.65**	**7.05**	**0.00**	**0.00**	4.00	**30.70**
13MN105 (8/25/2014)	**0.00**	41.94	**63.44**	**7.07**	**0.00**	**0.00**	**9.00**	**34.41**
13MN105 (8/10/2015)	**0.00**	**20.08**	**75.31**	**6.82**	**0.00**	**0.00**	**8.00**	17.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

During the fish sampling on Butterfield Creek, TP concentrations varied (31 unique samples at four different stations). Twelve of the 31 values exceed the phosphorus criteria for the southern river nutrient region (0.150 mg/L). Additional sampling on the reach also shows varied concentrations. An additional 14 phosphorous samples were taken, 12 at two biological stations and two additional samples were taken each on a unique reach, S008-658 and S008-566. The mean TP concentration across all stations was 0.13 mg/L.

Chlorophyll a samples were collected in 2015 at five unique stations, including biological stations where continuous DO monitoring occurred; samples were collected the same day as continuous monitoring sondes were retrieved. Concentrations ranged from 7.48 to 44.4 ug/L and occurred in late July and late August. Only one reading was above the southern eutrophication standard of 35 ug/L at biological station 13MN105. At least one violation or more of the DO Flux standard were observed in 2015 at all three biological stations during continuous DO monitoring, including station 13MN105 where elevated chlorophyll a levels were discovered. DO flux levels violating the standard were identified repeatedly in 2015 at stations 13MN105 and 13MN128. No violations were observed during continuous DO monitoring at biological station 13MN156 in 2016. There were no BOD samples collected on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.28 – 9.4 in the reach. Four readings were above 8.5 pH in the reach.

Nearly all of the macroinvertebrate metrics associated with eutrophication indicate potential stress (see table below). There was a high percentage of tolerant taxa across all visits. There was also a low count of collector-filterer taxa and EPT taxa across all visits. The highest quantities of collector-gatherer taxa were seen in 2013 at the two downstream most stations, while the lowest results were seen at the upstream station in the same year. Intolerant taxa were absent at all but one visit on 13MN128 in 2013.

Table 107. Macroinvertebrate metrics that respond to eutrophication stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN156 (2013)	**19.00**	**1.00**	**4.00**	**1.00**	**0.00**	**100.00**
13MN156 (2014)	**30.00**	**1.00**	**9.00**	**1.00**	**0.00**	**93.33**
13MN156 (2015)	**32.00**	**2.00**	**11.00**	**2.00**	**0.00**	**90.00**
13MN125 (2013)	**36.00**	**2.00**	**13.00**	**7.00**	**0.00**	**94.44**
13MN125 (2014)	**36.00**	**4.00**	**13.00**	**10.00**	**0.00**	**86.11**
13MN128 (2013)	**34.00**	**3.00**	**15.00**	**4.00**	1.00	**91.18**
13MN128 (2014)	39.00	**3.00**	**11.00**	**4.00**	**0.00**	**94.87**
13MN105 (2013)	**42.00**	**6.00**	16.00	**12.00**	**0.00**	**88.10**
13MN105 (2014)	**35.00**	**4.00**	**12.00**	**3.00**	**0.00**	**91.43**
13MN105 (2015)	**29.00**	**3.00**	**9.00**	**3.00**	**0.00**	**89.66**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish metrics show similar results to the macroinvertebrate data, indicating possible eutrophication stress (see table below). There were generally low percentages of darters, all sensitive fish metrics were below their respective averages and there was a complete absence of intolerant fish. All but two visits exceeded had high percentages of tolerant individuals. Eutrophication biological stress metrics are very general in nature and could be indicators of other stressors along the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were observed at least once at each station during numerous sampling events. Biological station 13MN105, the downstream most station had the greatest number of visits with above average quantities of omnivorous taxa, suggesting eutrophication stress within the reach.

Elevated phosphorous concentrations, high DO fluctuations, an elevated chlorophyll a concentration detected at station 13MN105 and observed algal and plant growth (see pictures) in conjunction with a response in stress metric data for both fish and macroinvertebrates suggests that eutrophication is a likely stressor within the reach at this time.

Table 108. Fish metrics that respond to eutrophication stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TaxaCount	SensitivePct	DarterPct	OmnivorePct	SLithopPct	TolPct	IntolerantPct
13MN156 (5/25/2013)	**8.00**	**0.00**	**9.09**	**18.18**	50.65	**90.91**	**0.00**
13MN156 (7/11/2013)	**9.00**	**0.00**	**8.06**	**37.90**	56.85	**91.94**	**0.00**
13MN156 (6/11/2014)	**3.00**	**0.00**	**0.00**	0.00	**14.29**	**100.00**	**0.00**
13MN156 (7/1/2014)	**7.00**	**0.00**	**0.00**	6.21	**26.90**	**99.31**	**0.00**
13MN156 (7/22/2014)	**6.00**	**0.00**	**0.00**	9.22	**15.50**	**100.00**	**0.00**
13MN156 (8/26/2014)	**7.00**	**0.00**	**0.00**	12.50	36.17	**100.00**	**0.00**
13MN156 (7/15/2015)	**7.00**	**0.00**	**1.65**	**19.23**	53.85	**98.35**	**0.00**
13MN125 (5/25/2013)	**4.00**	**0.00**	**0.00**	0.00	**25.00**	**100.00**	**0.00**
13MN125 (7/10/2013)	**3.00**	**0.00**	**0.00**	**22.39**	**28.57**	**100.00**	**0.00**
13MN125 (7/30/2013)	**7.00**	**0.00**	17.91	**100.00**	32.84	**82.09**	**0.00**
13MN125 (7/1/2014)	**9.00**	**0.00**	**3.92**	7.84	**15.68**	**90.20**	**0.00**
13MN125 (8/26/2014)	12.00	**0.00**	**6.90**	3.45	**17.24**	**81.03**	**0.00**
13MN125 (7/22/2014)	12.00	**0.00**	**6.54**	**23.36**	**15.89**	**86.92**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	11.50	7.90	11.50	14.71	31.50	72.80	1.60
13MN128 (5/29/2013)	**3.00**	**0.00**	**0.00**	**17.72**	50.00	**100.00**	**0.00**
13MN128 (7/10/2013)	**10.00**	**1.27**	**7.59**	5.04	**20.25**	**75.95**	**0.00**
13MN128 (7/30/2013)	**11.00**	**0.00**	51.26	2.67	**7.56**	21.01	**0.00**
13MN128 (8/28/2013)	**10.00**	**0.00**	30.67	**33.33**	**4.00**	17.33	**0.00**
13MN128 (5/27/2014)	**7.00**	**0.00**	**1.85**	**64.81**	66.67	**96.30**	**0.00**
13MN128 (7/1/2014)	**7.00**	**0.00**	**0.00**	**77.66**	38.30	**95.74**	**0.00**
13MN128 (7/21/2014)	**14.00**	**0.00**	**8.79**	15.08	**15.58**	52.51	**0.00**
13MN128 (8/26/2014)	**9.00**	**0.78**	**8.59**	**21.88**	**29.69**	**65.63**	**0.00**
13MN105 (7/10/2013)	**18.00**	**0.48**	**0.72**	**27.03**	**22.32**	**72.25**	**0.00**
13MN105 (7/30/2013)	22.00	**0.00**	**4.83**	7.59	**33.97**	**80.55**	**0.00**
13MN105 (8/27/2013)	**13.00**	**0.00**	**3.05**	2.03	81.22	**84.77**	**0.00**
13MN105 (7/1/2014)	**15.00**	**0.00**	**2.46**	**37.70**	**16.39**	**59.84**	**0.00**
13MN105 (7/21/2014)	**13.00**	**0.00**	14.91	**18.42**	**18.42**	**59.65**	**0.00**

Station (Year sampled)	TaxaCount	SensitivePct	DarterPct	OmnivorePct	SLithopPct	TolPct	IntolerantPct
13MN105 (5/28/2014)	**14.00**	**0.00**	**2.42**	**16.53**	**33.06**	**90.52**	**0.00**
13MMN105 (6/12/2014)	**2.00**	**0.00**	**0.00**	**50.00**	**0.00**	**100.00**	**0.00**
13MN105 (8/25/2014)	19.00	**0.00**	**11.83**	**22.94**	**25.45**	**63.44**	**0.00**
13MN105 (8/10/2015)	19.00	**0.00**	12.13	**23.85**	45.19	**75.31**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.30*	*16.90*	*11.90*	*16.53*	*37.00*	*44.90*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↓	↑	↓

Figure 105. Biological station 13MN156 (July 31, 2013) algae.

Figure 106. Biological station 13MN125 (August 23, 2016) filamentous algae (left); biological station 13MN125 (June 1, 2016) algae (right).

Nitrate

During the biological fish sample for the four stations, 33 samples were taken from 2013 to 2015 from May to August. Nitrate concentrations ranged from natural ambient levels at 0.05 mg/L recorded in late July and August of 2013 to 27 mg on July 1, 2014, with nine of 33 samples having concentrations greater or equal to 15 mg/L. There were an additional 22 samples taken on this reach from 2013 to 2016 from May to September with a single sample from February. Nitrate concentrations ranged from 0.2 mg/L in September of 2013 and 26 mg/L in June of 2015, half of these samples had concentrations greater or equal to 15 mg/L. The lowest concentrations were typically seen in August or September, when flows were likely lower, while highest concentrations were observed during the spring and early summer months.

The macroinvertebrates in this reach show an almost universal negative response to elevated nitrate concentrations (see table below). The nitrate index score ranged from 3 to 5.75 while the average for Prairie Streams GP class threshold is 3.2. The index score, in addition to the percentage of nitrate tolerant individuals indicates a community dominated by nitrate tolerant taxa. All but one sample had a high percentage of nitrate tolerant individuals that exceeded the Prairie Streams GP class threshold. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) and decreased intolerant and Trichoptera taxa. The Trichoptera taxa count was low at all but one visit on biological station 13MN105 and the non-hydropsychid Trichoptera individual percentages were low at all stations but two visits on 13MN105. Numbers of nitrogen tolerant taxa were low at all but three visits, only one of which can be explained by low overall taxa count.

Fish are not generally good indicators of nitrate related stress.

Macroinvertebrate data suggests that nitrate is a likely stressor in the reach at this time.

Table 109. Macroinvertebrate metrics that respond to nitrate stress in Butterfield Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L)
13MN156 (2013)													15.00 (5/25/2013)
13MN156 (2013)	19.00	**1.00**	**4.00**	**1.00**	**0.00**	**100.00**	**1.00**	**0.29**	**5.24**	**0.00**	14.00	**96.80**	19.00 (7/11/2013)
13MN156 (2014)													24.00 (6/11/2014)
13MN156 (2014)													27.00 (7/1/2014)
13MN156 (2014)													7.90 (7/22/2014)
13MN156 (2014)	30.00	**1.00**	**9.00**	**1.00**	**0.00**	**93.33**	**0.00**	**0.00**	**5.57**	**0.00**	**19.00**	**77.30**	8.90 (8/26/2014)
13MN125 (2013)													11.00 (5/25/2013)
13MN125 (2013)													16.00 (7/10/2013)
13MN125 (2013)	**36.00**	**2.00**	**13.00**	**6.00**	**0.00**	**94.44**	**2.00**	**1.58**	**4.68**	**0.00**	**26.00**	**90.50**	2.00 (7/30/2013)

13MN125 (2014)													18.00 (6/11/2014)
13MN125 (2014)													25.00 (7/1/2014)
13MN125 (2014)	**36.00**	**4.00**	**13.00**	**7.00**	**0.00**	**86.11**	**4.00**	**4.35**	**4.53**	**0.00**	**22.00**	**86.00**	7.40 (8/26/2014)
13MN125 (2014)													7.80 (7/22/2014)
13MN128 (2013)													12.00 (5/29/2013)
13MN128 (2013)													12.00 (7/10/2013)
13MN128 (2013)													0.05 (7/30/2013)
13MN128 (2013)	39.00	**3.00**	**11.00**	**4.00**	**0.00**	**94.87**	**1.00**	**1.0**	**4.80**	**0.00**	**26.00**	**91.70**	0.05 (8/28/2013)
13MN128 (2014)													4.90 (5/27/2014)
13MN128 (2014)													15.00 (7/1/2014)
13MN128 (2014)													4.00 (7/21/2014)
13MN128 (2014)	34.00	**3.00**	**15.00**	**4.00**	**1.00**	**91.18**	**1.00**	**0.94**	**4.20**	**1.00**	**22.00**	**77.20**	5.60 (8/26/2014)
13MN105 (2013)	42.00	**6.00**	**16.00**	**11.00**	**0.00**	**88.10**	5.00	10.36	**3.78**	**1.00**	**27.00**	**86.10**	10 .00 (7/10/2013)
13MN105 (2013)													0.45 (7/30/2013)
13MN105 (2013)													0.05 (8/27/2013)
13MN105 (2014)	**35.00**	**4.00**	**12.00**	**3.00**	**0.00**	**91.40**	**2.00**	7.30	3.00	**0.00**	**21.00**	50.60	14 .00 (7/1/2014)

13MN105 (2014)													3.20 (7/21/2014)
13MN105 (2015)													3.60 (5/28/2015)
13MMN105 (2014)													12.00 (6/12/2014)
13MN105 (2015)													0.06 (8/10/2015)
13MN105 (2015)	**29.00**	**3.00**	**9.00**	**3.00**	**0.00**	**89.70**	**2.00**	**0.32**	**7.24**	**1.00**	16.00	**89.50**	5.80 (8/25/2015)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*4.40*	*4.80*	*3.10*	*2.00*	*18.80*	*55.10*	
Expected response to nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

During the biological sampling on Butterfield Creek there were 31 grab samples collected for TSS on the reach from 4 biological stations from 2013 – 2015, no samples exceeded the southern region's standard of 65 mg/L. In 2013, 11 additional TSS samples were collected from May thru June; only one reading was above the 65 mg/L standard. During SID investigations in 2015 and 2016, 21 additional TSS samples were gathered on the reach, four readings were above the standard. 150-transparency tube measurements have been collected on the reach from 2001-2006, 2010 and 2013-2016, 50 readings were below 20 cm. The WID was listed for a turbidity impairment in 2006. Elevated sediment levels were captured after a rainfall event in 2016 during SID investigations, providing visual evidence of turbid conditions (see photo below).

A majority of TSS stress metric data suggests that the macroinvertebrates on the reach are showing stress to elevated TSS levels (see table below). Nearly all visits had TSS Index scores above the Prairie Streams GP Class average, suggesting potential that TSS concentrations are influencing the macroinvertebrates on the reach. Nearly every visit was absent of TSS intolerant taxa; on the visit where TSS intolerant taxa were present, numbers were below the class average, suggesting stress. Almost all visits had above average quantities of TSS tolerant taxa, individuals or both. All but one visit had below average quantities of collector-filterer taxa and were absent of plecoptera taxa, plecoptera taxa require clear clean substrates and clear water as do collector filters which rely on clear visibility to gather nourishment.

Table 110. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN156 (2013)	**0.29**	**0.00**	**18.92**	**0.00**	**0.00**	6.00	**88.38**
13MN156 (2014)	**0.67**	**0.00**	**16.25**	**0.00**	**0.00**	10.00	**44.00**
13MN156 (2015)	**10.56**	**0.00**	**17.66**	**0.00**	**0.00**	7.00	**48.14**
13MN125 (2013)	**2.22**	**0.00**	**18.55**	**0.00**	**0.00**	**14.00**	**52.53**
13MN125 (2014)	**10.70**	**0.00**	**22.24**	**0.00**	**0.00**	**17.00**	**64.00**
13MN128 (2013)	**3.65**	**0.00**	**18.82**	**0.00**	**0.00**	**15.00**	**58.94**
13MN128 (2014)	**6.90**	**0.00**	15.30	1.00	**0.31**	9.00	35.31
13MN105 (2013)	**7.77**	**0.00**	**20.72**	**0.00**	**0.00**	**14.00**	**48.54**
13MN105 (2014)	14.29	**0.00**	14.08	**0.00**	**0.00**	**14.00**	20.57
13MN105 (2015)	**1.60**	**0.00**	**21.24**	**0.00**	**0.00**	8.00	**66.88**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was a mixed response to TSS stress within the fish community (see table below). Multiple visits at stations 13MN125 and 13MN105 had TSS Index scores above their respective averages, suggesting potential for TSS related stress at these stations, while stations 13MN156 and 13MN128 did not show much response. The following taxa metrics had below average quantities across nearly all visits, benthic feeders, herbivores, riffle dwelling taxa and simple lithophilic spawners. Benthic feeders require clear water to find nourishment. Herbivore numbers drop when turbidity levels rise because plants have difficulty becoming established in streams where the sediments in the streambed are continually shifting and increasing turbidity levels limit photosynthesis for aquatic macrophytes. Riffle dwelling taxa and lithophilic spawners respond negatively to elevated levels of TSS stress because they require clean coarse substrates to thrive. Intolerant taxa were absent across all visits and stations and few sensitive species were observed across all visits and stations; however, this could be explained by other stressors. TSS tolerant taxa were in above average abundance at station 13MN105 and 13MN125 suggesting potential isolated stress for fish communities within the reach.

The preponderance of macroinvertebrate metric data within the reach suggests that elevated concentrations of TSS on the reach are likely influencing macroinvertebrate communities. While nearly all fish visits are responding to some TSS stress metrics the impact appears to be greatest at 13MN125 and 13MN105.Evidence of high turbidity levels identified by a 2006 turbidity impairment confirm that TSS is a stressor to the biota on the reach.

Figure 107. Biological station 13MN109 (June 2016) sediment laden stream.

Table 111. Fish metrics that respond to high TSS stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria for Fish Class 3. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN156 (2013)	40.32	**0.00**	32.26	**0.00**	**0.00**	**8.06**	32.26	**0.00**	32.26
13MN156 (2014)	**3.45**	**0.00**	**3.45**	**0.00**	**0.69**	**0.69**	**3.45**	**0.00**	**3.45**
13MN156 (2014	**8.00**	**0.00**	**8.00**	**0.00**	**0.00**	**0.00**	**8.00**	**0.00**	**8.00**
13MN156 (2014)	**7.80**	**0.00**	**7.80**	**0.00**	**0.00**	**0.00**	**7.80**	**0.00**	**7.80**
13MN156 (2015)	**9.89**	**0.00**	**8.24**	**0.00**	**0.55**	**1.65**	**8.24**	**0.00**	**8.24**
13MN125 (2013)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
13MN125 (2013)	40.30	**0.00**	**22.39**	**0.00**	**0.00**	17.91	**22.39**	**0.00**	22.39
13MN125 (2014)	**5.88**	**0.00**	**1.96**	**0.00**	5.88	**9.80**	**1.96**	**0.00**	**1.96**
13MN125 (2014)	**8.62**	**0.00**	**1.72**	**0.00**	6.90	**10.34**	**1.72**	**0.00**	**1.72**
13MN125 (2014)	**9.35**	**0.00**	**2.80**	**0.00**	26.17	**12.15**	**2.80**	**0.00**	**2.80**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.6*	*26.2*	*7.9*	*14.60*
Expected response to stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN156 (2015)	13.04	**0.00**	**0.00**	**0.00**	0.00
13MN156 (2013)	13.91	**0.00**	**0.00**	**0.00**	0.00
13MN156 (2014)	13.19	**0.00**	**0.00**	**0.00**	0.00
13MN156 (2014	12.55	**0.00**	**0.00**	**0.00**	0.00
13MN156 (2014)	13.77	**0.00**	**0.00**	**1.00**	**5.49**
13MN125 (2013)	**14.88**	**0.00**	**0.00**	**1.00**	**5.97**
13MN125 (2014)	**16.63**	**0.00**	**0.00**	**1.00**	1.96
13MN125 (2014)	**15.15**	**0.00**	**0.00**	**3.00**	**5.17**
13MN125 (2014)	**21.58**	**0.00**	**0.00**	**3.00**	**28.04**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

Table 112. Fish metrics that respond to high TSS stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria for Fish Class 2. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN128 (2013)	**24.05**	**0.00**	**17.72**	**0.00**	13.92	**7.59**	**17.72**	**1.27**	**17.72**
13MN128 (2013)	54.62	17.65	**4.20**	**0.00**	26.89	71.43	**4.20**	**0.00**	**4.20**
13MN128 (2013)	**32.00**	36.00	**1.33**	**0.00**	50.67	72.00	**1.33**	**0.00**	**4.00**
13MN128 (2014)	**22.61**	**0.00**	**14.07**	**0.00**	36.93	42.96	**14.07**	**0.00**	**12.81**
13MN128 (2014)	**29.69**	**0.00**	**21.88**	**0.00**	24.22	24.22	**21.88**	**0.78**	21.88
13MN105 (2013)	**26.32**	**2.15**	**25.12**	**0.00**	23.44	20.10	**25.84**	**0.48**	26.56
13MN105 (2013)	**11.97**	**1.96**	**7.25**	**0.00**	**10.82**	**13.81**	**7.36**	**0.00**	**6.10**
13MN105 (2013)	**5.08**	**3.55**	**2.03**	**0.00**	**5.58**	**7.11**	**2.03**	**0.00**	**2.03**
13MN105 (2014)	**34.21**	**0.00**	**19.30**	**0.00**	24.56	36.84	**19.30**	**0.00**	**16.67**
13MN105 (2014)	**33.69**	**0.72**	**21.86**	**0.00**	25.81	33.69	**21.86**	**0.00**	20.43
13MN105 (2015)	**32.22**	**0.00**	**17.57**	**0.00**	**10.46**	**14.23**	**17.57**	**0.00**	**17.99**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN128 (2013)	**20.01**	**0.00**	**0.00**	2.00	**26.58**
13MN128 (2013)	13.96	**0.00**	**0.00**	1.00	7.56
13MN128 (2013)	14.35	**0.00**	**0.00**	2.00	12.00
13MN128 (2014)	13.50	**0.00**	**0.00**	2.00	3.27
13MN128 (2014)	14.14	**0.00**	**0.00**	**0.00**	0.00
13MN105 (2013)	18.51	**0.00**	**0.00**	**5.00**	**21.53**
13MN105 (2013)	**22.38**	**0.00**	**0.00**	**4.00**	**33.14**
13MN105 (2013)	**19.95**	**0.00**	**0.00**	2.00	**46.19**
13MN105 (2014)	18.51	**0.00**	**0.00**	**4.00**	12.28
13MN105 (2014)	17.76	**0.00**	**0.00**	**5.00**	**14.34**
13MN105 (2015)	17.12	**0.00**	**0.00**	**3.00**	**16.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*

Habitat

Thirty-seven qualitative habitat surveys were conducted on the reach at four biological stations, 13MN156 (9), 13MN125 (8), 13MN128 (9) and 13MN105 (11) from 2013-2015 (see graphs below). MSHA scores ranged from fair to poor across all visits, higher average MSHA scores were seen at the upstream two stations 13MN156 (46.9 and 13MN125 (53.275), while poor averages were seen at downstream stations, 13MN128 (38.38) and 13MN105 (42.66). Landuse surrounding the reach is dominated by row crop agriculture; however, there are several feedlots scattered across the reach including several moderately sized hog facilities, several small cattle feedlots and a very large (3960 Animal unit) poultry operation. The Butterfield wastewater treatment facility discharges to Butterfield Creek between biological station 13MN156 and 13MN125. A majority of Butterfield Creek has been channelized. Generally, riparian buffers across the reach are limited in size, but there are pockets of woodland areas where buffers are large and small sections on the reach where Butterfield Creek retains its natural sinuous path. Buffers along the biological monitoring stations were very narrow to moderately sized. While evidence of stream bank erosion was indicated at all biological stations, prevalence was greater at mid stations 13MN125 and 13MN128. Coarse substrate embeddedness was documented at all stations with rating ranging from light to severe, with most readings in the moderate to severe categories. Riffle/run/pool sequences were identified at least one MSHA survey at all biological stations; however, presence of riffles was limited, most channels were predominately comprised of runs, with limited to moderate pool composition, with generally fair channel development scores seen across the MSHA surveys. Stream depth variability across the sites ranged from good to fair. Most stream habitat cover scores were moderate to sparse. Overall biological stations had moderate stream stability scores.

Figure 108. Percentage of MSHA subcategory scores for station 13MN105, in Butterfield Creek.

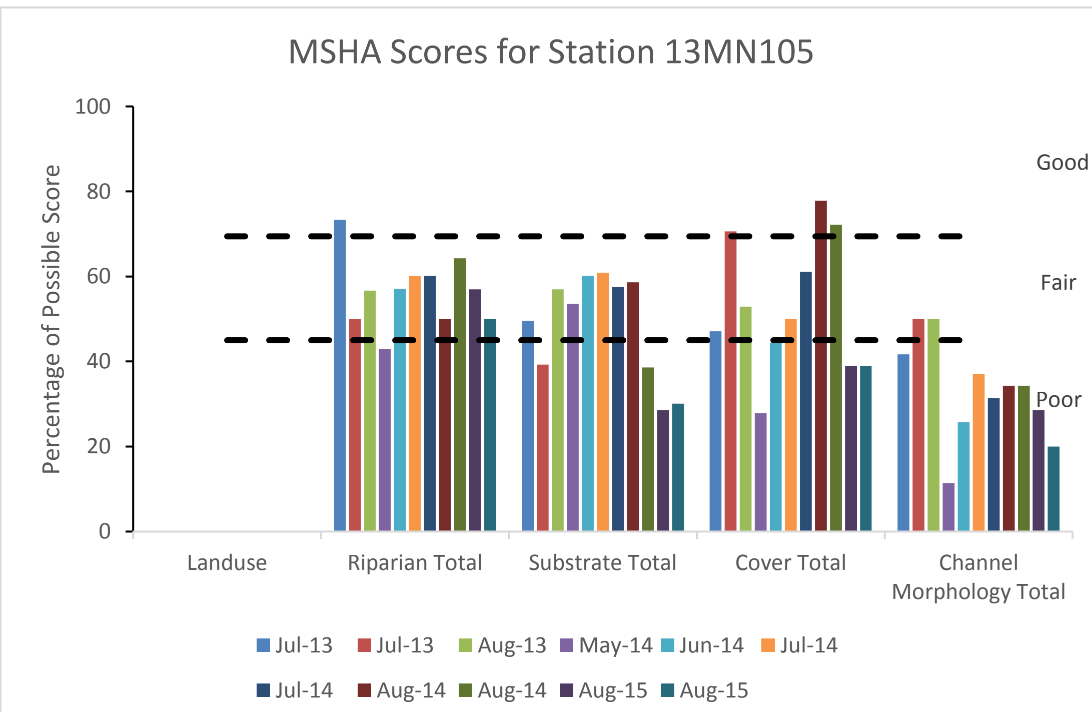


Figure 109. Percentage of MSHA subcategory scores for station 13MN125, in Butterfield Creek.

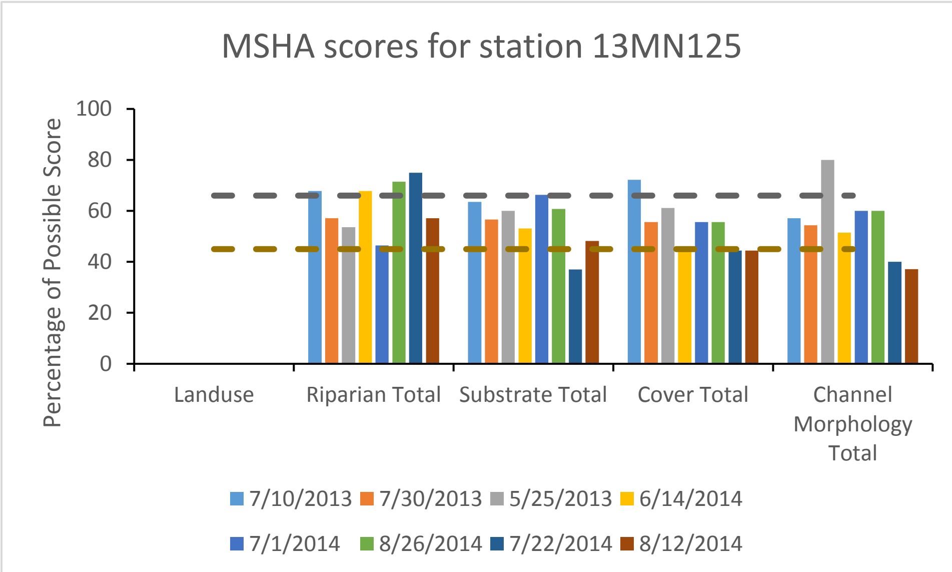


Figure 110. Percentage of MSHA subcategory scores for station 13MN128, in Butterfield Creek.

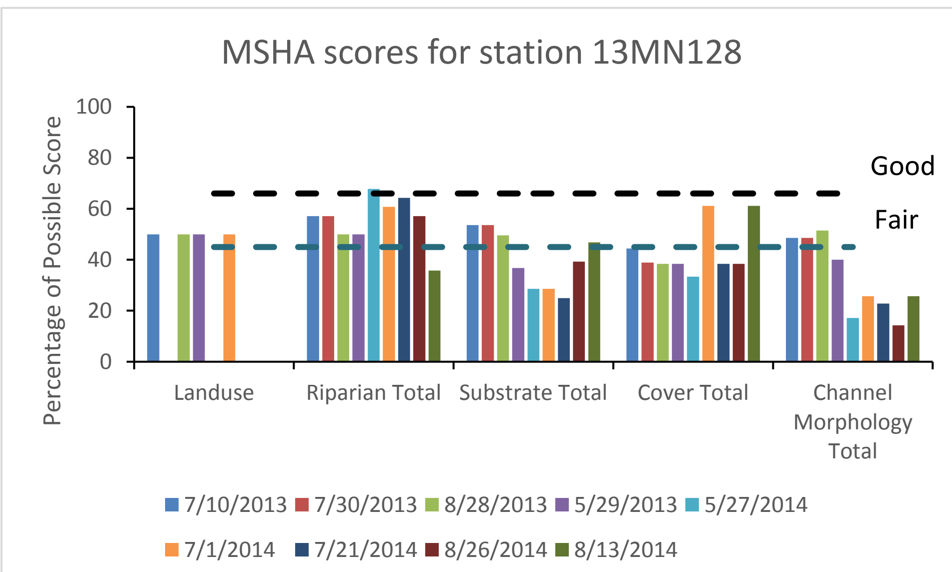
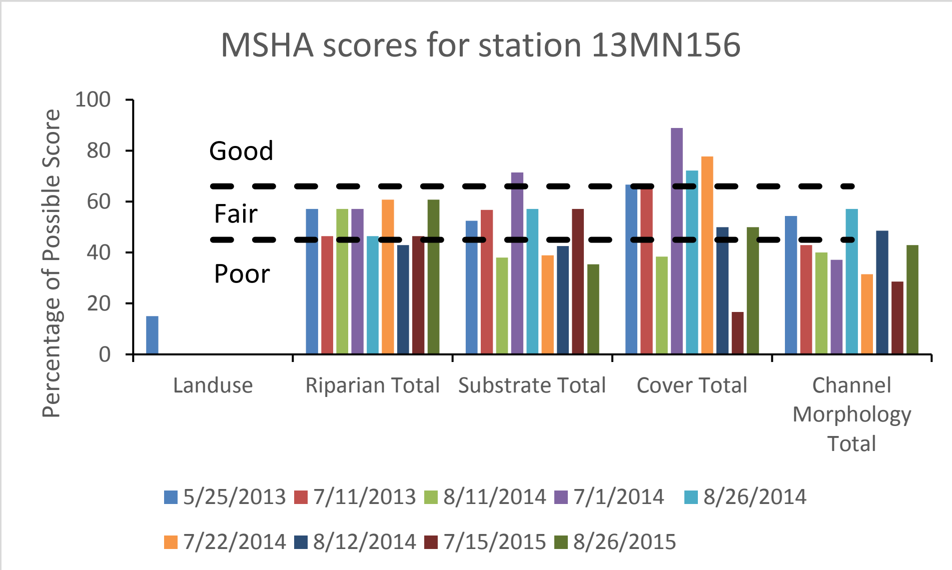


Figure 111. Percentage of MSHA subcategory scores for station 13MN156, in Butterfield Creek.



There was mixed response to habitat related metric stress across the fish communities within the reach (see table below). There are inconsistencies in community response across stations and within visits at unique stations. However, tolerant taxa were abundant across the reach at all stations and visits. There were limited quantities of riffle dwelling taxa and low quantities of piscivores, indicating limited habitat availability for more sensitive taxa and predatory taxa. Most visits also had low quantities of benthic insectivores which ties to abundant levels of sediment. Stress appeared most pronounced at station 13MN105, and to a somewhat lesser extent at stations 13MN156 and 13MN125. The downstream most station, 13MN128, showed more limited metric response to habitat stress. Negative habitat attributes are consistent with lower MSHA habitat scores, and degradation observed in photographs taken during biological visits (see below). A preponderance of evidence suggests that habitat stress is likely to be affecting the fish communities within the reach and any improvements made would be advantageous across the reach.

Table 113. Fish metrics that respond to degraded habitat stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LithFrimPct	DarterSculpSucPct	RifflePct	BenInsect-TolPct	PiscivorePct	PioneerPct	SLithopPct
13MN156 (2013)	**90.91**	80.52	**9.09**	**15.58**	**9.09**	**0.00**	**44.16**	50.65
13MN156 (2013)	**91.94**	74.19	**8.06**	32.26	**8.06**	**0.00**	37.50	56.85
13MN156 (2014)	**100.00**	85.71	**0.00**	**0.00**	**0.00**	**0.00**	**71.43**	**14.29**
13MN156 (2014	**99.31**	75.86	**0.00**	**3.45**	**0.00**	**0.00**	**51.03**	**26.90**
13MN156 (2014)	**100.00**	**56.74**	**0.00**	**7.80**	**0.00**	**0.00**	21.99	**15.50**
13MN156 (2014)	**100.00**	**41.50**	**0.00**	**8.00**	**0.00**	**0.00**	31.00	36.17
13MN156 (2015)	**98.35**	79.12	**1.65**	**8.24**	**1.65**	**0.00**	37.36	53.85
13MN125 (2013)	**100.00**	**28.57**	**0.00**	**0.00**	**0.00**	**0.00**	28.57	**25.00**
13MN125 (2013)	**82.09**	**65.67**	17.91	**22.39**	17.91	**0.00**	**56.72**	**28.57**
13MN125 (2013)	**100.00**	**25.00**	**0.00**	**25.00**	**0.00**	**0.00**	12.50	32.84
13MN125 (2014)	**90.20**	**60.78**	**3.92**	**1.96**	**3.92**	**0.00**	**56.86**	**15.68**
13MN125 (2014)	**81.03**	**37.93**	**6.90**	**1.72**	**6.90**	**1.72**	**55.17**	**17.24**
13MN125 (2014)	**86.92**	**24.30**	**6.54**	**2.80**	**6.54**	**0.00**	36.45	**15.89**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*69.21*	*12.55*	*28.33*	*14.22*	*1.62*	*37.79*	31.50
13MN128 (5/29/2013)	**75.95**	**22.78**	**7.59**	**17.72**	**7.59**	13.92	**32.91**	50.00
13MN128 (7/10/2013)	**21.01**	**8.40**	51.26	**4.20**	51.26	24.37	**57.14**	**20.25**
13MN128 (7/30/2013)	**17.33**	**8.00**	30.67	**1.33**	30.67	48.00	**37.33**	**7.56**
13MN128 (8/28/2013)	**100**	100	**0.00**	33.33	**0.00**	**0.00**	**50.00**	**4.00**
13MN128 (5/27/2014)	**96.3**	70.37	**1.85**	64.81	**1.85**	**0.00**	**27.78**	66.67
13MN128 (7/1/2014)	**95.74**	**55.32**	**0.00**	38.3	**0.00**	**0.00**	10.64	**38.30**
13MN128 (7/21/2014)	**52.51**	**43.22**	**8.79**	**14.07**	**8.79**	**2.76**	**36.43**	**15.58**
13MN128 (8/26/2014)	**65.63**	63.28	**8.59**	**21.88**	**8.59**	8.59	**45.31**	**29.69**
13MN105 (7/10/2013)	**72.25**	**34.45**	**1.91**	**25.84**	**1.91**	**3.59**	17.22	**22.32**
13MN105 (7/30/2013)	**80.55**	**25.09**	**4.95**	**7.36**	**4.95**	**2.99**	11.97	**33.97**

Station (Year sampled)	TolPct	LithFrimPct	DarterSculpSucPct	RifflePct	BenInsect-TolPct	PiscivorePct	PioneerPct	SLithopPct
13MN105 (8/27/2013)	**84.77**	**11.17**	**3.05**	**2.03**	**3.05**	**5.08**	14.21	81.22
13MN105 (7/1/2014)	**59.84**	**31.15**	**3.28**	**15.57**	**3.28**	**1.64**	10.66	**16.39**
13MN105 (7/21/2014)	**59.65**	**45.61**	**14.91**	**19.3**	**14.91**	**1.75**	**42.11**	**18.42**
13MN105 (5/28/2014)	**90.52**	**41.53**	**2.42**	**16.94**	**3.02**	**0.00**	**20.56**	**33.06**
13MMN105 (6/12/2014)	**100.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	**0.00**
13MN105 (8/25/2014)	**63.44**	**48.75**	**11.83**	**21.86**	**11.83**	**3.23**	**32.26**	**25.45**
13MN105 (8/10/2015)	**75.31**	58.58	**13.39**	**17.57**	**16.74**	**1.67**	**32.64**	45.19
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*58.26*	*18.18*	*32.49*	*20.40*	*5.24*	*19.02*	39.38
Expected response to Habitat stress	↑	↓	↓	↓	↓	↓	↑	↓

There was mixed response to habitat related stress metrics in the macroinvertebrate community as well (see table below). All stations had above average quantities of legless taxa and nearly all stations had lower than average clinger taxa, suggesting limited availability of coarse substrates and woody debris. Pictorial evidence of eroding streams banks and limited riffle presence within the biological reaches are consistent with increasing quantities of legless taxa (worms, etc.) that do not require hard substrates and thrive In fine sediment laden conditions. However, climber taxa were prevalent at nearly all stations suggesting an abundance of macrophyte and overhanging vegetation habitat availability. Five of eight visits had fewer than average sprawler taxa. Metric data suggests that habitat is a limiting factor for macroinvertebrate communities at stations 13MN156 and 13MN128, but is less consistent as a stressor at stations 13MN125 and 13MN105.

Table 114. Macroinvertebrate metrics that respond to degraded habitat stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN156 (2013)	1.75	88.92	**1.17**	**0.29**	**97.67**	**4.96**
13MN156 (2014)	**14.38**	43.48	**24.42**	**1.00**	**84.95**	**10.37**

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN125 (2013)	6.96	40.51	**19.62**	**12.66**	**78.17**	19.94
13MN125 (2014)	3.35	31.10	43.14	40.13	**50.50**	**12.71**
13MN128 (2013)	6.31	50.50	**21.26**	**9.64**	**85.05**	**12.96**
13MN128 (2014)	**21.32**	34.48	**22.88**	**3.76**	**89.34**	**14.42**
13MN105 (2013)	8.74	21.68	**34.30**	46.93	**31.07**	30.74
13MN105 (2014)	**22.54**	**16.19**	**26.98**	**7.94**	**72.06**	21.91
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 112. Biological station 13MN156 (May 25, 2013) braided channel, remnants of past bank sloughs (left); narrow riparian buffer (left).


Figure 113. Biological station 13MN109 (July 2013) stream bank erosion (left); sediment deposition (middle); (May 1, 2014) sediment deposition and stream bank erosion (left).



Figure 114. Biological station 13MN125 (August 15, 2013) stream bank erosion (left); (July 10, 2013) stream bank erosion (right).

Figure 115. Biological station 13MN125 (August 15, 2013) stream bank erosion (left); low flow (right).

Figure 116. Biological station 13MN128 (August 14, 2013) stream bank erosion (left); (July 31, 2013) erosion and sediment deposition (right).

Figure 117. Biological station 13MN105 (August 13, 2014) evidence of erosion from adjacent agricultural field (upper left); (June 12, 2014) stream bank erosion (upper right); beaver dam (lower left); beaver dam (lower right).

Figure 118. Biological station 13MN125 (June 15, 2016) field connection (left); Butterfield Creek 330th St. crossing (August 21, 2016) animal trampling of stream banks (middle); filamentous algae and no riparian buffer (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. A beaver dam was identified as a potential barrier upstream of biological station 13MN156. It is not likely having an impact on stream connectivity within the reach. However, potential connectivity issues were identified at three road crossings in the watershed, downstream of biological station 13MN156 at 650th Ave. the culvert is perched, posing a potential barrier at low flow and inverted, posing a potential barrier at high flows. This can be observed looking at the fish species list at the table below, six fewer species were identified at the upstream most site

13MN156, compared to the next downstream station 13MN125. Two additional barriers were identified at 730th Ave., were an inverted culvert poses connectivity issues at high flow and 310th St. where an inverted culvert poses as a barrier at high flows and an extensive rock dam riffle poses as a potential barrier at low flows. Eight species were identified at the downstream most station 13MN105 that were not observed at upstream station 13MN128.

Seven known migratory fish species were captured on the reach, black bullhead and white sucker were identified at all reaches, central stoneroller were found at the upstream most reach and the downstream two reaches, Iowa darter and walleye were only observed at the two downstream most stations, while shorthead and silver redhorse were only observed at the downstream most station (see table below).

Only 2 of 19 mussel species were identified on the reach during DNR mussel surveys from 1999-2003. Mussels identified were *Fusconaia flava* (Wabash pigtoe) and *Lampsilis siliquoidea* (fatmucket). Only one survey site was sampled on the reach for mussels, closer to Butterfield's confluence with St. James Creek. As such mussel data cannot help understand potential barriers observed upstream of the survey site that may be impeded by manmade barriers.

Present evidence suggests that longitudinal connectivity is creating limitations for the fish communities on the reach at this time and is a likely form of stress.

Table 115. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number/barrier	Beaver dam	13MN156	perched culvert/inverted	13MN125	13MN128	inverted	inverted culvert/ rock riffle barrier?	13MN105
WID		-516		-516	-516			-516
Fish taxa								
bigmouth buffalo				x				x
bigmouth shiner				x	x			x
black bullhead		X		x	x			x
blacknose dace		X		x	x			x
blackside darter					x			x
bluntnose minnow		X		x	x			x
brassy minnow								x
brook stickleback		X						
central stoneroller		X			x			x
common carp		X		x	x			x
common shiner					x			x
creek chub		X		x	x			x
fathead minnow		X		x				x
green sunfish		X						x
Iowa darter					x			
johnny darter		X		x	x			x
largemouth bass					x			x
orange spotted sunfish				x	x			x
northern hogsucker								x

Field Number/barrier	Beaver dam	13MN156	perched culvert/inverted	13MN125	13MN128	inverted	inverted culvert/ rock riffle barrier?	13MN105
northern pike				x	x			x
sand shiner				x	x			x
shorthead redhorse								x
silver redhorse								x
spotfin shiner				x	x			x
tadpole madtom								x
Walleye					x			x
white sucker		X		x	x			x
yellow bullhead					x			x
yellow perch		X		x	x			x

Figure 119. Biological station 13MN156 (July 11, 2013) beaver dam in upstream section of the reach.

Figure 120. Butterfield Creek at 640th St. (August 31, 2016) filamentous algae and perched culvert (left and right).

The Altered Watercourses GIS layer for Minnesota streams indicates that the 25.18 mile long reach of the Butterfield Creek is 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were identified at the biological stations.

Four species were identified on the reach that are known lake species: black bullhead, yellow perch, yellow bullhead and largemouth bass. Presence of lake species can be an indication of lentic low flow conditions and altered hydrology. Yellow perch and black bullhead were identified at all stations while, yellow bullhead and largemouth bass were only identified at 13MN128 and 13MN105.Below average quantities of long-lived taxa were identified at all visits on station 13MN156 and only occasionally at visits at 13MN125 and 13MN128. Below average quantities of riffle dwelling species were observed at all but one visit on 13MN156, on all visits at station 13MN125 and 13MN105 and most visits on 13MN128. This suggests there is potential for low flow stress across the reach; however, long-lived taxa results at 13MN128 are counterintuitive (see table below).

Table 116. Fish metrics that respond to altered hydrology stress in Butterfield Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN156 (2013)	**90.91**	**0.00**	**15.58**
13MN156 (2013)	**91.94**	**0.69**	32.26
13MN156 (2014)	**100.00**	**0.00**	**0.00**
13MN156 (2014	**99.31**	**0.00**	**3.45**
13MN156 (2014)	**100.00**	**0.55**	**7.8**
13MN156 (2014)	**100.00**	**0.00**	**8.00**
13MN156 (2015)	**98.35**	**0.69**	**8.24**
13MN125 (2013)	**100**	**0.00**	**0.00**
13MN125 (2013)	**82.09**	**0.00**	**22.39**
13MN125 (2013)	**100.00**	5.88	**25.00**
13MN125 (2014)	**90.2**	6.90	**1.96**
13MN125 (2014)	**81.03**	26.17	**1.72**
13MN125 (2014)	**86.92**	**0.00**	**2.80**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
13MN128 (5/29/2013)	**75.95**	13.92	**17.72**
13MN128 (7/10/2013)	**21.01**	26.89	**4.20**
13MN128 (7/30/2013)	**17.33**	50.67	**1.33**
13MN128 (8/28/2013)	**100.00**	36.93	33.33
13MN128 (5/27/2014)	**96.30**	24.22	64.81
13MN128 (7/1/2014)	**95.74**	13.92	38.30
13MN128 (7/21/2014)	**52.51**	26.89	**14.07**
13MN128 (8/26/2014)	**65.63**	50.67	**21.88**
13MN105 (7/10/2013)	**72.25**	23.44	**25.84**
13MN105 (7/30/2013)	**80.55**	**10.82**	**7.36**

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN105 (8/27/2013)	**84.77**	**5.58**	**2.03**
13MN105 (7/1/2014)	**59.84**	24.56	**15.57**
13MN105 (7/21/2014)	**59.65**	25.81	**19.30**
13MN105 (5/28/2014)	**90.52**	**10.46**	**16.94**
13MMN105 (6/12/2014)	**100.00**	23.44	**0.00**
13MN105 (8/25/2014)	**63.44**	**10.82**	**21.86**
13MN105 (8/10/2015)	**75.31**	**5.58**	**17.57**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.80*	*32.49*
Expected response to stress	↑	↓	↓

Low flow was documented in 2012 at stations 13MN128 and 13MN109 (see photographs). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow was also documented in 2013 at macroinvertebrate visits in August at station 13MN125 and 13MN156 (see photos below). Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is stressing biota within the reach at this time, but may be impacting some stations more greatly than others.

Figure 121. Biological station 13MN128 (September 12, 2012) low flow (left); biological station 13MN109 (September 12, 2012) intermittent flow (right).

Figure 122. Biological station 13MN125 (August 15, 2013) bank erosion (left); low flow (right).

Figure 123. Biological station 13MN156 (July 31, 2013) dry stream channel (left); duckweed in stream suggesting limited flow (right).

4.1.3. AUID Summary

The fish and macroinvertebrate communities on Butterfield Creek were degraded by elevated concentrations of unionized ammonia and nitrogen, eutrophication, elevated levels of TSS, degraded habitat conditions, longitudinal connectivity and altered hydrology.

This modified (channelized) stream reach has many negative habitat characteristics that are stressing the biological communities as seen in fair to poor MSHA scores across the reach. Row crop agriculture dominating the adjacent land use, limited coarse substrate availability, stream bank erosion and limited channel morphology all contribute to degraded biological communities. Conditions observed are likely the result of past channel modifications. Inputs from tile drainage during runoff events are contributing to elevated concentrations of nitrogen and phosphorous, leading to in stream eutrophication as seen in elevated levels of phosphorous, DO flux across the reach and high chlorophyll a concentrations at 13MN105, as well as elevated flows that are scouring stream banks and causing shifting stream beds. This in turn buries riffle habitat, fills in pools and is detrimental for sensitive taxa which require diverse habitat conditions. Low flows within the reach are also stressing biological communities during the late summer months, tile and wetland drainage have lowered the surrounding water table in the watershed impeding baseflow conditions during the late summer months drastically limiting what degraded habitat is available.

Additional investigation of nutrients would be useful in better understanding potential contributions of P loading within the reach.

A perched culvert, inverted culvert and a large rock riffle in the watershed are impeding longitudinal connectivity in the reach by limiting migratory fish taxa during high and low flows. Efforts to improve problem culverts and remove barriers would be beneficial to fish communities.

Conductivity was an inconclusive stressor at this time. While elevated conductivity levels were observed within the reach, and a biological metric response was observed, there was insufficient connecting chemical data to indicate stress within the reach.

DO is an inconclusive stressor along the reach at this time. While below average concentrations were detected at station 13MN156 during continuous DO monitoring, biological metrics indicated that there was an inconsistent response to low DO stress in both the fish or macroinvertebrate communities. Additional evidence to solidify the extent of the stressor is still needed. Any efforts to bring DO levels into attainment would likely be beneficial to both biological indicators.

Table 117. Summary of stressor determinations for Butterfield Creek (516).

		Stressors:							
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**	**Chloride/Conductivity**	**Ammonia**
Butterfield Creek	07020010-516	o	●	●	●	●	●	O	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

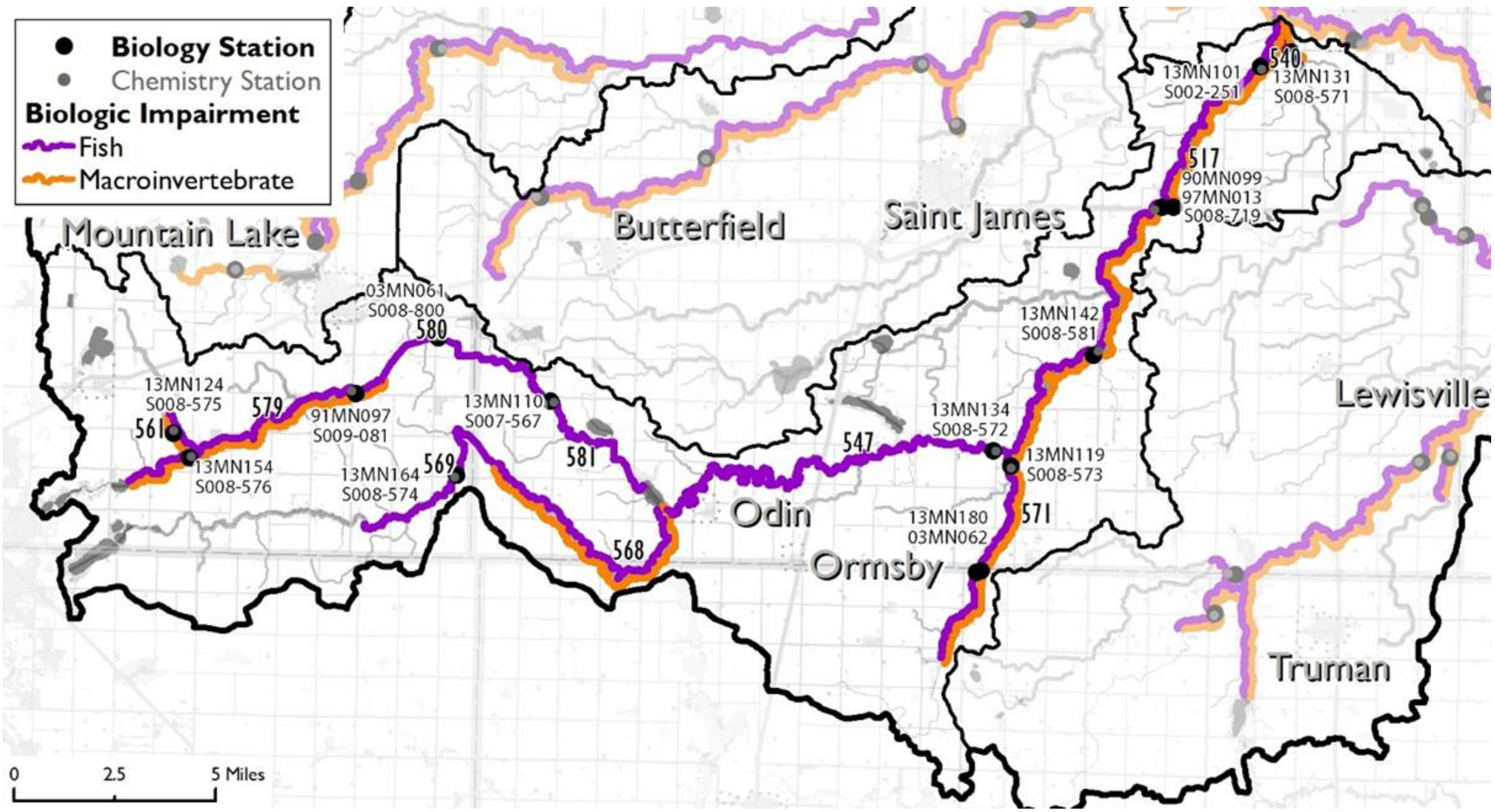
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

South Fork Watonwan River

The South Fork Watonwan River encompasses the southwestern most reaches of the Watonwan River Watershed. The headwaters of the South Fork Watonwan River begin east of Windom flow in an Easterly direction, gaining the flow of its principal tributary, Judicial Ditch one west of Odin. South Fork then gains the flow of Willow Creek before turning in a sharp northeasterly direction, ultimately flowing to the mainstem of the Watonwan River a couple miles west of Madelia.

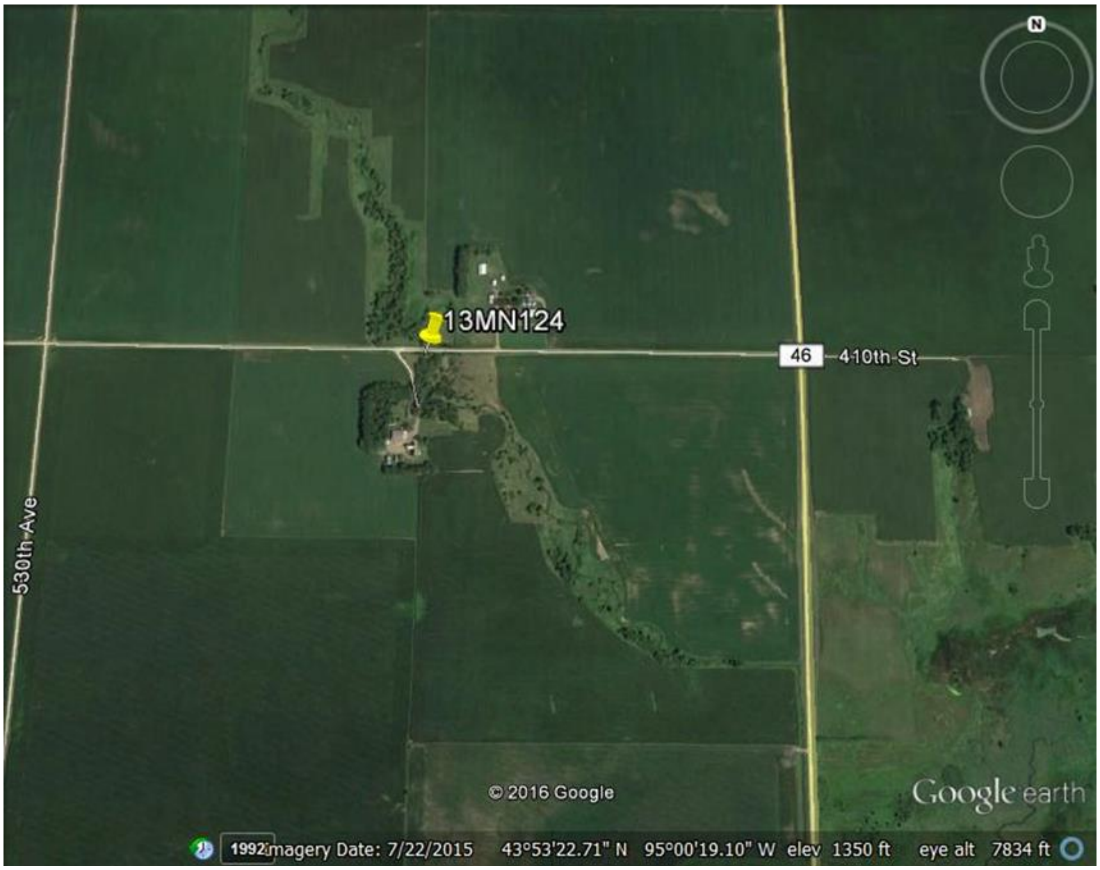
Figure 124. Biological impairment map of the South Fork Watonwan River subwatershed.



4.1. Unnamed Creek -561

Unnamed Creek (07020010-561) covers 1.6 stream miles of the outlet of a tributary stream to Judicial Ditch 1, lying 1.5 miles southeast of the community of Bingham Lake. The reach begins upstream of 410th St. and joins JD 1 just west of Co. Hwy 46. This reach is classified as general use warmwater 2B. This reach is impaired for aquatic life for degraded fish and macroinvertebrate communities (2015). There are no upstream assessments for this tributary.

Figure 125. Google Earth image of Unnamed Creek (-561).



4.1.1. Biological communities

There is one biological station on this reach, 13MN124. It was sampled in 2013 and 2014 for both fish and macroinvertebrates. Only the fish visit from 2014 was considered to be assessable as the 2013 sampling event produced no fish and was deemed not assessable due presumed impacts caused by an extreme drought from 2012, limiting the ability for fish to migrate back into headwater streams. The 2014 sampling visit scored a zero due to a limited capture of only three creek chub (see graph below).

Macroinvertebrate results fell below lower confidence intervals for general use during both 2013 and 2014 visits with MIBI scores of 22.6 (2013) and 15.2 (2014). Both communities had a high percentage of tolerant taxa (Tolerant2ChTxPct), low numbers of predators (Predator), trichoptera (Trichoptera), climber taxa (ClimberCh), insect taxa (InsectTxPct) and low scores in DomFiveChPct (see graph below). The 2013 community was dominated by physa (141), polypedilum (43), cheumatopyche (23) and Thienemamimyia Gr (23), while the 2014 community was dominated by Simulium (164), Physells (39), Hyalella (37) and Polypedilum (18).

Figure 126. Fish metrics of the Southern Headwaters Class IBI for station 13MN124, Unnamed Creek.

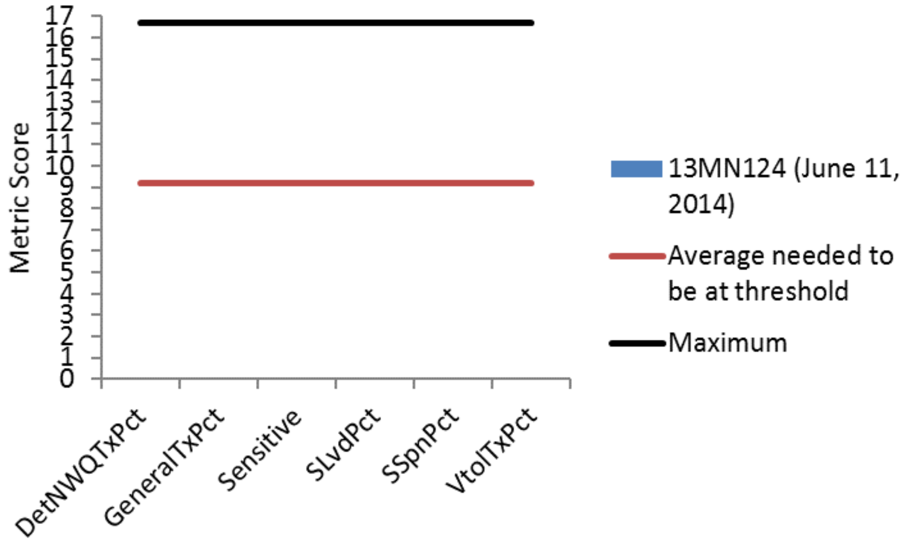
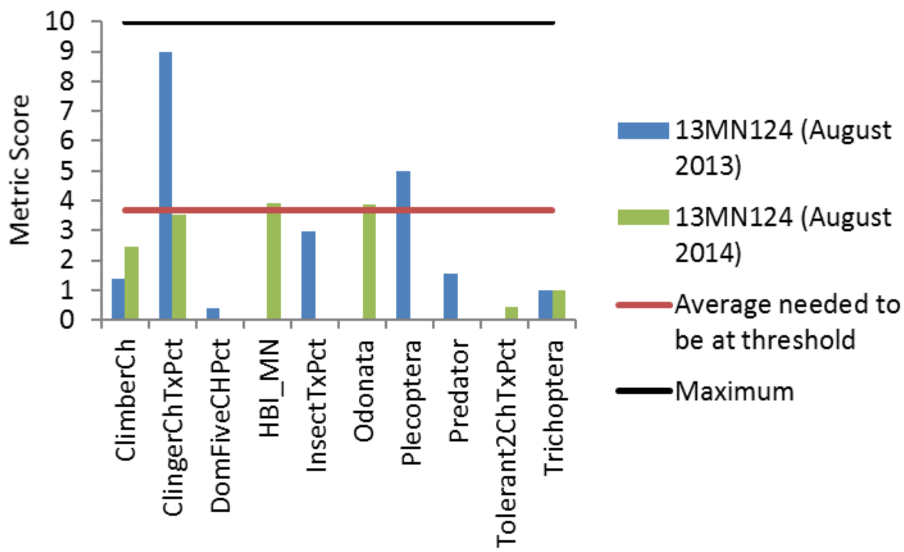


Figure 127. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 13MN124, Unnamed Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Four DO measurements were collected on the reach during biological visits in 2013 and 2014; all values were within the normal range for DO. No samples fell below the low DO standard of 5 mg/L. Eight additional DO samples were collected during the SID investigations in 2015 and 2016 along the reach, no samples fell below the low DO standard; however, one sample was 14.33 mg/L suggesting a potential for high DO flux along the reach. Additional DO monitoring involving continuous measurements could help identify whether or not DO flux could be a potential concern on the reach.

There were differing results between the two macroinvertebrate samples on station 13MN124 regarding the macroinvertebrate response to low DO metrics (see table below). Low DO Index scores along the reach were near the average, with one instance rising above and one below the class average. Both stations had low quantities of EPT taxa, low HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) scores, low quantities of low DO intolerant taxa and above average quantities of low DO tolerant taxa.

Table 118. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN124 (2013)	**30.00**	**9.00**	0.00	**6.86**	**4.00**	**4.22**	**8.00**	4.22
13MN124 (2014)	**24.00**	**5.00**	3.90	7.24	**1.00**	**6.83**	**5.00**	**13.35**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Fish metrics also show response to DO stress; however, limited consideration should be given the fish metrics because only a single species of fish was captured in the reach. As such, tabular data was omitted from the report. Only creek chub were captured, creek chub are tolerant taxa that are not low DO tolerant species, nor are they sensitive to low DO conditions.

Limited chemical data was available within the reach. Macroinvertebrate metrics in the reach exhibit some response to low DO metrics. Insufficient information is available to conclude stress within the reach. Additional chemical data collection including continuous monitoring and an additional fish sample would be useful in better understand the potential of low DO stress in the reach. Low DO is an inconclusive stressor in the reach at this time.

Eutrophication

There were two phosphorous samples collected at 13MN124 in 2013 and 2014, neither sample was above the southern regional eutrophication standard of 0.15 mg/L. Four additional samples were gathered in 2016, none of which exceeded the standard. There were no chlorophyll a or BOD readings collected in this reach nor DO flux data to review. DO grab sample data ranged from 7.83 mg/L to 14.33 mg/L in the reach indicating potential for elevated DO flux in the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.62 – 8.24 in the reach.

The macroinvertebrate community is showing potential signs of eutrophication stress (see table below). Within the community there is an absence of intolerant taxa and an overabundance of tolerant taxa. There were also limited numbers of collector-filterer, collector-gatherer and EPT taxa as compared to class thresholds.

Table 119. Macroinvertebrate metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN124 (2013)	**30.00**	**4.00**	**10.00**	**9.00**	**0.00**	**96.67**
13MN124 (2014)	**24.00**	**4.00**	**8.00**	**5.00**	**0.00**	**91.67**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Fish metrics also show potential response to eutrophication stress; however, only one species was captured during sampling visits, creek chub; a generalist species which is tolerant of biological stressors. As such the fish metric tables has been omitted from the report.

Insufficient data is available to determine biological stress within the reach due to a limited chemical dataset with an absence of response variable data. Biological metric information for eutrophication is not a great indicator of stress as many metrics are general in nature and could point to several different stressors. Eutrophication is inconclusive as a stressor in this AUID.

Nitrate

Biological station 13MN124 was sampled twice for fish and as such was sampled twice for nitrates, concentrations ranged from 27 mg/L in June of 2013 to 14 mg/L in June of 2014. An additional seven samples were taken for nitrogen in 2015 and 2016 during the months of May, June, August and September with a single sample collected in February. Nitrate concentrations ranged from 3.7 mg/L in August and September to 27 mg/L in May, with an overall average concentration of 17.15 mg/L. Five of the nine total samples were above 15 mg/L.

The macroinvertebrates in this reach show inconsistent indication they are stressed by the elevated nitrate concentrations (see table below). The nitrate index score was 3.6 and 4.8, while the average for Southern Streams meeting impairment threshold is 2.9. This suggests that overall the community present is quite tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) and decreased intolerant and Trichoptera taxa, all of which are lacking in this reach. The total nitrate tolerant taxa and the number of nitrate tolerant individuals were above the average during the 2013 visit but were well below the average for the 2014 visit.

Table 120. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Nitrate Relevant Metrics	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L)
13MN124 (2013)	**30.00**	**4.00**	**10.00**	8.00	**0.00**	**96.66**	**2.60**	**3.00**	**4.80**	**0.00**	**20.00**	**93.20**	27.00 (6/18/13)
13MN124 (2014)	**24.00**	**4.00**	**8.00**	**4.00**	**0.00**	**91.66**	**3.73**	**3.00**	**3.60**	**0.00**	14.00	32.90	14 .00 (6/11/14)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish are generally not very good indicators of nitrate stress. As only three creek chub were collected during the fish, utility of looking at fish metrics is even less useful. As such, metric tables for fish in this reach have been omitted from the report. Creek chub are generalist tolerant taxa that are not good indicators of nitrate stress.

Despite evidence of elevated nitrate concentrations occurring in the reach before and after macroinvertebrate visits, there was an inconsistent response to nitrate stress between the two macroinvertebrate visits. While it may not be a consistent form of stress, it appears that nitrates are stressing the macroinvertebrate communities in the reach at least on an intermittent basis. As such, nitrates are a stressor on the reach at this time.

Suspended sediment

TSS samples were collected during fish visits at biological station 13MN124 in 2013 and 2014; neither sampled exceeded the southern regional TSS standard of 65 mg/L. No TSS samples were collected prior to biological monitoring within the reach. Seven additional TSS samples were collected on the reach during SID investigations in 2015 and 2016, no sampled exceeded TSS standards. Eight transparency tube measurements were gathered on the reach from 2015 and 2016 during SID investigations, values ranged from 31 cm to 74 cm, no readings fell below the southern regional standard of 10 cm.

There are mixed results in the manner that the macroinvertebrates at station 13MN124 respond to the elevated TSS stress metrics (see table below). The TSS Index score at the initial visit showed a clear response to elevated TSS levels indicating potential for stress while the second visit's TSS Index score was near the class average. Both stations lacked TSS intolerant taxa and had below average quantities of TSS intolerant taxa; however, only the 2013 visit had a high quantity of TSS tolerant individuals. While the 2013 visit had insufficient collector-filter numbers and sufficient numbers of plecoptera, the second visit was opposite.

Only three creek chubs were captured during fish sampling so metric evidence is likely skewed to producing a potential for a false positive for TSS stress. As such, metric data for fish has been omitted from the report.

Limited chemical data indicating TSS stress and inconsistencies in the macroinvertebrate metric response suggest that there is insufficient information to make a determination of stress at this time.

Table 121. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN124 (2013)	**8.77**	0.97	**18.76**	**0.00**	**0.00**	11.00	**75.00**
13MN124 (2014)	54.21	**0.00**	15.48	**0.00**	**0.00**	7.00	21.43
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Habitat

Three MSHA habitat surveys were conducted on reach 13MN124 from 2013-2014 with an average score of 52.85 (see graph below). Landuse in the upstream watershed is comprised of row crop agriculture and six feedlots (bovine, swine and one bird facility). This unnamed tributary is channelized in the upstream portion of the watershed and natural in the lower 1.3 miles where the biological station is located. While the wooded riparian zone spans 10-50 meters along the biological reach it is very narrow further upstream in the watershed. Heavy bank erosion was indicated within the stream corridor caused by a combination of high flow events and animal trampling. There was good natural stream channel development with a variety of coarse and fine substrates. Stream bank erosion and sedimentation of coarse substrates attributed to a moderate stream stability score. Individual metric scores of the MSHA can be seen in the graph below.

Figure 128. Percentage of MSHA subcategory scores for station 13MN124, Unnamed Creek.

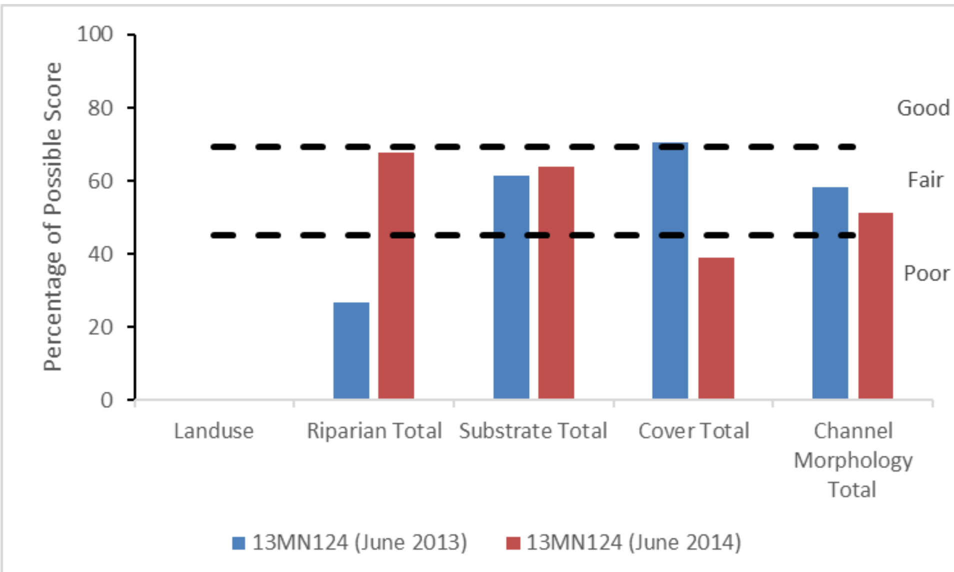


Figure 129. Biological station 13MN124 (May 1, 2015) stream bank erosion (left and right).

No fish were captured during sampling so metric evidence is of minimal value to determine degraded habitat stress. Metrics show that creek chub are a tolerant pioneering taxa. Metric tables have been omitted from the report due to their limited utility.

The macroinvertebrate community shows a mixed response to degraded habitat stress metrics (see table below). Both visits show low quantities of burrower taxa. Low quantities of burrowing taxa indicate that there is not an abundant supply of fine sediments for burrowers to thrive. There were low quantities of EPT taxa and sprawler taxa, indicating potential for stress. EPT taxa are generally more sensitive to disturbed conditions. There were sufficient quantities of climber taxa which suggest and abundance of overhanging vegetation or aquatic macrophytes within the reach. Inconsistent numbers were found between visits with regards to the abundance of legless and clinger taxa. An abundance of legless taxa corresponds to an abundance of fine sediment; where as an abundance of clinger taxa would suggest an abundance of coarse substrates and woody debris. Habitat stress appears to be variable in the reach year to year.

While erosion, sedimentation and limited habitat availability appear to be a concern in the reach, their effects on the macroinvertebrate community are inconsistent across sampling visits. Despite inconsistencies, presence of habitat stressors and evidence of metric effects indicate that degraded habitat conditions are a conclusive stressor for the macroinvertebrate community in the reach at this time.

Table 122. Macroinvertebrate metrics that respond to degraded habitat conditions stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN124 (2013)	1.30	62.66	**23.05**	**18.51**	**76.95**	**2.92**
13MN124 (2014)	1.56	20.56	59.81	**12.15**	23.68	**11.84**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 130. Biological station 13MN124 (May 24, 2016) cattle access to stream.

Altered hydrology/ Longitudinal connectivity

There are no known dams within the reach. There is a perched culvert approximately 10 miles downstream of the reach on WID -581 (upstream of biological station 13MN110) that may be limiting fish passage upstream. A comparison of species richness above and below the fish barrier (see table below), shows that similar species are found above and below the barrier, with greater diversity identified above the barrier. However, a large wetland complex located on the next downstream WID -579 may be creating a different kind of barrier on the reach. This 'natural' barrier could be inhibiting the ability of downstream species to migrate up into the reach, resulting in low overall biological diversity observed.

Only two species were identified upstream of the wetland, compared to 14 downstream of the wetland. Only one species was captured within the reach. It is not a known migratory taxa (see table below). There were no DNR mussel surveys conducted on the reach.

Additional investigation would be useful to better understand potential barriers in the reach that appear to be limiting longitudinal connectivity in the reach. Longitudinal connectivity will be an inconclusive stressor on the reach until additional evidence is gathered to explain low taxa counts observed.

Table 123. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number/Barrier	13MN124	13MN154	wetland	91MN097	03MN061	Perched Culvert	13MN110
WID	-561	-579		-579	-580		-581
Fish Taxa							
bigmouth shiner				x			
black bullhead		x		x	x		
blacknose dace				x			
blackside darter				x			x
bluntnose minnow				x			x
brook stickleback				x			
central stoneroller				x			x
common shiner				x			
creek chub	x	x		x	x		x
fathead minnow				x			
johnny darter				x	x		x
northern pike					x		x
walleye				x			
white sucker				x	x		x
yellow bullhead				x			

The Altered Watercourses GIS layer for Minnesota streams indicates that the 1.63 mile long reach of Unnamed Creek is 75% natural and 25% modified. Its headwaters, upstream of -561 are 100% channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor. While undercut banks were not apparent within the reach, severe bank erosion and instream sedimentation were observed at the biological station.

There was an absence of riffle dwelling and long-lived taxa within the reach, both metrics can be an indication that altered hydrology is a stressor. No lake taxa were identified within the reach, presence of lake taxa can indicate persistent low flow conditions in the reach, which may be caused by altered hydrology within the reach. Metric data should be taken lightly as only a single taxa was identified within the reach.

Photographic evidence at the biological station from September 2012 indicates intermittent stream conditions occurred during that fall (see below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. It appears maintaining baseflow within the reach is a problem and likely having negative impacts on the biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events (see below). Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Present data suggests that altered hydrology is a likely stressor within the reach at this time.

Figure 131. Biological station 13MN124 (May 2, 2016) constantly flowing pipe (left and right).

Figure 132. Biological station 13MN124 (September 12, 2012) intermittent streambed.

4.1.3. AUID Summary

Elevated nitrates, degraded habitat conditions and altered hydrology are stressors to biological communities within the reach. Evidence of elevated nitrate concentrations are present in the reach, the macroinvertebrate community sampled during the 2013 visit showed a clear response to nitrate stress metrics. Tile drainage in the watershed is a likely source of nitrates from non-point agricultural contributions. Additional information could be useful in better understanding year-to-year variability in the reach. Evidence of habitat related stress was observed during MSHA observations during the fish visits including stream bank erosion, sedimentation of coarse substrates and limited habitat availability; macroinvertebrate stress metric data showed a direct response to these stressors. Low flow conditions were observed in the fall of 2012 that exhibit the cumulating effects of wetland drainage and tile drainage lowering the overall water table and baseflow within the system. Altered hydrology in turn can have negative impacts on stream habitat as observed through stream bank erosion and sedimentation in the reach.

Low DO, eutrophication, TSS, and longitudinal connectivity are inconclusive stressors in the reach at this time. Limited chemistry data was available for consideration. The macroinvertebrate community shows potential for low DO stress in the reach. The phosphorous dataset for the reach was small and lacked any response variable data that may indicate stress. Additional DO and P chemistry collection including continuous sonde deployment with DO readings could be useful in better understanding the potential of the stressor. The macroinvertebrates showed inconsistent response to elevated TSS within the reach while limited chemistry data has been obtained to confirm elevated TSS concentration exist within the reach. There are no known manmade barriers within the reach that appear to be limiting longitudinal connectivity. A wetland downstream of the biological station on JD 1 may help explain low taxa counts observed upstream of the wetland. Additional investigation is needed to better understand potential impediments to the fish community within the reach.

Present fish data has limited utility in determining stressors in the reach because only a single taxa was captured. Future efforts made to resample the fish community in the reach should strive for a sample in July or August to see if similar results are observed.

Table 124. Summary of stressor determinations for Unnamed Creek (561).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Unnamed Creek	07020010-561	o	o	●	o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

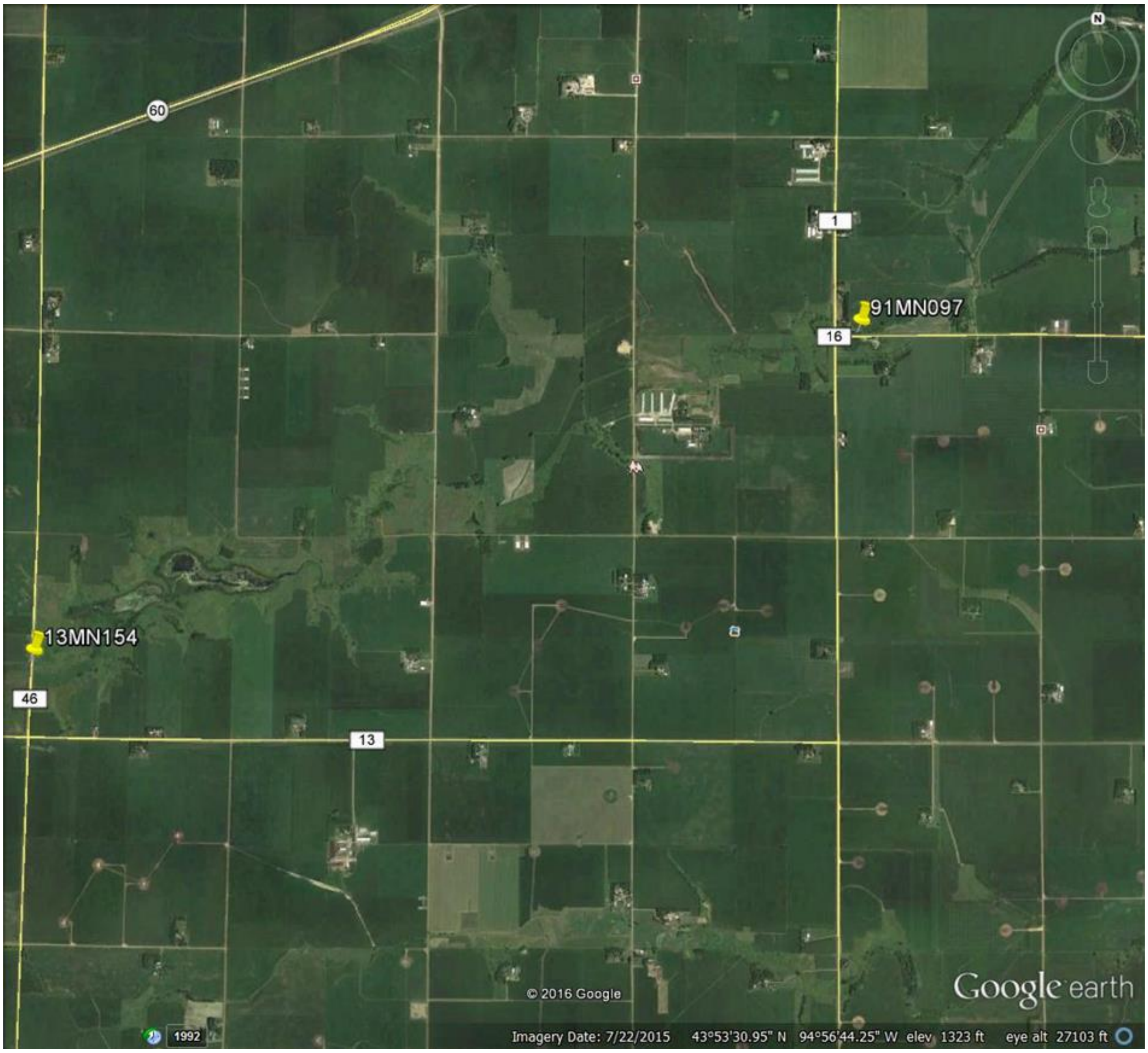
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. JD 1 -579

Judicial Ditch 1 (07020010) spans from the outlet of the Parso Lake Chain, about 4 miles east of Windom and flows west 10 stream miles to downstream reach (07020010-580), which begins east of CR 99. Classification for this reach is general use warmwater 2B. The reach is impaired for aquatic life for lack of fish and macroinvertebrate communities (2015).

Throughout its course, it gains the flow of Unnamed Creek (07020010-561) just upstream of Co. Hwy 46.

Figure 133. Google Earth image of Judicial Ditch 1 (-579).



4.1.1. Biological communities

There are two biological stations on this reach with three assessable fish visits. 13MN154 sampled twice for fish in 2013, on June 18 and July 24, both samples received FIBI scores of zero due to low end scoring from low capture rates (below threshold and lower confidence interval). Only creek chub and black bullhead were captured in June while no fish were captured in July. Fish metric data at station 13MN154 has limited utility due to the limited catch and low diversity. Species that were collected were very tolerant.

The downstream station, 91MN097, has assessable FIBI data derived from a 2014 sample on June 11, 2014, the score 2.5, also fell below the lower confidence interval. While there was a fish visit in 2013, the data was deemed unreportable due to inconsistent methods, making metric data not useful. The sample was dominated by creek chub, blacknose dace and bluntnose minnow. A non-reportable visit from 2009 shows that a more robust community was present (more species (10) and individuals (56)) but results still would have fallen below standards had they been assessable (see graph below).

Macroinvertebrate data is limited to two visits at biological station 91MN097. An attempt to obtain a sample at 13MN154, the upstream station, was made in 2013; however, insufficient flows prohibited sampling. The 2013 visit scored 17.2 falling below threshold (MIBI: 37) and lower confidence limits, while the 2014 visit scored a 29.8 which was within lower confidence limits (see graph below).

Dominant taxa in the 2013 sample included: Polypedilum (59), Physa (50), Caenis hilaris (45), Cheumatopsyche (33) and Thienemannimya Gr (28). Dominant taxa in the 2014 sample included: Cheumatopsyche (70), Polypedilum (65), Rheotanytarsus (21) and Hyalella (20).

Figure 134. Fish metrics of the Southern Streams Class IBI for station 91MN097, Judicial Ditch 1.

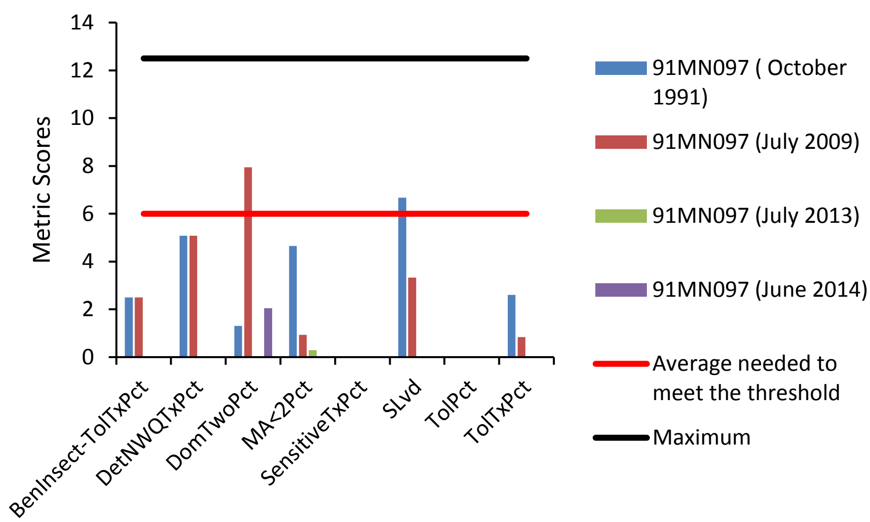


Figure 135. Fish metrics of the Southern Headwaters Class IBI for station 13MN154, Judicial Ditch 1.

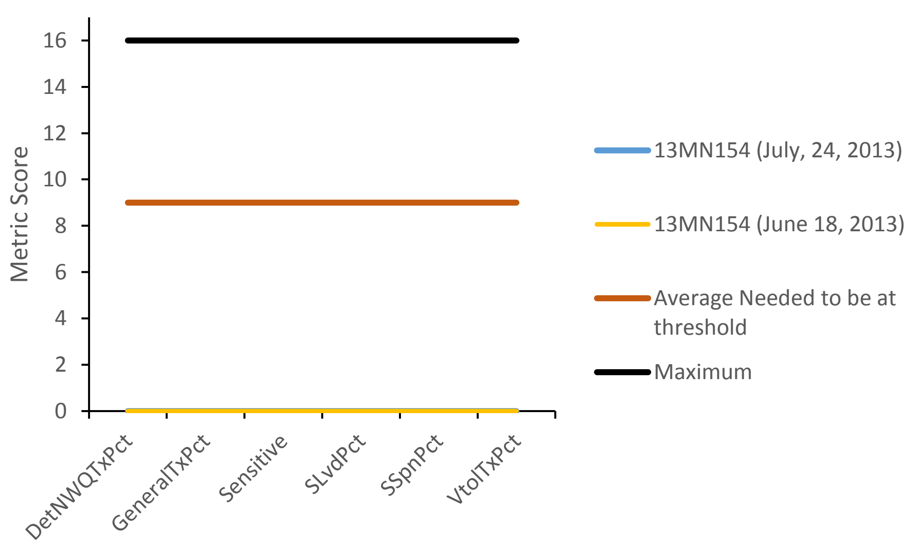
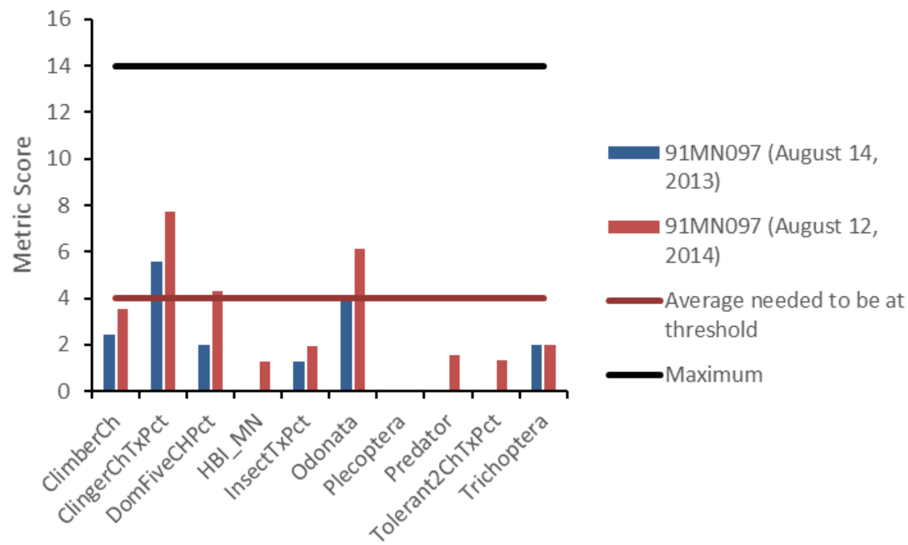


Figure 136. Invert metrics of the Southern Streams RR Class IBI for station 91MN097, Judicial Ditch 1.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There were eight DO measurements taken during biological visits at two stations, 91MN097 and 13MN154 in 2009, 2013 and 2014, values ranged from 7.8 mg/L at 13MN154 to 10.21 mg/L at the same station. No DO samples were collected on the reach prior to biological monitoring activities. Nine additional DO measurements were collected on the reach in 2016 as part of SID investigations; values ranged from 7.59 mg/L to 12.68 mg/L, no samples fell below the low DO standard of 5 mg/L.

There was a mixed response in the macroinvertebrate community to low DO metrics (see table below). The Low DO Index score was just below the average for the southern streams class, suggesting that that low DO stress is not the primary stressor to the macroinvertebrates. However, quantities of low DO tolerant individuals were above the class average at both visits, as well as a lower than average amount of low DO intolerant taxa. There was also an above average HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score signifying stress.

Table 125. Macroinvertebrate metrics that respond to low DO stress in Judicial Ditch 1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
91MN097 (2013)	**40.00**	12.00	**8.60**	**6.96**	**3.00**	**6.21**	4.00	**16.67**
91MN097 (2014)	**29.00**	9.00	**7.90**	**6.81**	**5.00**	**7.37**	**6.00**	**15.38**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The utility of the fish data is limited due to limited diversity and quantity of individuals observed during sampling (see table below). DO index scores do not suggest that low DO stress is likely for either station. There was an abundance of generally tolerant taxa and an absence of late maturing individuals. No generally sensitive nor low DO sensitive taxa were observed within the reach. There were below average quantities of DO tolerant taxa and individuals.

There was no evidence of low DO conditions within the reach; however, the chemistry dataset was limited to a handful of samples collected during biological and SID investigations. Macroinvertebrate metric data suggested a potential for low DO stress; but evidence was marginal and not overly compelling. Fish metric data had limited value given lack of diversity within the reach. As such, low DO is an inconclusive stressor in the reach at this time. Additional continuous DO monitoring would provide greater understanding of whether or not low DO conditions exist within the reach and whether or not they are resulting in stress to aquatic communities. A macroinvertebrate sample should be obtained at the upstream station 13MN154 to better understand potential for low DO stress and other stresses in the upper reaches.

Table 126. Fish metrics that respond to low DO stress in Judicial Ditch 1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN154 (2013)	**0.00**	**0.00**	**100.00**	7.05	**0.00**	**0.00**	1.00	12.50
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
91MN097 (2014)	**0.00**	**0.00**	**91.11**	7.25	**0.00**	**0.00**	1.00	6.67
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

There were 4 phosphorous samples collected on two stations during the fish visits in 2013 and 2014, all samples were below the southern regional eutrophication standard of 0.15 mg/L. Five additional samples were gathered in 2016, none exceeded the standard. There were no chlorophyll a or BOD samples collected on this reach. DO grab sample data ranged from 7.59 mg/L to 12.68 mg/L indicating potential for elevated DO flux within the reach. No continuous DO monitoring was conducted thus daily DO flux could not be calculated. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.8 – 8.27 in the reach.

The macroinvertebrate community appears to be showing some stress in the eutrophication metrics; however, the response was less pronounced at the 2013 visit as compared to the 2014 visit (see table below). Both visits had an absence of intolerant taxa and an abundance of tolerant taxa. There were also lower than average counts of collector-filterer, collector-gatherer and EPT taxa.

Table 127. Macroinvertebrate metrics that respond to eutrophication stress in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
91MN097 (2013)	**29.00**	**4.00**	**10.00**	**9.00**	**0.00**	**96.55**
91MN097 (2014)	**40.00**	**6.00**	**14.00**	**12.00**	**0.00**	**87.50**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

There appears to be a somewhat mixed response to eutrophication stress metrics among the fish communities within the reach (see table below). However, the utility of the fish data is limited due to limited diversity and quantity of individuals observed during sampling. All visits where fish were captured produced an abundance of tolerant taxa and an absence of both intolerant and sensitive taxa. Numbers of simple lithophilic spawners appear to be increasing over time at 91MN097, but all fall below the average for the southern headwaters class. Above average quantities of darters were identified at the 2013 visit at 91MN097 and above average quantities of simple lithophilic spawners were identified at the 2013 visit at 13MN154, reflecting some variability in stress over time and location within the reach. A positive relationship exists between eutrophication and omnivorous fish. Omnivore quantities across all visits were below the average for the southern streams class, suggesting the eutrophication is not a primary stressor in the reach for the fish community.

Eutrophication stress metrics in the reach are very general in nature and are not solely good indicators of eutrophication stress as perceived stress could be attributed to other stressors in the reach. While no phosphorous readings were identified above the southern regional eutrophication standard within the reach, the chemical dataset was limited to a handful of samples gathered during biological visits and SID investigations. Additional chemical data collection including response variable data could be useful in ruling out potential eutrophication stress within the reach. Until more information is available eutrophication is an inconclusive stressor in the reach at this time.

Table 128. Fish metrics that respond to eutrophication stress in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN154 (2013)	**0.00**	**0.00**	41.46	12.50	**100.00**	**2.00**	**0.00**
13MN154 (2014)	**0.00**	**0.00**	**0.00**	0.00	**x**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
91MN097 (2014)	**0.00**	**8.89**	**31.11**	6.67	**91.11**	**4.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

The nitrate chemistry dataset within the reach is limited to that collected during biological visits and during SID investigations. During the fish sample, the nitrate concentration at 91MN097 was 5.5 mg/L at both the July 2013 and June 2014 visits. At station 13MN154, the nitrate concentration was 13 mg/L at both the June and July 2013 visits. An additional five samples were collected in 2016 during the months of February, May and June. Nitrate concentrations ranged from 4.8 mg/L on May 24 to 21 mg/L on May 2 and May 31, with an overall average nitrate concentration of 14.22 mg/L. Five readings were above 15 mg/L.

The macroinvertebrates in this reach show potential indication of nitrate stress (see table below). The nitrate index score was 3.78 and 4.04, while the average for Southern Streams RR meeting the impairment threshold is 2.9. This suggests that overall the community present is tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct); this was evident during the June visit but not the July visit. Trichoptera taxa numbers are just below the threshold. Intolerant taxa counts are also below the threshold. The number of nitrate tolerant individuals was only marginally above the threshold in 2014 and 15% above the threshold in 2013, whereas nitrate tolerant taxa counts were below the threshold for the 2013 visit and exceeded the threshold during the 2014 visit. While the percentage of nitrate tolerant individuals was above the threshold for both visits, it was only marginally above the threshold during the 2014 visit.

Fish are not generally good indicators of nitrate stress. In additional due to the limited diversity observed during fish visits nitrate metric data for fish has been omitted from the report, results showed an abundance of tolerant taxa and an absence of sensitive taxa in the reach.

Elevated nitrate concentrations were identified within the reach. While nitrate concentrations appear to vary widely even during spring months when nitrate levels are typically their highest the macroinvertebrate community showed a direct response to nitrate related stress. As such, nitrate stress is a conclusive stressor within the reach at this time.

Table 129. Macroinvertebrate metrics that respond to elevated nitrates in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera **TrichwoHydroPct**	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Date Fish Visit)
91MN097 (2013)	**29.00**	**4.00**	**10.00**	9.00	**0.00**	**96.55**	**4.00**	7.19	**4.04**	**0.00**	17.00	**85.60**	5.50 (7/22/2013)
91MN097 (2014)	**40.00**	6.00	14.00	9.00	**0.00**	**87.50**	**4.00**	**2.56**	**3.78**	**0.00**	**21.00**	**70.80**	5.50 (6/11/2014)
13MN154 (2013)													13.00 (6/18/2013)
13MN154 (2013)													13.00 (7/24/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	*4.30*	*5.50*	*2.90*	*2.40*	*18.80*	*69.80*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Four TSS samples were collected on two unique biological stations in 2013 and 2014, no values exceeded the southern regional TSS standard of 65 mg/L. No TSS monitoring occurred on the reach prior to biological sampling events in 2013. Two of five TSS samples collected in 2015 and 2016 as part of SID investigations exceeded regional TSS standards.

A majority of elevated TSS stress metrics indicated that TSS is likely impacting the macroinvertebrate community within the reach (see table below). The TSS Index Score was above average for the Southern Streams RR Class, suggesting a potential for TSS related stress. There was an absence of TSS intolerant taxa and an abundance of TSS tolerant individuals. There was also an absence plecoptera taxa. Low quantities of plecoptera (stonefly) taxa can be indicative of limited availability of coarse substrate in a reach due to high sedimentation levels.

Table 130. Macroinvertebrate metrics that respond to high TSS stress in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
91MN097 (7/22/2013)	**15.36**	**0.00**	**18.68**	**0.00**	**0.00**	9.00	**57.52**
91MN097 (6/11/2014)	33.01	**0.00**	**17.53**	**0.00**	**0.00**	12.00	**53.53**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Fish metric data for elevated TSS stress is not a good tool for determination of TSS stress and the fish samples produced so few fish (see table below). As such little information can be deciphered from the metrics for station 13MN154 aside that the taxa identified were tolerant. The community at station 91MN097 had no centrarchids taxa, herbivores, intolerant taxa, long-lived taxa, riffle dwelling taxa or simple lithophilic spawners. Low quantities of taxa that rely on coarse substrates (lithophilic spawners, riffle dwellers, benthic insectivores, etc.) can be an indication of high sedimentation and suspended sediments in a reach. In contrast, the TSS Index score is below average for the Southern Streams Class at 91MN097, suggesting that TSS may not be stressing the fish community. The unclear response in the metrics is likely due to the low fish diversity and small sample set observed in the reach.

TSS stress is presently inconclusive in the reach at this time. While the macroinvertebrate community TSS stress metrics suggests TSS is a likely stressor in the reach, elevated TSS concentrations were only identified twice on the reach within a limited dataset. A more robust fish sample would be useful in better understanding potential for stress within the reach. Additional information is needed to characterize the stressor in the reach.

Table 131. Fish metrics that respond to high TSS stress in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

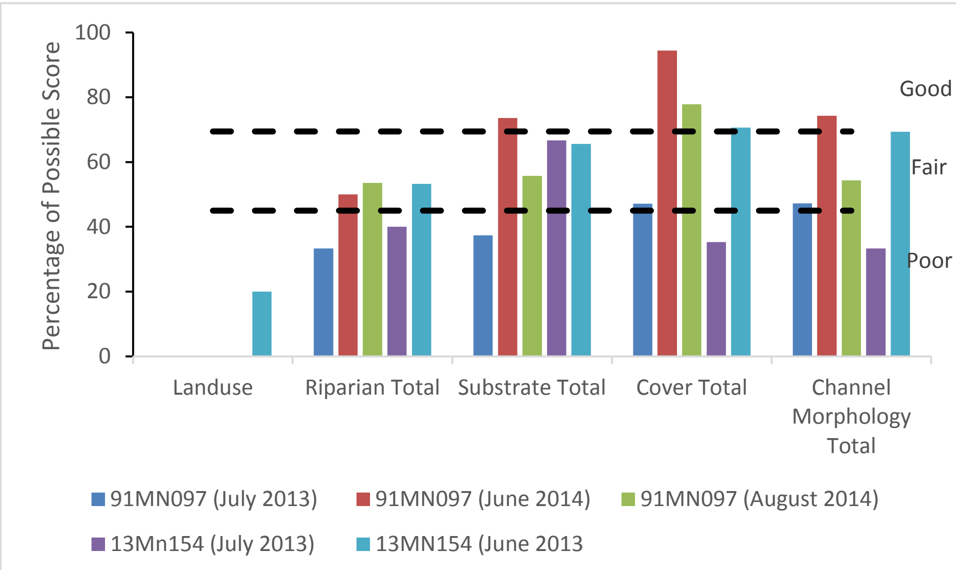
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN154 (2013)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
91MN097 (2014)	**8.89**	**0.00**	**0.00**	**0.00**	**0.00**	**8.90**	**0.00**	**0.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN154 (2013)	**15.92**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to stress	↑	↓	↓	↑	↑
91MN097 (2014)	14.52	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

Five qualitative stream habitat surveys have been conducted on the reach at two biological stations 91MN097 (one survey in 2013 and two in 2014) and 13MN154 (two surveys in 2013) (see graph below). Average MSHA scores were fair at both stations; however, there were discrepancies between visits of 20 to 30 points, suggesting potential inflated high scores or dramatic in year variations of overall habitat quality. Landuse along the reach is dominated by row crop agriculture with scattered livestock operations; predominately swine and one poultry facility large enough to require a non-discharge surface water permit adjacent to the reach. Within the biological stations, riparian buffers were moderate to very narrow, overall riparian buffers appear to be more extensive in the upper half of the reach and more narrow in the lower half. More than half of the reach appears to have been modified by channelization. Stream bank erosion was more prevalent at the lower biological station 91MN097. Lightly to moderately embedded coarse substrates were observed at both stations. While all natural stream channel types were observed at both stations, run was the most abundant. Stream bank stability ranged from low to moderate/high across visits. There is a surface water discharge ¾ of a mile upstream of station 91MN097.

Figure 137. Percentage of MSHA subcategory scores for station 91MN097 and 13MN154 in Judicial Ditch 1.



A majority of degraded habitat stress metrics appear to be negatively impacting the fish community within the reach (see table below). While lithophilic spawners were present in sufficient quantities, other taxa which require more diverse habitat types were lacking. There were low quantities of piscivore, 'darter, sculpin, sucker', pioneering and riffle dwelling taxa as well as a low abundance of benthic insectivores and simple lithophilic spawners. This suggests an absence of coarse substrate habitats, sedimentation and loss of habitat variability within the reach. There is an abundance of tolerant taxa across all visits, which can be a reflection of multiple stressors.

Table 132. Fish metrics that respond to degraded habitat conditions in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SlithopPct
13MN154 (2013)	**100.00**	**0.00**	87.50	**0.00**	0.00	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*70.64*
91MN097 (2014)	**91.11**	**0.00**	66.67	**8.89**	**68.89**	**0.00**	**8.89**	**31.11**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a generally negative response to degraded habitat metrics within the macroinvertebrate community (see table below). Some consistencies were seen between the two visits; there were above average quantities of burrower and legless taxa and below average numbers of sprawler and clinger taxa. Elevated quantities of burrower and legless taxa are generally seen when sedimentation is abundant in a reach and diverse habitat availability is limited. Low quantities of clinger and sprawler taxa indicate limited availability of coarse substrates and woody debris within the reach. Above average numbers of climber taxa were identified and may be related to a prevalence of overhanging vegetation within the reach.

Preponderance of data indicates that both fish and macroinvertebrates are stressed by degraded habitat conditions observed during MSHA surveys in the reach.

Table 133. Macroinvertebrate metrics that respond to degraded habitat conditions in Judicial Ditch 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
91MN097 (2013)	**17.97**	41.18	**25.82**	44.12	**52.94**	**5.23**
91MN097 (2014)	**8.65**	26.92	**45.51**	**41.03**	**48.40**	**9.94**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 138. Biological station 13MN154 (July 24, 2013) sediment deposition.

Figure 139. Biological station 91MN097 (June 11, 2014) stream bank erosion (left); (May 2, 2016) stream bank erosion (right).

Altered hydrology/Longitudinal connectivity

There are two lock and dam control structures downstream of biological station 13MN154. There is also a perched culvert approximately 5 miles downstream of the reach on WID -581 (upstream of biological station 13MN110). Only two fish taxa were identified upstream of known barriers in the reach, while 12 additional species were observed downstream of the structure. One migratory fish species was observed upstream of the barriers, black bullhead. Four migratory fish species were observed downstream of the barrier but not upstream, blackside darter, central stoneroller, walleye and white sucker. The wetland downstream of 13MN154 may also be limiting fish passage by providing uninhabitable conditions for would be migrants. There were no DNR mussel surveys conducted on the reach (see table below).

These barriers are likely limiting fish migration along the reach and likely explain the dramatic difference in species composition between the upstream and downstream station within the reach. Drastic reduction in fish species above the structure within the reach suggest that longitudinal connectivity is limiting the fish communities in the reach at this time.

Table 134. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory fish species. Fish taxa in blue are known lake species.

Field Number	13MN124	13MN154	Structures	wetland	91MN097	03MN061	Perched Culvert	13MN110
WID	-561	-579			-579	-580		-581
Fish Taxa								
bigmouth shiner					x			
black bullhead		x			x	x		
blacknose dace					x			
blackside darter					x			x
bluntnose minnow					x			x
brook stickleback					x			
central stoneroller					x			x
common shiner					x			
creek chub	X	x			x	x		x
fathead minnow					x			
johnny darter					x	x		x
northern pike						x		x
walleye					x			
white sucker					x	x		x
yellow bullhead					x			

The Altered Watercourses GIS layer for Minnesota streams indicates that the 10.19 mile long reach of Judicial Ditch 1 is 80% modified and 20% natural. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed at the biological stations.

Low quantities of riffle and long-lived taxa were observed during fish sampling across all stations on Judicial Ditch 1, which can be an indication of altered hydrologic stress. Presence of lake taxa within a reach can also be an indication of low flow conditions and altered hydrology, both black bullhead and yellow bullhead, common lake taxa, were identified on the reach. Lake taxa thrive in lentic conditions, which can occur under low flow conditions caused by altered hydrology (see table below).

Table 135. Fish metrics that respond to altered hydrology stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN154 (2013)	**100.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
91MN097 (2014)	**91.11**	**0.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to stress	↑	↓	↓

Low flow was documented in 2012 at biological station 13MN154 (see photographs below) but not at station 91MN097 in fall of 2012. In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow conditions were also identified on the reach in 2013 at biological station 13MN154, when macroinvertebrate crews attempted to sample the station in August they were unable to due to insufficient flow conditions. Baseflow appears to be a continuous problem in the reach and is having negative impacts on its biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is stressing biological communities in the reach, especially in the upper parts of the reach at station 13MN154.

Figure 140. Biological station 13MN154 (September 12, 2012) dry streambed with drain tile pump (left); (July 10, 2014) water damaged field, limited riparian buffer (right).

4.1.3. AUID Summary

Nitrates, degraded habitat conditions, altered hydrology and longitudinal connectivity are stressors within the reach. The macroinvertebrate community responded negatively to nitrate stress. Grab sample nitrogen data suggests that nitrogen levels within the reach are high in the spring months, suggesting that outflow from drain tiles is a likely contributor to elevated conditions observed. This modified (channelized) stream reach has many negative habitat characteristics that are stressing the biological communities. The adjacent agricultural landuse, limited channel development, sparse cover availability, bank erosion and in channel siltation create limited habitat availability that favors tolerant taxa. Conditions observed are likely the result of past channel modifications and increased flows and inputs during storm events by historic wetland drainage and modern tile drainage, as well as the after effects in late summer months of low flow conditions and dry streambeds. High flows tie into elevated chemical concentrations of nitrogen and TSS observed at the site.

Known fish barriers within the reach have created a dramatic difference in species composition between the upstream and downstream biological stations within the reach. Removal or alteration of the fish barriers between station 13MN154 and 91MN097 would likely help improve longitudinal connectivity along the reach and improve taxa diversity.

Dissolved oxygen (DO), eutrophication and TSS are inconclusive stressors in the reach. While there was no chemical evidence to suggest low DO conditions or elevated phosphorous levels exist within the site, the dataset was very small and did not include any continuous sonde deployments or response indicator datasets. Macroinvertebrate data at the downstream station showed potential for low DO stress while there was no dataset at the upstream station. Utility of using fish metric data to determine low DO and stress was limited due to low diversities identified. While metric response to eutrophication was observed, the biology could be responding to other more prolific stressors within the reach and the fish results are limited by low diversity. Additional data collection, including continuous sonde deployment would be useful at better understanding potential for stress within the reach. Limited grab sample data suggests that nitrogen levels within the reach are high in the spring months, suggesting that outflow from drain tiles is a likely contributor to elevated conditions observed. While the macroinvertebrate community responded negatively to nitrate stress, stress metrics were not consistent across sampling visits. A limited dataset also showed elevated TSS readings after spring rainfall events and macroinvertebrate response to TSS related stress; however, the TSS dataset was limited to two elevated readings in a handful of samples. Additional water chemistry data would be useful to gather information to better understand the extent of these potential stressors.

Table 136. Summary of stressor determinations for JD 1 (579).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
JD 1	07020010-579	o	o	●	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. JD 1 -580

This reach (07020010-580) is the continuation of Judicial Ditch 1, starting at upstream reach (07020010-579) just east of CR 99 and flowing 4.3 stream miles to reach 07020010-581 at Co. Hwy. 128. This reach is classified as modified use warmwater 2Bm. This reach is currently impaired for aquatic life for a degraded fish community and is a carryforward fish impairment from a previous assessment.

Figure 141. Google Earth image of Judicial Ditch 1 (-580).

4.1.1. Biological communities

There is only one biological monitoring station on this reach: 03MN061. A single fish visit from July 9, 2003, scored an FIBI of zero, falling below threshold and the lower confidence interval. The low score was a result of low end scoring due to low capture rates. The dominant species were creek chub and white sucker; however, only 15 individuals from five species were captured. Macroinvertebrates were also sampled once in 2003 but were not reassessed as the data was out of the 10 year assessment window and considered expired at the time of assessment (see graph below).

The macroinvertebrate community is also highly degraded. The MIBI score was 11.4, nearly 9 points below the modified use threshold for the Prairie Streams GP class. There was an absence of clinger taxa, collectorer filterer taxa, intolerant taxa and trichoptera (see graph below). Polypedium and Physa (snails) were the most abundant taxa within the sample.

Figure 142. Fish metrics of the Southern Streams Class IBI for station 03MN061, Judicial Ditch 1.

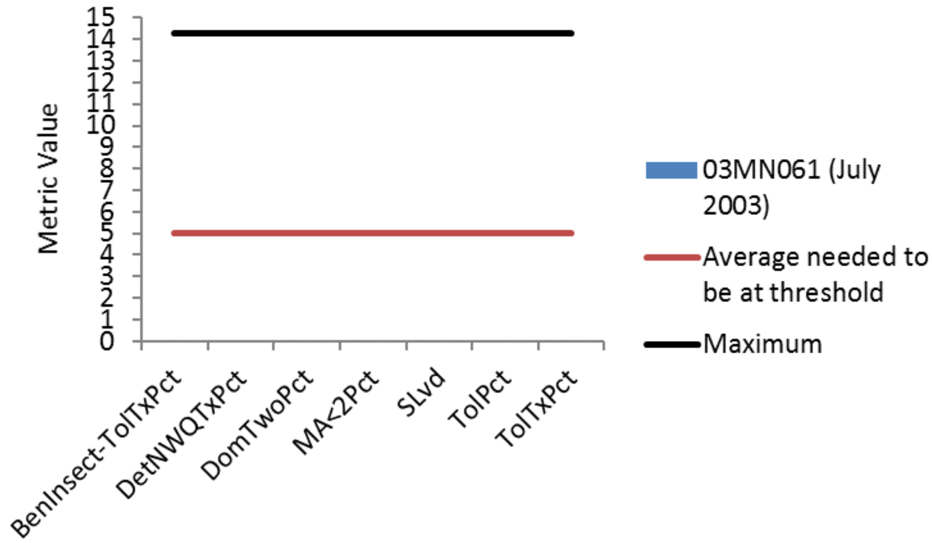
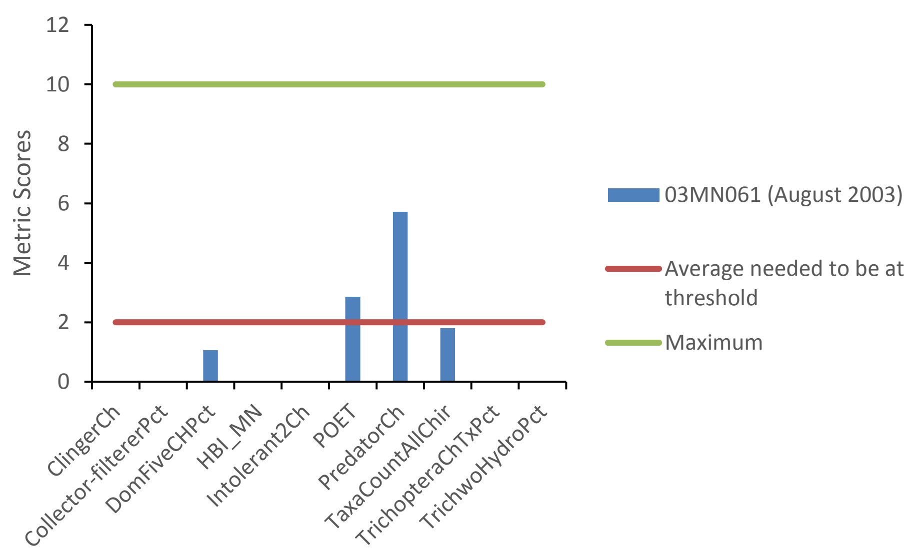


Figure 143. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 03MN061, Judicial Ditch 1.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

One DO sample was collected during the fish visit at biological station 03MN061 in 2003; the value was 9.3 mg/L on July 9, 2003 at 11:14 PM. No samples were collected on the reach prior to biological sampling. Nine additional DO samples were collected during SID investigations in 2014, 2015 and 2016; samples ranged from 5.61 mg/L (10:30am) on August 17, 2015 to 14.83 mg/L on July 10, 2014 at 2:18 PM. Elevated DO readings led to continuous DO monitoring within JD 1 from August 10 - August 17 of 2015 (see graph below). DO readings below the 5 mg/L low DO standard were recorded each of the eight days during the sonde's deployment. In addition, the DO flux standard of 4.5 was exceeded on seven days of continuous sonde deployment (see graph below).

Figure 144. Diurnal DO results for station 03MN061 August 10 -17, 2015.

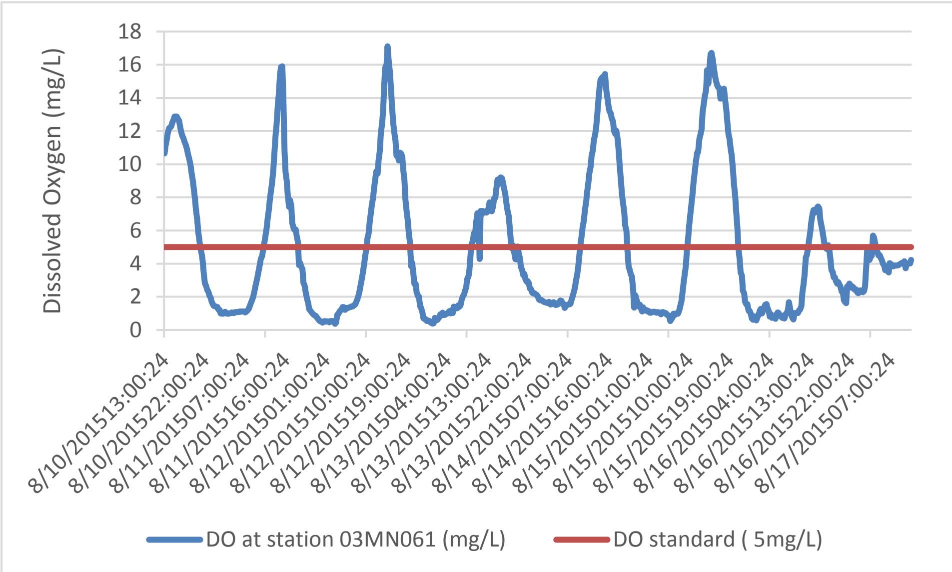
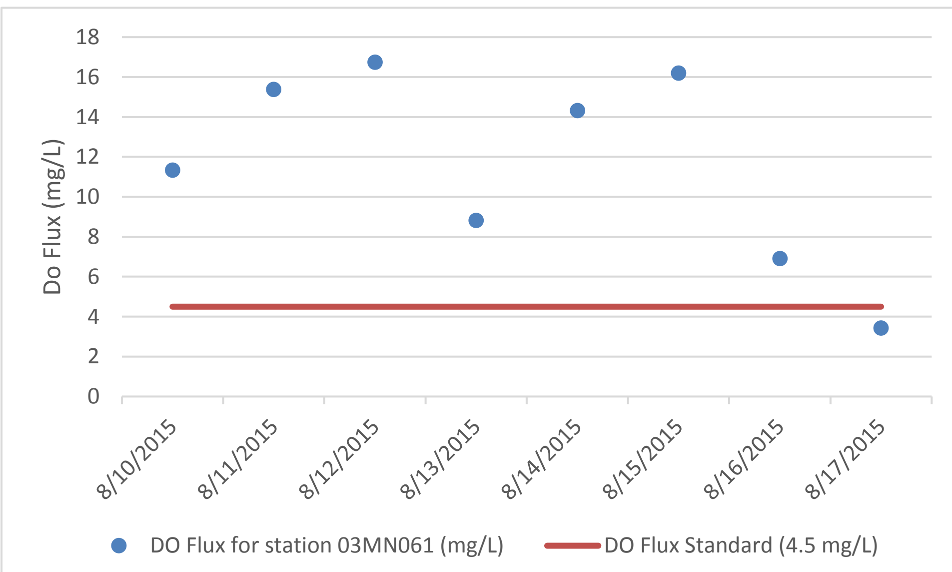


Figure 145. Daily DO Flux results for station 03MN061 August 10 -17, 2015.



The fish community does not a strong response to low DO metrics within the reach (see table below). The low DO Index score is very close to the southern streams average, suggesting that the likelihood that DO is a stressor is small. While there was an abundance of tolerant taxa within the reach and an absence of both generally sensitive and low DO sensitive taxa, quantities of low DO tolerant taxa or individuals were below the southern streams MU class average, suggesting that low DO stress is having limited impact on the fish community. As few fish were captured during the fish sample, metric data may not be as reliable in the determination of stressors; an additional fish sample with a greater number of individuals captured would likely provide more useful metric data to determine stressors in the reach.

Table 137. Fish metrics that respond to low DO stress in JD 1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
03MN061 (7/9/2003)	**0.00**	33.33	**86.67**	7.15	**0.00**	**0.00**	2.00	13.33
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*8.38*	*27.98*	*46.38*	*6.78*	*0.1*	*1.08*	*5.5*	*54.58*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There was an inconsistent response to low DO stress metrics within the macroinvertebrate community (see table below). The Low DO Index score is below the average for the Prairie Streams GP MU class, indicating a likelihood for stress. There was an absence of low DO intolerant taxa; however, the quantity of low DO tolerant taxa was average as was the quantity of low DO tolerant individuals. There was also an above average HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score and low quantities of EPT taxa, signifying potential stress.

Table 138. Macroinvertebrate metrics that respond to low DO stress in JD 1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
03MN061 (2013)	**25.00**	**2.00**	**9.10**	**5.96**	**0.00**	**0.00**	10.00	29.81
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Continuous DO monitoring in 2015 indicates that low DO conditions are problematic within the reach. Macroinvertebrate metric data also signals that low DO stress may be having some negative effects on the community. However, fish metrics are not showing evidence of low DO stress; results could be skewed due to limited sample size at the visit (15 individuals from 5 species). Low DO stress is inconclusive until an additional fish sample can be obtained that can better aid in the understanding of DO stress within the reach. Any improvements to low DO conditions observed would likely be beneficial to aquatic communities even if low DO stress were ruled out in the reach at a later date.

Eutrophication

The phosphorous concentration at the fish visit at 03MN061 was 0.087 mg/L, below the southern regional eutrophication standard of 0.15 mg/L. Six additional samples were collected in 2015 and 2016, only one reading was above the standard. Phosphorous concentrations ranged from 0.051 mg/L to 0.309 mg/L, with an average value of 0.09 mg/L. There were no chlorophyll a samples collected. DO grab samples on the reach ranged from 5.61 mg/L to 14.83 mg/L, indicating potential for elevated DO flux. Follow up continuous DO monitoring at biological monitoring station 03MN061 indicated that the DO flux standard of 4.5 was exceeded on 7 days of continuous sonde deployment in August of 2015. In addition, pictorial evidence (below) suggests that elevated nutrient levels are leading to nuisance algal growth within the reach. There were no BOD samples collected on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.42 – 8.29 in the reach.

Eutrophication metrics for fish signal potential that elevated nutrients are causing stress to the fish community (see table below). No sensitive or intolerant taxa were captured. There was an abundance of tolerant taxa. Darter counts were low and quantities of simple lithophilic spawners were only marginally below the average. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivore, taxa were identified within the reach suggesting potential for eutrophication stress to be influencing the fish community in the reach.

Table 139. Fish metrics that respond to eutrophication stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
03MN061 (7/9/2003)	**0.00**	**6.67**	**33.33**	**40.00**	**86.67**	**5.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*8.38*	*13.57*	*26.17*	*25.10*	*46.38*	*14.52*	*0.86*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

The macroinvertebrate community responded to eutrophication stress in all six metrics (see table below). There were no intolerant taxa captured. There was an abundance of tolerant taxa and low counts of collector-filterer, collector-gatherer and EPT taxa.

Both fish and macroinvertebrate metrics that respond to eutrophication metrics in the reach are very general stressor metrics and could be responding to other stressors in the reach. Eutrophication is presently an inconclusive stressor within the reach due to a limited chemical dataset for elevated phosphorous. DO flux and pictorial evidence indicate potential for stress but additional information should be gathered to solidify the stressor within the reach.

Table 140. Macroinvertebrate metrics that respond to eutrophication stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
03MN061 (2013)	**25.00**	**1.00**	**7.00**	**2.00**	**0.00**	**92.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Figure 146. Biological station 03MN061 (July 10, 2014) filamentous algae.

Nitrate

The water chemistry dataset was limited to collections made during the fish visit and stressor identification studies. A single nitrate sample was taken during the biological investigation at the fish visit on July 9, 2003 with a concentration of 13 mg/L. An additional five samples were collected in 2015 and 2016, during the months of February, May, June and August. Nitrate concentrations ranged from 0.78 mg/L in August of 2015 to 20 mg/L in May of 2016. The overall average nitrate concentration across all visits was 14 mg/L. Three of eight samples were above 15 mg/L.

Fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate. There was an abundance of tolerant fish taxa in the reach and an absence of sensitive and intolerant taxa. The percentage of darters within the reach was below the class average (see table below). As few fish were captured during the fish sample, metric data may not be as reliable in the determination of stressors.

Table 141. Fish metrics that respond to nitrate stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
03MN061 (2003)	**0.00**	**6.67**	**86.67**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*8.38*	*13.57*	*46.38*	*0.86*
Expected response to Nitrate stress	↓	↓	↑	↓

The macroinvertebrates in this reach are not impaired, but do show some response to elevated nitrate levels (see table below). The nitrate index score was 3.94, while the average for Prairie Streams GP MU is 2.9. This suggests that overall the community present is tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). While intolerant taxa and non-hydropsychid individuals are not in abundance here, their absence can also be due to other stressors. Trichoptera taxa were also absent indicating stress. However, the number of nitrate tolerant taxa were low and the percentage of nitrate tolerant individuals was only marginally above the threshold.

Table 142. Macroinvertebrate metrics that respond to nitrate stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
03MN061 (2003)	**25.00**	**1.00**	**7.00**	**2.00**	**0.00**	**92.00**	**0.00**	**0.00**	**3.94**	0.00	9.00	**63.35**	13.00 (7/9/2003)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*	*2.60*	***0.66***	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Nitrate is an inconclusive stressor in the reach. Chemistry data indicates elevated nitrate concentrations exist within the reach; however, fish metric data does not provide firm evidence that nitrates are stressing the community. Efforts to lower nitrate inputs to the reach would likely be beneficial to the macroinvertebrate community which would likely have been impaired had the data not fallen outside of the assessment window.

Suspended sediment

One TSS sample was collected during biological sampling at station 03MN061 in 2003; it was below the southern regional TSS standard of 65 mg/L. No TSS samples were collected on the reach prior to 2003 nor after until SID investigations occurred in 2015 and 2016 producing six TSS samples, only one value exceeded regional TSS standards.

The fish are showing a negative response to a majority of habitat related TSS metrics (see table below). There were lower than average quantities of benthic feeders and perciformes and a complete absence of centrarchids, herbivores, lithophilic and simple lithophilic spawners, riffle dwellers and TSS intolerant taxa. This could imply sedimented conditions within the reach due to limited availability of coarse and riffle habitat. Limited quantities of benthic feeders could indicate a lack of water clarity within the reach as could low quantities of herbivores, as turbid conditions could be limiting plant growth within the reach. In contrast, the TSS Index score was below the average for the southern streams class, suggesting that TSS stress is unlikely; this was corroborated by an absence of TSS tolerant taxa. As few fish were captured during the fish sample, metric data may not be as reliable in the determination of stressors.

Table 143. Fish metrics that respond to high TSS stress in JD1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
03MN061 (2013)	**8.89**	**0.00**	**0.00**	**0.00**	**0.00**	**8.90**	**0.00**	**0.00**	**0.00**
Southern Streams Average MU	*30.08*	*6.17*	*17.98*	*0.86*	*21.25*	*28.69*	*19.54*	*8.38*	*16.15*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
03MN061 (2013)	14.94	0.00	0.00	0.00	0.00
Southern Streams Average MU	*19.64*	*0.00*	*0.00*	*2.70*	*28.19*
Expected response to TSS stress	↑	↓	↓	↑	↑

The macroinvertebrate community within the reach is responding negatively to elevated TSS metrics (see table below). The TSS Index Score was above the average for the Prairie Streams GP Class, suggesting that elevated TSS levels are likely negatively influencing the macroinvertebrates. TSS intolerant taxa were absent from the site while there was a high percentage of TSS tolerant individuals. There were also below average quantities of collector-filterer taxa and plecoptera taxa, indicating potential turbid conditions and sedimentation in the reach.

Table 144. Macroinvertebrate metrics that respond to high TSS stress in JD1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
03MN061 (7/9/2003)	**0.32**	**0.00**	**17.31**	**0.00**	**0.00**	9.00	**67.39**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.02*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

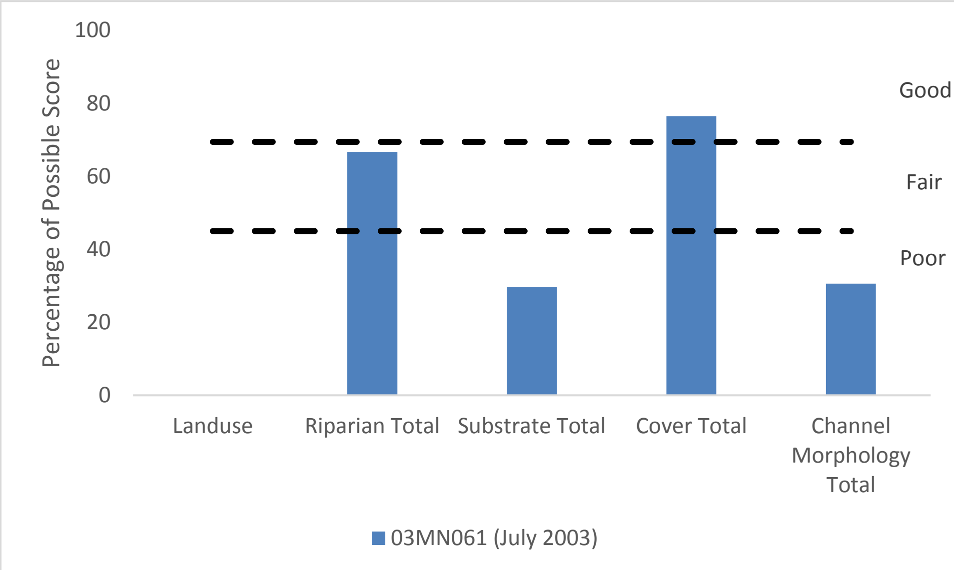
At present, TSS is an inconclusive stressor within the reach. A limited chemical dataset indicates potential for elevated turbidity in the reach but insufficient data is currently available to make a judgement. While fish show limited response to direct TSS metrics, the metric dataset set is limited by a small sample size. The macroinvertebrate community indicates a higher potential for TSS stress within the reach; however, the macroinvertebrate data was not assessed. More chemistry data is needed to confirm that elevated TSS levels exist within the reach. A more robust fish sample could also be more telling of how the fish are responding to stress within the reach.

Habitat

One qualitative stream habitat survey was conducted on biological station 03MN061 in 2003 and was rated poor (42.1) (see graph below). The stream reach is channelized throughout its course. The surrounding landuse along the reach is comprised of row crop agriculture. There are two small cattle operations adjacent to the stream reach upstream of the biological station. Wide grass riparian buffers were identified along the trapezoidal channel within the confines of the biological station; however, along the entire length of the stream reach buffers appear narrow overall. While stream bank erosion was not identified within the reach, fine substrates were dominant within the streambed and what coarse substrates were observed were severely embedded. The stream channel within the biological station was ubiquitous in nature, comprised entirely of run channel type. Habitat types were limited to overhanging vegetation, undercut banks and stream macrophytes, but those present were extensive.

There is a surface water discharge – industrial process wastewater NPDES permit – upstream of biological station 03MN061.

Figure 147. Percentage of MSHA subcategory scores for station 03MN061 in Judicial Ditch 1.



The fish community showed some response to degraded habitat metrics within the reach (see table below). As previously mentioned, few fish were captured during the fish sample; as such, metric data may not be as reliable in the determination of stressors. There was an abundance of tolerant taxa and pioneering species within the reach and low quantities of benthic insectivores, simple lithophilic spawners and 'darter, sculpin, sucker' taxa. High quantities of pioneering taxa in the reach can be an indication of disturbed conditions as pioneering species are often the first taxa to become reestablished where other taxa have been pushed out due to degraded conditions. Low quantities of taxa that rely on coarse substrates, including darters and lithophilic spawners confirm that limited coarse substrate and riffle habitat are available on the reach. In contrast, there were sufficient quantities of piscivores, lithophilic spawners and riffle dwelling species. These numbers are unusual as riffle and coarse sediment habitats appear almost nonexistent within the reach. This provides additional evidence that a 15 individual, five species sample size is skewing the results observed.

Table 145. Fish metrics that respond to degraded habitat conditions in JD1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
03MN061 (7/9/2003)	**86.67**	6.67	80.00	**6.67**	**53.33**	33.33	**6.67**	**33.33**
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*46.38*	*8.02*	*35.59*	*16.45*	*23.58*	*19.54*	*19.05*	*26.17*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to degraded habitat metrics by the macroinvertebrates (see table below). While there were sufficient quantities of climbing taxa and below average counts on burrowers, there were low counts on clingers, sprawlers and EPT taxa and an abundance of legless taxa. This suggests that while there was an abundance of overhanging vegetation on the reach which climbers could adhere to, there was an abundance of taxa that subsist with little in stream habitat structure (coarse substrates, woody debris, etc.), like snails and worms, suggesting that poor habitat conditions are having negative implications on the biological communities.

Table 146. Macroinvertebrate metrics that respond to degraded habitat conditions in JD1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN061 (2013)	5.38	64.87	**3.48**	**3.16**	**66.14**	**19.62**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to stress	↑	↓	↓	↓	↑	↓

Figure 148. Biological station 03MN061 (May 21, 2003) trapezoidal channel (left); (July 10, 2014) sediment and algae (right).

MSHA and biological metrics show implications that degraded habitat conditions are negatively stressing biological communities within the reach.

Altered hydrology/Longitudinal connectivity

There are no known dams within the reach. There is a perched culvert approximately three miles downstream of the reach on WID -581 (upstream of biological station 13MN110), that may be limiting fish passage upstream. A comparison of species richness above and below the fish barrier shows that only 5 fish taxa were captured within the reach, two were migratory fish species: black bullhead and white sucker (see table below). Downstream three additional taxa were collected at station 13MN110 (WID -581), while 10 additional species were captured upstream at -571 91MN097. This suggests a potential barrier between station 91MN097 and 03MN061. No mussel surveys were conducted on the reach.

Evidence suggests barrier(s) are likely limiting migration within the reach; however, additional investigation will be necessary to confirm the stressor. As such, longitudinal connectivity is an inconclusive stressor within the reach at this time.

Table 147. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory species. Fish taxa in blue are known lake species.

Field Number	13MN124	13MN154	Structures/wetland	91MN097	03MN061	Perched Culvert	13MN110
WID	-561	-579		-579	-580		-581
	Judicial Ditch 1	Judicial Ditch 1		Judicial Ditch 1	Judicial Ditch 1		Judicial Ditch 1
Fish Taxa							
bigmouth shiner				x			
black bullhead		x		x	x		
blacknose dace				x			
blackside darter				x			x
bluntnose minnow				x			x
brook stickleback				x			
central stoneroller				x			x
common shiner				x			
creek chub	x	x		x	x		x
fathead minnow				x			
johnny darter				x	x		x
northern pike					x		x
walleye				x			
white sucker				x	x		x
yellow bullhead				x			

The Altered Watercourses GIS layer for Minnesota streams indicates that the 4.37 mile long reach of Judicial Ditch 1 is 100% modified. A majority of its headwaters upstream of AUID -581 has also been channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor. While the trapezoidal channel observed at the biological station does not actively erode above the water surface, it is likely that increased flows from agricultural tile drain inputs are causing channel scouring, undercut banks and greater sediment loads, burying coarse sediments and decreasing the availability of instream habitat within the reach.

An absence of long-lived taxa was observed during fish sampling, which can be an indication of altered hydrologic stress. However, there were sufficient quantities of riffle dwelling taxa, low quantities of riffle dwelling taxa can also be indications of altered hydrological stress (see table below). Fish metric data utility is limited within the reach due to the small sample size of fish captured (15 individuals, 5 taxa). One lake taxa, black bullhead was identified within the reach. Presence of lake taxa within a reach can be an indication that low flow conditions persist within a reach as lake species do not require lotic conditions.

Table 148. Fish metrics that respond to altered hydrology stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
03MN061 (7/9/2003)	**86.67**	**0.00**	33.33
Statewide average for Class 2 Southern Streams stations that are meeting the Modified Use Threshold (35.0)	*46.38*	*21.25*	*19.54*
Expected response to Altered Hydrology stress	↑	↓	↓

There were no photographs taken on the reach in the fall of 2012; as such, there is no photographic evidence of flow conditions on the reach during times of low flow. However, evidence of a dry stream channel was observed at the next downstream WID -581 at biological station 13MN110 in September of 2012 (see photographs). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem within Judicial Ditch 1 is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Evidence that the reach was cut off from downstream reaches due to low flow conditions indicates that altered hydrology is stressing the reach at this time.

Figure 149. Biological station 03MN061 (July 10, 2014) illegal ditch cleanout (upper left and right); drain tile (lower left).

4.1.3. AUID Summary

Habitat and altered hydrology are stressors within the reach. The biology in the reach is held to modified use standards because of limited habitat quality identified within the reach. The MSHA score at the site was poor; there was ubiquitous channel structure (run) and domination of fine sediments (sand and silt) within the reach. Available cover was limited to instream macrophytes, overhanging vegetation and undercut banks. Reduced habitat conditions can be linked to landuse modifications within the watershed, including channel straightening and drain tiling, which have direct impacts on stream hydrology, increasing flows, eroding stream banks and increasing the sediment supply to the stream, limiting available instream habitat. Increased flows during times of peak flow can reduce baseflow within a reach in later times in the year when precipitation inputs decrease causing stream beds to dry as was observed in the next downstream reach. This implies that this reach also likely went dry or at the very least was intermittent in the fall of 2012 and had negative implications to the reach's biological communities.

Low DO, eutrophication, nitrates, suspended sediment and longitudinal connectivity are inconclusive stressors in the reach. Continuous sonde measurements showed DO levels falling below the standard during every day of continuous sonde deployment in 2015; this was confirmed by a response to low DO stress metric information observed in the macroinvertebrate community. However, fish metric data did not respond to low DO stress, which may be attributed to the low sample size or other stressors. There was a limited amount of water chemistry data available within the reach; as such, while exceedances of standards occurred for P, N and TSS, there was a limited chemical dataset to draw from. Elevated DO flux concentrations in the reach, in conjunction with a response in the biological stress metrics and photographic evidence of nuisance algae suggest a potential for eutrophication to be a concern within the reach. Additional phosphorous and response variable sampling in mid to late summer would be useful in better characterizing extent of potential stress. Elevated nitrogen levels were observed during the spring months during stressor identification investigations, suggesting that the surrounding agricultural rich landscape is a likely contributor to the stressor during peak drain tile runoff during spring storm events. Macroinvertebrate metric data suggested that there was some negative response to nitrate stress. Additional chemistry collection could bolster the limited dataset and help better define the potential stressor. While there was only a single elevated TSS reading, macroinvertebrate metric data suggests that elevated suspended sediment levels are having negative impacts on the biota in the reach. Additional TSS sampling would be useful to better understand the potential stressor. In addition, another fish sample would be useful to obtain more reliable metric data for deciphering stressors for this impairment. It is suspected that barriers within the reach are likely having negative impacts on fish movement within the reach and are limiting fish communities. Additional investigation of culverts between station 91MN097 and 03MN061 is needed to confirm that a barrier exists between the two stations as species composition is drastically different between the two stations.

Table 149. Summary of stressor determinations for JD 1 (580).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
JD 1	07020010-580	o	o	o	o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

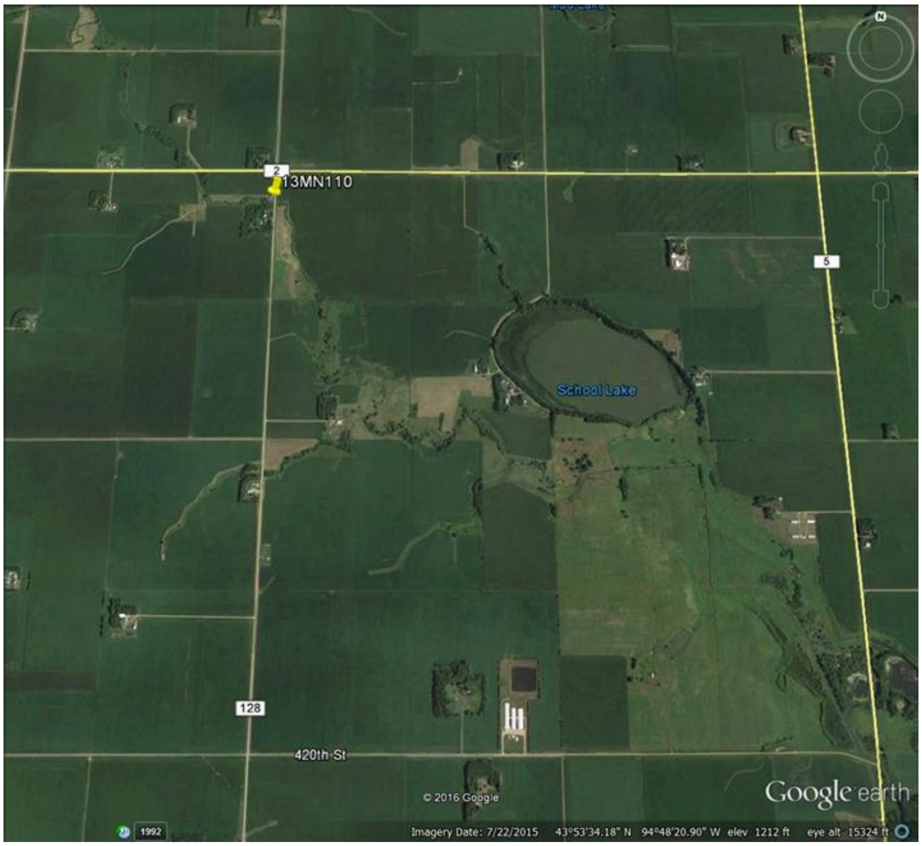
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. JD 1 -581

Reach (07020010-581) is the culmination of Judicial Ditch 1, starting at the outflow of reach (07020010-580) at Co. Hwy 128 and flowing southeast 7.8 river miles before emptying to Irish Lake. This reach is classified as general use warmwater 2B. The reach is currently impaired for aquatic life for lacking fish community (2015) and for aquatic recreation for high levels of *E. coli* bacteria (2015).

This reach receives the outflow of School Lake.

Figure 150. Google Earth image of Judicial Ditch 1 (-581).



4.1.1. Biological communities

There is one biological station on this reach 13MN110. Fish were sampled once in 2013, on July 23 resulting in and FIBI score of 38 below threshold (50) and lower confidence interval. The collection was dominated by two species, creek chub and white sucker; a total of eight species were captured. The FIBI scored below the average threshold needed to meet standards in four metrics: tolerant percent, Dominant Two Percent, percent of individuals that take more than two years to mature and tolerant taxa percent (see graph below).

There was also one macroinvertebrate sampled collected in 2013 which had an MIBI score of 42.1 above the threshold of 37 and within upper confidence limits. Plecoptera taxa were absent within the macroinvertebrate sample. Predator and trichoptera quantities were low (see graph below). Top three taxa collected included: Hyalella, Polypedilum and Physa.

Figure 151. Fish metrics of the Southern Streams Class IBI for station 13MN110, Judicial Ditch 1.

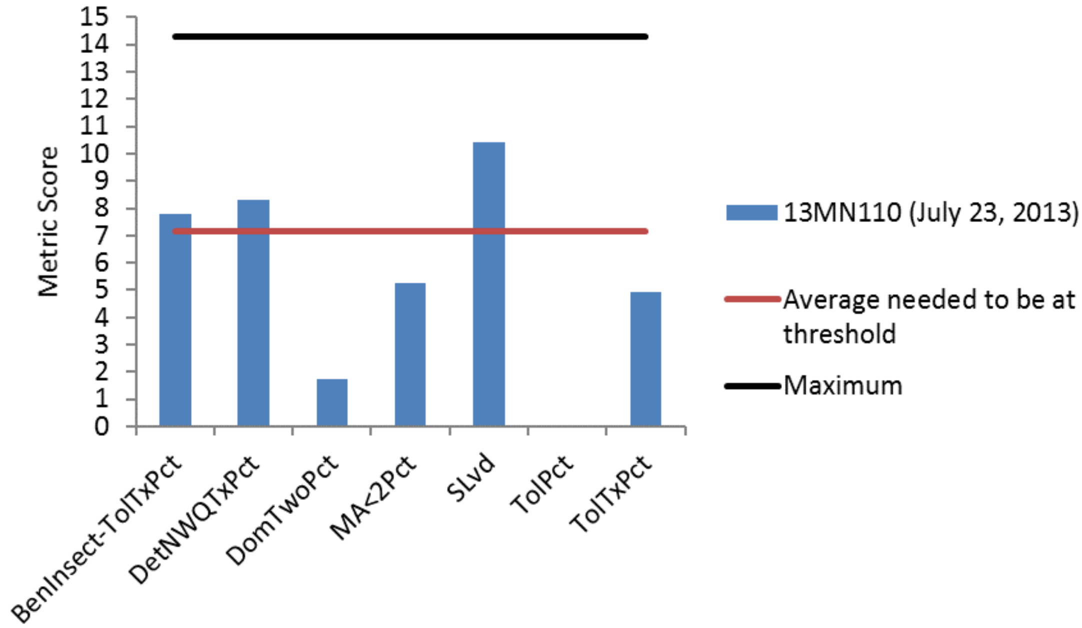
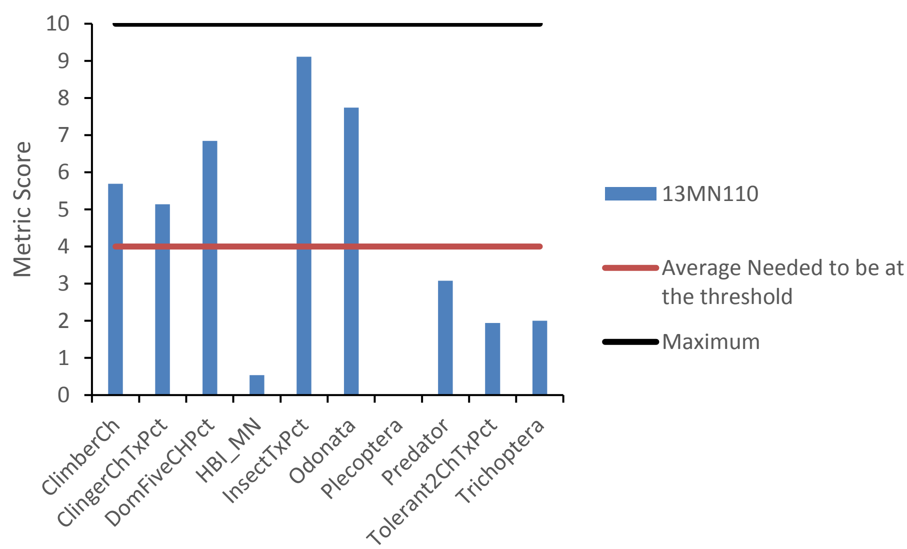


Figure 152. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 13MN110, Judicial Ditch 1.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Three DO measurements were collected during biological sampling events in 2013 and 2014, values ranged from 5.37 mg/L at 9:15 am on July 23, 2013 to 10.72 mg/L at 5:39 PM on August 14, 2013. Eighteen additional DO samples were collected on the reach from 2013 – 2016, values ranged from 5.92 mg/L at 10:40am on 8/6/2013 to 12.55 mg/L at 5:00pm on 2/22/2016. A continuous sonde was deployed within the reach at 13MN110 from August 10 – August 17 in 2015 (see graph below). DO readings fell below the standard during every diurnal cycle during deployment. The DO flux standard of 4.5 was exceeded seven of eight days during deployment, suggesting potential for eutrophication stress as well (see graph below).

Figure 153. Diurnal DO results for station 13MN110 August 10 -17, 2015.

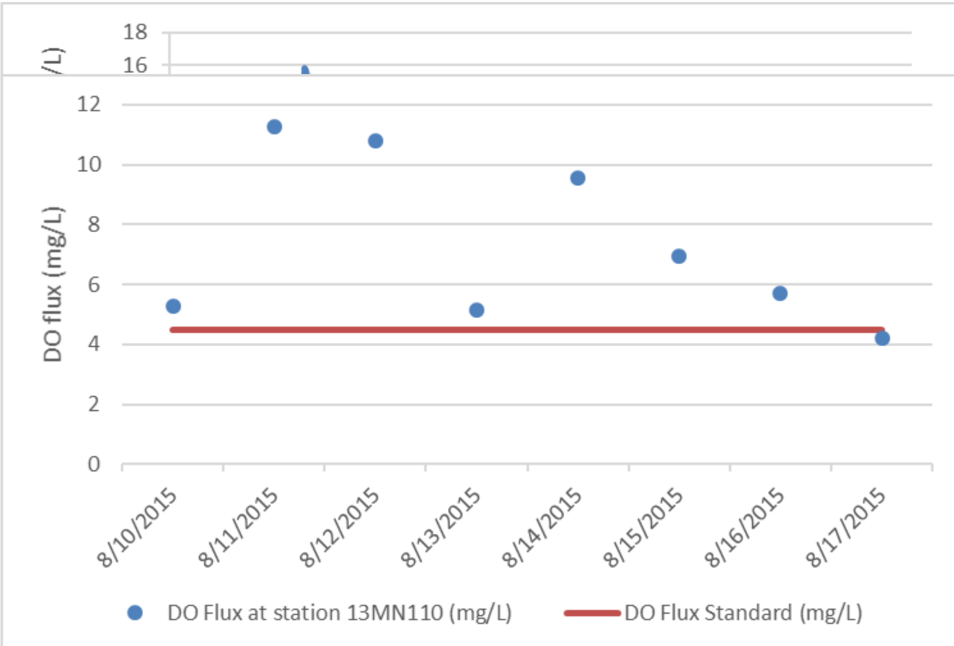


Figure 154. Daily DO Flux results for station 13MN110 August 10 -17, 2015.

There was a mixed response to low DO stress metrics within the fish community (see table below). The DO Index score was above average for the Southern Streams Class, indicating that low DO is not a likely stressor within the reach. While there was an abundance of tolerant taxa within the reach and a lack of sensitive taxa, this could be explained by other stressors. There was also low quantities of DO tolerant taxa suggesting that low DO is not a likely stressor at this time.

Table 150. Fish metrics that respond to low DO stress in JD1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN110 (2013)	**0.00**	29.89	**79.98**	7.23	**0.00**	**0.00**	1.00	2.23
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrate community is not impaired, sometimes looking at metric results from multiple indicators can provide additional insight to stressors within a reach. The macroinvertebrate community responded negatively to low DO metrics at station 13MN110 (see table below). The Low DO Index score was slightly below average for the Southern Streams RR Class, suggesting potential for low DO to stress the macroinvertebrates. There was a lower than average abundance of low DO intolerant taxa and below average quantities of low DO intolerant taxa and individuals. However, quantities of generally tolerant taxa were well above average.

Table 151. Macroinvertebrate metrics that respond to low DO stress in JD1 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN110 (2013)	**39.00**	11.00	**8.20**	**6.84**	**6.00**	**9.69**	**7.00**	**25.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*11.00*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Continuous sonde data shows that low DO conditions exist within the reach. However, fish metric data does not suggest low DO conditions are stressing the community. The macroinvertebrate community, while not impaired, is showing some negative influence to low DO conditions. Efforts to bring DO levels into attainment would be beneficial to prevent a future impairment in the macroinvertebrate community, as the MIBI score fell within upper confidence limits. As such, low DO is an inconclusive stressor in the reach at this time.

Eutrophication

The phosphorous reading taken during the fish sample was 0.03 mg/L, which was less than the southern regional eutrophication standard of 0.15 mg/L. Nine additional phosphorous samples were collected in 2013 as part of intensive watershed monitoring efforts from May thru September, only one sample was above the standard, average concentrations were 0.075 mg/L. An additional eight phosphorous samples were collected in 2015 and 2016, three were above the standard. Phosphorous concentrations ranged from 0.049 mg/L to 0.219 mg/L, with an average concentration of 0.12 mg/L. One chlorophyll a concentration was collected in 2015, in conjunction with the retrieval of the continuous sonde with a value of 21.6 ug/L, below the regional 35 ug/L standard. DO grab samples collected on the reach range from 5.61 mg/L to 12.55 mg/L indicating potential for elevated DO flux readings on the reach. 2015 continuous sonde data showed that the DO flux standard of 4.5 was exceeded seven of eight days during deployment, suggesting potential for eutrophication stress. There were no BOD samples collected on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.71 – 10.02 in the reach.

There was a mixed response to eutrophication at the fish visit (see table below). There was a complete absence of intolerant and sensitive taxa and a high percentage of tolerant taxa. In contrast, quantities of simple lithophilic spawners were only marginally below the threshold while the darter percent exceeded the threshold. A positive relationship exists between eutrophication and omnivorous fish. An above average quantity of omnivore taxa were identified within the reach suggesting that eutrophication is a probable stressor in the reach.

Table 152. Fish metrics that respond to eutrophication stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN110 (7/23/2013)	**0.00**	17.88	**33.52**	**29.89**	**79.89**	41.00	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While the macroinvertebrate community is not impaired, looking at stress metrics from both indicators can be useful in better understanding potential stressors within a reach. The macroinvertebrate community also shows a response to eutrophication stress (see table below). All metrics were below the averages needed to meet their respective thresholds; however, quantities of collector-filterer taxa, collector-gatherer taxa and EPT taxa were only marginally below the statewide average. There was an absence of intolerant taxa and an abundance of tolerant taxa.

Table 153. Macroinvertebrate metrics that respond to eutrophication stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN110 (2013)	**39.00**	**5.00**	**13.00**	**11.00**	**0.00**	**84.62**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Chemical evidence suggests there is potential for elevated P concentrations in the reach but only four exceedances were identified during sampling. While both fish and macroinvertebrate data respond to eutrophication stress metrics, metrics used are very general in nature and could be indicators of other stressors within the reach. However, an abundance of omnivore taxa in the fish community suggests that eutrophication stress is apparent. Response variable data also suggests potential for stress from high DO flux readings and high pH levels. Additional data collection should include observational evidence of algae and macrophyte growth in the reach. At this time, eutrophication is an inconclusive stressor within the reach.

Nitrate

There was one nitrate sample collected in conjunction with a fish sample at 13MN110, the concentrations of 2.1 mg/L was collected on July 23, 2013. An additional 19 samples were collected during 2013, 2015 and 2016 from the months of May through September with a single sample collected in February. Nitrate concentrations ranged from 0.19 mg/L in August of 2015 to 20.9 mg/L in June of 2013, with an overall average concentration of 10 mg/L. Seven concentrations were above 15 mg/L and occurred in May of 2016 and June and July of 2013.

Fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate. The macroinvertebrates in this reach are not impaired, but do show some response to nitrate stress within the reach (see table below). The nitrate index score was 3.32, while the average for Southern Streams meeting impairment threshold is 2.9. This suggests that overall the community present is somewhat tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). While intolerant taxa and non-hydropsychid individuals are not in abundance here, their absence can also be due to another stressor present. The number of Trichoptera taxa were just below average while the nitrate tolerant taxa count was just above average, and the percent of nitrate tolerant individuals was below the average indicated less macroinvertebrate response to nitrate stress.

Nitrate is an inconclusive stressor within the reach. Efforts to reduce nitrogen in the reach would likely benefit macroinvertebrate communities and reduce the likelihood of the community to fall below impairment thresholds at a later date.

Table 154. Macroinvertebrate metrics that respond to nitrate stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN110 (7/23/2013)	**39.00**	**5.00**	13.00	8.00	**0.00**	**84.62**	**4.00**	**4.73**	**3.32**	**0.00**	**20.00**	55.3.	2.10 (7/23/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

One TSS sample was collected at station 13MN110 during the fish visit in 2013 and did not exceed the southern regional TSS standard of 65 mg/L. Ten additional TSS samples were collected in 2013, none of these sampled exceeded TSS standards. Three of eight additional samples collected on the reach for SID investigations in 2015 and 2016 were above TSS standards.

There was a mixed response to TSS metrics in the fish community (see table below). The TSS Index score was below the average for the Southern Streams Class, indicating a low potential for TSS stress to affect the fish community. There were low quantities of centrarchids, intolerant taxa, long-lived taxa, perciforms and sensitive species; while there was an abundance of benthic feeders, herbivores, riffle dwellers and simple lithophilic spawners, contrary to what one might expect. An abundance of benthic feeders and herbivores suggest good water clarity conditions persist within the reach, allowing sufficient visibility for taxa to gather food and sufficient light for plant photosynthesis. Abundance lithophilic spawners and riffle dwelling taxa suggest that sedimentation is not prevalent within the reach either. There were also no TSS tolerant taxa.

Table 155. Fish metrics that respond to high TSS stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN110 (2013)	48.04	**0.00**	31.01	**0.00**	**2.23**	**17.88**	31.01	**0.00**	29.89
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN110 (2013)	14.33	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

The macroinvertebrate community at station 13MN110 responded negatively to all elevated TSS stress metrics (see table below). The TSS Index Score was above the average for the Southern Streams RR Class, suggesting that elevated TSS may be having a negative impact on the macroinvertebrates. There were low quantities of TSS intolerant taxa and abundance of TSS tolerant taxa and individuals. In addition, there were low quantities of collector-filterer and plecoptera taxa.

Table 156. Macroinvertebrate metrics that respond to high TSS stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

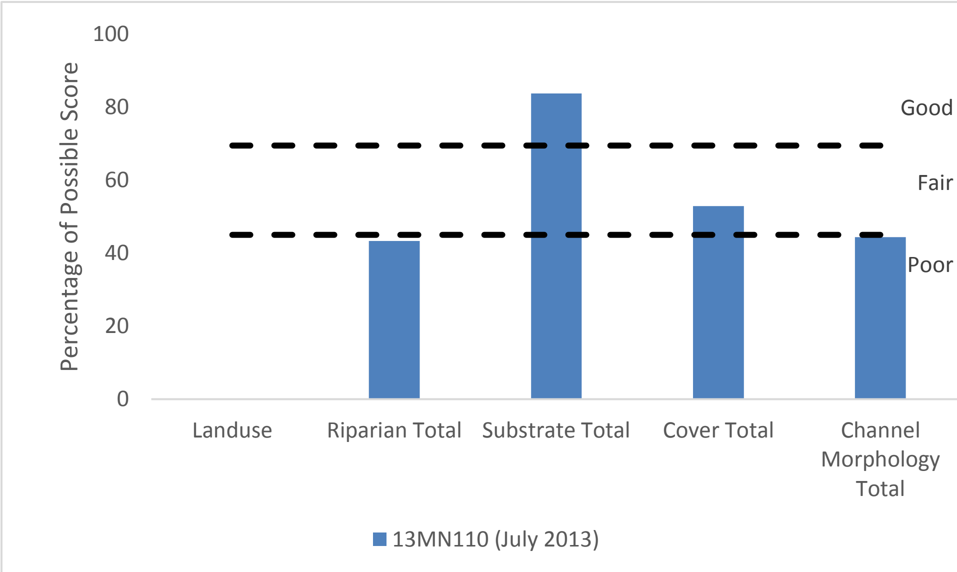
Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN110 (7/23/2013)	**17.03**	**0.00**	**18.54**	**1.00**	**0.63**	**15.00**	**53.44**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The metric evidence suggests that TSS is an inconclusive stressor to the fish community at this time and may be having negative impacts to the macroinvertebrate community within the reach. Elevated TSS readings were identified during high spring flow sampling during SID investigations but was not otherwise identified within the reach. Additional biological data would be useful in better understanding the potential elevated levels of TSS may have in stressing biological communities in the reach.

Habitat

There was a single qualitative habitat assessment on the reach in 2013 at biological station 13MN110, with a fair rating (54.1) (see graph below). Row crop agriculture is the predominate landuse along the reach. There are a handful of small livestock operations adjacent to the stream along the reach (swine and avian). A majority of the reach is channelized. Riparian buffer extent varies along the reach, with narrower buffers observed in the upper portions of the reach larger buffers were observed moving towards Irish Lake. While run channel type is abundant within the biological reach, similar to upstream stations on different WIDs; overall stream substrates within the station were more diverse and were dominated by coarse substrates as opposed to fine sediment. Present coarse substrates were only lightly embedded. While the stream bed is more stable than upstream stations, stream banks are less stable as moderate to heavy bank erosion was observed. Stream habitat types were also more diverse than upstream stations but were more sparsely found within the biological reach.

Figure 155. Percentage of MSHA subcategory scores for station 13MN110 in Judicial Ditch 1.



The fish community responded negatively to all but one of the degraded habitat metrics (see table below). While there were sufficient lithophilic spawners within the reach, the community was dominated by tolerant species, lacked piscivore taxa and had an abundance of pioneering taxa. Low quantities of piscivore taxa infer that limited habitat is available for predatory species, like deep pools. Pioneering taxa do not rely on diverse habitat availability to thrive. While the following taxa were below the respective average for the Southern Streams Class, they were only marginally below the average: 'darter, sculpin, sucker' taxa, simple lithophilic spawners and benthic insectivores. Marginal results suggest that habitat is not a leading stressor on the reach but is having negative impacts on the overall community.

Table 157. Fish metrics that respond to degraded habitat conditions in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN110 (7/23/2013)	**79.89**	**2.23**	74.02	**17.88**	**63.13**	31.01	**17.88**	**33.52**
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*30.20*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to degraded habitat stress within the macroinvertebrate community (see table below). While there were sufficient quantities of climbing and sprawler taxa and low counts of burrowing taxa. Prevalence of climbing taxa is consistent with an abundance of emergent plants within the reach, while high numbers of sprawlers could be a result of sampling rock and woody debris. There were lower than average counts on clingers and EPT taxa and an abundance of legless taxa. Low counts on clinger taxa may infer that rock/riffle and woody debris habitat are not overly prevalent in the reach.

Table 158. Macroinvertebrate metrics that respond to degraded habitat conditions in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN110 (7/23/2013)	3.16	29.34	**29.65**	**27.544**	**38.80**	23.03
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to stress	↑	↓	↓	↓	↑	↓

Metric data confirms MSHA findings that available habitat in the reach is diverse but sparse in abundance. Improvements to habitat conditions in the reach would benefit both biological indicators. While habitat conditions are better than other sites on JD 1 conditions are still stressing biota in the reach.

Figure 156. Biological station 13MN110 (July 23, 2013).

Altered hydrology/Longitudinal connectivity

There are no known dams within the reach. There is a perched culvert within the reach upstream of biological station 13MN110, that may be limiting fish passage upstream (see photo below). Seven total species were captured at 13MN110; three were migratory taxa: white sucker, blackside darter and central stoneroller (see table below). Eight species were captured upstream of the perched culvert that were not observed at 13MN110, two of which were migratory species. Fourteen species were captured downstream on the South Fork Watonwan River at station 13MN134 that were not seen at station 13MN110. There is a lake and a dam between the two biological stations suggesting that the dam on the South Fork Watonwan may be limiting fish migration into Judicial Ditch 1.There were no mussel surveys conducted by the DNR on Judicial Ditch 1.

Variance in diversity at WIDs above and below -581 in conjunction with the presence of known barriers suggest that longitudinal connectivity is stressing the fish community on the reach at this time.

Table 159. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN124	13MN154	Structures/wetland	91MN097	03MN061	Perched Culvert	13MN110	Lake	DAM	13MN134
WID	-561	-579		-579	-580		-581		SFWatonwan	SFWatonwan
	JD1	JD1		JD1	JD1		JD1			
Fish Taxa										
bigmouth shiner				x						x
black bullhead		x		x	x					x
blacknose dace				x						x
blackside darter				x			x			x
brassy minnow										x
bluntnose minnow				x			x			x
brook stickleback				x						
central stoneroller				x			x			x
channel catfish										x
common carp										x
common shiner				x						
creek chub	x	x		x	x		x			x
fathead minnow				x						x
green sunfish										x
johnny darter				x	x		x			x
northern pike					x		x			x
quillback										x
sand shiner										x
shorthead redhorse										x

Field Number	13MN124	13MN154	Structures/wetland	91MN097	03MN061	Perched Culvert	13MN110	Lake	DAM	13MN134
spotfin shiner										x
tadpole madtom										x
walleye				x						
white sucker				x	x		x			
yellow bullhead				x						

Figure 157. Biological station 13MN110 (July 23, 2013) low head dam, fish barrier.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 7.77 mile long reach of Judicial Ditch 1 is 81% modified and 19% natural. A majority of its headwaters upstream of AUID -581 has also been channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. The DNR conducted a geomorphology survey on this reach of Judicial Ditch 1 near the biological station and identified the reach as a stable, narrow E channel. The reach has a moderate sediment supply with a high erosion potential. JD1 benefits from the maintenance of riparian vegetation for stream stability and has a good recovery potential.

Low quantities of long-lived taxa were observed during fish sampling, which can be an indication of altered hydrologic stress (see table below). However, there were nearly sufficient quantities of riffle dwelling taxa, low quantities of riffle dwelling taxa can also be indications of altered hydrological stress.

Table 160. Fish metrics that respond to altered hydrology stress in JD 1 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN110 (7/23/2013)	**79.89**	**2.23**	**31.01**
Statewide average for Class 2 Southern Streams stations that are meeting the General Use Threshold (50.0)	*44.85*	*13.6*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Station 13MN110 was dry during the fall of 2012 (see photo below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on its biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Extreme low flows in conjunction with agricultural drainage indicate that altered hydrology is a stressor in the reach at this time.

Figure 158. Biological station 13MN110 (September 2012) dry streambed.

4.1.3. AUID Summary

Habitat, altered hydrology and longitudinal connectivity are stressors within the reach. MSHA habitat scores were fair at this reach, but heavy stream bank erosion was noted and instream habitat cover was sparse. Erosion is likely a result of high flows from upstream modified reaches which are heavily drain tiled to quickly drain farm fields during high flow events. Metric data suggested that diversity of instream habitat exists but may be vulnerable within the reach as available habitat was sparse. Stream bank erosion is having negative implications of overall channel stability within the reach. While riffle, run and pool habitat were identified, 80% of channel type in the reach was classified as run, resulting in a poor channel development score. While conditions are improved compared to upstream reaches on Judicial Ditch 1, limitations still suggest that degraded habitat is stressing the biology within the reach. Reduced habitat conditions can be linked to landuse modifications within the watershed, including channel straightening and drain tiling, which have direct impacts on stream hydrology, increasing flows, eroding stream banks and increasing the sediment supply to the stream, limiting available instream habitat. Increased flows during times of peak flow can reduce baseflow within a reach in later times in the year when precipitation inputs decrease causing streambeds to dry up, as was observed on the reach in the fall of 2012. Fish barriers were identified above and below the reach. Fish taxa diversity varied drastically above and downstream of barriers. Four migratory taxa identified above and below the reach were not identified within the reach, implicating that barriers are limiting biological diversity and natural fish migrations.

Low DO, eutrophication, nitrate and TSS are inconclusive stressors within the reach. While low DO conditions were identified within the watershed, there was limited response in the fish community to low DO stress metrics. The macroinvertebrate community did show negative response to low DO stress. Because the MIBI score fell within upper confidence limits measures should be taken to improve DO conditions on the reach to prevent future impairment to the macroinvertebrates. Any efforts to help the macroinvertebrate community would also likely benefit the fish community in the reach. A limited phosphorous data set was available within the reach; however, readings above the standard were identified. Continuous sonde deployment showed DO flux ratings rising above the 4.5 mg/L flux standard 7 days during deployment, suggesting that eutrophication is a potential stressor within the reach. Metric data also suggests that eutrophication is stressing the biological communities. Additional chemistry collected would be useful to bolster evidence for the potential stressor. Elevated nitrogen levels were also identified within the reach. While the dataset was not large, elevated samples were identified during spring months when agricultural tile drainage is at its peak and as such is a likely source for elevated levels observed. While macroinvertebrates are not impaired, they did exhibit some response to nitrate stress metrics, suggesting that any efforts to curb levels could prevent the community from falling below attainment standards. Three of 14 TSS samples collected on the reach indicate elevated TSS levels are present within the reach, a 20% exceedance rate. While the dataset is small, the macroinvertebrate community metric data shows that while the macroinvertebrates are not impaired they indicate a negative response to TSS stress; however, the fish community shows limited response to TSS stress metrics. Additional biological samples could be useful in better understanding how the biological community is responding to elevated levels of TSS in the reach. Any reductions in TSS within the reach would be useful to prevent the macroinvertebrate community IBI from falling below standards in the future.

Table 161. Summary of stressor determinations for JD 1 (581).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
JD 1	07020010-581	o	o	o	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

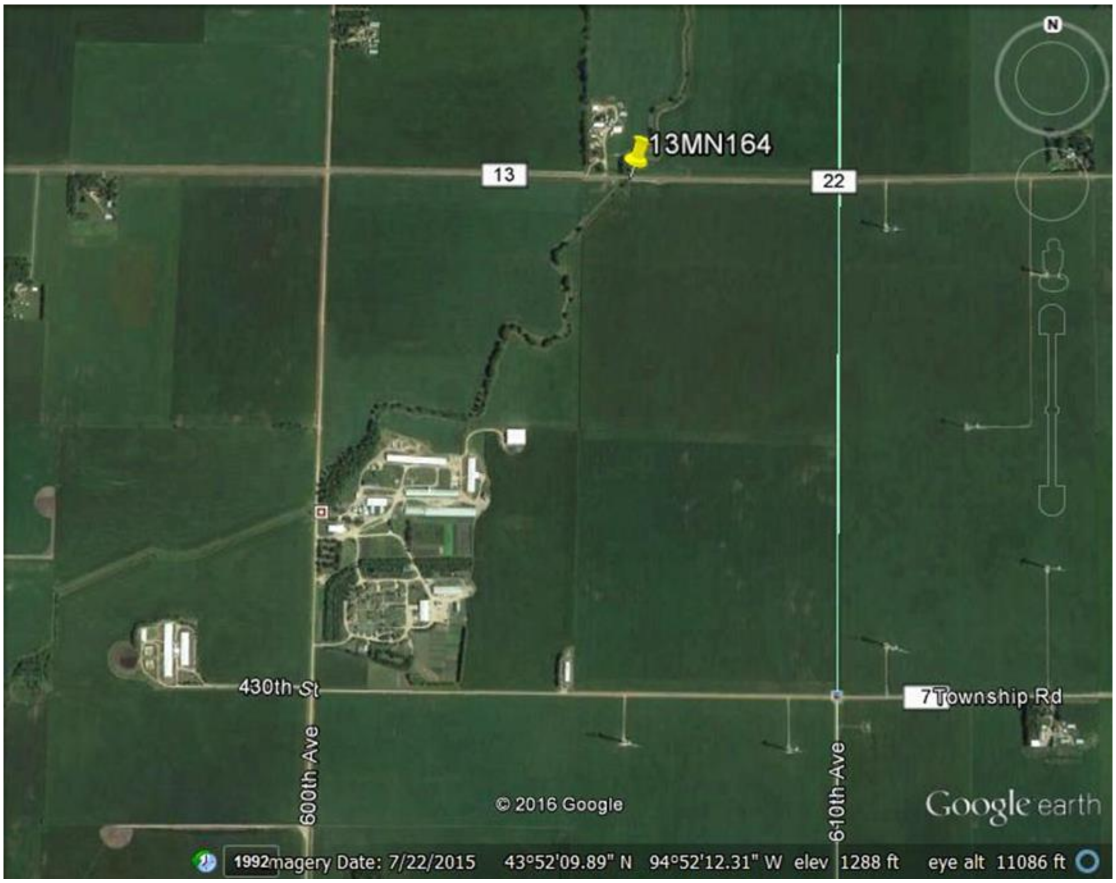
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. South Fork Watonwan River -569

This reach is the upstream most assessed reach of the South Fork Watonwan River (07020010-569). It begins upstream of 590th Ave. and flows northeast 6.6 river miles before transitioning to the next downstream reach of the South Fork Watonwan River (07020010-568) just upstream of Co. Hwy. 22. Classification for this reach is general use warmwater (2B). This reach is impaired for aquatic life for lacking a healthy fish assemblage (2015).

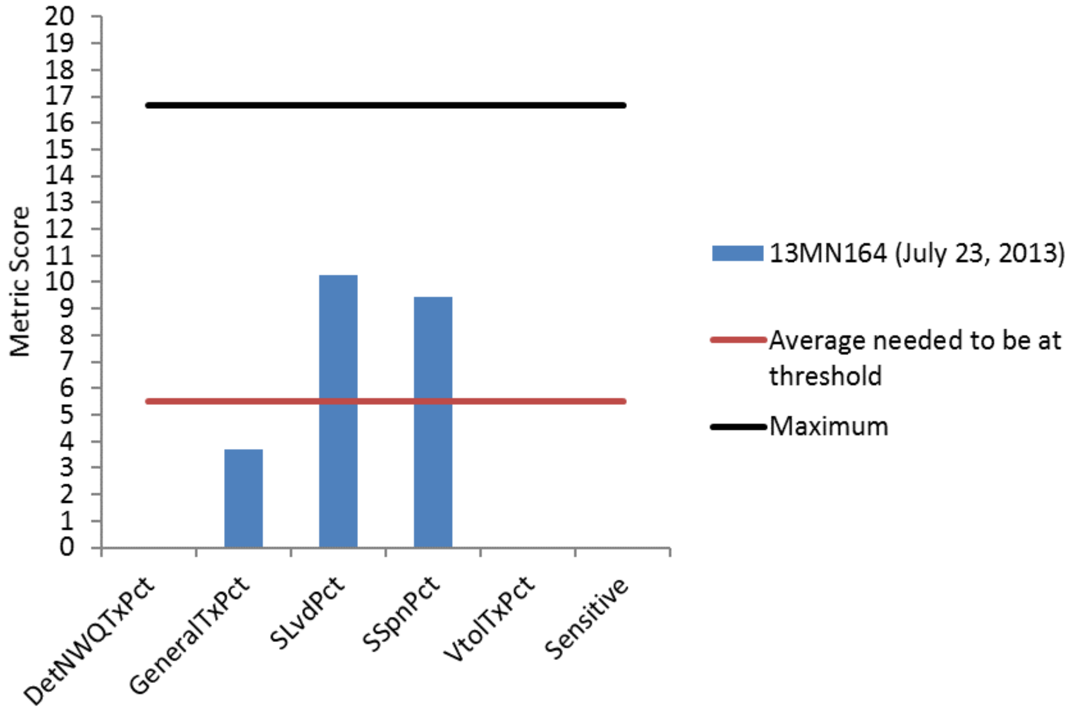
Figure 159. Google Earth image of Unnamed Creek (-569).



4.1.1. Biological communities

There is one biological station on this reach, 13MN164. The station was sampled once for fish in 2013 and was not sampled for macroinvertebrates in 2014 due to insufficient flow and an absence of available habitat for sampling. FIBI scored 23.4, which is below the threshold and lower confidence limits. The two dominant species captured were common carp and bluntnose minnow. All taxa observed were generally tolerant. The community scored a zero for three of the six metrics in this class indicating an absence of sensitive taxa (sensitive) in the reach an overabundance of very tolerant taxa (VtolTxPct), detritivores (DetNWQTxPct) and generalist species (GeneralTxPct). There were sufficient quantities of long-lived taxa, judging by a low quantity of short-lived species (SlvdPct) and serial spawners (SSpnPct) (see graph below).

Figure 160. Fish metrics of the Southern Headwaters Class IBI for station 13MN164, South Fork Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There was one DO measurement collected during the fish visit at station 13MN164 with a value of 9.78 mg/L. No previous DO measurements were collected on the reach prior to biological sampling. Eight additional DO samples were collected during SID investigations in 2015 and 2016. Values ranged from 7.81 mg/L to 11.43 mg/L. All values were above the low DO standard of 5 mg/L. A continuous DO sonde was deployed within the reach from July 15 – July 23 in 2015 (see graph below). The minimum DO value recorded was 6.65 mg/L with a high reading of 11.31 mg/L. No values fell below the low DO standard, but DO flux was reached the standard of 4.5 mg/L during one day of deployment (see graph below). Continuous DO monitoring was repeated in 2016 from August 23 – September 7 (see graph below). Similarly DO concentrations did not fall below the low DO standard; however, DO flux was above the standard for seven consecutive days during the deployment suggesting potential for eutrophication stress (see graph below).

Figure 161. Diurnal DO results for station 13MN164 July 15 - 24, 2015.

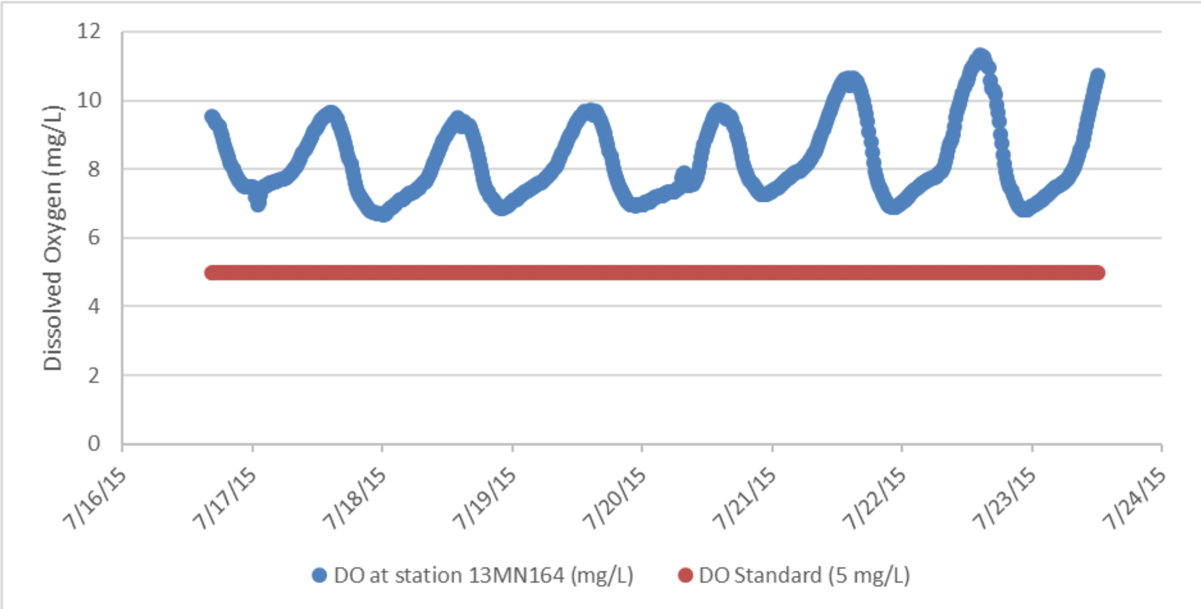


Figure 162. Daily DO Flux results for station 13MN164 July 15 - 24, 2015.

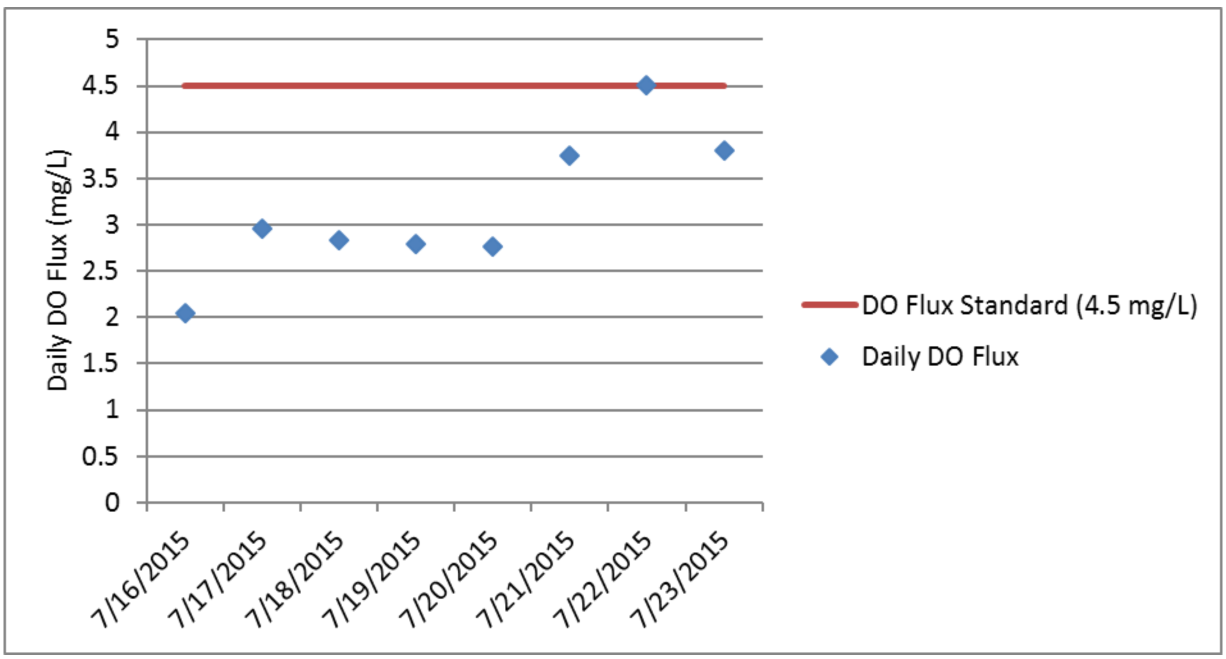


Figure 163. Diurnal DO results for station 13MN164 August 24 –September 7, 2016.

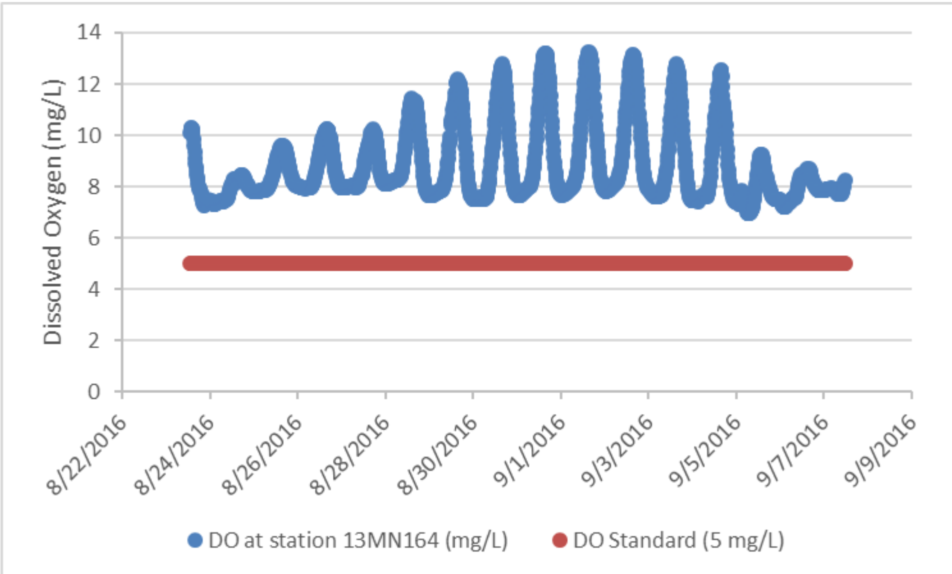
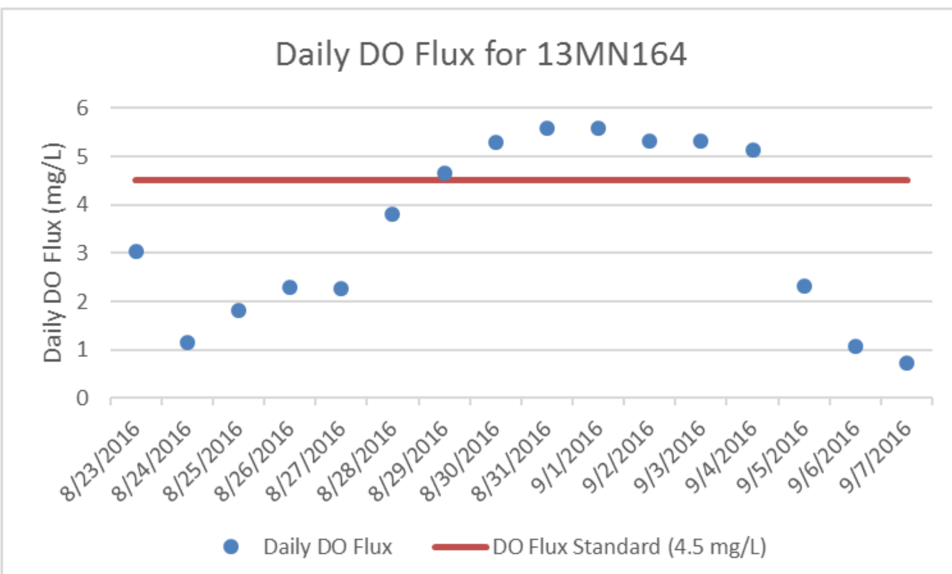


Figure 164. Daily DO Flux results for station 13MN164 August 24 –September 7, 2016.



There was a negative response in the low DO stress metrics within the fish community (see table below). The DO Index score was below the Southern Headwaters Class average, suggesting potential for low DO stress. There was an absence of late maturing taxa, generally sensitive and DO sensitive species, while the entire community was comprised of tolerant species. There was an abundance of low DO tolerant taxa within the reach as well. Low DO is an inconclusive stressor in the reach at this time. It appears as though previous attempts to capture low DO conditions in the reach have been unsuccessful perhaps due to sonde deployments during high water years where low DO conditions are less pronounced. Negative metric response to low DO conditions suggests more attempts should be made to captures suspected low DO conditions within the reach.

Table 162. Fish metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN164 (2013)	**0.00**	**0.00**	**100.00**	**6.56**	**0.00**	**0.00**	3.00	**66.67**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

One phosphorous sample was collected during the fish visit at 13MN164 on July 23, 2013. The value was 0.07 mg/L; the concentration was below the southern region eutrophication standard of 0.15 mg/L. In 2016, 5 additional samples were collected at 13MN164, two of the five samples exceeded the standard. Phosphorous concentrations ranged from 0.065 mg/L to 0.303 mg/L, with an overall average concentration of 0.15 mg/L. There were no chlorophyll a samples collected on this reach or BOD samples. DO grab samples on the reach ranged from 7.18 mg/L to 11.43 mg/L indicating potential for elevated DO flux on the reach. During continuous DO monitoring in 2015 DO flux reached the standard of 4.5 mg/L during one day of deployment. In 2016, DO flux was above the standard for seven consecutive days during the deployment suggesting potential for eutrophication stress. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.68 – 8.35 in the reach.

The fish community showed a negative response to eutrophication stress (see table below). The community lacked sensitive, darter, simple lithophilic spawner and intolerant taxa and was entirely comprised of tolerant taxa. Eutrophication metrics are general in nature and do not necessarily implicate eutrophication stress but could be responding to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivore taxa were identified within the reach, which suggests that eutrophication may be stressing the fish community. Elevated phosphorous levels in conjunction with high DO flux indicate eutrophication as a potential stressor in the reach; however, at present the chemical dataset is small. Additional information to bolster the dataset and obtain additional response variable data would be useful in helping to better define the stressor. As such, eutrophication is an inconclusive stressor in the reach at this time.

Table 163. Fish metrics that respond to eutrophication stress in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN164 (2013)	**0.00**	**0.00**	**0.00**	**61.90**	**100.00**	**6.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

The water chemistry dataset is limited to information collected during the fish visit and during the stressor identification investigations. The nitrogen concentration during fish visit at 13MN164 was 9.2 mg/L on July 23, 2013. Five additional samples were collected in 2016 during the months of February, May and June. Nitrate concentrations ranged from 18 mg/L in late June to 22 mg/L All samples were above 15 mg/L except for the concentration observed during the biological visit.

No macroinvertebrate data is available as insufficient flows inhibited macroinvertebrate sampling. Macroinvertebrates typically show a greater response to elevated nitrate concentrations than fish do. While nitrate related stress metrics indicate that the fish community is responding negatively to elevated nitrate stress with an absence of sensitive, intolerant and darter taxa and exclusively being comprised of tolerant taxa, these metrics are very general stress related metrics and could very easily be responding to other stressors within the reach (see table below).

Attaining a macroinvertebrate sample on the reach would be useful in better understanding potential for nitrate related stress within the reach. Additional information could help diagnose the degree to which nitrate exposure is stressing the biology in the reach. Until additional information is gathered nitrate will remain an inconclusive stressor within the reach.

Table 164. Fish metrics that respond to nitrate stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN164 (2013)	**0.00**	**0.00**	**100.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*
Expected response to Nitrate stress	↓	↓	↑	↓

Suspended sediment

There was one TSS sample collected during biological sampling in 2013 at station 13MN164, the concentration was 25 mg/L, below the southern regional TSS standard of 65 mg/L. No TSS samples were collected on the reach prior to the biological monitoring visit. Four of six samples collected during SID investigations in 2015 and 2016, exceeded the southern regional TSS standard. Values collected during SID visits ranged from 11 mg/L to 140 mg/L. Exceedances occurred in February, May and June of 2016.

The fish community is responding negatively to a majority of TSS stress metrics (see table below). An elevated TSS Index Score well above the Southern Headwaters class average indicates the fish community is likely impacted by TSS stress. An absence of herbivores (HrbNWQPct), riffle dwelling species (RifflePct), simple lithophilic spawners (SLithFrimPct), Perciforms (Percfm-TolPct), Centrarchids (Centr-TolPct) and benthic feeders (BenFdFrimPct) confirms this. In addition, there were no sensitive (SensitivePct), generally intolerant (IntolerantPct), or TSS intolerant taxa. Conditions observed could be a reflection of other stressors or could be a result of a small sample size with few taxa captured. Stream bank erosion was identified as moderate during MSHA observations and evidence of bare banks are apparent (photos below). TSS tolerant taxa were over abundant in the reach at 55%.

While evidence of TSS stress is prevalent within fish metrics above there is limited TSS data available to define the extent and duration of TSS stress within the reach. In addition, the fish community may be exhibiting inaccurate metric response due to the low sample size observed. TSS is an inconclusive stressor within the reach until additional evidence is gathered to strengthen the case against the stressor.

Table 165. Fish metrics that respond to elevated TSS stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

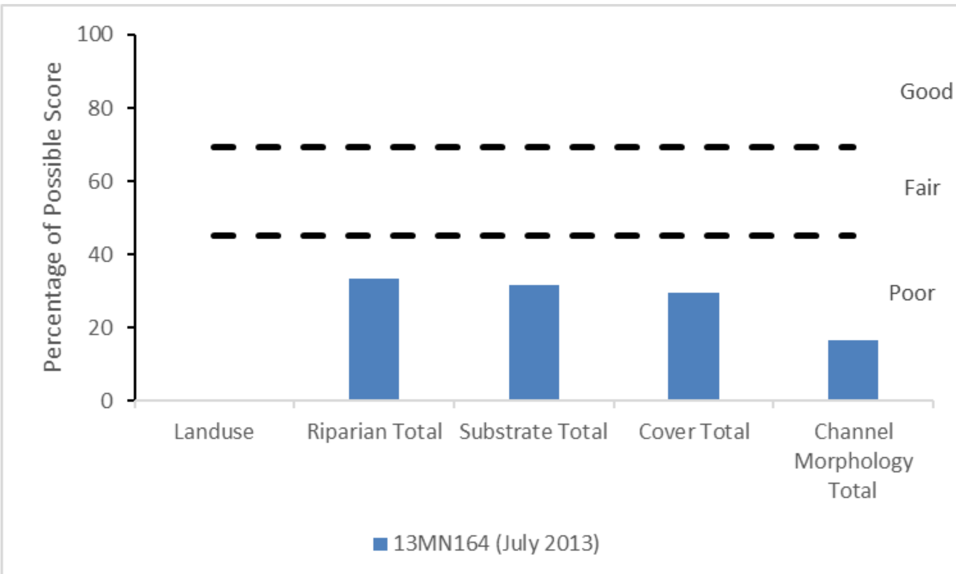
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN164 (2013)	**0.00**	**0.00**	**0.00**	**0.00**	54.76	**0.00**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN164 (2014)	**30.92**	**0.00**	**0.00**	**1.00**	**55.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

One qualitative habitat survey has been conducted on the biological station within the reach in 2013 (see graph below). The MSHA score was very poor (24.5). Row crop agriculture is the prominent landuse surrounding the reach and there are three large feedlots (swine and poultry) near the reach upstream of the biological station. A majority of the reach is channelized with very narrow riparian buffers comprised of reed canary grass and sporadic trees. The stream channel is ubiquitous in nature with limited natural channel development (90% run). Stream channel stability was rated low due to prevalent stream bank erosion and fine substrates and a moving bed load (see photos below). No coarse substrates were identified within the stream channel; instream fish habitat cover was sparse.

Figure 165. Percentage of MSHA subcategory scores for station 13MN164, South Fork Watonwan River.



The fish community is showing a response to most degraded habitat metrics (see table below). There was an abundance of tolerant taxa (TolPct) and a complete absence of piscivore (PiscivorePct), riffle dwelling (Riffle Pct), benthic insectivores (BenInsect-TolPct), simple lithophilic spawners (SlithopPct) and darter, sculpin, sucker taxa (DarterSculpSucPct); as well as a lower than average quantity of lithophilic spawners (LithFrimPct). Absence of predatory taxa like piscivores can indicate an absence of deep pools, which were not found in the reach. Absence of taxa that require coarse substrates, including lithophilic spawners, darters and riffle dwelling taxa is evidence that coarse substrates and riffles are lacking in the reach; this was confirmed in MSHA observations. Pioneering species (PioneerPct) were not found in great quantities in the reach. When pioneering taxa area found in larger quantities can be an indication of disturbance as they do not require diverse habitat types. A majority of evidence indicates that degraded habitat is stressing the fish community within the reach.

Table 166. Fish metrics that respond to degraded habitat conditions stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN164 (2014)	**100.00**	**0.00**	**7.14**	**0.00**	35.71	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*70.64*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

Figure 166. Biological station 13MN164 (July 23, 2013) stream bank erosion, recently cleaned out channel (left); riprap bank stabilization (right).

Altered hydrology/Longitudinal connectivity

There are no dams along the reach. There are a series of three water control structures 5 miles upstream of the reach on Fish Lake. However, it is not likely that these barriers are impacting the fish community. There is another dam approximately 13 miles downstream on WID -547. A comparison of fish diversity above and below the dam, shows 25 species found below the dam and only 11 upstream of the dam (see table below). Five migratory fish taxa observed downstream of the dam were not seen above the dam on reach -568 or -569, black bullhead, central stoneroller, quillback, shorthead redhorse, silver redhorse and slenderhead darter. Two known migratory fish taxa were observed upstream of the dam, white sucker and blackside darter.

Only one species of mussel was identified above the dam: *Anodontoides ferussacianus* (Cylindrical papershell), while twelve species were identified below the dam during DNR mussel surveys from 1999-2003. Species included: *Amblema plicata* (threeridge), *Fusconaia flava* (Wabash Pigtoe), *Lampsillis cardium* (Plain pocketbook), *Lasmigona complanata* (While heelsplitter), *Lasmigona compressa* (Creek heelsplitter), *Leptodea fragilis* (Fragile Papersplitter), *Lampsilis siliquoidea* (Fatmucket), *Pyganodon grandis* (Giant floater), *Potmilus ohiensis* (Pink Papershell), *Pleurobema sintoxia* (Round pigtoe) and

Strophitus undulates (Creeper). Absence of mussel taxa in the reach is often an indicator of longitudinal connectivity stress as many mussel taxa rely of fish for mobility in a reach to complete their life cycles.

Limited diversity observed above the dam in both fish and mussel species suggests that longitudinal connectivity is stressing the reach's fish community.

Table 167. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory fish species while fish taxa in blue are known lake species.

Field Number	13MN164	13MN109	Dam	13MN134	13MN142
WID	-569	-568		-547	-517
Fish Taxa					
bigmouth buffalo					X
bigmouth shiner	x	x		x	X
black bullhead				x	X
blacknose dace				x	X
blackside darter		x		x	x
bluntnose minnow	x			x	x
brassy minnow	x			x	
brook stickleback					
central stoneroller				x	x
channel catfish				x	
common carp	x	x		x	x
creek chub	x	x		x	x
fathead minnow	x	x		x	x
green sunfish				x	x
johnny darter		x		x	x
northern pike		x		x	x
quillback				x	
sand shiner				x	x
shorthead redhorse				x	x
silver redhorse					x
slenderhead darter					x
spotfin shiner		x		x	x
stonecat					x
tadpole madtom				x	
white sucker		x		x	x
yellow bullhead					

The Altered Watercourses GIS layer for Minnesota streams indicates that the 6.57 mile long reach of South Fork Watonwan River is 95% modified and 5% natural. Its headwaters, upstream of -569 are predominately channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed within the reach.

Figure 167. Biological station 13MN164 (July 23, 2013) drain tile, riprap armored bank.

No known lake taxa were identified within the reach; presence of lake taxa within a sample can be indicative of low flow conditions and may be a sign of altered hydrology stress. Low quantities of riffle taxa were observed during fish sampling which can be an indicator of altered hydrologic stress (see table below). There was an overabundance of long-lived taxa in the reach, which may suggest that altered hydrology is not a stressor in this reach.

Table 168. Fish metrics that respond to altered hydrology stress in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN164 (2013)	**100.00**	54.76	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*26.20*
Expected response to Altered Hydrology stress	↑	↓	↓

Low flow was documented in 2012 at the next downstream WID -568 at station 13MN109 (see photographs above). No photographs were taken of station 13MN164 on the reach in fall of 2012; however, it is a safe assumption that if low flow conditions were present downstream, upstream stations were also likely impacted. In 2012, southwestern Minnesota experienced a significant drought, low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow conditions were identified on the reach in 2014 as well when macroinvertebrate crews attempted to sample the station but were unable to in August due to insufficient flow. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on its biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months. Evidence of the connection between agricultural fields and the adjacent reach can be observed in photos below.

Preponderance of evidence suggests that both altered hydrology is stressing the fish community within the reach at this time.

Figure 168. Biological station 13MN164 (June 15, 2016) stream field connection (left); (May 1, 2016) stream field connection (right).

4.1.3. AUID Summary

Degraded habitat conditions, longitudinal connectivity and altered hydrology are stressing the fish community within this portion of the South Fork Watonwan River. Stream ditching and maintenance of the channelized reach have resulted in an unstable stream system with an abundance of stream bank erosion and sedimentation within the stream bed, leaving limited habitat available for aquatic biota. Drain tiles on the landscape have also increased stream flows during precipitation events, further escalating erosive conditions within the reach. A downstream dam is also limiting natural fish migration along the river and limiting taxonomic diversity within the reach. Five migratory fish taxa observed downstream of the dam were not observed upstream of the dam, and twelve mussel taxa were identified downstream of the dam and not observed upstream. Evidence of a dry streambed during late summer of 2012 downstream of reach of the South Fork Watonwan River was an indication that low flow conditions were also impacting reach -569 simultaneously. Low flow conditions are likely the result of drain tiles and channelization in the reach as altered hydrology has designed a system so efficient at draining water off the landscape that baseflow conditions can no longer be maintained during periods of dry weather or drought.

Low DO, eutrophication, nitrogen and TSS were inconclusive stressors along the reach. While there was no chemical evidence suggesting low DO conditions exist within the reach, there was a negative response to low DO stress metrics, indicating potential for stress. Previous attempts to capture low DO conditions during continuous sonde deployments have likely proven unsuccessful due to samples being collected during high water years. There were elevated chemical results for phosphorous, nitrogen and TSS along the reach; however, datasets were small and concentrated during rainfall events. DO flux exceedances were observed in 2015 and 2016 within the reach suggesting potential for eutrophication stress. Fish metric data showed some response to eutrophication, nitrate and TSS; however, only five species were captured during the sampling visit, potentially skewing metric results and metrics for eutrophication and nitrate are very general in nature and may be responding to other stressors within the reach. Additional water chemistry data collection to bolster chemistry datasets and better define stress in the reach would be useful. Obtaining a macroinvertebrate sample in the reach would aid in the understanding of potential stressors, especially nitrates.

Table 169. Summary of stressor determinations for South Fork Watonwan River (569).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
South Fork Watonwan River	07020010-569	o	o	o	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

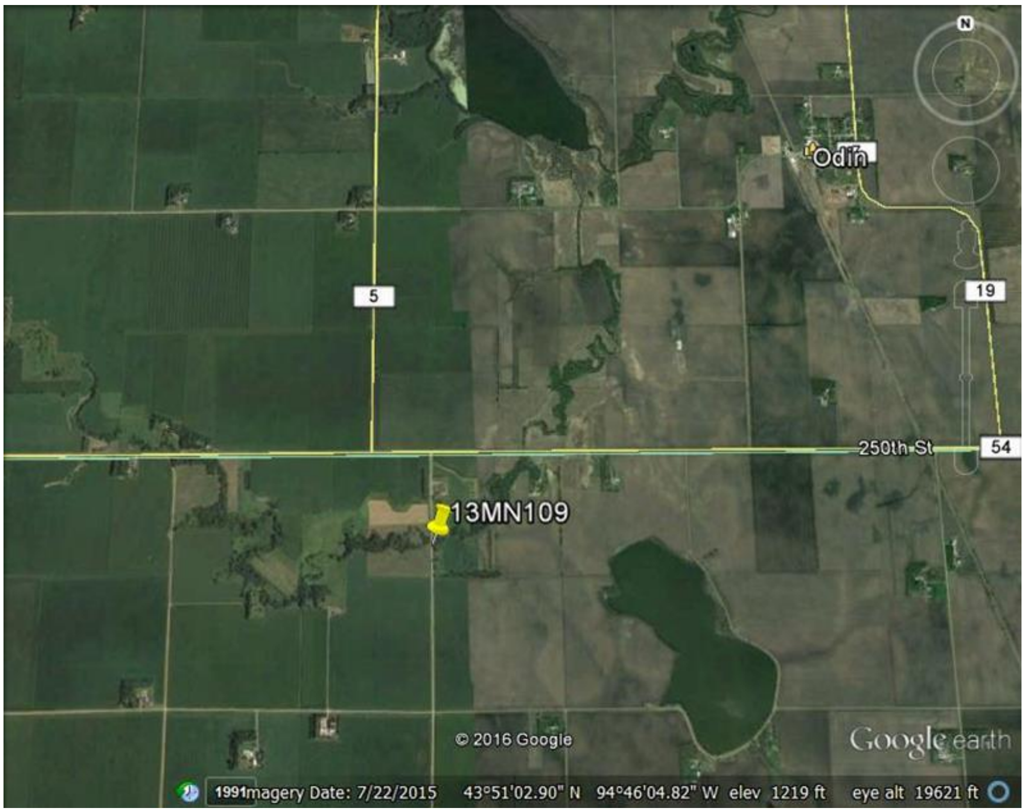
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. South Fork Watonwan River -568

This reach (07020010-568) is a flow through section of the South Fork Watonwan River; it begins at the termination of upstream reach (07020010-569) at CSAH 22 in the southwest corner of Watonwan County and flows nearly 12 river miles before joining the outflow of Judicial Ditch 1 (07020010-581) in Irish Lake. The reach is classified as general use warmwater (2B). This reach is impaired for aquatic life for lacking healthy fish and macroinvertebrate communities (2015), as well as for aquatic recreation for elevated levels of *E. coli* bacteria (2015).

Figure 169. Google Earth image of South Fork Watonwan River (-568).



4.1.1. Biological communities

Only one biological station is present on this reach, 13MN109. There were three fish visits but only one was considered assessable. The 2013 visit was thrown out due to low sampling effort, and the 2014 June visit was deemed not assessable due to sampling too early in the index period. The July 2014 visit was assessed, scoring a 32.2, below the threshold (50) and lower confidence limits. Sample numbers were skewed by a single very tolerant species, fathead minnow (545 individuals). The FIBI received three zero scores for dominant two percent, limited quantities of late maturing individuals (MA<2pt) and tolerant percent. Seven species were captured (see graph below). Presence of two darter species, johnny and blackside darter likely aided higher scoring metrics.

Macroinvertebrates were sampled twice, once in 2013 and again in 2014. The initial visit in 2013 fell just within the lower confidence limit at 29.9 while the 2014 visit fell just below. Metric scores fell below averages needed to meet standards for the following categories: trichoptera taxa richness (trichoptera taxa), predator taxa richness (excluding chironomids) (predator taxa), the relative percentage of taxa with tolerance values equal to or greater than 6, using MN TVs (Tolerant 2ChTxPct), the relative percentage of insectivorous taxa (Insect Taxa percent), the taxa richness of climbers (Climber Ch) and the percentage of dominant five taxa (DomfivePct) (see graph below). The 2013 visit was dominated by Cheumatopsyche, Baetis, Polypedilum and Heptageniidae; while the 2014 visit was dominated by Hyalella, Simulium, Baetis and Parantanytarus.

Figure 170. Fish metrics of the Southern Streams Class IBI for station 13MN109, South Fork Watonwan River.

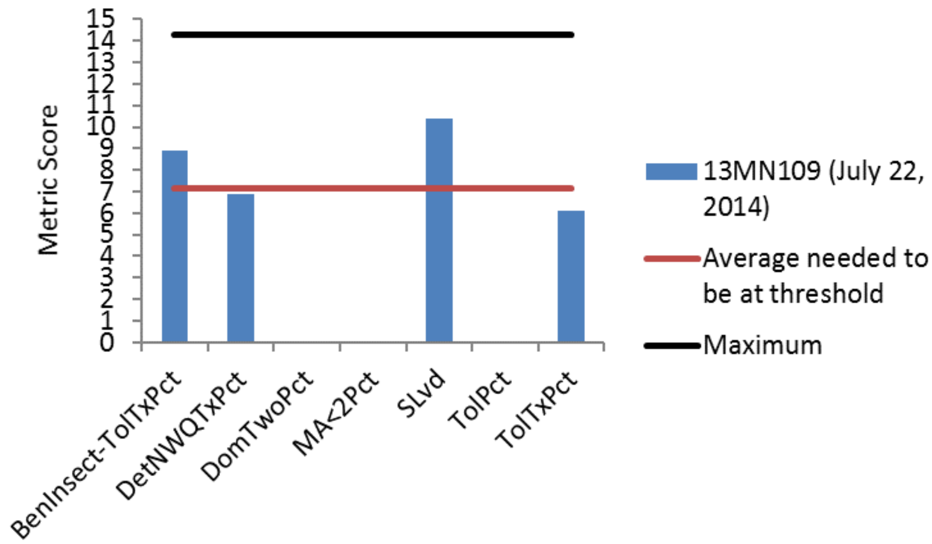
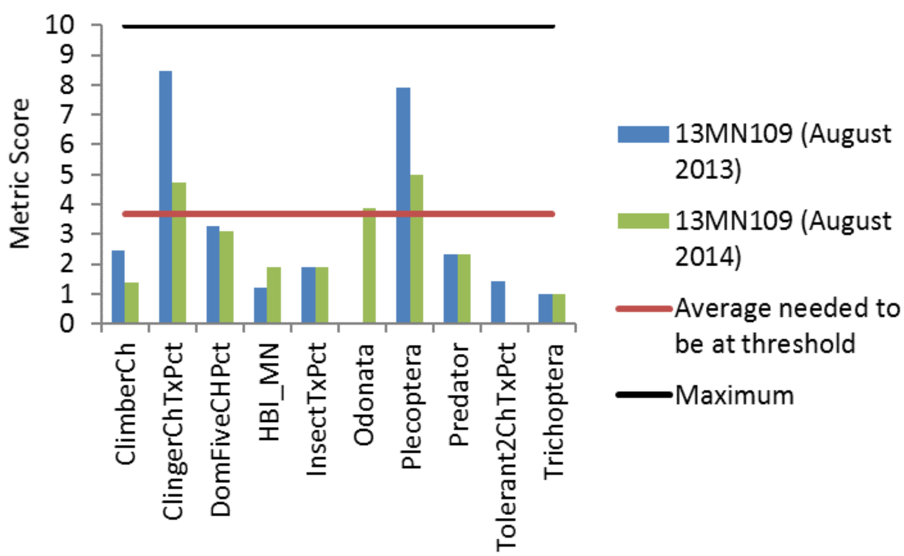


Figure 171. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 13MN109, South Fork Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

DO measurements were collected on five occasions during biological monitoring events in 2013 and 2014. Samples ranged from 9.35 to 12.88 mg/L, and all were above the DO standard of 5 mg/L. Twenty-nine additional DO samples were collected on the reach at station S007-568 from 2013 – 2016. DO values ranged from 5.96 – 12.77 mg/L, and all were above the standard. A few high afternoon DO readings prompted additional continuous DO monitoring on station 13MN109 from July 16 – July 23 in

2015 (see graph below). During deployment DO readings ranged from 6.45 mg/L to 9.78 mg/L, resulting in no readings below the standard. DO flux ranged from 1.47 mg/L to 2.89 mg/L, falling below the 4.5 mg/L standard (see graph below).

Figure 172. Diurnal DO results for station 13MN109 July 16 –24, 2015.

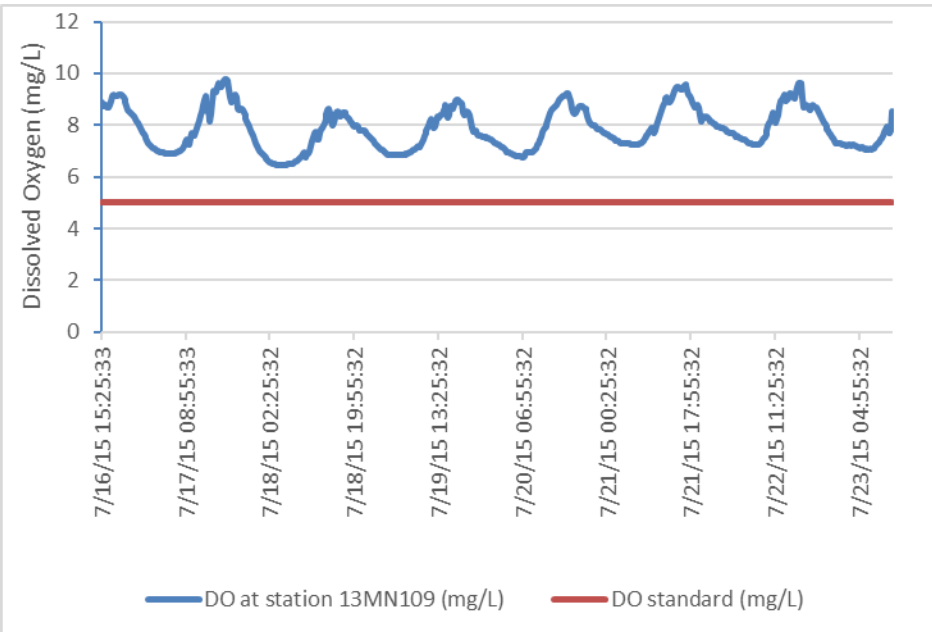
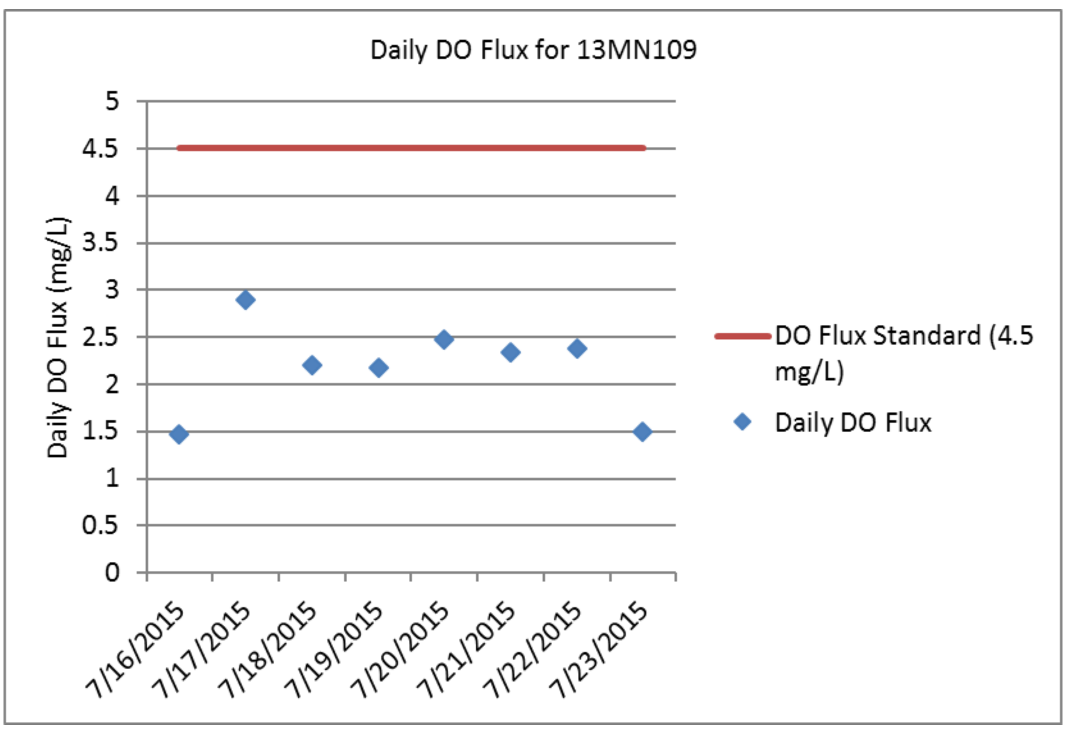


Figure 173. Daily DO Flux results for station 13MN109 July 16 –24, 2015.



There was a mixed response to low DO stress within the macroinvertebrate community (see table below). While the 2014 visit at station 13MN109 shows some response to all low DO metrics, the 2013 visit shows an above average low DO index score and lower than average quantities of low DO tolerant taxa, suggesting unstable conditions from year to year. The Low DO index score for the 2014 visit was just below the southern streams RR average; however, there was an abundance of low DO tolerant individuals suggesting potential for low DO stress.

Table 170. Macroinvertebrate metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN109 (2013)	**31.00**	**11.00**	**1.19**	7.34	**6.00**	**23.64**	3.00	4.79
13MN109 (2014)	**31.00**	**13.00**	**1.90**	**6.81**	**4.00**	**10.93**	**7.00**	**31.51**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Similar to the macroinvertebrate community, the fish community showed a mixed response to low DO stress (see table below). The low DO Index score for station 13MN109 was below average, suggesting potential for low DO stress. There were also very few taxa that take more than three years to mature indicating stress on longer lived species within the site. While there was a high percentage of tolerant individuals and an absence of generally sensitive taxa and low DO sensitive taxa, this could be attributed to other stressors. There were lower than average numbers of low DO tolerant taxa, which may indicate that other stressors may be having greater impacts on the fish at the site.

While biological metric data suggests potential for low DO stress within the reach, there is currently little chemical evidence to suggest low DO conditions occur within the reach. Additional continuous DO data collection during low flow periods could help better define the potential stressor within the reach. Low DO is an inconclusive stressor in the reach at this time.

Table 171. Fish metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN109 (2014)	**0.00**	**0.34**	**93.55**	**6.26**	**0.00**	**0.00**	2.00	**92.70**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

There were three phosphorous samples taken during the biological visits at 13MN109 in 2013 and 2014, none of these samples were above the standard for the southern region (0.15 mg/L). Eight additional samples were collected at the same station in 2015 and 2016; only one reading exceeded the standard. The range in phosphorous concentrations was 0.065 mg/L to 0.4 mg/L, with an average concentration of 0.11 mg/L. There was one chlorophyll a sample collected on the reach, with a concentration of 72.3 ug/L, well above the southern eutrophication standard of 35 ug/L. DO values ranged from 5.96 – 12.77 mg/L indicating potential for elevated DO flux. DO flux data gathered during continuous DO monitoring in 2015 shows no occurrence of DO flux over the 4.5 mg/L standard. There were no BOD samples collected on this reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.69 – 8.64 in the reach.

There was a mixed response to eutrophication stress within the macroinvertebrate community (see table below). There was an absence of intolerant taxa and low counts of collector-filterer taxa. There was an abundance of tolerant taxa collected at both visits. Collector gatherer counts were also marginally below average while EPT counts were slightly below the average in 2013, then slightly above in 2014.

Table 172. Macroinvertebrate metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN109 (2013)	**31.00**	**4.00**	**10.00**	**11.00**	**0.00**	**87.10**
13MN109 (2014)	**31.00**	**2.00**	**10.00**	13.00	**0.00**	**93.55**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community metrics show greater signs of eutrophication stress (see table below). There was an absence of sensitive and intolerant taxa and a high percentage of tolerant taxa. Darter counts were also low as were those of simple lithophilic spawners. However, these metrics are general stress metrics and may be responding to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. A positive relationship exists between eutrophication and omnivorous fish. An abundance of omnivorous fish were identified within the fish sample, suggesting that eutrophication may be a stressor to the fish community within the reach.

While the biology shows some potential signs of eutrophication stress, most metrics are general in nature and do not point to a single stressor. In addition, limited chemical evidence exists to implicate eutrophication as a stressor in the reach at this time. Additional chemical data would be useful to better understand the stressor's potential within the reach. As such, eutrophication is an inconclusive stressor in the reach at this time.

Table 173. Fish metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN109 (2014)	**0.00**	**6.28**	**33.33**	**92.87**	**93.55**	**7.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

Three nitrate samples were collected during the fish visits on station 13MN109, concentrations ranged from 9.2 mg/L in July of 2013 to 16 mg/L in June of 2014. An additional 16 samples were collected during 2013, 2015 and 2016 spanning the months of May to September and a single reading collected in February. Nitrate concentrations ranged from 0.2 mg/L in September to 25 mg/L in June, with an overall average concentration of 15.26 mg/L. Half of the 18 samples taken on this reach were above 15 mg/L.

The macroinvertebrates in this reach show some indication that they are stressed by the elevated nitrate concentrations (see table below). The nitrate index score was 3.4 and 3.65, while the average for Southern Streams meeting impairment threshold is 2.9. This suggests that overall the community present is somewhat tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) which was apparent during the June visit in 2014 but not during the July visit in 2013. There was an absence of nitrate intolerant taxa within the reach and a below average quantity of trichoptera taxa. The number of nitrate tolerant individuals was only marginally above the average while the response for nitrate tolerant individuals was inconsistent between visits.

Fish are not generally good indicators of nitrate stress within a reach. Metrics that do respond to nitrate stress are general stress related metrics that could be indicators of other stressors. There was an abundance of tolerant taxa in the reach and an absence of intolerant and sensitive taxa in the reach. Darter counts were low, signifying potential stress.

While chemical evidence suggests high nitrate levels are persistent during spring months, the percentage of nitrate tolerant individuals is variable year to year. Nitrate appears to be periodically stressing the macroinvertebrate community in the reach, but may not be the primary stressor in the reach. Additional nitrate data collection would be advantageous to better understand the extent of nitrate contributions in the reach. As such, nitrate is a stressor to macroinvertebrate communities in the reach at this time, but inconclusive for fish due to lack of sufficient metric response to indicate stress.

Table 174. Macroinvertebrate that respond to nitrate stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Date fish visit)
13MN109 (2013)	**31.00**	**4.00**	**10.00**	**12.00**	**0.00**	**87.10**	**3.00**	**5.43**	**3.40**	**0.00**	**19.00**	**77.70**	9.2 (7/23/2013)
13MN109 (2014)	**31.00**	**2.00**	**10.00**	**9.00**	**0.00**	**93.50**	**3.00**	**2.90**	**3.65**	**0.00**	**19.00**	52.40	16.00 (6/11/2014)
13MN109 (2014)													11.00 (7/22/2014)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Three TSS samples were collected during fish sampling visits at biological station 13MN109 in 2013 and 2014; no samples exceeded the southern regional standard for TSS (65 mg/L). One of nine samples collected in 2013 from May thru September exceeded the TSS standard. Four of eleven additional samples collected in 2015 and 2016 for stressor identification investigations exceeded the regional TSS standard.

The macroinvertebrate community showed a mixed response to TSS stress (see table below). TSS Index scores exceeded the average needed to meet standards for both visit for the southern streams RR class, suggesting that TSS is likely stressing the macroinvertebrates within the reach. There was also an absence of TSS intolerant taxa across the visits, but only one visit had an overabundance of TSS tolerant individuals. The percentage of collector filterer individuals was just below average, while plecoptera percentages hovered above and below the average.

Table 175. Macroinvertebrate metrics that respond to high TSS stress in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN109 (7/23/2013)	**21.73**	0.96	**18.82**	**0.00**	**0.00**	10.00	**58.79**
13MN109 (6/11/2014)	**24.52**	**0.322**	**16.95**	**0.00**	**0.00**	11.00	28.62
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The fish community appears to be responding negatively to most TSS stress metrics (see table below). The TSS Index score was well above the threshold, suggesting the community is likely stressed by elevated levels of TSS. There was also an absence of generally intolerant, TSS intolerant and sensitive taxa. There were limited numbers of riffle dwelling species, simple lithophilic spawners, herbivores, benthic feeders, centrarchids and perciformes. Low quantities of benthic feeders could suggest limited water clarity within the reach, as benthic feeders rely on sight to gather food. Low quantities of herbivores could indicate that limited water clarity is stifling potential plant growth in the reach. Low quantities of taxa that require coarse substrates and riffles could suggest sedimentation in the reach a potential side effect of limited water clarity. Surprisingly, there was an absence of TSS tolerant taxa in the reach. It is possible that the overabundance of fathead minnow in the reach is skewing metric data.

Chemical evidence, while limited to a handful of elevated TSS concentrations collected during high flow events, suggests that elevated TSS concentrations exist in the reach. The biological metric data indicates potential for TSS stress within the reach, consistent with chemical findings. While the overall metric response was inconsistent, with variable quantities of TSS tolerant taxa and an absence of TSS tolerant fish, preponderance of evidence suggests that problems are present. As such, TSS in a stressor within the reach at this time. Additional chemical evidence and biological sampling would be useful in better understanding the extent of TSS stress within the reach.

Table 176. Fish metrics that respond to high TSS stress conditions in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

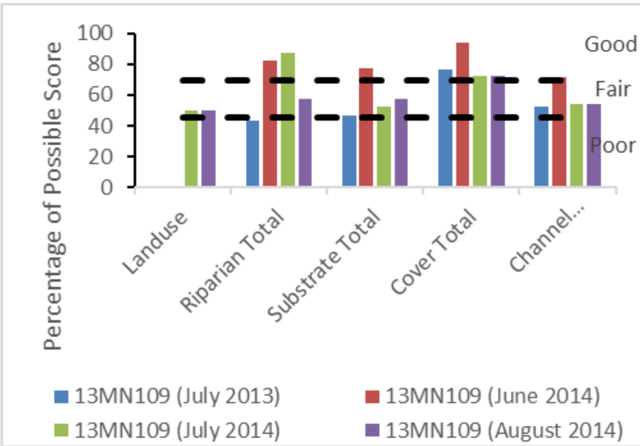
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN109 (2014)	**6.45**	**0.00**	**0.34**	**0.00**	**0.17**	**6.28**	**0.34**	**0.00**	**0.34**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN109 (2014)	**23.53**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

Four qualitative habitat surveys have been completed at biological station 13MN109, 1 in 2013 and 3 in 2014, with an overall average score of 60.65 (see graph below). There was a 24 point spread between MSHA scores when comparing the four sampling events. This variation in score across visits could be a result of discrepancies in surveyor opinion, or overlooking the presence of pasture adjacent to the reach resulting in overinflated scores. Landuse scores show dramatic differences, from zero during two visits to fair at the remaining visits (very narrow to extensive). Upon closer inspection, when comparing station photos and aerial photography, an abundance of row crop agriculture and presence of open pasture in the surrounding landuse outweigh the limited vegetative cover in the immediate riparian zone to include “forest, wetland, prairie, shrub” as a dominant surrounding landuse, which inflated MSHA scores at two visits. Row crop agriculture is the primary surrounding landuse for the reach, with a handful of moderately sized hog operations. While perennial vegetation of grasses and trees surround the biological station’s riparian zone, cattle have access to the stream in the summer months when they pasture the riparian zone. Stream bank erosion and sedimentation of coarse substrates was identified, indicating stream bank and bed instability. Calls on embeddedness of coarse substrates varied from light to moderate while bank erosion varied from light to heavy. Variations in MSHA scoring could also indicate an instable system with shifting stream banks and substrates. Instream substrates were diverse and moderate amounts of instream habitat cover were available. Natural stream channel development was identified on the reach including riffle, run and pool sequences.

Figure 174. Percentage of MSHA subcategory scores for station 13MN109, South Fork Watonwan River.



The fish community is showing signs of habitat related stress at station 13MN109 (see table below). There was an abundance of tolerant taxa. There were lower than average quantities of piscivores, lithophilic and simple lithophilic spawners, riffle dwelling species, 'darter, sculpin, sucker' species and benthic insectivores. This is reflective of limited diversity within the site and the fact that five of the seven species captured had only three or fewer individuals captured. Low quantities of taxa that require coarse substrates and riffle dwelling taxa suggest that these habitats are limited within the reach. Low quantities of piscivores indicate that limited habitat is available for predatory taxa like deep pools, which was noted during multiple visits. The reach was dominated by pioneering species (545 fathead minnow); pioneering taxa do not require diverse habitat conditions to persist indicating an elevated probability of degraded habitat conditions.

Table 177. Fish metrics that respond to degraded habitat conditions in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN109 (6/11/2014)	**93.55**	**0.17**	**0.68**	**6.28**	**98.81**	**0.34**	**6.28**	**0.51**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

In contrast, the macroinvertebrate community is demonstrating a limited response to degraded habitat stress (see table below). There were low numbers of burrowing and legless species at both visits, suggesting that fine sediments are not overly abundant in the reach. There was also an abundance of climber species, which is likely a reflection of an abundance of overhanging vegetation within the reach. Discrepancies were observed between the visits with regards to the clinger, sprawler and EPT metrics. This could suggest limited availability of coarse substrates or woody debris in the reach. The discrepancies within the metrics could be a result of varying habitat types sampled during the two visits, in 2013 rock riffle and woody debris habitat were sampled while in 2014, in addition to rock riffle and woody debris, overhanging vegetation was also sampled.

Observations at MSHA visits vary drastically between visits, suggesting inconsistencies in judgements of the metrics or wide variation in condition from visit to visit. It appears a variety of habitats are available within the reach but evidence of light sedimentation and filling in of pools appears to be negatively effecting the fish community resulting in stress. Macroinvertebrate communities show an inconsistent response to habitat stress within the reach.

Table 178. Macroinvertebrate metrics that respond to degraded habitat conditions stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN109 (2013)	1.60	23.00	59.11	64.54	27.80	**8.63**
13MN109 (2014)	3.55	13.23	**47.42**	**26.77**	30.00	28.71
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 175. Biological station 13MN109 (July 23, 2013) stream bank erosion and sediment deposition.

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. However, there is a dam on the next downstream WID -547. A comparison of fish diversity above and below the dam shows 25 species found below the dam and only 11 upstream of the dam. Six migratory fish taxa observed downstream of the dam were not seen above the dam on reach -568 or -569, black bullhead, central stoneroller, quillback, shorthead redhorse, silver redhorse and slenderhead darter. Two known migratory fish taxa were observed upstream of the dam, white sucker and blackside darter (see table below).

Only one species of mussel was identified above the dam: *Anodontoides ferussacianus* (Cylindrical papershell)), while twelve species were identified below the dam during DNR mussel surveys from 1999-2003, including: *Amblema plicata* (threeridge), *Fusconaia flava* (Wabash Pigtoe), *Lampsillis cardium* (Plain pocketbook), *Lasmigona complanata* (While heelsplitter), *Lasmigona compressa* (Creek heelsplitter), *Leptodea fragilis* (Fragile Papersplitter), *Lampsilis siliquoidea* (Fatmucket), *Pyganodon grandis* (Giant floater), *Potmilus ohiensis* (Pink Papershell), *Pleurobema sintoxia* (Round pigtoe) and *Strophitus undulates* (Creeper). Absence of mussel taxa in the reach is often an indicator of longitudinal connectivity stress as many mussel taxa rely of fish taxa for mobility in a reach to complete their life cycles.

Limited diversity including low quantities of migratory species observed above the dam compared to below the dam in both fish and mussel species suggests that longitudinal connectivity is stressing biota within the reach.

Table 179. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory species. Fish taxa in blue are known lake species.

Field Number	13MN164	13MN109	Dam	13MN134	13MN142
WID	-569	-568		-547	-517
Fish Taxa					
bigmouth buffalo					x
bigmouth shiner	X	x		x	x
black bullhead				x	x
blacknose dace				x	x
blackside darter		x		x	x
bluntnose minnow	X			x	x
brassy minnow	X			x	
brook stickleback					
central stoneroller				x	x
channel catfish				x	
common carp	X	x		x	x
creek chub	X	x		x	x
fathead minnow	X	x		x	x
green sunfish				x	x
johnny darter		x		x	x
northern pike		x		x	x
quillback				x	
sand shiner				x	x
shorthead redhorse				x	x

Field Number	13MN164	13MN109	Dam	13MN134	13MN142
silver redhorse					x
slenderhead darter					x
spotfin shiner		x		x	x
stonecat					x
tadpole madtom				x	
white sucker		x		x	x
yellow bullhead					

The Altered Watercourses GIS layer for Minnesota streams indicates that the 11.88 mile long reach of the South Fork Watonwan River 93% natural and 7% modified. Its headwaters, upstream of -568 are nearly 100% channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed within the reach.

No known lake taxa were identified within the reach; presence of lake taxa within a sample can be indicative of low flow conditions and may be a sign of altered hydrology stress. Low quantities of long-lived and riffle taxa were observed during fish sampling, both metrics can be indicators of altered hydrologic stress (see table below).

Table 180. Fish metrics that respond to altered hydrology stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN109 (6/11/2014)	**93.55**	**0.17**	**0.34**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Low flow was documented in 2012 at station 13MN109 (see photographs below). In 2012, southwestern Minnesota experienced a significant drought, low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Figure 176. Biological station 13MN109 (September 2012) low flow conditions (left and right).

4.1.3. AUID Summary

The fish community is being stressed by degraded habitat and longitudinal connectivity, while altered hydrology is stressing both indicators within the reach.

While the average MSHA score within the reach is fair to good, two visits have overinflated landuse scores due to not considering the present open pasture within the reach and giving the reach credit for a narrow natural riparian corridor which is not representative of the upstream two-three mile riparian zone that should have been considered. There was also varied calls across a wide range of metrics within MSHA scores from bank erosion to present substrate types and percentage of channel types present suggesting either a stream in a constant state of change or inconsistent observations between visits. Fish metrics suggest potential stress due to erosion and sedimentation of pools and coarse substrates. While the macroinvertebrate community does not show a similar response to degraded habitat conditions, any improvements made would likely benefit both indicators.

A downstream dam on the South Fork Watonwan River is limiting fish migrations in the system and has led to a drastic reduction in fish diversity across the South Fork Watonwan River limiting fish and mussel communities. Efforts to improve connectivity in the reach would benefit the biology within the South Fork Watonwan River.

Inconsistent baseflow is also a source of stress on the reach. Limited water storage in the watershed in conjunction with extensive networks of drain tiles for agricultural drainage have created an efficient system for draining water off the landscape quickly, dropping the natural water table and reducing baseflow during drier times of the year, as was observed in 2012 when the streambed within the reach went dry.

Elevated nitrate concentrations are periodically stressing macroinvertebrate communities in the reach. Elevated nitrogen levels were observed in the reach during the spring months suggesting a connection to tile drains observed in the site. Additional nitrate data collection would be useful to better define the extent of nitrate contributions by agricultural drain tile inputs. Fish metric data was insufficient to determine nitrate stress at this time.

Both the fish and macroinvertebrate community are being stressed by elevated concentrations of TSS within the reach. TSS concentrations exceeded regional standards during event based sampling. Both fish and macroinvertebrate metrics showed a response to TSS stress; however, there was not a consistent response across all visits. Additional chemistry collection would be useful in better understanding the extent of stress within the reach. An additional biological visit for both indicators would also be useful in better understanding the stressor.

DO and eutrophication are inconclusive stressors within the reach. There were no grab sample or continuous monitoring DO readings below the standard. Macroinvertebrate metric data showed discrepant results with regards to DO stress, suggesting potential for problems. Only one elevated phosphorous reading was identified in the reach but the dataset was small. While the DO flux was not above the standard during continuous sonde deployment, a chlorophyll a sample collected on the reach was more than twice the standard, suggesting potential problems within the reach. Additional chemistry collection would be useful in better characterizing potential stress within the reach. An additional biological visit for both indicators would be useful in better characterizing potential stressors in the reach.

Table 181. Summary of stressor determinations for South Fork Watonwan River (568).Table 4.170. Summary of stressor determinations for South Fork Watonwan River (568).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
South Fork Watonwan River	07020010-568	o	o	o/●	●	●/o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

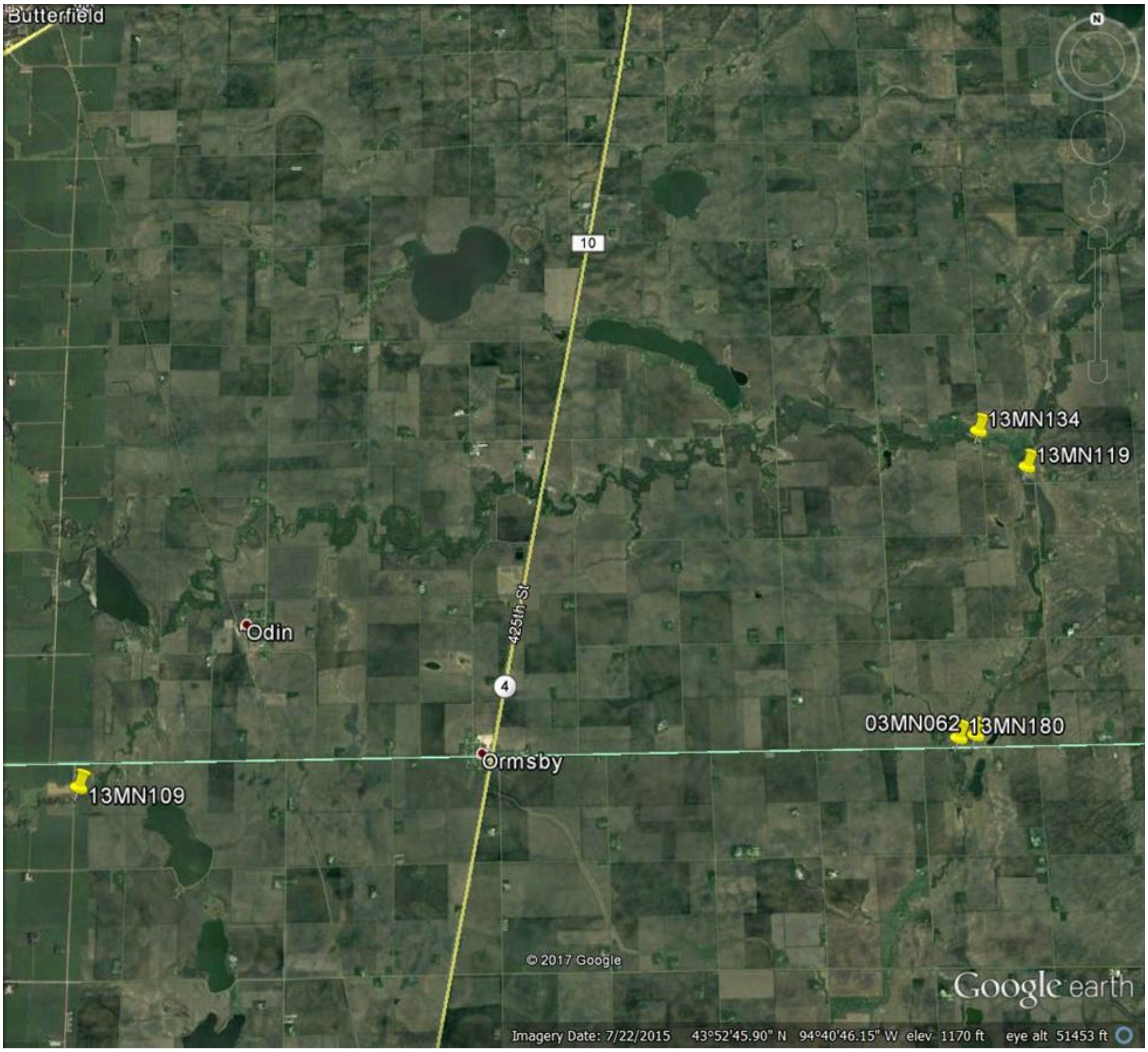
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. South Fork Watonwan River -547

Reach (07020010-547) is the continuation of the South Fork Watonwan River starting at the outlet of Irish Lake and flowing east nearly 21 river miles, terminating upstream of the confluence of Willow Creek upstream of Co. Hwy 122, reach (07020010-517). The reach is classified as general use warmwater 2B. The reach is currently impaired for aquatic life for lacking fish community (2015) and high levels of turbidity (2006).

Figure 177. Google Earth image of South Fork Watonwan River (-547).



4.1.1. Biological communities

There is one bio site along the reach. 13MN134 had an F-IBI score of 25. The GU threshold for this reach is 50. All FIBI metrics scored below the average threshold needed to meet standards. The fish community was dominated by tolerant individuals from a handful of species including: sand shiner, bigmouth shiner, white sucker and spotfin shiner. Twenty species were identified within the sample, with 1,161 individuals captured. There was an abundance of tolerant taxa in the sample resulting in zero scoring for the tolerant percent metric. There were low quantities of individuals that take greater than two years to mature. There was a high quantity of short-lived species and an above average percentage of detritivores (see graph below).

Macroinvertebrates were sampled twice in 2013. This duplicate visit scored eight points above and six points below the GU threshold of 41. For the purposes of assessment the higher score was given precedence as it represented the maximum potential biological community at the time of sampling, as such the macroinvertebrate community met its designated use. There was an absence of predator taxa at both visits. While the HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score hovered just above the threshold at both visits (see graph below).

Figure 178. Fish metrics of the Southern Streams Class IBI for station 13MN134, South Fork Watonwan River.

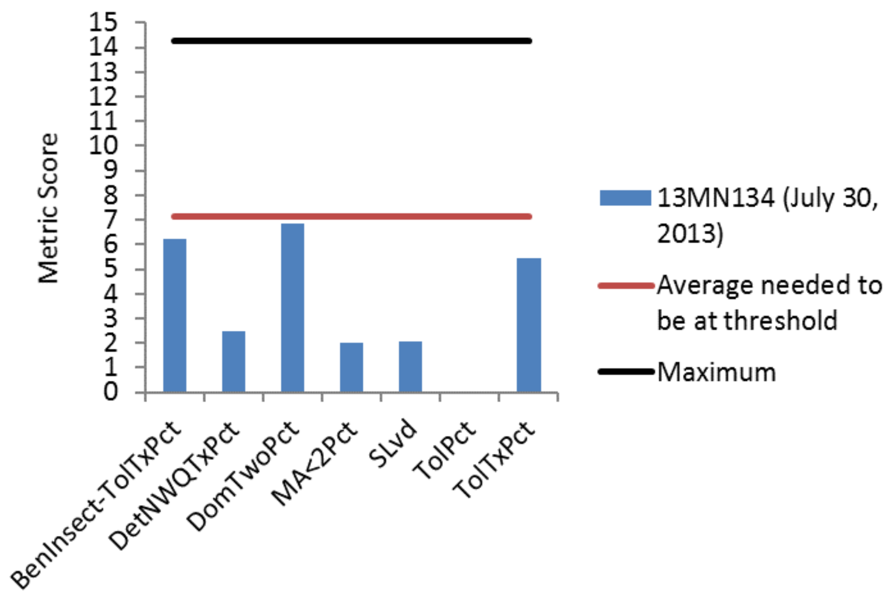
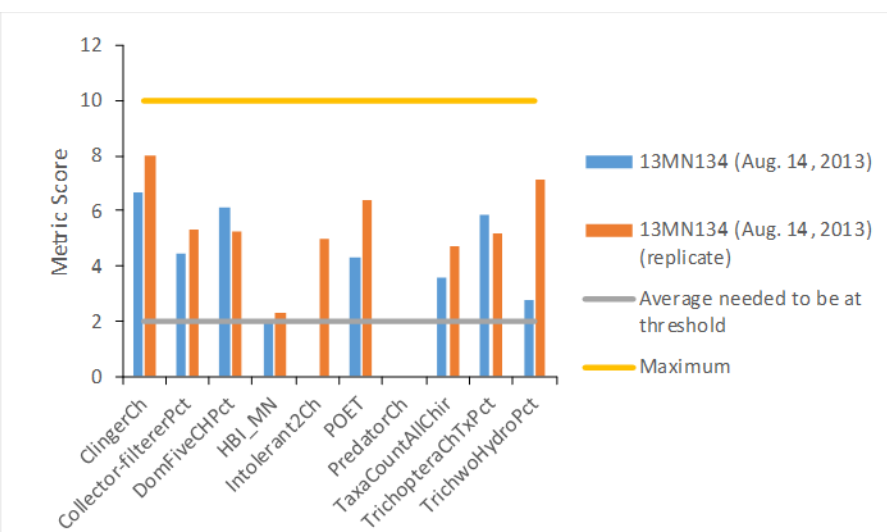


Figure 179. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN134, South Fork Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There were two DO measurements collected during the fish visit, 9.13 mg/L on August 14, 2013 at 3:31pm and 11.81 mg/L on July 30, 2016 at 4:19pm. Neither reading fell below the DO standard of 5 mg/L No DO samples were collected prior to biological sampling. Six additional DO samples were collected in 2016, values ranged from 7.84 mg/L to 12.72 mg/L, two were above 10 mg/L.

The fish community showed a mixed response to low DO stress (see table below). The DO Index score was above the average needed to meet the southern streams threshold, indicating that DO is not likely a significant source of stress in the community. However, there was an absence of DO sensitive taxa, generally sensitive taxa and blow quantities of late maturing individuals, signifying potential stress. However, these metrics may be responding to other stressors within the reach. There was also greater than average quantities of low DO tolerant taxa but low numbers of low DO tolerant individuals.

Table 182. Fish metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN134 (2013)	**0.00**	**12.58**	**79.16**	7.24	**0.00**	**0.00**	**7.00**	5.77
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrate community is not impaired within the reach, looking at stress metrics from both indicators can aid in the understanding of stressors within the reach. The macroinvertebrate community does not show a strong response to low DO stress (see table below). DO index score metrics were above the average needed to meet the threshold in the prairie streams class, inferring that macroinvertebrates are not likely responding to low DO stress. HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) scores were only slightly above the average needed to meet class thresholds. There were low quantities of DO tolerant taxa and individuals and above average quantities of low DO intolerant taxa, although one station had lower than average quantities of low DO intolerant individuals.

Table 183. Macroinvertebrate metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN134 (2013)	**31.00**	8.00	**8.30**	7.24	3.00	**2.89**	4.00	7.39
13MN134 (2013)	**35.00**	10.00	**8.20**	7.36	7.00	10.90	6.00	3.21
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is no chemical evidence to suggest low DO conditions exist within the reach; however, the chemical data set is small and may not be telling the entire story. There has been no continuous DO monitoring in the reach or early morning sampling when one would expect low DO conditions to occur. Cumulatively, the metric data does not strongly suggest that low DO is stressing the fish community at this time. As such, DO is an inconclusive stressor in the reach at this time.

Eutrophication

The phosphorous concentration at the fish visit in 2013 was 0.035 mg/L, below the southern region eutrophication standard of 0.15 mg/L. Five additional phosphorous readings were taken in 2016, two were above the standard. The average concentration of phosphorous was 0.187 mg/L. There were no chlorophyll a or BOD samples collected on this reach, nor were continuous DO measurements taken to determine DO flux. DO values ranged from 7.84 mg/L to 12.72 mg/L indicating potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.79 – 8.86 in the reach.

The fish community metrics show potential signs of eutrophication stress (see table below). Within the community, there was an absence of sensitive and intolerant taxa and low counts of darters and simple lithophilic spawners. There was also an abundance of tolerant individuals. However, these metrics are general in nature and could be pointing to other sources of stress within the reach. A positive relationship exists between eutrophication and omnivorous fish. Below average quantities of omnivorous fish were identified in the fish sample suggesting that eutrophication is not a predominate stressor to the fish community.

Table 184. Fish metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN134	**0.00**	**8.87**	**16.37**	16.71	**79.16**	20.00	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While the macroinvertebrate community is not impaired, looking at stress metrics from both indicators can be beneficial in better understanding potential stressors within a reach. There appears to be some response to eutrophication stress metrics in the macroinvertebrate community (see table below). While all eutrophication metrics scored below their respective averages at both visits at station 13MN134, EPT taxa numbers and the quantities of collector-gatherer taxa were only marginally below their respective averages. In contrast, there was a great abundance of tolerant taxa and an absence of intolerant taxa. Low quantities of collector-filterer and collector gatherer taxa were also observed.

Table 185. Macroinvertebrate metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN134 (2013)	**32.00**	**1.00**	**11.00**	**8.00**	**0.00**	**93.75**
13MN134 (2013)	**31.00**	**5.00**	**13.00**	**10.00**	**0.00**	**96.77**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*37.00*	*4.95*	*19.13*	*8.91*	*0.24*	*81.88*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

There is limited chemical evidence to implicate eutrophication as a stressor in the reach at this time. Additional phosphorous data and response variable data, including DO flux, chlorophyll a and BOD data is needed to better characterize the potential for eutrophication within the reach. While biological metric data suggests potential for stress within the reach, eutrophication stress metrics are general in nature and could be responding to other stressors within the reach. As such, eutrophication is an inconclusive stressor at this time.

Nitrate

Water chemistry data is limited to data gathered during the biological sampling visits and stressor identification investigations. The nitrate concentration observed at the fish visit on July 30th, 2013 was 1.2 mg/L. Four additional samples were collected in 2016 from the months of March, May and June. Nitrate concentrations ranged from 9 mg/L to 20 mg/L, with an overall average of 13.64 mg/L. Three of the four readings were above 15 mg/L. All May and June readings occurred after rainfall events.

Fish often do not show a strong response to increased nitrate concentrations. The fish community was dominated by tolerant taxa and had no intolerant or sensitive taxa. These metrics are general in nature and could be the result of other stressors within the reach.

While the macroinvertebrate community is not impaired within the reach, sometimes looking at all available metric data can aid in the understanding of potential stressors on the reach. Macroinvertebrate communities are also often more affected by elevated nitrate concentrations. The metric data indicate that elevated nitrate concentrations are negatively impacting macroinvertebrates in the reach. The nitrate index score was 3.78 and 3.90, while the average for Prairie Streams GP class meeting impairment threshold is 3.2. This suggests that overall the community present is quite tolerant to high nitrate concentrations. The number of nitrate tolerant individuals is above average for both visits as was the number of nitrate tolerant taxa and nitrate intolerant taxa. However, the quantity of Trichoptera taxa were above the average and the percentage of non-hydropsychid trichoptera showed mixed results between the two visits.

Table 186. Macroinvertebrate metrics that respond to nitrate stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN134 (2013)	**31.00**	**5.00**	**13.00**	**8.00**	**0.00**	**96.77**	3.00	0.97	**3.78**	**1.00**	**20.00**	**78.20**	1.20 (7/30/2013)
13MN134 (2013)	**35.00**	**5.00**	**14.00**	**10.00**	1.00	**88.57**	3.00	**4.82**	**3.90**	**0.00**	**23.00**	**77.80**	
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	***2.60***	***2.40***	***3.20***	***1.10***	***18.00***	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

While elevated nitrate concentrations were evident in the reach during spring runoff events, nitrates are an inconclusive stressor to the fish community at this time as fish are not good indicators of nitrate related stress. Reducing nitrate concentrations would be beneficial for the macroinvertebrate community, which is responding negatively to elevated nitrate concentrations to prevent future MIBI readings from falling below impairment thresholds.

Suspended sediment

One TSS sample was collected during the fish visit at 13MN134; the result was below the southern regional TSS standard of 65 mg/L. No TSS samples were collected on the reach prior to biological monitoring in 2013. Six additional TSS samples were collected in 2016 as part of SID investigations, three samples exceeded regional TSS standards. There were 271 transparency readings taken from 2001-2011, 2015 and 2016, 15 readings were below 10 cm. There is a turbidity impairment on the reach identified in 2006.

The fish community is responding negatively to a majority of TSS stress related metrics (see table below). The TSS Index score for the station was above the Southern Streams Class average, suggesting that TSS stress is likely affecting the fish community. The fish community had low quantities of benthic feeders, centrarchids, herbivores, intolerant taxa, long-lived taxa and simple lithophilic spawners, perciformes, riffle dwellers and sensitive taxa, all of which suggest TSS stress. Low quantities of taxa that require coarse substrates like, riffle dweller and lithophilic spawners can suggest sedimentation within a reach, which can occur in conjunction with turbid conditions. Low quantities of benthic feeders could suggest limited water transparency limiting their ability to gather food. Low quantities of herbivores in the reach could reflect turbid conditions, which limit plant growth in the reach or continuous sedimentation limiting plant establishment in the substrates. There were no TSS intolerant taxa present and greater than average quantities of TSS tolerant taxa and individuals.

Table 187. Fish metrics that respond to high TSS stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN134 (2013)	**17.83**	**0.00**	**12.32**	**0.00**	**1.81**	**10.66**	**4.39**	**0.31**	**4.70**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN134 (2013)	**25.66**	**0.00**	**0.00**	**5.00**	**51.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

While the macroinvertebrate community is not impaired within the reach, looking at all available biological metric data can be useful in better understanding potential stressors within a reach. The macroinvertebrate community responded negatively to a majority of TSS stress metrics (see table below). The TSS Index score at station 13MN134 was above the Prairie Streams GP Class average, suggesting that TSS is a likely stressor to the macroinvertebrate community. There was a greater than average abundance of TSS tolerant taxa and individuals and few TSS intolerant individuals. Plecoptera taxa were also lacking in the both samples; low quantities of plecoptera taxa within a reach can signify sedimentation of coarse substrates, a side effect of turbid conditions. However, there were sufficient quantities of collector-filterer taxa, which may indicate turbid conditions are episodic and not persistent within the reach.

Table 188. Macroinvertebrate metrics that respond to high TSS stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

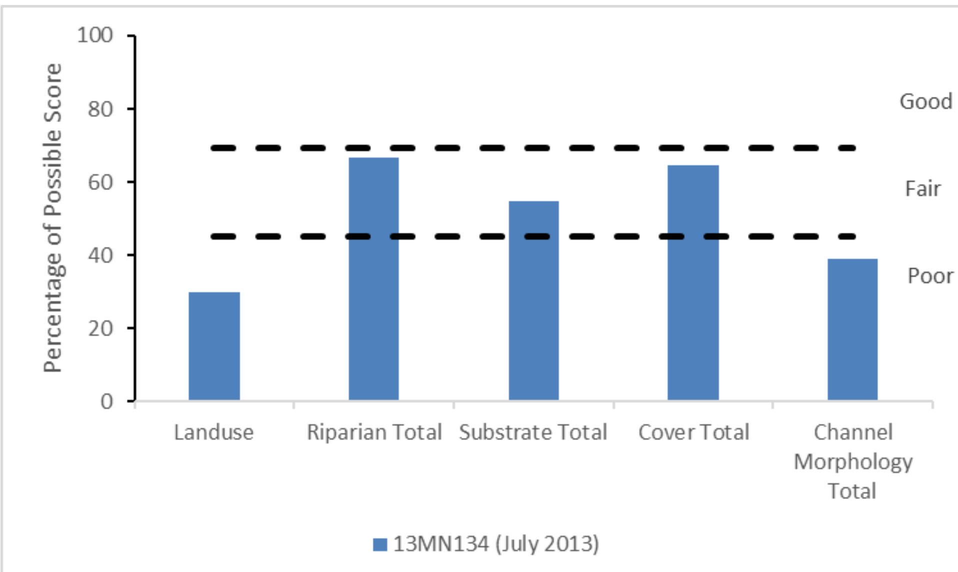
Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN134 (2013)	17.10	**0.00**	**22.14**	**0.00**	**0.00**	**13.00**	**71.70**
13MN134 (2013)	20.26	**0.32**	**20.58**	2.00	**0.96**	**14.00**	**75.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

A preponderance of metric and chemical evidence suggests that elevated levels of TSS are stressing the fish community in the reach.

Habitat

One qualitative stream habitat survey was conducted at biological station 13MN134 in 2013 (see graph below). The MSHA rating was fair (51.3). Overall landuse along the reach is utilized for row crop agriculture and other agricultural activities including hay fields and livestock rearing. There are two large swine facilities in the watershed with greater than 1000 animal units and a handful of small feedlots (swine, horse). The communities of South Branch and Odin are unsewered. There are a few petroleum leak sites near the community of Odin near the upper portion of the reach. The reach retains its natural sinuosity throughout a majority of the reach; it has a predominately wooded stream corridor of mature trees. At the biological station the riparian width is greater than 100 meters wide on either bank. Erosion and sedimentation are problematic in the reach, resulting in a moderate stream stability score (see photos below). Riffles were not found within the biological sampling reach; 80% of the reach was comprised as run while 20% was pool. A moderate amount of instream cover was noted as available to aquatic biota within the reach.

Figure 180. Percentage of MSHA subcategory scores for station 13MN134 in South Fork Watonwan River.



The fish community at station 13MN134 is responding negatively to a majority of degraded habitat metrics (see table below). There is a high percentage of tolerant taxa within the reach. In addition, there were below average quantities of piscivores, lithophilic and simple lithophilic spawners, 'darter, sculpin, sucker species', riffle dwelling species and benthic insectivores. Low numbers of darter, suckers and lithophilic spawner and riffle dwelling taxa corroborate low quantities of coarse substrates and riffles within the reach, which was identified during the MSHA survey. Low quantities of piscivore taxa could indicate that limited habitat is available for predatory taxa like deep pools, or that pools are being filled in by sediment. Habitat stress metrics reflect characteristics of species, which require specific habitat niches; low quantities of these taxa indicate diverse habitats are not widely available within the reach.

Table 189. Fish metrics that respond to degraded habitat conditions in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN134 (2013)	**79.16**	**0.26**	**20.76**	**8.96**	16.71	**12.40**	**9.22**	**16.37**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

While the macroinvertebrate community is not impaired within the reach, reviewing metric data from both indicators can be useful in better understanding potential stressors in a reach. In contrast to the fish results, the macroinvertebrate community showed only a marginal response to degraded habitat conditions (see table below). There were low quantities of burrower taxa and above average quantities of climber, clinger and EPT taxa. High quantities of climber taxa can be a reflection of an abundance of overhanging vegetation available within the reach as was observed. High quantities of clinger taxa are a reflection of the abundance of woody debris observed at the station. There was an above average quantity of legless taxa, which includes worm, and snail taxa that have limited habitat requirements suggesting potential for stress.

Table 190. Macroinvertebrate metrics that respond to degraded habitat conditions in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN134 (7/30/2013)	5.81	26.77	36.45	45.16	**48.06**	27.42
13MN134 Repeat	2.89	38.26	38.91	44.37	**45.98**	**17.68**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

A preponderance of data including MSHA results and a negative response to degraded habitat metrics in the fish community indicate that habitat is stressing the fish in the reach. While macroinvertebrates did not show a similar response, better results are likely due to the present community taking advantage of habitat niches that are not as beneficial to the fish community (overhanging vegetation and woody debris).

Figure 181. Biological station 13MN134 (August 14, 2013) stream bank erosion (upper left); sediment deposition (upper right); sediment deposition and erosion (lower left); (May 24, 2016) stream bank erosion (lower right).

Altered hydrology/Longitudinal connectivity

There is a dam within the reach upstream of biological station 13MN134. Eleven fish taxa were identified above the dam in upstream WIDs, only two of these taxa are known migratory species, blackside darter and white sucker. Twenty taxa were identified within the reach (below the dam), six of which were migratory fish taxa, four of which were not identified above the dam, including black bullhead, central stoneroller, quillback, shorthead redhorse, silver redhorse and slenderhead darter. Three additional species were identified in the next downstream WID that were not identified in -547 (see table below).

One mussel taxa was identified within the reach during DNR surveys from 1999-2003, *Amblema plicata* (Threeridge). Four additional mussel taxa were identified above the reach: *Anodontoides ferussacianus* (cylindrical papershell), *Lasmigona complanta* (white heelsplitter), *Leptodea fragillis* (fragile papershell), and *Strophitus unulatus* (creeper). Twelve mussel species were identified downstream of the reach on the South Fork Watonwan River. Limited presence of mussel taxa in a reach can be a good indication of a longitudinal connectivity stressor because many mussel taxa rely on migratory fish to complete their life cycles.

While the fish community below the dam does not indicate connectivity in the reach is a concern, mussel taxa and fish communities in WIDs upstream of the barrier suggest that isolated longitudinal connectivity stress is present within the reach above the dam; however, there is no fish visit above the dam within the reach to corroborate this claim. As such, longitudinal connectivity is an inconclusive stressor in the reach, until an additional fish sample is obtained to verify limited diversity above the dam and within the reach.

Table 191. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Taxa in blue are known lake species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN164	13MN109	Dam	13MN134	13MN142
WID	-569	-568		-547	-517
Fish Taxa					
bigmouth buffalo					X
bigmouth shiner	X	x		x	X
black bullhead				x	X
blacknose dace				x	X
blackside darter		x		x	X
bluntnose minnow	X			x	X
brassy minnow	X			x	
brook stickleback					
central stoneroller				x	X
channel catfish				x	
common carp	X	x		x	X
creek chub	X	x		x	X
fathead minnow	X	x		x	X
green sunfish				x	X
johnny darter		x		x	X
northern pike		x		x	x
quillback				x	
sand shiner				x	x
shorthead redhorse				x	x
silver redhorse					x
slenderhead darter					x
spotfin shiner		x		x	x
stonecat					x
tadpole madtom				x	
white sucker		x		x	x
yellow bullhead					

The Altered Watercourses GIS layer for Minnesota streams indicates that the 20.71 mile long reach of the South Fork Watonwan River is 5% modified and 95% natural. A large portion of the South Fork Watonwan's headwaters upstream of AUID -547 has been channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed at the biological station.

Low quantities of long-lived taxa and riffle dwelling taxa were identified within the reach. Limited presence of taxa that fit these descriptions can indicate that low flow conditions caused by altered hydrology may be causing stress within the reach. One lake taxa, black bullhead was identified within the reach. Presence of lake taxa within a reach can signify low flowing conditions and can indicate potential low flow conditions caused by altered hydrology within a reach (see table below).

Table 192. Fish metrics that respond to altered hydrology stress in the South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN134 (2013)	**79.16**	**1.81**	**12.40**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Evidence of low flow conditions was observed at biological station 13MN134 in September of 2012 (see photo below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach. Low flow conditions were also observed in the next downstream WID -517 at station 13MN142.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

It is likely that upstream stream alteration is causing stress to the biological community downstream on this reach by sending larger volumes of water downstream, leading to stream bank erosion and stream bank destabilization and resulting in low baseflow conditions in late summer months, which greatly inhibit aquatic biology.

Figure 182. Biological station 13MN134 (September 12, 2013) low flow.

4.1.3. AUID Summary

TSS, degraded habitat and altered hydrology are stressors to the fish community within the reach. A turbidity impairment corroborates the presence of elevated levels of suspended sediment in the reach as does recent elevated samples gathered during spring runoff events for SID. Fish responded negatively to both habitat related TSS stress metrics as well as having an abundance of TSS tolerant individuals within the reach. Macroinvertebrates also had an abundance of TSS tolerant taxa within the community. Elevated levels of instream sediment are consistent with observations made during MSHA surveys, including an abundance of fine sediments within the reach, embedded coarse substrates and moderate stream bank erosion. The fish metrics are responding poorly to the absence of riffles in the reach and the limited availability of coarse substrates (Gravel was the only coarse substrate identified.). Instream sedimentation is limiting the fish community. While the reach is predominately natural, upstream channel modifications through ditching and impacts from agricultural inputs from above and within the watershed, including tile drainage, are likely having cumulative impacts on the biology within the reach by increasing stream bank erosion with higher flows and causing sedimentation. Wetland draining in conjunction with extensive tile drainage in the upstream watershed has also decreased water table levels within the reach limiting the availability of baseflow reach causing extreme low flow conditions in the late summer months that inhibit aquatic biology.

Eutrophication and nitrates are inconclusive stressors within the reach. There was a small phosphorous dataset with some readings above the southern regional standard, but there were no response variable data to corroborate potential eutrophication stress. While biological metric data suggested potential for eutrophication stress within the reach, additional chemical information will be needed to help better define the stressor. While evidence of high nitrate concentrations were present in the reach during spring runoff, the dataset was small. Fish are also not good indicators of nitrate stress. However, the macroinvertebrate community responded negatively to elevated nitrate levels. Efforts to reduce nitrates are needed to prevent future impairment to the macroinvertebrates in the reach.

Longitudinal connectivity is an inconclusive stressor on the reach at this time. While the biological station was below a known dam within the reach and not exhibiting signs of longitudinal connectivity stress, it is presumed that the barrier is likely limiting the fish within the reach upstream of the dam as it has also limited fish communities on upstream WIDs. Mussel survey data also suggests potential for longitudinal stress along the reach. A fish survey above the dam and within the reach would likely confirm assumed stress.

DO is also an inconclusive stressor in the reach. Limited available chemistry data does not show DO levels falling below the 5 mg/L standard; however, the dataset is small and does not include any continuous DO monitoring or early morning samples, when DO troughs generally occur. Biological metric data did not exhibit a strong response to low DO stress.

Table 193. Summary of stressor determinations for South Fork Watonwan River (547).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
South Fork Watonwan River	07020010-547	o	o	o	●	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

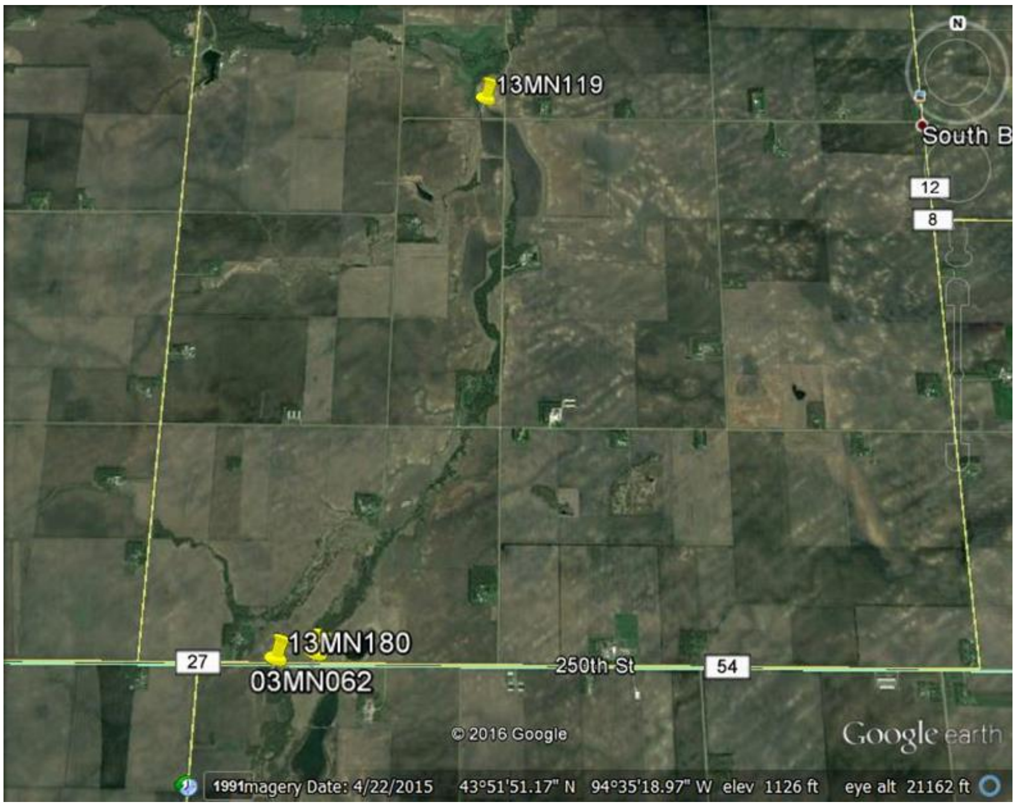
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Willow Creek -571

This reach (07020010-571) is the downstream most reach of Willow Creek, a tributary of the South Branch Watonwan River. The reach begins at the outlet of upstream reach (07020010-521) downstream of 220th St. and flows 8.6 river miles before joining the South Branch of the Watonwan upstream of CR 122. The reach is classified as general use warmwater (2B). The reach is currently impaired for aquatic life for degraded fish (2006) and macroinvertebrate (2015) communities.

Figure 183. Google Earth image of Willow Creek (-571).



4.1.1. Biological communities

There are three biological sites along the reach with four F-IBI sampling events. Station 03MN062 was sampled once in 2003 and scored 42.4, below the threshold (55) but within lower confidence limits. Station 13MN119 was sampled once in 2013 and scored 27.3, below the threshold (55) and lower confidence limits. Station 13MN180 was sampled twice for fish; the 2013 FIBI score was five, and the 2014 FIBI scored zero, both samples scored below the threshold (55) and lower confidence limits. Station 13MN180 had low capture rates at both visits (less than 25 species, resulting in low end scoring), dominant taxa within the visits included common carp, fathead minnow, blacknose dace and creek chub. The dominant species at 03MN062 included: creek chub, blacknose dace and white sucker.

The dominant species at 13MN119 included: blacknose dace, fathead minnow, bigmouth shiner, white sucker and sand shiner.

In comparing visits temporally it appears as though the quality of the fish community in the reach (diversity and individual fish count) has drastically diminished since the initial sampling event in 2003 (03MN062 is just downstream of station 13MN180). Looking at more recent visits, longitudinally, it appears as though diversity and fish numbers are worse in the reach's headwaters at sampling station 13MN180 in comparison to the downstream station 13MN119 (see graph below).

Macroinvertebrates were sampled at station 13MN119 in 2013. Efforts were made to sample macroinvertebrates at 13MN180 in 2013 and 2014 but were unsuccessful as the station was completely dry. Macroinvertebrates were not sampled at station 03MN062 in 2003 for unknown reasons. At 13MN119 the MIBI score was 35.2, below the threshold (41) but within lower confidence limits. Dominant taxa captured included: Polypedilum, Thienemannimyia Gr., Cheumatopsyche and Physa. Two metrics scored zero: relative abundance of non-hydropsychid Trichoptera individuals (TrichwoHydroPct) and taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN TVs (Intolerant 2Ch). In addition, the following metrics failed to meet threshold averages needed to meet the standard: relative percentage of Trichoptera Taxa (TrichopteraChTXPct), taxa richness of Plecoptera, Odonata, Ephemeroptera, Trichoptera) POET, HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) and relative abundance percentage of collectorer-filterer individuals in a subsample (Collector-filterer percent) (see graph below).

Figure 184. Fish metrics of the Southern Streams Class IBI for station 13MN119, Willow Creek.

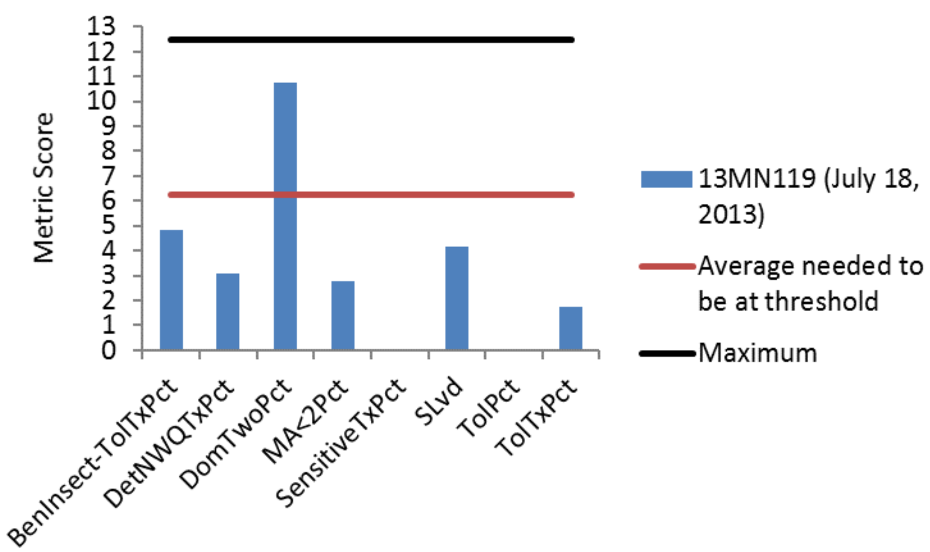


Figure 185. Fish metrics of the Southern Headwaters Class IBI for station 03MN062 and 13MN180, Willow Creek.

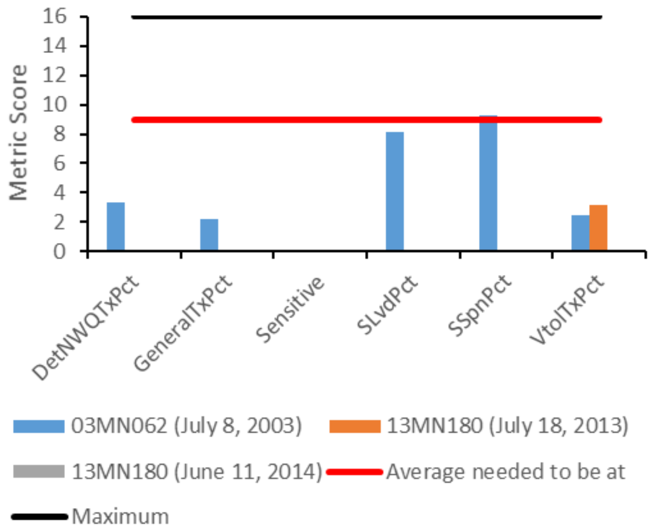
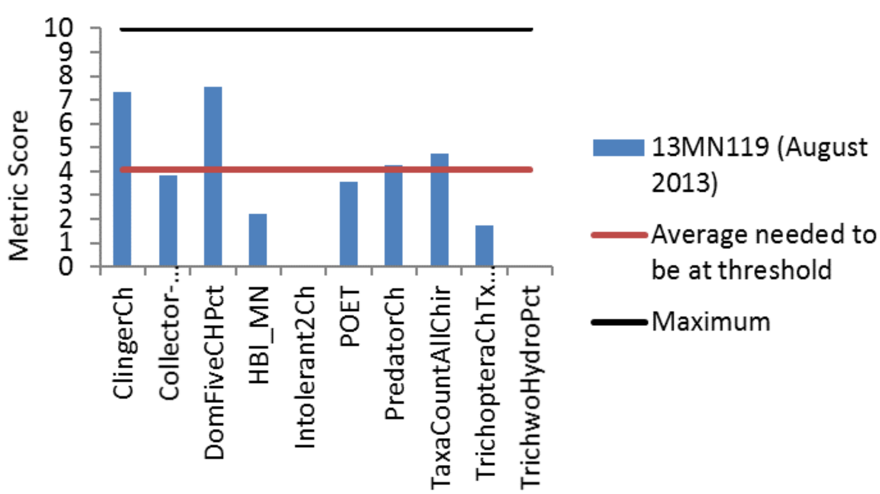


Figure 186. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN119, Willow Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Seven DO measurements have been collected on the reach at three biological stations from 2003, 2013 and 2014. Values ranged from 6.6 mg/L at 13MN180 on July 18, 2013 to 10.69 mg/L on August 13, 2013 at station 13MN119; all values were above the low DO standard of 5 mg/L. No DO samples were collected on the reach prior to biological monitoring. An additional 11 DO samples were gathered during SID investigations in 2015 and 2016, values ranged from 7.88 mg/L to 13.31 mg/L suggesting potential for high DO flux . A continuous sonde was deployed in 2016 from August 24 to September 7 to monitor DO levels (see graph below). No readings fell below the low DO standard, but DO flux exceeded the standard during three days of the deployment, suggesting potential eutrophication issues within the reach (see graph below).

Figure 187. Diurnal DO results for station 13MN119 August 24 –September 7, 2016.

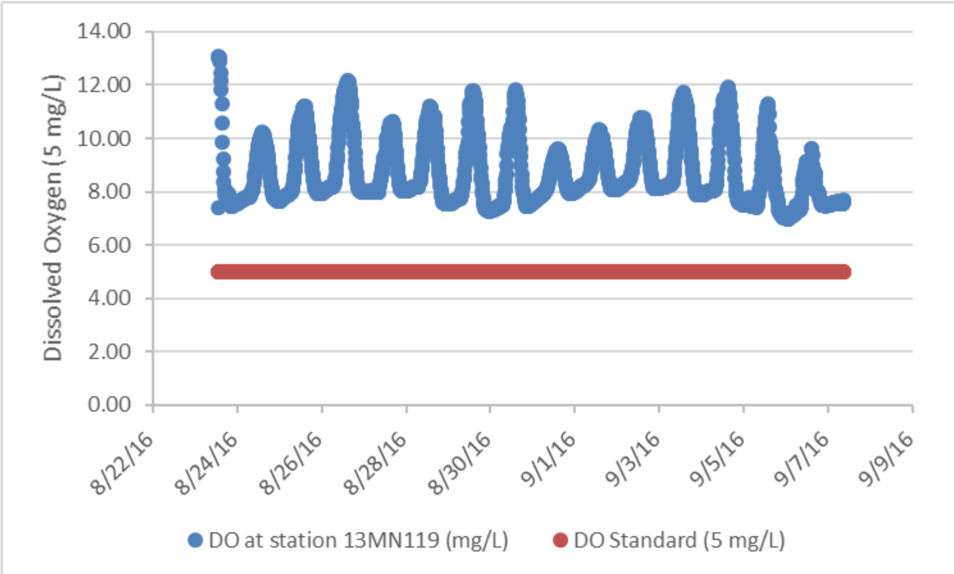
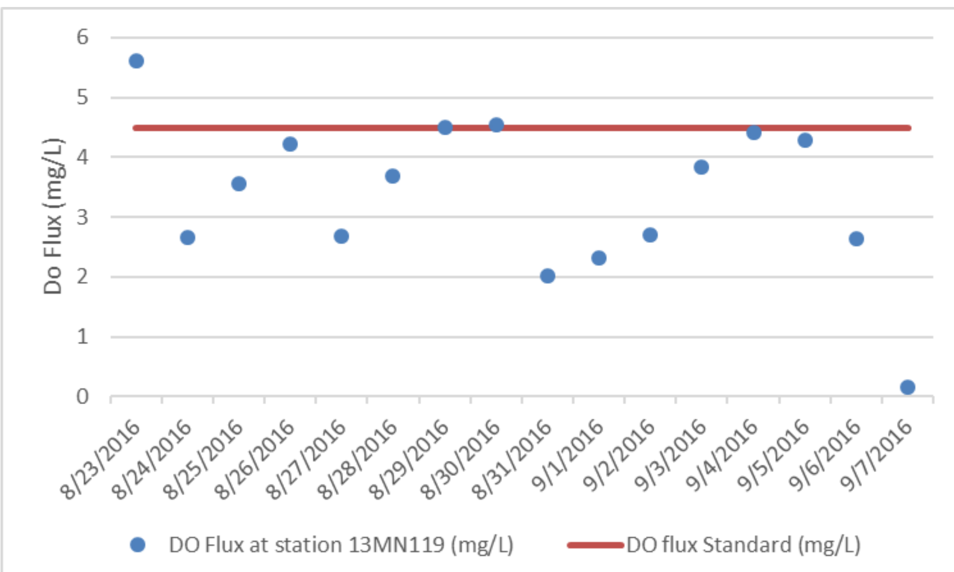


Figure 188. Daily DO Flux results for station 13MN119 August 24 –September 7, 2016.



The macroinvertebrate community is showing a mixed response to low DO stress (see table below). The low DO Index score was above the Prairie Streams GP class average, suggesting that the community is not likely stressed by low DO levels. While there were below average quantities of EPT taxa and general taxa diversity, suggesting stress, there were also below average quantities of low DO tolerant taxa and above average quantities of low DO intolerant taxa, indicating the low DO stress is unlikely. Low quantities of EPT and general taxa counts are likely attributed to other stressors in the reach.

Table 194. Macroinvertebrate metrics that respond to low DO stress in Willow Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN119 (2013)	**35.00**	**5.00**	2.20	6.94	3.00	10.93	7.00	10.46
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish community is showing a mixed response to low DO stress within the reach (see table below). The low DO Index score at station 13MN119 was just below the average for the Southern Streams Class, indicating a low probability that low DO levels are impacting the fish community. The low DO Index score at station 03MN062 was just above the average for the Southern Headwaters Class while mixed results were observed between the two visits at 13MN180, one above the class average and one below. There was an absence of generally sensitive and low DO sensitive taxa within the reach and generally low quantities of late maturing taxa, indicating potential for low DO stress within the reach. There were also below average quantities of DO tolerant taxa, suggesting that other stressors may be influencing fish communities. There was an abundance of low DO tolerant individuals at the first visit of the upstream most station on the reach and at the downstream most visit in the reach, 83% of the individuals captured at 13MN180 were tolerant of low DO conditions. While results at stations 13MN119 and 13MN180 may be skewed by low taxa and individual counts during visits, present metric data suggests potential for low DO stress within the reach.

Table 195. Fish metrics that respond to low DO stress in Willow Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
03MN062 (7/8/2003)	**0.00**	**9.68**	**95.70**	7.19	**0.00**	**0.00**	2.00	2.69
13MN180 (7/18/2013)	**0.00**	**8.33**	**100.00**	**6.50**	**0.00**	**0.00**	3.00	**83.33**
13MN180 (6/11/2014)	**0.00**	**0.00**	**100.00**	7.74	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
13MN119 (2013)	**0.00**	14.81	**93.12**	**7.13**	**0.00**	**0.00**	3.00	**24.34**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is no chemical evidence of low DO conditions within the reach. The macroinvertebrate community is exhibiting limited signs of low DO stress while two fish visits suggest that low DO conditions may exist within the reach but results could be skewed by low sample size. As fish metric data may be skewed by low taxa count and sample size during fish surveys, additional fish samples would be useful on station 13MN119 and 13MN180 to determine whether low sample size can be attributed to sampling too early in the season or is reflective of the true condition in the reach. Additional continuous DO monitoring would be useful during a more normal year to see if low DO conditions exist within the reach. DO stress is inconclusive for fish and not likely for the macroinvertebrates.

Eutrophication

There were four phosphorous samples collected at three biological stations during four visits. Two readings at one station (13MN180) were above the southern regional eutrophication standard of 0.15 mg/L. Seven additional samples were collected in 2015 and 2016 at biological station 13MN119, 3 of these samples exceeded standards. Phosphorous concentrations ranged from 0.056 mg/L to 0.348 mg/L, with an average concentration of 0.159 mg/L, exceedances occurred in June of 2015, and May, June and September of 2016 . There was one chlorophyll a sample collected in 2015 (2.59 mg/L), below the southern eutrophication standard of 35 ug/L. No BOD samples were collected in the reach. DO values ranged from 6.6 mg/L to 13.31 mg/L in the reach indicating potential for elevated DO flux. In 2016 during continuous sonde deployment at 13MN119, DO flux exceeded the standard during three days of the deployment, suggesting potential eutrophication issues within the reach. There was also an abundance of filamentous algae identified at biological station 13MN119 in May of 2015 (see photo below). As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.7 – 8.41 in the reach.

The macroinvertebrate community is showing a response to eutrophication stress metrics (see table below). There is an absence of intolerant taxa and an abundance of tolerant taxa in the reach. There were low numbers of collector-filterer, collector-gatherer and EPT taxa as well, signaling potential stress within the reach.

Figure 189. Biological station 13MN119 (May 6, 2015) filamentous algae.

Table 196. Macroinvertebrate metrics that respond to eutrophication stress in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN119 (2013)	**35.00**	**4.00**	**12.00**	**5.00**	**0.00**	**97.14**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*37.00*	*4.95*	*19.13*	*8.91*	*0.24*	*81.88*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community responded negatively to a majority of eutrophication stress metrics (see table below). Intolerant and sensitive taxa were absent across all stations and visits, and all visits were dominated by tolerant taxa. Darter counts were also low across all visits. Simple lithophilic spawner counts were above average at two visits 13MN119 and the 2014 visit on 13MN180, while they were below average at station 03MN062 and the 2013 visit on station 13MN180. However, these metrics are general in nature and could be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were identified sporadically on the reach, once at mid station 13MN180 and at the downstream most station 13MN119, suggesting that eutrophication is a potential stressor to the fish community within the reach.

Table 197. Fish metrics that respond to eutrophication stress in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
03MN062 (7/8/2003)	**0.00**	**4.30**	**22.04**	12.37	**95.07**	**9.00**	**0.00**
13MN180 (7/18/2013)	**0.00**	**0.00**	**8.33**	**83.33**	**100**	**5.00**	**0.00**
13MN180 (6/11/2014)	**0.00**	**0.00**	71.43	0.00	**100**	**2.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
13MN119 (2013)	**0.00**	**5.80**	37.57	**38.10**	**93.12**	**13.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While elevated phosphorous concentrations were identified within the reach, the dataset was small and there was limited response variable data available to confirm eutrophication stress aside from a few elevated DO flux readings. Both fish and macroinvertebrates responded negatively to eutrophication stress metrics; however, eutrophication stress metrics are general in nature and could be indications of other stressors in the reach. As such, eutrophication is an inconclusive stressor in the reach at this time.

Nitrate

During the fish samples, four nitrate samples were collected in 2003, 2013 and 2014. Nitrate concentrations ranged from 9.3 mg/L on 7/18/2013 to 20 mg/L on July 8, 2003. Two of the four readings were above 15 mg/L at the two upstream most stations 13MN180 and 03MN062. An additional seven samples were collected in 2015 and 2016 during the months of February, May, June and September at 13MN119. Nitrate concentrations ranged from 0.41 mg/L in August of 2015 to 26 mg/L in May of 2016, with an average overall concentration of 17.25 mg/L. Seven samples were above 15 mg/L. As such, high nitrates were observed at all stations on the reach.

The macroinvertebrates in this reach show consistent indication they are stressed by the elevated nitrate concentrations (see table below). The nitrate index score at station 13MN119 was 4.04, while the average for modified Prairie Streams GP class meeting the impairment threshold is 3.2. This suggests that overall the community present is tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) and decreased intolerant and Trichoptera taxa, all of which are lacking in this reach. Additionally, the number of nitrate tolerant individuals (83.3%) is much higher than average and correspond to a higher than average quantity of nitrate tolerant taxa.

Fish are not good indicators of nitrate stress. The fish communities on the reach were dominated by tolerant taxa and had few tolerant and sensitive taxa and limited numbers of darters. All of these nitrate related stress metrics for fish are very general in nature and could be indicators of other stressors in the reach.

High nitrates are stressing macroinvertebrates in the reach.

Table 198. Macroinvertebrate metrics that respond to nitrate stress in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
03MN062 (No Invert Visit)													20.00 (7/8/2003)
13MN180 (No Invert Visit)													12.00 (7/18/2013)
13MN180 (No Invert Visit)													19.00 (6/11/2014)
13MN119 2013)	**35.00**	**4.00**	**12.00**	**5.00**	**0.00**	**97.14**	**1.00**	**0.00**	**4.04**	**0.00**	**22.00**	**83.30**	9.30 (7/18/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*2.60*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Four TSS samples were collected on three unique biological monitoring station fish visits in 2003, 2013 and 2014; none of these samples exceeded the southern regional TSS standard of 65 mg/L. No additional TSS samples were collected within the reach prior to biological visits in 2013 or 2003. Eight TSS samples were collected from 2015 to 2016 for stressor identification investigations at station 13MN119, two values exceeded regional TSS standards in May and June of 2016. Values ranged from 4.4 mg/L in September of 2015 to 130 mg/L in June of 2016. A DNR geomorphology survey near biological station 13MN119 identified an excess of fine sediments in the reach as well as active cutting, deposition and stream bank sloughing, which is a likely source of suspended sediments observed during SID investigations.

There was a mixed response to elevated TSS stress within the macroinvertebrate community (see table below). The TSS index score for the site was above the Prairie Streams GP class average indicating a high potential that elevated TSS levels are impacting the macroinvertebrates within the reach. In contrast, there was an above average abundance of collector-filterer taxa and plecoptera taxa, which suggests turbid conditions in the reach are not persistent in the reach but a result of episodic events during high flows as collectorer-filterer taxa require clear conditions to gather food. Despite this, there was an absence of TSS intolerant taxa and an abundance of TSS tolerant taxa in the reach.

Table 199. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN119 (2013)	14.71	0.33	**17.97**	**0.00**	**0.00**	9.00	**51.63**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was a mixed response to elevated TSS stress within the fish community (see table below). Nearly all community related metrics responded negatively to TSS stress on the reach, including lower than average abundances of benthic feeders, centrarchids, herbivores, simple lithophilic spawners and riffle dwelling species. An absence of sensitive and intolerant species could be the result of other stressors. Only one station, 13MN180, had a TSS Index score above the Southern Headwaters Class average and was the only reach where above average quantities of TSS tolerant taxa were observed. This could be related to low quantities of fish taxa and individuals captured at stations 13MN180 and 13MN119 and may indicate that available metric data is skewed.

Table 200. Fish metrics that respond to high TSS stress in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
03MN062 (2003)	**20.43**	**0.00**	**16.13**	**0.00**	**0.00**	**4.30**	**16.13**	**0.00**	**9.68**
13MN180 (2013)	**8.33**	**0.00**	**8.33**	**0.00**	50.00	**0.00**	**8.33**	**0.00**	**8.33**
13MN180 (2014)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
13MN119 (2013)	**22.22**	**0.00**	**17.46**	**0.00**	**4.23**	**5.82**	**17.46**	**0.00**	**14.81**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

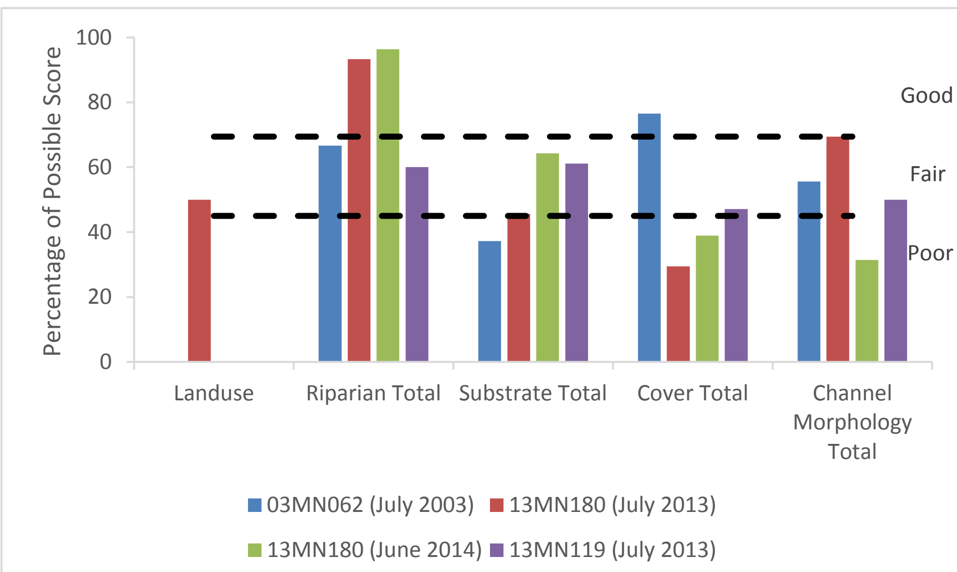
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
03MN062 (2003)	14.34	**0.00**	**0.00**	0.00	0.00
13MN180 (2013)	**30.47**	**0.00**	**0.00**	**1.00**	**50.00**
13MN180 (2014)	10.66	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
13MN119 (2013)	17.98	**0.00**	**0.00**	2.00	12.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Due to a limited chemistry dataset with only a few samples above the standard after rainfall events and inconsistent metric data, which may be skewed due to low sample size in the fish visit, TSS is an inconclusive stressor at this time.

Habitat

There were four qualitative habitat surveys conducted within the reach, one at station 03MN062 in 2003, two at station 13MN180 in 2013 and 2014 and one at station 13MN119 in 2013 (see graph below). MSHA readings across all visits were fair ranging from 49.5 to 58.8. Row crop agriculture is the predominant landuse surrounding the reach with a few feedlots adjacent to the reach (bovine and swine). Riparian buffers along the reach appear extensive where Willow Creek follows its natural course, which is the case for a majority of this reach. In contrast, channelized sections of the reach have much narrower riparian corridors. Heavy bank erosion was identified at reach 03MN062, where limited channel erosion was identified at 13MN180 and 13MN119 (see photos below). Coarse substrates were lightly embedded within the reach. Overall stream bank stability was rated moderate. Natural stream channel development was fair across the surveys. Fish cover across the stations ranged from moderate at the 2003 visit to sparse at subsequent visits at stations 13MN180 and 13MN119. A DNR geomorphology survey near biological station 13MN119 identified an excess of fine sediments in the reach as well as active cutting, deposition and stream bank sloughing.

Figure 190. Percentage of MSHA subcategory scores for station 03MN062, 13MN180 and 13MN119 in Willow Creek.



There was a mixed response to degraded habitat within the fish communities of Willow Creek (see table below). There was an overabundance of tolerant taxa within the reach. There was an absence of piscivore taxa and below average quantities of 'darter, sculpin, sucker' taxa, benthic insectivores and riffle dwellers. This suggests limited cover for predatory species, limited availability of riffle habitat and coarse substrate habitat. Almost all habitat metrics showed a negative response at 03MN062, suggesting that the greatest habitat stress within the reach is observed in the reaches headwaters and impacts are less severe moving downstream on the reach. However, low fish capture rates were observed at all visits but station 03MN062 and low sample size could be skewing metric results.

Table 201. Fish metrics that respond to degraded habitat conditions in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
03MN062 (2003)	**95.7**	**0.00**	87.63	**4.30**	**66.67**	**16.13**	**4.30**	**22.04**
13MN180 (2013)	**100.00**	**0.00**	**16.67**	**0.00**	33.33	**8.33**	**0.00**	**8.33**
13MN180 (2014)	**100.00**	**0.00**	100.00	**0.00**	28.57	**0.00**	**0.00**	71.43
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*37.00*
13MN119 (2013)	**93.12**	**0.00**	**41.27**	**5.82**	**30.16**	**17.46**	**5.82**	37.57
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↑

There was mixed response to degraded habitat within the macroinvertebrate community (see table below). There was an abundance of climber taxa within the reach at station 13MN119. This suggests an abundance of overhanging vegetation in the reach. The quantity of clinger and sprawler taxa were below the average for the Prairie Streams GP Class, which implies limited availability of coarse substrates and woody debris habitat. There was also an abundance of burrower and legless taxa, which thrive in streams laden with fine sediments and limited habitat diversity.

Table 202. Macroinvertebrate metrics that respond to degraded habitat conditions in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN119 (2013)	**12.42**	26.80	**28.76**	**26.14**	**67.32**	**18.95**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Preponderance of evidence indicates degraded habitat conditions are stressing the biology in the reach.

Figure 191. Biological station 13MN180 (July 18, 2013) raw banks (left); biological station 13MN119 (July 18, 2013) sloughing banks (right).

Figure 192. . Biological station 13MN119 (July 18, 2013) sedimentation and stream bank erosion.

Altered hydrology/Longitudinal connectivity

There are no known dams on Willow Creek or any known fish barriers within the reach. Only six species were identified at the upstream most station on Willow Creek 13MN180, while station 03MN062 had nine species and the downstream most station 13MN119 had 13 species. One known migratory fish species was identified at all three stations, white sucker. Other migratory fish taxa were observed within the reach, black bullhead were only seen at the mid station 03MN062 and blackside darter were only observed at the downstream most station 13MN119, while central stoneroller were observed at the two downstream most stations. Four other migratory fish taxa were observed on the South Fork Watonwan River, above and/or below Willow Creek's confluence. Ten species were observed on the two South Fork Watonwan biological stations that bookended the Willow Creek confluence (see table below).

There were no DNR mussel surveys conducted on Willow Creek.

There is inconclusive information to determine whether or not longitudinal connectivity is a stressor on the reach at this time. Additional investigation would be advantageous in better understanding the potential of road crossing and culverts to act as barriers and limit longitudinal connectivity within the reach.

Table 203. Taxa comparison of biological stations along reach. Taxa in bold are known migratory fish species. Taxa in blue are known lake species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN134	13MN180	03MN062	13MN119	13MN142
WID	-547	-571	-571	-571	-517
	South Fork Watonwan	Willow Creek	Willow Creek	Willow Creek	South Fork Watonwan
Fish Taxa					
bigmouth buffalo					x
bigmouth shiner	x		X	x	x
black bullhead	x		X		x
blacknose dace	x	X	X	x	x
blackside darter	x			x	x
bluntnose minnow	x		X	x	x
brassy minnow	x	X			
brook stickleback					
central stoneroller	x		X	x	x
channel catfish	x				
common carp	x	x		x	x
common shiner				x	
creek chub	x	x	x	x	x
fathead minnow	x	x	x	x	x
green sunfish	x			x	x
johnny darter	x		x	x	x
northern pike	x				x
quillback	x				
sand shiner	x			x	x
shorthead redhorse	x				x
silver redhorse					x
slenderhead darter					x
spotfin shiner	x				x
stonecat					x
tadpole madtom	x				
white sucker	x	x	x	x	x
yellow bullhead					

The Altered Watercourses GIS layer for Minnesota streams indicates that the 8.65 mile long reach of the Willow River is 12% modified and 88% natural. Its headwaters, upstream of -572 are predominately channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. Geomorphology surveys conducted by DNR survey crews identified Willow Creek as a narrow deep E channel with good flood plain connectivity. An excess of fine sediments was identified as was active cutting, deposition and stream bank sloughing. The reach has good recovery potential if existing riparian buffers are maintained and would benefit from increased water storage within its watershed (DNR, 2014). According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor. There are no known fish barriers along the reach. However, beaver activity including a beaver dam was found in 2012/2013 downstream of the geomorphology station.

Black bullhead were the only known lake taxa were identified within the reach; presence of lake taxa within a sample can be indicative of low flow conditions and may be a sign of altered hydrology stress. Low quantities of riffle taxa were observed during fish sampling across all stations on Willow Creek, which can be an indicator of altered hydrologic stress. There was an abundance of long-lived taxa at one visit on station 13Mn180, while quantities at other visits were below average. Low quantities of long-lived taxa in a sample suggest altered hydrologic stress is impacting the reach; however, discrepant information is presented within the dataset, which could be skewed by low taxa counts at most visits (see table below).

Table 204. Fish metrics that respond to altered hydrology stress in Willow Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
03MN062 (2003)	**95.70**	**0.00**	**16.13**
13MN180 (2013)	**100.00**	50.00	**8.33**
13MN180 (2014)	**100.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
13MN119 (2013)	**93.12**	**4.23**	**17.46**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.6*	*32.49*
Expected response to stress	↑	↓	↓

Low flow was documented in 2012 at biological stations 03MN062 and 13MN119 (see photographs below). No photographs were taken of station 13MN180 in fall of 2012; however, it is a safe assumption that if low flow conditions were present downstream, upstream stations were also likely impacted. In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow conditions were identified on the reach in 2013 and 2014 as well at biological station 13MN119, when macroinvertebrate crews attempted to sample the station in August in both years they were unable to sample due to insufficient flow in the reach. Sufficient baseflow appears to be a persistent problem in the reach and is likely having negative impacts on its biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is a likely stressor within the reach at this time.

Figure 193. Biological station 03MN062 (September 2012) dry streambed (left); biological station 13MN119 (September 2012) extreme low flow (right).

Figure 194. Biological station 13MN119 (July 10, 2014) remnant of flooded field (left); (June 2016) flooded field (right).

4.1.3. AUID Summary

Degraded habitat, altered hydrology and nitrogen are stressors within the reach. Conditions observed are likely attributed to extensive agricultural landuse within the region and historic wetland drainage and stream ditching. Erosion impacts from rain events are exacerbated by inputs from drain tiles from agricultural fields. This causes increasing stream power and erosive ability of the stream, thus increasing the instream sediment load, which covers coarse substrates and fills in pools and riffles and limits available habitat. This is confirmed by MSHA observations across the reach and a biological response including an abundance of burrowing and legless taxa and limited prevalence of riffle dwelling taxa and coarse substrate obligates. While the chemical dataset for nitrogen was limited to 11 samples, seven were above 15 mg/L. Elevated samples were collected during spring months, indicating that concentrations are likely influenced by contributions from tile drainage from the surrounding and upstream agricultural landscape. Macroinvertebrate metrics showed a strong response to nitrate related stress, further strengthening the case for the stressor. In addition to stress brought on my elevated flows during spring runoff events, low flow events are also persistent in the reach observed in 2012 – 2014. Low flows in the reach are a result of extensive drainage in the watershed reducing the level of the water table and limiting summer baseflow causing low flow conditions and dry streambeds that have dramatic impacts on aquatic biological communities.

Eutrophication, TSS and longitudinal connectivity are inconclusive stressors within the reach. While the chemical dataset was small, a majority phosphorous samples exceeded the regional standard. A few elevated DO flux levels also indicate that eutrophication stress is a potential concern within the reach. Both fish and macroinvertebrate eutrophication stress metrics also indicated a probability of stress. Additional data would be helpful to solidify findings and build a stronger case for this potential stressor. The TSS dataset was small, elevated concentrations observed were during event-based sampling. Macroinvertebrate metric data shows that stress is likely, but the metric response within the fish community was less clear, fish responded negatively to sedimentation related metrics but only one station had an abundance of TSS tolerant individuals. Fish results may also be skewed by low sample size. Additional TSS data would help bolster the case for TSS as a stressor. While there are no known fish barriers within the reach, low sample counts observed during the fish visits in 2013 and 2014 and varied presence of migratory fish taxa across the reach suggest that potential barriers may exist within the reach that is limiting longitudinal connectivity. Additional investigation is needed to understand the potential stressor within the reach.

DO is not a likely stressor to the macroinvertebrate community within the reach at this time, there was no evidence from grab samples or continuous sonde deployment that DO levels were below the standard. Fish metrics show potential for low DO stress within the reach but it is not clear if low fish counts are skewing stress metrics. Additional continuous DO monitoring during a more normal water year would be useful to better understand the potential for low DO conditions within the reach.

An additional attempt to monitor fish at stations 13MN119 and 13MN180 during mid-summer baseflow conditions would be helpful to see if more greater fish taxa and numbers are observed as a more robust community would provide better stress related metric data. An additional attempt to sample macroinvertebrates at station 13MN180 and 03MN062 would also be useful in providing a broader picture of metric stress across the reach.

Table 205. Summary of stressor determinations for Willow Creek (571).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Willow Creek	07020010-571	-/o	o	●	o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

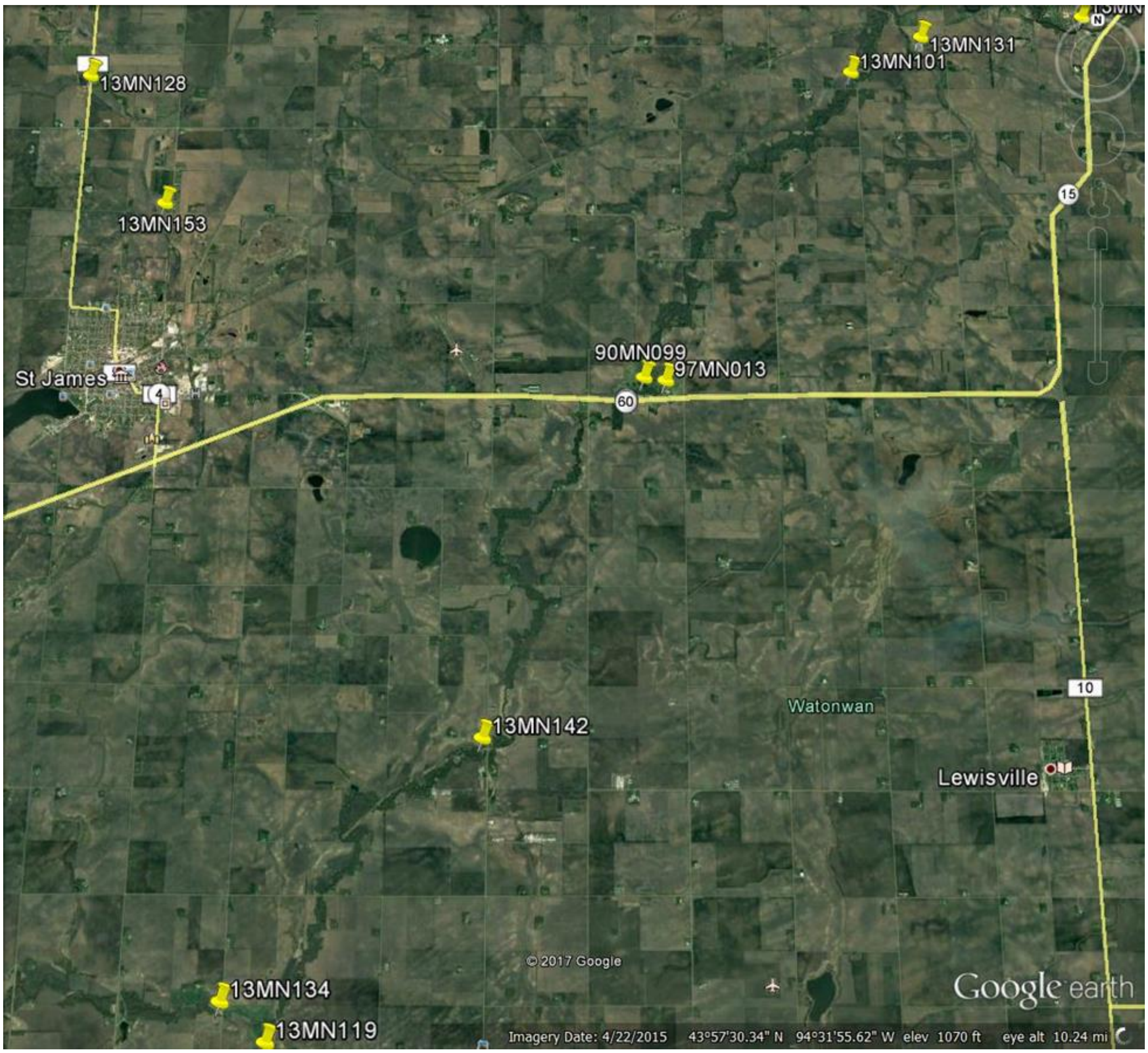
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. South Fork Watonwan River -517

Reach (07020010-517) is the culmination of the South Fork Watonwan River. It begins at the outflow of reach (07020010-547), upstream of CR 122 and flows northeast 25 river miles to its confluence with the mainstem Watonwan River (07020010-510) downstream of Co. Hwy 116. Throughout its course, it gains the flow of Willow Creek (07020010-571) and Spring Brook (07020010-540). This reach is classified as general use warmwater 2B. This reach is impaired for aquatic life, for both fish and macroinvertebrate communities (2015) and excessive levels of turbidity (2006) and for aquatic recreation for high levels of fecal coliform bacteria (2006).

Figure 195. Google Earth image of South Fork Watonwan River (-517).



4.1.1. Biological communities

There are four biological stations on this reach with eight fish visits and six macroinvertebrate visits. The table below summarizes the FIBI and MIBI results at all stations (see table below).

Two FIBI results from 90MN099met standards while the remaining did not, all but two of the remaining visits fell within the lower confidence interval. The highest FIBI results were observed at the mid station while the lowest were observed at the upstream and downstream most station. All fish visits lacked sensitive taxa. The following fish metrics were below the average threshold needed to meet standards for a majority of the observed visits: percent detritivorous species (DetNWQTxPct), number of short-lived species (SLvd), tolerant percent (TolPct) and percentage of individuals that mature after two years (MA<2Pct). Overwhelmingly fish visits were dominated by tolerant taxa (see graph below). Across the reach fish communities were generally dominated by sand shiners, bluntnose minnow, white suckers and spotfin shiners.

Table 206. Summary of fish and macroinvertebrate visits and IBI scores in the reach.

Field Number	Fish Visit Date	FishIBI	FIBI GU Threshold	FIBI CI	Invert Visit Date	MIBI	Invert GU_Threshold	Invert CI
13MN142	7/17/2013	40.1	50	9	8/14/2013	43	41	14
90MN099	8/8/2001	47.7	50	9	9/12/2002	54.9	41	14
90MN099	8/17/2010	59.7	50	9	8/19/2010	41	41	14
90MN099	9/1/2010	59.9	50	9	8/14/2013	33.6	41	14
90MN099	7/16/2013	44.8	50	9	X	x	X	x
97MN013	8/27/1997	42.5	50	9	X	x	X	x
13MN101	7/17/2013	43.9	50	9	8/14/2013	34.8	41	14
13MN101	7/22/2014	39	50	9	8/13/2014	49.9	41	14

Results from four of six macroinvertebrate visits met standards while two did not and fell within lower confidence limits, both events occurred in 2013 at stations 90MN099 and 13MN101. All visits scored a zero on the Intolerant2Ch metric (taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN TVs). Both failing stations scored less than the average needed to meet standards for the following metrics: relative percentage of trichoptera taxa (TrichopteraChTxPct), taxa richness of predators (PredatorCh), and HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota). The failing visit for 90MN099 also scored a zero for metric TrichwoHydroPct (Relative abundance (%) of non-hydropsychid Trichoptera individuals in subsample). The failing visit for 13MN101 also scored a zero for the metric collector-filterer percent (Collector-filtererPct) (see graph below). Both failing visits scored near the average needed to meet standards for the percentage of dominant five taxa in subsample (DomFiveChPct), inferring that the MIBIs were not skewed by an abundance of a few tolerant taxa. Macroinvertebrates at station 13MN142 were dominated by: Cheumatopsyche, Tricorythodes, Polypedilum and Stenelmis taxa. Station 90MN099 was dominated by Cheumatopsyche, Stenelmis and Tricorythodes taxa. Station 13MN101 was dominate by Heptagenia, Tricorythodes, Heptageniidae and Stenelmis during the 2013 visit and Polypedilium, Ablabesmyia and Physella during the 2014 visit.

Figure 196. Fish metrics of the Southern Streams Class IBI for station 13MN142, 90MN099, 97MN013 and 13MN101, South Fork Watonwan River.

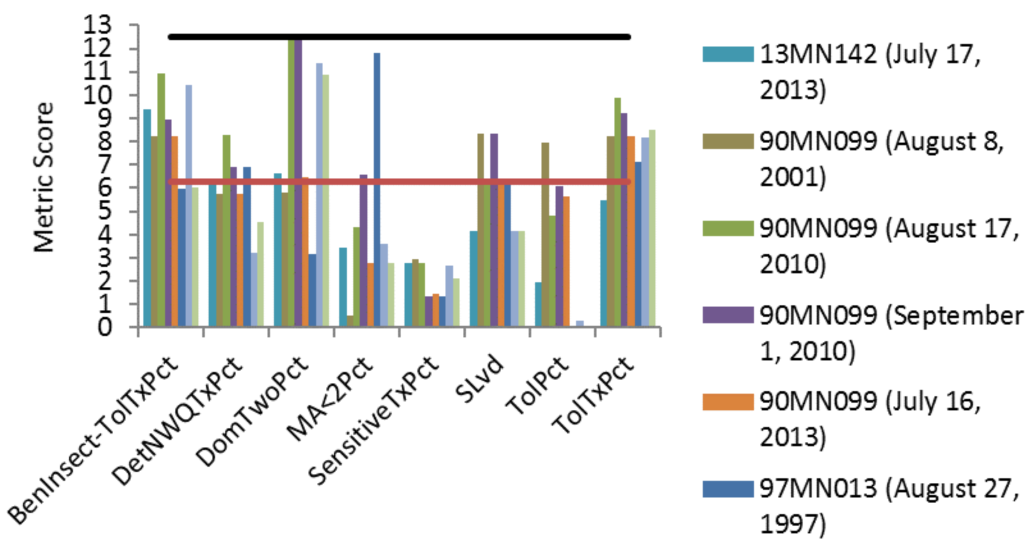
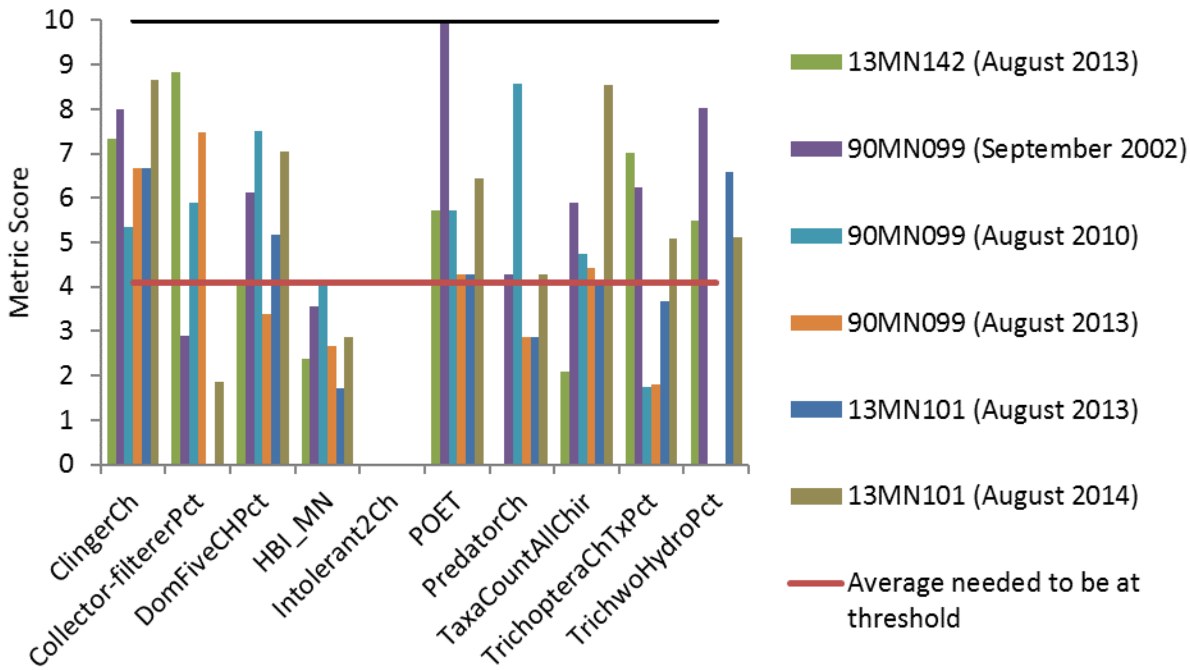


Figure 197. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN142, 90MN099, 97MN013 and 13MN101, South Fork Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There were 12 DO samples collected during biological visits at three unique stations, values ranged from 7.01 mg/L at 90MN099 July 16, 2013 at 11:15 AM to 10.05 mg/L at station 13MN142 at 4:13 PM. There were 101 additional DO samples taken on the reach from 2013 to 2016, values ranged from 6.67 mg/L on June 19, 2016 at 12:50 PM to 16.04 mg/L on April 21, 2015 at 5:35 PM. No values fell below the low DO standard of 5 mg/L. A YSI sonde was deployed at 97MN013 from July 31 to August 6, 2015 to continuously monitor DO levels (see graph below). Violations of the DO standard of 5 mg/L were not recorded during deployment, nor were there violations of the 4.5 mg/L DO flux standard. DO levels were in normal ranges throughout the deployment. DO flux levels ranged from 1.72 mg/L to 2.87 mg/L (see graph below).

High flows in 2016 did not allow for additional planned DO monitoring in that year, additional continuous DO monitoring could be useful to better understand the systems diurnal DO swings as 2015 was also a higher water year.

Figure 198. Diurnal DO results for station 97MN013 July 31 - August 6, 2015.

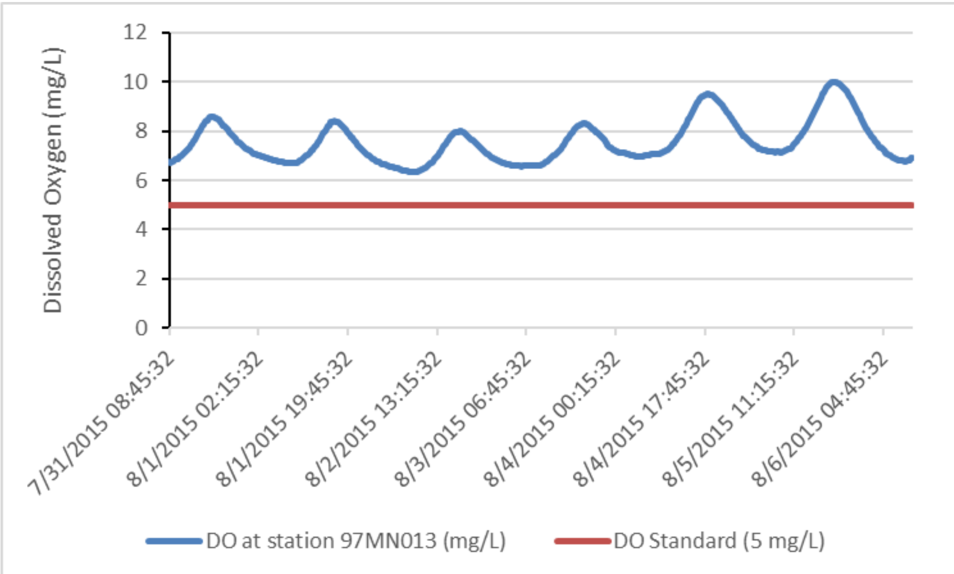
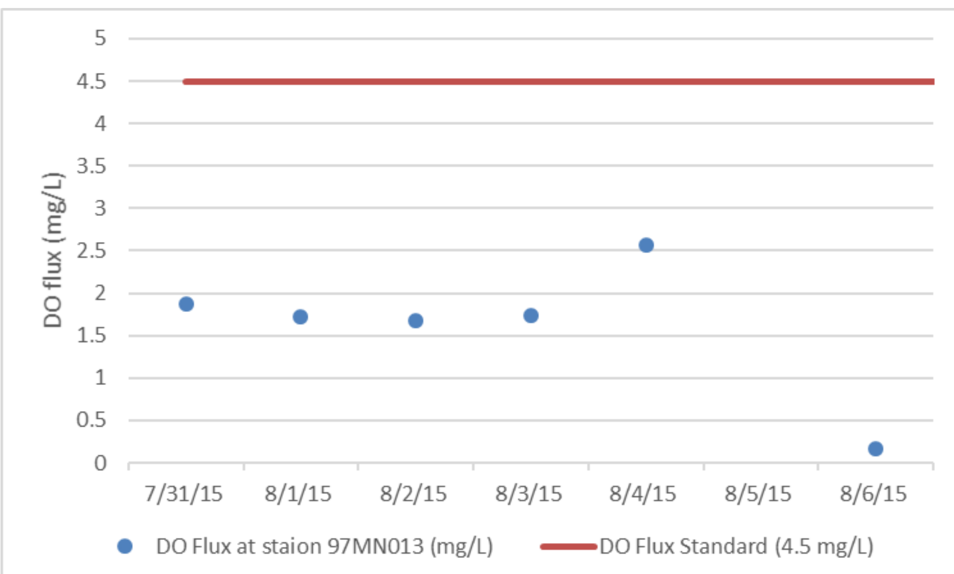


Figure 199. Daily DO Flux results for station 97MN013 July 31 - August 6, 2015.



The macroinvertebrate community is not showing abundant signs of low DO stress (see table below). DO Index scores all fell within respective ranges to meet the threshold. HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) metric values were also below the average at all visits except the 2013 visit at 90MN099, suggesting isolated low DO stress at this station. There were higher than average quantities of low DO intolerant species and individuals. Only one station 13MN101 had higher than average quantities of low DO tolerant taxa but did not have high numbers of low DO intolerant individuals, nor did the other visits.

Table 207. Macroinvertebrate metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN142 (2013)	**26.00**	10.00	2.93	7.38	5.00	**4.47**	2.00	2.24
90MN099 (2002)	38.00	17.00	7.80	7.21	8.00	10.52	3.00	1.20
90MN099 (2010)	**33.00**	**6.00**	7.60	7.29	4.00	11.67	5.00	8.50
90MN099 (2013)	**34.00**	**7.00**	**8.10**	6.82	4.00	6.17	5.00	15.43
13MN101 (2013)	**33.00**	**7.00**	1.71	7.25	4.00	**2.84**	5.00	4.10
13MN101 (2014)	48.00	11.00	2.86	6.75	5.00	**4.41**	**11.00**	12.30
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish community appears to be showing marginal response to low DO stress (see table below). The DO index score was near the threshold at nearly all fish visits, suggesting that it is unlikely low DO conditions are stressing fish communities. There was an abundance of tolerant species at all visits. Generally sensitive taxa and low DO sensitive taxa were low in numbers at nearly all visits, while quantities of DO tolerant taxa were abundant at all visits but individual DO tolerant taxa counts were above the southern streams class average at select visits, suggesting variable levels of DO stress spatially and temporally. Quantities of late maturing taxa were also limited across all visits.

Table 208. Fish metrics that respond to low DO stress in South Fork Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN142 (2013)	**0.53**	**20.68**	**67.72**	7.21	**0.00**	**0.00**	**5.00**	6.86
90MN099 (2001)	**1.61**	**1.10**	**45.02**	**7.15**	**0.00**	**0.00**	**6.00**	9.32
90MN099 (2010)	**3.47**	**3.47**	**56.94**	**7.14**	**0.00**	**0.00**	**7.00**	**18.75**
90MN099 (2010)	**4.68**	**4.68**	**52.05**	7.26	**0.00**	**0.00**	**8.00**	14.62
90MN099 (2013)	**0.76**	**0.76**	**53.79**	**7.11**	**0.00**	**0.00**	**6.00**	**19.70**
97MN013 (1997)	**0.31**	**5.33**	**86.52**	**6.39**	2.00	6.27	7.00	**79.00**
13MN101 (2013)	**1.05**	**20.94**	**73.82**	**7.10**	**0.00**	**0.00**	**5.00**	**23.56**
13MN101 (2014)	**1.42**	**14.25**	**76.35**	7.70	2.00	**0.01**	**9.00**	15.67
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is no chemical evidence in a large dataset to suggest low DO conditions exist within the reach. Macroinvertebrate metrics that respond to low DO stress also do not indicate that low DO is stressing the macroinvertebrate community. Fish metric results suggest that low DO may have been a stressor to the reach in the past at station 97MN013 where and abundance of DO tolerant individual were observed in 1997 but more recent data within the reach shows only a few samples had quantities of low DO tolerant individuals slightly above the Southern Streams GU average at station 90MN099. This suggests that a potential problem exists which has not been detected during DO monitoring and suggests that additional monitoring is warranted. Present of evidence suggests that low DO is an inconclusive stressor to biological communities within the reach at this time.

Eutrophication

There were seven phosphorous samples taken on this reach at three stations, only one value exceeded the southern region eutrophication standard of 0.15 mg/L. There were 180 additional phosphorous samples collected on the reach from 2000-2002 and 2013-2016 at two EQUIS stations. One-hundred-seven samples exceeded the southern regional eutrophication standard with a maximum value of 0.97 mg/L and an average concentration of 0.209 mg/L. There was only one chlorophyll a sample collected on the reach with a value of 6.94 ug/L, below the southern eutrophication standard of 35 ug/L. DO grab sample values in the reach ranged from 6.6 mg/L to 16.04 mg/L indicating potential for elevated DO flux. DO flux data from continuous sonde deployment did not yield any flux readings above the 4.5 mg/L standard. There were no BOD samples collected on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.57 – 10.08 in the reach.

Nearly all of the macroinvertebrate metrics associated with eutrophication indicate stress (see table below). Intolerant taxa were absent across all visits and there was a high relative percentage of taxa with tolerance values equal to or greater than six (Tolerant2ChTxPct), suggesting stress. Nearly all visits had lower than average quantities of collector filterer taxa, collector gatherer taxa and EPT taxa, also indicating potential stress.

Table 209. Macroinvertebrate metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN142 (2013)	**26.00**	**4.00**	**8.00**	**10.00**	**0.00**	**88.46**
90MN099 (2002)	**39.00**	8.00	**13.00**	17.00	**0.00**	**78.95**
90MN099 (2010)	**35.00**	**3.00**	**11.00**	**6.00**	**0.00**	**78.78**
90MN099 (2013)	**35.00**	**5.00**	**13.00**	**7.00**	**0.00**	**94.12**
13MN101 (2013)	**33.00**	**1.00**	**10.00**	**7.00**	**0.00**	**87.88**
13MN101 (2014)	48.00	**5.00**	23.00	**11.00**	**0.00**	**87.50**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*37.00*	*4.95*	*19.13*	*8.91*	*0.24*	*81.88*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

There was a mixed response in the fish metrics with regards to eutrophication stress (see table below). All stations and visits had an absence of intolerant taxa and a low percentage of sensitive taxa as well as an abundance of tolerant taxa. Only one visit had higher than average simple lithophilic spawner quantities, while three had higher than average darter counts, these inconsistencies in the dataset were only apparent at station 90MN099. These metrics are general in nature and could be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were observed across the sampling reach, suggesting potential for eutrophication stress.

Table 210. Fish metrics that respond to eutrophication stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN142 (2013)	**0.53**	**4.32**	**22.57**	**25.21**	**67.72**	20.00	**0.00**
90MN099 (2001)	**1.61**	17.04	**17.68**	8.04	**45.02**	**19.00**	**0.00**
90MN099 (2010)	**3.47**	15.28	**36.11**	**18.06**	**56.94**	20.00	**0.00**
90MN099 (2010)	**4.68**	**9.94**	42.11	15.79	**52.05**	22.00	**0.00**
90MN099 (2013)	**0.76**	**3.03**	17.42	**28.79**	**53.79**	**19.00**	**0.00**
97MN013 (1997)	**0.31**	**6.58**	**10.97**	**71.79**	**86.52**	21.00	**0.00**
13MN101 (2013)	**1.05**	**5.24**	**23.04**	**27.25**	**73.82**	21.00	**0.00**
13MN101 (2014)	**1.42**	**11.68**	**17.38**	**19.09**	**76.35**	26.00	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While eutrophication stress metrics in the reach suggest a high potential for eutrophication stress within the reach, a majority of these metrics are general stress related metrics and could be responding to other stressors within the reach. While elevated phosphorous concentrations appear to be persistent within the reach, what limited response indicator data exists does not indicate elevated phosphorous concentrations are problematic. Additional response variable data should be collected in conjunction with phosphorous sampling to insure that elevated phosphorous concentrations are not stressing biota in the reach. As such, eutrophication is an inconclusive stressor at this time.

Nitrate

During the fish visits there were seven nitrate samples collected at three stations from 2001 to 2014. Samples were collected during the months of July, August and September. Nitrate concentrations ranged from 0.31 mg/L in September of 2010 to 8 mg/L in July of 2013. An additional 125 samples were collected during the years 2000, 2001, 2002, 2013, 2014 and 2015. Samples were collected from April thru October. Nitrate concentrations ranged from 0.07 mg/L in August of 2001 to 19.6 mg/L in June of 2013, with an overall average concentration of 7.9 mg/L. Eighteen samples equaled or exceeded 15 mg/L, these values occurred during the months of May, June and early July in 2001, 2013 and 2014, a 13% exceedance rate.

The macroinvertebrates in this reach show an inconsistent response to elevated nitrate concentrations (see table below). The nitrate index score ranged from 2.9 to 4.41, while the average for modified Prairie Streams meeting impairment threshold is 3.2. There was some differences among sites and years, with the best result seen in 2002 and the worst in 2014. Nitrate intolerant taxa were lacking at all visits except for the 2002 visit at 90MN099, potentially inferring some degradation overtime. Trichoptera taxa were above average at half of the visits, with lowest results observed at 90MN099 during more recent visits. Nitrate tolerant individuals were abundant at stations 13MN101 and 13MN142 but not at 90MN099. Suggesting that nitrate stress is more apparent in the upstream most (13MN142) and downstream most (13MN101) portions of the reach but not at the mid station (90MN099). Elevated levels of nitrate tolerant taxa were seen at both visits on 13MN101 and were only slightly above the average at the final visit at 90MN099. Percentages of Non-hydropsychid Trichoptera taxa were above the average needed to meet the threshold for all visits except the two most recent visits on 90MN099.

Fish are generally not good indicators of nitrate stress. There was an overabundance of tolerant taxa in the reach and an absence of intolerant taxa. Below average quantities of sensitive taxa were present in the reach. All stations but 90MN099 lacked sufficient quantities of darter taxa. Stress metrics that indicate nitrate stress in a reach are general in nature and may be indications of other stressors in a reach.

Preponderance of evidence suggests that the macroinvertebrate community is stressed by elevated levels of nitrates in the reach. Elevated levels of nitrates are prevalent in the spring months when agricultural runoff and tile drainage is at its peak.

Table 211. Macroinvertebrate metrics that respond to nitrate stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L))Date Fish Visit)
13MN142 (2013)	**26.00**	**4.00**	**8.00**	**10.00**	**0.00**	**88.46**	3.00	2.90	**3.85**	**0.00**	16.00	**74.10**	7.10 (7/17/2013)
90MN099 (2002)	38.00	8.00	**13.00**	15.00	**0.00**	**78.95**	4.00	6.20	2.90	3.00	16.00	48.60	
90MN099 (2001)													2.80 (8/8/2001)
90MN099 (2010)	**33.00**	**3.00**	**11.00**	**6.00**	**0.00**	**78.79**	**1.00**	**0.00**	**3.23**	**1.00**	15.00	47.90	1.20 (8/17/2010)
90MN099 (2010)													0.31 (9/1/2010)
90MN099 (2013)	**34.00**	**5.00**	**13.00**	**6.00**	**0.00**	**94.12**	**1.00**	**0.00**	3.20	**0.00**	**19.00**	49.10	8.00 (7/16/2013)
13MN101 (2013)	**33.00**	**1.00**	**10.00**	**7.00**	**0.00**	**87.88**	**2.00**	4.10	**4.03**	**0.00**	**26.00**	**65.30**	7.10 (7/13/2013)
13MN101 (2014)	48.00	**5.00**	23.00	**10.00**	**0.00**	**87.5**	4.00	2.50	**4.41**	**0.00**	**21.00**	**80.80**	5.10 (7/22/2014)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*2.60*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Seven TSS samples were collected on this reach at three unique biological stations in 2001, 2010, 2013 and 2014, no values exceeded the southern regional TSS standard of 65 mg/L. Eighty-seven of 182 TSS samples collected from 2000 -2002 and 2013 – 2016 exceeded the regional standard for TSS a 48 % exceedance rate. Samples were collected at biological station 13MN101, the downstream most biological station in the reach. Exceedances occurred from 2000-2002 and 2013-2016 during the spring and summer months. One hundred and seventy-five transparency readings were taken in the reach at two stations in the reach, 13MN101 and S001-749. Samples at 13MN101 were gathered from 2013 to 2016 whiles samples at S001-749 were collected from 2001-2003. Twenty-two readings were below the 10 cm southern regional standard, four of these readings were at S001-749 while 18 were at 13MN101. Low transparency readings were identified across years from May thru August. Transparency readings ranged from 3 cm to greater than 100 cm, with an average reading of 28.7 cm. A turbidity impairment was identified on the reach in 2006. A DNR geomorphology survey was conducted near biological station 13MN101. Results indicated the South Fork has the highest sediment yield of the Watonwan Watershed, with high rates of stream bank erosion and a high sediment supply, which is not effectively transported through its system (DNR, 2014).

The macroinvertebrate community had a negative response to most TSS stress metrics on the reach (see table below). The TSS Index score at all stations was above the Prairie Streams GP Class, indicating that TSS stress is likely impacting the macroinvertebrates on the reach. There was a near absence of TSS intolerant taxa across biological stations and an abundance of TSS tolerant taxa and individuals, providing additional evidence of TSS stress. Low collector-filterer counts were observed at both visits at station 13MN101 and the 2002 visit at 99MN099, while plecoptera were absent at station 13MN101 and two visits on 99MN099. The preponderance of information suggests that TSS is s stressor for the macroinvertebrate community.

Table 212. Macroinvertebrate metrics that respond to high TSS stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN142 (2013)	33.55	0.32	**22.71**	**0.00**	**0.00**	**12.00**	**81.15**
90MN099 (2002)	**11.21**	**0.00**	**22.08**	**2.00**	**1.24**	**17.00**	**77.09**
90MN099 (2010)	22.47	**0.00**	**18.83**	**0.00**	**0.00**	**12.00**	**56.15**
90MN099 (2013)	28.48	0.31	**20.45**	**0.00**	**0.00**	**14.00**	**68.21**
13MN101 (2013)	**0.32**	0.95	**25.74**	**0.00**	**0.00**	**16.00**	**78.23**
13MN101 (2014)	**7.28**	**0.00**	**18.71**	**0.00**	**0.00**	**18.00**	**50.47**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

A majority of fish communities on the reach respond negatively to elevated TSS metrics (see table below). All eight biological stations have above average TSS Index scores when compared to the average for the Southern Streams Class, indicated a high potential for the fish community to be stressed by elevated TSS levels. There was a plethora of TSS tolerant taxa and individuals across all reaches, indicating great potential of TSS stress. There were also low concentrations of benthic feeders, centrarchids, herbivores, perciformes, riffle dwellers and sensitive taxa. Low quantities of benthic feeders within a reach can suggest that water clarity inhibits a benthic feeders ability to locate food. Low quantities of herbivore taxa could indicate that limited water clarity is limiting light penetration in a reach inhibiting plant growth or could be an indication of an instable streambed and shifting sediments, inhibiting the establishment of aquatic macrophytes within the reach. In contrast, some visits had above average quantities of long-lived taxa and simple lithophilic spawners. This could indicate that sedimentation is less of an issue in the reach as coarse substrates are readily available at some stations or this could be an indication of a constantly shifting bed load.

Table 213. Fish metrics that respond to high TSS stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN142 (2013)	**22.68**	**0.00**	**18.99**	**0.00**	**5.70**	**4.32**	**20.89**	**0.53**	20.15
90MN099 (2001)	**4.82**	**0.00**	**1.93**	**0.00**	**6.75**	**18.65**	**3.54**	**1.61**	**2.89**
90MN099 (2010)	**27.78**	**0.00**	**14.58**	**0.00**	16.67	**16.67**	**22.92**	**3.47**	24.31
90MN099 (2010)	**30.99**	**0.00**	**15.20**	**0.00**	22.81	**12.87**	**26.32**	**4.68**	30.99
90MN099 (2013)	**15.91**	**0.00**	**13.64**	**0.00**	16.67	**3.79**	**15.15**	**0.76**	**15.91**
97MN013 (1997)	**5.02**	**3.13**	**4.08**	**0.00**	**8.46**	**10.66**	**4.39**	**0.31**	**4.70**
13MN101 (2013)	**23.04**	**0.00**	**12.04**	**0.00**	18.32	**6.28**	**18.85**	**1.05**	20.42
13MN101 (2014)	**21.65**	**1.42**	**12.54**	**0.00**	**6.55**	**15.10**	**13.96**	**1.42**	**13.39**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

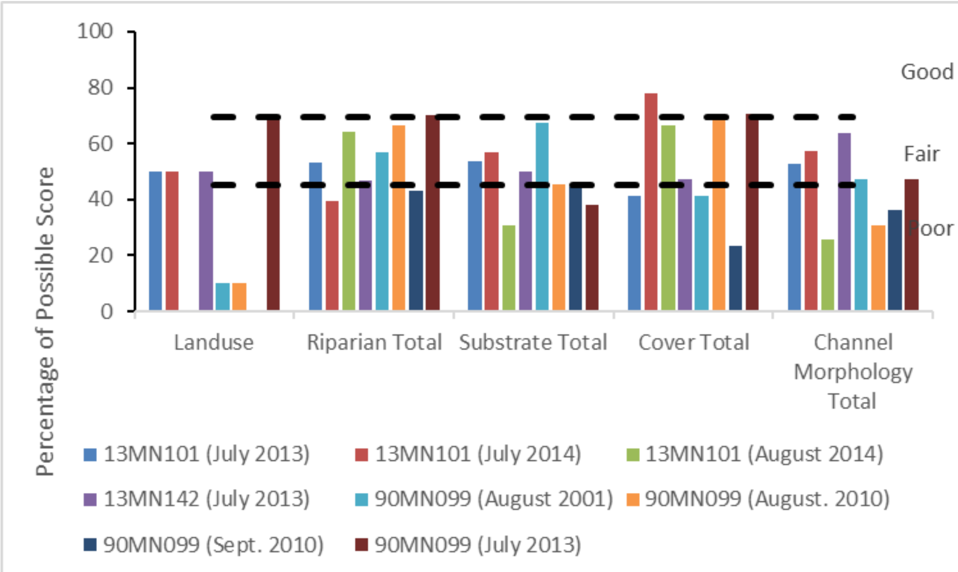
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN142 (2013)	**27.35**	**0.00**	**0.00**	**4.00**	**57.00**
90MN099 (2001)	**26.95**	**0.00**	**0.00**	**7.00**	**64.00**
90MN099 (2010)	**23.46**	**0.00**	**0.00**	**4.00**	**24.00**
90MN099 (2010)	**21.42**	**0.00**	**0.00**	**6.00**	**37.00**
90MN099 (2013)	**29.08**	**0.00**	**0.00**	**6.00**	**70.00**
97MN013 (1997)	**26.86**	**0.00**	**0.00**	**7.00**	**18.00**
13MN101 (2013)	**27.24**	**0.00**	**0.00**	**6.00**	**48.00**
13MN101 (2014)	**23.40**	**0.00**	**0.00**	**8.00**	**25.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Elevated levels of suspended sediment in the reach in conjunction with a negative response to TSS stress metrics by both biological indicators confirm TSS is a stressor in the reach.

Habitat

Eight qualitative stream habitat surveys have been conducted within the reach, one in 2013 at station 13MN142, four at station 90MN099 in 2001, 2010 (2) and 2013 and three at stations 13MN101, one in 2013 and two in 2014 (see graph below). MSHA scores range from fair to poor across the reach, with an average rating of 48.4. Row crop agriculture is prominent across the landscape. Feedlots are scattered throughout the reach (swine and bovine), the largest facility with 1,335 animal units (5,700 pigs) is located less than half a mile upstream of biological station 13MN142. Overall, the stream reach retains its natural sinuous character throughout its reach with a majority of the immediate surrounding stream bank riparian zone is comprised of mature trees. Buffer extent varies across the reach but it appears predominately moderate to wide from 10 - 50 m. Stream bank erosion and sedimentation of coarse substrates was identified across all of the biological stations (see photos below). Channel stability scores were stifled by incised channels and a moving bed load dominated by fine sediments (see photos below). Limited stream modifications have helped this stretch of the South Fork Watonwan retain some natural channel progression with riffles, runs and pools identified at all biological stations along the reach. Fish habitat cover was sparse to moderate across the stations. A DNR geomorphology survey was conducted near biological station 13MN101. Results indicated the South Fork has the highest sediment yield of the Watonwan Watershed, with high rates of stream bank erosion and a high sediment supply which is not effectively transported through its system (DNR, 2014).

Figure 200. Percentage of MSHA subcategory scores for station 13MN101, 13MN142, 90MN099 in South Fork Watonwan River.



The fish community is predominately showing a negative response to degraded habitat metrics along the reach (see table below). Across all visits there was an abundance of tolerant taxa. All visits had low quantities of riffle dwelling species and simple lithophilic spawners. This implies insufficient availability of coarse substrate and riffle habitat within the reach. Elevated quantities of pioneering taxa were identified at nearly all visits within the reach. Abundance of pioneering taxa in a reach typically increases in more disturbed reaches within limited habitat diversity. Nearly all visits across the stations, except two visits in 2010 at 90MN099 had below average quantities of piscivore and benthic insectivore taxa. Low quantities of piscivore taxa indicates limited habitat availability for top predators in the reach like deep pools. Low numbers of benthic insectivores can indicate limited quality habitat across the stream bottoms within a reach.

Table 214. Fish metrics that respond to degraded habitat conditions in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN142 (2013)	**67.72**	**0.32**	**25.84**	**5.80**	**17.09**	**20.89**	**6.12**	**22.57**
90MN099 (1990)	**66.94**	**0.00**	63.71	19.35	**37.90**	**26.61**	**19.35**	**15.32**
90MN099 (2001)	**45.02**	**1.61**	**29.58**	**17.36**	**17.36**	**3.54**	**17.68**	**17.68**
90MN099 (2009)	**72.92**	**0.00**	**16.67**	**12.50**	**16.67**	**4.17**	**12.50**	**10.42**
90MN099 (2010)	**56.94**	5.56	**43.06**	27.08	**29.17**	**22.92**	27.78	**36.11**
90MN099 (2010)	**52.05**	5.26	**44.44**	32.16	**19.30**	**26.32**	32.16	**42.11**
90MN099 (2013)	**53.79**	**2.27**	**21.97**	**4.55**	8.33	**15.15**	**4.55**	**17.42**
97MN013 (1997)	**86.52**	**3.45**	**18.81**	**7.52**	8.46	**4.39**	**7.52**	**10.97**
13MN101 (2013)	**73.82**	**1.57**	**28.27**	**14.14**	**20.94**	**18.85**	**14.14**	**23.04**

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN101 (2014)	**76.35**	**3.13**	**27.35**	**12.25**	**46.72**	**13.96**	**12.25**	**17.38**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to degraded habitat metrics in the macroinvertebrate communities along the reach (see table below). Insufficient quantities of climber taxa were noted at all stations except the 2014 visit at 13MN101, this indicates little instream macroinvertebrate cover or overhanging vegetative cover was available within the reach which is consistent with MSHA observations. All but two visits had abundant quantities of legless taxa within the reach. An abundance of legless taxa confirms an abundance of fine sediment in the reach identified during MSHA surveys. Sufficient quantities of clinger taxa were identified at all stations except for the downstream most station 13MN101. Station 13MN101 had limited coarse substrate and riffle habitat within the station, which may explain low numbers observed.

Table 215. Macroinvertebrate metrics that respond to degraded habitat conditions in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN142 (2013)	4.79	**15.34**	55.59	55.91	**30.99**	19.49
90MN099 (2002)	1.56	**15.58**	47.35	71.03	16.20	24.61
90MN099 (2010)	2.85	**10.76**	56.33	**38.61**	**35.44**	20.25
90MN099 (2013)	**19.20**	**2.17**	57.28	50.15	**30.65**	**17.65**
13MN101 (2013)	4.10	**15.14**	**51.74**	62.15	20.50	**17.98**
13MN101 (2014)	6.96	37.97	**21.84**	**14.87**	**77.22**	25.32
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

MSHA surveys indicate degraded habitat conditions are present within the reach including stream bank erosion, sedimentation and limited availability and diversity of instream cover. Fish habitat metrics exhibited a strong response to degraded habitat metrics while the macroinvertebrate community shows some response to habitat stress. Evidence suggests degraded habitat is a major stressor to the fish in the reach but is a more moderate stressor to the macroinvertebrate community.

Figure 201. Biological station 13MN101 (July 17, 2013) stream bank erosion.

Figure 202. Biological station 13MN142 (August 14, 2013) depositional sediment (left); (May 1, 2015) sediment deposition (right).

Figure 203. Biological station 13MN142 (July 17, 2013) eroded stream bank with narrow buffer (left); biological station 90MN099 (August 1, 2008) incised channel and sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams within the reach. There were 30 fish species identified within the reach; 20 species were captured at station 13MN142. Twenty-eight species were captured at station 90MN099, and 21 species were captured at station 13MN101. Twenty species were captured at the next upstream station 13MN134 on WID -547 while 24 species were captured on the next downstream biological station on the Watonwan River. Species diversity across the reach and above and below the reach does not indicate concerns of longitudinal connectivity in the reach. This is also apparent by the abundance of migratory fish species observed across the reach and at biological stations above and below the reach. Ten migratory fish taxa were identified within the reach including: black bullhead, blackside darter, central stoneroller, golden redhorse, quillback, shorthead redhorse, silver redhorse, slenderhead darter, walleye and white sucker (see table below).

Twelve of nineteen mussel taxa were observed within the reach during DNR mussel surveys from 1999-2003 including: *Anodontoides ferussacianus* (Cylindrical papershell), *Amblema plicata* (Threeridge), *Fusconaia flava* (Wabash pigtoe), *Lampsillis cardium* (plaine pocketbook), *Lasmigona complana* (white heelsplitter), *Lasmigon compressa* (Creek heelsplitter), *Leptoda fragilius* (fragile papershell), *Lampsilis siliquoidea* (fatmucket), *Pyganodon grandis* (giant floater), *Potamilus ohiensis* (pink papershell), *Pleurobema sintoxia* (Round pigtoe) and *Stophitus undulates* (Creeper). Five additional mussel taxa were observed on WIDs downstream of the reach on the mainstem Watonwan River including: *Toxolasma parvum* (Lilliput), *Actinonaias ligamentina* (mucket), *Lasmigona costata* (fluted shell), *Ligumia recta* (black sandshell) and *Quadrula quadrula* (maple leaf). Abundance of mussel taxa in the reach indicates that longitudinal connectivity is not a likely stressor as many mussel taxa rely on migratory fish species to complete their life cycles.

Preponderance of evidence indicates that longitudinal connectivity is not a stressor in the reach at this time.

Table 216. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Taxa in blue are known lake species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN134	13MN142	90MN099	13Mn101	13MN161
WID	-547	-517	-517	-517	-510
Fish Taxa	SFWatonwan	SFWatonwan	SFWatonwan	SFWatonwan	Watonwan River
bigmouth buffalo		x	x		
bigmouth shiner	x	x	X	x	x
black bullhead	x	x	X		x
blacknose dace	x	x	X		
blackside darter	x	x	X	x	x
bluntnose minnow	x	x	X	x	x
brassy minnow	x			x	x
brook stickleback					
central stoneroller	x	x	X	x	x
channel catfish	x		X		
common carp	x	x	X	x	x
creek chub	x	x	X	x	x
fathead minnow	x	x	X	x	x
golden redhorse			x	x	x

Field Number	13MN134	13MN142	90MN099	13Mn101	13MN161
green sunfish	x	x	x		
johnny darter	x	x	x	x	x
largemouth bass					x
northern hogsucker			x	x	x
northern pike	x	x	x	x	x
oranges potted sunfish			x	x	x
quillback	x			x	x
sand shiner	x	x	x	x	x
shorthead redhorse	x	x	x	x	x
silver redhorse		x	x	x	x
slenderhead darter		x	x	x	x
spotfin shiner	x	x	x	x	x
stonecat		x	x		
tadpole madtom	x		x		
walleye			x	x	x
white sucker	x	x	x	x	x
yellow bullhead			x		
yellow perch			x		x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 25.2 mile long reach of the South Fork Watonwan River is 6% modified and 94% natural. A large portion of the South Fork Watonwan's headwaters upstream of AUID -517 has been channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. A geomorphology survey was conducted within the reach near biological station 13MN101 by the DNR and found the South Fork Watonwan River to be an entrenched, deeply incised F5 channel. The South Fork has the highest sediment yield of the Watonwan Watershed, with high rates of stream bank erosion and a high sediment supply which is not effectively transported through its system. While riparian buffers play a moderate role in maintaining streambank stability within the reach, the South Fork has a high sensitivity to disturbance and a poor recovery potential (DNR, 2014). According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed at the biological station. It is likely that upstream stream alteration is causing stress to the biological community downstream on this reach by sending larger volumes of water and sediment downstream, leading to stream bank erosions and stream bank destabilization and sedimentation within stream reaches.

Three known lake taxa were identified within the reach including: black bullhead, yellow bullhead and yellow perch. Presence of lake taxa within a reach can be an indication of low flow conditions influenced by altered hydrology. Low quantities of riffle dwelling taxa were identified within the reach as well. Low quantities of riffle taxa can be an indication of low flow conditions caused by altered hydrology. Low quantities of long-lived taxa can also be a sign of altered hydrology stress. Low quantities of long-lived taxa were identified at biological stations 97MN013, 13MN142 and select visits on 13MN101 and 90MN099 (see table below).

Table 217. Fish metrics that respond to altered hydrology stress in South Fork Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN142 (2013)	**67.72**	**5.70**	**20.89**
90MN099 (2001)	**45.02**	**6.75**	**3.54**
90MN099 (2010)	**56.94**	16.67	**22.92**
90MN099 (2010)	**52.05**	22.81	**26.32**
90MN099 (2013)	**53.79**	16.67	**15.15**
97MN013 (1997)	**86.52**	**8.46**	**4.39**
13MN101 (2013)	**73.82**	18.32	**18.85**
13MN101 (2014)	**76.35**	**6.55**	**13.96**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Evidence of low flow conditions was observed at biological station 13MN142 in September of 2012 (see photo below). In 2012, southwestern Minnesota experienced a significant drought, low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach. No photographs were taken of station 90MN099 or 97MN013 in September of 2012; however, pictures taken at 13MN101 during the same time do not show low flow conditions. This could imply that low flow conditions only occurred in the upper portions of the reach in 2012.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Evidence suggests that altered hydrology is a stressor in the reach, at least in the upper portions of the reach where low flows have been indicated and biological metrics are responding to low flow conditions.

Figure 204. Biological station 13MN142 (September 13, 2012) low flow.

4.1.3. AUID Summary

Nitrates, TSS, degraded habitat and altered hydrology are stressors within the reach. Nitrogen is an isolated stressor in the reach to macroinvertebrate communities at stations 13MN101 and 13MN142, the upstream and downstream most biological stations on the reach. Macroinvertebrate metrics at these stations had high quantities of nitrate tolerant individuals. Nitrogen concentrations were above 15 mg/L for 13% of samples from a large dataset, exceedances were observed in the spring months when drain tile contributions are plentiful suggesting agricultural contributions are playing a role in high levels observed. The macroinvertebrate and fish communities responded negatively to elevated levels of suspended sediments within the reach. The stressor confirms the 2006 turbidity impairment. High levels of suspended sediment can be linked to elevated flows from agricultural drainage, causing stream bank erosion. Heavily modified stream reaches in the headwaters of the watershed are likely having cumulative impacts within the reach, as are adjacent contributions from agricultural land uses on the landscape from drain tiles, narrow riparian buffers and limited natural water retention on the landscape, which increase stream flows and stream power and increases streams erosive ability. Bank erosion and increased sediment loads have had negative impacts on stream habitat within the reach, as was seen in MSHA observations and the fish and macroinvertebrate stress metrics, limiting the diversity and availability of instream habitat. Low flow conditions were observed at the upstream most station on the reach in 2012. Low flow conditions in the late summer months are a result of a reduction of water retention on the landscape and an increase in tile drainage, which decreases water table levels, limiting available baseflow during periods of drier weather.

Eutrophication and DO are an inconclusive stressors within the reach. While there is abundant chemical evidence indicating that elevated phosphorous concentrations exist in the watershed, there was limited response variable data to confirm potential issues for the biology within the reach. Continuous sonde deployment did not produce DO flux swings greater than the standard and a single chlorophyll a sample collected was low. Despite lack of response variable information, biological metric data suggests that eutrophication may be a possible stressor. Additional collection of response variable data, including DO flux data during more typical water years, would be useful in better understanding the potential of this stressor. While there was no evidence that DO concentrations fell below the 5mg/L standard in a large dataset of grab samples or during continuous monitoring, fish metric data suggests potential for low DO conditions to exist within the reach. This suggests that present monitoring may have missed low DO sags and additional low DO monitoring is needed to further understand the potential of the stressor.

Longitudinal connectivity is not a stressor in the reach at this time. An absence of fish barriers and an abundance of migratory fish taxa and mussel taxa within the reach indicate that longitudinal connectivity is not a stressor to fish communities within the reach.

Table 218. Summary of stressor determinations for South Fork Watonwan River.

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
South Fork Watonwan River	07020010-517	o	o	●	●	●	●	-

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

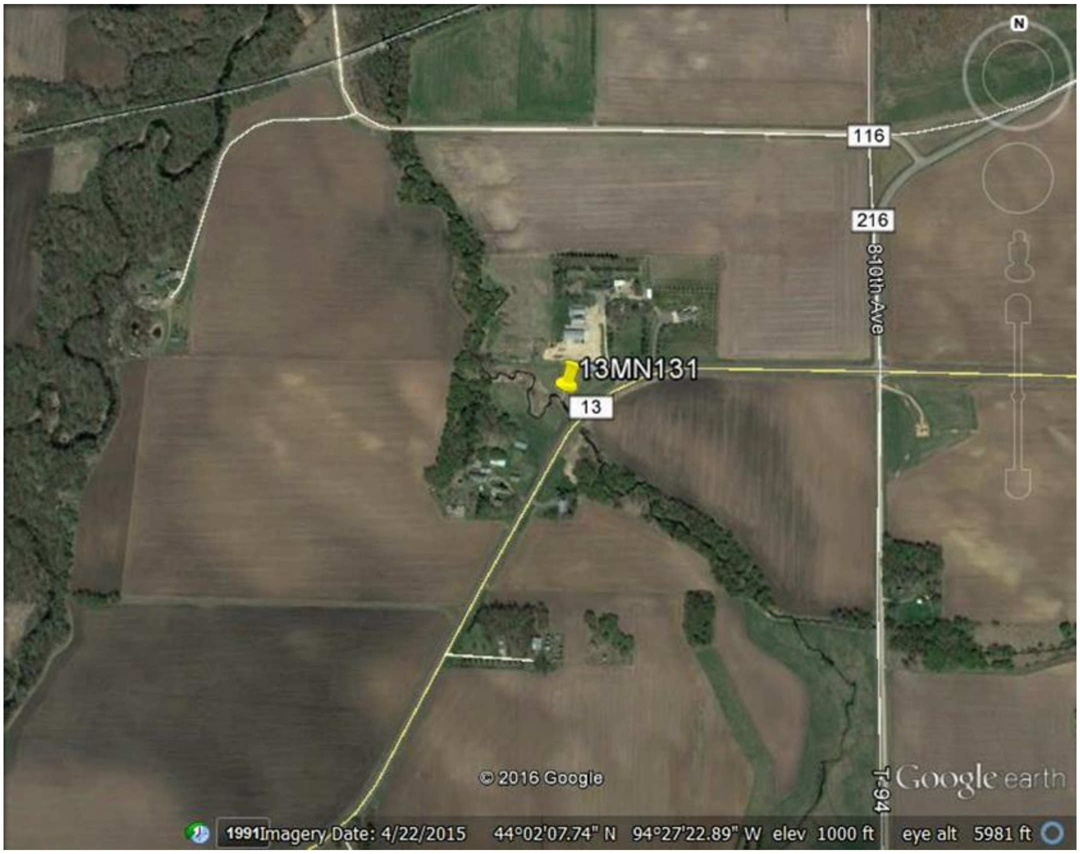
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Spring Brook -540

The tributary of Spring Brook (07020010-540) begins west of Twp. Rd. 94 and joins the South Branch Watonwan River just north of Co. Hwy 116, approximately two miles east of Madelia. The reach covers just over a mile of the natural portion of Spring Brook. This reach is classified as general use warmwater 2B. This reach is impaired for aquatic life for lack of fish and macroinvertebrate assemblage (2015).

No upstream reaches on the Spring Brook have been assessed.

Figure 205. Google Earth image of Spring Brook (-540).



4.1.1. Biological communities

There is one biological station on this reach, 13MN131. The station was sampled once for fish and macroinvertebrates in 2013. The fish visit fell below the threshold (55) and lower confidence interval with and FIBI score of 38.9. The sample included nine species and only 54 individuals. Dominant taxa sampled were all tolerant species including white sucker, creek chub and fathead minnow. Metrics fell short of meeting averages in four of six categories (see figure below). There was an absence of sensitive taxa within the community (Sensitive), a high percentage of very tolerant taxa (VtolTxPct), had an abundance of generalist individuals (GeneralTxPct) and an abundance of detritivorous species (DETNWQTxPct) (see graph below).

The macroinvertebrate visit scored 33.5, below threshold (41) but within lower confidence limits. The community was dominated by the following species: polypedilum (51), labrundinia (35), physa (28) and Cricotopus (21). Seven of ten metrics fell below the average needed to meet standards. The community lacked intolerant taxa (Intolertant2Ch) and had a low percentage of collector and filterer species (collector-filtererPct), relative abundance of taxa belonging to trichoptera individuals in a subsample

(TricopteraChTxPct) and relative abundance of non-hydropsychid trichoptera individuals in a subsample (TrichoHydroPct). The community also had a low HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score. There were also marginally below average quantities of taxa richness of Plecoptera, Odonata, Ephemeroptera and Trichoptera (POET) and predatory species (PredatorCh). The community was not skewed by a few individuals from a single genera as noted in the (DomFiveCHPct) and fair amounts of clinger taxa (ClingerCh) (see graph below).

Figure 206. Fish metrics of the Southern Headwaters Class IBI for station 13MN131, Spring Brook.

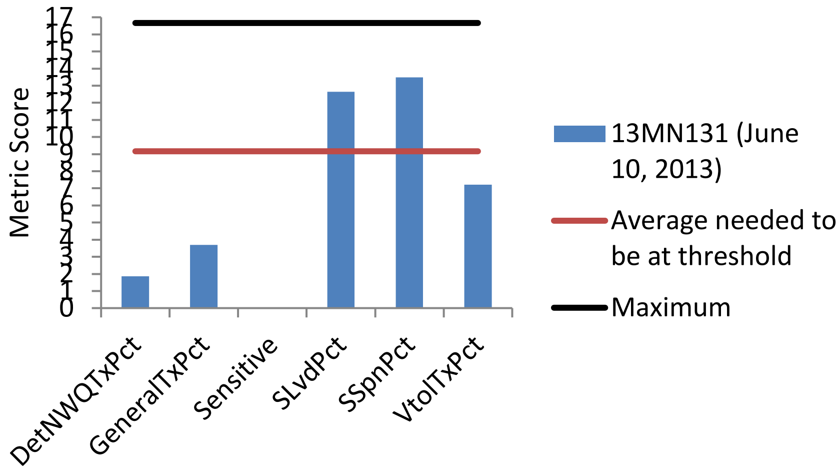
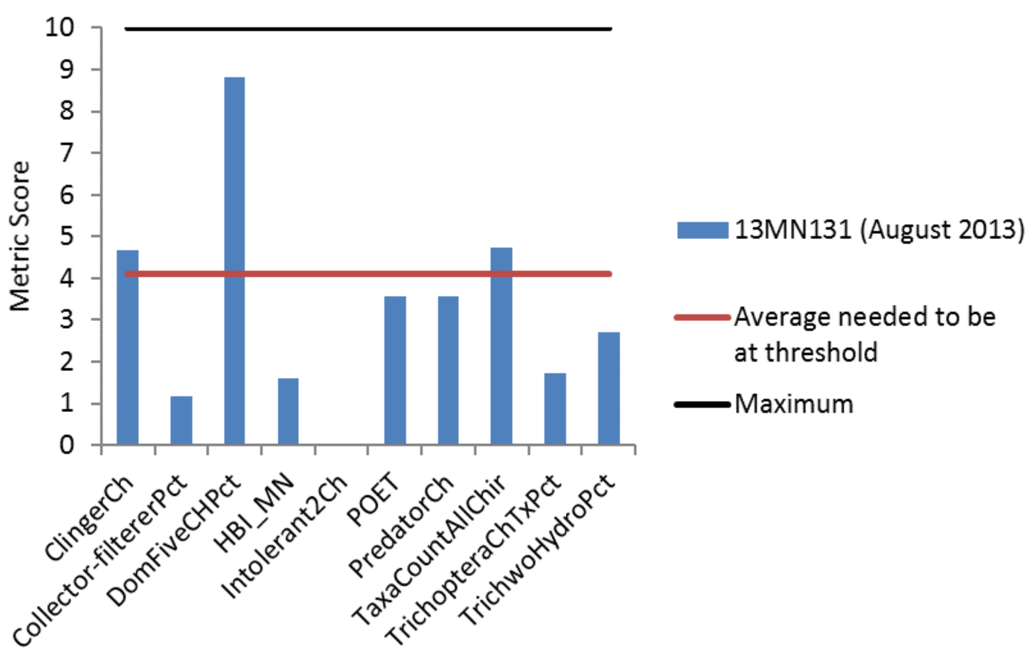


Figure 207. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN131, Spring Brook.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There were three DO measurements collected during biological monitoring visits at station 13MN131 in 2013, all samples were within the normal range for DO and did not fall below the 5 mg/L low DO standard. Eight additional DO samples were taken during SID investigations in 2015 and 2016, values ranged from 6.68 mg/L to 12.53 mg/L.

The macroinvertebrate community metrics within the reach at station 13MN131 show little to no response to low DO stress (see table below). There was an above average Low DO Index score, which suggests that low DO is an unlikely stressor given the composition of the macroinvertebrate community. There were above average quantities of low DO intolerant taxa and below average numbers of low DO tolerant taxa and individuals. While the overall taxa count and EPT numbers are low compared to the Prairie Streams Class average, this is likely attributed to other stressors in the reach.

Table 219. Macroinvertebrate metrics that respond to low DO stress in Spring Brook compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN131 (2013)	**35.00**	**4.00**	1.60	6.65	3.00	5.71	8.00	12.38
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is a mixed response to low DO stress in the fish community within the reach (see table below). The DO Index score is very close to the average for the southern headwaters class, suggesting that low DO is not a likely stressor for the fish community. However, there were low quantities of DO sensitive taxa and above average quantities of DO tolerant taxa and individuals, indicating potential for stress. The fish community was dominated by tolerant individuals and lacked sensitive species as well, both are general stress metrics and could be indications of other stressors within the reach. There was also an abundance of taxa that take longer than three years to mature in the reach. Taxa that take longer to mature are generally less tolerant of low DO conditions.

Table 220. Fish metrics that respond to low DO stress in Spring Brook compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN131 (2013)	**0.00**	50.00	**94.44**	**7.03**	**0.00**	**0.00**	**4.00**	**31.48**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is no chemical evidence within the reach to suggest low DO conditions are present within the reach; however, the present dataset is limited to only a few samples and no continuous monitoring data. While the macroinvertebrate stress metrics indicate that it is unlikely the community is stressed by low DO, 31% of the fish community was comprised of DO tolerant individuals. This suggests potential that low DO conditions may be impacting the fish community within the reach. This could also be a reflection of presence of black bullhead, northern pike and an abundance of white sucker in the sample. Additional chemical investigation including continuous DO measurements within the reach could help better understand whether or not the fish community is in fact stressed by low DO conditions. DO is not a stressor for macroinvertebrates at this time but is an inconclusive stressor to the fish community.

Eutrophication

There was one phosphorous sample collected during the fish visit in 2013 at station 13MN131. The concentration did not exceed the southern region eutrophication standard of 0.15 mg/L. Nine additional samples were collected at 13MN131 from 2015 and 2016, only one sample exceeded the standard. Phosphorous concentrations ranged from 0.044 mg/L to 0.379 mg/L, with an average concentration of 0.136 mg/L. There was a single chlorophyll a sample collected in 2015 with a concentration of 4.3 ug/L, below the southern eutrophication standard of 35 ug/L. There were no BOD samples collected on the reach or continuous DO monitoring to calculate DO flux. DO grab samples collected on the reach ranged from 6.68 mg/L to 12.53 mg/L. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.47 – 7.95 in the reach.

The macroinvertebrate metrics associated with eutrophication indicate eutrophication is a potential stressor on the reach (see table below). There was an absence of intolerant taxa and a high percentage of tolerant taxa. There were very low numbers of collector-filterer, collector-gatherer and EPT taxa within the reach.

Table 221. Macroinvertebrate metrics that respond to eutrophication stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN131 (2013)	**35.00**	**2.00**	**13.00**	**4.00**	**0.00**	**88.57**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*37.00*	*4.95*	*19.13*	*8.91*	*0.24*	*81.88*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Eutrophication metrics in the reach indicate that the fish community is potentially stressed by eutrophication (see table below). There was an absence of intolerant and sensitive taxa in the reach and an abundance of tolerant taxa. There were also lower than average counts of darters and simple lithophilic spawners. However, these stress metrics are general in nature and may be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. An above average quantity of omnivorous fish were identified within the reach at biological station 13MN131 suggesting potential for eutrophication stress in the reach.

Table 222. Fish metrics that respond to eutrophication stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN131 (2013)	**0.00**	**1.85**	**22.22**	**70.37**	**94.44**	**9.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

There was a very small chemical dataset in the reach, only one sample exceeded southern regional eutrophication standard. There was limited available response variable data within the reach as well, which did not indicate stress. Despite this, there was a response to eutrophication stress metrics in the reach in both fish and macroinvertebrate communities; however, these stress metrics are general in nature and could be indications of other stressors within the reach. As such, eutrophication is an inconclusive stressor in the reach at this time.

Nitrate

The chemistry dataset is limited to a grab sample collected during the fish sample in June of 2013 and seven samples collected during SID investigations. During the fish sample at 13MN131 on June 10, 2013, the nitrate concentration was 12 mg/L. Seven additional nitrate samples were collected at this station in 2015 and 2016 during the months of February, May, June and August. Nitrate concentrations range from 1.2 mg/L in August to 18 mg/L in May, with an overall average concentration of 11.5 mg/L. Only two readings were above 15 mg/L.

The macroinvertebrate nitrate stress metrics in this reach indicate that elevated nitrate concentrations are likely stressing the macroinvertebrate community (see table below). The nitrate index score was 4.27, while the average for the Prairie Streams GP class to meet the impairment threshold is 3.2. This suggests that overall the community present is tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichoHydroPct) and decreased intolerant taxa, both which are lacking in this reach. Additionally, the number of nitrate tolerant taxa and individuals are higher than class average.

Table 223. Macroinvertebrate metrics that respond to elevated nitrate stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN131 (2013)	**35.00**	**2.00**	**13.00**	**4.00**	**0.00**	**88.57**	1.00	**0.958**	**4.27**	**1.00**	**24.00**	**83.50**	12.00 (6/10/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	***0.00***	***2.40***	***3.20***	***1.10***	***18.00***	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish are not generally good indicators of nitrate stress in a reach. Ninety-four percent of the reach was comprised of tolerant taxa. There was an absence of sensitive taxa in the reach. There were also below average quantities of darter taxa in the reach. While there was a positive response to nitrate stress within the fish community, nitrate stress metrics for fish are general in nature and can be indicators of other stressors within a reach.

There was a limited chemical dataset in the reach for nitrates, only two samples were above 15 mg/L. However, there was a high percentage of the macroinvertebrate community that is tolerant of elevated nitrate conditions and the community had a high Nitrate Index Score indicating potential for nitrate stress. Despite a small chemical dataset, there is sufficient evidence at this time to determine nitrate as a stressor in the reach for the macroinvertebrate community while fish results are inconclusive. Additional targeted nitrate sampling should occur in spring months after rainfall events to identify frequency and duration of elevated nitrate concentrations within the reach.

Suspended sediment

There was one TSS sample collected during the biological visit at station 13MN131, the value was 11 mg/L, below the southern regional TSS standard of 65 mg/L. Seven additional TSS samples were collected on the reach in 2015 and 2016 as part of SID investigations; one sample exceeded the southern regional TSS standard with a reading on 120 mg/L in June of 2016 after a storm event, all other samples were below 20 mg/L.

TSS stress metrics show mixed results for the macroinvertebrate community (see table below). The TSS Index score was near the average for the Prairie Streams GP class, indicating that TSS is not a likely stressor for the macroinvertebrate community. There was an absence of TSS intolerant taxa and plecoptera taxa within the community, indicating potential for TSS related stress. Low quantities of plecoptera taxa in a reach can be an indication of a lack of available coarse substrates in a reach, which can be a result of high levels of suspended sediment. There was also a lower than average quantities of collector-filterer taxa. Low quantities of collector-filterer taxa could be an indication that water clarity is limiting their ability to thrive. Despite this, there were also low numbers of TSS tolerant taxa and individuals; there abundance in a reach is often a better indication of TSS related stress.

Table 224. Macroinvertebrate metrics that respond to high TSS stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN131 (2013)	**4.79**	**0.00**	16.63	**0.00**	**0.00**	9.00	35.56
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was a somewhat mixed response to TSS stress metrics in the fish community as well (see table below). TSS Index Score was above the average for the Southern Headwaters, suggesting that TSS is a potential stressor for the fish community. There was an above average quantity of benthic feeders, herbivores, riffle dwellers and simple lithophilic spawners within the reach. This suggests that coarse substrates and riffles are prevalent within the reach and sedimentation is not a primary concern, indicating potential for elevated TSS levels to be low. However, there were below average quantities of Perciformes and Centrarcidae, which indicate potential for TSS related stress as they are sensitive to water clarity. Overall, there was an absence of sensitive species, TSS sensitive species and intolerant species within the community, but these are general stress metrics and could be attributed to other stressors.

Table 225. Fish metrics that respond to high TSS stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN131 (2013)	51.85	**0.00**	50.00	**0.00**	**3.70**	**1.85**	50.00	**0.00**	50.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.06*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

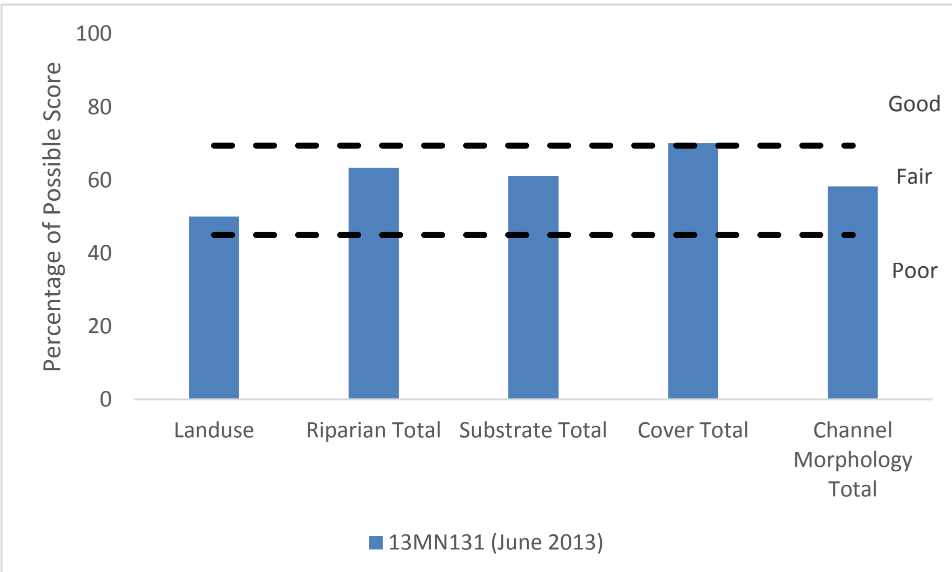
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN131 (2013)	**17.56**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

There is a very small chemical dataset consisting of TSS samples collected after spring rainfall events in 2015 and 2016. As only one TSS reading was above the southern regional TSS standard, and there was some negative response to TSS biological metrics within the fish and macroinvertebrate communities, it can be concluded that TSS is an inconclusive stressor to biological communities at this juncture. Additional data is needed to further understand the stressor in the reach.

Habitat

The MSHA rating at station 13MN131 was fair (61.5) (see graph below). The landuse score is likely overinflated as upstream landuse is almost exclusively row crop agriculture with a few small tree groves around nearby farmyards. There are three feedlot operations in the upstream watershed, one small bovine operation and two moderately sized swine operations. At the station, the reach is natural; but a majority of the stream upstream of the bio site has been channelized. An extensive to wide natural riparian zone of tall grasses was identified within the biological reach, providing limited shading to the stream. The instream zone showed some stream bank erosion and sedimentation in runs (see photo below). A variety of substrates were identified including: silt, sand and moderately embedded gravel, resulting in a moderate/high stream stability score. Moderate quantities of instream habitat cover were also identified. There was limited natural channel progression found in the stream, only 5% of the reach classified as riffle. Individual metric scores of the MSHA can be seen in (see graph below).

Figure 208. Percentage of MSHA subcategory scores for station 13MN131, Spring Brook.



The fish community within the reach is showing a mixed response to degraded habitat stress (see table below). There were above average quantities of piscivores, riffle dwellers and simple lithophilic spawners within the reach and below average quantities of pioneering species. This implies there is sufficient refuge for predatory taxa in the reach and sufficient quantities of coarse substrates. When low quantities of pioneering taxa are identified it can be inferred that a diverse array of habitat types are generally available to the biota in the reach. However, there were reduced quantities of lithophilic spawners, benthic insectivores and 'darter, sculpin and round bodied sucker' species. This suggests that while riffle and coarse substrate habitat may be available in the reach it may not be in quantities sufficient enough to allow for a complex biological community. Overall the fish community within the reach taxa are tolerant, comprising over 94% of the community; however, this metric like others can be influenced by other stressors. The fish community was comprised of white sucker, fathead minnow, creek chub, brassy minnow, black bullhead, northern pike, johnny dater, bluntnose minnow and blacknose dace. While nine species were captured most are generalists and are not an indication of great habitat conditions.

Table 226. Fish metrics that respond to degraded habitat conditions in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN131 (2013)	**94.44**	3.70	**64.81**	**1.85**	29.63	50.00	**1.85**	51.85
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*70.64*
Expected response to stress	↑	↓	↓	↓	↑	↓	↓	↑

Similar to the fish community the macroinvertebrates within the reach are showing mixed signs of degraded habitat stress (see table below). There was an abundance of climber taxa in the reach which is likely indicative of an abundance of overhanging vegetation and aquatic macrophytes within the reach was identified during MSHA surveys. While there were below average quantities of burrowing taxa, there were above average numbers of legless taxa suggesting potential for sedimentation in the reach. Legless taxa are generalists when it comes to their habitat needs and do not require clean coarse substrates or habitat structure and often are found in fine sediments. Low quantities of clinger taxa suggest that while coarse substrates are present in the reach they are not abundant, nor is available woody debris. This is apparent also due to the fact that only overhanging vegetation was sampled during the macroinvertebrate survey. Macroinvertebrate surveys are intended to sample the most prevalent habitat types that make up a majority of the stream reach. This implies that coarse substrates and other habitat types are not overly abundant within the reach.

Table 227. Macroinvertebrate metrics that respond to degraded habitat conditions in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN131 (2013)	6.39	36.10	**30.99**	**9.59**	**75.40**	**17.25**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to stress	↑	↓	↓	↓	↑	↓

Figure 209. Biological station 13MN131 (July 10, 2014) sediment deposition.

While the MSHA survey conducted in 2013 gave the reach a score on the higher side of fair, upon further inspection it appears that scores may be over generous and may not reflect current conditions on the reach as several metrics appear over inflated when comparing observations made between the fish and invertebrate visits and SID investigations. While a variety of habitats appear to be present on the reach, overall habitat availability appears to be lacking when looking at macroinvertebrate habitat metrics. During the macroinvertebrate visit, only overhanging vegetation was sampled in the reach. This indicates that while other habitat types may have been present in the reach, i.e. woody debris, coarse substrates and aquatic macrophytes they were not prevalent enough in the reach to warrant samples. While the fish community had a mixed response to habitat metrics, the fish community is dominated by few individuals from nine generally tolerant taxa and metrics appear skewed. Evidence of bank erosion and sedimentation were noted in the reach. Evidence suggests habitat is a likely stressor to the biology in the reach but may not be a primary stressor to the fish community. Future monitoring efforts should include an additional MSHA qualitative habitat survey and quantitative habitat survey to better understand habitat conditions within the reach.

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. Nine fish species were identified at biological station 13MN131 in 2013, two of which are known migratory taxa: black bullhead and white sucker. There were no known mussel surveys taken on this reach. Additional investigation between the biological station and the Spring Brooks outlet to the South Branch Watonwan River may be useful in order to understand if any unknown barriers could be limiting fish migration in the reach. Due to the limited data set available along the reach, longitudinal connectivity is an inconclusive stressor on the reach at this time.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 1.14 mile long reach of Spring Brook in 100% modified; however, natural segments are apparent along the reach, as was observed at the biological station. Its headwaters, upstream of -540 is 100% channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor. Instream sedimentation was observed within the biological reach while there was limited stream bank erosion and an absence of undercut banks.

There was a lower than average quantity of long-lived taxa within the reach and a plentiful supply of riffle dwelling taxa. Low quantities of both metrics can be an indication of altered hydrology stress within the reach. Only one known lake taxa was identified within the reach, black bullhead. Presence of lake taxa within a reach can be an indication of low flow conditions and potential altered hydrology stress. Metric data presented does not provide a strong case for altered hydrology as a stressor in the reach (see table below).

Table 228. Fish metrics that respond to altered hydrology stress in Spring Brook compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN131 (2013)	**94.44**	3.70	50.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
Expected response to Altered Hydrology stress	↑	↓	↓

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. While photographs were taken in September of 2012 at the biological station within the reach, it does not appear that extreme low flow or dry streambed conditions occurred within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles.

Insufficient evidence is available to implicate altered hydrology as a stressor within the reach at this time, thus the stressor is inconclusive.

4.1.3. AUID Summary

Elevated nitrate concentrations and degraded habitat conditions are stressing the biological communities within the reach. The macroinvertebrate community appears to be limited by availability of diverse habitat types including coarse substrates and woody debris, which could be related to instream sedimentation and stream bank erosion. High flows can likely be attributed to pulses of flow during storm events, increased by upstream agricultural runoff and drain tiles, which increase the streams power to scour banks and move sediment, disturbing biological habitat. Drain tiles are also likely acting as a conduit for nitrates to reach the stream through agricultural runoff. Macroinvertebrate metrics show a strong inclination for nitrate stress, while fish data was inconclusive. While the MSHA score is just below the good threshold, upon closer inspection results appear over inflated. Fish metrics also appear to respond better to degraded habitat stress than the species composition and numbers suggest which indicates that fish metrics are likely overinflated and low numbers of nine generally tolerant species were captured. An additional fish sample may be useful to obtain additional metric data for comparison. Additional monitoring should also include another MSHA habitat survey and quantitative habitat data to better understand habitat stressors effecting the biota in the reach and additional nitrogen data in the spring months to better understand extent of nitrate contributions.

Low dissolved oxygen (DO) is an inconclusive stressor in the reach to the fish community and is not stressing the macroinvertebrate community at this time. Eutrophication and nitrates are also inconclusive stressors in the reach. There was no chemical evidence to indicate low DO conditions exist within the reach and limited chemical evidence to indicate elevated P is persistent in the reach; however, the datasets are small. While the macroinvertebrate community exhibited no response to low DO stress the fish community had an above average percentage of DO tolerant individuals within the reach. Both fish and macroinvertebrates responded negatively to eutrophication stress metrics in the reach but these stress metrics are general in nature and could be indicators of other stressors. The macroinvertebrate community indicated a high potential for nitrate related stress in the reach. Additional chemistry data collection including continuous DO monitoring and phosphorous sampling in conjunction with response variable data collection would be useful to be able to better understand the potential of low DO and eutrophication stress within the reach.

TSS, altered hydrology and longitudinal connectivity are inconclusive stressors on the reach. The TSS dataset in the reach was small and only a single reading exceeded standards after a six plus inch rain event in June of 2016; however, fish and macroinvertebrate metric data show some indication of potential TSS related stress within the reach. Additional information is needed to better clarify the potential of the stressor. While there are no known barriers on the reach, additional ground trothing may be useful to rule out longitudinal connectivity as a potential stressor on the reach. There was no evidence of low flow conditions within the reach. The stream reach was channelized. There is little wetland storage left in the watershed and agricultural in the Watonwan River Watershed has relied heavily on drain tiles to remove water from their fields quickly. There is no stream flow data to indicate high flows that cause stream bank erosion and sedimentation in the watershed are a result of altered hydrology. Additional investigation to make this connection would be needed to better understand the stressor.

Table 229. Summary of stressor identification determinations for Spring Brook (540).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
Spring Brook	07020010-540	o/-	o	o/●	o	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

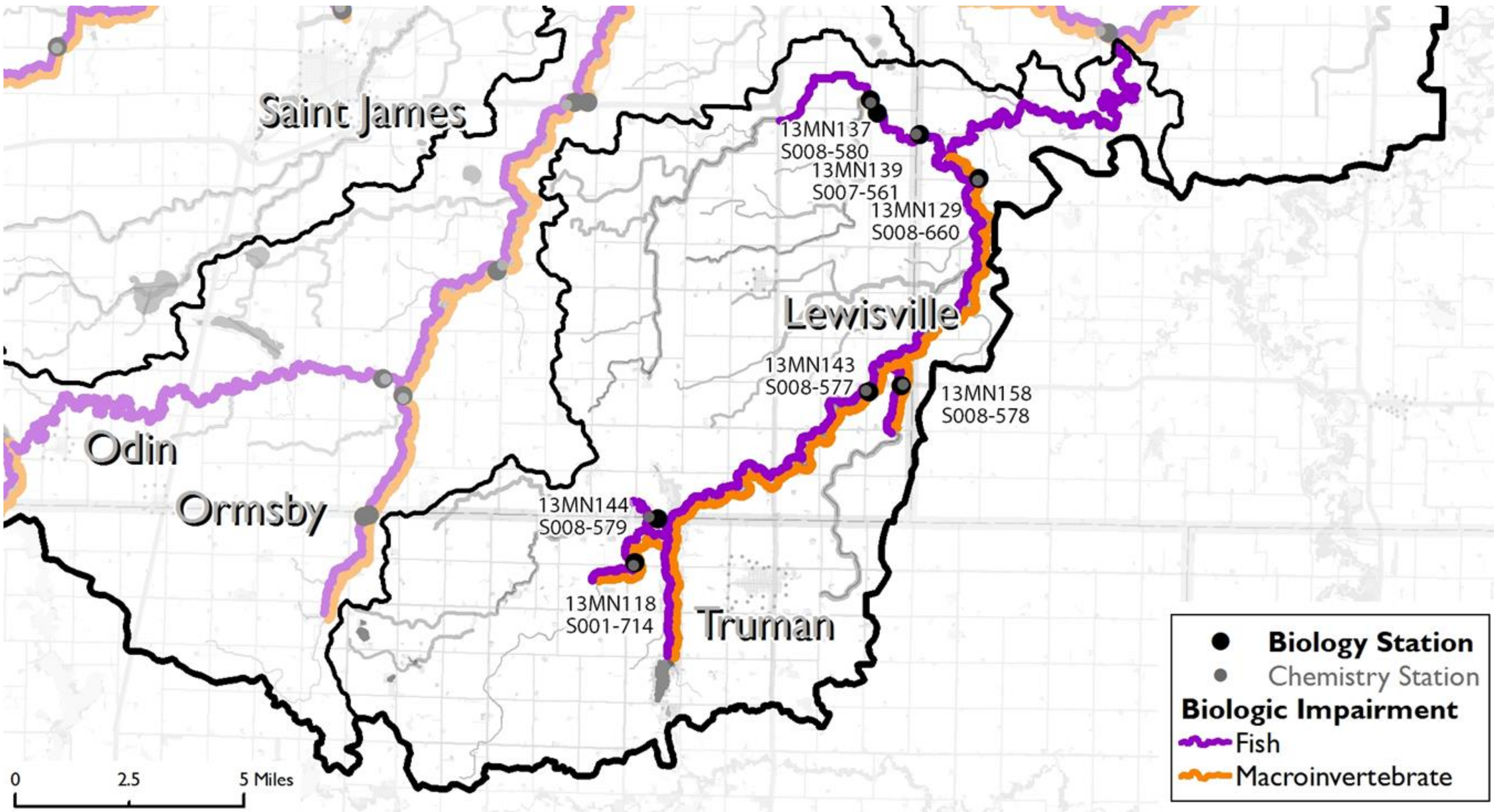
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

Perch Creek

Perch Creek lies on the Watonwan River Watershed's eastern boundaries. Beginning at Perch lake a few miles southwest of Truman and flowing in a northeasterly direction past Lewisville. Along its course, Perch Creek gains the flow of several small agricultural drainage ditches and two named tributaries, Mink Creek and Spring Branch Creek. Perch Creek joins the mainstem Watonwan River several miles downstream of the Watonwan River's confluence with the South Fork Watonwan River.

Figure 210. Biological impairment map of the Perch Creek subwatershed.



4.1. Mink Creek -577

Mink Creek (07020010-577) is a tributary of Perch Creek (07020010-524). The reach begins 3.5 miles west of Truman upstream of CR 39 and flows 3.7 stream miles northeast, joining Perch Creek (07020010-523) downstream of CR 52. This reach is classified as general use warmwater 2Bg. This reach is impaired for aquatic life for fish and macroinvertebrates (2015).

Figure 211. Google Earth image of Mink Creek (-577).

4.1.1. Biological communities

There is one biological monitoring location on this reach, 13MN118 sampled in 2013 and 2015. FIBI results were 28.3 and 31.1 respectively, below the threshold (55). Fewer individuals were captured during the initial visit as were fewer species, six species were captured in 2015 compared to 2013's four taxa. Species captured were predominately tolerant to degraded conditions. Sensitive taxa were absent in the 2013 sample. Overall, low diversity also attributed to low scoring. There were above average quantities of short-lived species (SLvdPct) and above average quantities of detritivores in the reach (DetNWQTPct) (see graph below).

Macroinvertebrates were only sampled once at station 13MN118 in 2013. An attempt to resample the macroinvertebrates in 2015 was unsuccessful due to insufficient flow conditions inhibiting sampling. The MIBI score in 2013 was 36.4 below the threshold (41) but within lower confidence limits. Dominant taxa in the reach included: Polypedilum, Physa and Heptagenia. The community lacked intolerant taxa (Intolertant2Ch) and had a low relative abundance of taxa belonging to trichoptera individuals in a subsample (TricopteraChTxPct) and relative abundance of non-hydropsychid trichoptera individuals in a subsample (TrichoHydroPct). The community also had a low HBI_MN ((A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score. There were also marginally below average quantities of taxa richness of Plechoptera, Odonata, Ephemeroptera and Trichoptera (POET), predatory species (PredatorCh) and collectorer filterer taxa (Collector-filtererPct). The community was not skewed by a few individuals from a single genera as noted in the (DomFiveCHPct) and had fair amounts of clinger taxa (ClingerCh) (see graph below).

Figure 212. Fish metrics of the Southern Headwaters Class IBI for station 13MN118, Mink Creek.

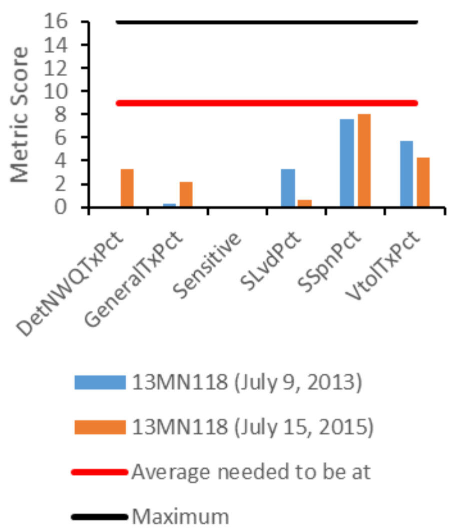
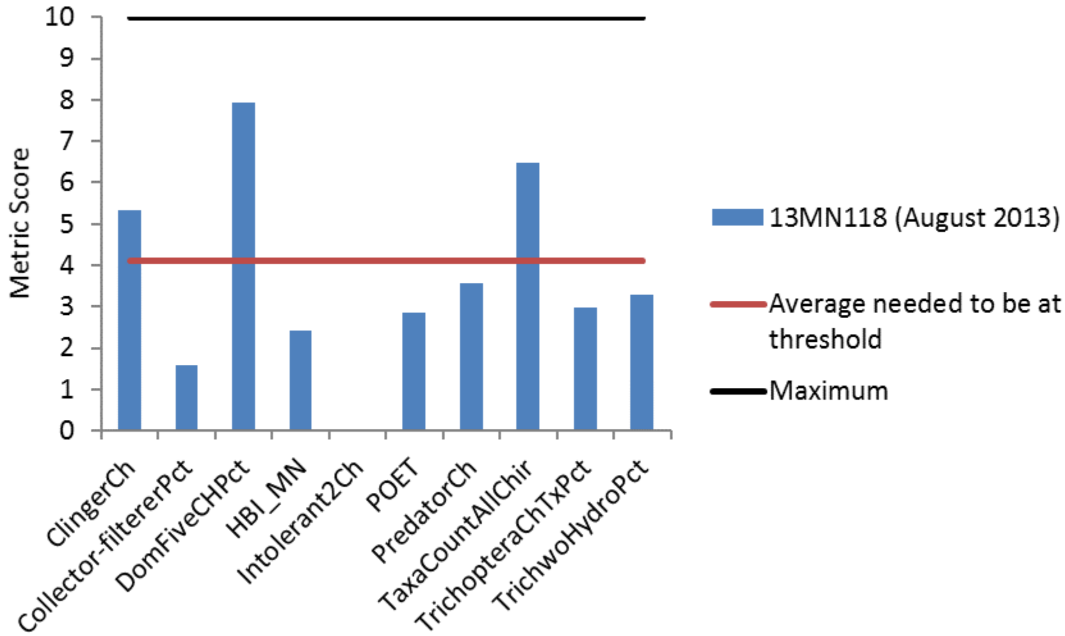


Figure 213. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN118, Mink Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Three DO readings were taken during biological visits at 13MN118; values ranged from 6.12 mg/L on July 15, 2015 at 1:00 PM to 9.23 mg/L on August 13, 2013 at 5:23 PM. Seven additional samples were taken during stressor identification investigations, no observations fell below the 5 mg/L DO standard.

The macroinvertebrate community showed only a slight response to low DO stress (see table below). The Low DO Index score was slightly higher than the Prairie Streams GP Class average, indicating that low DO stress is not likely stressing the macroinvertebrates within the reach. A marginally higher than average number of DO tolerant taxa were identified, but quantities of low DO intolerant individuals were relatively low compared to the Prairie Streams GP Class average. There was a low percentage of DO intolerant individuals as well; however, the overall quantity of DO Intolerant taxa was above class averages.

Table 230. Macroinvertebrate metrics that respond to low DO stress in Mink Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN118 (2013)	41.00	8.00	**2.41**	6.61	3.00	**2.80**	**9.00**	10.25
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to stress	↓	↓	↑	↓	↓	↓	↑	↑

Similarly, fish communities are showing a mixed response to potential low DO stress (see table below). The 2013 visit has a Low DO Index score just above the Southern Headwaters Class threshold, while the 2015 visit had a score below the threshold. Inconsistent results could be the result of low sample size in the 2013 fish visit. Both visits had lower than average DO tolerant taxa counts but elevated counts of DO tolerant individuals, suggesting stress. There was an absence of generally sensitive taxa and DO sensitive taxa. There was also an abundance of generally tolerant taxa.

Table 231. Fish metrics that respond to low DO stress in Mink Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN118 (2013)	**0.00**	29.63	**96.30**	7.31	**0.00**	**0.00**	2.00	**22.22**
13MN118 (2015)	**0.00**	**2.34**	**100.00**	**6.42**	**0.00**	**0.00**	2.00	**61.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.2*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While there is no chemical evidence of low DO conditions within the reach, the dataset is small and no samples were collected prior to 9 AM within the reach. The macroinvertebrate community did not respond negatively to low DO stress metrics in the reach. The 2015 fish visit indicated potential for low DO conditions in the reach with a below average Low DO index score and an abundance of DO tolerant taxa. As such, low DO is not a likely stressor for the macroinvertebrate community in the reach and is an inconsistent stressor for the fish community. Additional DO data should be gathered on the reach including continuous DO monitoring to capture any low DO conditions in the reach that may exist.

Eutrophication

One of two phosphorous concentrations collected during the fish visits exceeded the southern region eutrophication standard. Six additional phosphorous samples were collected in 2015 and 2016, three were above 0.15 mg/L. Phosphorous concentrations ranged from 0.05 mg/L to 0.317 mg/L, with an overall concentration of 0.16 mg/L. There were no chlorophyll a samples, DO flux measurements or BOD measurements collected on this reach. DO grab sample data ranged from 6.12 mg/L to 11.89 mg/L indicating potential for elevated DO flux in the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.5 – 8.05 in the reach.

The macroinvertebrate community shows some response to eutrophication stress metrics (see table below). There was a high percentage of tolerant taxa and an absence of tolerant taxa. Collector-filterer numbers were also below the southern streams average. However, collector-gatherer numbers were higher than the class average.

Table 232. Macroinvertebrate metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN118 (2013)	**41.00**	**5.00**	17.00	**8.00**	**0.00**	**90.24**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community also showed some response to eutrophication stress metrics (see table below). There was an absence of sensitive and intolerant taxa and an abundance of tolerant species. The community lacked darter taxa but conversely had an abundant population of simple lithophilic spawners. However, these metrics are general stress metrics and could be pointing to other stressors within the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous, fish were identified during biological sampling, suggesting potential for eutrophication in the reach.

Table 233. Fish metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN118 (2013)	**0.00**	**0.00**	77.78	**48.15**	**96.30**	**4.00**	**0.00**
13MN118 (2015)	**0.00**	**0.00**	32.03	**15.63**	**100.00**	**6.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Additional chemistry data collection would be useful in better understanding the potential for eutrophication stress within the reach, including response variable data. While biological communities appear to be responding to eutrophication in the reach, eutrophication stress metrics are very general in nature and may be responding to other stressors in the reach. Until additional data can confirm or refute the potential stressor, eutrophication is an inconclusive stressor at this time.

Nitrate

Nitrate data from the fish visits produced concentrations of 24 mg/L on July 9, 2013 and 14 mg/L on July 15, 2015. The remaining water chemistry dataset was limited to data collected during stressor identification investigations in 2015 and 2016 during the months of May, June and July and a single visit in February. The dataset includes seven readings with nitrate concentrations ranging from 21 mg/L in June of 2015 to 35 mg/L in May of 2016. There were two readings above 30 mg/L.

Predominately macroinvertebrate metrics indicate an adverse response to elevated nitrogen conditions (see table below). The nitrate specific metrics show better than average quantities of Trichoptera taxa. The nitrate index score was 4.4, while the average for Southern Streams meeting impairment threshold is 3.2. This suggests that overall the community present is generally tolerant to high nitrate concentrations. Quantities of nitrate tolerant individuals greatly exceed the Prairie Streams GP Class average, as does the percentage of nitrate tolerant individuals. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). While intolerant taxa and non-hydropsychid individuals are not in abundance here, their absence can also be due to another stressor present.

Table 234. Macroinvertebrate metrics that respond to nitrate stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish
13MN118 (2013)	**41.00**	**5.00**	17.00	**6.00**	**0.00**	**90.24**	2.00	1.25	**4.40**	**0.00**	**30.00**	**85.10**	24.00 (7/9/2013)
13MN118 (2015, Inverts Not sampled, Insufficient Flow)													14.00 (7/15/2015)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*0.00*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

While macroinvertebrates are better indicators of nitrate stress than fish, metrics in the table below can indicate where or not there is potential for the fish community to be affected by nitrate stress as well. High quantities of tolerant individuals and low quantities of sensitive, intolerant and darter species are all potential indicators that the fish community may also be affected by nitrate stress. While there was a positive response to nitrate stress within the fish community, nitrate stress metrics for fish are general in nature and can be indicators of other stressors within a reach.

While there was a limited chemical dataset in the reach for nitrates, concentrations were elevated across all samples. There was also a high percentage of the macroinvertebrate community that is tolerant of elevated nitrate conditions and the community had a high Nitrate Index Score indicating potential for nitrate stress. While nitrogen stress is inconclusive for the fish community due to limitations of current stress metrics data shows that the macroinvertebrates are stressed by elevated nitrates within the reach.

Table 235. Fish metrics that respond to nitrate stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN118 (2013)	**0.00**	**0.00**	**96.30**	**0.00**
13MN118 (2015)	**0.00**	**0.00**	**100.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*8.55*	*12.08*	*70.64*	*1.95*
Expected response to Nitrate stress	↓	↓	↑	↓

Suspended sediment

There were two TSS samples collected during fish visits at biological station 13MN118 in 2013 and 2015, neither sample exceeded the southern regional TSS standard of 65 mg/L. No TSS samples were collected on the reach prior to biological monitoring efforts. Eight additional samples were collected in 2015 and 2016 as part of SID investigations, no samples exceeded TSS standards.

The macroinvertebrate community responded negatively to all TSS stress metrics at station 13MN118 (see table below). The TSS Index score was above the average for the Prairie Streams GP Class average, indicating a potential for the macroinvertebrate community to be stressed by elevated TSS concentrations. There was an absence of TSS intolerant taxa at the site but only slightly above average quantities of TSS tolerant taxa and individuals. There were also lower than average quantities of collector-filterer taxa and an absence of plecoptera taxa. Collector-filterer taxa require clear conditions to locate nourishment while plecoptera (stoneflies) require clear coarse substrates as habitat, turbidity in a stream can also be an indication of instream sedimentation.

Table 236. Macroinvertebrate metrics that respond to high TSS stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN118 (2013)	**6.23**	**0.00**	**17.50**	**0.00**	**0.00**	**13.00**	**45.34**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was limited response to TSS stress metrics within the fish community (see table below). The TSS Index scores were below average for the Southern Headwaters Class, indicating there is little potential for elevated TSS levels to be impacting the fish community within the reach. While there was an absence of intolerant and sensitive taxa, there were also no TSS tolerant taxa found, suggesting that low counts are likely explained by other stressors. Low quantities of benthic feeders, Centrarchids, intolerant taxa, long-lived taxa, perciformes and sensitive could be an indication of TSS habitat related stress. There were inconsistencies between the two visits with regards to quantities of herbivores and riffle dwellers with greater numbers observed during the 2013 visit comparted to the 2015 visit. Greater species and numbers of individuals were observed during the second visit suggesting high quantities of herbivores and riffle dwelling taxa are likely inflated scores.

While present chemistry data does not indicate elevated TSS levels are present within the reach, the dataset is limited. Macroinvertebrate metric data suggests potential for TSS related stress within the reach while the fish data does not. As such, TSS is an inconclusive stressor for the macroinvertebrates within the reach while it is not a stressor for the fish community.

Table 237. Fish metrics that respond to high TSS stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

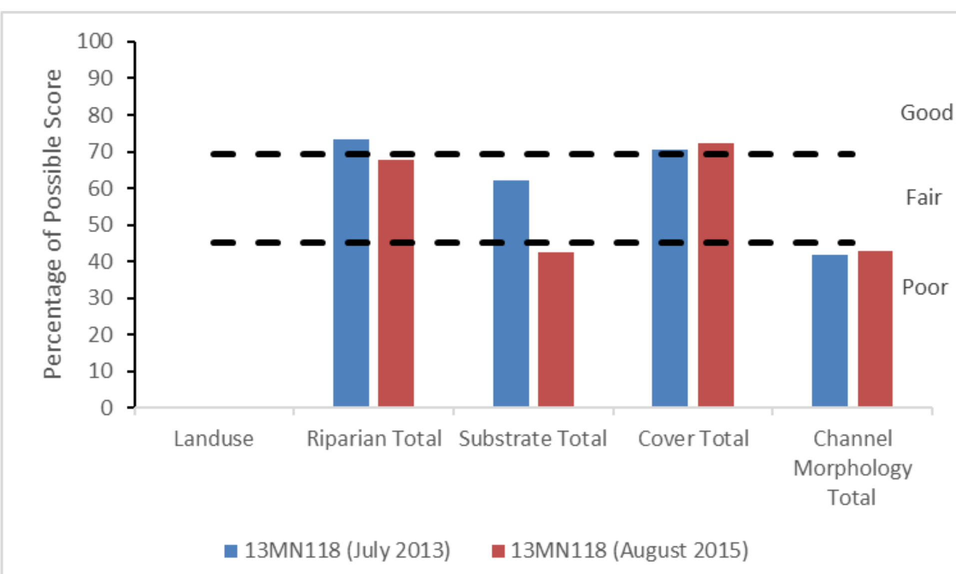
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN118 (2013)	**29.63**	**0.00**	29.63	**0.00**	**3.70**	**0.00**	29.63	**0.00**	29.63
13MN118 (2015)	**2.34**	**0.00**	**2.34**	**0.00**	**0.00**	**0.00**	**2.34**	**0.00**	**2.34**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN118 (2013)	13.64	**0.00**	**0.00**	0.00	0.00
13MN118 (2015)	13.52	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

MSHA scores were fair at both visits at 13MN118, with the 2015 visit scoring five points below the initial visit (see graph below). Slight changes in MSHA score from 2013 to 2015 may indicate an increase in stream bank erosion and sedimentation. Landuse within the watershed is predominately row crop agriculture, but also includes 14 moderately sized confined animal feeding operations predominately holding bovines or swine. Nine facilities are greater than 350 animal units in size; five exceed 700 animal units. The stream reach has an intact wooded riparian zone 10-50 meters in width, moderate stream shading and some stream bank erosion (see photo below). The in-stream zone had moderate amounts of available cover, limited riffle habitat and while coarse substrates were present within the reach, their abundance appeared limited. What coarse substrates were available were lightly to moderately embedded. Channel morphology scores at both visits was poor due to limited depth variability, little stream sinuosity and channel development. Overall channel stability was moderate to high; however, this may continue to deteriorate if sediment levels continue to increase. The stream channel appears incised and is actively cutting; sediment deposition has formed midchannel bars within the reach.

Figure 214. Percentage of MSHA subcategory scores for stations 13MN118 in Mink Creek.



The fish community shows a mixed response to habitat stress metrics within the reach (see table below). There was an abundance of tolerant taxa within the reach and low counts of 'darter, sculpin, sucker' and benthic insectivore taxa at both visits. The 2013 fish visit however, may be misleading as few individuals and taxa were captured during the visit, which may be biasing the results. The 2015 visit which produced two more taxa and more individuals had low quantities of lithophilic spawners, riffle dwelling species and piscivores. This indicates corroborates observations of limited availability of coarse substrates and riffles within the reach. Low quantities of piscivores could indicate limited habitat availability (deep pools) for predatory taxa.

Table 238. Fish metrics that respond to degraded habitat stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN118 (2013)	**96.30**	3.70	77.78	**0.00**	18.52	29.63	**0.00**	77.78
13MN118 (2015)	**100.00**	**0.00**	**37.50**	**0.00**	18.75	**2.34**	**0.00**	32.03
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	31.50
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to habitat stress metrics in the macroinvertebrate sample as well (see table below). There were fewer than average quantities of clinger, EPT and sprawling species within the reach. Low quantities of clingers and sprawling taxa within a reach is an indication that limited coarse substrate habitat and woody debris are available within the reach, even though woody debris habitat was sampled within the reach. There were below average quantities of burrowing taxa but an overabundance of legless taxa, suggesting a prevalence of fine sediment in the reach. Large quantities of climbing species is consistent with prevalence of overhanging vegetation, which was one of two habitats sampled within the reach.

A majority of the metrics suggest that habitat stress is likely having negative impacts on both the fish and macroinvertebrate community within the reach.

Table 239. Macroinvertebrate metrics that respond to degraded habitat stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN118 (2013)	9.35	46.42	**19.63**	**12.77**	**83.49**	**16.20**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Figure 215. Biological station 13MN118 (July 9, 2013) stream bank erosion (left); sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. There is the potential for low flow barriers along 'home made' stream crossings which could be barrier to connectivity at high flow conditions (see aerial photos below).

Six unique species were captured on the reach during fish sampling. Four of these species were not observed at the next downstream biological station on Perch Creek, but were observed further downstream in the watershed. Four species observed at the next downstream biological station 13MN143 on Perch Creek -524 were not observed on Mink Creek, two of these species are migratory fish taxa. One migratory fish taxa was observed on the reach, white sucker (see table below). DNR did not perform any mussel surveys on Mink Creek.

Insufficient information is available to determine whether or not longitudinal connectivity is a stressor on the reach at this time. Additional investigations would be useful to better understand the potential for stream road crossings to limit natural fish migration within the reach.

Table 240. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Taxa in blue are known lake species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN118	13MN143	13MN129	01MN015	97MN011
WID	-577	-524	-524	-523	-523
	Mink Creek	Perch Creek	Perch Creek	Perch Creek	Perch Creek
Fish Taxa					
bigmouth shiner	x		x	x	x
black bullhead		x		x	x
blacknose dace	x		x	x	x
blackside darter		x	x	x	x
bluntnose minnow		x	x	x	x
brassy minnow				x	x
brook stickleback	x				x
central stoneroller			x		x
common carp			x		x
common shiner				x	x
creek chub			x	x	x

Field Number	13MN118	13MN143	13MN129	01MN015	97MN011
fathead minnow	x			x	x
gen. redhorse					x
golden redhorse			x		x
green sunfish			x	x	x
johnny darter		x		x	x
largemouth bass					x
northern hogsucker				x	x
northern pike	x	x	x	x	x
sand shiner			x	x	x
shorthead redhorse					x
silver redhorse			x	x	
slenderhead darter				x	x
spotfin shiner			x	x	x
stonecat				x	x
white sucker	x	x	x	x	x

Figure 216. Google Earth aerial image of Mink Creek 'home made' stream crossing. Culvert appears to be undersized causing downstream scouring.

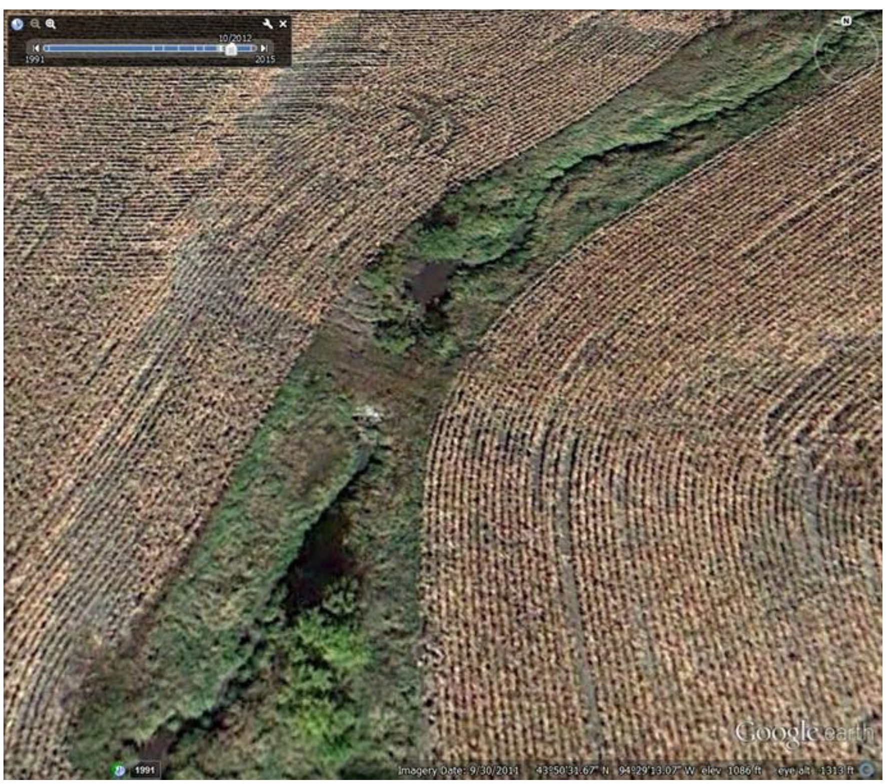


Figure 217. Google Earth aerial image of Mink Creek 'homemade' stream crossing. Culvert appears undersized causing downstream scouring.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 3.68 mile long reach of Mink Creek is 24% natural and 76% modified. Upstream of the reach, Mink Creek is entirely modified. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed within the reach.

No lake species were identified during fish sampling. The presence of lake taxa within a reach can be an indication of potential low flow conditions and altered hydrology stress.

There were inconsistent results when comparing quantities of riffle dwelling taxa in the 2013 and 2015 fish visits. Inconsistencies are likely attributed to the low quantities of taxa and individuals captured during the 2013 visit. There were also low quantities of long-lived taxa in the reach at both visits. Low quantities of riffle dwelling and long-lived taxa can also be an indication of altered hydrology stress (see table below).

Table 241. Fish metrics that respond to altered hydrology stress in Mink Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN118 (2013)	**96.3**	**3.70**	29.63
13MN118 (2015)	**100.00**	**0.00**	**2.34**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
Expected response to Altered Hydrology stress	↑	↓	↓

A dry streambed was observed at station 13MN118 in September of 2012 (see photographs below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. An attempt to resample the macroinvertebrate community in 2015 was unsuccessful due to insufficient flow conditions, confirming flow instability within the reach. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Figure 218. Biological station 13MN118 (September 2012) dry streambed.

4.1.3. AUID Summary

Habitat and altered hydrology are stressors to the biological communities within the reach. Mink Creek has been channelized throughout a majority of its flowage to provide drainage for the watersheds surrounding agricultural landuse, agricultural fields have been tile drained to dry agricultural fields out quickly after rain events and historic wetlands have been drained limited natural water storage in the subwatershed. This results in higher flows after storm events. High flows after precipitation events are causing stream bank instability within the reach resulting in stream bank erosion. An increase in stream sediment load is filling in pool and riffle habitat and limiting the availability of diverse habitat types within the reach. Installation of drain tiles and draining of wetlands has decreased the natural water table limiting available baseflow during the dry late summer months, which was observed in 2013 and 2015.

Nitrogen is a stressor to the macroinvertebrate community within the reach. Elevated levels of nitrogen were consistently observed within a small dataset on the reach. Nitrogen samples were elevated during baseflow conditions during the fish visits and after rainfall events during SID sampling. Concentrations ranged from 14 mg/L to 35 mg/L and suggest that elevated nitrate concentrations are linked to inputs from drain tile runoff. Macroinvertebrates exhibited a strong response to stress with an abundance of nitrate tolerant taxa identified within the reach.

DO, eutrophication and longitudinal connectivity are inconclusive stressors within the reach. There were no low DO violations noted in a small dataset. While macroinvertebrate data did not exhibit a significant response to low DO stress the fish community stress metrics indicated that a high percentage of DO tolerant taxa were present in the reach. Additional chemistry data collection, including continuous sonde monitoring to better understand diurnal DO flux should be gathered to better understand the potential for low DO conditions to exist within the reach. Elevated phosphorous concentrations were identified within a small dataset on the reach. However, there was no response variable data to confirm or deny eutrophication stress within the reach. While biological metrics show apparent stress in the reach, it cannot be determined whether or not the observed stress in these metrics was due to eutrophication or other stressors within the reach. While there are no known dams on the reach, several stream crossings may be inhibiting fish migration during periods of high and low flows. Additional on the ground investigation is needed to confirm whether potential barriers are inhibiting the fish community within the reach.

TSS was an inconclusive stressor to the macroinvertebrates on the reach and does not appear to be stressing the fish community. While there was no chemical evidence implicating elevated TSS concentrations exist within the reach, the dataset is small and limited to biological sampling and SID investigations. As macroinvertebrate metric data suggests potential for stress, additional data collection is needed to rule out the potential stressor.

Table 242. Summary if stressor determinations for Mink Creek (577).

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Altered Hydrology	Connectivity
Mink Creek	07020010-577	o/-	o	●	-/o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

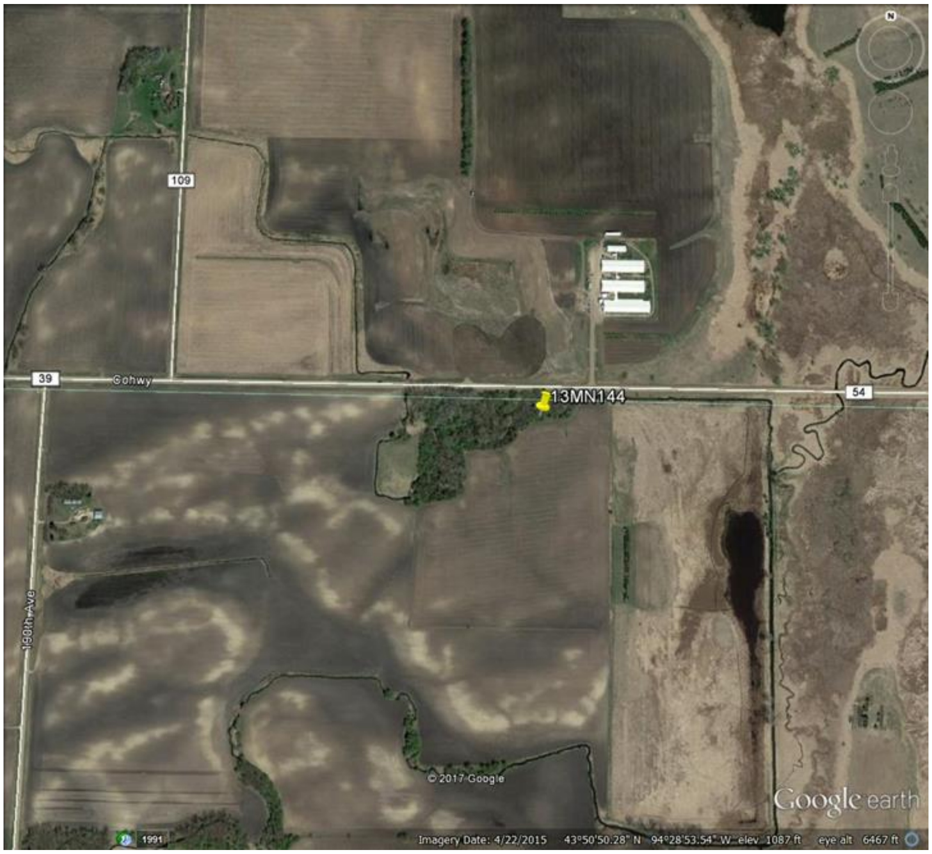
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Unnamed Creek (Judicial Ditch 72) -557

Unnamed Creek (Judicial Ditch 72) (07020010-557) is a tributary reach of Perch Creek. It begins upstream of Co. Hwy. 109 and flows east two miles to Perch Creek (07020010-524), three miles northwest of Truman. Classification for this reach is general use warmwater 2Bg. The reach is impaired for aquatic life for a degraded fish community (2015).

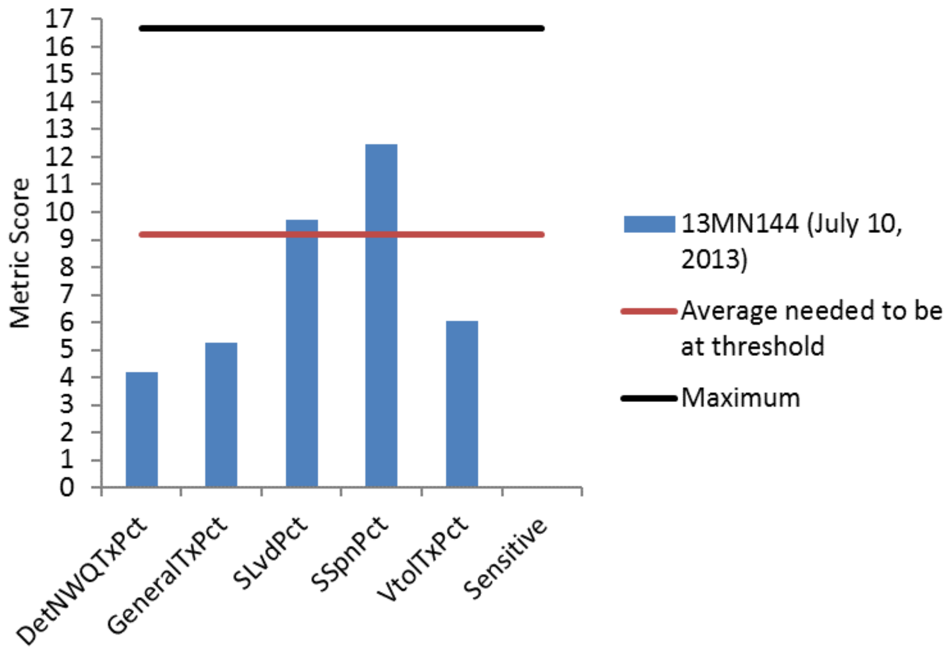
Figure 219. Google Earth image of Unnamed Creek (Judicial Ditch 72) (-557).



4.1.1. Biological communities

There is one biological monitoring station on this reach. 13MN144 was sampled once for fish in 2013. It was not sampled for macroinvertebrates due to insufficient flows limiting available habitat for sampling. The FIBI scored 37.6, below the threshold (55) and lower confidence limits. Eight species were sampled; dominant taxa captured included johnny darter, blacknose dace and white sucker. Sensitive taxa were absent in the fish community while there was an abundance of very tolerant taxa. There was an abundance of generalist (GeneralTxPct) and detritivore (DetNWQTxPct) taxa resulting in below average ratings in both metrics. There were sufficient quantities of serial spawners (SSpnPct) and short-lived taxa (SlvdPct) (see graph below).

Figure 220. Fish metrics of the Southern Headwaters Class IBI for stations 13MN144, Unnamed Creek (Judicial Ditch 72).



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Two DO readings were taken during biological visits in 2013. Both fell within normal ranges at 7.24 mg/L and 7.85 mg/L respectively. Seven additional DO samples were collected in 2016 during SID investigations and ranged from 6.88 mg/L on June 23, 2016 at 9:58 am to 11.51 mg/L on May 2, 2016 at 3:06 pm. No continuous DO monitoring was conducted on the reach.

Fish community data shows a mixed response to low DO stress metrics (see table below). The DO Index score was 7.27, above the southern headwaters average of 7.13. This suggests that low DO conditions are not likely stressing the fish community within the reach. There was an absence of DO sensitive taxa and generally sensitive taxa. There was also a large percentage of tolerant taxa in the sample. However, there was not an abundance of DO tolerant taxa or DO tolerant individuals, suggesting that other stressors are likely having a greater impact on the fish community in the reach. As such, DO is not a likely stressor to the fish within the reach at this time.

Table 243. Fish metrics that respond to low DO stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN144 (7/10/2013)	**0.00**	**12.50**	**87.50**	7.27	**0.00**	**0.00**	1.00	7.32
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Eutrophication

The phosphorous sample collected during the fish visit in 2013 had a concentration of 0.236 mg/L, above the southern region eutrophication standard of 0.15 mg/L. An additional five samples were gathered in 2016 during SID investigations. Two samples were above the eutrophication standard. Phosphorous concentrations ranged from 0.05 mg/L on May 24 to 0.317 mg/L on June 15, with an average concentration of 0.149 mg/L. There were no chlorophyll a or BOD samples collected on this reach nor was other response variable data collected. DO grab sample data ranged from 6.88 mg/L to 11.51 mg/L indicating potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.67 – 8.27 in the reach.

There was mixed results to eutrophication stress within the fish community (see table below). There was a high percentage of tolerant species and an absence of intolerant and sensitive taxa. However, counts of darters and simple lithophilic spawners were both above the southern headwaters class average. All of these eutrophication stress metrics are general in nature and could be responding to other stressors within the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were observed on the biological station suggesting potential for eutrophication stress on the reach.

Due to a limited chemical dataset and a lack of sufficient response variable data to confirm eutrophication stress, eutrophication is an inconclusive stressor in the reach at this time.

Table 244. Fish metrics that respond to eutrophication stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN144 (7/10/2013)	**0.00**	12.50	41.46	**26.83**	**87.50**	**8.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	7.90	11.50	31.50	14.71	72.80	11.50	1.60
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Nitrate

Nitrate concentrations were elevated above background levels during the fish visit, the concentration was 11 mg/L on July 10, 2013. Five additional nitrate samples were collected in 2016 as part of the stressor identification investigations during the months of February, May and June. Nitrate concentrations ranged from 25 mg/L to 30 mg/L, both low and high concentrations were collected in May.

Fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate; unfortunately, there were no macroinvertebrate samples collected on this reach. Fish metrics that respond to nitrate stress are general in nature and do not implicate nitrates as a stressor as metrics could be responding to other stressors within the reach. There was an absence of intolerant and sensitive species and an abundance of tolerant species. There were above average quantities of darter species within the reach (see table below).

Due to insufficient information, it is difficult to determine whether or not nitrate is a stressor to the fish on the reach. Additional sampling including an attempt to sample macroinvertebrates on the reach could be useful in determining whether or not nitrate may be stressing biological communities within the reach.

Table 245. Fish metrics that respond to nitrate stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN144 (2013)	**0.00**	12.50	**87.50**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*7.90*	*11.50*	*72.80*	*1.60*
Expected response to Nitrate stress	↓	↓	↑	↓

Suspended sediment

One TSS sample was collected at biological station 13MN144 during the fish visit; the concentration was 9.6 mg/L and did not exceed the southern regional TSS standard of 65 mg/L. No TSS samples were gathered along the reach prior to biological monitoring efforts. Seven additional TSS samples were collected along the reach in 2015 and 2016 as part of SID investigations, values ranged from 1.6 mg/L June 16, 2015 to 20 mg/L on June 16, 2016; no samples exceeded TSS standards.

There was a mixed response to TSS stress metrics within the fish community on the reach (see table below). The TSS Index score was below average for the Southern Headwaters Class, suggesting a low likelihood that TSS is stressing the fish community. There were low quantities of centrarchids, herbivores, lithophilic spawners and riffle dwelling species, all of which can be characteristic of elevated TSS concentrations. However, there were no TSS tolerant taxa present, nor were benthic feeders or simple lithophilic spawners lacking within the reach. While intolerant and sensitive taxa were absent within the reach, this could be explained by other stressors. It is possible that a response to TSS in the metrics below is a result of habitat related stress and sedimentation in the reach. At this time, fish metrics do not indicate a likelihood of TSS related stress and chemistry data collected during spring event based sampling does not indicate elevated levels of TSS are problematic within the reach; as a result, TSS is not a stressor in the reach at this time.

Table 246. Fish metrics that respond to high TSS stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

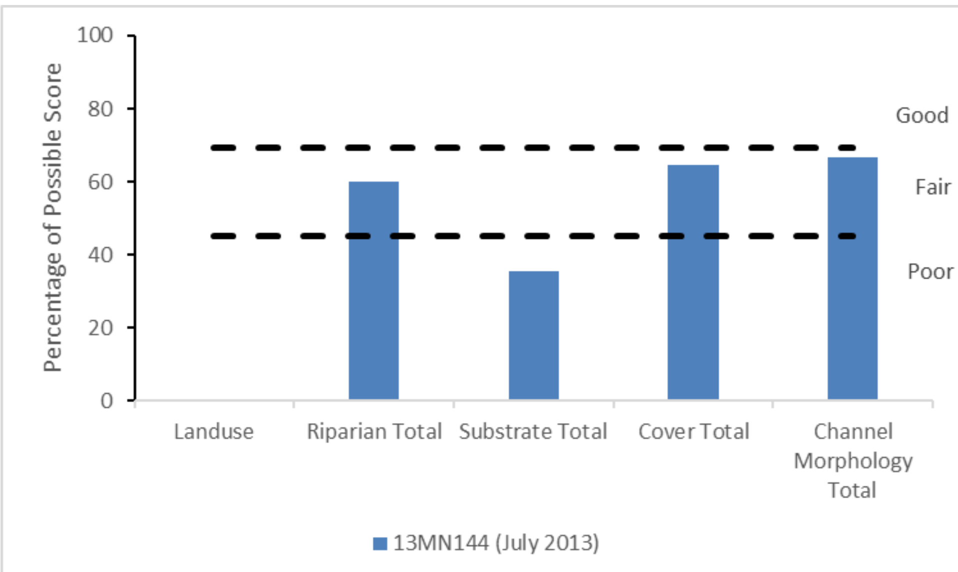
Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN144 (2013)	48.78	**0.00**	**21.95**	**0.00**	**0.00**	26.83	**21.95**	**0.00**	19.51
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN144 (2013)	13.82	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

Habitat

One qualitative habitat survey was conducted on the reach at the biological station 13MN144 in 2013 (see graph below). The MSHA score was rated fair (53.6). Surrounding landuse for the reach was row crop agriculture. Adjacent to the biological monitoring station is a very large swine facility with 2,206.8 animal units (5,517 pigs). A majority of the reach is channelized; limited grass buffers line the stream banks upstream of the biological station while a moderately sized buffer of mature trees lined the banks at the biological station followed by and extensive grass buffer further downstream of the station before it enters Perch Creek. While a majority of the reach was classified as run channel type (70%), riffles and pools were also observed resulting in a good channel development score. Moderate habitat cover was available for the biota, including overhanging vegetation, deep pools, woody debris and root wads. Heavy stream bank erosion was identified. While fine substrates dominated the reach, gravel was identified in riffles and was moderately embedded. An unstable streambed and unstable stream banks resulted in an overall low stream stability score.

Figure 221. Percentage of MSHA subcategory scores for station 13MN144 in Unnamed Creek (Judicial Ditch 72).



There was a mixed response to degraded habitat metric stress within the fish community on the reach (see table below). There was a slightly above average quantity of tolerant taxa within the reach. There were below average quantities of piscivores, lithophilic spawners and riffle dwellers in the sample. There were sufficient quantities of 'darter, sculpin, sucker' taxa, benthic insectivores and simple lithophilic spawners. The MSHA score is limited by substrates within the reach, limited to sand, silt and gravel. While riffles in the reach are present, they only comprise 10% of the reach and are predominately comprised of embedded gravel and sand. These limitations are evident by the low quantity of riffle dwelling taxa in the reach and low quantities of simple lithophilic spawners. While darter counts were prevalent in the reach, only johnny darters were collected, somewhat skewing the numbers. Preponderance of evidence suggests that degraded habitat conditions are stressing the fish community in the reach.

Table 247. Fish metrics that respond to degraded habitat stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN144 (7/10/2013)	**73.17**	**0.00**	**53.66**	26.83	**48.78**	**21.95**	26.83	41.46
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*31.50*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

Figure 222. Biological station 13MN144 (July 10, 2013) raw banks (left); (June 2016) stream bank erosion (right).

Altered hydrology/Longitudinal connectivity

There are no known fish barriers on the reach or downstream of the reach on Perch Creek. Eight fish species were captured at station 13MN144; on the next downstream station on Perch Creek, only seven species were identified. Two species sampled on the reach are known migratory fish species, white sucker and central stoneroller. While greater diversity was observed further downstream on Perch Creek, it is not known whether low taxa diversity in the upper portions of Perch Creek are due to their size and position in the watershed or unknown barriers within the reach limiting longitudinal connectivity (see table below). There were no DNR mussel survey data collected on the reach. At present, longitudinal connectivity is an inconclusive stressor on the reach, until additional investigation is conducted to determine whether culverts may be limiting fish movements on the reach during periods of high or low flow.

Table 248. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Taxa in blue are known lake species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	13MN144	13MN143	13MN129	01MN015	97MN011
WID	-577	-524	-524	-523	-523
Fish Taxa					
bigmouth shiner	x		x	x	X
black bullhead		x		x	X
blacknose dace	x		x	x	X
blackside darter		x	x	x	X
bluntnose minnow	x	x	x	x	X
brassy minnow				x	X
brook stickleback					X
central stoneroller	x		x		X
common carp			x		X
common shiner				x	X
creek chub	x	x	x	x	X
fathead minnow	x	x		x	X
gen. redhorse					X
golden redhorse			x		X
green sunfish			x	x	X
johnny darter	x	x		x	X
largemouth bass					X
northern hogsucker				x	X
northern pike		x	x	x	X
sand shiner			x	x	X
shorthead redhorse					X
silver redhorse			x	x	
slenderhead darter				x	X
spotfin shiner			x	x	X
stonecat				x	X
white sucker	x	x	x	x	X

The Altered Watercourses GIS layer for Minnesota streams indicates that the 2.03 mile long reach of Unnamed Creek is 13% natural and 87% modified. Upstream of the reach, Judicial Ditch 72's headwaters are also 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks, and an overall reduction in diversity. According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor, while undercut banks were not identified at the biological station, stream bank erosion was heavy and channel stability was low.

No lake species were identified within the reach; the presence of lake taxa within a reach can imply low flow conditions and altered hydrologic stress. There was an absence of long-lived taxa within the reach and a below average quantity of riffle dwelling taxa. Low quantities of individuals in both metrics can also be an indication of altered hydrology stress within the reach (see table below).

A dry streambed was observed at station 13MN144 in September of 2012 (see photograph below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow conditions were also observed in August of 2013, limiting the ability of biological monitoring crews to collect a macroinvertebrate sample (see photo below). Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is a stressing the biology within the reach at this time.

Table 249. Fish metrics that respond to altered hydrology stress in Unnamed Creek (Judicial Ditch 72) compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN144 (7/10/2013)	**73.17**	**0.00**	**21.95**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
Expected response to stress	↑	↓	↓

Figure 223. Biological station 13MN144 (September 12, 2013) dry streambed (left); (August 13, 2013) low flow (right).

4.1.3. AUID Summary

Habitat and altered hydrology are stressing the fish within the reach. Practices to improve agricultural productivity in the watershed are having negative implications within the reach. Historical wetland drainage, installation of tile drainage and ditching have led to an increase in stream flows after rain events and a deficit of stream flow in the late summer months. Elevated stream flows have led to stream bank erosion, which causes sedimentation within the stream reach, limiting the availability of diverse habitats including coarse substrates, riffles and deep pools.

Eutrophication is an inconclusive stressor in the reach, while elevated phosphorous concentrations were observed in the reach, the dataset is limited and no response variable data was present to confirm that elevated concentrations are problematic. Additional response variable information would be useful in better understanding the potential concerns on the reach including chlorophyll a and BOD samples and continuous DO monitoring to obtain DO flux data.

Nitrates are also an inconclusive stressor on the reach. While elevated nitrogen concentrations were identified during spring and early summer runoff sampling, fish are not good indicators of nitrate stress. A macroinvertebrate sample would be useful to better understand if elevated nitrogen concentrations are limiting biological communities within the reach, as macroinvertebrates typically are better indicators of nitrate stress.

DO and TSS are not likely stressors. There was no chemical evidence to suggest elevated TSS concentrations occur within the reach, even during high flow events, nor was there evidence indicating low DO conditions were present; however, the dataset is limited to a few grab samples. Biological metrics did not respond to low DO or elevated TSS concentrations in the reach. TSS stress metrics that may indicate TSS related stress are indicative of sedimentation and point to habitat as a stressor in the reach.

Table 250. Summary of stressor determinations for Spring Creek (557).

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Altered Hydrology	Connectivity
Unnamed Creek (Judicial Ditch 72)	07020010-557	--	o	o	--	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

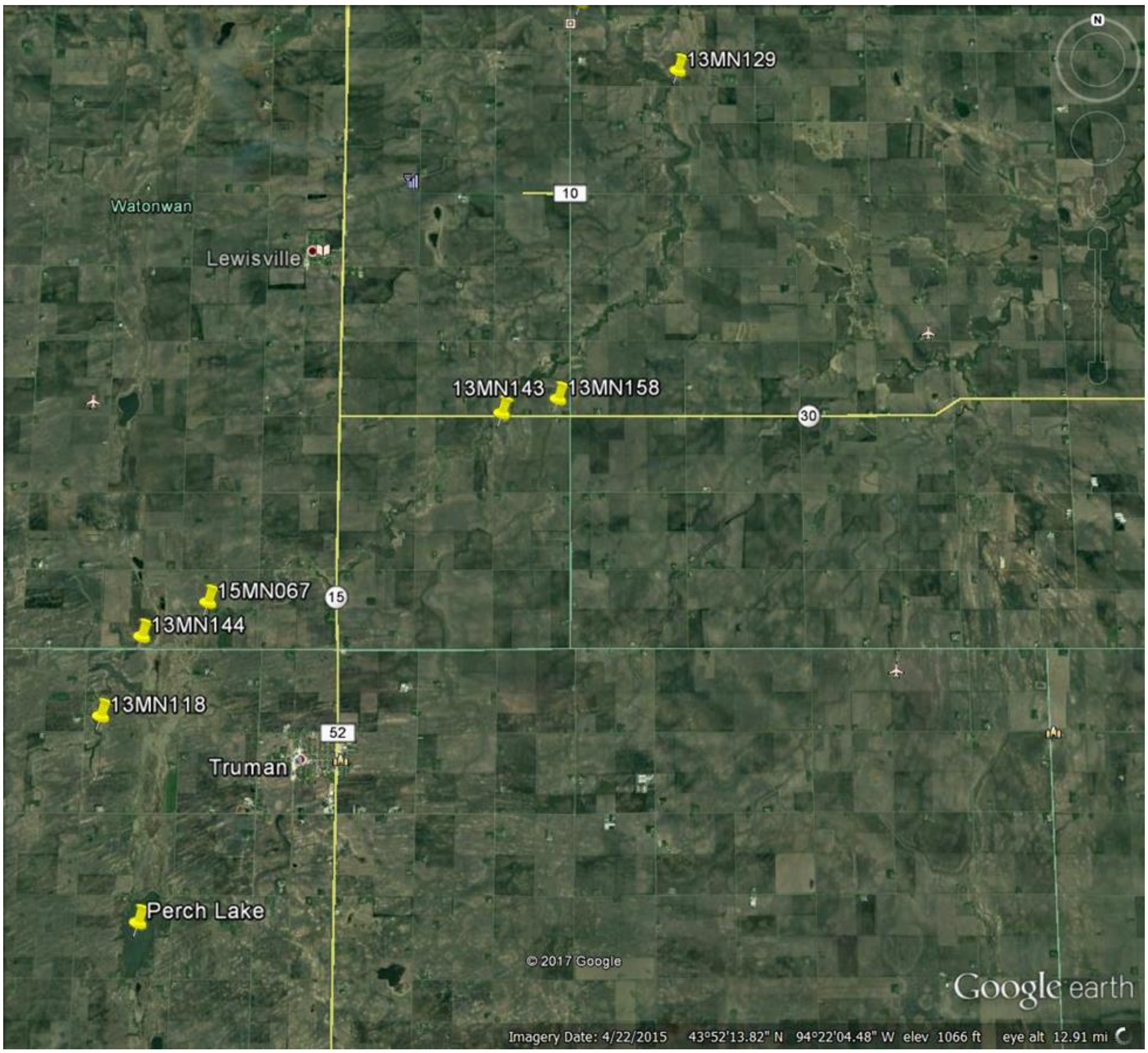
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Perch Creek -524

This reach (07020010-524) is the headwaters section of Perch Creek. Perch Creek starts at the outlet of Perch Lake, encompassing 25 stream miles to downstream reach (0702000-523), just upstream of the Spring Branch Creek confluence, downstream of Twp. Hwy. 75, about four miles East of Lewisville. The reach is classified as general use warmwater 2B. The reach is impaired for aquatic life for both fish and macroinvertebrate assemblages (2015) and excessive levels of turbidity (2006).

Throughout its course, it gains the flow of Mink Creek (07020010-577), Unnamed Creek (07020010-557) Unnamed Creek (07020010-526) and Unnamed Creek (07020010-584).

Figure 224. Google Earth image of Perch Creek (-524).



4.1.1. Biological communities

This reach has two stations sampled for biology. Station 13MN143 was sampled once in 2013 and again in 2014. The initial visit received low end scoring of zero due to the small sample size; a subsequent visit in 2014 scored 59, above the threshold (50) but within lower confidence limits. While individual taxa quantities at the second visit were only marginally higher than the first visit, the community's top species changed to include not only tolerant white sucker but also blackside darter, greatly improving the overall score. Site 13MN129 was sampled once in 2013 and scored 30.4, below the threshold (50) and lower confidence limits. Bluntnose minnow, bigmouth shiner and sand shiner, all tolerant species, dominated the site's community. Low metrics scoring for the 2014 visit at 13MN143 included: the dominant two taxa percentage (Dom Two Percent) and quantity of taxa that take greater than two years to mature (MA<2Pct); implying that the sample was hyper dominated by two species and did not include taxa that take longer than two years to mature, indicating stress (see graph below).

Macroinvertebrates were sampled once at each station in 2013. 13MN143 scored below the threshold (41) for Prairie Streams GP but within lower confidence limits. 13MN129 scored 32.3 below the threshold (37) for Southern Streams RR but also within lower confidence limits. The sample at 13MN143 was hyper dominated by Physa taxa (snails) while the community at 13MN129 was more balanced between four groups: Cheumatopsyche (56), Polypedilum (45), Physa (34) and Simulium (30). Low metrics for 13MN143 macroinvertebrate visit include zero scores for Intolerant 2CH (taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN TVs), HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) and a low score for collector filterer percent (see graph below).

An additional station was sampled for fish further upstream on this reach of Perch Creek as part of a random statewide monitoring effort, 15EM067, but was not assessed due to wetland characteristics.

Figure 225. Fish metrics of the Southern Streams Class IBI for station 13MN143, Perch Creek.

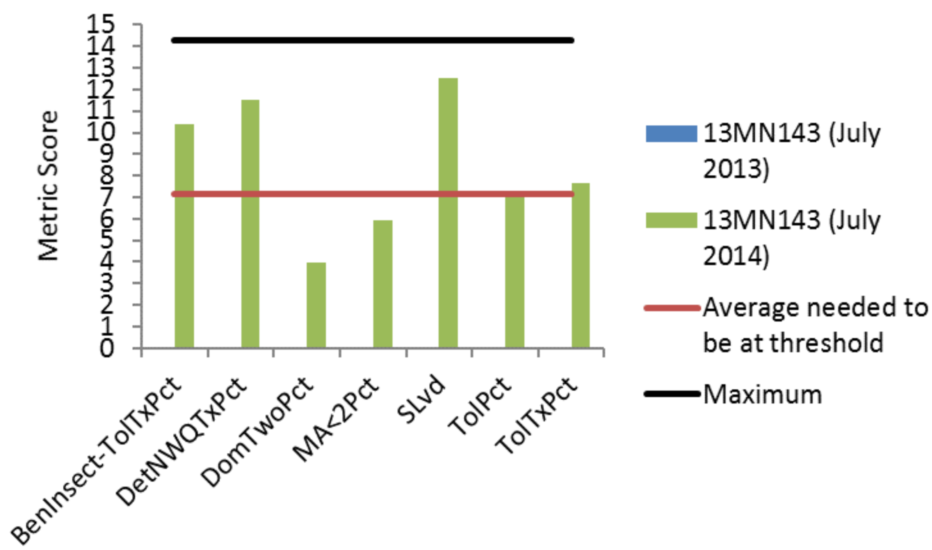


Figure 226. Fish metrics of the Southern Streams Class IBI for station 13MN129, Perch Creek.

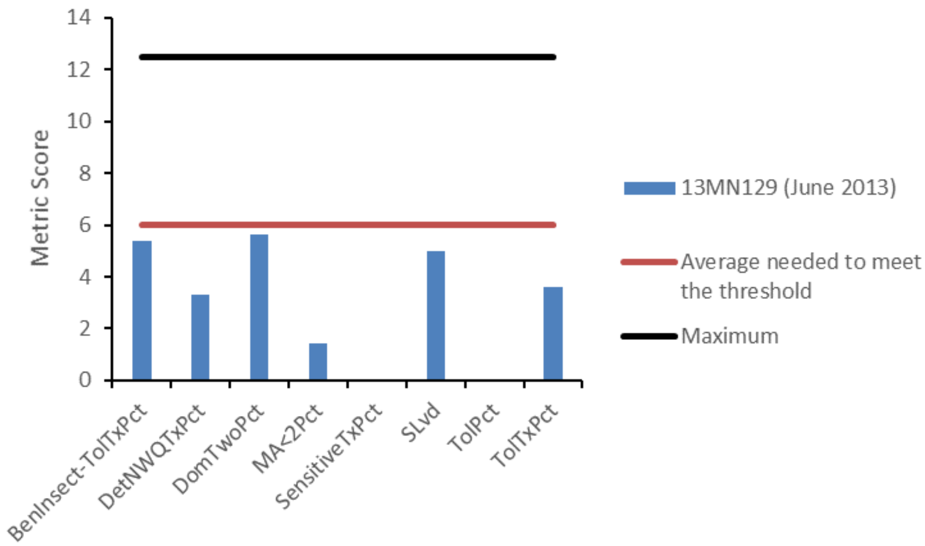


Figure 227. Macroinvertebrate metrics of the Southern Streams Class IBI for station 13MN143, Perch Creek.

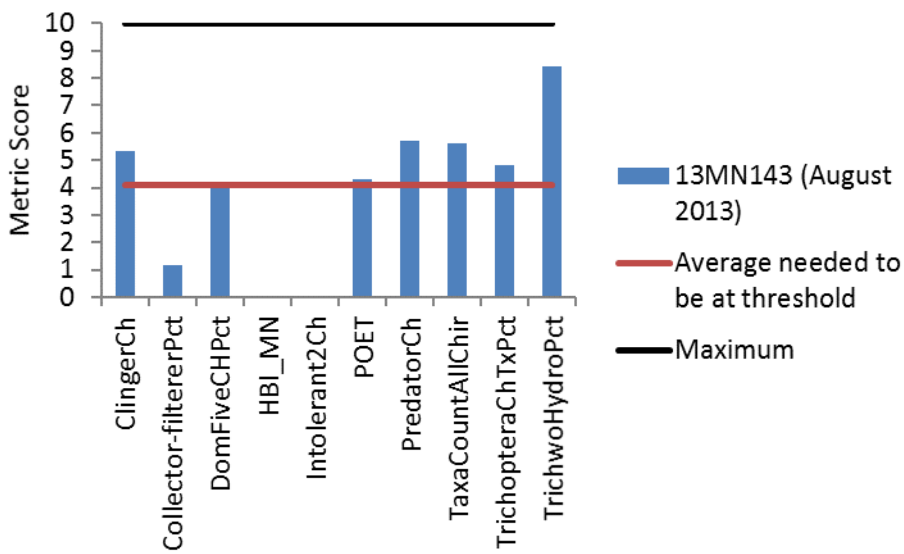
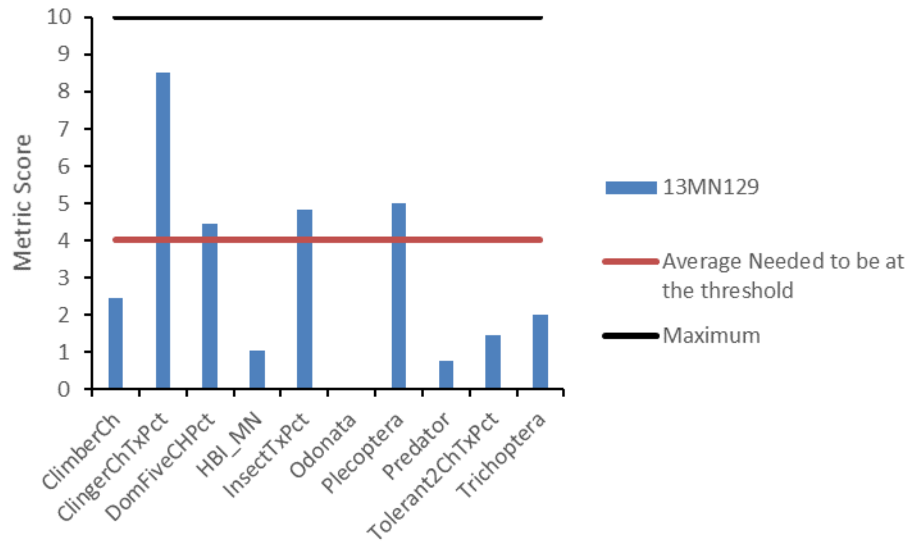


Figure 228. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 13MN129, Perch Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Seven DO readings were collected during the biological monitoring visits at three stations from 2013-2015. DO values ranged from 6.7 mg/L on 7/1/2015 at 5:09 pm at station 13MN143 to 10.29 mg/L on 8/12/2014 at 6:31 pm at station 15EM067. No DO measurements were collected prior to biological sampling within the reach. Eleven additional DO measurements were collected in 2015 and 2016; all values were within normal DO ranges. No continuous DO measurements were collected on the reach.

There was a mixed response to low DO stress in the macroinvertebrate community within the reach (see table below). Station 13MN143 fell within the threshold for the low DO index score while 13MN129 was just above the threshold, suggesting that low DO stress is not likely stressing the macroinvertebrates in the reach. Both stations had low numbers of low DO intolerant taxa and above average quantities of low DO tolerant taxa but low overall quantities of low DO tolerant individuals, this suggests that other stressors are likely be having a greater impact to the macroinvertebrate community.

Table 251. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN143 (2013)	38.00	**7.00**	**0.00**	6.76	**2.00**	**1.25**	**12.00**	7.84
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
13MN129 (2013)	38.00	12.00	**8.00**	**7.70**	**5.00**	**7.30**	**7.00**	7.99
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Fish metrics also show a mixed response to low DO stress (see table below). The DO index score across all visits was at or just above the average needed to meet the threshold for the southern streams class. There was nearly a complete absence of DO sensitive taxa and no generally sensitive fish taxa. While there was an abundance of tolerant taxa across nearly all visits, DO tolerant taxa and individual percentages were not high.

Table 252. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN143 (2013)	**0.00**	**44.44**	**77.78**	7.19	**0.00**	**0.00**	0.00	0.00
13MN143 (2014)	**0.00**	**31.03**	48.28	7.13	**0.00**	**0.00**	2.00	13.79
13MN129 (2013)	**0.00**	**9.26**	**84.26**	7.24	**0.00**	**0.00**	3.00	2.78
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*7.90*	*13.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Lack of chemical evidence to indicate low DO conditions are present in the reach in conjunction with a lack of metric data pointing to low DO stress, suggests that low DO is not a likely stressor to biological communities within the reach at this time.

Eutrophication

Phosphorous concentrations taken in conjunction with fish visits in 2013, ranged from 0.073 mg/L at station 13MN129 on June 10, 2013 to 0.344 mg/L on July 22, 2014, at station 13MN143. Values above average southern regional eutrophication standard of 0.15 mg/L were observed at both visits on station 13MN143. Sixteen additional phosphorous samples were collected in 2015 and 2016; seven of those samples were at or exceeded the southern regional standard. Phosphorous concentrations ranged from 0.065 mg/L to 0.676 mg/L, with an average concentration of 0.186 mg/L. There was a single chlorophyll a sample collected in 2015 with a value of 7.05 ug/L, below the southern eutrophication standard of 35 ug/L. There was no BOD data collected on the reach, nor was continuous DO monitoring data available to calculate DO flux. DO grab samples collected on the reach range from 6.7 mg/L to 10.39 mg/L. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.58 – 9.12 in the reach.

The macroinvertebrate community metric results suggest possible eutrophication stress (see table below). There was a lower number of collector-filterers and collector-gatherers than the average of visits meeting the biocriteria. There was also a large proportion of the community that was tolerant.

Table 253. Macroinvertebrate metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN129 (2013)	**38.00**	**6.00**	**13.00**	12.00	1.00	**86.84**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
13MN143 (2013)	**38.00**	**3.00**	**11.00**	**7.00**	**0.00**	**89.47**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*37.00*	*4.95*	*19.13*	*8.91*	*0.24*	*81.88*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

There were inconsistent results in the fish community metrics with response to eutrophication stress (see table below). Intolerant and sensitive species were absent across all samples. All samples also had a greater than average percentage of tolerant taxa. While low quantities of darters and simple lithophilic spawners were seen at station 13MN129, quantities were sufficient at both visits at station 13MN143. While the fish visits at station 13MN129 had 14 species and greater quantities of individuals, it performed more poorly to the stress metrics compared to the visits at station 13MN143, where fewer taxa (3-6 species) and individuals were captured. While data suggests that potential for eutrophication stress within the fish community within the reach is higher at station 13MN129 than 13MN143, it could be a product of skewed metric data due to low capture rates. Most eutrophication stress metrics are also general in nature and could be pointing to other stressors in the reach. However, a positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were identified at biological station 13MN143.

Table 254. Fish metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN129 (2013)	**0.00**	**7.85**	**16.67**	1.85	**84.26**	**14.00**	**0.00**
13MN143 (2013)	**0.00**	22.22	44.44	**44.44**	**77.78**	**3.00**	**0.00**
13MN143 (2014)	**0.00**	41.38	62.07	**34.48**	**48.28**	**6.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While phosphorous levels appear elevated within the reach, there is little response variable data available to confirm that eutrophication is a problem in the reach. Biological stress metrics that indicate eutrophication stress are very general in nature and could easily be responding to other stressors within the reach. As such, eutrophication is an inconclusive stressor at this time.

Nitrate

There were three nitrate concentrations taken during the fish visits; the concentration was highest at June visit in 2013 at 13MN129 at 18 mg/L, while visits at 13MN143 and 15EM067 taken in July of 2013 and 2015 were only 5.7 mg/L and 7.5 mg/L respectively. Fifteen additional samples were collected at the biological stations in 2015 and 2016 during SID investigations in the months of February, May, June, July and September. Nitrate concentrations ranged from < 0.5 mg/L in September of 2015 to 30 mg/L in May of 2016, with an average value of 16.37 mg/L. Eight measurements were above 15 mg/L, collected during the months of May and June.

Macroinvertebrate nitrate stress metric data suggests the community is responding negatively to nitrate stress (see table below). The nitrate index score ranged from 3.39 to 4.7, while the average for modified Prairie Streams meeting impairment threshold is 2.99 for the Southern Streams RR Class and 3.2 for the Prairie Streams GP class. Nitrogen tolerant taxa and the percentage of nitrate tolerant individuals are both abundant in this reach. Nitrate intolerant taxa were absent within the reach. The percentage of non-hydropsychid trichoptera was above average as was the Trichoptera taxa count at two of the three reaches indicated a mixed response to nitrate stress as compared to the other nitrate tolerance metrics.

Fish are not good indicators of nitrate related stress. Fish communities in the reach were dominated by tolerant taxa and were absent of sensitive and intolerant taxa. While darter numbers were only low at station 13MN129, few fish were captured at visits at station 13MN143 potentially skewing the results.

High nitrate levels appear persistent during spring months. The macroinvertebrate community responded negatively to a majority of nitrate stress metrics. As such, the macroinvertebrates on the reach are currently stressed by elevated nitrate levels in the reach while the fish community is inconclusive due to limited utility of nitrate stress metric response for fish data.

Table 255. Macroinvertebrate metrics that respond to nitrate stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
15EM067 (No Visit)													7.5 (7/7/2015)
13MN129 (2013)	**38.00**	**6.00**	13.00	11.00	1.00	**86.84**	**4.00**	8.68	**3.39**	**0.00**	**24.00**	**77.00**	18 (6/10/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the FIBI General Use Threshold Average (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
13MN143 (2013)	38.00	**3.00**	**11.00**	**5.00**	**0.00**	**89.47**	3.00	6.98	**4.70**	**0.00**	**23.00**	**89.30**	5.7 (7/10/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	*2.60*	*2.40*	*3.20*	*1.10*	*18.00*	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Suspended sediment

Four TSS samples were collected at three unique biological stations from 2013 – 2015, no levels exceeded the southern regional TSS standard of 65 m/L. Values ranged from 7.2 mg/L on July 10, 2013 at station 13Mn143 to 56 mg/L on July 7, 2015 at station 15EM067. The average value was 24.55 mg/L. No TSS samples were collected on the reach prior to 2013. Eleven additional TSS samples were collected in 2015 and 2016 as part of SID investigations at biological station 13MN129 and 13MN143. Values ranged from 8 mg/L on September 1, 2015 to 66 mg/L on July 14, 2016 at station 13MN129, only one value exceeded TSS standards**.** The average TSS reading was 30.73 mg/L. The turbidity impairment on the reach is derived from transparency tube data. There were 403 transparency measurements collected on the reach from 2000 – 2004 and 2013 – 2016. There were 60 readings below the 10 cm standard for transparency.

A majority of TSS stress metric related data suggests that the macroinvertebrate community is negatively impacted by TSS stress (see table below). The TSS Index score was above the respective thresholds at both biological stations, suggesting potential for TSS stress. There were few if any TSS intolerant taxa within the samples and an abundance of TSS tolerant taxa and individuals; plecoptera taxa were also absent across the reach. Absence of plecoptera taxa can be an indication of instream sedimentation, which can be a side effect of turbid conditions. There were ample quantities of collector-filterer taxa at station 13MN129 while numbers were low at station 13MN143.

Table 256. Macroinvertebrate metrics that respond to high TSS stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN129 (6/10/2013)	32.15	**0.00**	**17.89**	**0.00**	**0.00**	**17.00**	**53.67**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
13MN143 (7/10/2013)	**4.76**	**0.00**	**18.55**	**0.00**	**0.00**	**17.00**	**71.47**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The fish community on the reach shows a mixed response to TSS stress metrics (see table below). The TSS Index score was above the class average for station 13MN129 but was below the class average at both visits on station 13MN143. This could be a reflection of greater risk for TSS stress further downstream in the reach, or could be due to skewed metrics from the visits at 13MN143 where few fish taxa and individuals were captured. Above average quantities of TSS tolerant taxa were observed at station 13MN129, suggesting potential for TSS stress at least in the lower portions of the reach. Station 13MN129 also had below average quantities of benthic insectivores (BenFdFrimPct), centrarchids (Centr-TolPct), herbivores (HrbNWQPct), long-lived (LlvdPct), perciformes (Percfm-TolPct), riffle dwellers

(RifflePct) and simple lithophilic spawning (SLithFrimPct) taxa. Low quantities of riffle dwelling taxa, simple lithophilic spawners, herbivores and benthic insectivores can be an indication of sedimentation in a reach, which typically occurs as a result of high levels of suspended sediment in the water column.

Table 257. Fish metrics that respond to high TSS stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN129 (2013)	**9.26**	**0.00**	**3.70**	**0.00**	**4.63**	**1.85**	**3.70**	**0.00**	**9.26**
13MN143 (2013)	66.67	**0.00**	44.44	**0.00**	**0.00**	22.22	44.44	**0.00**	44.44
13MN143 (2013)	41.38	**0.00**	31.03	**0.00**	**10.34**	41.38	31.03	**0.00**	31.03
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20 0*	*16.9*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

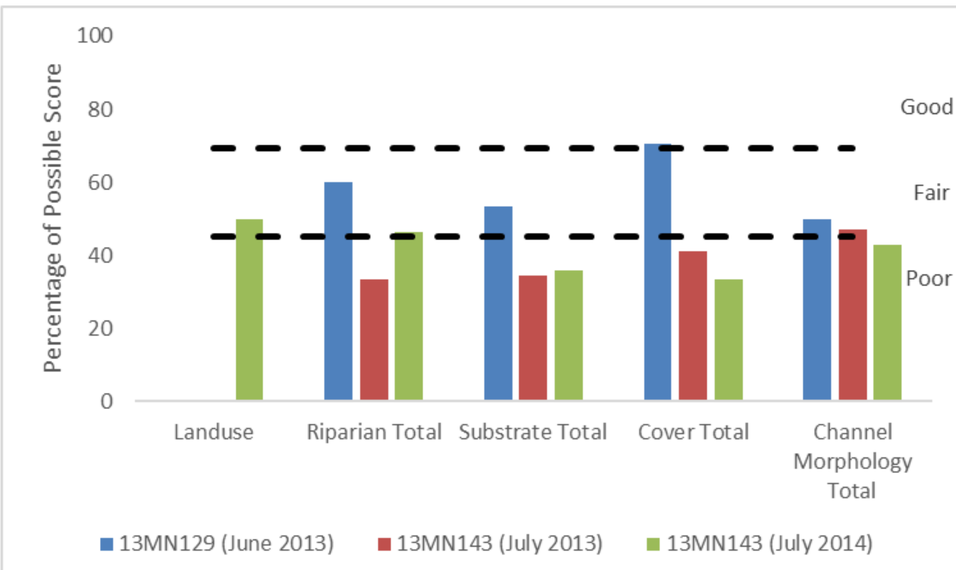
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN129 (2013)	**23.12**	**0.00**	**0.00**	**3.00**	**26.00**
13MN143 (2013)	16.21	**0.00**	**0.00**	0.00	0.00
13MN143 (2014)	13.81	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

Elevated levels of suspended sediment were identified in the reach after storm events as indicated during SID sampling and were identified prior to biological sampling in the identification of the turbidity impairment. In addition, the macroinvertebrate community and fish at station 13MN129 indicate that TSS is an active stressor to biological communities within the reach.

Habitat

Three qualitative habitat surveys were conducted on the reach at assessable biological monitoring stations, two at 13MN143 in 2013 and 2014 and one at 13MN129 in 2013 (see graph below). MSHA scores were lowest at the midreach station 13MN143, with an average score of 39.15 (poor) and marginally improved at the upstream station 13MN129, with a score of 53.45 (fair). The landuse in the surrounding watershed is comprised of row crop agriculture with a few small to medium sized feedlots scattered on the landscape. The upper third of the reach is predominately channelized with limited grass riparian buffers where trees do not line the stream banks. Buffer extent improves somewhat moving downstream to more sinuous portions of the reach, where banks are more protected by mature trees. The surrounding landuse score for station 13MN143 appears inflated. While forest/wetland/prairie/shrub was checked as a predominate surrounding landuse during the 2014 visit, the landuse category appears limited to the adjacent riparian zone and does not reflect a majority of the landuse within the upstream watershed, as was observed during the 2013 visit. Stream bank erosion and embedded coarse substrates were identified within the reach at both biological stations with greater levels observed at the upstream station (see photos below). Fine sediments (silt, sand and clay) dominated both stations. Shifting bed load and eroding banks attributed to moderate to low stream stability rankings at both stations. Natural channel progression within the biological stations was ranked fair, dominated by run and pool channel types (riffles were only observed in 5% of the reach at the downstream station, 13MN129). Instream habitat cover for biota was more abundant, diverse at the downstream station, and sparse at the upstream station. Deep pools, logs and woody debris, instream macrophytes were identified cover types at both stations while boulders and undercut banks were only observed at downstream station 13MN129.

Figure 229. Percentage of MSHA subcategory scores for station 13MN129 and 13MN143 in Perch Creek.



The fish community at biological station 13MN129 is showing a greater response to degraded habitat metrics than upstream station 13MN143 (see table below). This suggests that there is an isolated habitat stressor to the fish community in the lower portions of this reach or the low taxa and individuals collected during the fish visits at reach 13MN143 are skewing results. Station 13MN129 had a negative response to all taxa related habitat stress metrics, including low quantities of piscivore taxa (PiscivorePct), lithophilic (LithFrimPct) and simple lithophilic (SLithopPct) spawners, 'darter, sculpin, sucker' taxa (DarterSculpSucPct), riffle dwelling taxa (RifflePct) and benthic insectivores (BenInsect-TolPct). Limited biological representation from these groups relates to a lack of riffles, instream sedimentation and low habitat diversity within the reach. Station 13MN129 showed an inconsistent response to habitat stress metric, with low quantities of simple lithophilic spawners and piscivore taxa at only one visit. All stations had above average quantities of pioneering taxa. High quantities of pioneering taxa are often identified in highly disturbed reaches, as they do not have specific habitat requirements to thrive.

Table 258. Fish metrics that respond to degraded habitat stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN129 (2013)	**84.26**	**0.93**	**20.37**	**10.19**	**29.63**	**3.70**	**10.19**	**16.67**
13MN143 (2013)	**77.78**	**0.00**	**44.44**	22.22	**55.56**	44.44	22.22	44.44
13MN143 (2013)	**48.28**	10.34	75.86	41.38	**24.14**	31.03	41.38	62.07
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

The macroinvertebrate community responds negatively to habitat related stress at both stations but not within all related metrics (see table below). At the downstream station, there were above average quantities of burrowers and legless, indicating signs of habitat stress. High quantities of legless and burrowing taxa are typical in streams with an abundance of fine sediments and limited availability of coarse substrates. At the upstream station while there were below average quantities of burrowing taxa, there were still above average quantities of legless taxa. There were abundant quantities of climbing taxa at both reaches, which are consistent with stations with abundant quantities of instream macrophytes, which was evident within the biological stations. Low quantities of sprawler and ETP taxa were present at both stations, indicating stress. Metric evidence suggests that there are vulnerable habitats within the reach, but severity of stress appears to vary by station. Habitat degradation is negatively influencing the macroinvertebrate community within the reach.

Table 259. Macroinvertebrate metrics that respond to degraded habitat stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN129 (6/10/2013)	**8.04**	27.97	53.06	**41.48**	**45.34**	**3.86**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
13MN143 (7/10/2013)	5.71	62.54	**18.10**	**17.14**	**78.73**	**5.40**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Degraded habitat conditions observed during MSHA surveys in conjunction with a negative response in habitat metrics by the fish and macroinvertebrate community confirm habitat stress within the reach. A skewed metric response in the fish visit at 13MN143 appears to be the result of small taxa lists and not due to lack of stress in the reach.

Figure 230. Biological station 13MN143 (July 22, 2014) stream bank erosion (upper left); sediment deposition (upper right); bank sloughing (lower left); (May 2, 2016) stream field connection (lower right).

Figure 231. Biological station 13MN129 (June 10, 2013) stream bank erosion (left); (May 1, 2015) livestock access to stream (right).

Altered hydrology/Longitudinal connectivity

There are no known dams within the reach. Fish diversity declines moving upstream on the reach at the upstream most station (13MN143) only six unique taxa were observed, three of which are known migratory taxa. At the downstream most station, 13MN129, 14 taxa were identified, three migratory taxa were found at this station that were not observed at the upstream most station, including central stoneroller, golden redhorse and silver redhorse. Diversity shift could be related to relative stream order within the reach or it could warrant additional investigation to determine whether or not a connectivity barrier may be responsible for the drastic change in species composition. One additional migratory taxa was identified in a further downstream reach on Perch Creek (-523) that was not observed in this reach (-524), slenderhead darter. Seven taxa were observed downstream of the reach in reach -524 that were not observed within this reach (-523) (see table below). This suggests that other potential barriers may exist between the two WIDs.

Seven of nineteen mussel species identified in the greater Watonwan Watershed were identified within the reach; two were identified both above and below both biological stations including: *Lampsilis siliquoidea* (fatmucket) and *Pyganodon gradis* (giant floater). While five additional taxa were identified at downstream station 13MN129 but not observed at upstream station 13MN143 including *Anodontoides ferussacianus* (cylindrical papershell), *Fuscinaia flava* (Wabash pigtoe), *Lasmigona complanata* (White heelsplitter), *Leptodea fragilis* (fragile papershell) and *Ligumia subrostrata* (pond mussel). This discrepancy of the presence of mussel taxa throughout the reach could be additional evidence of a barrier within the reach, which may be limiting longitudinal connectivity.

Thus, longitudinal connectivity is an inconclusive stressor within the reach until additional investigation can determine whether or not potential barriers exist within the reach.

Table 260. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory fish species, while text in blue indicate known lake species.

Field Number	13MN143	13MN129	01MN015	97MN011
WID	-524	-524	-523	-523
Fish Taxa				
bigmouth shiner		x	x	x
black bullhead	x		x	x
blacknose dace		x	x	x
blackside darter	x	x	x	x
bluntnose minnow	x	x	x	x
brassy minnow			x	x
brook stickleback				x
central stoneroller		x		x
common carp		x		x
common shiner			x	x
creek chub		x	x	x
fathead minnow			x	x
gen. redhorse				x
golden redhorse		x		x
green sunfish		x	x	x
johnny darter	x		x	x
largemouth bass				x

Field Number	13MN143	13MN129	01MN015	97MN011
northern hogsucker			x	x
northern pike	x	x	x	x
sand shiner		x	x	x
shorthead redhorse				x
silver redhorse		x	x	
slenderhead darter			x	x
spotfin shiner		x	x	x
stonecat			x	x
white sucker	x	x	x	x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 25.23 mile long reach of Perch Creek is 14% modified and 86% natural. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. While modified channels are not abundant within the reach, agricultural landuse is prolific, causing hydraulic alteration in the means of replacing perennial vegetation with monoculture agriculture and the prevalence of drain tiles which dramatically increasing stream flows after rain events. The DNR geomorphology survey crew conducted a survey on Perch Creek near biological station 13MN129 and identified the reach as a narrow and deep E6 channel that is in a relatively stable state connected to its floodplain. The stream is highly sensitive to disturbance with a high erosion potential; present vegetated riparian buffers play a significant role in maintaining current stream stability. The stream sediment supply for the reach is low compared to other sites in the watershed (DNR, 2014). According to CADDIS, bank erosion and instability and undercut banks are site evidence that altered hydrology is a potential stressor, bank erosion and limited channel stability was observed at the biological sites, sedimentation also appears to be a concern within the reach.

Table 261. Fish metrics that respond to altered hydrology stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN129 (2013)	**84.26**	**4.63**	**3.70**
13MN143 (2013)	**77.78**	**0.00**	44.44
13MN143 (2013)	**48.28**	**10.34**	**31.03**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*44.85*	*13.60*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Only one known lake dwelling species was identified on the reach, presence of lake taxa can be indicative of low flow and altered hydrology stress within the reach. While there were below average quantities of long-lived taxa at both station in the reach, station 13MN143 had sufficient quantities of riffle taxa. Low quantities of long-lived and riffle taxa can be indicators of altered hydrology stress (see table above).

Low flow was documented in 2012 at stations 13MN143 and 13MN129 (see photographs below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is a likely stressor within the reach at this time.

Figure 232. Biological station 13MN129 (September 13, 2012) dry streambed (left); biological station 97MN011 (September 13, 2012) very low flow and sediment deposition (right).

4.1.3. AUID Summary

Nitrate, TSS, degraded habitat and altered hydrology are stressors within the reach. Limitations within the Perch Creek system are heavily influenced by the surrounding agricultural landuse within the reach. Changes to the natural hydrology of the subwatershed including wetland draining and increasing installations of drain tiles within agricultural fields are sending storm event runoff to streams at an expedited rate, increasing stream power and its erosive power, scouring stream banks, increasing suspended sediment levels and depositing sediments over riffles and coarse substrates and filling in pool habitat. This results in degraded habitat conditions that negatively influence both the fish and macroinvertebrate communities. Landscape alterations influencing high flows in the spring are also drastically reduce stream flows in the late summer months, further limiting biological potential on the reach. TSS stress is evident in a metric response in both biological communities and corroborates elevated quantities of TSS identified by an existing TSS impairment and follow up SID investigations. Fifty percent of 18 nitrate samples collected on the reach were above 15 mg/L. Elevated readings were identified during spring months, indicating a connection to surrounding agricultural landuse and inputs from drain tiles adjacent to agricultural fields within the stream reach during precipitation and runoff events. Macroinvertebrate stress metric data showed a strong response to nitrate related stress. Fish community metric data is insufficient to implicate nitrate stress for fish.

Eutrophication and longitudinal connectivity are inconclusive stressors within the reach. Seven of 19 phosphorous samples collected in the reach exceeded the southern regional eutrophication standard. However, there was limited response variable data in the reach. Biological metric data suggests both fish at station 13MN129, and macroinvertebrates at both biological stations, are potentially responding negatively to eutrophication stress but as metrics are general in nature it is difficult to say whether or not other stressors are at play. Additional response variable data is needed to better characterize the stressor, including DO flux data from continuous sonde deployment and additional chlorophyll a and BOD samples. Additional investigation is needed to determine if there are potential barriers to fish migration by conducting culvert surveys between biological station 13MN129 and 13MN143 to determine whether or not connectivity is a potential stressor along the reach, drastic differences in fish diversity between the two stations and varying mussel diversity along the reach suggests potential for stream connectivity issues.

DO is not a likely stressor on the reach at this time. Available chemistry data was limited but what data was available indicated no violations of the low DO standard and both fish and macroinvertebrate metrics did not respond to low DO stress within the reach.

Table 262. Summary of stressor determinations for Perch Creek (524).

		Stressors:					
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology/Connectivity**
Perch Creek	07020010-524	--	o	o/●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

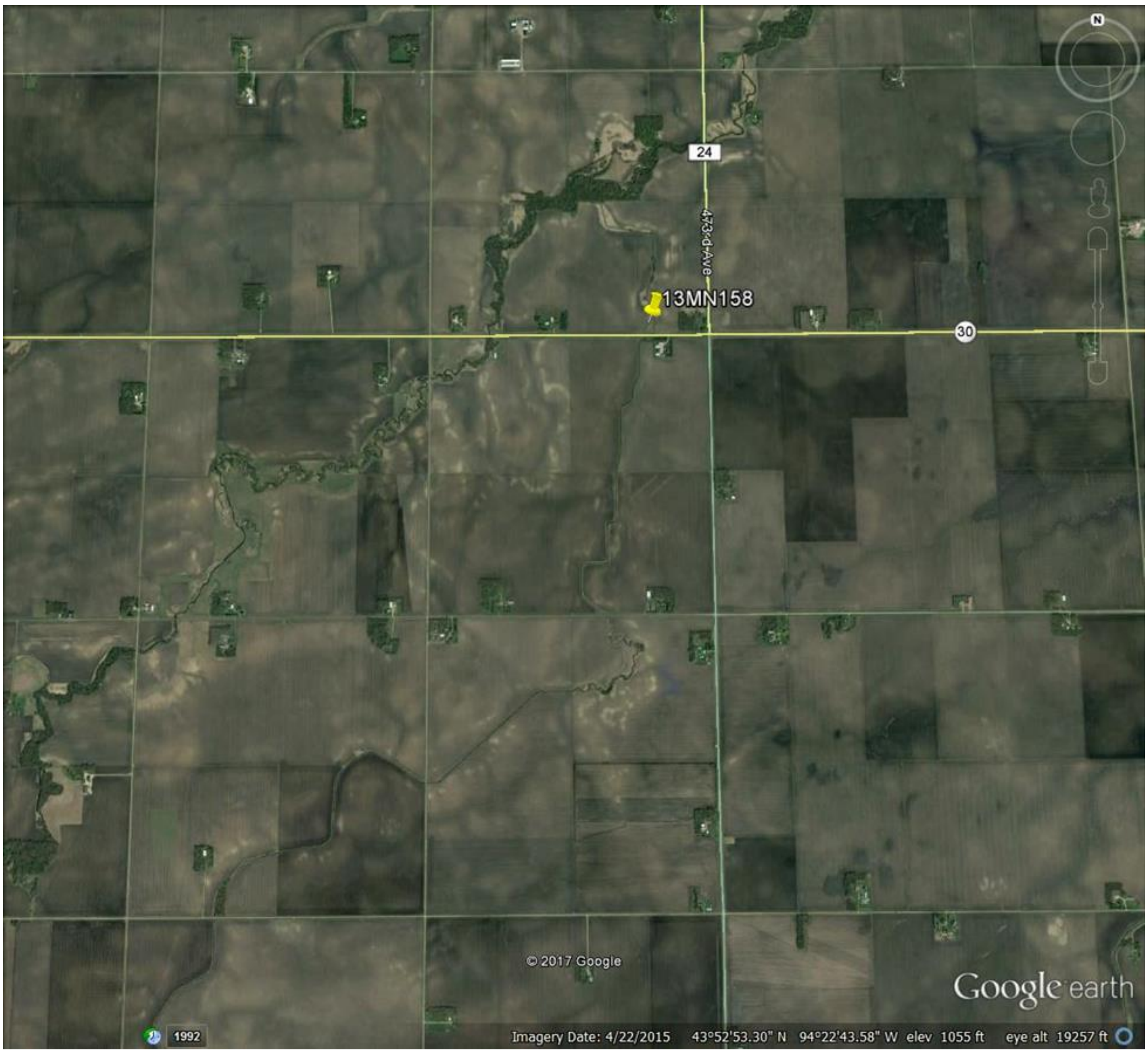
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Unnamed Creek -526

Unnamed Creek (07020010-526) is a tributary stream of Perch Creek. The assessed reach is four miles northeast of Truman; it starts downstream of Co. Hwy. 107 and flows north 2.3 miles before joining Perch Creek (07020010-524) downstream of MN Hwy. 30. This reach is classified as modified use warmwater 2Bm. This reach in impaired for aquatic life for degraded fish and macroinvertebrate communities (2015).

This reach is fed by a limited resource value water.

Figure 233. Google Earth image of Unnamed Creek (-526).



4.1.1. Biological communities

One biological monitoring station occurs on this AUID, 13MN158. There was a single fish visit in 2013 that scored a 1.2, falling below the threshold (33) and lower confidence interval for modified use. The community was hyper dominated by fathead minnow. Only five tolerant taxa were captured on the reach. The only metric within the FIBI that had a score for was short-lived percentage (see graph below). The fish community is representative of a severely degraded condition.

There was also a macroinvertebrate sample taken in 2013 that scored 18, also below the threshold (22) and lower confidence limits. The community was overwhelmingly dominated by Physa (151) taxa, followed by Hyalella (66) and Paratanytarsus (20). The sample received two zero metric scores for HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) and Intolerant2Ch (Taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN TVs). The sample was disproportionately dominated by predator taxa but had low numbers of clingers and collector/filterer taxon (see graph below).

Biological station 13MN168 lies upstream on a limited resource value water reach that feeds the assessed reach; biological community results at 13MN168 were similar to station 13MN158.

Figure 234. Fish metrics of the Southern Headwaters Class IBI for station 13MN158, Unnamed Creek.

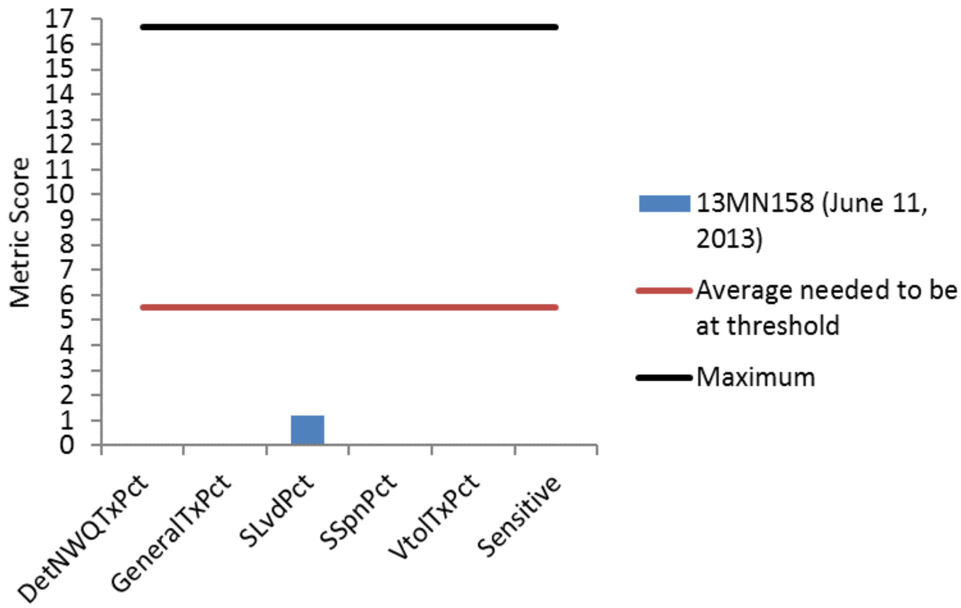
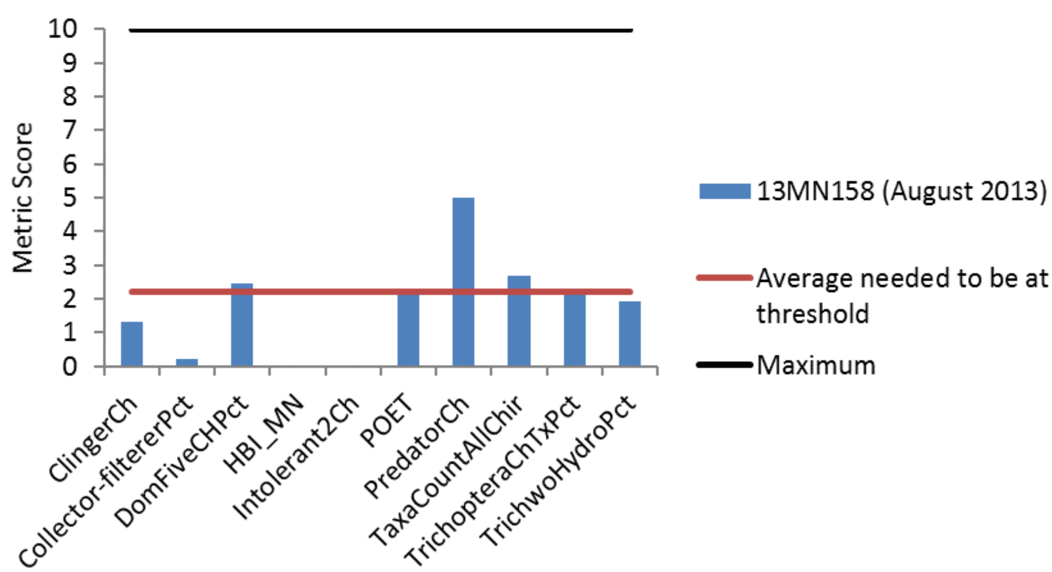


Figure 235. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN158, Unnamed Creek.



4.1.2. Data evaluation for each Candidate Cause

Conductivity

Specific conductance is an indication of the amount of dissolved minerals or total dissolved solids in the water. Elevated conductivity can be toxic to biological organisms through effects on osmoregulation.

There were 10 specific conductance readings taken along the reach from one EQUIS station in 2015 and 2016. The highest reading was 1575 ug/L on September 1, 2015, with a second sample above 1000 ug/L in August of 2015. Conductivity levels were not elevated during fish and macroinvertebrate visits. Elevated conductivity levels may not be caused by only elevated chloride concentrations but can serve as a surrogate or indicator for ions in the water. Chloride was only collected once on the reach on 2/26/2016 with an average value of 49.85 mg/L, well below the standard (230 mg/L).

An elevated reading was also observed about a mile upstream of the reach on a different AUID at biological station 03MN064, a conductivity reading of 1724 ug/L was observed on July 29, 2003, this demonstrates elevated levels of conductivity across multiple years. There are no tributaries between the biological station and the start of AUID -526.

From a biological standpoint, sunfish based assemblages can increase due to elevated chloride levels (Centrarchidae). No sunfish taxa were caught within the reach.

Chloride and conductivity related stress could also result in reduced overall taxa richness of macroinvertebrate communities, decreases in mayfly (Ephemeroptera) percentages, mayfly taxa richness and EPT taxa. Macroinvertebrate metric data that respond to elevated conductivity levels were well below average, suggesting a potential for elevated conductivity stress within the macroinvertebrate community; however, the stress response could be due to accumulated stress from other stressors on the reach (see table below).

While the observed conductivity values >1000 are concerning, limited conductivity data within the reach is inconclusive at this time to determine stress.

Table 263. Macroinvertebrate metrics that respond to conductivity stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	TaxaCount	EphemeropteraCh	EphemeropteraPct	EPT
13MN158 (2013)	**15.00**	**2.00**	**0.91**	**3.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting Modified Use Threshold (22.0)	33.59	3.44	16.52	4.84
Expected response to Conductivity stress	↓	↓	↓	↓

Dissolved oxygen

Two DO measurements were taken during biological visits at 13MN158. Readings were 8.13 mg/L at 8:30 am on June 11, 2013 and 13.39 mg/L on August 13, 2013 at 2:14 pm. Ten additional DO samples were collected at the station in 2015 and 2016. The low reading was 4.92 mg/L on August 17, 2015 at

12:15 pm, falling below the 5 mg/L DO standard, while the highest reading was 16.33 mg/L on May 24, 2016 at 2:56 pm. Detection of DO levels below the standard in 2015 prompted continuous dissolved oxygen follow up monitoring during SID investigations (see graph below). A YSI sonde was deployed on August 10 – 17 in 2015. DO readings fell well below standards nearly every day during monitoring. On August 16 and 17 DO levels did not rise above the standard, bottoming out at 0 mg/L on consecutive days. The DO flux was exceeded on five of the eight days of continuous monitoring, topping out at 10.03 mg/L (see graph below). The average daily flux was 6.75 mg/L.

Figure 236. Diurnal DO results for station 13MN158 August 10-17, 2015.

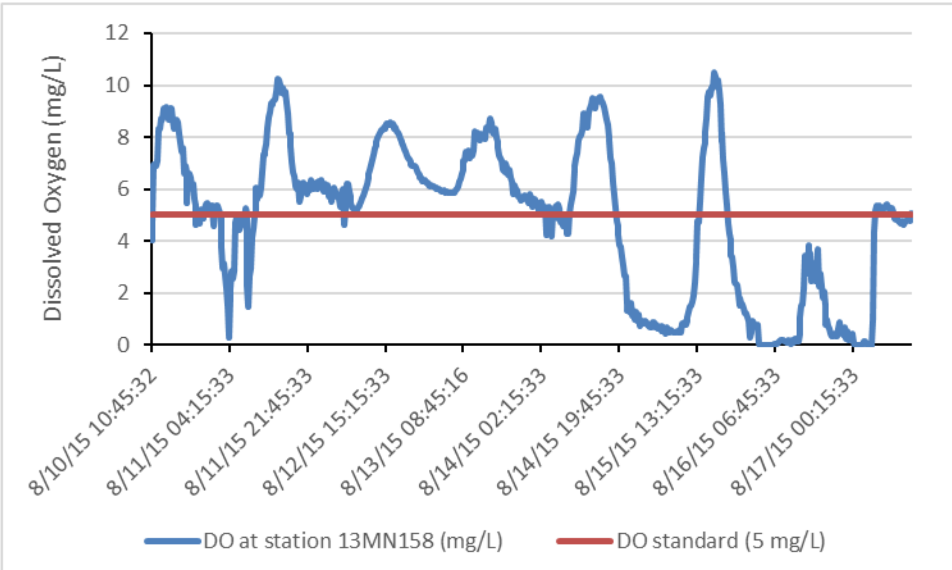
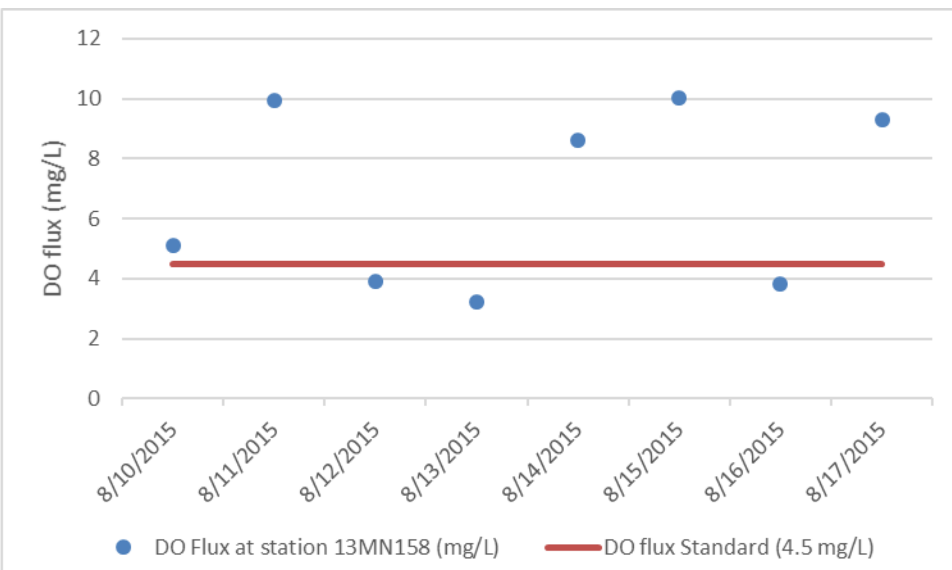


Figure 237. Daily DO Flux results for station 13MN158 August 10-17, 2015.



All macroinvertebrate low DO metrics showed a mixed response to low DO stress (see table below). The low DO index score was only marginally above the average needed to meet the threshold for the Prairie Streams class, indicating marginal potential for low DO stress to impact the macroinvertebrate community within the reach. There was an absence of low DO intolerant taxa and a low quantity of EPT taxa. There was also an above average quantity of Low DO tolerant taxa and low DO tolerant individuals, implicating greater potential for stress.

Table 264. Macroinvertebrate metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN158 (2013)	**28.00**	**3.00**	0.00	6.37	**0.00**	**0.00**	9.00	**38.25**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Limited stock should be taken when looking at fish metric data due to the low capture rate of the sample and potential for false positive stressor hits. Fish metrics showed a response to low DO stress (see table below). The low DO Index score indicates potential for stress in the fish community, falling below the average for the southern headwaters class. There was an absence of generally sensitive taxa and low DO sensitive taxa. Despite 100% of the community being generally intolerant, low DO tolerant taxa and individuals were not overly abundant, but nearly 79% of individuals captured were tolerant to low DO conditions. The high percentage of low DO tolerant individuals is like attributed to the abundance of fathead minnows in the sample.

Table 265. Fish metrics that respond to low DO stress in Unnamed Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN158 (2013)	**0.00**	**1.41**	**100.00**	**6.40**	**0.00**	**0.00**	1.00	**78.87**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*6.02*	*14.39*	*19.30*	*6.89*	*0.11*	*0.11*	*3.94*	*36.89*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

Continuous DO data collection indicates that low DO conditions are present in the reach. Biological response to low DO stress metrics in the fish community, which indicates that low DO is a stressor in the reach. However, low DO stress metrics in the macroinvertebrate community were less telling suggesting inconclusive stress for the macroinvertebrates.

Eutrophication

The phosphorous concentration at the fish visit at station 13MN158 fell below the southern regional standard of 0.15 mg/L, with a value of 0.062 mg/L on June 11, 2013. Eight additional samples were gathered at 13MN158 in 2015 and 2016 during SID investigations. Phosphorous concentrations ranged from 0.057 mg/L on May 24, 2016 to 1.18 mg/L on August 15, 2017, with an average concentration of 0.246 mg/L. Three values were above the standard. One Chlorophyll a sample was taken in 2015 with a value of 27.4 ug/L, below the southern eutrophication standard of 35 ug/L. No BOD samples were collected on the reach. DO grab samples ranged from 4.92 mg/L to 16.33 mg/L indicating potential for elevated DO flux in the reach. In 2015, during continuous DO sampling, the DO flux was exceeded on five of the eight days of continuous monitoring, topping out at 10.03 mg/L. The average daily flux was 6.75 mg/L. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.6 – 8.38 in the reach.

The macroinvertebrate community results suggest potential for eutrophication stress (see table below). There was a lower number of collector-filterers and collector-gatherers than the average of visits meeting the biocriteria. There was also a large proportion of the community that was tolerant and an absence of intolerant species.

Table 266. Macroinvertebrate metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN158 (2013)	**28.00**	**2.00**	**8.00**	**3.00**	**0.00**	**92.86**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Limited stock should be taken when looking at fish metric data due to the low quantities of individuals captured and the preponderance of fathead minnow in the sample as this increases the potential for false positive stressor hits. The fish community metrics also show potential for eutrophication stress (see table below). There was a complete absence of sensitive (SensitivePct), intolerant (IntolerantPct) and darter species (darter percent). The percentage of simple lithophilic spawners was also very low. The entire population was comprised of tolerant species. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were identified within the reach.

Table 267. Fish metrics that respond to eutrophication stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN158 (2013)	**0.00**	**0.00**	**1.41**	**80.28**	**100.00**	**5.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	10.56	30.09	19.80	76.70	10.03	0.52
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

Elevated phosphorous concentrations in conjunction with elevated DO flux in the reach suggests potential for eutrophication stress within the reach. While both fish and macroinvertebrate communities responded negatively to eutrophication stress metrics, the metrics are general in nature and could be responding to other stressors within the reach. Presence of elevated DO flux within the reach also provides potential evidence of eutrophication stress but additional response variable data is needed to confirm the stressor in the reach. As such, eutrophication is an inconclusive stressor in the reach at this time.

Nitrate

During the fish visit, the nitrate concentration at 13MN158 was measured at 32 mg/L on June 11, 2013. An additional 10 samples were collected in 2015 and 2016 at the same location during SID investigations in the months of May thru September with a single sample collected in February. The nitrate concentration ranged from 0.07 mg/L in August of 2015 to 35 mg/L in May of 2016, with an overall average nitrate concentration of 31.29 mg/L. Nine of 11 nitrate samples were above 15 mg/L.

The macroinvertebrate community responded adversely to all nitrate tolerant metrics (see table below). The nitrate index score was 7.2, while the average for Southern Streams meeting impairment threshold is 3.2. This suggests that overall the community present is extremely tolerant to high nitrate concentrations. The Trichoptera taxa count was only slightly below the threshold. The count of nitrate tolerant taxa was only marginally above average and the percentage of nitrate tolerant individuals was less than 10 % above the Prairie Streams GP (MU) class average. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). While intolerant taxa and non-hydropsychid individuals are not in abundance here, their absence can also be due to another stressor present.

Table 268. Macroinvertebrate metrics that respond to nitrate stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN158 (2013)	**28.00**	**2.00**	**8.00**	**3.00**	**0.00**	**92.86**	**1.00**	**0.61**	**7.20**	0.00	**19.00**	**68.40**	32.00 (6/11/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.00*	*11.57*	*4.84*	*0.11*	*87.94*	***1.99***	***0.66***	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish are not typically good indicators of nitrate related stress. Biological metrics that potentially indicate nitrate stress in fish communities are general in nature and may be responding to other stressors within the reach. Limited stock should be taken when looking at fish metric data due to low numbers of taxa and individuals sampled as this could provide potential for false positive stressor hits. Metrics show an absence of sensitive, intolerant and darter taxa in the reach and a fish community dominated by tolerant taxa.

Data suggests that that elevated nitrate concentrations are stressing the macroinvertebrate community within the reach, while stress to the fish community is inconclusive due to limitations of fish metrics that respond to nitrate stress.

Suspended sediment

One TSS sample was collected on the reach in 2013 during the fish visit; the sample was 9.6 mg/L on June 11, 2013, below the southern regional TSS standard of 65 mg/L. No TSS monitoring was conducted on this reach prior to 2013. Eleven additional TSS samples were gathered at the biological station in 2015 and 2016 as part of SID investigations after storm events in the spring months, values ranged from 2.8 mg/L on June 16, 2015 to 42 mg/L on June 16, 2016, none of these readings exceeded TSS standards. The average TSS concentration was 20.53 mg/L.

The macroinvertebrate community on the reach showed a negative response to all but one TSS stress related metric (see table below). The TSS Index score was above the respective average for the Prairie Stream GP Class, suggesting potential for TSS to stress the macroinvertebrates. TSS intolerant taxa were absent within the reach. While the TSS tolerant taxa count was slightly below the class average on the reach, individual quantities of TSS tolerant taxa were above the norm. Both collector-filterer and plecoptera taxa were also below their respective averages within the reach, low quantities of collector filterer taxa could indicate turbid conditions are limiting their ability to gather nourishment along the reach, limiting their numbers while low plecoptera numbers could represent sedimentation on the reach, which can occur as a result of elevated TSS levels.

Table 269. Macroinvertebrate metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN158 (2013)	**1.22**	**0.00**	**18.03**	**0.00**	**0.00**	10.00	**57.23**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.00*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Careful consideration should be taken when looking at fish metric data in the reach due to low taxa count and low quantities of individuals captured as this could lead to potential false positive stressor hits (see table below). While there was a high TSS Index score in the reach, above the class average, there were no TSS tolerant taxa identified within the reach. There were below average quantities of benthic insectivores (BenFDFrimPct), centrarchids (Centr-TolPct), herbivores (HrbNWQPct), long-lived taxa

(LlvdPct), Perciformes (Percfm-TolPct), riffle dwelling taxa (RifflePct), sensitive taxa (SensitivePct) and simple lithophilic spawners (SLithFrimPct), all of which are potential indicators of elevated concentrations of TSS in a reach. Some of these metrics could be pointing to habitat related stress in the reach as well, as many fish related TSS stress metrics could be an after effect of elevated levels of TSS, like sedimentation of riffles, absence of coarse substrate habitat and limited availability of aquatic macrophyte habitat.

Table 270. Fish metrics that respond to high TSS stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN158 (2013)	**1.41**	**0.00**	**1.41**	**0.00**	**0.00**	**0.00**	**1.41**	**0.00**	**1.41**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*21.54*	*0.52*	*4.91*	*15.11*	*22.62*	*6.02*	*15.69*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

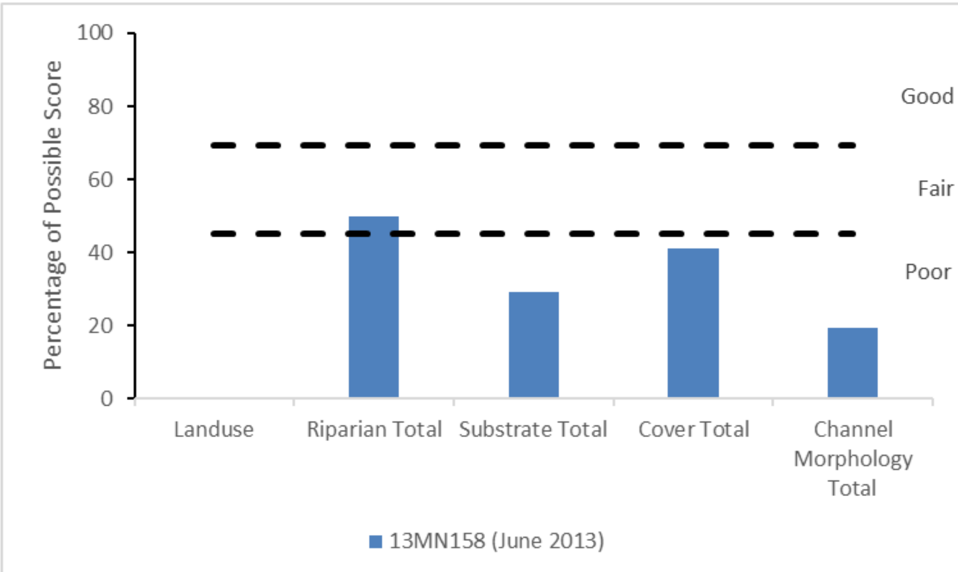
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN158 (2013)	**22.82**	**0.00**	**0.00**	**0.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*17.35*	*0.04*	*0.01*	*0.66*	*5.36*
Expected response to TSS stress	↑	↓	↓	↑	↑

While the TSS dataset in the reach is small, there was little evidence that high TSS concentrations exist in the reach even after spring rain events. TSS stress metric data suggests potential for TSS stress in the reach in both fish and macroinvertebrate communities; however, metrics could be responding to sedimentation in the reach indicating habitat stress. As such, TSS is an inconclusive stressor in the reach at this time.

Habitat

One qualitative habitat survey was conducted on the reach in 2013 at biological station 13MN158 (see graph below). MSHA results were poor (37.5). The surrounding landuse for the reach is row crop agriculture. The entire length of the reach has been channelized, narrow riparian corridors are comprised of reed canary grass, providing little stream shading (see photo below). Overall, the reach is ubiquitous in nature with no natural channel progression (100% run), has limited substrate diversity (sand and gravel), depth variability or instream habitat. Available habitat types included undercut banks, overhanging vegetation, submergent macrophytes and woody debris. While in stream sedimentation appears problematic, stream banks are fairly stable with limited stream bank erosion observed (see photo below), which resulted in a moderate overall stream stability score.

Figure 238. Percentage of MSHA subcategory scores for station 13MN158 in Unnamed Creek.



Low taxa and individual counts should be considered when looking at the fish data as metrics have a potential to be skewed due to the small dataset. Metric data shows a fish community dominated by pioneering individuals, which are tolerant of degraded habitat conditions (see table below). There was also an absence of piscivore taxa, 'darter, sculpin, sucker' taxa and benthic insectivores. An absence of top predator species is likely related to a lack of available deep pool and other complex habitat availability. Low quantities of lithophilic and simple lithophilic spawners and riffle dwellers were also observed which are reflective of an absence of riffles in the reach and limited presence of clean coarse substrates for spawning.

Table 271. Fish metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN158 (2013)	**100.00**	**0.00**	**8.45**	**0.00**	**91.55**	**1.41**	**0.00**	**1.41**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*46.70*	*1.97*	*57.98*	*10.59*	*32.54*	*22.62*	*10.91*	*32.54*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response in the macroinvertebrate community to habitat related stress on station 13MN158 (see table below). There were below average quantities clinger taxa within the reach, while quantities of climber and sprawling taxa were abundant. Prevalence of overhanging vegetation in the reach, along with the fact that overhanging vegetation was the only habitat sampled could indicate the abundance of climber taxa within the reach. Low quantities of clinger taxa are likely related to limited quantities of coarse substrate and woody debris habitat available. An abundance of burrowing and legless taxa indicates an abundance of fine sediments in the reach as well.

Table 272. Macroinvertebrate metrics that respond to degraded habitat stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN158 (2013)	**6.69**	52.58	**8.81**	**1.52**	**72.64**	27.36
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.07*	*18.46*	*38.49*	*30.93*	*43.48*	*21.94*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Preponderance of data suggests that limited habitat is also stressing the biota within the reach.

Figure 239. Biological station 13MN158 (June 11, 2013) narrow riparian zone (left); (June 14, 2016) stream bank erosion and sediment deposition (right).

Altered hydrology/Longitudinal connectivity

No known fish barriers exist within the reach or upstream of the reach. Only five fish species were identified within the reach (see table below). Eleven species not identified at biological station 13MN158 were identified at the next downstream station on Perch Creek. This could be an indication that a barrier exists limiting fish migration between the two systems. While a single migratory fish species was captured at 13MN158, white sucker; an additional four migratory fish taxa were identified at the next downstream station on Perch Creek but not at 13MN158 (see table below).

There were no mussel surveys conducted in the reach by the DNR.

Until additional on the ground investigation can be completed to determine whether or not a fish barrier is present on the reach or downstream of the biological station on Perch Creek, longitudinal connectivity is an inconclusive stressor at this time.

Table 273. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish taxa in bold are known migratory fish species, while text in blue indicate known lake species.

Field Number	13MN143	13MN158	13MN129	01MN015	97MN011
WID	-524	-526	-524	-523	-523
Fish Taxa					
bigmouth shiner		x	x	x	x
black bullhead	x			x	x
blacknose dace			x	x	x
blackside darter	x		x	x	x
bluntnose minnow	x	x	x	x	x
brassy minnow				x	x
brook stickleback					x
central stoneroller			x		x
common carp			x		x
common shiner				x	x
creek chub	x	x	x	x	x
fathead minnow	x	x		x	x
gen. redhorse					x
golden redhorse			x		x
green sunfish			x	x	x
johnny darter	x			x	x
largemouth bass					x
northern hogsucker				x	x
northern pike	x		x	x	x
sand shiner			x	x	x
shorthead redhorse					x
silver redhorse			x	x	
slenderhead darter				x	x
spotfin shiner			x	x	x
stonecat				x	x
white sucker	x	x	x	x	x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 2.32 mile long reach of Unnamed Creek is 100% modified. Upstream of the reach, its headwaters is also 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. Reduced channel stability was identified within the reach while stream bank erosion was limited; however, extensive alteration within the reach and limited diversity within the fish community and limited habitat availability indicates potential altered hydrology stress.

No known lake dwelling species was identified on the reach. The presence of lake taxa can be indicative of low flow and altered hydrology stress. There were low numbers of riffle dwelling taxa and an absence of long-lived species at station 13MN158, both metrics can also be indications of altered hydrology stress (see table below).

Table 274. Fish metrics that respond to altered hydrology stress in Unnamed Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN158 (2013)	**100**	**0**	**1.41**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*46.70*	*4.91*	*22.62*
Expected response to Altered Hydrology stress	↑	↓	↓

Low flow was documented in 2012 at station 13MN158 (see photograph below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Evidence suggests that altered hydrology is a likely stressor within the reach at this time.

Figure 240. Biological station 13MN158 (September 12, 2012) dry streambed.

4.1.3. AUID Summary

DO, nitrates, degraded habitat and altered hydrology are stressors along the reach.

The reach is showing impact of surrounding agricultural landuse. The stream is 100% modified resulting in ubiquitous stream conditions providing limited available instream habitat for aquatic biology. Ditching has provided some stability to stream banks on the reach but ditch cleanouts and high flows in the spring has led to a domination of fine substrates, limiting potential habitat. Historic wetland drainage, poor riparian buffers and drain tiling is leading to high runoff and spring flows, moving in stream sediments and limiting habitat availability and resulting in a lower water table and lowering base flow during the late summer months leading to dry stream beds, limiting aquatic biota. Biological communities are typical of a channelized system with heavily degraded habitat.

Low DO concentrations on the reach prompted additional continuous DO monitoring. The results of which produced eight consecutive days with DO levels below the low DO standard. Fish data corroborates low DO readings observed, responding negatively to low DO metrics. Fish community data was limited due to a hyper-dominated community by fathead minnows and limited quantities of other taxa captured; however, fathead minnow are tolerant to low DO conditions and their dominance in the reach is also likely signaling stress. The macroinvertebrate response to low DO stress metrics was inconsistent suggesting that low DO is an inconclusive stressor for that indicator.

Elevated nitrogen concentrations were observed in conjunction with the fish visit with a reading of 32 mg/L in June of 2013; in addition, nine of 11 follow up nitrogen samples were above 15 mg/L collected during spring months when drain tile inputs are greatest. Macroinvertebrate nitrate stress related metrics also implicate nitrates as a stressor. Nitrates are an inconclusive stressor to the fish community along the reach due to limitations of fish nitrate stress metrics.

TSS and eutrophication are inconclusive stressors along the reach at this time. While there was a negative metric response to elevated TSS within the macroinvertebrate community, there is currently no chemical dataset to confirm elevated TSS concentrations occur within the reach. As such, it is more likely that other stressors are having a greater impact on the biological communities at this time. Elevated phosphorous concentrations were identified during SID investigations with a high reading of 1.18 mg/L. Continuous sonde readings also showed five days of DO flux rising above the standard. This paired information in conjunction with negative metric response data from the biology suggests that eutrophication is a stressor along the reach. However, the dataset is limited and additional data collection and response variable data would help bolster current findings.

Conductivity is an inconclusive stressors along the reach at this time. High conductivity levels were identified in the small chemical dataset within this reach. The highest observed level was 1575 ug/L on September 1, 2015. Chloride data was limited to one sample along the reach and was not abnormal. Additional investigation may be warranted to determine whether elevated conductivity levels may be impacting the biological communities within the reach. Additional investigation of the upstream discharger permitee may be warranted, as it could be a potential source of elevated chloride levels observed.

Table 275. Summary of stressor determinations for Unnamed Creek (526).

Stream Name	AUID	Stressors:							
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity
Unnamed Creek	07020010-526	●/o	o	o/●	o	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

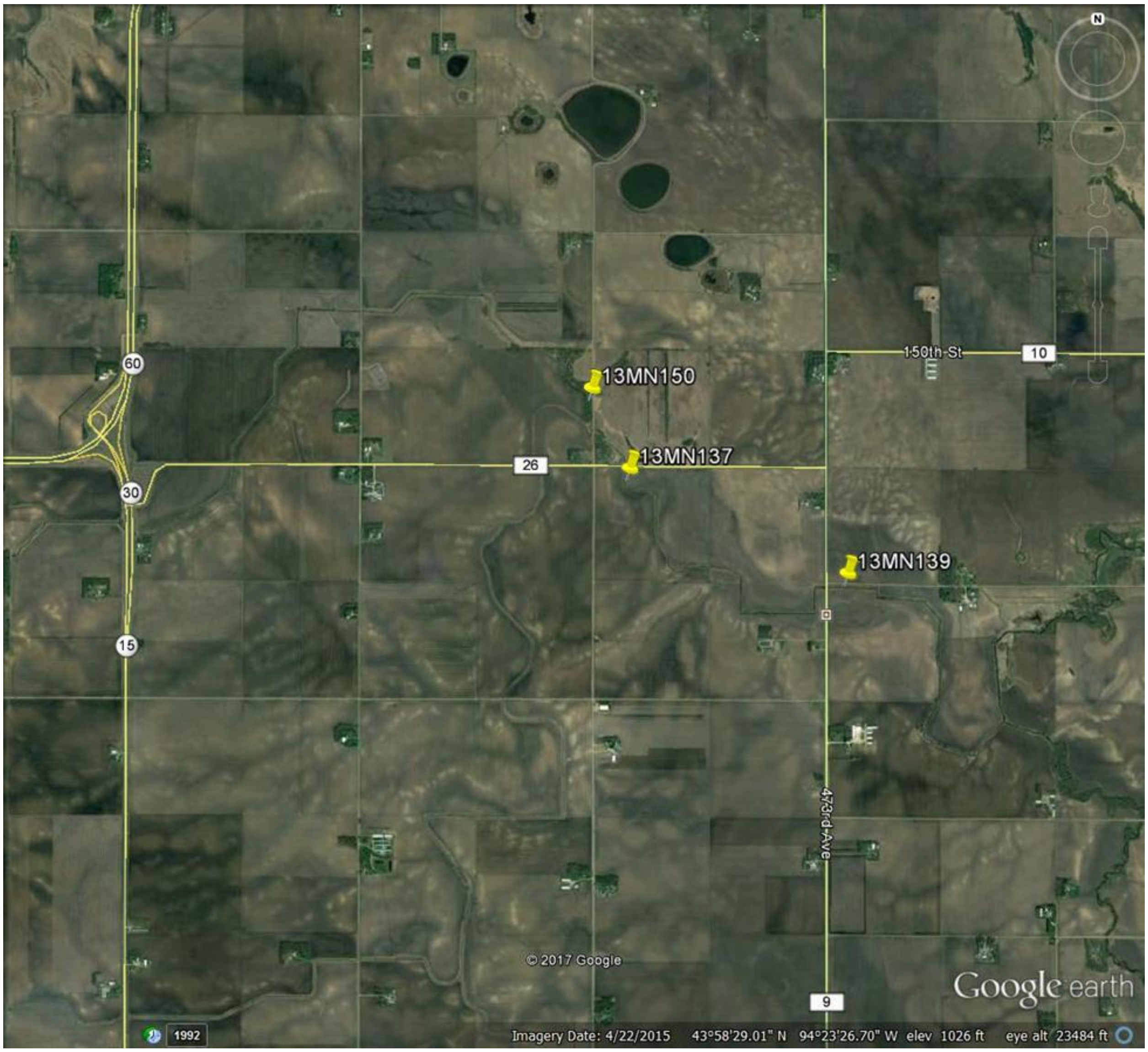
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Spring Branch Creek -574

Spring Branch Creek (07020010-574) is a tributary to Perch Creek. The reach stretches seven stream miles from MN HWY 30/MN HWY 15 to downstream of CR 9 where it joins Perch Creek (07020010-523). The reach is classified modified warmwater use 2Bm. This reach is impaired for aquatic life for degraded fish community (2015) and for aquatic recreation for high levels of *E. coli* bacteria (2015).

The reach receives outflow of a limited resource value water stream (Unnamed Ditch) between biological stations 13MN150 (upstream) and 13MN137 (downstream).

Figure 241. Google Earth image of Spring Branch Creek (-574).



4.1.1. Biological communities

There are three biological stations on this reach 13MN150, 13MN137 and 13MN139, each station was sampled once in 2013 for fish. Stations 13MN150 and 13MN137 scored below the modified use threshold and lower confidence interval while 13MN139 scored three points below the modified use threshold and fell within lower confidence limits. The upstream most and downstream most station's communities sampled were each comprised of less than 25 individuals, resulting in low end scoring. All communities were dominated by tolerant species including bluntnose minnow and common carp. Station 13MN150 is classified as low gradient and scored zero for 5 of 9 metrics (see graph below). There was an absence of sensitive species, pioneering taxa and simple lithophilic spawners and a high percentage of tolerant taxa. The community was disproportionately dominated by omnivorous species. Stations 13MN139 and 13MN137 are both in the southern streams class for fish, both stations scored a zero for tolerant percent and were both below metrics for DomTwoPct (Relative abundance (%) of individuals of the two most abundant species) and MA<2pct (Relative abundance (%) of individuals of with a female maturing <=2 years).

Each station was also sampled once for macroinvertebrates and all visits were above modified use standards, one visit fell just below the general use threshold.

Figure 242. Fish metrics of the Southern Streams Class IBI for stations 13MN139 and 13MN137, Spring Branch Creek.

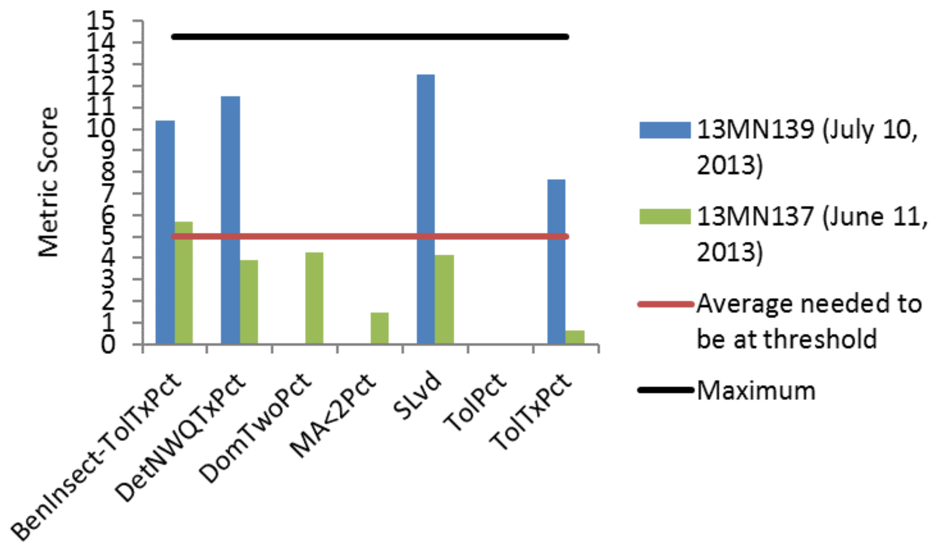
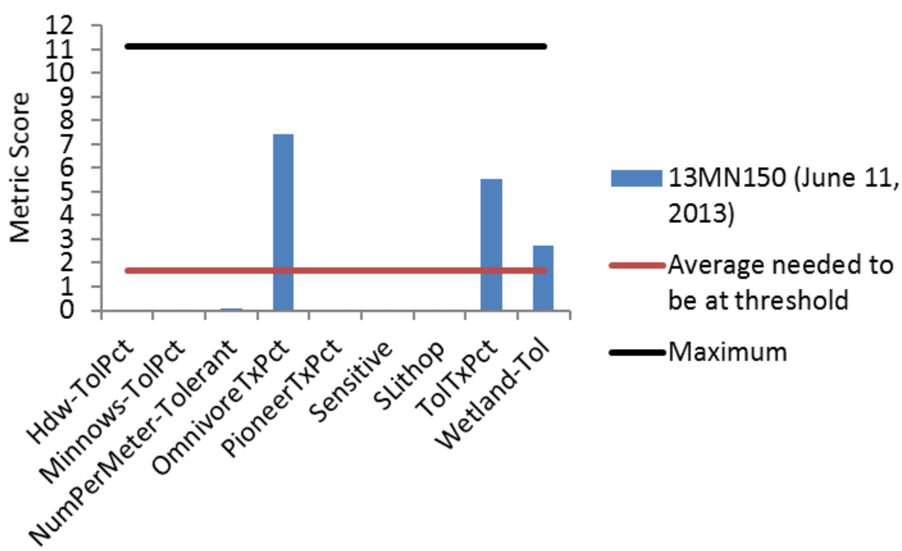


Figure 243. Fish metrics of the Low Gradient Class IBI for stations 13MN150, Spring Branch Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Seven DO readings were taken in 2013 at three stations on this reach during biological monitoring visits. DO values ranged from 7.35 mg/L observed on June 11, 2013 at 5:13 pm to 10.3 mg/L taken on 8/12/2013 at 7:08 pm, both readings were taken at station 13MN137. Fourteen additional readings were collected in 2015 and 2016 at the bio stations. Four readings hovered around the 5 mg/L DO standard; they were collected on September 1, 2015 and July 14, 2016 at stations 13MN150 and 13MN137. One measurement at 13MN150 fell below the standard with a reading of 4.07 mg/L on September 1, 2015 at 12:20 pm. High flows in 2016 limited the ability to collect continuous DO data on this reach in 2016. Additional monitoring could provide more insight regarding DO flux and potential low DO conditions within the reach.

The fish community is showing a mixed response to low DO stress (see table below). The DO index score values were near the respective threshold for stations within the streams class, indicating the fish may be marginally stressed by low DO conditions. There was an overall absence of DO sensitive taxa and general sensitive taxa in the reach, but there were not high quantities of DO tolerant taxa nor a high percentage of DO tolerant individuals at most visits. One visit did have a high percentage of low DO tolerant individuals, 13MN139. However, both station 13MN139 and 13MN150 had extremely low numbers of individuals and taxa captured, as such, metric results for these visits may be skewed.

Table 276. Fish metrics that respond to low DO stress in Spring Branch Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN150 (2013)	**0.00**	**0.00**	**84.62**	7.00	**0.00**	**0.00**	5.00	15.39
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*17.28*	*9.79*	*56.03*	*6.13*	*0.00*	*0.00*	*5.02*	*72.68*
13MN137 (2013)	**0.00**	**0.00**	**91.53**	7.13	**0.00**	**0.00**	4.00	8.47
13MN139 (2013)	**0.00**	**11.11**	**66.67**	6.81	**0.00**	**0.00**	2.00	**55.56**
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*8.38*	*27.98*	*46.38*	*6.78*	*0.1*	*1.08*	*5.5*	*54.58*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrate community in the reach is not impaired, sometimes looking at metric data from all indicators in the reach can provide additional insight to potential stressors in the reach. The macroinvertebrate community shows a marginal response to low DO metrics (see table below). The DO index score at all stations was above the average needed to meet the threshold for the prairie streams class, suggesting that low DO stress is not likely impacting the macroinvertebrate community. There were above average quantities of low DO intolerant taxa but below average quantities of low DO individuals at nearly all visits but below average quantities of low DO tolerant taxa and individuals.

Above average quantities of EPT taxa also indicate that the community is not showing potential signs of low DO stress.

Table 277. Macroinvertebrate metrics that respond to low DO stress in Spring Branch Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN150 (2013)	**30.00**	18.77	**8.62**	6.63	1.00	**0.32**	*6.00*	27.42
13MN137 (2013)	35.00	9.00	**8.90**	6.49	2.00	**0.94**	*8.00*	18.69
13MN139 (2013)	33.00	9.00	**9.10**	6.75	2.00	**0.625**	*8.00*	15.63
13MN139 (2013)	34.00	8.00	**9.10**	6.67	2.00	1.28	*7.00*	19.49
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*4.84*	*8.00*	*6.13*	*1.04*	*1.12*	*10.00*	*38.13*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While grab samples collected suggest potential for low DO conditions to occur within the reach, neither the fish nor macroinvertebrate community is showing a strong signal that low DO conditions are causing observed stressed in the reach. Low taxa and individuals observed during two of the three fish visits could be skewing metric data that would indicate stress. As such, low DO stress is an inconclusive stressor in the reach at this time.

Eutrophication

Phosphorous values were below the southern region eutrophication standard during the fish visits at all three biological stations on this reach. Twenty additional phosphorous samples were collected in 2013, 2015 and 2016 at stations 13MN139 and 13MN150; nine readings were above the standard. Violations of the standard were observed at both stations. Phosphorous concentrations ranged from 0.033 mg/L on May 24, 2016 at 13MN150 to 0.627 mg/L on Sept. 1, 2015 at 13MN150, with an overall average concentration of 0.17 mg/L. Chlorophyll a samples were collected in 2015, once at stations 13MN139 and 13MN150, readings were low at 1.36 ug/L and 1.42 ug/L respectively, below the southern eutrophication standard of 35 ug/L. An abundance of algal growth was observed in 2015 at station 13MN139 (see photo below). There were no BOD samples of DO flux measurements collected on this reach. DO grab samples collected on the reach ranged from 4.07 mg/L to 11.02 mg/L suggesting potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.32 – 8.77 in the reach.

The fish community appears to be showing a negative response to eutrophication stress metrics (see table below). There was an absence of sensitive and intolerant taxa, as well as low quantities of darters and simple lithophilic spawners. The percentage of tolerant species was also high across all visits. However, these stress metrics are general in nature and may be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. High quantities of omnivorous fish were identified only at the downstream most station 13MN139, suggesting eutrophication could be an isolated stressor in the lower portion of the reach.

Table 278. Fish metrics that respond to eutrophication stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN150 (2013)	**0.00**	**7.69**	**0.00**	7.69	**84.62**	**6.00**	**0.00**
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*17.28*	*6.56*	*20.49*	*16.77*	*56.03*	*11.74*	*3.61*
13MN137 (2013)	**0.00**	**8.47**	**23.73**	6.78	**91.53**	**11.00**	**0.00**
13MN139 (2013)	**0.00**	**11.11**	**11.11**	**44.44**	**66.67**	**6.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*33.59*	*3.22*	*11.57*	*25.08*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While the macroinvertebrate community in the reach is not currently impaired, sometimes looking at all available indicator data and their associated stress metrics can provide insight into potential stressors within a reach. A negative response was observed in the macroinvertebrate community with regards to eutrophication stress metrics (see table below). There were fewer collector-filterers and collector-gatherers than the average of similar stations meeting the biocriteria. There were no intolerant taxa and high percentage of the taxa in the sample were tolerant.

Table 279. Macroinvertebrate metrics that respond to eutrophication stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN150 (2013)						
13MN137 (2013)	**35.00**	**4.00**	**10.00**	**9.00**	**0.00**	**97.14**
13MN139 (2013)	**34.00**	**1.00**	**11.00**	**9.00**	**0.00**	**94.12**
13MN139 (2013)	**33.00**	**2.00**	**12.00**	**8.00**	**0.00**	**93.94**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.22*	*11.57*	*4.84*	*0.11*	*86.63*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Despite an apparent response to eutrophication stress metrics in both the fish and macroinvertebrate communities within the reach, metric data is general in nature and does not point directly to eutrophication stress as a negative response could be due to other stressors within the reach. Due to a limited chemical set with no positive response variable indicator data, eutrophication stress is inconclusive at this time. Additional response variable evidence should be collected to affirm the potential of the stressor within the reach.

Figure 244. Biological station 13MN139 (August 13, 2013) algae.

Nitrate

Three nitrate samples were collected during the fish visits from 2013, ranging from 13 mg/L to 14 mg/L. There were an additional 20 samples taken on this reach in 2013, 2015 and 2016, during the months of May thru September with a single sample collected in February. Nitrate concentrations ranged from 0.05 mg/L in September of 2015 to 25 mg/L in May of 2016, with an average concentration of 11.59 mg/L. Five samples were above 15 mg/L and were collected in the months of May, June and July.

Fish often do not show strong response to increased nitrate concentrations. Macroinvertebrate communities are often more affected by nitrate. Nitrate related stress metrics for fish are general in nature and as such are not good at implicating nitrate stress. Fish communities were dominated by tolerant taxa, lacked sensitive and intolerant taxa and had few darter taxa (see table below).

Table 280. Macroinvertebrate metrics that respond to nitrate stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN150 (2013)	**26.00**	**2.00**	**7.00**	**6.00**	**0.00**	**96.15**	2.00	**2.27**	**4.78**	0.00	**22.00**	**97.10**	14.00 (6/11/2013)
13MN137 (2013)	**35.00**	**4.00**	**10.00**	**8.00**	**0.00**	**97.14**	**3.00**	4.72	**4.49**	0.00	**25.00**	**82.20**	13.00 (6/11/2013)
13MN139 (2013)	**34.00**	**1.00**	**11.00**	**7.00**	**0.00**	**94.12**	**3.00**	8.81	**4.53**	0.00	**24.00**	**89.10**	14.00 (7/10/2013)
13MN139 (2013)	**33.00**	**2.00**	**12.00**	**7.00**	**0.00**	**93.94**	2.00	5.45	**4.68**	0.00	**26.00**	**93.80**	X
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*33.59*	*3.00*	*11.57*	*4.84*	*0.11*	*87.94*	*1.99*	*0.66*	*3.30*	*0.00*	*19.85*	*62.54*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

The macroinvertebrates in this reach are not impaired, but do show some negative response to elevated levels of nitrates. The nitrate specific metrics show near average numbers of Trichoptera taxa (see table below). The nitrate index score ranged from 4.49 to 4.78, while the average for Southern Streams meeting impairment threshold is 3.2. This suggests that overall the community present is tolerant to high nitrate concentrations. There also is a greater than average abundance of nitrate tolerant taxa and a very high percentage of nitrate tolerant individuals across all visits. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). Non-hydropsychid individuals were above the average at all but 13MN150, which was just below average. The absences of nitrate intolerant taxa could be due to another stressor present. Additional chemical data to corroborate the nitrate metric response would be useful in solidifying nitrogen as a potential stressor within the reach. While macroinvertebrates are not impaired, any efforts to reduce nitrate concentrations within the reach would likely benefit the macroinvertebrate community and insure macroinvertebrates do not succumb to nitrate related impairments in the future.

Table 281. Fish metrics that respond to nitrate stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
13MN150 (2013)	**0.00**	7.69	**84.62**	**0.00**
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*17.28*	*6.56*	*56.03*	*3.61*
13MN137 (2013)	**0.00**	**8.47**	**91.53**	**0.00**
13MN139 (2013)	**0.00**	**11.11**	**66.67**	**0.00**
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*8.38*	*13.57*	*46.38*	*0.86*
Expected response to Nitrate stress	↓	↓	↑	↓

Suspended sediment

Three TSS samples were collected on the reach at three fish visits in 2013. Values ranged from 14 mg/L at station 13MN139 on July 10, 2013, while visits at station 13MN137 and 13MN150 on June 11, 2013 both produced readings of 120 mg/L, above the southern regional TSS standard of 65 mg/L. Twenty additional TSS samples were collected in 2013 from May thru September as part of intensive watershed monitoring, and in 2015 and 2016 during SID investigations. Values ranged from 4 mg/L on May 8, 2013 to 85 mg/L on July 1, 2013, only one sampled exceeded standards. The average value was 27.68 mg/L.

The fish community is showing a mixed response to TSS stress (see table below). While the TSS index score was above the southern streams average at both 13MN137 and 13MN139, suggesting potential for stress, there was only an abundance of TSS tolerant taxa or individuals at 13MN139. All stations had below average quantities of benthic feeders, centrarchids, herbivores, simple lithophilic spawners, perciformes and riffle dwellers. Low taxa counts for these metrics could indicate potential sedimentation within the reach, which can be a side effect of elevated levels of suspended sediment in the water column. While intolerant and sensitive taxa were also lacking within the reach; this could be explained by other stressors. Low taxa and individual counts at station 13MN137 and 13MN150 could be skewing metric response to potential elevated levels of TSS within the reach.

Table 282. Fish metrics that respond to high TSS stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN150 (2013)	**7.69**	**0.00**	**0.00**	**0.00**	15.38	**7.69**	**0.00**	**0.00**	**0.00**
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*12.20*	*4.38*	*12.26*	*3.61*	*7.09*	*13.36*	*7.35*	*12.28*	*9.08*
13MN137 (2013)	**11.86**	**0.00**	**8.47**	**0.00**	**1.69**	**8.47**	**8.47**	**0.00**	**0.00**
13MN139 (2013)	**33.33**	**0.00**	**11.11**	**0.00**	66.67	**11.11**	22.22	**0.00**	**11.11**
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*30.08*	*6.17*	*17.98*	*0.86*	*21.25*	*28.69*	*19.54*	*8.38*	*16.15*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN137 (2013)	**20.50**	0.00	**0.00**	2.00	10.00
13MN139 (2013)	**26.31**	0.00	**0.00**	1.00	**44.00**
Southern Streams Average MU	*19.64*	*0.00*	*0.00*	*2.70*	*28.19*
Expected response to stress	↑	↓	↓	↑	↑
13MN150 (2013)	**20.97**	0.00	0.00	1.00	7.69
Low Gradient Streams Average MU	*20.63*	*0.00*	*0.00*	*1.00*	*11.95*
Expected response to TSS stress	↑	↓	↓	↑	↑

While the macroinvertebrate community within the reach is not impaired, sometimes looking at all indicator stress metrics in a reach can provide additional insight into potential stressors. The macroinvertebrate community within the reach showed an overwhelmingly negative response to TSS stress metrics (see table below). All biological stations had above average TSS Index scores for the

Prairie Streams GP Class, indicating potential for a negative response to TSS stress. There was a complete absence of TSS intolerant taxa. While only half of visits had above average TSS tolerant taxa numbers, all had an abundance of TSS tolerant individuals. There was also a complete absence of plecoptera taxa and below average quantities of collector-filterer taxa. Low quantities of plecoptera taxa can imply sedimentation within a reach of coarse substrates, a resulting effect of elevated TSS concentrations in the water column.

Table 283. Macroinvertebrate metrics that respond to high TSS stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

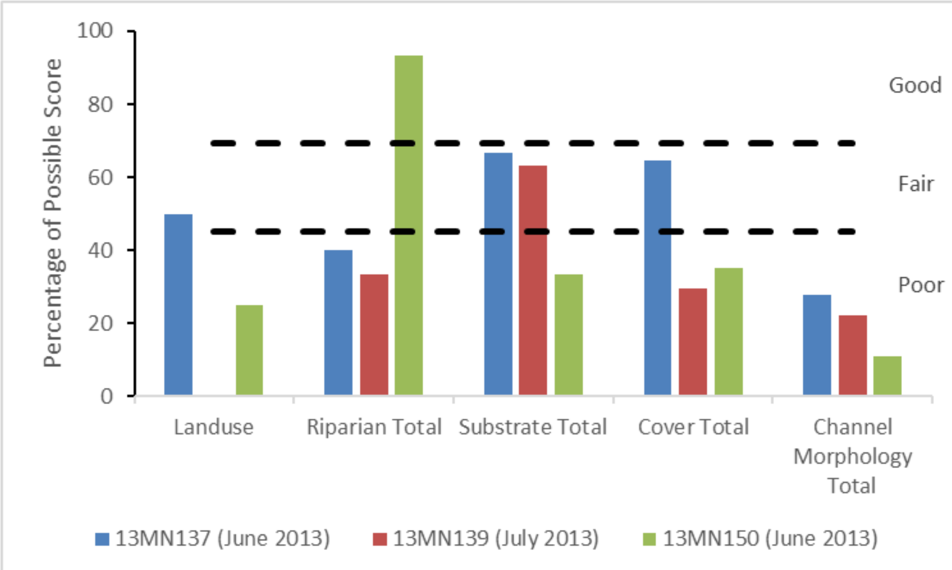
Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN150 (2013)	**7.34**	**0.00**	**19.81**	**0.00**	**0.00**	**13.00**	**47.74**
13MN137 (2013)	**5.97**	**0.00**	**17.75**	**0.00**	**0.00**	**11.00**	**53.58**
13MN139 (2013)	**0.31**	**0.00**	**19.97**	**0.00**	**0.00**	**12.00**	**63.44**
13MN139 (2013)	**2.24**	**0.00**	**18.45**	**0.00**	**0.00**	**11.00**	**57.83**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.91*	*0.00*	*16.02*	*0.60*	*0.68*	*10.98*	*35.60*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

A response to TSS stress metrics was observed at biological station 13MN139 in the fish community and across macroinvertebrate visits. While elevated concentrations of suspended sediment were observed during two of three fish visits only one additional elevated TSS sample was observed within the reach, even when half of the sampling events were targeted after storm events. Limited chemical evidence to corroborate metric data suggests that TSS is an inconclusive stressor in the reach at this time.

Habitat

Three qualitative habitat surveys were conducted on the reach in 2013, one at each of the three biological stations: 13MN139, 13MN137 and 13MN150. MSHA scores were poor at the upstream (13MN150) and downstream (13MN139) most stations and were just above the poor rating with a fair score (47.5) at the mid station 13MN137 (see graph below). Riparian landuse along the reach is dominated by row crop agriculture with a couple large hog facilities near the reach. Nearly the entire length of the reach has been channelized. There is a limited grass riparian corridor along a majority of the reach (see photo below). Landuse scores for two of the stations are likely overinflated as higher scores were given for presence of tree cover in the surrounding riparian zones at these sites (see figure). Habitat cover was sparse at the two lowest scoring reaches and moderate at the middle reach. Stream bank erosion was identified in the downstream two stations (see photos). All three stations had little to know natural channel progression and limited depth variability. Fine sediments dominated substrate types and embeddedness of coarse substrates was observed where coarse substrates were seen. Overall stream stability scores were low to moderate.

Figure 245. Percentage of MSHA subcategory scores for station 13MN137, 13MN139 and 13MN150 in Spring Branch Creek.



Habitat stress to the fish community on the reach appears to be most apparent at biological station 13MN137 and 13MN150 and less pronounced at station 13MN139 where there were sufficient quantities of darters, limited quantities of pioneering species and a fair quantity of benthic insectivores (see table below). Tolerant taxa were abundant in all reaches. Lithophilic and simple lithophilic spawners and riffle dwelling species were below average in all reaches as well. Low taxa and individual counts at fish visits on 13MN137 and 13MN150 show a greater response to habitat related stress metrics including an abundance of pioneering taxa, low quantities of riffle dwelling taxa and simple lithophilic spawners.

Table 284. Fish metrics that respond to degraded habitat stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN150 (2013)	**84.62**	7.69	**23.08**	7.69	**76.92**	**0.00**	**7.69**	**0.00**
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*56.03*	*3.67*	*25.67*	*6.80*	*19.02*	*12.17*	*20.04*	*37.00*
13MN137 (2013)	**91.53**	**0.00**	**32.20**	**8.47**	**50.85**	**8.47**	**8.47**	**23.73**
13MN139 (2013)	**66.67**	11.11	**22.22**	22.22	11.11	**22.22**	22.22	**11.11**
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*46.38*	*8.02*	*35.59*	*16.45*	*23.58*	*19.54*	*19.05*	*26.17*
Expected response to stress	↑	↓	↓	↓	↑	↓	↓	↓

While the macroinvertebrate community in the reach is not impaired, sometimes looking at all available indicator stress metric data can provide insight into potential stressors within the reach. There was a somewhat mixed response to habitat stress metrics in the macroinvertebrate community (see table below). While there were sufficient quantities of burrower and climber taxa at most stations, there were insufficient quantities of clinger and sprawler taxa. This is likely a reflection of prevalent overhanging vegetation and a limitation of other habitat types along the reach. A general abundance of burrowing and legless taxa in the reach are consistent with observations in the MSHA indicating a prevalence of fine sediment and limited availability of coarse substrates within the reach.

Table 285. Macroinvertebrate metrics that respond to degraded habitat stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN150 (6/11/2013)	**15.86**	29.13	**11.65**	**21.68**	**75.40**	**19.09**
13MN137 (6/11/2013)	**16.98**	46.86	**12.26**	**19.50**	**69.50**	**12.89**
13MN139 (7/10/2013)	8.18	51.26	**17.92**	**26.73**	**63.52**	**10.06**
13MN139 (2013)	**13.78**	53.21	**7.69**	**21.80**	**72.76**	**14.10**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.07*	*18.46*	*38.49*	*30.93*	*43.48*	*21.94*
Expected response to stress	↑	↓	↓	↓	↑	↓

Preponderance of evidence suggests that degraded habitat conditions are negatively impacting biological communities within the reach. A near absence of riffle habitat, limited availability of coarse substrates and diverse habitat types along with a negative response to habitat stress metrics indicates that habitat is a stressor within the reach.

Figure 246. Biological station 13MN137 (June 11, 2013) sloughing bank (left); no riparian buffer (right).

Figure 247. Spring Branch Creek at 360th St. (July 14, 2016) stream field connection.

Figure 248. Spring Branch Creek CR 110 (June 14, 2016) flooded pasture (left); stream field connection (right).

Figure 249. Spring Branch Creek Hwy 10 (June 14, 2016) drain tiles and small riparian buffer.

Altered hydrology/Longitudinal connectivity

There are two known fish barriers along the reach. The first is located at the downstream side of MN HWY 15 at the start of the reach. This barrier has been identified as an inverted culvert, with a large downstream rock riffle dam and serves as a potential barrier to fish passage at high flows. All biological stations were downstream of this barrier. The next barrier is located upstream of biological station 13MN139 (see photo below). The midchannel in the reach has the highest diversity in the reach, 12 species were identified at 13MN037, while only five species were found at upstream station 13MN150 and only six species were identified at downstream station 13MN139. No migratory fish taxa were found at the upstream most station, while the mid station had three migratory species: black bullhead, blackside darter and central stoneroller; only two migratory fish taxa were identified at the downstream most station: central stoneroller and shorthead redhorse. The series of barriers may be limiting fish communities (see table below). No mussel surveys were conducted by the DNR on Spring Branch Creek. As such, connectivity is an inconclusive stressor along the reach at this time. Additional investigation is needed to better understand potential variations in stream taxa lists between station 13MN150 and 13MN137 including additional culvert survey to identify more potential barriers in the reach that may be negatively impacting fish migration.

Table 286. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right.

Field Number	barrier	13MN150	13MN137	barrier	13MN139
WID		-574	-574		-574
Fish Taxa					
bigmouth shiner		x	x		x
black bullhead			x		
blacknose dace			x		
blackside darter			x		
bluntnose minnow		x	x		
central stoneroller			x		x
common carp		x	x		x
fathead minnow			x		
green sunfish			x		
johnny darter		x	x		x
northern pike		x	x		x
sand shiner			x		
shorthead redhorse					x

Figure 250. Biological station 13MN139 (July 10, 2013) fish barrier (upper left); (May 1, 2015) intermittent flow fish barrier (upper right and lower left); (September 1, 2015) no flow (lower right).

The Altered Watercourses GIS layer for Minnesota streams indicates that the 7.1 mile long reach of Spring Branch Creek is 100% modified. Upstream of the reach, its headwaters is also 100% modified. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were identified within the reach.

Only one known lake dwelling species was identified on the reach, black bullhead at the middle station. The presence of lake taxa on a reach can be indicative of low flow and altered hydrology stress within the reach. There were low numbers of riffle dwelling taxa at both the upstream and downstream stations but not at the mid station in the reach. A sufficient quantity of long-lived taxa were identified at the two downstream most stations at the reach but low quantities were observed at the downstream most station 13MN137. Low quantities of riffle dwelling and long-lived taxa can be indicative of altered hydrological stress (see table below).

Intermittent flow conditions or dry streambeds were documented in 2012 across the reach at all three biological stations (see photographs below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions.

Intermittent conditions along the reach were also observed within the reach in May and September of 2015 (see photos above). Baseflow appears to be a potential problem in the reach and is likely having negative impacts on biological communities within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Preponderance of evidence suggests that altered hydrology is a likely stressor within the reach at this time.

Table 287. Fish metrics that respond to altered hydrology stress in Spring Branch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN150 (2013)	**84.62**	15.38	**0.00**
Statewide average for Class 7 Low Gradient stations that meet Modified Use Threshold (15)	*56.03*	*7.09*	*12.17*
13MN137 (2013)	**91.53**	**1.69**	**8.47**
13MN139 (2013)	**66.67**	66.67	22.22
Statewide average for Class 2 Southern Streams stations that meet Modified Use Threshold (35.0)	*46.38*	*21.25*	*19.54*
Expected response to Altered Hydrology stress	↑	↓	↓

Figure 251. Biological station 13MN137 (September 12, 2012) dry streambed and small buffer (left); biological station 13MN139 (September 12, 2013) intermittent flow (right).

Figure 252. Biological station 13MN150 (September 12, 2013) intermittent channel.

4.1.3. AUID Summary

Degraded habitat conditions and altered hydrology are stressors within the reach.

Agricultural landuse in the watershed and channelization has drastically reduced habitat quality within the reach. MSHA habitat results indicate habitat conditions along the reach are fair to poor and the stream reach has been 100% modified. Riffles are nearly absent within the reach, channel types are near ubiquitous and fine sediments are prevalent, what coarse substrates are available degraded by in stream sedimentation. Stream habitat types are limited to overhanging vegetation, aquatic macrophytes, logs and woody debris. Historic wetland drainage, channelization of the stream reach and tile drainage all contribute to high spring flows that lead to bank erosion and instream sedimentation. Lowered water tables and limited water storage on the landscape is also contributing to low flow conditions observed in the late summer months. Lack of flow and diverse habitat availability in the reach is negatively impacting the potential of fish communities within the reach and will likely have negative implications for the macroinvertebrate community in the future as well.

Low DO, eutrophication, nitrates, TSS and longitudinal connectivity are inconclusive stressors on the reach at this time. While single grab readings suggest a potential for low DO conditions to exist within the reach, conditions during SID monitoring limited the ability of assessors to obtain continuous sonde data to bolster the dataset. Biological metrics did not show a strong response to low DO stress within the reach. Similarly, elevated phosphorous concentrations were identified within the reach but the present dataset is small and does not include necessary response indicator information to corroborate potential concerns. Future monitoring plans for the reach should include continuous DO monitoring to better understand the potential for low DO conditions and stress within the reach and to obtain DO flux data and other response variable data to better characterize potential eutrophication stress within the reach. While known fish barriers are present within the reach, the station with the highest fish taxa count in sandwiched between two fish barriers (13MN139). Biological station 13MN137 upstream has fewer taxa indicating potential for an unknown barrier to exist between the two stations while low taxa counts at the downstream most station suggest potential barriers between Spring Branch Creek and downstream Perch Creek. Additional on the ground investigation is needed during periods of lower flow to better understand whether additional barriers are causing longitudinal connectivity stress along the reach.

Fish do not generally respond to nitrate related stress, macroinvertebrates are better indicators of nitrate related stress but they are not impaired within the reach. While macroinvertebrate metric data shows that macroinvertebrates are responding negatively to elevated levels of nitrates within the reach. Any efforts to reduce nitrate concentrations in the reach would likely be beneficial in insuring the macroinvertebrate community does not fall below impairment thresholds in the future.

Similarly, the macroinvertebrate community showed a strong negative response to TSS stress within the reach. The fish community showed isolated response within the reach at station 13MN139. Despite this response, there was a limited chemical dataset demonstrating that elevated TSS levels are a persistent problem within the reach. While high TSS levels were seen during the fish visits, no elevated concentrations were observed during high flow chemistry samples taken in 2015 and 2016. Additional information is needed to better understand potential for TSS stress within the reach.

Table 288. Summary of stressor determinations for Spring Branch Creek (574).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Spring Branch Creek	07020010-574	o	o	o	o	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

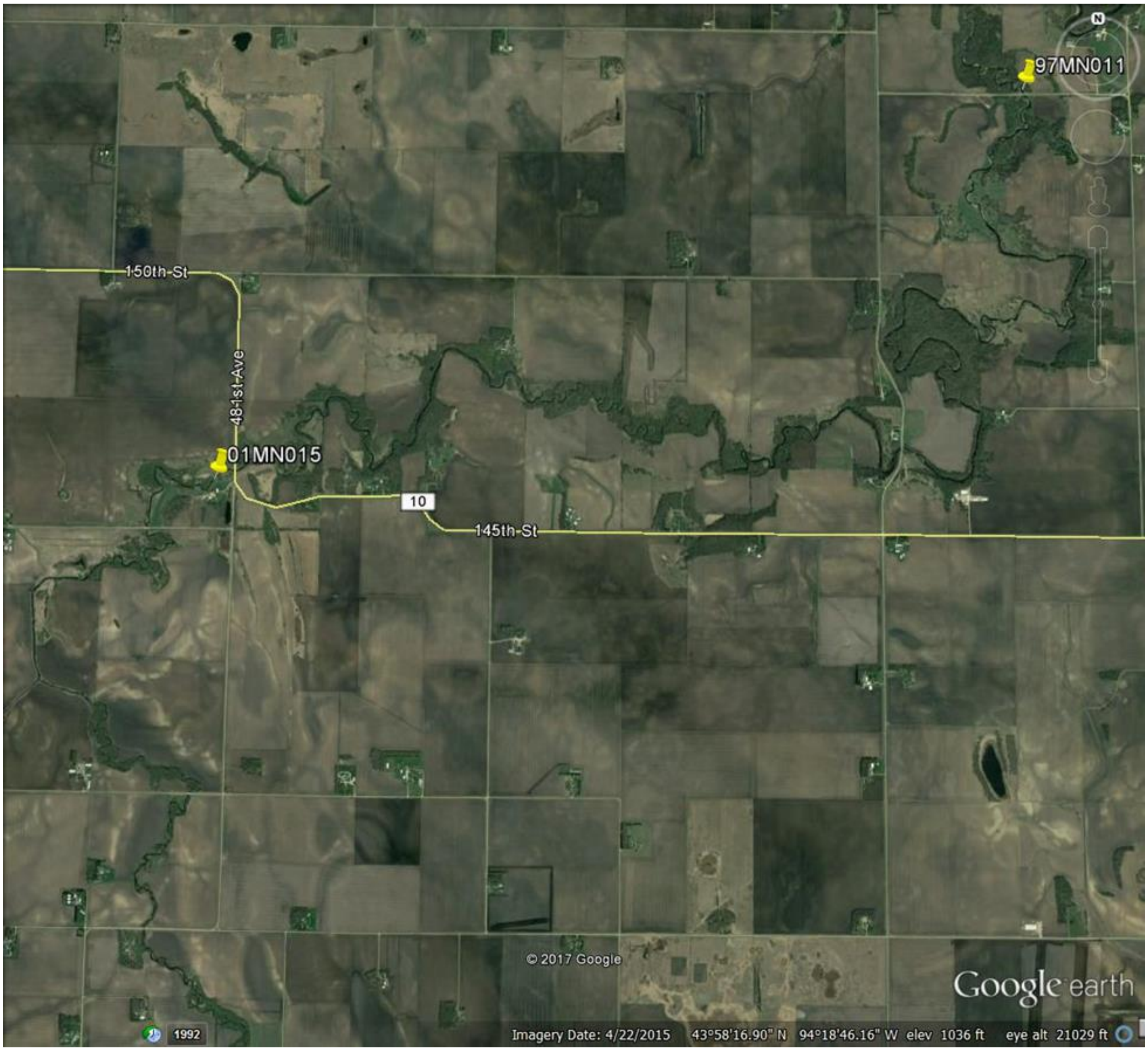
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Perch Creek -523

Reach (07020010-523) is the continuation Perch Creek, starting at the outflow of reach (07020010-524). This section begins downstream of the confluence of Spring Branch Creek (07020010-574) and flows northeast 12 miles before emptying to the Watonwan River (07020010-501) downstream of Co. Hwy 135. Classification for this reach is general use warmwater 2Bg. This reach is impaired for aquatic life for a degraded fish community (2015) and for aquatic life for high levels of *E.coli* bacteria (2015).

Figure 253. Google Earth image of Perch Creek (-523).



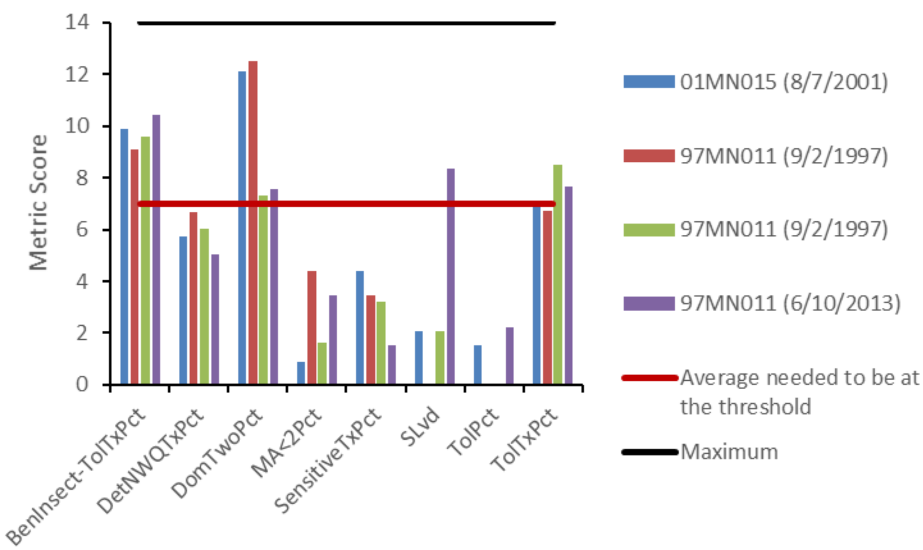
4.1.1. Biological communities

There were two biological stations on the reach 01MN015 and 97MN013; however, only one station had assessable data, 97MN013. Biological station 01MN015 was sampled once in 2001.

There was one assessable F-IBI sampling event at 97MN013, which occurred June 10, 2013. It scored 41, which is below the GU threshold (50) and at the lower CL. There were two earlier samples on this reach in 1997 and 1998. Scores were just above and below the 2013 visit. Dominant species across all visits were tolerant (TolPct). There below average quantities of individuals that take more than two years to mature (MA<2Pct). There was also an abundance of detritivores captured at all visits (DetNWQTxPct). Inconsistent quantities of short-lived taxa (Slvd) were observed across the three visits with lowest quantities observed during the 2013 visit. There were also low quantities of sensitive taxa (SensitiveTxPct) (see graph below). Dominant taxa captured during fish visits included sand shiner, bigmouth shiner, fathead minnow, white sucker, bluntnose minnow and spotfin shiner. While FIBI score has remained consistent over time, the total species count has reduced from 25 in 1997 to 18 in 2013. The individual count of fish captured was drastically lower in the 2013 visit (261) compared to the 1998 visit (1,078) and the 1997 visit (1,570). There was also a historic fish sample collected at station 01MN015 in 2001 that was outside of the assessment window. It scored 43.7, which is below the GU threshold (50) but within lower confidence limits. The sample was dominated by tolerant taxa (TolPct). There were above average quantities of detritivores and individuals that take less than two years to mature. While there were below average quantities of sensitive taxa and short-lived taxa. Bluntnose minnow, sand shiner, spotfin shiner, johnny darter and green sunfish dominated the sample.

Macroinvertebrates were sampled once in 2013 and scored above the threshold but within upper confidence limits.

Figure 254. Fish metrics of the Southern Streams Class IBI for stations 01MN015 and 97MN011, Perch Creek.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Three DO measurements were collected at two stations during the biological visits, samples ranged from 6.4 mg/L on August 7, 2001 5:10 pm at 01MN015 to 10.89 mg/L on August 12, 2013 at 3:39 pm at 97MN011. No additional samples were collected on the reach prior to or between biological sampling events. Eleven additional sampling events in 2015 - 2016 showed DO concentrations meeting the 5 mg/L DO standard, with values ranging from 7.05 mg/L at 1:00 pm on September 1, 2015 to 13.18 mg/L on February 22, 2016 at 11:20 am.

The fish community showed a marginal response to low DO stress (see table below). The low DO Index scores for the visits were all very near the average for the Southern Streams Class, suggesting that there is a low probability that low DO conditions are stressing the fish within the reach. While above average quantities of low DO tolerant individuals were observed at station 01MN015 and the 1997 visit at 97MN011, more recent visits fall within the threshold, suggesting potential improvement on the reach.

However, there were low quantities of late maturing individuals and low quantities of DO sensitive and generally sensitive taxa across all visits; however, this could be due to other stressors in the reach.

Table 289. Fish metrics that respond to low DO stress in Perch Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
01MN015 (2001)	**3.21**	**6.77**	**69.23**	**7.18**	**0**	**0**	**17.22**	**26.31**
97MN011 (1997)	**3.69**	**20.32**	**80.32**	**7.14**	**0.00**	**0.00**	**8.00**	**20.38**
97MN011 (1998)	**1.76**	**10.48**	**78.66**	7.28	**1.00**	0.01	**7.00**	6.49
97MN011 (2013)	**0.77**	**19.54**	**66.67**	**7.18**	**0.00**	**0.00**	4.00	11.15
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrate community is not impaired within the reach, sometimes looking at all available metric data is useful in better understanding potential stressors. The macroinvertebrate community shows a mixed response to low DO stress (see table below). The low DO Index score hovered around the southern streams average at both stations, suggesting that potential for low DO stress is unlikely in the reach. Both stations showed lower than average quantities of low DO tolerant individuals but only one had an above average quantity of low DO tolerant taxa. There were below average quantities of low DO intolerant individuals at both visits. Only the upstream station 01MN015 had above average quantities of EPT taxa. Macroinvertebrate metric data suggests a low potential for low DO stress within the reach.

Table 290. Macroinvertebrate metrics that respond to low DO stress in Perch Creek compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
01MN015 (2001)	49.00	18.00	**6.90**	**7.00**	9.00	**8.94**	4.00	4.97
97MN011 (2013)	**42.00**	**13.00**	**7.90**	7.16	**5.00**	**11.04**	**8.00**	9.42
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There is no chemical evidence to suggest low DO conditions occur within the reach. While there was limited response to low DO stress to the fish communities during early sampling within the reach, there is less response to low DO stress within more recent visits. Macroinvertebrate data also showed limited evidence of potential low DO stress within the reach. Preponderance of evidence suggests that low DO is an unlikely stressor within the reach in this time.

Eutrophication

There was only one phosphorous sample collected during the fish visit at station 97MN011 in 2013; the result was 0.075 mg/L, blow the southern river eutrophication standard of 0.15 mg/L. One phosphorous sample was also collected during the fish visit at station 01MN015. The concentration was 0.21 mg/L on August 7, 2001, above the southern regional eutrophication standard. An additional eighteen phosphorous samples were gathered in 2013, 2015 and 2016; in the months of May thru September at 97MN011 (one sample was collected at EQUIS station S009-296). Phosphorous concentrations ranged from 0.07 mg/L on May 24, 2016 to 0.676 mg/L on June 15, 2016. The average concentration was 0.178 mg/L. Of these samples, seven were at or above the southern region eutrophication standard of 0.15 mg/L. There was one chlorophyll a sample collected in 2015 at biological station 97MN011 on September 1, the reading was 45.9 ug/L, above the 35 ug/L southern regional eutrophication standard. There were no BOD samples collected on the reach, nor were any DO flux measurements gathered. DO values collected during grab sample events ranged from 6.4 mg/L to 13.18 mg/L suggesting potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.47 – 8.71 in the reach.

The fish community is showing some metric response to potential eutrophication stress within the reach (see table below). There was a high percentage of tolerant taxa, an absence of intolerant taxa and a low quantity of sensitive species across the reach. Quantities of darters and simple lithophilic spawners were also below class averages at nearly all visits. Comparing 1997 results with results to 2013 for station 97MN011, it appears as though the fish community has degraded overtime for nearly all stress metrics. However, these metrics are general in nature and could be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish were only identified at a single visit on the reach in 1997, more recent data shows quantities of omnivorous fish below the class average suggesting that eutrophication stress is not likely stressing the fish community.

Table 291. Fish metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmivorePct	TolPct	TaxaCount	IntolerantPct
01MN015 (2001)	**3.21**	15.61	**11.14**	7.35	**69.23**	**19.00**	**0.00**
97MN011 (1997)	**3.69**	**8.03**	**33.18**	**29.30**	**80.32**	25.00	**0.00**
97MN011 (1998)	**1.76**	**3.25**	**19.57**	9.00	**78.66**	27.00	**0.00**
97MN011 (2013)	**0.77**	**1.53**	**18.77**	8.05	**66.67**	**18.00**	**0.00**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to stress	↓	↓	↓	↑	↑	↓	↓

While the macroinvertebrate community is not impaired within the reach, sometimes looking at all available metric data is useful in better understanding potential stressors. There was a mixed response in the macroinvertebrate community with regards to eutrophication stress (see table below). There was a high percentage of tolerant taxa and an absence of intolerant taxa. Quantities of collector-gatherer taxa and EPT taxa were both above the southern stream average needed to meet biocriteria t station 97MN011 while collector gatherer counts were below average at station 01MN015 and EPT counts were above average. Quantities of collector-filterer taxa were only slightly below the average at both visits. Present metric information suggests low potential for eutrophication stress within the macroinvertebrate community within the reach.

Table 292. Macroinvertebrate metrics that respond to eutrophication stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
01MN015 (2001)	49.00	**7.00**	**6.00**	16.00	**0.00**	**77.55**
97MN011 (2013)	**42.00**	**7.00**	17.00	13.00	**0.00**	**88.10**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

Fish metric data suggest potential for eutrophication stress within the reach; however, eutrophication stress metrics are general in nature and do not necessarily implicate eutrophication stress within the reach and could very easily be pointing to other stressors in the reach. While chemical evidence suggests potential for elevated phosphorous concentrations in the reach, the response variable dataset is limited to a single elevated chlorophyll a sample. Additional chemical response data is needed to clarify eutrophication stress within the reach, DO flux information and additional chlorophyll a and BOD samples would be advantageous to better understand the extent of the stress within the reach.

Nitrate

The nitrate concentrations from the fish visits was 9.1 mg/L at station 01MN015 on August 7, 2001 and 13 mg/L at station 91MN097 on June 10, 2013. There were an additional 17 nitrate samples collected from 2013 thru 2016 during the months of May through September, including one visit in February of 2016. Nitrate concentrations ranged from 0.05mg/L in August of 2015 to 26 mg/L in May of 2016, with an overall average concentration of 11.04 mg/L. Five of these nitrate concentrations were above 15 mg/L in the months of May and June.

Fish often do not show strong response to increased nitrate concentrations. Potential metrics that do respond to nitrate stress are general in nature and do not necessarily reflect nitrate stress as they may be attributed to other stressors. Across the reach, the fish community was dominated by tolerant taxa (see table below). There were low quantities of sensitive and darter taxa and an absence of intolerant taxa.

Table 293. Fish metrics that respond to nitrate stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	TolPct	IntolerantPct
97MN011 (1997)	**3.69**	**8.03**	**80.32**	**0.00**
97MN011 (1998)	**1.76**	**3.25**	**78.66**	**0.00**
97MN011 (2013)	**0.77**	**1.53**	**66.67**	**0.00**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*18.65*	*11.68*	*44.85*	*4.97*
Expected response to Nitrate stress	↓	↓	↑	↓

Macroinvertebrate communities are often more affected by nitrate stress. While the macroinvertebrate community is not impaired within the reach, sometimes looking at all available metric data is useful in better understanding potential stressors. The macroinvertebrates in this reach show some response to elevated nitrate concentrations (see table below). The nitrate index score for station 97MN011 was 3.8, while the average for modified Prairie Streams meeting impairment threshold is 3.2. Station 01MN047 had a below average nitrate index score of 2.77. This suggests that the macroinvertebrates at station 97MN011 are more likely to show impacts of nitrate related stress than 01MN015. This could imply variation of potential stress within the reach or could reflect a potential increase in nitrate levels between macroinvertebrate visits. Increasing nitrate concentrations also correlate with a low level of nitrate intolerant taxa, an abundance of nitrate tolerant taxa and the high percentage of nitrate tolerant individuals. While low quantities of nitrate intolerant taxa and above average quantities of nitrate tolerant taxa were identified at both reaches, only station 97MN011 had above average quantities of nitrate tolerant individuals. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct), inversely the percentage of non-hydropsychid Trichoptera were above the average for the Southern Streams RR class as was the quantity of Trichoptera taxa at station 97MN011 but were below average at 01MN015.

Table 294. Macroinvertebrate metrics that respond to nitrate stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year Sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
01MN015 (2001)	**49.00**	**7.00**	**6.00**	16.00	**0.00**	**77.55**	5.00	**1.37**	2.77	**2.00**	**19.00**	37.09	9.1 (8/7/2001)
97MN011 (2013)	**42.00**	**7.00**	17.00	12.00	**0.00**	**88.09**	6.00	6.54	**3.80**	**1.00**	**23.00**	**79.60**	13.00 (6/10/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

The chemical dataset gathered outside of biological data collection shows that the reach has elevated spring nitrate conditions, especially after event based sampling. While macroinvertebrates are a more reliable indicator of nitrate stress, fish metrics can provide additional supporting information in determining potential stress. An abundance of tolerant species, coupled with low quantities of sensitive taxa and an absence of intolerant taxa and low quantities of darter species could all be results of nitrate stress within a reach but are not definitive metrics to be utilized without additional information. The macroinvertebrate community in the reach appears to show a negative response to nitrate related stress at least at the downstream most station on the reach, 97MN011. Any efforts to reduce nitrate concentrations along the reach would be beneficial in preventing macroinvertebrates from falling below impairment thresholds in the future. Nitrate is an inconclusive stressor for the fish community at this time.

Suspended sediment

Two TSS samples were collected on the reach during biological monitoring efforts. Station 97MN011 produced one TSS measurement of 23 mg/L sampled on June 10, 2013, and station 01MN015 produced one TSS sample of 11 mg/L on August 7, 2001, neither sample exceeded the southern regional TSS standard of 65 mg/L. Ten additional TSS samples were gathered in the reach in 2013 as part of intensive watershed monitoring efforts, an additional nine TSS samples were gathered along the reach in 2015 and 2016 as part of SID investigations at biological station 97MN011 and one EQUIS station S009-296. Values ranged from 7 mg/L on July 24, 2013 to 420 mg/L on June 15, 2016. Six samples were above the southern regional standard. The average concentration was 61.14 mg/L.

A majority of TSS stress metrics within the reach indicate that fish are responding negatively to TSS related stress (see table below). TSS index scores were all above the Southern Streams Class average of 19.2, indicating potential for TSS stress to the fish community. All taxa related metrics point to TSS stress; there were low quantities of benthic feeders, centrarchids, herbivores, long-lived taxa, simple lithophilic spawners, perciformes and riffle dwelling species. Low quantities of these taxa could be responding to sedimentation within the reach, which is a common side effect of elevated levels of suspended sediment. High levels of suspended sediments can inhibit foraging, the establishment of quantic macroinvertebrates and fill in pool habitat and cover coarse substrates. There were few sensitive and intolerant species found on the reach, which are not necessarily a product of TSS stress and could be a result of other stressors. There were also above average numbers of TSS tolerant taxa and individuals across nearly all visits, suggesting TSS related stress is having impacts on the reach.

Table 295. Fish metrics that respond to high TSS stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
01MN015 (2001)	**17.22**	**0.00**	**5.51**	**0.00**	**2.41**	**15.61**	**7.46**	**3.21**	6.54
97MN011 (1997)	**23.18**	**0.06**	**15.73**	**0.00**	**8.34**	**8.09**	**20.06**	**3.69**	20.13
97MN011 (1998)	**10.76**	**0.00**	**7.24**	**0.00**	**6.12**	**3.62**	**9.28**	**1.76**	**10.02**
97MN011 (2013)	**20.38**	**0.00**	**4.62**	**0.38**	**10.77**	**1.54**	**8.85**	**1.15**	**18.08**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
01MN015 (2001)	**22.89**	**0.00**	**0.00**	2.00	**30.00**
97MN011 (1997)	**20.20**	**0.00**	**0.00**	**3.00**	**19.00**
97MN011 (1998)	**24.52**	**0.00**	**0.00**	**6.00**	**53.00**
97MN011 (2013)	**25.14**	**0.00**	**0.00**	**4.00**	**41.00**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

While the macroinvertebrate community is not impaired within the reach, sometimes looking at all available metric data is useful in better understanding potential stressors within the reach. The macroinvertebrate community is showing a mixed response TSS stress related metrics (see table below). The TSS Index score was below average, suggesting that the macroinvertebrate community is not responding negatively to elevated TSS concentrations. There as a below average number of TSS intolerant taxa in the reach; however, there were also few TSS intolerant taxa or individuals present (see table below). An absence of plecoptera taxa may indicate elevated TSS stress but could reflect habit limitations in the reach as well.

Table 296. Macroinvertebrate metrics that respond to high TSS stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
97MN011 (2013)	34.31	**0.00**	7.22	8.00	**0.33**	7.00	9.30
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

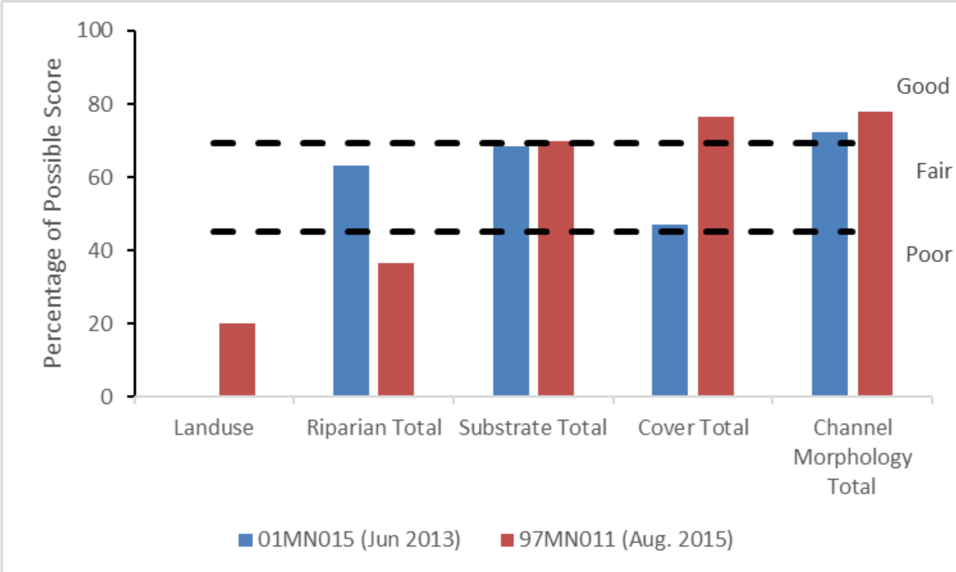
There was a 35% exceedance rate in elevated TSS concentrations during assessments. Fish metric data responded negatively to TSS stress metrics, while the macroinvertebrate community showed only a marginal response to TSS stress related metrics. A preponderance of data suggests that TSS is a stressor to the fish community on the reach.

Habitat

There were two qualitative habitat surveys conducted on this reach at two unique biological stations, 97MN011 was surveyed once in 2013 and 01MN015 was surveyed once in 2001 (see graph below). MSHA scores were fair at the upstream station 01MN015 (62) and good at the downstream station 97MN011 (66.3). Landuse surrounding the reach is predominately row crop agriculture with a handful of small to moderately sized swine operations. The riparian corridor along 97MN011 is an open pasture. Overall, the stream reach is predominately natural with some channelized sections. While extensive forested buffers line some portions of the reach, other areas have very limited buffers. Limited habitat cover was available at the upstream station but more abundant at the downstream station. Stream bank erosion and sedimentation were prevalent at both reaches (see photos below). Natural channel development was good at both stations. Instream substrates were diverse and coarse substrates were only lightly embedded. Overall stream channel stability was good at both stations.

The DNR geomorphology survey crews visited the reach near biological station 97MN011 and identified the stream as slightly entrenched, with good access to its floodplain. The survey indicated that Perch Creek is highly sensitive to disturbance, with a high sediment supply and a very high erosion potential (DNR, 2014).

Figure 255. Percentage of MSHA subcategory scores for stations 01MN015 and 97MN011 in Perch Creek.



The fish community responded negatively to almost all degraded habitat stress related metrics within the reach (see table below). There was an abundance of tolerant taxa and pioneering species (at all but one visit on 97MN011). Pioneering taxa are generally the first taxa to move in after disturbance as they have more general habitat requirements. There were limited quantities of piscivores, lithophilic and simple lithophilic spawners, 'darter, sculpin, sucker' taxa, riffle dwelling taxa and benthic insectivores. This suggests limited available coarse substrates and riffle habitat are available in the reach. This also suggests that present habitat conditions are not conducive for predatory species either. While MSHA scores were on the higher side of fair and the lower side of good, where a variety of habitats were present within the reach their abundance was not sufficient enough to provide for a robust diverse fish community.

Table 297. Fish metrics that respond to degraded habitat stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
01MN015 (2001)	**69.23**	**0.11**	**18.48**	**17.91**	**50.29**	**7.46**	**18.14**	**11.4**
97MN011 (1997)	**80.32**	**0.25**	**34.78**	**18.15**	**24.78**	**20.06**	**18.34**	**33.18**
97MN011 (1998)	**78.66**	**0.19**	**21.99**	**7.79**	14.10	**9.28**	**7.88**	**19.57**
97MN011 (2013)	**66.67**	**0.38**	**19.92**	**16.86**	**36.40**	**9.58**	**16.86**	**18.77**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

The macroinvertebrates within the reach showed a mixed response to degraded habitat stress metrics (see table below). Station 01MN015 had below average quantities of climbing species, this could be reflective of an absence of aquatic macrophyte habitat within the reach and sparse available habitat otherwise and due to the fact overhanging vegetation was not sampled. While high quantities of clinger taxa at station 97MN011 are consistent with a greater availability of overhanging vegetation habitat (which were sampled) and presence of aquatic macrophytes within the station. There was also an abundance of legless taxa in the reach, suggesting a prevalence of fine sediments in the reach. Large quantities of clinger taxa can likely be attributed to both samples including coarse rock riffles and woody debris.

Table 298. Macroinvertebrate metrics that respond to high TSS stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN015 (2001)	4.11	**3.77**	61.99	42.81	**46.92**	18.84
97MN011 (2013)	**8.50**	24.51	50.98	49.35	**44.77**	**5.88**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

While MSHA scores flirt on the edge of good ratings, fish are responding negatively to habitat related stress in the reach. While coarse substrates and riffles are present at both reaches, habitat availability is sparse to moderate. Erosion on the reach is likely contributing to sedimentation of coarse substrates that may be resulting in a negative response from riffle dwelling and coarse substrate obligates. While macroinvertebrates in the reach are showing little sign of habitat, stress within the reach there was an abundance of legless taxa, which are consistent with in stream sedimentation. The data indicates that degraded habitat is stressing the fish community.

Figure 256. Biological station 97MN011 (June 10, 2013) stream bank erosion (left); biological station 01MN015 (July 10, 2014) sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams within the reach. Seven species were identified at 97MN011, the downstream most station on the reach that were not observed at upstream station 01MN015. Four known migratory fish taxa were observed at both stations, black bullhead, blackside darter, slenderhead darter and white sucker. Three additional migratory fish taxa were identified at the downstream most station on the reach but not at 01MN015, these species included central stoneroller, golden redhorse and shorthead redhorse; however, both central stonerollers and golden redhorse were observed at the next upstream WID on perch creek -524. Silver redhorse were observed at the upstream station on the reach and the next upstream WID (-524) but were not captured at the downstream most station 97MN011 (see table below).

Fourteen of 19 mussel species that were sought out in DNR mussel surveys in the Watonwan Watershed from 1999-2003 were observed in this reach on Perch Creek. Eight species were observed at both stations on the reach including: *Anodontoides ferussacianus* (Cylindrical papershell), *Lampsillis cardium* (Plain Pocketbook), *Lasmigona complanata* (White heelsplitter), *Leptodea fragilis* (Fragile Papershell), *Lampsillis siliquoidea* (Fatmucmket), *Pyganodon grandis* (Giant Floater), *Strophitus undulates* (Creeper) and *Toxolasma parvu*, (Lilliput). Six species were identified at the downstream station only: *Actinonaias ligamentina* (Mucket), *Amblema plicata* (Three ridge), *Fusconaia flava* (Wabash Pigtoe), *Ligumia recta* (Black Sandshell), *Ligumia subrostrata* (Pond mussel) *and Potamilus ohienisis* (Pink Papershell). Abundance of mussel taxa in a reach is evidence that longitudinal connectivity is not a likely barrier to fish communities within the reach because many mussel taxa rely on migratory fish taxa to complete their lifecycles.

Evidence suggests that it is unlikely longitudinal stress is impacting fish communities in the reach at this time.

Table 299. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish species in bold are known migratory fish. Fish species in blue are known lake species.

Field Number	13MN143	13MN129	01MN015	97MN011
WID	-524	-524	-523	-523
Fish Taxa				
bigmouth shiner		x	x	x
black bullhead	x		x	x
blacknose dace		x	x	x
blackside darter	x	x	x	x
bluntnose minnow	x	x	x	x
brassy minnow			x	x
brook stickleback				x
central stoneroller		x		x
common carp		x		x
common shiner			x	x
creek chub		x	x	x
fathead minnow			x	x
gen. redhorse				x
golden redhorse		x		x
green sunfish		x	x	x
johnny darter	x		x	x
largemouth bass				x
northern hogsucker			x	x

Field Number	13MN143	13MN129	01MN015	97MN011
northern pike	x	x	x	x
sand shiner		x	x	x
shorthead redhorse				x
silver redhorse		x	x	
slenderhead darter			x	x
spotfin shiner		x	x	x
stonecat			x	x
white sucker	x	x	x	x

The Altered Watercourses GIS layer for Minnesota streams indicates that the 12.09 mile long reach of Perch Creek is 93% natural and 7% modified. Upstream of the reach, Perch Creek is predominately natural; the reach also receives flow from Spring Branch Creek, which is completely channelized. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor, while undercut banks were not identified at the biological station, stream bank erosion was evident. DNR geomorphology survey crews visited the reach near biological station 97MN011 and identified the stream as a C4 channel. Here Perch Creek, while slightly entrenched, has good access to its floodplain, a good balance of coarse substrates and good channel development with a high recovery potential. The streams' intact riparian buffer plays a significant role in maintaining the stream's stability. Perch Creek is highly sensitive to disturbance, with a high sediment supply and a very high erosion potential and would benefit in conservation efforts to maintain its vegetated buffers (DNR, 2014).

Two known lake species were identified within the reach, largemouth bass were observed at station 97MN011, while black bullhead were noted at both stations in the reach. Presence of lake species within a reach can be an indication of low flow and altered hydrology stress. Low quantities of long-lived taxa and riffle dwelling species during fish visits also indicate potential for altered hydrology stress (see table below).

Table 300. Fish metrics that respond to altered hydrology stress in Perch Creek compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
01MN015 (2001)	**69.23**	**2.41**	**7.46**
97MN011 (1997)	**80.32**	**8.34**	**20.06**
97MN011 (1998)	**78.66**	**6.12**	**9.28**
97MN011 (2013)	**66.67**	**10.77**	**9.58**
Statewide average for Class 2 Southern Streams stations that meet the General Use Threshold (50.0)	*44.85*	*13.6*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

Low flow conditions were observed at 97MN011 in September of 2012 (see photograph below). In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Baseflow appears to be a potentially problematic in the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, embedding coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds in the drier late summer months.

Conflicting evidence from DNR stream geomorphology surveys and presence of low flow conditions in 2012 cause altered hydrology to be an inconclusive stressor at this time. If measures are not taken to maintain vegetative barriers and stream stability within the reach it is likely that altered hydrology will cause greater stress to biological communities in the future.

Figure 257. Biological station 97MN011 (September 13, 2017) low flow.

4.1.3. AUID Summary

TSS and habitat conditions are stressors to the fish community within the reach. Elevated concentrations of TSS in the reach were identified during intensive watershed monitoring and SID investigations after rainfall events. The fish community had an abundance of TSS tolerant taxa within the reach and responded negatively to all TSS related taxa metrics. Stream bank erosion, sedimentation and a low abundance of diverse available habitat types are having negative impacts to the fish community within the reach. While MSHA scores are appear better than other reaches on the Watonwan Watershed there is room for improvement, which would benefit aquatic biota within the reach.

Eutrophication, nitrates and altered hydrology are inconclusive stressors within the reach. Fish metric data showed a potential connection to eutrophication stress. Elevated phosphorous concentrations observed in the reach suggest that there is a potential for eutrophication stress; however, there was little response variable data to back up metric observations. Continuous DO monitoring and DO flux data, as well as additional chlorophyll a data would be useful in verifying the potential stressor. While elevated nitrate concentrations were observed during SID investigations after spring runoff events, fish metric data does not currently provide sufficient evidence to implicate nitrate stress as stress metrics are general in nature. Macroinvertebrates, which are better indicators of nitrate related stress, show a metric response within the biological station in the lower reach. This suggests that while not impaired, any reductions in nitrate concentrations would be beneficial to the macroinvertebrates in the reach to prevent future impairment. Low flow conditions were identified in the reach in 2012 suggesting that baseflow in the reach is negatively influenced by upstream landuse modifications in the watershed, including wetland drainage and past installation of drain tiles, which are increasing flows during the spring and summer months and while lowering the water table and potential available baseflow in the late summer months. The DNR geomorphology survey suggested that the reach was predominately stable but had a high sediment load and potential for erosion. Additional evidence should be gathered to confirm that low flow conditions occur in the reach beyond extreme drought conditions and that the high flows increasing the streams ability to erode and move sediment are a result of altered hydrology and not high precipitation events.

Low DO and longitudinal connectivity are not stressors to the fish community within the reach. There was no chemical data confirming that low DO conditions occur within the reach; however, the dataset was small limited to biological visits and SID investigations. While there was some marginal metric response to potential low DO conditions to the fish community during two early fish visits more recent data refutes potential stress. There are no apparent barriers within the reach. There is a prevalence of migratory fish taxa across the reach and an abundance of mussel diversity, suggesting limited potential for longitudinal connectivity stress within the reach.

Table 301. Summary of stressor determinations for Perch Creek (523).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Perch Creek	07020010-523	--	o	o	●	●	o	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

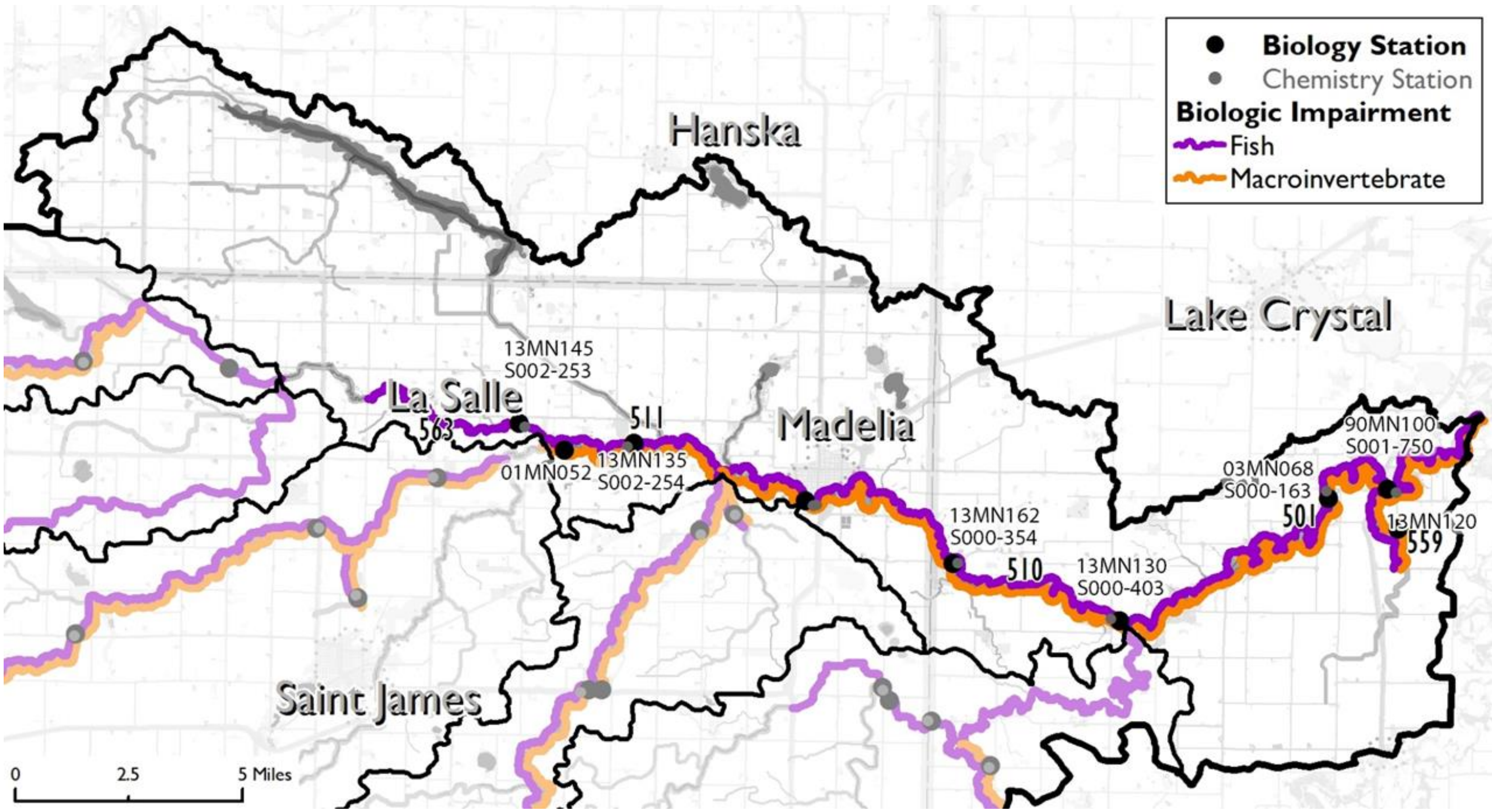
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

Lower Watonwan River

The Lower Watonwan River subwatershed is the terminal reach of the Watonwan River system before in enters the Blue Earth River and flows to the Minnesota River. This reach includes the mainstem of the Watonwan River starting just west of La Salle, after the confluence of the Upper Watonwan River with the North Fork Watonwan River. The river flows in a southeasterly direction, throughout its coarse it is joined by St. James, Creek and the South Fork of the Watonwan River, west of Madelia and Perch Creek before turning northeast towards Lake Crystal.

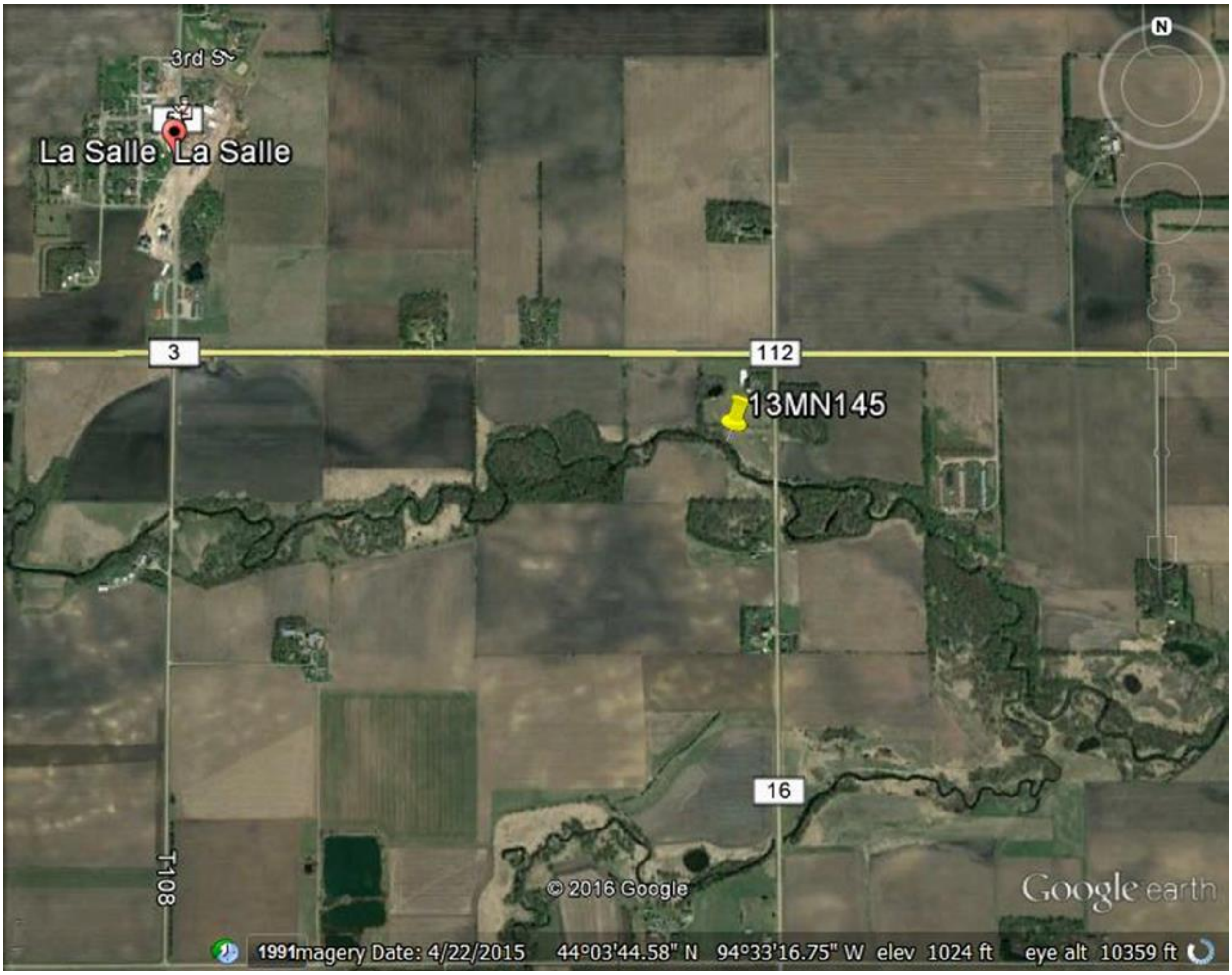
Figure 258. Biological impairment map of the Lower Watonwan River subwatershed.



4.1. Watonwan River -563

WID (07020010-563) is a nearly 6 river mile flow through section of the Watonwan River, stretching from the termination of upstream reach at Twp. Rd. 113 (07020010-512) to upstream of the outlet of St. James Creek, downstream of Co. Hwy 16, near La Salle. The reach is classified as general use warmwater Class 2B. The reach is impaired for aquatic life for a degraded fish community (2015) and high levels of turbidity (2006); as well as for aquatic life for high vales of fecal coliform bacteria.

Figure 259. Google Earth image of Watonwan River (-563).



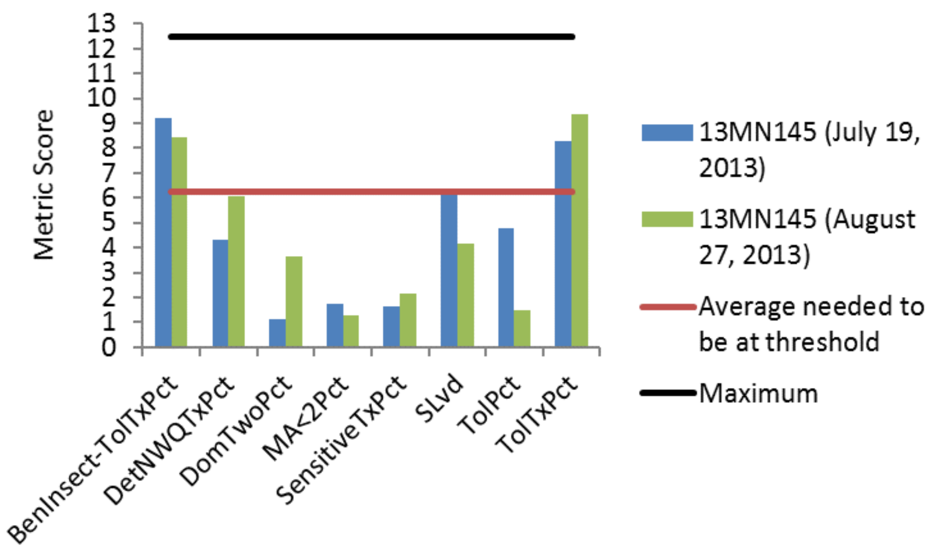
4.1.1. Biological communities

Only one biological station exists on this AUID 13MN145. It was sampled twice for fish in 2013 and once for macroinvertebrates. FIBI scores were 37.3 on 7/19/2013 and 36.5 on 8/27/2013; both scores fell below the threshold (50) and lower confidence interval. Dominant species captured at both visits were tolerant and included sand shiner, spotfin shiner, bluntnose minnow and common carp. Diversity ranged from 17 species at the initial visit and 26 taxa at the following visit.

Communities lacked sensitive taxa and scored at or below the averages needed to meet standards for six of eight metrics including: relative abundance of detritivorous species (DetNWQTxPct), relative abundance of individuals of the two most abundant species (DomTwoPct), relative abundance of individuals with a female mature age greater or equal to two years (MA<2Pct), relative abundance of short-lived taxa (SLvdPct) and relative abundance of tolerant taxa (TolPct) (see graph below).

Macroinvertebrates were sampled once and scored above the threshold and within upper confidence limits.

Figure 260. Fish metrics of the Southern Rivers Class IBI for station 13MN145, Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

There were three DO measurements collected on the reach during biological monitoring in 2013 at station 13MN145. DO levels ranged from 5.43 mg/L at 8:16 am on August 27, 2013 to 10.41 mg/L at 2:48 pm on August 15, 2013. As such, no readings fell below the low DO standard of 5 mg/L. Twenty additional DO samples were collected on the reach during the years of 2013, 2014 and 2016, all samples were above the low DO standard and fell within normal ranges. No continuous DO monitoring occurred on the reach.

The fish community within the reach showed a mixed response to low DO metrics (see table below). Both visits had DO index scores that were very near the average for the southern streams class. This suggests that low DO stress is not likely impacting the fish within the reach. There were few generally sensitive taxa in the reach and DO sensitive taxa were absent at both visits, suggesting potential for stress. DO tolerant taxa were over abundant at one visit; however, the percentage of the DO tolerant individuals that comprised the overall sample was below average at both visits. There was also a low abundance of individuals from species with a female mature age greater than or equal to 3 years. Both visits had a greater than average abundance of tolerant taxa; however, the abundance of tolerant taxa could be related to many other stressors as well as DO.

Table 302. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN145 (2013)	**1.10**	**11.03**	**56.99**	7.22	**0.00**	**0.00**	4.00	9.93
13MN145 (2013)	**0.24**	**7.39**	**69.48**	**7.19**	**0.00**	**0.00**	**8.00**	7.15
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*16.90*	*24.60*	*44.90*	*7.20*	*1.71*	*5.94*	*4.69*	*18.54*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While the macroinvertebrates in the reach are not impaired, sometimes looking at stress metrics from all indicators can provide additional insight into potential stressors within the reach. The macroinvertebrate community on the reach is showing few signs of low DO stress (see table below). The Low DO index score is above average indicating that the likelihood of DO stress impacting the biological community is low. There was an above average abundance of low DO intolerant taxa and a below average quantity of low DO tolerant taxa. The HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score was slightly above average and taxa counts were slightly below average, both metrics proximity to their respective averages is additional evidence that the macroinvertebrate community is not responding to low DO stress.

Table 303. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN145 (2013)	**36.00**	8.00	**8.00**	7.16	4.00	9.32	4.00	12.22
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There was no chemical evidence to suggest that low DO conditions are present within the reach; however, the dataset is small and includes only two DO readings prior to 9:00 am. Neither fish no macroinvertebrate metric data suggest that low DO concentrations are presently stressing biological communities within the reach.

Eutrophication

There were two phosphorous samples collected during the fish visits at 13MN145 in 2013, values were 0.097 mg/L on July 19, 2013 and 0.058 mg/L on August 27, 2013. Neither sample exceeded the southern region eutrophication standard on 0.15 mg/L. Additionally, 71 samples were collected from 2000 - 2002 and 2013 at the biological station. Of those samples, 35 were above the eutrophication standard. Phosphorous concentrations ranged from 0.054 mg/L to 0.64 mg/L, with an average concentration of 0.16 mg/L. There were no chlorophyll a or BOD samples collected on this reach. No continuous DO surveys have been conducted on the reach. DO values on the reach ranged from 5.43 to 10.41 mg/L indicating potential for elevated DO flux on the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.43 – 9.01 in the reach. Only one value was above 8.5.

The fish community is showing a mixed response to eutrophication stress within the reach (see table below). There were no intolerant taxa and above average quantities of tolerant taxa. There were also low numbers of sensitive and darter taxa, while counts of simple lithophilic spawners were only marginally below the threshold. However, these stress metrics are general in nature and could be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Below average quantities of omnivorous taxa were identified within the reach at both visits, suggesting that eutrophication is not a likely stressor in the reach at this time.

Table 304. Fish metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	TaxaCount	IntolerantPct
13MN145 (2013)	**1.10**	**5.51**	**35.29**	8.46	**56.99**	**17.00**	**0.00**
13MN145 (2013)	**0.24**	**6.20**	**34.62**	3.02	**69.48**	26.00	**0.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*16.90*	*11.90*	*37.00*	*17.00*	*44.90*	*19.30*	*4.20*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While the macroinvertebrates in the reach are not impaired, sometimes looking at stress metrics from all indicators can provide additional insight into potential stressors within the reach. The macroinvertebrate community metrics indicate a negative response to eutrophication stress within the reach (see table below). There was an abundance of tolerant taxa and an absence of intolerant taxa. There were also low quantities of collector-filterer taxa while numbers of collector gatherer and EPT taxa were only marginally below their respective thresholds.

Table 305. Macroinvertebrate metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN145 (2013)	**36.00**	**3.00**	**15.00**	**8.00**	**0.00**	**91.67**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The chemical dataset suggests potential for eutrophication stress to biological communities in the reach, with an abundance of evidence of elevated levels of phosphorous in a large dataset. However, there was no response variable data to confirm that elevated phosphorous concentrations have the potential to negatively impact the biology within the reach. While biological metric data shows a negative response to eutrophication stress in both the fish and macroinvertebrate communities, these stress metrics are general in nature and do not necessarily implicate eutrophication stress in the reach as the response could be due to other stressors. As such, eutrophication is an inconclusive stressor in the reach at this time.

Nitrate

During the biological sample collection at 13MN145 the nitrate concentration was 6.6 mg/L in July of 2013 and 0.67 mg/L in August of 2013. Seventy-one additional samples were taken during 2000, 2001, 2002 and 2013. The nitrate concentration ranged from 0.35 mg/L in August to 18 mg/L in July, with an overall average concentration of 8.17 mg/L. Only two readings were above 15 mg/L and occurred in late June and early July of 2013.

Fish do not exhibit a strong response to nitrate stress. Fish metrics that respond to nitrate stress are general in nature and could be implicating other stressors within the reach. There was an abundance of tolerant taxa in the reach and an absence of intolerant taxa. There were below average quantities of sensitive and darter taxa in the reach as well.

While the macroinvertebrates in the reach are not impaired, sometimes looking at stress metrics from all indicators can provide additional insight into potential stressors within the reach. The macroinvertebrates in this reach show a mixed signal to nitrate tolerant metrics (see table below). The nitrate index score was 3.79, while the average for Prairie Streams GP meeting impairment threshold is 3.2. This suggests that overall the community present is marginally tolerant to high nitrate concentrations. Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct) which was not observed in this reach. Trichoptera taxa numbers were also low. Nitrate intolerant taxa were absent in the reach, while nitrate tolerant taxa numbers and the percentage of nitrate tolerant individuals were slightly elevated above the class's averages suggesting that the macroinvertebrate community may be marginally stressed by elevated concentrations of nitrates in the reach.

Table 306. Macroinvertebrate metrics that respond to nitrate stress in the Watonwan River compared to the statewide average visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera **TrichwoHydroPct**	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN145 (2013)	**36.00**	**3.00**	**15.00**	**8.00**	**0.00**	**91.67**	3.00	3.22	**3.79**	**0.00**	**23.00**	**65.90**	6.60 (7/19/13)
13MN145 (No Invert Visit)													0.67 (8/27/13)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	***0.00***	***2.40***	***3.20***	***1.10***	***18.00***	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

A large chemical dataset suggests that elevated concentrations of nitrates within the reach is a rarity. While fish metrics that respond to nitrate stress indicate potential for stress, these metrics are very general in nature and are likely implicating other stressors in the reach. The macroinvertebrates in the reach showed a marginal negative response to elevated nitrate concentrations in the reach. Preponderance of evidence suggests that nitrate stress is inconclusive in the reach. Any efforts made to decrease nitrate concentrations would likely be beneficial to the reach's macroinvertebrate communities and could act as a safe guard against potential impairment in the future.

Suspended sediment

Two TSS samples were taken during the fish visits at station 13MN145 in 2013. Values were 34 mg/L on July 19 and 15 mg/L on August 27, neither sample exceeded the southern regional standard for TSS of 65 mg/L. Seventy-two additional samples were collected at the biological station from 2000 to 2013. Samples collected in 2013 were for intensive watershed monitoring. Values range from 7 mg/L on August 23 and September 3 of 2013 to 510 mg/L on May 18, 2000. The average of samples collected was 91.01 mg/L. Thirty-four samples collected exceeded the southern regional standard. One additional sample was collected in 2016 during SID investigations, which also exceeded the southern regional TSS standard.

The fish community at station 13MN145 responds negatively to nearly all of the TSS stress metrics (see table below). The TSS Index score at both fish visits was above the average for the southern streams GU class during both visits, which indicates a strong potential for elevated levels of TSS to impact the fish communities. There was an absence of TSS intolerant taxa and an abundance of TSS tolerant taxa and individuals. Additional metrics indicate low percentages of benthic insectivores, centrarchids, herbivores, intolerant taxa, long-lived taxa, perciformes, riffle dwellers, sensitive taxa and simple lithophilic spawners, all indicators of TSS related stress. Many of these metrics are indications of the results of elevated suspended sediments, including instream sedimentation, which is often a result of high sediment levels. High levels of sediments can cover coarse substrates, bury riffle habitat, fill in pools and inhibit aquatic macrophyte growth, diminishing obligates of those habitats.

Table 307. Fish metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN145 (2013)	**10.29**	**0.00**	**3.68**	**0.00**	13.97	**9.56**	**6.62**	**1.10**	**8.46**
13MN145 (2013)	**9.14**	**1.27**	**2.54**	**0.00**	**7.31**	**10.33**	**3.66**	**0.24**	**4.69**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*36.00*	*5.40*	*25.70*	*4.20*	*13.60*	*20.10*	*30.20*	*16.90*	*19.10*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN145 (2013)	**30.55**	**0.00**	**0.00**	**4.00**	**78.00**
13MN145 (2013)	**28.34**	**0.00**	**0.00**	**7.00**	**62.00**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*19.20*	*1.70*	*5.30*	*2.40*	*12.50*
Expected response to TSS stress	↑	↓	↓	↑	↑

While the macroinvertebrates in the reach are not impaired, sometimes looking at stress metrics from all indicators can provide additional insight into potential stressors within the reach. The macroinvertebrate community within the reach responded negatively to all but one of the TSS stress metrics (see table below). The TSS Index score for the macroinvertebrates was above the class average for Prairie Streams GP, which indicates a high potential for elevated TSS levels to negatively impact the community. There was an absence of TSS intolerant taxa and an abundance of TSS tolerant taxa and individuals, indicating stress. There was a slightly above average quantity of collector-filterer taxa, suggesting that collector filterer taxa in the reach are not exhibiting signs of stress. There were also an absence of plecoptera taxa suggesting limited available coarse substrate habitat, which could be an indication of elevated TSS levels in the reach.

Table 308. Macroinvertebrate metrics that respond to high TSS stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

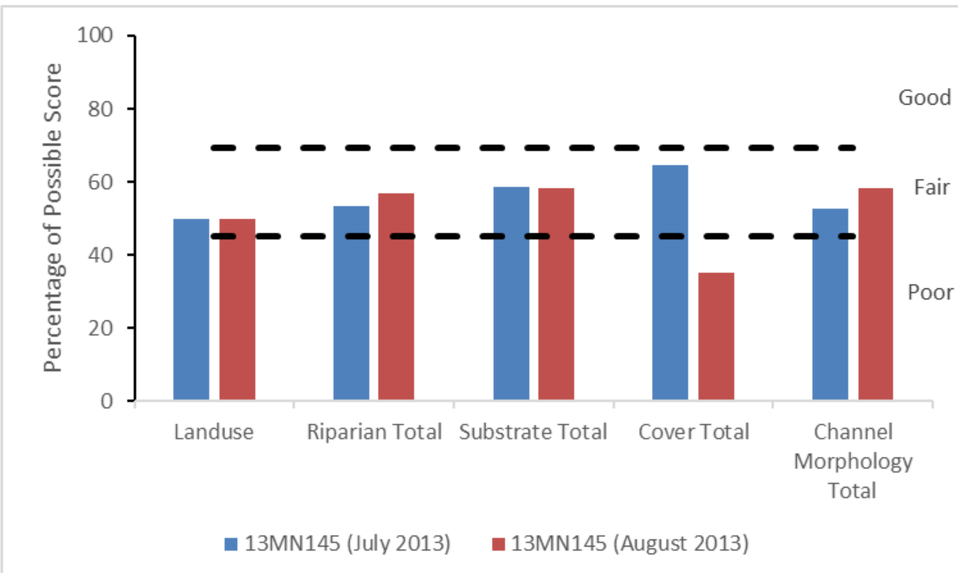
Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN145 (2013)	12.22	**0.00**	**19.66**	**0.00**	**0.00**	**15.00**	**50.16**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

There was a nearly 50% exceedance rate of TSS readings on the reach, indicating persistent elevated TSS concentrations on the reach. Both fish and macroinvertebrate community metrics responded negatively to elevated levels. Preponderance of evidence indicates TSS is a stressor on the reach.

Habitat

Biological station 13MN145 had two qualitative habitat assessments conducted in 2013, the average MSHA habitat score was 55.03 (Fair) (see graph below). Portions of the adjacent riparian zone within this stretch of the Watonwan River are wooded; however, a majority of landuse in the watershed is row crop agriculture; as such, landuse scores in the MSHA appear over inflated. There are about a dozen moderately sized feedlots near the reach, a majority of which are swine operations. Wooded riparian buffers appear intact along much of this sinuous reach; however, some channelized portions of the reach have nearly non-existent buffers. Stream bank erosion and coarse substrate sedimentation were observed during both surveys (see photos below). Instream habitat cover was sparse to moderate in the reach. Limited natural channel development was observed within the site; channel type was predominately run. A riffle was only observed at one visit and comprised only 5% of the reach. Individual metric scores of the MSHA can be seen in the figure below.

Figure 261. Percentage of MSHA subcategory scores for station 13MN145, Watonwan River.



Habitat stress metrics indicate that the fish community is responding negatively to habitat related stress within the reach (see table below). There were below average quantities of piscivore taxa, lithophilic and simple lithophilic spawners, 'darter, sculpin and round bodied suckers' and riffle dwellers. Low quantities of coarse substrate and riffle dwelling obligates can be a sign of sedimentation in the reach which was confirmed by MSHA observations. Low quantities of piscivore taxa can indicate a lack of available habitat for predatory species, like deep pools; this can be linked to limited habitat availability observed in the site. One of two samples indicated an overabundance of pioneering species. High quantities of pioneering species can be an indication of degraded habitat conditions as pioneering species have more general habitat requirements and do not require niche habitats that other more sensitive species require.

Table 309. Fish metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	TolPct	SLithopPct
F13MN145 (2013)	**56.99**	**2.21**	**11.03**	**9.56**	7.35	**6.62**	**9.56**	**9.56**
13MN145 (2013)	**69.48**	**2.15**	**7.95**	**8.59**	**25.12**	**3.66**	**8.59**	**6.36**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*44.85*	*5.24*	*58.26*	*18.18*	*19.02*	*32.49*	*20.04*	*37.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

While the macroinvertebrates in the reach are not impaired, sometimes looking at stress metrics from all indicators can provide additional insight into potential stressors within the reach. The macroinvertebrate community in the reach is showing a mixed response to degraded habitat stress metrics (see table below). There were above average quantities of burrowing and legless taxa in the sample, indicating a prevalence of fine sediments in the reach. Woody debris was the most prevalent habitat available to sample during the macroinvertebrate visit, this can help explain the high quantity of clinger and sprawler taxa present within the reach. Low quantities of climber taxa could be indicative of low prevalence of overhanging vegetation available in the reach and a near absence of instream aquatic macrophytes. Low quantities of EPT taxa also indicates that the community in the reach is potentially responding negatively to habitat stress.

Table 310. Macroinvertebrate metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN145 (2013)	**19.29**	**12.54**	41.48	**20.58**	**68.81**	22.83
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Overwhelming evidence suggests that degraded habitat is a stressor within the reach.

Figure 262. Biological station 13MN145 (July 19, 2013) stream bank erosion (left); (August 27, 2013) sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach or downstream of the reach. Twenty-six species were captured at station 13MN145. Ten of these species are known migratory fish taxa. Nine species were identified downstream of the reach that were not observed on this WID (see table below).

DNR mussel surveys from 1999-2003 identified 10 unique mussel taxa within the reach including: *Anodontoides ferussacianus* (cylindrical papershell), *Amblema plicata* (Threeridge), *Fusconaia flava* (Wabash pigtoe), *Lampsillis cardiu*, (Plain pocketbook), *Lasmigona companata* (White Heelsplitter), *Leptoda fragillis* (Fragile Papershell), *Lampsilis siliquoidea* (fatmucket), *Pyganodon grandis* (Giant floater), *Potamilus ohiensis* (Pink Papershell) and *Strophitus undulutus* (Creeper). Abundance of mussel taxa implies that longitudinal connectivity stress is not likely negatively impacting the reach as many mussel taxa rely on migratory fish to complete their life cycles.

Preponderance of evidence indicates that longitudinal connectivity is not a stressor in the reach.

Table 311. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish species in bold are known migratory fish. Fish species in blue are known lake species.

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
WID	-563	-511	-511	-510	-510	-510	-501	-501
Common Name								
bigmouth buffalo				x				
bigmouth shiner	x	x			x	x	x	
black bullhead	x	x		x			x	
blackside darter	x	x	x		x	x	x	x
blacknose dace		x				x		
bluntnose minnow	x	x	x	x	x	x	x	x
brassy minnow	x	x		x	x		x	
central stoneroller	x	x	x			x		x
channel catfish	x	x		x		x	x	x
common carp	x	x	x	x	x	x	x	x
common shiner	x	x						
creek chub	x	x	x		x	x		x
fantail darter								x
fathead minnow	x	x				x	x	
golden redhorse	x		x	x	x	x	x	x
green sunfish		x					x	x
highfin carpsucker				x				
johnny darter	x	x	x	x	x	x	x	x
largemouth bass	x	x	x	x	x			
mimic shiner				x				
northern hogsucker	x		x	x	x	x	x	x
northern pike	x	x	x	x	x		x	
orange spotted sunfish	x						x	x
quillback	x	x	x	x	x	x	x	x

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
river carpsucker		x						x
sand shiner	x	x	x	x	x	x	x	x
shorthead redhorse	x	x	x	x	x	x	x	x
silver redhorse	x		x	x		x	x	x
slenderhead darter	x	x	x	x		x	x	x
spotfin shiner	x	x	x	x	x	x	x	x
stonecat			x					x
walleye	x	x	x	x	x	x		x
white sucker	x	x	x	x		x	x	x
yellow bullhead		x	x				x	
yellow perch	x		x	x	x	x	x	x

The Altered watercourses GIS layer for Minnesota streams indicated that this 5.81 mile long reach of the Watonwan River (-563) is 88% natural. Two small portions of the reach have been straightened upstream of La Salle. Many of the watershed's headwater tributaries have been extensively altered in an effort to increase arable land and overall crop production. Modifications, including tile drainage, wetland draining and stream straightening and dredging efforts upstream of the reach have reduced the residence time of precipitation events and have hastened the ability for water to move off the landscape and into the Watonwan's ditch, stream and river network much more quickly. Increased flows during storm events move high volumes of water, destabilizing streams banks and carrying with them large volumes of sediment, which have negative impacts on instream habitat and aquatic communities. According to CADDIS, bank erosion and instability, and undercut banks are site evidence that altered hydrology is a potential stressor, all of which were observed on the reach.

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Photographs from biological station 13MN145 did not indicate that extreme low flow conditions were present at the reach in September of 2012.

There were three known lake taxa identified in the reach including: black bullhead, largemouth bass and yellow perch. Prevalence of lake species in a reach can indicate low flow conditions and may imply potential altered hydrologic stress. There was low quantities of riffle dwelling taxa within the reach as well. There were inconsistent results in the abundance of long-lived taxa in the reach between the two fish visits in 2013. Low quantities of riffle dwelling and long-lived taxa can be an indication of altered hydrological stress in the reach (see table below).

Table 312. Fish metrics that respond to altered hydrology stress compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN145 (2013)	**56.99**	13.97	**6.62**
13MN145 (2013)	**69.48**	**7.31**	**3.66**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50)	*44.85*	*13.6*	*32.49*
Expected response to Altered Hydrology stress	↑	↓	↓

While there is some metric and anecdotal information that may indicate potential stress by altered hydrology in the reach, there is presently insufficient evidence to conclude whether or not altered hydrology is a primary stressor within the reach.

4.1.3. AUID Summary

TSS and degraded habitat conditions are stressors in the reach. A negative response to elevated TSS concentrations in the biological metrics confirms the 2006 turbidity impairment within the reach. The TSS dataset shows a nearly 50% exceedance rate of the southern regional TSS standard, indicating persistent conditions of elevated TSS levels within the reach. Elevated TSS concentrations correspond to observed stream bank erosion, embeddedness of coarse substrates and sedimentation observed during fish visits, which are negatively impacting habitat availability within the reach. Elevated spring flows due to lack of water storage on the landscape due to historic wetland drainage and prevalence of tile drainage to remove water off agricultural fields quickly give streams great erosive power, scouring stream banks and shifting stream bed load and sediments, serving as a potential sediment source for elevated TSS concentrations observed. Improvements to stream stability, habitat diversity and availability would benefit biological communities within the reach.

Eutrophication, nitrates and altered hydrology are inconclusive stressors to the fish community in the reach. Nearly 50% of phosphorous samples collected exceeded the southern regional eutrophication standard; however, there was no available response variable data collected in the reach to confirm that elevated levels of phosphorous are negatively impacting the biology within the reach. Biological metric data responded negatively to potential eutrophication stress within the reach; however, metrics utilized are general in nature and do not necessarily indicate eutrophication stress. Additional response variable data is needed to better understand potential eutrophication stress within the reach. Fish do not typically show a strong response to nitrate related stress. Present fish metrics that do respond to nitrate stress are general in nature and likely implicate other stressors in the reach. Only a small percentage of nitrate concentrations were above 15 mg/L; however, the macroinvertebrate community still showed a marginal negative response to nitrate stress. Any efforts to reduce nitrate concentrations in the reach would benefit the macroinvertebrate community by reducing the potential of future macroinvertebrate impairment. While there is anecdotal evidence suggesting that high flow conditions after spring runoff events caused by upstream altered hydrology is occurring in the reach, additional stream flow data is needed to corroborate visual observations. While metric response suggested potential for low flow conditions to occur during the late summer months, photographic evidence from 2012 suggests that flows were sufficient during that summer to sustain aquatic life. Until additional stream flow information is gathered on the reach, altered hydrology will remain an inconclusive stressor.

Low DO and longitudinal connectivity are not stressors to biological communities in the reach. There is no chemical evidence of low DO conditions within the reach. Biological communities did not respond negatively to low DO stress metrics. There are no dams or known barriers within the reach. There was a prevalence of migratory fish taxa and mussel taxa within the reach providing additional evidence that longitudinal connectivity is not a stressor in the reach at this time.

Table 313. Summary of stressor determinations for Watonwan River (563).

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Altered Hydrology	Connectivity
Watonwan River	07020010-563	--	o	o	●	●	o	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

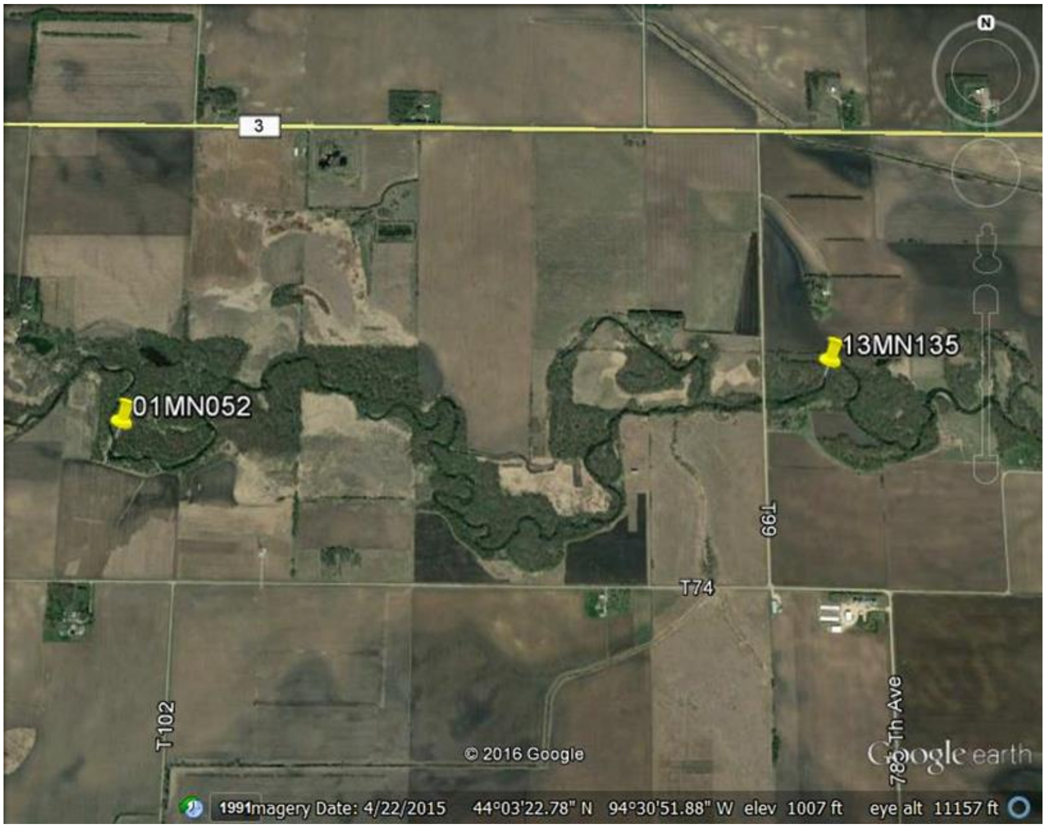
Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Watonwan River -511

The Watonwan River (07020010-511) is a flow through section of the Watonwan River from the confluence of St. James Creek, downstream of Co. Hwy 16, to just above the outlet of the South Fork Watonwan River, stretching 7.5 river miles between La Salle and Madelia. This reach is classified as general warmwater Class 2B. This reach is impaired for aquatic life, for lack of fish (2004) and macroinvertebrate communities (2015) as well as elevated levels of turbidity (2006) and for aquatic recreation for high levels of fecal coliform bacteria (2006).

Figure 263. Google Earth image of Watonwan River (-511).



4.1.1. Biological communities

There are two biological sites located within this reach, each was sampled twice. The first event at 13MN135 had a FIBI score of 52.9 from July 18, 2013, with the second event scoring a 50.5 from August 26, 2013. The threshold for this reach is 49 (GU) with a CI of 11. Both samples were above the threshold but within upper confidence limits. The present impairment on the reach arose from a 2001 sampling event at 01MN052, the FIBI score was 36.9 on August 6, 2001, below the threshold (49) and lower confidence limits. The station was resampled in 2015, the FIBI score of 28.1 on August 11, confirmed the existing impairment on the reach. Tolerant taxa were dominant across both stations and all visits. Predominant taxa in the reach included spotfin shiner, sand shiner, bluntnose minnow, and common carp.

In the metrics graph below, all visits fell below the average score needed to meet standards for the following metrics: taxa richness of piscivores (Piscivore), relative abundance (%) of sensitive species (SensitiveTxPctGR1), taxa richness of simple lithophils (SLithopGR1) and relative abundance (%) of detritivorous species (DetNWQTxPct).

Each biological station was sampled once for macroinvertebrates, 01MN052 was sampled in 2001 and 13MN135 was sampled in 2013. The MIBI score for station 01MN052 was scored in the Prairie Streams GP class and was above the threshold (41) and upper confidence limit at 56.2. Results at station 13MN135 were scored in the Southern Streams RR class and fell just below the threshold (37) at 35.1. MIBI metrics from station 13MN135 fell below the average score needed to meet the threshold for: taxa richness of climbers (ClimberCh), HBIMN_CH (a measure of pollution based on tolerance values assigned to each individual taxon developed by Chirhart), taxa richness of Odonata (Odanata), taxa richness of predators (excluding chironomid predator taxa) (Predator) and relative percentage of taxa with tolerance values equal to or greater than 6, using MN TVs (Tolerant2ChTxPct). However, the MIBI had high scores for the following metrics: taxa richness of Plecoptera (Plecoptera), relative abundance (%) of insectivorous species (InsectTxPct), relative abundance (%) of dominant five taxa in subsample (chironomid genera treated individually) (DomfiveChPct) and relative percentage of taxa adapted to cling to substrate in swift flowing water (ClingerChTxPct). MIBI metrics from station 01MN052 that fell below the threshold for the Prairie Streams GP class included taxa richness of macroinvertebrates with tolerance values less than or equal to 2 (Intolerant2Ch) and relative abundance (%) of non-hydropsychid Trichoptera individuals in subsample (TrichwoHydroPct) (see graph below).

Dominant macroinvertebrate taxa in the sample at station 01MN052 included Hydropsychidae, Chironomini, Baetis and Polypedilum. While the dominant species at station 13MN135 included Stenelmis, Cheumatopsyche, Heptagenia and Elmdae.

Biological results suggests stress on the reach is isolated for macroinvertebrates at station 13MN135 and isolated for fish at station 01MN052.

Figure 264. Fish metrics of the Southern Rivers Class IBI for stations 01MN052 and 13MN135, Watonwan River.

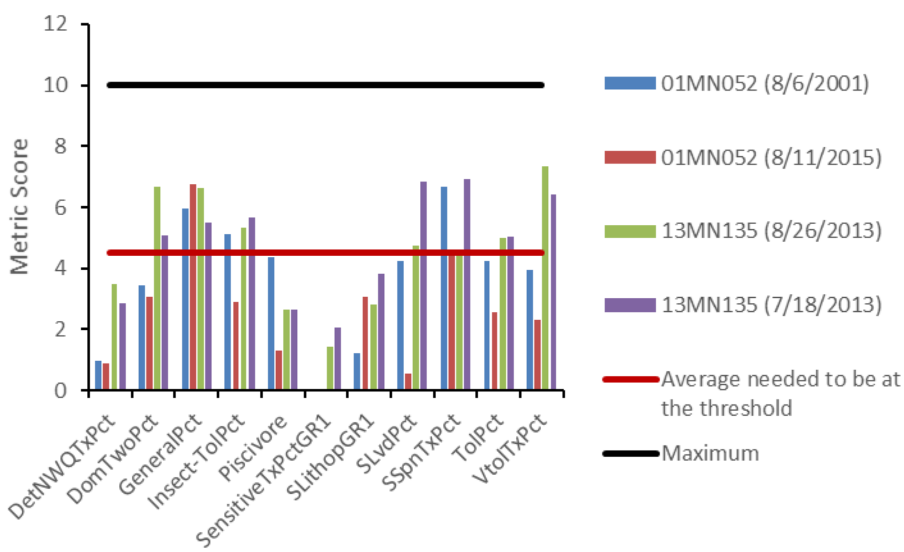


Figure 265. Macroinvertebrate metrics of the Southern Streams RR Class IBI for station 13MN135, Watonwan River.

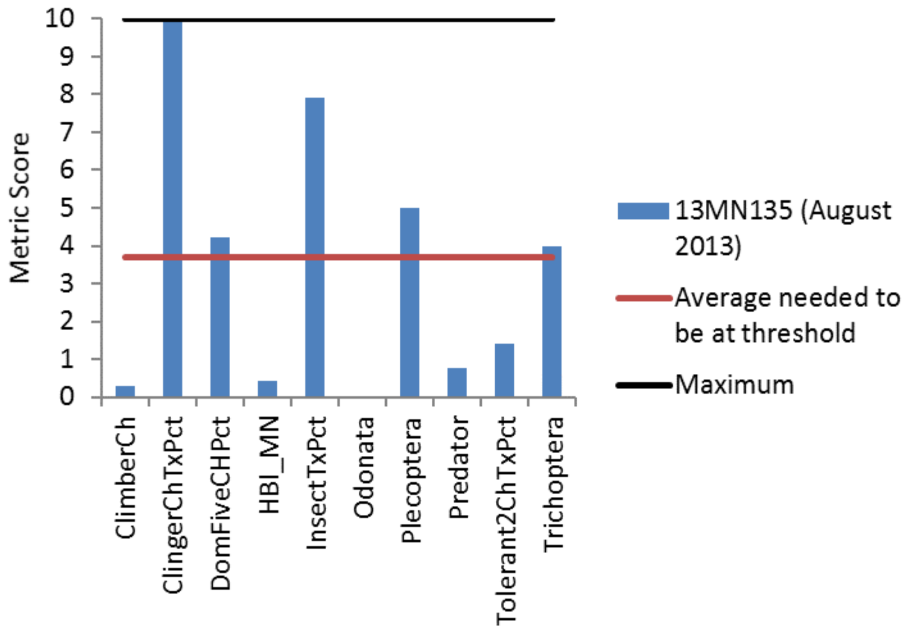
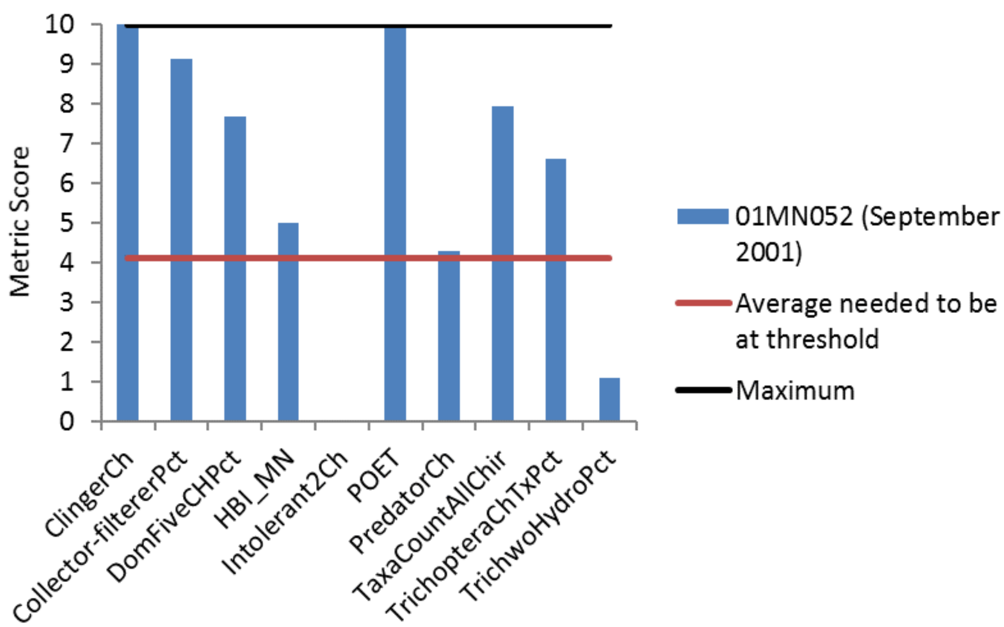


Figure 266. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 01MN052, Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Five DO measurements were collected during biological visits at stations 13MN135 (3 in 2013) and 01MN052 (1 in 2001 and 1 in 2013). Values ranged from 6.5 mg/L at 12:16 pm on August 6, 2001 at station 01MN052 to 8.9 mg/L at 10:49 am on August 11, 2015. Only one measurement was collected before 9 am. All samples were above the low DO standard of 5 mg/L. There were 120 additional DO measurements taken along the reach at station 13MN135 from 2013 -2016. Values ranged from 5.49 mg/L on July 20, 2016 at 12:15 pm to 13.95 mg/L on March 25, 2015 at 11:40 am. No samples fell below the low DO standard and none were above 14 mg/L. No continuous DO data collection was conducted in the reach.

Macroinvertebrate communities along the reach showed a limited response to low DO stress along the reach (see table below). Both stations had low DO index scores above their respective class averages, indicating that there is a low potential for low DO conditions to stress macroinvertebrates within the reach. There were low quantities of low DO tolerant taxa and individuals, confirming results from low DO index scores. Quantities of low DO intolerant taxa were above average at station 01MN052 and marginally below average at 13MN135. While both stations had lower than average taxa counts, this may be attributed to other stressors along the reach. High EPT taxa counts at both stations suggest that macroinvertebrate communities are not exhibiting great signs of stress.

Table 314. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
01MN052 (2001)	**41.00**	16.00	5.00	7.21	8.00	12.42	6.00	2.12
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
13MN135 (2013)	**31.00**	18.00	0.43	7.27	**8.00**	**10.79**	1.00	0.64
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*14.20*	*7.08*	*7.04*	*9.00*	*24.00*	*4.80*	*9.90*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The low DO Index score for all visits was below the class average, suggesting a potential for low DO conditions to stress fish communities in the reach (see table below). There were above average quantities of tolerant taxa and below average quantities of sensitive taxa at biological stations along the reach; however, these results could be explained by other stressors. There were below average quantities of taxa with females that take three or more years to mature, signifying potential for low DO stress. Above average quantities of low DO tolerant taxa were observed at all visits, while the percentage of DO tolerant individuals was only above average at the initial visit in 2001 at station 01MN052 and both visits at 13MN135, suggesting potential for inconsistent low DO stress and low DO conditions to exist on the reach.

Table 315. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
01MN052 (2001)	**0.00**	**3.53**	**49.65**	**7.01**	**0.00**	**0.00**	**6.00**	**25.88**
01MN052 (2015)	**0.82**	**6.54**	**60.49**	**7.39**	**1.00**	**1.09**	**8.00**	6.27
13MN135 (2013)	**3.09**	**28.35**	**39.69**	**7.12**	**0.00**	**0.00**	**5.00**	**17.99**
13MN135 (2013)	**3.35**	**22.59**	**40.17**	**7.06**	**0.00**	**0.00**	**4.00**	**28.35**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	**13.75**	**40.40**	**22.36**	*8.42*	*4.20*	*14.26*	*3.72*	*11.15*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

In a large dataset of DO observations across several years, there was no evidence that low DO concentrations fell below the standard in the reach. However, only four measurements were collected before 9:00 am, suggesting that it is possible that any potentially low diurnal flux below the standard may have been missed. Three samples in June and July of 2016 were below 6 mg/L during midday, suggesting potential for drops below the standard overnight. The fish data suggests that there is potential for low DO stress in the reach while the macroinvertebrate community does not. As such, low DO stress is not a likely stressor to the macroinvertebrate community and is an inconclusive stressor for the fish community in the reach at this time until additional evidence can be gathered to confirm or refute the stressor.

Eutrophication

There were four phosphorous samples collected during fish visits at two biological stations within the reach. Values ranged from 0.092 mg/L on August 11, 2015 to 0.28 mg/L on August 6, 2001, with both high and low samples observed at station 01MN052. One value exceeded the southern regional eutrophication standard of 0.15 mg/L. One hundred and ninety-five additional samples were collected from 2000-2002, in 2013 for intensive watershed monitoring purposes and from 2014-2016 during stressor identification investigations, with a majority of samples being collected in the spring and summer months. Phosphorous concentrations ranged from 0.033 mg/L on May 4, 2015 to 1.78 mg/L on October 27, 2016. The average concentration was 0.25 mg/L. One hundred and seventy-five samples exceeded the standard. Only one chlorophyll a measurement was collected from the reach in August of 2013 with a reading of 9.4 ug/L, below the 35 ug/L southern regional eutrophication standard. There were no BOD samples collected on the reach and no continuous DO monitoring conducted to measure DO flux. DO grab samples ranged from 5.49 mg/L to 13.95 mg/L suggesting potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.41 – 9.21 in the reach.

Macroinvertebrate metrics that indicate eutrophication stress showed a mixed response to stress (see table below). There was an abundance of tolerant taxa and an absence of intolerant taxa. Colletorgatherer taxa numbers were only marginally below the threshold. EPT taxa were prevalent in the reach suggesting lower potential for general stress.

Table 316. Macroinvertebrate metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
01MN052 (2001)	**41.00**	**6.00**	**13.00**	16.00	**0.00**	**82.93**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
13MN135 (2013)	**31.00**	**5.00**	**10.00**	18.00	**0.00**	**87.10**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community shows a mixed response to eutrophication stress across the reach (see table below). One visit at each station had slightly lower than average quantities of darters. All visits had greater than average quantities of simple lithophilic spawners and omnivorous taxa. While all stations had lower than average quantities of sensitive and intolerant species and higher than average quantities of tolerant taxa. However, these stress metrics are general in nature and may be pointing to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish taxa were identified during a single visit at each of the biological stations, suggesting potential for sporadic eutrophication stress within the reach.

Table 317. Fish metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	Omnivorous Fish Pct	TolPct	TaxaCount	IntolerantPct
01MN052 (2001)	**0.00**	**4.00**	27.78	**21.18**	**49.65**	**18.00**	**0.00**
01MN052 (2015)	**0.82**	4.90	30.43	7.36	**60.49**	**23.00**	**0.00**
13MN135 (2013)	**3.09**	**3.61**	46.67	7.95	**39.69**	**19.00**	**0.00**
13MN135 (2013)	**3.35**	11.72	31.58	**24.23**	**40.17**	**15.00**	**0.00**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	13.75	4.46	*24.97*	*15.72*	22.36	*22.44*	*4.60*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

An extensive phosphorous dataset shows persistent elevated phosphorous concentrations in the reach. However, limited response variable data is available to determine whether or not elevated phosphorous concentrations are causing eutrophication within the reach. While the biological communities generally responded negatively to eutrophication related metrics, these metrics are general in nature and do not necessarily implicate eutrophication stress as they may be responding to other stressors in the reach. Additional response variable data including DO flux, BOD and chlorophyll a data would be useful in better depicting potential eutrophication stress within the reach. Eutrophication is an inconclusive stressor at this time.

Nitrate

There were three fish sampling visits on this reach, which each produced nitrate samples, concentrations ranged from 0.64 mg/L on August of 2015 at station 01MN052 to 5.9 mg/L on July 18, 2013 at station 13MN135. An additional 196 samples were collected at biological station 13MN135 from 2000, 2001, 2002, 2013 and 2014 from the months of April through October. Nitrate concentrations ranged from to 0.38 mg/L on August 11, 2015 to 19.9 mg/L on May 14, 2016. The average concentration was 9.26 mg/L. Thirty-nine samples were at or above 15 mg/L in the months of February through July with a majority of samples falling in April and May across most years of the dataset.

The macroinvertebrates in this reach show an inconsistent response to elevated nitrate concentrations (see table below). The nitrate index score ranged from 2.9 at 01MN052 to 3.51 at 13MN135, both stations marginally exceeding the average needed to meet their respective thresholds. This suggests that elevated nitrates are not a major source of stress within the reach. There was an overall low quantity of nitrate tolerant taxa and low percentage of nitrate tolerant individuals, confirming that macroinvertebrates in the reach are not greatly impacted by elevated nitrate concentrations. There was a low abundance of nitrate intolerant taxa, but this could be explained by the presence of other stressors. An abundance of Trichoptera taxa was observed at both stations. Low quantities of non-hydropsychid Trichoptera were identified at reach 01MN052. This could relate to isolated stress at station 01MN052 or may infer some recovery on the reach between 2001 to 2013.

Fish are not often good indicators of nitrate related stress. Metrics used to determine nitrate stress are general in nature and could be responding to other forms of stress in the reach. There was an abundance of tolerant taxa in the reach, an absence of intolerant taxa and few sensitive species. Each biological station had a visit with below and above average quantities of darter taxa, signaling potential but inconsistent change of nitrate related stress to the fish community.

Table 318. Macroinvertebrate metrics that respond to nitrate stress in the Watonwan River compared to statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
01MN052 (2013)	**41.00**	**6.00**	**13.00**	14.00	**0.00**	**82.92**	4.00	**0.31**	**2.90**	**2.00**	17.00	28.80	5.20 (8/6/2001)
01MN052 (No Invert Visit)													0.64 (8/11/2015)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	***0.00***	***2.40***	***3.20***	***1.10***	***18.00***	*59.70*	
13MN135 (2013)													5.9 (7/1/2013)
13MN135 (2013)	**31.00**	**5.00**	**10.00**	15.00	**0.00**	**87.09**	6.00	6.03	**3.51**	**0.00**	17.00	48.57	1.40 (8/26/2013)
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*45.80*	*5.18*	*12.96*	*7.61*	*0.80*	*71.85*	***4.30***	***5.50***	***2.90***	***2.40***	***18.80***	***69.80***	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

While the chemical dataset shows that elevated concentrations of nitrates exist within the reach during spring months, levels are not as high as seen on other areas in the Watonwan River Watershed and do not occur frequently rising only slightly above 15 mg/L. The macroinvertebrates in the reach did not exhibit a strong response to nitrate related stress metrics. Preponderance of evidence suggests that nitrates are an inconclusive stressor in the reach at this time.

Suspended sediment

Four TSS samples were collected during fish visits at two biological stations 01MN052, collected in 2001 and 2015, and 13MN135, both collected in 2013. Values ranged from 6.4 mg/L at station 13MN135 on August 26, 2013 to 61 mg/L at station 01MN052 on August 6, 2001; all samples fell below the southern regional standard of 65 mg/L. One hundred ninety-six additional samples were collected on the reach at station 13MN135 from 2000 – 2002 and 2013 – 2016. Values ranged from 2 mg/L on April 10, 2015 to 430 mg/L on May 18, 2000, with average concentrations of 75.14 mg/L. Eighty-two of these samples exceeded the regional TSS standard. Recent TSS data collected within the last 10-year assessment window showed a greater than 30% exceedance rate and confirmed an existing TSS impairment on the reach, while secchi data was insufficient for assessment.

There was a mixed response in the macroinvertebrate community to TSS stress metrics along the reach (see table below). While the community at station 13MN135 responded negatively to all TSS stress metrics, station 01MN052 had above average quantities of collector-filterer taxa and TSS Intolerant taxa and responded negatively to the remaining metrics. The TSS Index score was above average for both visits, indicating a high potential for TSS stress in the reach. There were also above average quantities of TSS tolerant taxa and an abundance of TSS tolerant individuals, also indicating stress. There were below average quantities of plecoptera taxa at both stations, suggesting that availability of coarse substrates may be limited in the reach, potentially due to instream sedimentation caused by elevated levels of suspended sediment. A varied response to the metrics could be a result of the time between sampling events or could imply that stress is greater at station 13MN135.

Table 319. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
01MN052 (2001)	34.67	**0.31**	**18.90**	1.00	**0.30**	**21.00**	**61.82**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
13MN135 (2013)	**13.97**	**0.32**	**22.23**	**0.00**	**0.00**	**17.00**	**76.19**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*25.40*	*0.70*	*15.63*	*2.90*	*4.70*	*12.20*	*34.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

A mixed response to TSS stress was also observed in the fish communities along the reach (see table below). The TSS Index score across three of four visits was well above the class average, suggesting great potential for TSS stress within the fish community. There was not an abundance of TSS tolerant individuals and marginally above average quantities of TSS tolerant taxa were only observed at the initial visits at station 01MN052. All visits had below average quantities of benthic feeders, long-lived taxa, sensitive taxa and simple lithophilic spawners. All stations had higher than average quantities of herbivores. This is an oddity as no aquatic macrophytes were identified during MSHA surveys at any visits and overhanging vegetation was only identified at station 13MN135. Low quantities of riffle dwellers were more apparent at station 01MN052, which also had below average quantities of centrarchids and perciformes. This could be attributed to a difference in the presence of available habitat between the two stations, riffle habitat was only observed at one of two visits at 01MN052. Riffles only comprised 5% of the reach at that visit. Substrates in the reach were dominated by sand and silt and what coarse substrates were available (gravel), were severely embedded. In contrast, riffles were present at both visits at station 13MN135 and coarse substrates comprised a greater portion of the substrate within the reach and were not as embedded as station 01MN052. This could indicate that potential for TSS stress is greater at station 01MN052.

Table 320. Fish metrics that respond to high TSS stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
01MN052 (2001)	**6.12**	**0.94**	1.65	**0.00**	**13.88**	**5.65**	**3.53**	**0.00**	**3.29**
01MN052 (2015)	**7.63**	**0.00**	1.09	**0.00**	**8.45**	**7.08**	**3.00**	**0.82**	**3.54**
13MN135 (2013)	**19.67**	4.60	5.44	**0.00**	**24.69**	26.78	14.64	**3.35**	**12.13**
13MN135 (2013)	**18.04**	**1.55**	4.64	**0.00**	**41.24**	**12.37**	**11.86**	**3.09**	**23.20**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	21.36	4.12	1.04	4.63	43.61	17.97	13.92	13.53	24.97
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

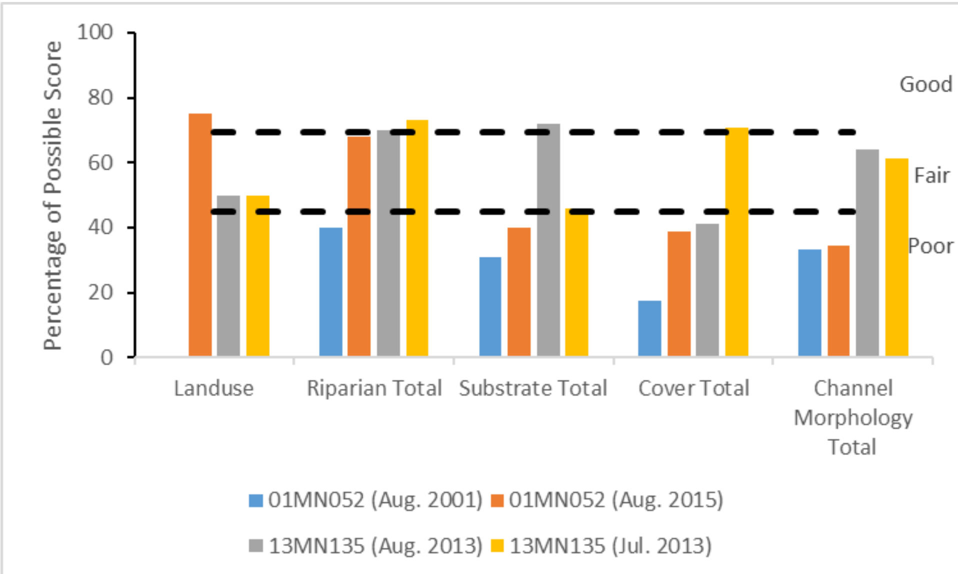
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
01MN052 (2001)	**30.54**	**0.00**	**0.00**	5.00	**69.00**
01MN052 (2015)	**29.47**	**0.00**	**0.00**	6.00	66.00
13MN135 (2013)	25.11	**0.00**	**0.00**	5.00	46.00
13MN135 (2013)	**29.42**	**0.00**	**0.00**	4.00	63.00
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*28.61*	*0.47*	*0.95*	*10.34*	*66.97*
Expected response to TSS stress	↑	↓	↓	↑	↑

Elevated TSS levels identified in the reach indicate a greater than 30% exceedance rate of the southern regional TSS standard, confirming the existing TSS impairment along the reach. The macroinvertebrate metrics overwhelmingly responded negatively to TSS stress metrics within the reach, while response was less strong in the fish community. Preponderance of evidence indicates that TSS is stressing macroinvertebrate communities on this portion of the Watonwan River but stress to the fish is inconclusive.

Habitat

There were four qualitative habitat assessments at two biological stations on the reach (see graph below). 01MN052 was surveyed twice (2001 and 2015) and 13MN135 was surveyed twice in 2013. MSHA scores were poor to fair across the reach with lower scores observed at the upstream station. MSHA scores have increased 14 points at station 01MN052 when comparing 2001 results to 2015 results but the MSHA score still falls within the poor threshold. The stream reach is natural and very sinuous; landuse in the watershed is comprised of row crop agriculture with moderate to extensive forested buffers along the stream corridor. Stream bank erosion and instream sedimentation were common issues observed at both stations but appear to be worse at the upstream station with severe ratings (see photo below). Predominate substrates in the upstream reach were sand and silt, sedimentation appears problematic in the reach (see photo below). While runs, riffles and pools were observed at both stations (5% of less), predominate channel types were run and pool. In stream fish cover was limited; at station 01MN052 only woody debris, undercut banks, overhanging vegetation and deep pools were observed. Cover types were identical at station 13MN135 with the addition of root wads. Depth variability was better at the downstream station. Individual metric scores of the MSHA can be seen in the graph below.

Figure 267. Percentage of MSHA subcategory scores for stations 01MN052 and 13MN135, Watonwan River.



The fish communities along the reach show a mixed response to habitat stress (see table below). Station 01MN052 showed a negative response to all habitat stress metrics in both the 2001 and 2015 visits. Station 13MN135 shows a mixed response to habitat stress within two visits in the same year. All visits had above average quantities of tolerant and pioneering taxa. Pioneering taxa are typically habitat generalists and can thrive in conditions that are more disturbed with limited habitat diversity. All stations also had below average quantities of lithophilic spawners, although quantities were higher at station 13MN135 compared to station 01MN052. Low quantities of riffle dwelling taxa, benthic insectivores and simple lithophilic spawners were observed at ¾ of the visits on the reach, suggesting some inconsistencies between visits at station 13MN135. Low quantities of coarse substrate obligates confirms MSHA observations of limited available coarse substrate habitat in the reach and observations that coarse substrates were somewhat more prevalent at station 13MN135 compared to 01MN052.

Table 321. Fish metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
01MN052 (2001)	**49.65**	**2.59**	**8.71**	**5.88**	**21.65**	**3.53**	**5.88**	**4.94**
01MN052 (2015)	**60.49**	**2.18**	**7.08**	**5.99**	**16.35**	**3.00**	**5.99**	**6.81**
13MN135 (2013)	**40.17**	19.25	**21.34**	18.83	**20.08**	14.64	**19.25**	**17.57**
13MN135 (2013)	**39.69**	21.13	**25.26**	21.13	**6.19**	**11.86**	21.13	25.26
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	*15.18*	*29.21*	*18.51*	*5.21*	*13.92*	*20.61*	*24.97*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

In contrast to the fish results, macroinvertebrates are showing greater inconsistency in degraded habitat metric response between the two stations (see table below). There were lower than average quantities of climbers and sprawlers at both stations. This prevalence is consistent with a near absence of aquatic macrophytes and overhanging vegetation and the sampling of woody debris habitat, which was a primary habitat type at both stations and corroborates the abundance of clinger taxa observed. Station 01MN052 had abundant quantities of burrower and clinger taxa while station 13MN135 did not. Both taxa prefer fine sediment habitat; while both stations had fine sediments as dominant substrate types, they were most abundant at the upstream station (01MN052).

Table 322. Macroinvertebrate metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN052 (2001)	**18.27**	**7.43**	45.82	58.82	**31.58**	**9.60**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.4*
13MN135 (2013)	1.27	**6.35**	80.00	43.18	7.94	**6.03**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Despite apparent improvements in MSHA scores at station 01MN052 from 2001 to 2015, habitat conditions in the reach remain poor, with moderately improved scores observed at the downstream station. Available habitat cover, stream channel stability and prevalence of fine substrates are all having negative impacts on biological communities within the reach. As such, degraded habitat is a stressor to the biology in the reach at this time.

Figure 268. Biological station 13MN135 (August 15, 2013) stream bank erosion (left); (September 12, 2012) sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach. Thirty species of fish were identified within the reach; nine species identified were known migratory fish species (see table below). Abundance of diversity in a reach is generally an implication that longitudinal connectivity is not stressing the fish communities.

Eight mussel taxa were identified within the reach during DNR surveys from 1999-2003, including: *Actinonaias ligamentina* (Mucket), *Anblema plicata* (Threeridge), *Fusconai flava* (Wabash pigtoe), *Lampsilis cardiu* (Plain packetbook), *Leptodea fragillis* (fragile papershell), *Lampsilis siliquoidea* (fatmucket), *Pyganodoen grandis* (Giant floater) and *Potamiluz ohiensis* (pink papershell). Prevalence of mussel taxa within a reach is an indication that longitudinal connectivity is not a likely stressor in the reach as many mussel taxa rely on migratory fish taxa to complete their life cycles.

Evidence suggests that longitudinal connectivity is not a stressor on the reach at this time.

Table 323. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish species in bold are known migratory fish. Fish species in blue are known lake species.

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
WID	-563	-511	-511	-510	-510	-510	-501	-501
Common Name								
bigmouth buffalo				x				
bigmouth shiner	x	x			x	x	x	
black bullhead	x	x		x			x	
blackside darter	x	x	x		x	x	x	x
blacknose dace		x				x		
bluntnose minnow	x	x	x	x	x	x	x	x
brassy minnow	x	x		x	x		x	
central stoneroller	x	x	x			x		x
channel catfish	x	x		x		x	x	x
common carp	x	x	x	x	x	x	x	x
common shiner	x	x						
creek chub	x	x	x		x	x		x
fantail darter								x
fathead minnow	x	x				x	x	
golden redhorse	x		x	x	x	x	x	x
green sunfish		x					x	x
highfin carpsucker				x				
johnny darter	x	x	x	x	x	x	x	x
largemouth bass	x	x	x	x	x			
mimic shiner				x				
northern hogsucker	x		x	x	x	x	x	x
northern pike	x	x	x	x	x		x	
orange spotted sunfish	x						x	x
quillback	x	x	x	x	x	x	x	x
river carpsucker		x						x

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
sand shiner	x	x	x	x	x	x	x	x
shorthead redhorse	x	x	x	x	x	x	x	x
silver redhorse	x		x	x		x	x	x
slenderhead darter	x	x	x	x		x	x	x
spotfin shiner	x	x	x	x	x	x	x	x
stonecat			x					x
walleye	x	x	x	x	x	x		x
white sucker	x	x	x	x		x	x	x
yellow bullhead		x	x				x	
yellow perch	x		x	x	x	x	x	x

The Altered watercourses GIS layer for Minnesota streams indicated that this 7.54 mile long reach of the Watonwan River (-511) is 100% natural. Many of the watershed's headwater tributaries have been extensively altered in an effort to increase arable land and overall crop production. Modifications, including tile drainage, wetland draining and stream straightening and dredging efforts have reduced the residence time of precipitation events and have hastened the ability for water to move off the landscape and into the Watonwan's ditch, stream and river network. Increased flows during storm events move high volumes of water, destabilizing streams banks and carrying with them large volumes of sediment, which have negative impacts on instream habitat and aquatic communities. According to CADDIS, bank erosion and instability, and undercut banks are site evidence that altered hydrology is a potential stressor.

Four species identified in the reach are known lake taxa. Prevalence of lake taxa within a reach can imply low flow or lentic conditions and can be an indicator of altered hydrology stress. Low quantities of long-lived taxa in a reach can be an indication of altered hydrology stress, as can low quantities of riffle dwelling taxa. Below average quantities of long-lived taxa were identified during all visits at all stations while low numbers of riffle dwelling taxa were only identified at station 01MN052 and one visit at 13MN135 (see table below).

Table 324. Fish metrics that respond to altered hydrology stress compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
01MN052 (2001)	**49.65**	**13.88**	**3.53**
01MN052 (2015)	**60.49**	**8.45**	**3.00**
13MN135 (2013)	**40.17**	**24.69**	14.64
13MN135 (2013)	**39.69**	**41.24**	**11.86**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	43.61	*13.92*
Expected response to Altered Hydrology stress	↑	↓	↓

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Low flow conditions dried up many streambeds in the greater Watonwan Watershed. Photographs from biological station 13MN135 indicate lower flow conditions were present at the reach in September of 2012, but did not appear to cause intermittent flow (see photo). There were no photos taken of 01MN052 in the fall of 2012.

Figure 269. Biological station 13MN135 (September 2012) low flow conditions.

There is insufficient information to determine if altered hydrology is a stressor to the biology within the reach.

4.1.3. AUID Summary

TSS and degraded habitat are stressors on the reach. Chemical data collection produced a robust dataset indicating elevated TSS levels are a persistent problem in the reach. Data that is more recent confirms the original turbidity listing. The fish and macroinvertebrates in the reach are responding negatively to TSS stress. The macroinvertebrate communities are dominated by TSS tolerant individuals and are responding negatively to limited habitat availability due to channel instability, stream bank erosion and sedimentation in the reach. While the fish community appears to generally be responding negatively to TSS stress metrics that relate to habitat stress, there is not an overabundance of TSS tolerant taxa or individuals, percentages of TSS tolerant individuals hovers around the average, suggesting that stress in inconclusive for the fish community in the reach. While habitat stress appears greater at upstream biological station 01MN052, similar habitat limitations were observed at the downstream station, even if coarse substrates were more prevalent. Limited diverse habitat cover is available within the reach, further limiting robust biological communities.

Eutrophication, nitrates and altered hydrology are inconclusive stressors on the reach. While an extensive phosphorous dataset suggests a high potential of eutrophication stress on the reach with a high exceedance rate, there is very limited response variable data to confirm that elevated phosphorous levels are in fact impacting biological communities in the reach. Metric data indicates potential for stress in both indicators; however, the metrics are very general and could be pointing to other stressors in the reach. Additional response variable data is needed to better understand potential eutrophication stress. Elevated nitrate concentrations were observed on the reach during the spring months; however, nitrate levels only rose to or above 15 mg/L 20% of the time. However, the macroinvertebrate community did not exhibit great signs of nitrate related stress in the reach. Fish metric data are insufficient in determining nitrate stress in the reach because metrics are general in nature and may be pointing to other stressors in the reach. Future efforts to reduce nitrate concentrations on the reach could prevent potential nitrate related stress to macroinvertebrates in the reach in the future. The upstream waters feeding into this reach of the Watonwan are generally heavily altered by channel straightening and removal of water storage on the landscape, while this stretch of the Watonwan River is 100% natural the reach is likely showing impacts from upstream modifications, negatively impacting stream stability, contributing to in stream erosion and sedimentation. Additional high flow data is needed to confirm these observations.

Low DO conditions are not stressing the macroinvertebrate communities in the reach at this time. In a large chemical dataset collected over several years there is no evidence of DO levels falling below the standard. Macroinvertebrate DO stress metrics did not indicate a negative response to low DO stress. However, there are several occasions where DO levels dropped near the 5 mg/L standard, and there was limited data available prior to 9:00 am, when low DO conditions generally occur. Fish metrics did show an inconsistent negative response to low DO stress within the reach, this suggests that potentially low DO conditions may be occurring in the reach. As such, low DO is an inconclusive stressor for the fish community until additional information can be gathered to better characterize the potential stressor.

Longitudinal connectivity is not likely stressing the fish community within the reach. There were no observed physical barriers within the reach. Fish diversity was sufficient at both stations, nine migratory fish taxa were observed and nine unique mussel taxa were identified.

Table 325. Summary of stressor determinations for Watonwan Rive (511).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Watonwan River	07020010-511	o/-	o	o	o/●	●	o	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

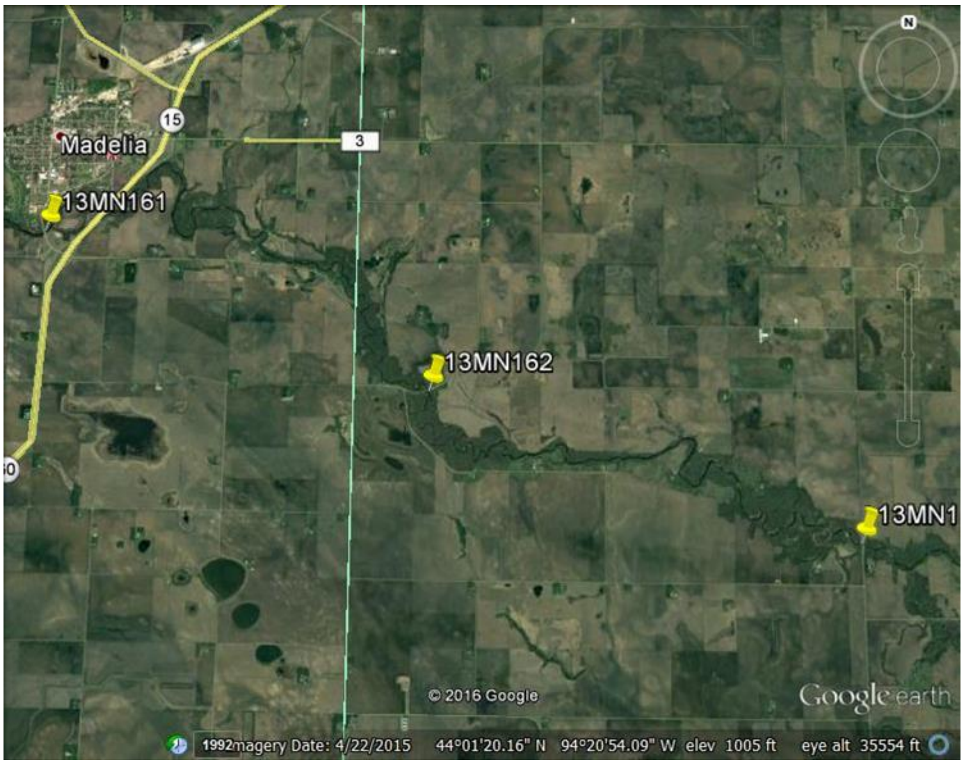
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Watonwan River -510

This flow through section of the Watonwan River (07020010-510) spans from the confluence of the South Fork Watonwan River, upstream of Madelia, to just above the confluence of Perch Creek downstream of CR 32, covering more than 16 river miles. The reach is classified as general use warmwater Class 2B. The reach is impaired for aquatic life, for degraded fish and macroinvertebrate communities (2015) as well as elevated levels of turbidity (2008) and aquatic recreation for high levels of E.coli bacteria (2015).

Upstream reaches include Watonwan River (07020010-511) and St James Creek (07020010-515).

Figure 270. Google Earth image of Watonwan River (-510).



4.1.1. Biological communities

There are three bio sites located along this reach (13MN161, 13MN162 and 13MN130) with four separate sampling events for F-IBI. FIBI scores across visits were fairly consistent, spreading from FIBI 39-43; visits at all stations scored below the threshold (49) but within lower confidence limits. Dominant species across visits predominately consisted of tolerant taxa including: sand shiner, common carp, spotfin shiner, bluntnose minnow and golden redhorse (somewhat intolerant). Visits ranged from 17 to 21 species.

All stations scored below FIBI averages needed to pass for the following metrics: relative abundance (%) of detritivorous species (DetNWQTxPct), relative abundance (%) of insectivorous individuals (excludes tolerant species) (Insect Tol-Percent), taxa richness of piscivores (Piscivore), relative abundance (%) of sensitive species (SensitiveTxPctGRI) and percent of tolerant individuals (TolPct). All stations but 13MN130 scored below average on the relative abundance (%) of simple lithophilic individuals (SLithopPct) (see graph below).

There were two visits at two stations for macroinvertebrates. Site 13MN161 was not sampled for macroinvertebrates due to insufficient flow limiting available habitat to sample in 2013. MIBI scores at both 13MN162 and 13MN130 fell below the threshold (31) and lower confidence limits ranging from 14.4 to 17.2. Both stations scored zeros for taxa richness of Odonata (Odanata) and taxa richness of predators (PredatorCh) metrics. They also scored below the average for the HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota), taxa richness of macroinvertebrates with tolerance values less than or equal to 4, using MN TVs (Intolerant2lessCh) and relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values equal to or greater than 8, Using MN TVs (VeryTolerant2Pct metrics) (see graph below). Dominant taxa at station 13MN130 were Cheumatopsyche (153), Tricorythodes (23), Hydropsychidae (19) and Baetis (18), while the dominant taxa at 13MN162 included Stenelmis (60), Polypedilum (52), Cheumatopsyche (44) and Tricorythodes (28).

Figure 271. Macroinvertebrate metrics of the Prairie Forest Rivers Class IBI for stations 13MN162 and 13MN130, Watonwan River.

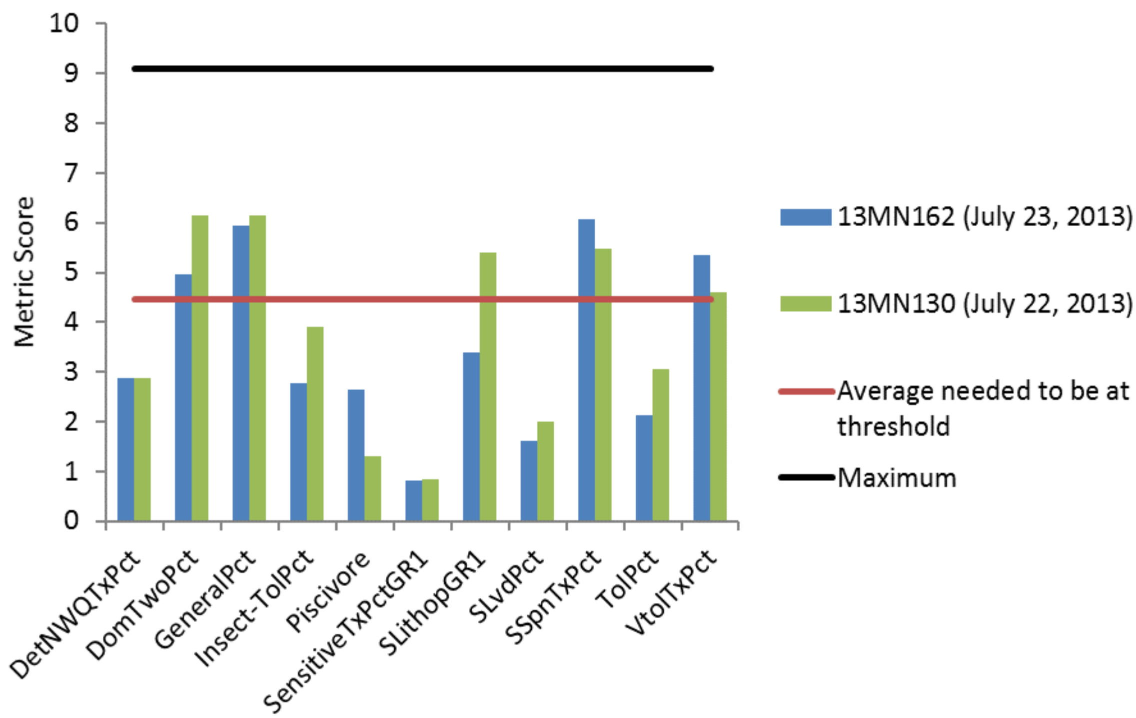
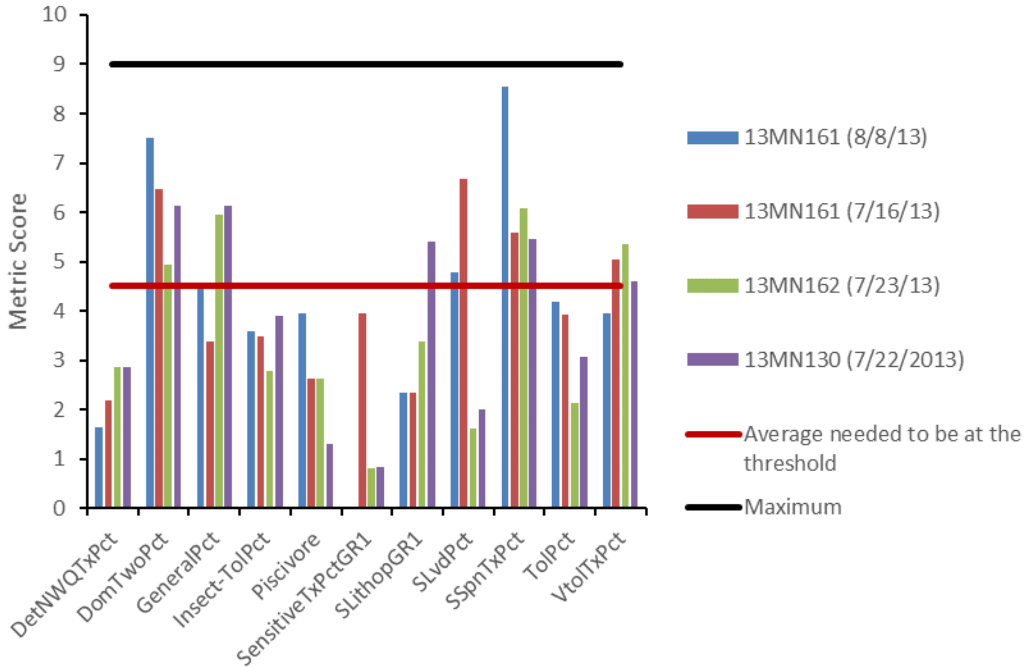


Figure 272. Fish metrics of the Southern Rivers Class IBI for stations 13MN162 and 13MN130, Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Conductivity

Specific conductance is an indication of the amount of dissolved minerals or total dissolved solids in the water. Elevated conductivity can be toxic to biological organisms through effects on osmoregulation.

There were 41 specific conductance readings taken along the reach from 2013 to 2016 from May thru September at four EQUIS stations: S008-718, S007-564, S000-403 and S000-354, with a majority of the readings being taken at S007-564 and S000-354 (biological station 13MN162). Values ranged from 655 ug/L at S007-564 on June 3, 2014 to 4160 ug/L at station S007-564 on May 29, 2013. One additional reading at EQUIS station S000-354 was above 1000 ug/L. Elevated conductivity may not be caused by only elevated chloride but can serve as a surrogate or indicator for ions in the water, such as chloride. There was no chloride data within the reach.

From a biological standpoint, sunfish based assemblages can increase due to elevated chloride levels (Centrarchidae). No sunfish taxa were caught within the reach.

Chloride and conductivity related stress can also result in reduced overall taxa richness of macroinvertebrate communities, decreases in mayfly (Ephemeroptera) percentages, mayfly taxa richness and EPT taxa. Macroinvertebrate metric data that respond to elevated conductivity levels were marginally below average for the percentage of the community, which are EPT taxa, while there was above average quantities of mayfly species with the reach (see table below).

While the observed conductivity values >1000 ug/L are concerning, limited conductivity data within the reach is inconclusive at this time to determine stress.

Table 326. Macroinvertebrate metrics that respond to elevated conductivity stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	TaxaCount	EphemeropteraCh	EphemeropteraPct	EPT
13MN162 (2013)	**19.00**	12.00	**23.43**	**11.00**
13MN130 (2013)	**17.00**	9.00	**22.47**	**10.00**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	35.49	7.11	33.46	11.40
Expected response to Conductivity stress	↓	↓	↓	↓

Dissolved oxygen

Four DO samples were collected during biological monitoring visits at three stations (13MN161, 13MN162 and 13MN130) in 2013. Samples ranged from 6.59 mg/L to 9.56 mg/L, falling within DO standards. An additional 47 DO samples were gathered on the reach at five EQUIS stations (S008-718, S007-564, S000-403, S000-354 and S000-355) with a majority of the readings being taken at S007-564 and S000-354 (biological station 13MN162). Samples were collected from 1975, 1977 with a majority of the samples taken from 2013 to 2016 from May thru September. Values ranged from 2.4 mg/L on January 27, 1977 at EQUIS station S000-355 to 15 mg/L at station S000-355 on August 21, 1975. Five samples were gathered in the mid 1970s and 42 were collected from 2013 – 2016. Samples collected in the 1970s produced three readings that fell below the 5 mg/L DO standard. Data that are more recent produced samples within normal DO ranges above the 5 mg/L standard.

In 2015, a YSI sonde was deployed at station 13MN161 from July 31 to August 5 to monitor continuous DO levels at the station (see graph below). During the deployment, the minimum value recorded was 5.38 mg/L while the maximum temperature was 9.94 mg/L. The highest level of DO flux observed within the reach during deployment was 3.91 (see graph below).

Figure 273. Daily Diurnal DO results for station 13MN161 July 31 – August 5, 2016.

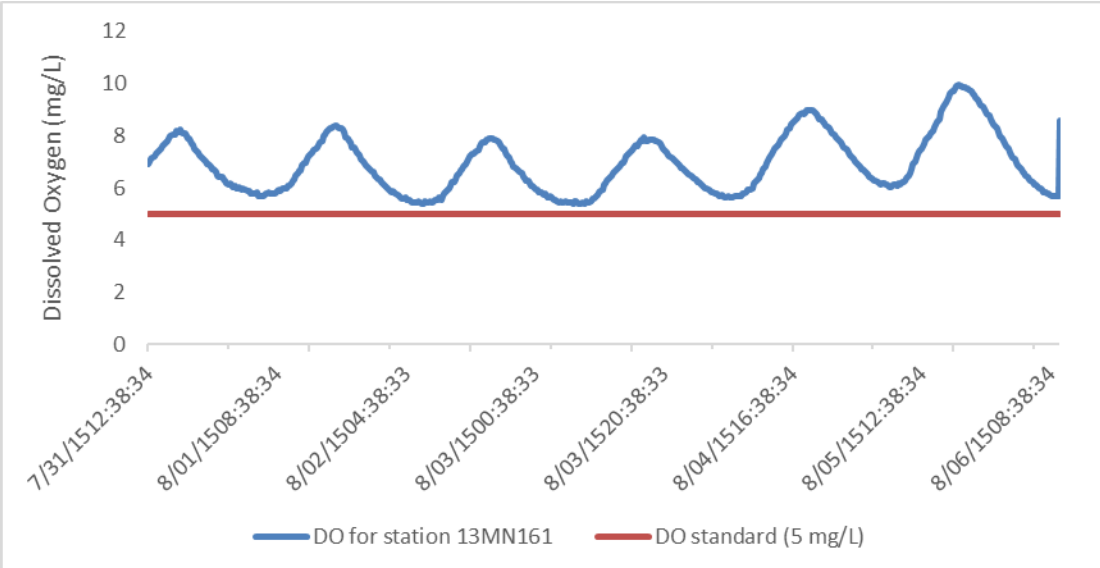
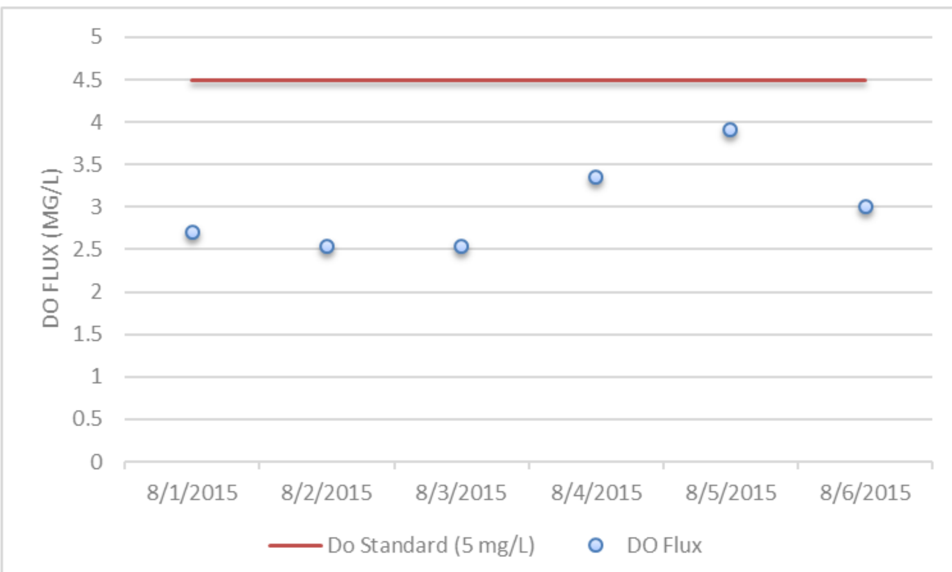


Figure 274. Daily DO Flux results for station 13MN161 July 31 – August 5, 2016.



There was not a clear response to low DO concentrations within the macroinvertebrate communities within the reach (see table below). There was a lower than average quantity of low DO intolerant taxa within the reach, but few DO tolerant taxa. The Low DO Index score at the biological stations was above average indicating the low DO levels are not a likely stressor for the macroinvertebrate communities.

Table 327. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN162 (2013)	36.00	17.00	2.09	7.35	8.00	**10.78**	2.00	0.98
13MN130 (2013)	**27.00**	14.00	2.00	7.46	**6.00**	**14.83**	1.00	0.63
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*11.40*	*7.32*	*7.13*	*6.80*	*20.16*	*4.41*	*38.80*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There was a mixed response to low DO stress metrics within the fish communities (see table below). The low DO Index score was below the average for the Southern Rivers Class, suggesting that low DO conditions are potentially stressing fish within the reach. An abundance of DO tolerant individuals at station 13MN161 and 13MN162, provides additional evidence that low DO conditions may be causing stress. While station 13MN130 had below average quantities of DO tolerant individuals suggesting that low DO stress may be isolated on the reach. Below average quantities of sensitive and DO sensitive taxa provide additional evidence for stress.

Table 328. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
13MN161 (7/16/2013)	**3.38**	40.76	**46.86**	**7.18**	**0.00**	**0.00**	**6.00**	**22.22**
13MN161 (8/8/2013	**8.28**	**34.30**	**49.04**	**7.00**	**1.00**	**0.01**	3.00	**40.13**
13MN162 (2013)	**0.28**	**11.90**	**64.31**	**7.08**	**0.00**	**0.00**	**5.00**	**25.21**
13MN130 (2013)	**5.76**	**24.85**	**56.36**	**7.23**	**0.00**	**0.00**	3.00	9.70
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	**13.75**	*40.40*	**22.36**	*8.42*	*4.20*	*14.26*	*3.72*	*11.15*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

While low DO observations were made on the reach in the 1970s, more recent DO data on the reach did not produce any concentrations below the low DO standard. Continuous DO monitoring in 2015 produced low DO readings just above the low DO standard, suggesting that future sampling at more opportune times could produce readings below the standard. The fish community showed a negative response in the low DO stress metrics at station 13MN161 and 13MN162, suggesting potential for low

DO stress in the upper portions of the reach. Additional DO continuous DO data should be collected at optimal times to determine if DO falls below the standard in the reach. As such, DO is not a stressor to the macroinvertebrate community while it is an inconclusive stressor to the fish community.

Eutrophication

Four phosphorous measurements were collected during biological monitoring visits at three stations in 2013, values ranged from 0.113 mg/L at station 13MN161 to 0.186 mg/L at station 13MN130, only one sample was above the southern river eutrophication standard of 0.15 mg/L. An additional 42 phosphorous samples were gathered along the reach at five EQUIS stations (S000-354, S000-355, S000-403, S007-564 and S008-718, with a majority of samples collected at stations S000-354 and S007-564). Five of the samples were collected from 1975 to 1977 and 35 samples were collected from 2013 to 2016. Concentrations ranged from 0.04 mg/L on August 21, 1975 at station S000-355 to 0.796 mg/L at station S000-354 on January 27, 1977. Twenty-eight of the samples were above the river eutrophication standard for the region. Twenty-two chlorophyll a samples have been collected on the reach, two were collected in 1977, 20 additional samples were collected from 2013 to 2015, samples ranged from 1.1 ug/L to 46.1 ug/L with an average value of 10.36 ug/L. Only on value was above the 35 ug/L southern regional eutrophication standard. Five BOD samples were taken on the reach from 1975 – 1977, samples ranged from 1.4 mg/L to 9.3 mg/, 2 readings were above the 3 mg/L southern standard for BOD. The average BOD reading was 4.58 mg/L. DO grab samples ranged from 2.4 mg/L to 15 mg/L suggesting potential for elevated DO flux within the reach. DO flux measured in 2015 during continuous sonde deployment did not produce any diurnal DO flux readings above the standard. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.62 – 8.57 in the reach.

Macroinvertebrate metrics show a mixed response to eutrophication stress within the reach (see table below). There was an absence of intolerant taxa and an abundance of tolerant taxa at both stations. EPT taxa numbers were above the average needed to meet standards at both visits. Station 13MN162 was just below standards for quantities of collector-filterer taxa and collector gatherer taxa, while 13MN130 fared worse.

Table 329. Macroinvertebrate metrics that respond to eutrophication stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN162 (2013)	36.00	6.00	1**5.00**	17.00	**0.00**	**77.78**
13MN130 (2013)	**27.00**	**5.00**	**9.00**	14.00	**0.00**	**88.89**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*5.76*	*11.93*	*11.40*	*0.83*	*74.35*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

There was a mixed response to eutrophication stress across the biological stations within the fish communities on the reach (see table below). Stations 13MN161 and 13MN162 exhibited a negative response to eutrophication stress responding adversely to the following taxa abundance metrics: darter and simple lithophilic spawners. Only station 13MN161 had above average quantities of omnivore taxa. All stations had above average quantities of tolerant taxa and below average quantities of sensitive taxa; however, these metrics could be impacted by other stressors. A positive relationship exists between eutrophication and omnivorous fish. Above average quantities of omnivorous fish in the reach were only identified at the upstream most biological station, suggesting potential for isolated stress within the reach.

Table 330. Fish metrics that respond to eutrophication stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	Omnivorous Fish Pct	TolPct	TaxaCount	IntolerantPct
13MN161 (7/16/2013)	**3.38**	**0.48**	**20.77**	**41.40**	**46.86**	**17.00**	**0.00**
13MN161 (8/8/2013)	**8.28**	**3.82**	**21.02**	**28.02**	**49.04**	**19.00**	**1.91**
13MN162 (2013)	**0.28**	**2.83**	**33.33**	15.58	**64.31**	**18.00**	**0.00**
13MN130 (2013)	**5.76**	6.06	42.85	10.00	**56.36**	**21.00**	**0.00**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	13.75	4.46	*24.97*	*15.72*	22.36	*22.44*	*4.63*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While phosphorous concentrations were elevated in the reach, available response variable data, including DO flux and chlorophyll a data do not suggest that elevated phosphorous concentrations are causing eutrophication within the reach. Both fish and macroinvertebrate stress metrics suggest potential eutrophication stress within the reach; however, metrics are general in nature and could be responding to other stressors in the reach. As such, eutrophication is an inconclusive stressor within the reach.

Nitrate

Four nitrate samples were collected during fish visits in 2013 at the three biological stations. Nitrate samples collected during fish visits were generally low, ranging from 3.6 mg/L on July 22, 2013 at station 13MN162 to 5.9 mg/L on July 16, 2013 at station 13MN161. Additional nitrate samples were collected on this reach during 1975, 1977, 2013, 2014, 2015 and 2016 at EQUIS stations S000-354, S000-355, S000-403, S007-564 and S008-718, totaling 42 samples. Nitrate concentrations ranged from 0.1 mg/L collected in August of 1975 to 17.1 mg/L collected in July of 2013, with an average overall concentration of 6.4 mg/L. Only values from two dates exceeded 15 mg/L in June and July of 2013.

Macroinvertebrates generally responded negatively to nitrate stress metrics (see table below). Nitrate Index scores were elevated at both stations indicating potential for nitrate stress to the macroinvertebrate community. There were also low quantities of nitrate intolerant taxa and an overabundance of nitrate tolerant individuals. There was also a low percentage of non-hydropsychid trichoptera individuals, which is known to decrease with nitrate stress.

Table 331. Macroinvertebrate metrics that respond to nitrate stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	% Nitrate Tolerant Individuals	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN161 (2013) (No invert visit)													5.9 mg/L (7/16/2013)
13MN161 (2013) (No invert visit)													1.7 mg/L (8/8/2013)
13MN162 (2013)	36.00	6.00	15.00	**11.00**	**0.00**	**77.78**	**4.00**	**1.32**	**3.60**	**0.00**	**17.00**	**56.50**	3.60 (7/22/2013)
13MN130 (2013)	**27.00**	6.00	**9.00**	**10.00**	**0.00**	**88.89**	**4.00**	**3.80**	**3.81**	**0.00**	15.00	**78.60**	4.10 (7/22/2013)
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*5.76*	*11.93*	*11.40*	*0.83*	*74.35*	*11.40*	*9.90*	*2.90*	*2.00*	*15.00*	*47.40*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish communities are not generally good indicators of nitrate stress in a reach. Fish metrics that respond to nitrate stress are general in nature and may be responding to other stressors on the reach. There was an abundance of tolerant taxa across the reach and below average quantities of sensitive and intolerant taxa. Darter counts were also low at the upstream two stations, which may be an indication that apparent stress is greater in the upper portions of the reach.

The preponderance of evidence suggests that there is potential for nitrate stress to the macroinvertebrate community within the reach even though there is not an extensive chemical dataset to back up the metric data. As such, nitrate is an inconclusive stressor at this time.

Suspended sediment

Four TSS samples were collected during biological monitoring investigations in 2013, two at station 13MN161 and one each at stations 13MN162 and 13MN130. Concentrations ranged from 20 mg/L at station 13MN130 on July 22, 2013 to 46 mg/l at station 13MN161 on August 8, 2013. None of the TSS samples collected during biological monitoring visits exceeded the southern regional TSS standard of 65 mg/L. Thirty TSS samples were gathered on the reach at five EQUIS stations: S000-354, S000-355, S000-403, S007-564 and S008-718, with a majority of samples collected at stations S000-354 and S007-564. Values ranged from 3.6 mg/L on January 27, 1977 at S000-354 to 196 mg/L on June 26, 2013 at S007-564. Four values exceeded the southern regional TSS standard. Five samples were collected on the reach during the years of 1975 and 1977, no samples exceeded TSS standards. An additional 22 TSS samples were collected on the reach in 2013, three readings exceeded TSS standards. SID investigations in 2015 and 2016 produced three additional TSS samples along the reach, one reading exceeded the standard. Seven-hundred and seventy-nine transparency tube readings were collected on the reach values ranged from 5 cm to > 100 cm with 20 samples falling below the 10 cm standard. Values below the standard were gathered in the early to mid 2000s and early 2010s, with a majority collected in the spring and early summer months and a couple in September. The reach is currently on the impaired waters list for elevated levels of suspended sediment.

The macroinvertebrates showed a mixed response to TSS stress metrics in the reach (see table below). The TSS Index score was above the average for the Prairie Forest Rivers Class for both stations, suggesting potential for TSS stress within the reach. There was an absence of TSS intolerant taxa in the reach. While the quantity of unique TSS tolerant taxa fell below the class average, TSS tolerant individuals comprised a high percentage of overall individuals in the reach, almost 25% above the class average, suggesting a high potential for stress. Low plecoptera counts also suggest elevated TSS stress. While sufficient quantities of collectorer filterer taxa may indicate that elevated levels of TSS are not persistent in the reach.

Table 332. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN162 (2013)	29.37	**0.00**	**19.75**	**0.00**	**0.00**	12.00	**73.82**
13MN130 (2013)	61.08	**0.35**	**20.81**	**0.00**	**0.00**	14.00	**73.20**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*22.95*	*0.55*	*18.38*	*2.52*	*3.91*	*14.09*	*49.06*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The fish communities on the reach showed a mixed response to TSS stress metric (see table below). The TSS Index score was above the class average in the upper portions of the reach on stations 13MN161 and 13MN162 but was below the class average at station 13MN130. This suggests that TSS stress in the reach could be isolated to its upper portions. This was also apparent in the abundance of TSS tolerant individuals, which showed above averages numbers at the upstream two stations but not at the downstream most station. There was an absence of TSS intolerant taxa in the reach as well. Across the reach, there were low quantities of centrarchids, intolerant taxa, perciformes, riffle dwelling taxa, sensitive taxa and simple lithophilic spawners. Low quantities of riffle dwelling taxa and simple lithophilic spawners could be a sign of sedimentation in the reach, a side effect of elevated TSS levels. A majority of the visits had above average numbers of herbivores, despite an absence of aquatic macrophyte habitat observed during MSHA visits.

Table 333. Fish metrics that respond to high TSS stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN161 (2013)	29.47	**0.48**	3.86	**0.00**	**41.55**	**4.35**	**8.21**	**3.38**	**20.77**
13MN161 (2013)	21.66	**0.00**	3.82	**1.91**	61.78	**15.29**	**9.55**	**8.28**	**17.83**
13MN162 (2013)	**8.50**	**0.28**	**0.28**	**0.00**	**24.93**	**5.95**	**3.68**	**0.28**	**8.50**
13MN130 (2013)	25.15	**0.00**	2.73	**0.00**	**20.30**	**6.97**	**13.33**	**5.76**	**23.03**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	21.36	4.12	1.04	4.63	43.61	17.97	13.92	13.53	24.97
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN161 (2013)	**30.95**	**0.00**	**0.00**	7.00	**67.00**
13MN161 (2013)	**31.08**	**0.00**	**0.00**	8.00	**68.00**
13MN162 (2013)	**30.57**	**0.00**	**0.00**	5.00	**67.00**
13MN130 (2013)	28.30	**0.00**	**0.00**	6.00	54.00
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*28.61*	*0.47*	*0.95*	*10.34*	*66.97*
Expected response to TSS stress	↑	↓	↓	↑	↑

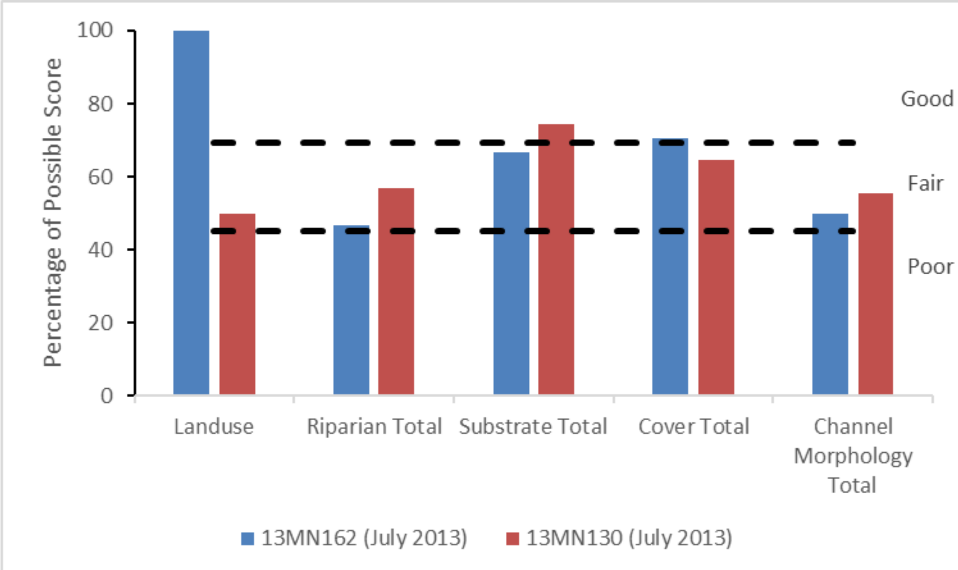
The chemical dataset shows that elevated concentrations of TSS occur in the reach, especially after rain events but are not persistent throughout the year. As both biological indicators are also responding negatively to TSS related stress metrics, especially in the upper reaches for the fish community TSS is a likely stressor within the reach.

Habitat

This section of the Watonwan River extends from just upstream of Madelia 11 miles downstream to the confluence of Perch Creek. While it appears some sections have been straightened, predominately the reach has maintained its natural sinuosity. Four MSHA qualitative habitat assessments were conducted on three distinct reaches in 2013, all scores were fair (see graph below). The MSHA scores gradually increase moving down the reach, from 54.3 at upstream station 13MN161 to 62.05 at the downstream most station 13MN130. Row crop agriculture is the reaches most prevalent landuse. Localized impacts from the city of Madelia could be contributing to the lower MSHA score observed at the upstream station. A handful of moderately sized swine operations are located in the lower 2/3 of the reach. Nearly the entire length of this portion of the Watonwan River has a wooded riparian buffer. The buffer extent varies along the reach as a whole; within the biological reaches, the buffer extent was predominately wide. While small riffles and pooled sections were identified at all three biological stations, overall limited natural channel development was observed. Stream bank erosion and sedimentation were observed across the biological stations and likely led to lower stream channel stability scores (see photos below). Individual metric scores for the MSHA can be seen in the graph below.

The DNR conducted a geomorphology survey on the reach, near station 13MN130. The survey identified the reach as moderately incised and while the stream has good floodplain connectivity, the river is in a stage of aggradation. The reach has a high sediment supply and is prone to erosion. In its current condition, it has good recovery potential (DNR, 2014).

Figure 275. Percentage of MSHA subcategory scores for stations 13MN162 and 13MN130, Watonwan River.



The fish communities along the reach show a mixed response to habitat stress (see table below). Station 13MN162 responded negatively to all degraded habitat stress metrics. All stations and visits had lower than average quantities of piscivores, riffle dwelling species and lithophilic spawners. Station 13MN161 responded negatively in all metrics but had sufficient quantities 'sculpin, darters and round bodied suckers' at both visits and lower than average numbers of pioneering species at one visit. Station 13MN130 had sufficient quantities of both benthic insectivores and simple lithophilic spawners but scored below the respective threshold for all other habitat related metrics. Metrics suggest habitat diversity is lacking in the reach, including a limited riffle and coarse substrate habitat and available diverse fish cover, which was apparent in MSHA observations.

Table 334. Fish metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN161 (2013)	**46.86**	**3.38**	**20.77**	19.81	**7.73**	**8.21**	**19.81**	**20.77**
13MN161 (2013)	**49.04**	**5.10**	**21.66**	19.11	1.27	**9.55**	**19.11**	**21.02**
13MN162 (2013)	**64.31**	**1.13**	**9.92**	**10.76**	**12.18**	**3.68**	**10.76**	**9.63**
13MN130 (2013)	**56.36**	**0.91**	**27.88**	28.48	**17.27**	**13.33**	28.48	27.27
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	*15.18*	*29.21*	*18.51*	*5.21*	*13.92*	*20.61*	*24.97*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was mixed response to degraded habitat stress within the macroinvertebrate community (see table below). Both stations had below average quantities of burrowing taxa and above average quantities of clinger taxa. An abundance of clinger habitat is likely attributed to a prevalence of woody debris habitat in the reach. Both stations however, had low quantities of sprawler taxa, which could be an indication of stress. There were inconsistent results in the reach with regards to abundance of EPT taxa, legless taxa and climber taxa suggesting that some habitat types are more readily available in one reach versus the other.

Table 335. Macroinvertebrate metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN162 (2013)	3.63	18.48	62.05	**45.54**	**31.68**	**9.90**
13MN130 (2013)	0.32	**3.80**	79.11	83.54	10.80	**8.23**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*6.92*	*14.03*	*43.19*	*54.79*	*25.94*	*27.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

MSAH observations indicate that habitat limitations exist within the reach, including stream bank erosion, sedimentation and lack of diverse available habitat types. The fish community showed a strong response to habitat related stress metrics in the reach, especially at the two most upstream stations while the macroinvertebrate communities responded negatively to some habitat stress metrics and not others. Evidence indicates that habitat is stressing the fish community but is an inconclusive stressor to the macroinvertebrate community in the reach. However, any improvements made to stream habitat would likely be beneficial to both indicators.

Figure 276. Biological station 13MN161 (August 8, 2013) stream bank erosion and sediment deposition (left); biological station 13MN162 (July 23, 2013) stream bank erosion (right).

Figure 277. Biological station 13MN162 (August 12, 2013) stream bank erosion and sediment deposition (left); stream bank erosion (right).

Figure 278. Biological station 13MN162 (July 23, 2013) armored stream bank (left); (September 12, 2013) armored stream bank (right).

Figure 279. Biological station 13MN130 (August 12, 2013) sediment deposition (left); (July 22, 2013) sediment deposition (right).

Altered hydrology/Longitudinal connectivity

There are no known dams along this stretch of the Watonwan River. There were 28 unique fish taxa identified in the reach; of these 11 are known to be migratory taxa (see table below). An abundance of migratory taxa within the reach generally indicates that longitudinal connectivity is not a likely stressor to the fish community.

Thirteen unique mussel taxa were identified within the reach during DNR surveys from 1999-2003; including: *Actinoaias ligamentina* (Mucket), *Anodontoides ferassacianus* (cylindrical papershell), *Alasmidonta marginata* (Elktoe), *Amblema plicata* (Threeridge), *Fusconaia flava* (Wabash Pigtoe), *Lampsilis cadium* (plain pocketbook*), Lasmigona costata* (fluted shell), *Leptodea fragillis* (fragile papershell), *Lampsilis siliquoidea* (fat mucket), *Pyganodon grandis* (giant floater), *Potamilus ohiensis* (pink papershell), *Quadrula quadrula* (maple leaf) and *Stophotus undulates* (creeper). Prevalence of mussel taxa within a reach indicates that longitudinal connectivity is not a likely stressor in the reach as mussels require migratory fish taxa to complete their life cycles.

Preponderance of evidence indicates that longitudinal connectivity is not a stressor within the reach.

Table 336. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish species in bold are known migratory fish. Fish species in blue are known lake species.

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
WID	-563	-511	-511	-510	-510	-510	-501	-501
Common Name								
bigmouth buffalo				x				
bigmouth shiner	x	x			x	x	x	
black bullhead	x	x		x			x	
blackside darter	x	x	x		x	x	x	x
blacknose dace		x				x		
bluntnose minnow	x	x	x	x	x	x	x	x
brassy minnow	x	x		x	x		x	
central stoneroller	x	x	x			x		x
channel catfish	x	x		x		x	x	x
common carp	x	x	x	x	x	x	x	x
common shiner	x	x						
creek chub	x	x	x		x	x		x
fantail darter								x
fathead minnow	x	x				x	x	
golden redhorse	x		x	x	x	x	x	x
green sunfish		x					x	x
highfin carpsucker				x				
johnny darter	x	x	x	x	x	x	x	x

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
largemouth bass	x	x	x	x	x			
mimic shiner				x				
northern hogsucker	x		x	x	x	x	x	x
northern pike	x	x	x	x	x		x	
orange spotted sunfish	x						x	x
quillback	x	x	x	x	x	x	x	x
river carpsucker		x						x
sand shiner	x	x	x	x	x	x	x	x
shorthead redhorse	x	x	x	x	x	x	x	x
silver redhorse	x		x	x		x	x	x
slenderhead darter	x	x	x	x		x	x	x
spotfin shiner	x	x	x	x	x	x	x	x
stonecat			x					x
walleye	x	x	x	x	x	x		x
white sucker	x	x	x	x		x	x	x
yellow bullhead		x	x				x	
yellow perch	x		x	x	x	x	x	x

The Altered watercourses GIS layer for Minnesota streams indicated that the 16.13 mile long reach of the Watonwan River (-510) is 100% natural. Many of the watershed's headwater tributaries have been extensively altered in an effort to increase arable land and overall crop production. Modifications, including tile drainage, wetland draining and stream straightening and dredging efforts have reduced the residence time of precipitation events and have hastened the ability for water to move off the landscape and into the Watonwan's ditch, stream and river network. Increased flows during storm events move high volumes of water, destabilizing streams banks and carrying with them large volumes of sediment, which have negative impacts on instream habitat and aquatic communities. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor. DNR conducted a geomorphology survey on the reach, near station 13MN130, identifying this segment of the Watonwan River as a moderately incised C5c channel. While the stream has good floodplain connectivity, the river is in a stage of aggradation. The reach has a high sediment supply and is prone to erosion. Present riparian buffers help maintain stream stability. In its current condition, it has good recovery potential (DNR, 2014).

Three known lake taxa were identified within the reach during fish sampling. Prevalence of lake taxa within the reach could indicate lentic and low flow conditions and could implicate altered hydrology as a potential stressor. Low quantities of riffle dwelling taxa and long-lived taxa can also be indications of altered hydrologic stress within a reach, while below average quantities of riffle dwelling taxa were identified across the reach, numbers of long-lived taxa were only deficient at the two most downstream stations (see table below).

Table 337. Fish metrics that respond to altered hydrology stress compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN161 (2013)	**46.86**	**41.55**	**8.21**
13MN161 (2013)	**49.04**	61.78	**9.55**
13MN162 (2013)	**64.31**	**24.93**	**3.68**
13MN130 (2013)	**56.36**	**20.30**	**13.33**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	43.61	*13.92*
Expected response to Altered Hydrology stress	↑	↓	↓

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. Photographs from the biological stations from that time period do not indicate extreme low flow conditions observed at other stations upstream in the watershed. However, lower flow conditions were observed in August of 2013 that inhibited macroinvertebrate sampling at station 13MN161. A check dam downstream of the reach made the entire reach a pool with no flow. This could prove problematic during periods of low flow, limiting potential flow and connectivity in the reach. However, during periods of normal flow conditions longitudinal connectivity is not a likely impacting natural fish migrations.

There is presently insufficient evidence to implicate altered hydrology as a stressor in this reach.

Figure 280. Biological station 13MN161 (September 2012) check dam.

4.1.3. AUID Summary

TSS and degraded habitat are stressors to biological communities within the reach. Elevated TSS concentrations identified in the reach can be linked back to spring rain events. High flows are exacerbated by extensive drainage in the upper watershed and straightened stream channels, creating pulses of flow after storms. High flows have more erosive power, scouring stream banks and causing moderate to severe erosion observed across the biological visits. This extra sediment in turn diminishes water clarity, increasing levels of suspended sediment and creates an unstable streambed causing sedimentation of coarse substrates and fills in riffles and pools. Fish metrics indicate sediment issues are greater in the upper portions of the reach as compared to downstream. While the macroinvertebrate community responded negatively to TSS stress it did not show a strong response to degraded habitat stress in the reach, as such habitat stress is inconclusive on the reach for the macroinvertebrate community.

Conductivity, DO, eutrophication, nitrates and altered hydrology are inconclusive stressors within the reach at this time. Two elevated conductivity concentrations were identified on the reach within a dataset of over 40 samples. The highest reading was 4160 ug/L, which is in and of itself a cause of concern. Conductivity levels should continue to be monitored on the reach to insure that the elevated reading was a fluke and not a persistent problem. Low DO conditions were detected during the 1970s on the reach, while more recent grab sample data did not produce any values below the standard, continuous DO monitoring in 2015 produced several diurnal lows just above the 5 mg/L standard at station 13MN161. Fish at the upstream stations within the reach, 13MN161 and 13MN162 responded negatively to low DO stress metrics while the fish at the downstream station and macroinvertebrate metrics across the reach did not, suggesting that DO is not a stressor to the macroinvertebrate community but only a potential stressor to the fish community. Additional DO data collection on the reach is needed to better characterize potential low DO conditions that may be stressing fish communities. While available response variable data did not suggest that elevated phosphorous concentrations are causing eutrophication in the reach, biological metrics suggest that eutrophication may be having negative impacts to biological communities. While elevated levels of nitrates were not generally seen in the chemical dataset in the reach, the macroinvertebrate metrics, which respond to nitrate stress, suggest that elevated nitrate concentrations may be problematic in the reach. Additional collection of nitrate data during the spring months would be useful to better define the potential stressor in the reach. While the stream reach is fed by many streams that have been extensively altered by wetland draining, tile drainage and channel ditching this reach of the Watonwan has retained its natural sinuosity. Observations made within the reach suggest that high flows after rain events are leading to stream bank erosion and a shifting bed load; however, flow data does not exist on the reach to confirm the potential stressor. Lower flows appear potentially problematic in dry years but do not appear to be causing intermittent or interstitial stretches on the river.

Longitudinal connectivity is not stressing the fish community in the reach at this time. There are no known barriers in the reach, there was an abundance of species diversity, including migratory taxa and a prevalence of mussel taxa.

Table 338. Summary of stressor determinations for Watonwan River (510).

		Stressors:							
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**	**Chloride/Conductivity**
Watonwan River	07020010-510	o/-	o	o	•	•/o	o	--	o

4.1 County Ditch 78 -559

County Ditch 78 (07020010-599) is a direct tributary stream to the Watonwan River, in in the Watonwan's lower reach. The reach is warmwater general use class 2B. The reach begins downstream of CSAH 13 in Blue Earth County and flows north joining the Watonwan River in Garden City, covering nearly 4 stream miles. The reach is impaired for aquatic life for lack of both fish and macroinvertebrate assemblages.

No upstream reaches on County Ditch 78 have been assessed.

Figure 281. Google Earth image of County Ditch 78 (-559).

4.1.1 Biological communities

Station 13MN120 is the only biological sampling location within the AUID. This station was sampled in 2013 for both fish and macroinvertebrate assemblages. The FIBI score just fails the threshold (55) by 1 point at 54 and is within the lower confidence interval. While sensitive taxa were present within the fish community, their numbers dwarfed quantities of more tolerant taxa. There were also above average quantities of detritivores (DetNWQTxPct), resulting in a below average metric score and above average quantities of very tolerant taxa (VtolTxPct) (see graph below). The top two taxa identified in the reach were central stoneroller and bluntnose minnow.

The MIBI score was 38.2, falling below the threshold (41) but within lower confidence limits. Dominant taxa in the reach included Physa, Acari and Dubiraphia. The community lacked intolerant taxa (Intolerant2Ch), collector filterer individuals (Collector-filtererPct) and scored low on the HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) metric (see graph below).

Figure 282. Fish metrics of the Southern Headwaters Class IBI for station 13MN120, County Ditch 78.

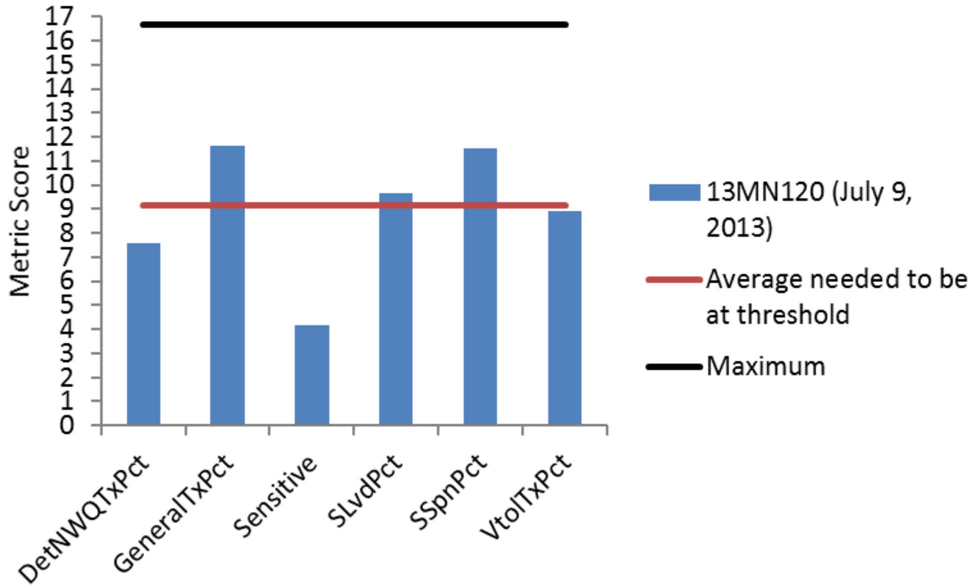
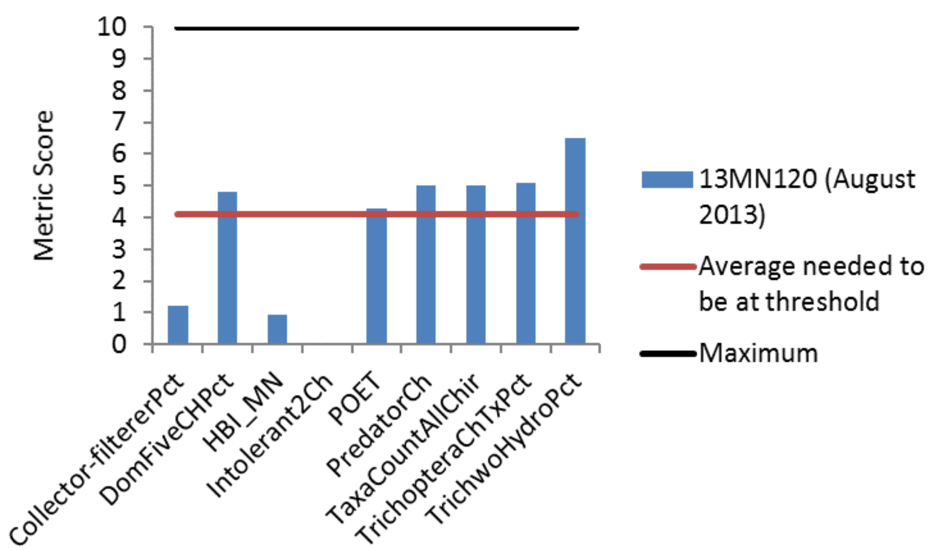


Figure 283. Macroinvertebrate metrics of the Prairie Streams GP Class IBI for station 13MN120, County Ditch 78.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

During biological sampling there were two DO measurements taken, the sample collected during the fish visit was 9.93 mg/L at 4:54 pm on July 9, 2013, while the sample collected during the invert visit was 6.99 mg/L at 12:23 pm on August 12, 2013, both samples appeared normal and neither fell below standards. Additional DO monitoring was conducted on this reach in 2014 – 2016 during stressor identification investigations. Of 10 samples collected, one fell below the standard of 5 mg/L, falling to 2.5 mg/L at 1:30 PM on September 1, 2015. Three additional samples fell below 7 mg/L, two of which occurred before 9am. The highest value recorded was 11.7 mg/L at 11:09 am in February 2015. No continuous DO monitoring occurred on the reach.

There was a mixed response to low DO stress within the macroinvertebrate community (see table below). The macroinvertebrate community has a DO index score below the Prairie Stream GP Class average, indicating potential for low DO stress. There was also a low quantity of low DO intolerant taxa. While there were marginally above average quantities of DO tolerant macroinvertebrate taxa, there was not an abundance of DO tolerant individuals, suggesting that DO is not likely a major form of stress in the reach. Low numbers of EPT taxa signal stress in the reach as does an above average HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) score; however, these metrics could be indications of other stressors within the reach.

Table 339. Macroinvertebrate metrics that respond to low DO stress in County Ditch 78 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
13MN120 (2013)	**36.00**	**6.00**	**9.23**	**5.66**	**1.00**	**2.31**	**9.00**	21.85
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.60*	*7.92*	*6.42*	*2.40*	*4.50*	*8.40*	*25.10*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

There was a mixed response to low DO stress within the fish community (see table below). The DO Index score was below the southern headwaters class average, indicating limited potential for low DO levels to stress the fish community. While DO sensitive taxa were absent in the fish community, numbers of DO tolerant taxa and individuals were also below average. There was a low percentage of fish that take 3 years or longer to mature (MA>3Pct), indicating that fish are quick to reproduce due to short life spans from the influence of human disturbance. The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions, suggesting a potential for low DO stress within the fish community. However, limited quantities of generally sensitive taxa and abundant quantities of generally tolerant taxa identified in the reach could be explained by other stressors.

Table 340. Fish metrics that respond to low DO stress in County Ditch 78 compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric values indicative of stress.

Station (Year sampled)	TaxaCount	MA>3Pct	SensitivePct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DOTolerant Pct
13MN120 (2013)	11.00	**4.48**	**1.49**	**89.55**	7.02	0.00	**0.00**	2.00	18.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*10.54*	*13.90*	*7.90*	*72.80*	*7.13*	*0.70*	*4.10*	*3.40*	*21.20*
Expected response to low DO stress	↓	↓	↓	↑	↓	↓	↓	↑	↑

While there is limited evidence that dissolved oxygen (DO) levels within the reach can dip below standards, the dataset is small. There was also a mixed response to low DO conditions in the metric data but bot strong evidence implicating low DO as a potential stressor to the fish or macroinvertebrate communities. Additional DO sampling before 9:00 am and continuous monitoring efforts could be useful in determining whether or not low DO conditions are persistent in the reach. As such, low DO is an inconclusive stressor in the reach at this time.

Eutrophication

Phosphorous data on the reach was limited to data collected during the fish visit in 2013 and stressor identification investigations in 2015 and 2016 at the biological monitoring station. Phosphorous concentrations exceeded the river eutrophication standard for the Southern Region of 0.15 mg/L during two of nine sampling events, but not during the fish visit on July 9, 2013 when the concentration was 0.12 mg/L. Phosphorous concentrations ranged from 0.032 mg/L on May 24, 2016 to 0.537 mg/L September 1, 2015, with an average of 0.18 mg/L. Observed exceedances occurred in September of 2015 and in June of 2016 and did not coincide with the biological visits. No chlorophyll A, BOD or DO flux data was available on the reach. DO grab samples collected on the reach ranged from 2.5 mg/L to 11.7 mg/L indicating potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.3 – 8.97 in the reach.

Results from macroinvertebrate metrics suggest potential for possible eutrophication stress (see table below). There were fewer collector-filterers and collector-gatherers than similar stations meeting the biocriteria. There were no intolerant taxa and a high percentage of tolerant taxa in the sample. There were few EPT taxa on the reach as well signifying stress.

Table 341. Macroinvertebrate metrics that respond to eutrophication stress in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
13MN120 (7/9/2013)	**36.00**	**3.00**	**11.00**	**6.00**	**0.00**	**91.70**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

The fish community showed somewhat similar results as the macroinvertebrate community (see table below). There were low percentages of darters and sensitive species and a complete absence of intolerant taxa. There was also an abundance of tolerant taxa. In contrast, there was an abundance of simple lithophilic spawners. These stress metrics are general in nature and any results above or below class averages could be indications of other stressors present in the reach. A positive relationship exists between eutrophication and omnivorous fish. Below average quantities of omnivorous fish were identified in the reach, suggesting that eutrophication is not a likely stressor to fish communities in the reach.

Table 342. Fish metrics that respond to eutrophication stress in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	DarterPct	SLithopPct	OmnivorePct	TolPct	IntolerantPct	TaxaCount
13MN120 (2013)	**1.49**	**7.46**	36.36	2.99	**89.55**	**0.00**	11.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*4.50*	*8.50*	*27.90*	*14.71*	*79.90*	*0.80*	*10.40*
Expected response to increased TP stress	↓	↓	↓	↑	↑	↓	↓

While elevated phosphorous concentrations were identified on the reach, there is no response variable data to confirm whether or not elevated phosphorous concentrations have the potential to stress aquatic biota. Despite an apparent strong response to eutrophication stress metrics within both the fish and macroinvertebrate communities, metrics used to identify eutrophication stress are general in nature and could be responding to other stressors. As such, eutrophication is an inconclusive stressor on the reach.

Nitrate

During the fish sample, the nitrate concentration at 13MN120 was measured at 20 mg/L on July 9, 2013. There were seven additional nitrate samples collected on this reach at the biological monitoring station in 2015 and 2016. Samples were collected in June and September of 2015 and in February, May and June of 2016. Nitrate concentrations ranged from 0.22 mg/L in September of 2015 to 25 mg/L in June of 2015, with an average concentration of 16.2 mg/L. Only two samples scored below 15 mg/L.

High nitrate concentrations often impacts macroinvertebrate communities more than fish assemblages. The nitrate specific metrics show better than average Trichoptera taxa in the reach (see table below). The nitrate index score was 3.6, while the average for the Prairie Streams GP class is 3.2. This suggests that the overall community present is marginally tolerant to high nitrogen concentrations. The station exceeded the averages for both number of nitrate tolerant taxa and the percentage of nitrate tolerant individuals when compared to the averages for Prairie Streams GP class (see table below). Increasing nitrate concentrations also correlate with a decrease in non-hydropsychid Trichoptera individual percentages in warmwater streams (sensitive caddisflies that do not spin nets; TrichwoHydroPct). While intolerant taxa and non-hydropsychid individuals are not in abundance here, their absence could also be due to another stressor present.

Table 343. Macroinvertebrate metrics that respond to eutrophication stress in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	Nitrate Tolerant Pct	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
13MN120 (2013)	**36.00**	**3.00**	**11.00**	**6.00**	**0.00**	**91.70**	3.00	**0.00**	**3.60**	**0.00**	**25.00**	**73.50**	20.00 (7/9/2013)
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*36.80*	*7.30*	*15.90*	*12.20*	*0.80*	*72.60*	***0.00***	***2.40***	***3.20***	***1.10***	***18.00***	*59.70*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish are not generally good indicators of nitrate related stress. Fish metrics that do respond to nitrate stress are general in nature and a negative response to these metrics could be an indication of other stressors in the reach. There was an abundance of tolerant taxa in the fish community, an absence of intolerant taxa, few sensitive taxa and below average counts on darter taxa, all indicating potential stress.

Elevated nitrate concentrations were identified on the reach and corroborate a negative response to nitrate stress metrics in the macroinvertebrate community indicating that nitrate is a stressor to macroinvertebrate communities in the reach. Fish are inconclusive to nitrate stress due to a lack of specific metrics that indicate nitrate stress in fish communities.

Suspended sediment

One TSS sample was collected during the fish visit in 2013. The value was 8.4 mg/L on July 9, 2013 and did not exceed the southern regional TSS standard of 65 mg/L. Additional TSS monitoring within the reach was limited to SID investigations in 2015 and 2016, which included seven samples. Concentrations ranged from 2 mg/L on September 1, 2015 to 65 mg/L on June 15, 2016, no samples exceeded TSS standards. One TSS sample collected on June 15, 2016 was just below standards at 65 mg/L; however, the rest of the values were below 10 mg/L. The average TSS value was 13.17 mg/L.

There were mixed results in macroinvertebrate metrics that respond to TSS stress (see table below). The TSS index score was also below the average suggesting that the macroinvertebrate community is not being overly stressed by high TSS levels. The community had lower than average quantities of Plecoptera, collector-filterer and intolerant taxa indicating potential for stress. However, there were lower than average quantities of TSS tolerant taxa and a lower than average TSS tolerant percent. Low quantities of plecoptera taxa could be related to limited availability of coarse substrate habitat, as gravel was the only coarse substrate identified in the reach.

Table 344. Macroinvertebrate metrics that respond to high TSS stress in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN120 (2013)	**4.97**	**0.00**	14.81	**0.00**	**0.00**	10.00	33.77
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*11.70*	*0.10*	*16.68*	*0.80*	*1.40*	*11.80*	*41.50*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

Similarly, the fish community also shows a mixed response to TSS stress metrics (see table below). The TSS index score was just above the class average for the southern headwaters class suggesting that TSS stress is not prominent in the reach. While TSS intolerant taxa were absent in the reach, so too were TSS tolerant taxa, which also indicates that TSS stress is not likely. There were greater than average quantities of herbivores, benthic feeders and riffle species and an absence of TSS tolerant taxa. There was a low abundance of non-tolerant Centrarchidae taxa, perciformes, long-lived species and simple lithophilic spawners and low quantities of sensitive taxa, suggesting potential stress. However, there was also an abundance of herbivores, benthic insectivores and riffle dwelling taxa, which suggests that TSS concentrations are not abundance in the reaches communities.

Table 345. Fish metrics that respond to high TSS stress in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
13MN120 (2013)	47.76	**0.00**	38.81	**0.00**	**1.49**	**7.46**	38.81	**1.49**	**4.48**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*35.00*	*1.00*	*22.40*	*1.60*	*4.50*	*13.60*	*26.20*	*7.90*	*14.60*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
13MN120 (2013)	**16.00**	**0.00**	**0.00**	0.00	0.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*15.40*	*0.90*	*4.10*	*0.40*	*2.00*
Expected response to TSS stress	↑	↓	↓	↑	↑

There is no chemical evidence available to suggest elevated TSS concentrations exist within the reach. While some TSS stress related metrics responded negatively to potential TSS stress in the reach, strongest metrics did not exhibit overwhelming response that TSS stress is a concern in the reach. As such, TSS is not a stressor in the reach at this time.

Habitat

This reach is predominately ditched, transitioning to a natural channel approximately 0.5 mi. upstream of the biological station. The ditched portion has little to no riparian buffer with a moderate to good riparian buffer of woods surrounding the natural portion of the reach. The MSHA score is 57.4 (fair) for station 13MN120 (see graph below). Landuse in the watershed is predominately comprised of row crop agriculture, resulting in a zero score for landuse metrics. Bank erosion in the reach was classified as moderate to severe, with evidence of stream bank sloughing in photographs below. In stream shading was limited to reed canary grass along stream banks. Stream substrate diversity was comprised of sand, silt and moderately embedded gravel. There were moderate amounts of instream fish and invertebrate cover comprised of undercut banks, overhanging vegetation, deep pools and boulders. Overall channel morphology scoring was good at the station, earning top marks for depth variability and sinuosity, good ratings for channel development and only moderate stream stability scores, due to a shifting streambed and eroding stream banks. Individual MSHA category scores for this station can be seen in the graph below.

Figure 284. Percentage of MSHA subcategory scores for station 13MN120, County Ditch 78.

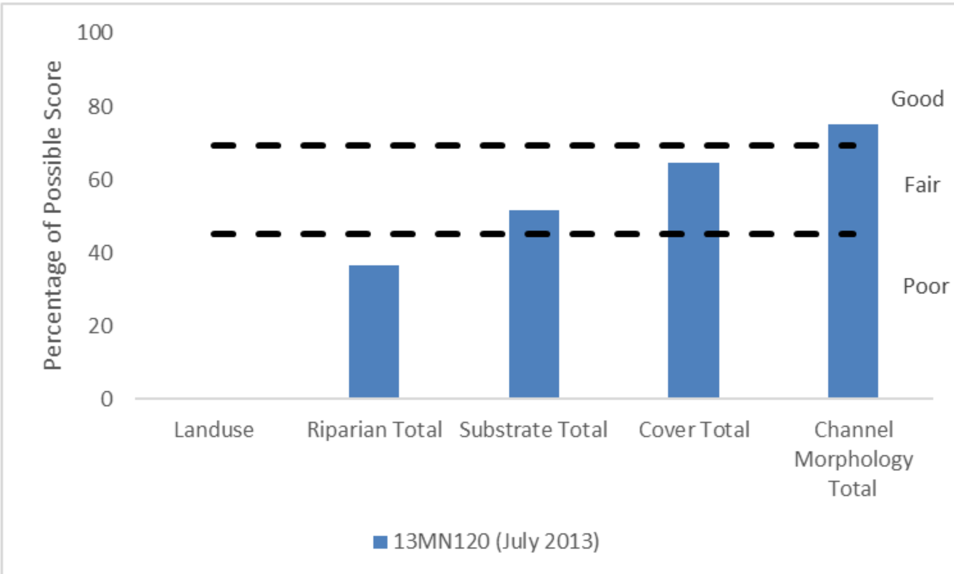


Figure 285. Biological station 13MN120 (July 9, 2013) stream bank sloughing (left); (July 10, 2014) stream bank erosion (right).

Figure 286. Biological station 13MN120 (September 1, 2015) sediment deposition in the culvert (left); (May 2, 2016) armored stream banks (right).

The fish showed a mixed response to habitat related stress metrics in the reach (see table below). There was an abundance of tolerant taxa in the reach and below average quantities of piscivore taxa, lithophilic spawners, 'darter, sculpin, sucker' taxa, benthic insectivores and simple lithophilic spawners. This suggests that availability of diverse habitat types is lacking in the reach. In addition, while riffles are present in the reach, present gravel habitat is not sufficient to support a diverse community of lithophilic spawners.

Table 346. Fish metrics that respond to degraded habitat conditions in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	PiscivorePct	LithFrimPct	DarterSculpSucPct	PioneerPct	RifflePct	BenInsect-TolPct	SLithopPct
13MN120 (2013)	**89.55**	**0.00**	**58.21**	**10.45**	40.30	38.81	**10.45**	**11.94**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*1.62*	*69.21*	*12.55*	*37.79*	*28.33*	*14.22*	*27.90*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

There was a mixed response to habitat related stress in the macroinvertebrate community (see table below). There were higher than average quantities of climber and clinger taxa, this is consistent with sampling of coarse substrates and overhanging vegetation, which were both prevalent in the reach. There were also below average quantities of burrowing taxa but above average quantities of legless taxa. Indicating that while TSS is not a stressor in the reach there is an abundance of fine sediment in the reach for legless taxa to reside. There were low quantities of sprawler taxa as well which can likely be attributed to an absence of woody debris habitat in the reach.

Table 347. Macroinvertebrate metrics that respond to degraded habitat conditions in County Ditch 78 compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
13MN120 (2013)	5.63	35.10	44.37	**16.23**	**50.99**	**10.60**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	*9.50*	*21.50*	*35.90*	*40.36*	*26.93*	*19.40*
Expected response to stress	↑	↓	↓	↓	↑	↓

The photographic evidence also showed degraded habitat conditions present. While the fish community shows a stronger response to degraded habitat related stress metrics, the macroinvertebrate community is also exhibiting signs of stress due to a prevalence of fine sediment in the reach and an absence of habitat structure in the reach for sprawling invertebrates. MSHA results indicate that diverse habitat availability is limited in the reach and stream bank erosion is prevalent. Evidence suggests that habitat is stressing biota in the reach at this time but may not be a primary source of stress for macroinvertebrates in the reach.

Altered hydrology/Longitudinal connectivity

There are no known dams or fish barriers within the reach. Eleven fish taxa were identified during MPCA fish surveys. Three of these taxa are known migratory fish species: golden redhorse, central stoneroller and white sucker, suggesting that there are no barriers in the stream between the station and the mainstem Watonwan River. There were no mussel surveys conducted by the DNR within the reach. While limited information is available, it does not appear that longitudinal connectivity is a stressor on the reach at this time.

The Altered Watercourses GIS layer for Minnesota streams indicates that the 3.96 mile long reach of County Ditch 78 in 100% modified. Closer review indicates that the creek has started to regain some of its past sinuosity downstream of the biological station and 527th Ave. and upstream of US Hwy 169. Its headwaters, upstream of -559 is 100% channelized for agricultural drainage. Modified channels typically lead to reduced habitat conditions, eroded banks and an overall reduction in diversity. According to CADDIS, bank erosion, bank instability and undercut banks are site evidence that altered hydrology is a potential stressor.

There was an abundance of riffle dwelling taxa within the reach but a limited quantity of long-lived fish taxa. Low quantities of both metrics can be an indication that altered hydrology is a stressor within the reach. No lake taxa were identified within the reach, presence of lake taxa can indicate persistent low flow conditions in the reach, which may be caused by altered hydrology (see table below).

Table 348. Fish metrics that respond to altered hydrology stress compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
13MN120 (2013)	**89.55**	**1.49**	38.81
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*70.64*	*4.50*	*28.33*
Expected response to Altered Hydrology stress	↑	↓	↓

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. While photographs were taken in September of 2012 at the biological station within the reach, it does not appear that extreme low flow or dry streambed conditions occurred within the reach.

Wetland drainage and extensive systems of tile drainage within the watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles. Removing water quickly from the landscape inhibits natural groundwater recharge and leaves riverine systems in a hydrologic deficit, reducing baseflow and ultimately drying up streambeds and leading to periods of low or no flow in the drier late summer months.

Present data suggests that altered hydrology is an inconclusive stressor in the reach at this time.

4.1.3 AUID Summary

Degraded habitat is stressing biological communities within the reach. While channel development in the reach presently includes riffle, run, pool sequences, and gravel substrates are available within the reach there was an absence of woody debris habitat, cobbles and aquatic vegetation. Stream bank erosion is prevalent in the reach, which is causing sedimentation in the reach, leading to greater quantities of legless invertebrate taxa (worms). Efforts to stabilize the stream channel are needed to protect present riffle and coarse substrate habitat before continued degradation leads to further destabilization in the reach.

Nitrates are a stressor to macroinvertebrate communities in the reach, but are inconclusive stressors to the fish community. Elevated nitrate concentrations identified during grab samples during spring months suggest that agricultural inputs from drain tiles are likely elevating nitrate concentrations in the reach. Macroinvertebrate communities in the reach showed a strong negative response to nitrate related stress metrics.

Low DO, eutrophication and altered hydrology are inconclusive stressors on the reach at this time. Limited chemical evidence suggests that DO levels can fall below the standard in the reach. However, neither biological indicator shows a strong response to potential low DO stress. Additional monitoring effort to better understand DO conditions in the reach including continuous monitoring would be beneficial. While elevated phosphorous concentrations were identified within the reach in a small dataset, there was no response variable data available to confirm that elevated phosphorous concentrations could be stressing aquatic biota in the reach. Stress metrics for the biological communities suggested eutrophication may be causing stress in the reach but metrics are general in nature and may be responding to other stressors in the reach. Additional response variable data and phosphorous data is needed to better understand the potential of eutrophication stress in the reach.

While there is no evidence of low flow stress related to altered hydrology in the reach, channel ditching within the upstream watershed, wetland drainage and tile drainage are likely contributing to stream bank erosion observed in the biological reach, a result of increased flows during precipitation events. Additional data beyond visual observations, including flow data, is needed to confirm the potential stressor in the reach.

TSS is not a stressor in the reach. There was no chemical evidence gathered to indicate elevated TSS levels occur in the reach, even in samples collected after spring precipitation events. Biological metrics did not exhibit a strong response to TSS stress related metrics either.

Table 349. Summary of stressor determination for County Ditch 79 (559).

		Stressors:						
Stream Name	**AUID**	**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
County Ditch 79	07020010-559	o	o	o/●	--	●/o	o	--

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

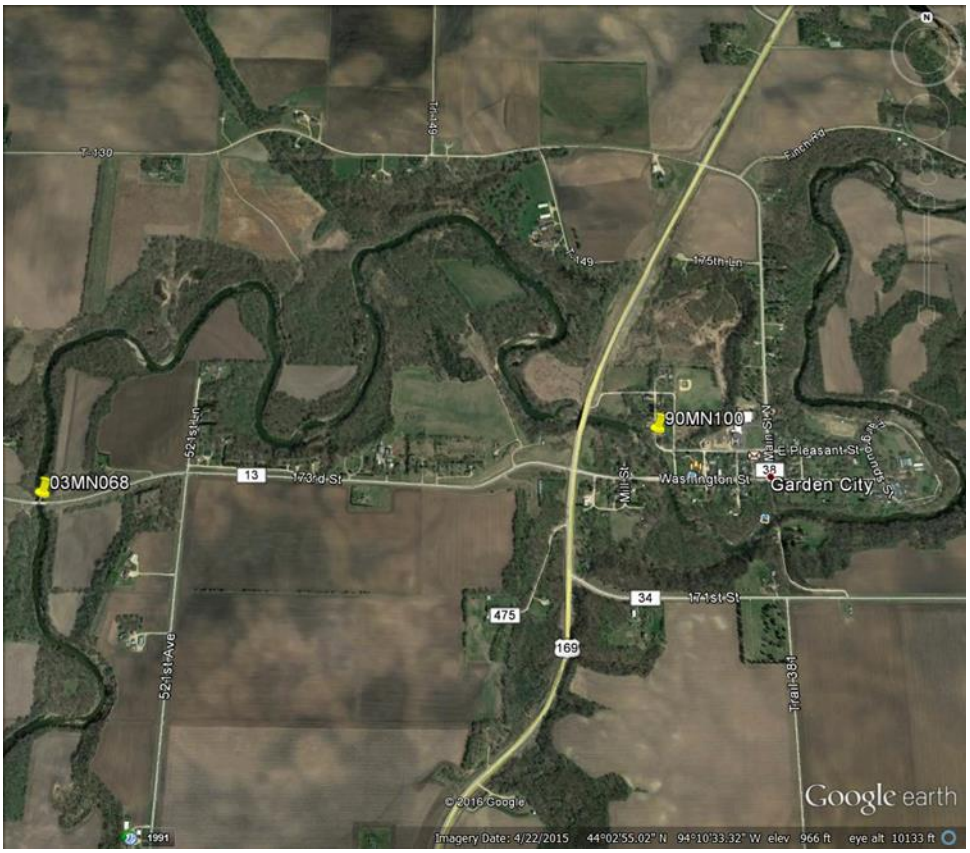
Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

4.1. Watonwan River -501

Watonwan River (07020010-501) is the terminal reach of the Watonwan system. The reach begins at the confluence of Perch Creek downstream of CR 32 and flows north east thru Garden City before joining the Blue Earth River HUC 8 two miles east of US Hwy. 169, covering nearly 18 river miles. The reach is warmwater general use Class 2B. The reach is impaired for aquatic life, for deficient fish and macroinvertebrate assemblages (2015) and for high levels of turbidity (2002), aquatic consumption, for elevated levels of mercury in fish tissue (2002) and aquatic recreation for excessive levels of fecal coliform (1994).

Upstream reaches include Watonwan River (07020010-510) and Perch Creek (07020010-533).

Figure 287. Google Earth image of Watonwan River (-501).



4.1.1. Biological communities

There are two biological stations along the reach, but only 03MN068 has reportable data, as the other station, 90MN100, was sampled using different protocols under the MRAP project. The Site 03MN068 had three separate sampling events for fish. A visit in 2003 and 2013 each scored below the threshold (49) and lower confidence limits (FIBI 37.3 in 2003 and FIBI 39 in August 2013), while an additional sample in 2013 scored below the threshold but within lower confidence limits (FIBI 44 in July 2013). The best scoring sample had the fewest number of individuals (81) and the fewest number of species (16) and was dominated by golden redhorse, a semi-intolerant species. The other samples had 335 to 533 individuals and 16 to 17 species but their communities were dominated by more tolerant species: sand shiner, spotfin shiner, bluntnose minnow and common carp. All visits fell below averages needed for passing FIBI scores for the following metrics: percentage of detritivores, short-lived percent and tolerant percent (see graph below).

There were three visits at 03MN068 for macroinvertebrates, the initial sample in August 2003 met MIBI requirements scoring 37.7, above the GU threshold and within upper confidence limits. The remaining samples fell below standards, the September 2003 visit fared the worst with an MIBI of 16, falling below lower confidence limits while the 2013 sample scored MIBI 25.2, within lower confidence limits.

Failing samples were dominated by the following species: Corixidae, Tricoythodes, Stenelmis and Dicrotendipes; and Hydropsyche, Triconrythodes, Stenelmis and Caenis respectively. All visits fell below averages needed for passing MIBI scores for the following metrics: HBI_MN (A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota), taxa richness of Odonata, and the taxa richness of macroinvertebrates with tolerance values less than or equal to four, using MN TVs (Intolerant2lessCh) (see graph below).

Figure 288. Fish Metrics of the Southern Rivers Class IBI for station 03MN068, Watonwan River.

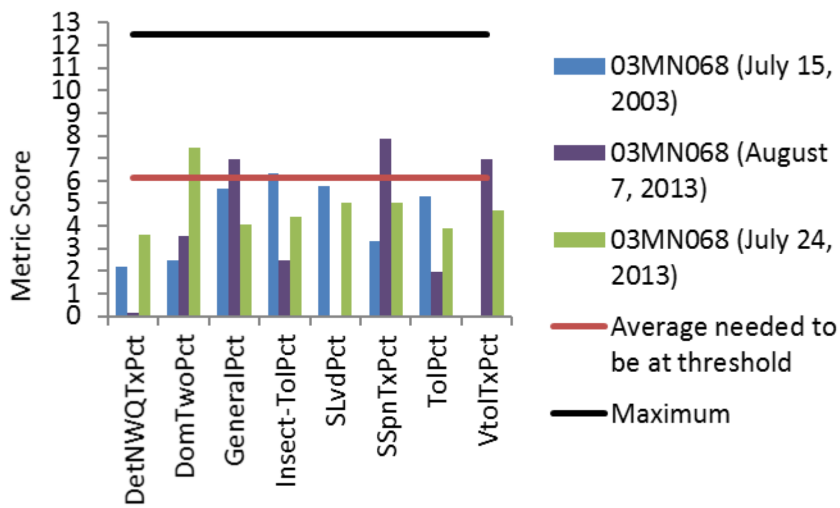
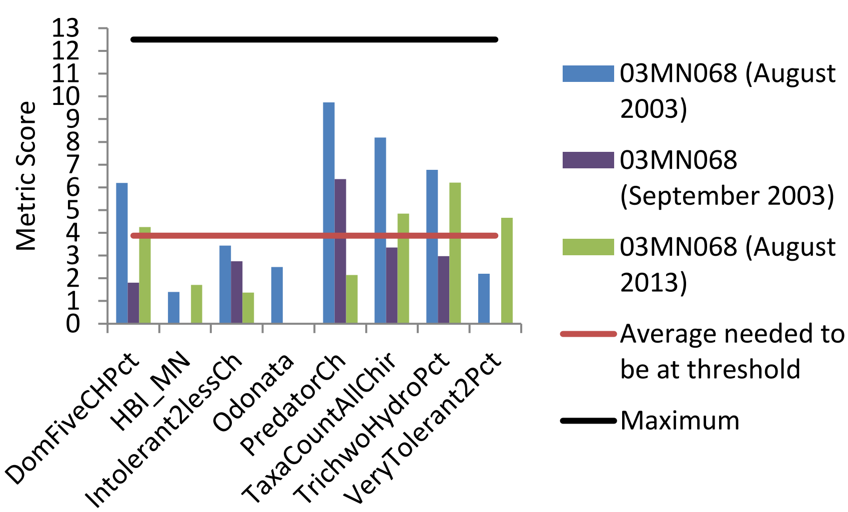


Figure 289. Macroinvertebrate metrics of the Prairie Forest Rivers Class IBI for station 03MN068, Watonwan River.



4.1.2. Data evaluation for each Candidate Cause

Dissolved oxygen

Three DO measurements were collected during fish visits at station 03MN068 in 2003 and 2013. DO values ranged from 6.85 mg/L to 11.66 mg/L and fell above the low DO standard of 5 mg/L. Four hundred and forty additional DO data points were collected on the reach over the following time frame: 1968 – 1977, 1981-1982, 1984-1985, 1987-1994, 1996-2001, 2003-2006 and 2008-2016. Throughout this timeframe, 10 DO readings fell below the low DO standard. Nine of these readings occurred in the 1970s and one occurred in 2005. Twenty-one DO samples collected were at or above 14 mg/L; over half of the high readings observed occurred within the last 10 years, suggesting that there is potential for high DO flux within the reach. Additional continuous chemistry monitoring could be useful in better understanding the potential for DO stress within the reach.

There was a mixed response in the macroinvertebrate community to low DO stress (see table below). The low DO index score was just below the Prairie Forest Rivers Class average for both 2003 visits but was above average for the 2013 visit, suggesting that low DO stress is not likely a primary stressor impacting the macroinvertebrate community within the reach. While there were below average quantities of low DO intolerant individuals across all three samples, there was not an overabundance of low DO tolerant individuals. There were low HBI_MN ((A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota) numbers across all three visits, indicating presence of stressors within the reach.

Table 350. Macroinvertebrate metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	EPTCh	HBI_MN	Low DO Index Score	Low DO Intolerant Taxa	Low DO Intolerant Pct	Low DO Tolerant Taxa	Low DO Tolerant Pct
03MN068 (2003)	41.00	16.00	**3.44**	**7.11**	**4.00**	**2.08**	**6.00**	5.95
03MN068 (2003)	**32.00**	**11.00**	**2.75**	**6.62**	**4.00**	**1.12**	**7.00**	12.29
03MN068 (2013)	37.00	14.00	**1.38**	7.25	9.00	**12.42**	4.00	10.51
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*11.40*	*7.32*	*7.13*	*6.80*	*20.16*	*4.41*	*38.80*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The fish metrics are showing a mixed response to low DO stress within the reach (see table below). The low DO Index score was below the average needed to meet the threshold for the Southern Rivers general use class, suggesting potential for low DO conditions to inhibit fish communities within the reach. There was also an absence of low DO sensitive fish within the reach and low counts of generally sensitive individuals. The number of low DO tolerant taxa was only marginally above the class average while two of three visits had above average quantities of low DO tolerant individuals, suggesting some potential for low DO stress.

Table 351. Fish metrics that respond to low DO stress in Watonwan River compared to the statewide average of visits meeting the modified use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	SensitivePct	MA>3Pct	TolPct	DO Index Score	DO Sensitive Taxa	DO Sensitive Pct	DO Tolerant Taxa	DO Tolerant Pct
03MN068 (2003)	**1.19**	**9.25**	**37.31**	**7.10**	**0.00**	**0.00**	**4.00**	**14.33**
03MN068 (2013)	**4.50**	**16.32**	16.32	**7.24**	**0.00**	**0.00**	**4.00**	8.26
03MN068 (2013)	**3.70**	**34.57**	**34.57**	**7.14**	**0.00**	**0.00**	**4.00**	**22.22**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	**13.75**	*40.40*	**22.36**	*8.42*	*4.20*	*14.26*	*3.72*	*11.15*
Expected response to low DO stress	↓	↓	↑	↓	↓	↓	↑	↑

The present chemical dataset does not suggest that low DO conditions are persistent in the reach, 42 of the 440+ DO samples collected in the reach were gathered prior to 9 am and only one of these readings gathered in 1977 was below the low DO standard. Attempts to gather continuous DO sonde data in 2016 were unsuccessful due to persistent high flow conditions in the late summer months. Macroinvertebrate metric data did not show a strong signal to low DO stress while the fish metric data was inconclusive. Additional DO sonde data would be useful to help rule out potential for low DO stress in the reach.

Eutrophication

Three phosphorous samples were collected during fish visits at station 03MN068 in 2003 and 2013, samples ranged from 0.076 mg/L to 0.265 mg/L. Only one of the three values exceeded the southern regional eutrophication standard of 0.15 mg/L. An additional 890 phosphorous samples were collected on the reach over the following time frame: 1968 -1977, 1981-1982, 1984-1985, 1987-1989, 1990 – 1994 and 1996 to 2016, primary collected in the spring and summer months. Of these samples, 652 exceeded standards, 152 of those samples were gathered in the last 10 years. Seventy-two chlorophyll a samples were collected in the following time frame: 1977, 1997 -1999, 2001, 2004, 2006, 2009 – 2010, 2012 -2013 and 2014. The lowest chlorophyll a recording was 2.6 ug/L, the highest was 133 ug/L and the overall average reading was 26.64 ug/L. Seventeen of the samples were above the 35 ug/L southern regional eutrophication standard for Chlorophyll a. Elevated Chlorophyll a concentrations were observed in the 1990s, 2000s and 2010s. BOD samples were collected on the reach 213 times primarily at EQUIS station S000-163 (biological station 03MN068) from 1968-1977, 1981-1982, 1984-1985, 1987-1994, 1997-1999, 2001, 2004, 2006 and 2009. A majority of samples were collected prior to 1997. Values ranged from < 0.5 mg/L to 17 mg/L with an average concentration of 3.81 mg/L. 117 samples were above the southern regional BOD standard of 3 mg/L. While 94 of these samples were collected before 1990, six elevated samples were collected from 2006 and 2009. No DO flux data was available within the reach. DO grab sample data ranged from 3 mg/L to 18.51 mg/L indicating potential for elevated DO flux within the reach. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 4.88– 10.38 in the reach; 40 of 490 values were above 8.5 (an 8% exceedance rate).

There was a mixed response in the macroinvertebrate metrics associated with eutrophication stress (see table below. There was an absence of intolerant taxa across all visits. Higher than average percentages of tolerant taxa were observed across all stations but were more pronounced in the two later visits. Collector filterer taxa counts were also low across all visits while collectorer gatherer numbers and EPT taxa counts floated were just above and below the average needed to meet standards. The potential response to eutrophication stress seems to somewhat increase over time when comparing the 2003 to 2013 visits. Macroinvertebrate metrics which respond to eutrophication stress, are general in nature and could be responding to other stressors in the reach.

Table 352. Macroinvertebrate metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant2Ch	Tolerant2ChTxPct
03MN068 (2003)	**37.00**	**3.00**	15.00	14.00	**0.00**	73.17
03MN068 (2003)	**41.00**	**2.00**	12.00	16.00	**0.00**	**81.25**
03MN068 (9/9/2013)	**32.00**	**5.00**	13.00	**11.00**	**0.00**	**81.08**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*5.76*	*11.93*	*11.40*	*0.83*	*74.35*
Expected response to increased TP stress	↓	↓	↓	↓	↓	↑

In the fish community there was also a mixed response to eutrophication stress metrics (see table below). Two visits had lower than average quantities of darter taxa, while all visits had sufficient quantities of simple lithophilic spawners. All visits had a higher than average abundance of tolerant taxa and a low quantity of sensitive taxa; however, this could be attributed to other stressors in the reach. A positive relationship exists between eutrophication and omnivorous fish. Below average quantities of omnivorous fish were identified in the reach at two of the three fish visits on the reach, suggesting potential for sporadic eutrophication stress within the reach.

Table 353. Fish metrics that respond to eutrophication stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TaxaCount	SensitivePct	DarterPct	Omnivorous Fish Pct	SLithopPct	TolPct	IntolerantPct
03MN068 (2003)	18.00	**1.19**	**3.28**	14.03	41.18	**37.31**	**0.00**
03MN068 (2013)	17.00	**3.70**	**3.70**	4.88	41.18	**49.38**	**0.00**
03MN068 (2013)	16.00	**4.50**	6.38	**22.22**	37.50	**65.67**	**0.00**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.44*	13.75	4.46	*15.72*	*24.97*	*22.36*	*4.63*
Expected response to increased TP stress	↓	↓	↓	↑	↓	↑	↓

While there is a strong indication that elevated phosphorous concentrations are present in the reach and 11% of all Chlorophyll a response variable data suggest potential for eutrophication stress within the reach, there was a mixed response to eutrophication stress metrics among both the fish and macroinvertebrate communities. In addition, present response variable datasets are old**;** more recent data would be advantageous. While eutrophication stress is inconclusive in the reach, any efforts to reduce nutrient concentrations in the reach would likely benefit aquatic communities.

Nitrate

There were three nitrate samples collected during fish visits from 2003 and 2013 at 03MN068. Nitrate concentrations ranged from 10 mg/L on July 15, 2003 to 1.4 mg/L on August 7, 2013. An additional 804 samples were collected over the years of 1968 thru 1977, 1981, 1982, 1984, 1985, 1987, 1988, 1989, 1990 thru 1994, 1996, 1997, 1999 thru 2014 and 2016. Samples were collected from January to December. Nitrate concentrations ranged from 0.1 mg/L in samples collected from August, September and October, from 1976, 1985, 1987 thru 1989, to 20 mg/L observed in May of 1991, with an overall average concentration of 6.9 mg/L. A total of 43 nitrate concentrations were equal to or above 15 mg/L; these observations occurred from May thru July and were seen in the following years: 1972, 1990, 1991, 2001, 2004, 2005, 2006, 2013 and 2014.

There was a somewhat mixed response to nitrate stress within the macroinvertebrate community within the reach (see table below). Only two of the three visits had slightly above average Nitrate Index scores suggesting that nitrate is not likely a significant form of stress within the reach. This is consistent with a slight above average percentage of nitrate tolerant individuals at two of the three visits on the reach and marginally above average numbers of nitrate tolerant taxon at the same two stations. There were low quantities of nitrate intolerant taxa across all visits the reach and an overall absence on generally intolerant taxa, which could be attributed to other stressors. Low percentages of trichoptera and non-hydrosychid trichoptera may also be a potential indication of nitrate related stress.

Table 354. Macroinvertebrate metrics that respond to nitrate stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Sample Year)	Macroinvertebrate Taxa Count	Collector-filtererCh	Collector-gathererCh	EPT	Intolerant 2 Ch	Tolerant2ChTxPct	Trichoptera Taxa	% Non-hydropsychid trichoptera TrichwoHydroPct	Nitrate Index Score	Nitrate Intolerant Taxa	Nitrate Tolerant Taxa	Nitrate Tolerant Pct	Nitrate concentration at time of fish sample (mg/L) (Fish Visit Date)
03MN068 (2003)	41.00	**3.00**	15.00	16.00	**0.00**	73.17	**7.00**	**4.57**	2.55	**0.00**	14.00	25.10	10.00 (7/15/2003)
03MN068 (2013)	37.00	**5.00**	13.00	12.00	**0.00**	**81.08**	**6.00**	**3.82**	**2.95**	**1.00**	**19.00**	**48.40**	3.20 (7/24/2013)
03MN068 (2013)	**32.00**	**2.00**	12.00	**11.00**	**0.00**	**81.25**	**3.00**	**1.12**	**3.01**	**0.00**	**17.00**	**47.80**	1.40 (8/7/2013)
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*35.50*	*5.76*	*11.93*	*11.40*	*0.83*	*74.35*	*11.40*	*9.90*	*2.90*	*2.00*	*15.00*	*47.40*	
Expected response to Nitrate stress	↓	↓	↓	↓	↓	↑	↓	↓	↑	↓	↑	↑	

Fish are not generally good indicators of nitrate related stress in a reach. Biological metrics that respond to nitrate stress in fish communities are general in nature and may be responding to other stressors in the reach. There was an absence of intolerant taxa and low quantities of sensitive taxa across all visits. 2/3 of the visits had high quantities of tolerant taxa and low quantities of darter taxa, which may also be signs of stress.

While elevated nitrate concentrations were identified on the reach a majority of data collected suggest that elevated nitrate concentrations are not a persistent problem in the reach. At present, a majority of the data does not suggest nitrate is stressing macroinvertebrate communities in the reach; however, metric data suggests that response to nitrate stress metrics is on the rise and could continue to rise if nitrate concentrations are not kept in check and could potentially stress macroinvertebrate communities in the future. Present data and understanding of the impacts of nitrate stress on fish communities make nitrate an inconclusive stressor for this indicator at this time.

Suspended sediment

Three TSS samples were collected during biological monitoring at station 03MN068 in 2013 and 2003. TSS concentrations ranged from 60 mg/L on August 7, 2013 to 91 mg/L on July 15, 2013; two of samples exceeded the southern regional TSS standard of 65 mg/L. Additional TSS sampling across the reach has been widespread with 885 samples gathered from 1968 – 1977, 1981-1982, 1984-1985, 1987-1994 and 1996 to 2016. The greatest amount of observations have been collected within the last 10 years. Of those samples taken, 370 were above the TSS standard, with exceedances occurring across most years when samples were taken. A TSS impairment was identified on the reach in 2002.

Macroinvertebrate metrics which respond to elevated TSS concentrations suggest that TSS is a likely stressor within the reach (see table below). The TSS Index score was above the average needed to meet the standard for the Prairie Forest Rivers Class for all three visits within the reach. Few TSS intolerant taxa were identified and there was an abundance of TSS tolerant taxa and individuals at nearly all visits. TSS tolerant individuals comprised 67.83 – 75.30% of total individuals found across the visits. Low quantities of plecoptera taxa and collector filterer taxa were identified at two of the three visits; low quantities of these species can be attributed to sedimentation within the reach limiting available coarse substrate habitats.

Table 355. Macroinvertebrate metrics that respond to high TSS stress in Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	Collector-filtererPct	PlecopteraPct	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
03MN068 (2003)	**7.32**	**0.00**	**22.52**	4.00	**1.79**	14.00	**75.30**
03MN068 (2013)	**1.97**	**0.28**	**24.11**	**2.00**	**1.12**	**15.00**	**82.40**
03MN068 (2013)	26.43	1.27	**20.54**	**1.00**	**0.32**	**16.00**	**67.83**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*22.95*	*0.55*	*18.38*	*2.52*	*3.91*	*14.09*	*49.06*
Expected response to TSS stress	↓	↓	↑	↓	↓	↑	↑

The fish community is showing a mixed response to TSS stress metrics in the reach (see table below). The TSS Index score was elevated across 2/3 of visits on the reach for the southern rivers class, suggesting a potential for elevated TSS stress. There was also an absence of TSS intolerant taxa across the reach. However, above average quantities of TSS tolerant individuals were only observed during the 2003 visit. All visits had below average quantities of long-lived taxa, perciformes, riffle dwelling taxa, sensitive taxa and generally intolerant taxa. Only the 2003 visit had below average quantities of herbivores while 2/3 of visits had below average quantities of simple lithophilic spawners and benthic feeders. Overwhelmingly the fish community is showing a negative response to sedimentation, which can be a direct result of elevated levels of suspended sediment in a reach, burying complex habitats needed for a diverse fish community to thrive. Present metric evidence suggests that there has potentially been some reduction in response to TSS stress when comparing 2003 visit to the 2013 visit. However, lingering impacts remain as potential sedimentation has resulted in below average scores for many habitat related TSS metrics.

Table 356. Fish metrics that respond to high TSS stress in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BenFdFrimPct	Centr-TolPct	HrbNWQPct	IntolerantPct	LlvdPct	Percfm-TolPct	RifflePct	Sensitive Pct	SLithFrimPct
03MN068 (2003)	**7.76**	**0.00**	**0.90**	**0.00**	**15.82**	**3.28**	**2.99**	**1.19**	**7.16**
03MN068 (2013)	**15.76**	**0.00**	1.50	**0.00**	**12.20**	**6.57**	**7.50**	**4.50**	**12.95**
03MN068 (2013)	32.10	**0.00**	2.47	**0.00**	**30.86**	**4.94**	**7.41**	**3.70**	29.63
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	**21.36**	**4.12**	**1.04**	**4.63**	**43.61**	**17.97**	**13.92**	**13.53**	**24.97**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓

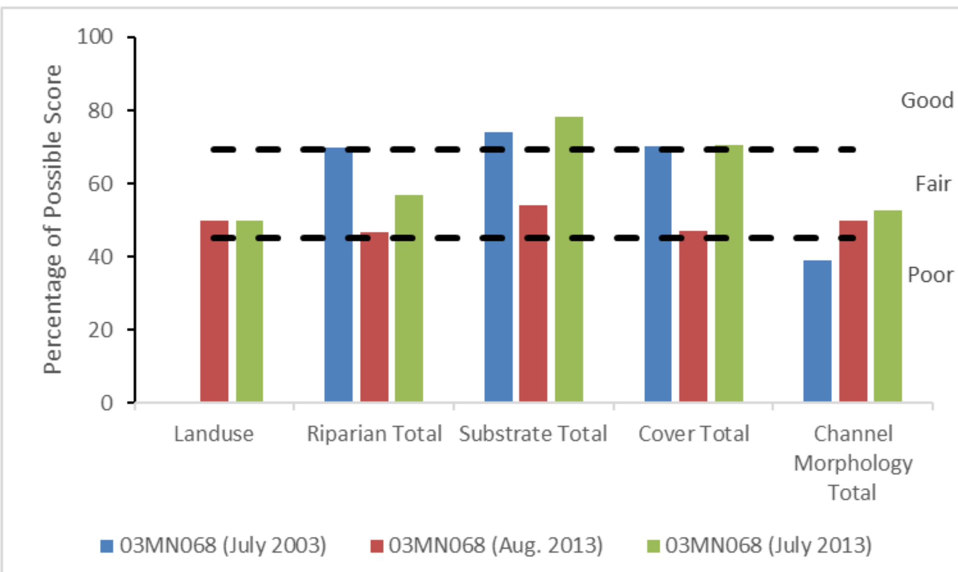
Station (Year sampled)	TSS Index Score	TSS Intolerant Taxa	TSS Intolerant Pct	TSS Tolerant Taxa	TSS Tolerant Pct
03MN068 (2003)	**31.93**	**0.00**	**0.00**	6.00	**73.00**
03MN068 (2013)	**29.27**	**0.00**	**0.00**	5.00	60.00
03MN068 (2013)	28.02	**0.00**	**0.00**	4.00	48.00
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*28.61*	*0.47*	*0.95*	*10.34*	*66.97*
Expected response to TSS stress	↑	↓	↓	↑	↑

A strong TSS dataset identified a TSS impairment on the reach in 2002; recently collected TSS data indicates that TSS continues to be a persistent problem in the reach. Macroinvertebrates in the reach showed a clear negative response to TSS stress metrics, indicating TSS stress in the reach while there was a less clear response to the fish community resulting in an inconclusive conclusion of TSS stress for that indicator.

Habitat

Three MSHA qualitative habitat surveys have been conducted within the reach at station 03MN068, once in 2003 and twice in 2013 (see graph below). The average score was 56.72 (Fair). Landuse in the upstream watershed is predominately row crop agriculture; much of the riparian zone along the reach is wooded with moderate to wide riparian buffers. There are a handful of small to moderately sized livestock operations upstream of the biological station on the reach including several swine operations and one large poultry facility. While no stream bank erosion was identified in 2003, heavy erosion was apparent during 2013 visits (see photo below). Natural channel development also improved overtime, only runs were observed in 2003, pools and a riffle were identified in subsequent 2013 visits. There was a good mix of substrates, with moderately embedded coarse substrates. Instream habitat cover was identified as sparse to moderate. Overall channel stability was moderate, due to bed load and bank stability concerns. Individual MSHA category scores for the station can be seen in the graph below.

Figure 290. Percentage of MSHA subcategory scores for station 03MN068, Watonwan River.



The fish community metrics show mixed response to habitat related stress (see table below). There was a higher than average percentage of tolerant species and pioneering species. There were lower than average quantities of piscivores and riffle dwelling species across all visits. All metrics responded negatively to their respective thresholds during the 2003 visit; however, more recent data shows discrepant results in quantities of simple lithophilic spawners, lithophilic spawners, non-tolerant benthic insectivores and the overall abundance of darter, sculpin and round bodied suckers. Low quantities of piscivore taxa reflect a fish community with few top predators, inferring the fish community's trophic structure is generally imbalanced. High quantities of pioneering species suggest habitat disturbance, as pioneering species are generally found in greatest numbers at highly disturbed habitats where other fish have been displaced. Low quantities of riffle dwelling species are consistent with the limited presence of riffles within the reach. While low quantities of lithophilic and simple lithophilic spawners could indicate sedimentation in the reach of coarse substrates. Results suggest that potentially habitat conditions have improved somewhat over time but are still unstable.

Table 357. Fish metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	Piscivore Percent	LithFrimPct	DarterSculpSucPct	Pioneer Percent	RifflePct	BenInsect-TolPct	SLithopPct
03MN068 (2003)	**37.31**	**1.19**	**10.75**	**10.45**	**14.03**	**2.99**	**10.45**	**10.75**
03MN068 (2013)	**65.67**	**0.00**	**16.7**	19.14	**17.28**	**7.50**	**19.14**	32.10
03MN068 (2013)	**49.38**	**0.94**	34.57	33.33	**17.45**	**7.41**	33.33	**16.70**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	*15.18*	*29.21*	*18.51*	*5.21*	*13.92*	*20.61*	*24.97*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓	↓	↓

Similar to the fish community, the macroinvertebrate community is showing a mixed response to degraded habitat metrics (see table below). All visits had below average numbers of sprawler and climber taxa and above average quantities of burrowing taxa. Below average quantities of climber taxa maybe be related to an absence of aquatic macrophytes in the reach and limited availability of overhanging vegetation. Only woody debris and rock riffle habitat were sampled in the reach at all visits. An abundance of burrowing obligates suggests that sedimentation is problematic in the reach. Low quantities of clinger taxa were observed at two of three visits on the reach, numbers of clinger taxa are generally higher when woody debris and coarse substrates are the primary habitats sampled in a reach. Higher numbers of sprawling taxa would also be expected for the same reason. Metric results suggest that potentially habitat conditions have improved somewhat over time, as some of the 2013 metric scores are above class averages including legless, EPT and clinger taxa. However, overwhelmingly metric data suggests that habitat conditions remain unstable in the reach and are stressing the macroinvertebrate community.

Table 358. Macroinvertebrate metrics that respond to degraded habitat conditions in the Watonwan River compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN068 (2003)	**8.84**	**13.11**	**37.50**	**48.17**	**28.66**	**26.52**
03MN068 (2003)	**15.17**	**2.25**	**19.66**	**23.03**	17.98	**12.92**
03MN068 (2013)	**13.06**	**4.46**	58.92	66.88	13.38	**21.02**
Statewide average Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31)	*6.92*	*14.03*	*43.19*	*54.79*	*25.94*	*27.00*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

While overall MSHA habitat scores in the reach are fair, upon closer inspection present habitat conditions are limiting aquatic biology in the reach. Limited habitat diversity, natural channel protection, sedimentation and overall habitat availability are effecting biological communities. In addition, metrics evidence implicates stress in the reach. A preponderance of evidence suggests that habitat is a stressor to both indicators in the reach at this time.

Figure 291. Biological station 03MN068 (August 2, 2013) stream bank erosion.

Altered hydrology/Longitudinal connectivity

There are no known dams along the reach; however, the Rapidan dam on the Blue Earth River is about four miles downstream of the Watonwan River's confluence with the Blue Earth River. Migratory fish species on the Minnesota River are impeded by this structure in their ability to migrate up into the Blue Earth and Watonwan River Watersheds. Within the reach, 29 fish taxa were captured; 11 of these species are known migratory taxa (see table below). Abundant diversity within the reach and prevaleance of migratory taxa suggests that longitudinal connectivity is not likely having great negative impacts on the fish community at this time. During DNR mussel surveys from 1999-2003, 15 unique mussel taxa were identified in the reach, including: *Anodontoides ferussacianus* (cylindrical papershell), *Actinonaias ligamentina* (mucket), Alasmidonta marginata (elktoe), Ambema plicata (threeridge), Lampsilis cardium (Plain pocketbook*), Lasmigona companata* (White heelsplitter), *Lasmigona costata* (fluted shell), *Leptodea fragilis* (fragile papershell), *Ligumia recta* (Black sandshell), *Lampsilis silquoidea* (fatmucket), *Pyganoson grandis* (giant floater), *Potamilus ohiensis* (Pink Papershell), *Quadrula* (maple leaf), *Strophitus unduatus* (creeper) and *Toxolasma parvus* (Lilliput). Abundance of mussel taxa in the reach is another indication that longitudinal connectivity is not a likely stressor in the reach as mussel taxa rely on migratory fish species to complete their life cycles.

Preponderance of data suggests that longitudinal connectivity is not a likely stressor on the reach at this time. However, any effort to limit the connectivity impacts of the Rapidan Dam would likely have beneficial implications for the fish communities within both the Watonwan River and Blue Earth River Watersheds.

Table 359. Taxa comparision of biological stations along reach. Taxa in bold are known migratory fish species. Biological stations are organized from upstream most station to downstream from left to right. Fish species in bold are known migratory fish. Fish species in blue are known lake species.

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
WID	-563	-511	-511	-510	-510	-510	-501	-501
Common Name								
bigmouth buffalo				x				
bigmouth shiner	x	x			x	x	x	
black bullhead	x	x		x			x	
blackside darter	x	x	x		x	x	x	x
blacknose dace		x				x		
bluntnose minnow	x	x	x	x	x	x	x	x
brassy minnow	x	x		x	x		x	
central stoneroller	x	x	x			x		x
channel catfish	x	x		x		x	x	x
common carp	x	x	x	x	x	x	x	x
common shiner	x	x						
creek chub	x	x	x		x	x		x
fantail darter								x
fathead minnow	x	x				x	x	
golden redhorse	x		x	x	x	x	x	x
green sunfish		x					x	x
highfin carpsucker				x				
johnny darter	x	x	x	x	x	x	x	x
largemouth bass	x	x	x	x	x			
mimic shiner				x				
northern hogsucker	x		x	x	x	x	x	x
northern pike	x	x	x	x	x		x	
orange spotted sunfish	x						x	x
quillback	x	x	x	x	x	x	x	x
river carpsucker		x						x

Field Number	13MN145	01MN052	13MN135	13MN161	13MN162	13MN130	03MN068	90MN100
sand shiner	x	x	x	x	x	x	x	x
shorthead redhorse	x	x	x	x	x	x	x	x
silver redhorse	x		x	x		x	x	x
slenderhead darter	x	x	x	x		x	x	x
spotfin shiner	x	x	x	x	x	x	x	x
stonecat			x					x
walleye	x	x	x	x	x	x		x
white sucker	x	x	x	x		x	x	x
yellow bullhead		x	x				x	
yellow perch	x		x	x	x	x	x	x

The Altered watercourses GIS layer for Minnesota streams indicated that the 17.88 mile long reach of the Watonwan River (-501) is 100% natural. Many of the watershed's headwater tributaries have been extensively altered in an effort to increase arable land and overall crop production. Modifications, including tile drainage, wetland draining and stream straightening and dredging efforts have reduced the residence time of precipitation events and have hastened the ability for water to move off the landscape and into the Watonwan's ditch, stream and river network. Increased flows during storm events move high volumes of water, destabilizing streams banks and carrying with them large volumes of sediment, which have negative impacts on instream habitat and aquatic communities.

According to CADDIS, bank erosion and instability, and undercut banks are site evidence that altered hydrology is a potential stressor. The DNR geomorphology stream survey crew identified the reach as an entrenched F4 channel. While this stretch of the Watonwan has wide forested buffers, the river is in a state of widening and aggradation, a result of downstream Rapidan dam, which has reduced stream flow and attributed to higher sediment loads. Compared to other sites in the watershed, this stretch of the Watonwan has an average sediment supply.

Wetland drainage and extensive systems of tile drainage within the upstream watershed have reduced water storage on the landscape resulting in increased peak flows during storm events. Higher flows have increasing power to scour stream banks and degrade habitat conditions, including widening stream channels, covering coarse substrates and filling in pools and riffles.

There were low quantities of riffle dwelling and long-lived taxa within the reach. Limited representation from taxa in these metrics imply that low flow conditions are present in the watershed and may suggest that altered hydrology is a likely stressor in the reach. In addition, three known lake fish taxa were identified in the reach. Presence of lake taxa could imply low flow or lentic conditions in the reach that could also be a result of altered hydrological stress within the reach (see table below).

Table 360. Fish metrics that respond to altered hydrology stress compared to the statewide average of visits meeting the general use biocriteria. Bold indicates metric value indicative of stress.

Station (Year sampled)	TolPct	LlvdPct	RifflePct
03MN068 (2003)	**37.31**	**15.82**	**2.99**
03MN068 (2013)	**65.67**	**12.20**	**7.50**
03MN068 (2013)	**49.38**	**30.86**	**7.41**
Statewide average Class 1 Southern Rivers stations that are meeting the General Use Threshold (49)	*22.05*	**43.61**	*13.92*
Expected response to Altered Hydrology stress	↑	↓	↓

In 2012, southwestern Minnesota experienced a significant drought; low flow conditions observed may have also been influenced by extreme climatic conditions. While photographs were taken in September of 2012 at the biological station within the reach, it does not appear that extreme low flow or dry streambed conditions occurred within the reach.

Present data suggests there is insufficient information to implicate altered hydrology as a stressor within the reach at this time.

Figure 292. Biological station 03MN068 (June 28, 2016) drain tile.

4.1.3. AUID Summary

Habitat is a stressor to both fish and macroinvertebrates within the reach, while TSS is a conclusive stressor only to the macroinvertebrate community in the reach. The turbidity impairment identified in 2002, had been confirmed by more recent data gathered in the reach. The macroinvertebrate community has shown a strong negative response to elevated TSS concentrations with above average quantities of TSS tolerant taxa. High levels of TSS are likely connected to stream bank erosion observed during MSHA investigations on the reach and are contributing to instream sedimentation of coarse substrates, reducing the quality of available habitat types and limiting the establishment of aquatic macroinvertebrates. While the fish community metrics are responding negatively to sedimentation related metrics in the reach, there is a less clear response as to whether or not TSS itself is stressing fish communities and will remain inconclusive as a stressor at this time. In comparing 2003 results to data from 2013 visits, data suggests potentially small improvements have been made over time in the level of habitat and TSS stress in the reach; however, more work is needed to improve present conditions on the reach.

Low DO is an inconclusive stressor on the reach for the fish community at this time. A large chemical dataset suggests that low DO conditions are not prevalent on the reach; however, the dataset is old, includes a limited quantity of DO samples collected prior to 9 am and does not include any continuous DO monitoring. The low DO index score for all visits in the fish community was marginally below the average needed to meet standards across all visits, this suggests potential for stress. There were also marginally above average quantities of low DO tolerant taxa and above average quantities of low DO tolerant individuals at two of three visits, with the highest quantity occurring in the most recent visit. The present dataset is inconclusive until additional continuous DO monitoring can better characterize potential for low DO conditions to occur within the reach. While low DO is not likely the primary stressor impacting the fish community in the reach, it may be a contributing stressor. At present, the macroinvertebrate metrics do not suggest that low DO is a stressor to that community at this time.

Eutrophication is an inconclusive stressor in the reach at this time as well. While elevated phosphorous concentrations are consistent across the reach, only 11% of Chlorophyll a samples collected suggest that elevated phosphorous concentrations may be impacting aquatic communities. In addition, of those elevated samples collected, most are from the late 90s and early 2000s and few fall into the most recent 10-year assessment window. Metric data from both indicators does not show a strong response to eutrophication stress metrics which are already general in nature and may be responding to other stressors in the reach. Additional response variable data in the reach is limited to old BOD data with most elevated concentrations occurring prior to the early 1990s. Additional response variable data would be useful to better characterize potential eutrophication stress in the reach.

Altered hydrology is an inconclusive stressor in the reach at this time. While low flow conditions were present in the watershed in the fall of 2012, this reach had sufficient water levels to support biological communities. Low quantities of long-lived taxa and the presence of lake species in the reach suggests that more lentic conditions can occur within the reach, which may be the result of altered hydrological conditions and the downstream impoundment. Additional information is needed to understand potential for altered hydrology stress within the reach.

Nitrate is not a stressor to the macroinvertebrate community at this time. While elevated nitrate concentrations were identified in the reach, concentrations were only above 15 mg/L about 5% of the time. Metric data suggests that nitrate concentrations in 2013 may have been higher compared to 2003, suggesting a potential increase in exposure over time or year-to-year variation. Nitrate concentrations should continue to be monitored to insure the nutrient does not become a stressor in the future. Nitrate is an inconclusive stressor to the fish community due to the lack of adequate metrics to properly identify nitrate related stress in that indicator.

Longitudinal connectivity is not a stressor to fish communities on the reach. There is an abundance of migratory fish taxa and mussel diversity within the reach. However, watershed as a whole would likely benefit from modifications to allow fish migration from the Minnesota River upstream of the Rapidan Dam to allow the influx of once extirpated species in the watershed.

Table 361. Summary of stressor determinations for Watonwan River (501).Table 4.346. Summary of stressor determinations for Watonwan River (501).

		Stressors:						
Stream Name		**Dissolved Oxygen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Altered Hydrology**	**Connectivity**
Watonwan River	07020010-501	o/-	o	o/-	o/●	●	o	-

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

5. Evaluation of Candidate Causes of Lake Investigations organized by Lake

5.1 Lake Hanska, 08-0026-00, Brown County

Impairment: An assessment conducted in 2014 determined Hanska Lake was impaired for Aquatic Life use based on the Fish IBI (FIBI). The FIBI Tool 7 was used to calculate a score using fish data collected in 2012 and resulted in a score of 14. The impairment threshold for FIBI Tool 7 lakes is 36 and the 90% confidence interval is 27-45.

5.1.1 Biology

Fish Community: Basin characteristics place Lake Hanksa in lake class 41, which is scored with the FIBI Tool 7. Lakes assessed with FIBI Tool 7 are characterized as over 80% littoral with hard water and are primarily located in the southern and western parts of Minnesota. Many lakes assessed with FIBI Tool 7, including Hanska, would have frequent winterkill of some degree without winter aeration systems.

The diversity of insectivore species, small benthic dwellers, and vegetation-dwelling species were all low compared to other FIBI Tool 7 lakes of similar size. The number of tolerant species and proportion of tolerant species (primarily Common Carp) in some gears was high. Fish sampled at Lake Hanska included five insectivorous species and one species considered vegetative-dwelling in the Fish IBI. Channel Catfish dominated the gill net catch (43% of gill net catch biomass), Common Carp were the dominant species by biomass in the trap nets, and Bluegill was the most abundant species in nearshore sampling gear. Five tolerant species were captured across all gears combined. Common Carp comprised 13% of the gill net biomass and 35% of the trapnet biomass. Black Bullhead accounted for 6% of the gill net biomass and only 3% of trapnet biomass. Bigmouth Buffalo, Green sunfish, and Fathead Minnow, while present, were sampled in low numbers. These fish community indicators and a low proportion of centrarchids in the trap net catch (23% by biomass) likely reflect poor water quality and a lack of complex nearshore habitat. Note that the overall number of fish sampled in the nearshore survey was low compared to similar lakes (only 148 total fish were sampled) and sampling visibility during electrofishing was noted as poor, which likely limited sampling effectiveness at some stations.

Historically Lake Hanska's fish community was influenced by its connection to the Watonwan River. Over the past 40 or so years, the fish community of Lake Hanska has been affected by intensive lake management actions directed at improving habitat for wildlife and fishing opportunities including: dam installation and replacement, dredging, chemical reclamation, drawdowns and reverse aeration, fish stocking, and winter aeration. See discussion in the in-lake disturbance section.

Plant Community: A tool to evaluate aquatic life use in lakes based on aquatic plant community data is currently being developed. A transect plant survey on Lake Hanska was completed by DNR Fisheries in 2006. Ten aquatic plant species were sampled including six submerged species and the floristic quality index was 16. This scored above the thresholds for plant assessment (Radomski and Perleberg, 2012). Note that the Radomski and Perleberg plant community indices were designed to respond to nutrient impairment and resulting loss in water clarity and work continues to develop tools to describe impairments to the nearshore fringe plant community (emergent and/or floating-leaf).

5.1.2. Data evaluation for Each Candidate Cause

Watershed disturbance

The contributing watershed for Lake Hanska is about 25,000 acres (the ratio of watershed to lake size is about 14:1). About 80% of the contributing watershed is classified as cultivated and 5% as developed (National Land Cover Database (NLCD)2011) – see Figures 1 and 2. The percent of developed and cultivated land cover remained unchanged from 2001 – 2011 (NLCD). Corn was the most common crop type each year from 2006-2014, and was present on 40-55% of the land within the contributing watershed. Soybeans and/or legumes were also common. Few wetlands remain in the contributing watershed (about 6% of contributing watershed). There are about 45 permitted feedlots in the contributing watershed (MNPCA Feedlots ArcGIS layer 4/2015).

Lake Hanska receives surface water from Judicial Ditch 5, County Ditch 33, and through a wetland feature on the northwest portion of the lake. The ditches drain agricultural fields (see Figure 295 and Figure 296) and based on aerial imagery, there does not appear to be a vegetated buffer adjacent to much of the land adjacent ditches flowing into Lake Hanska. There are no lakes upstream of Lake Hanska.

Lake Hanska has an outlet located on the southeast part of the lake, which drains through a channel to the Watonwan River. There is a variable crest dam at the outlet with stop logs. The dam controls the water level of Lake Hanska, and is a barrier to fish immigration at most flows according to the DNR lake management plan. It may not be a complete barrier to fish migration at high flows. See Figure 297.

Figure 293. Lake Hanska - 2011 NLCD Land Cover Classification.

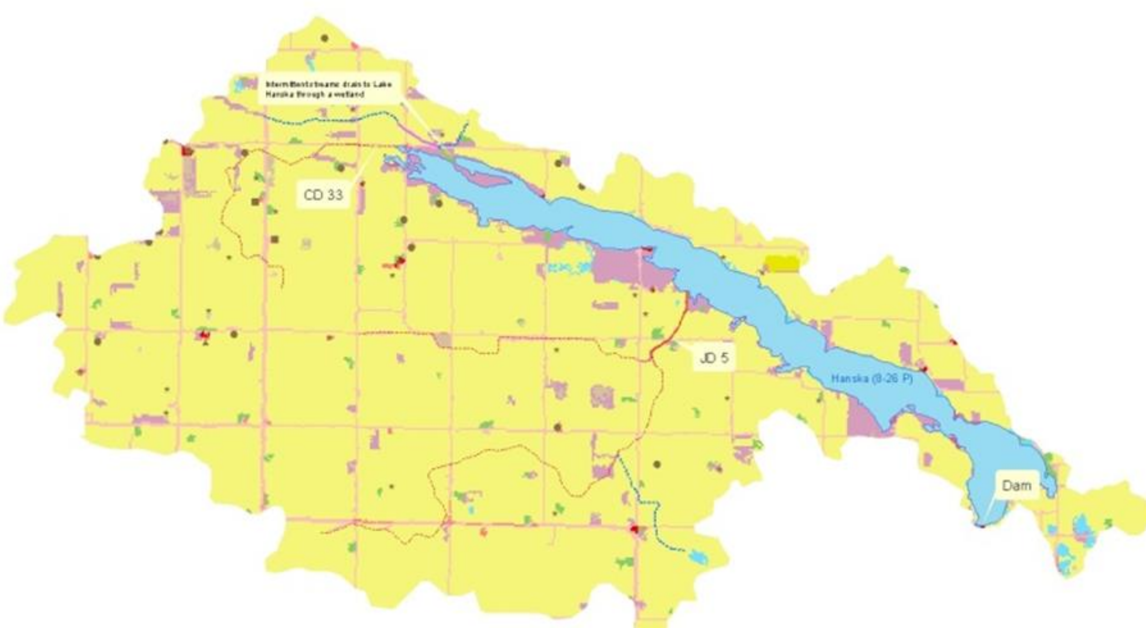


Figure 294. Lake Hanska - Contributing watershed landuse and crop type.

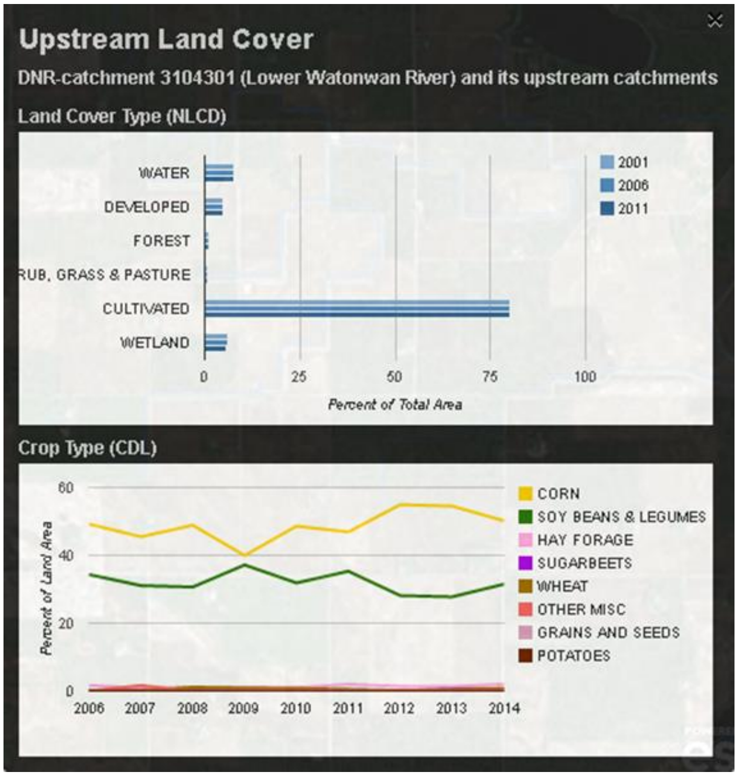


Figure 295. Lake Hanska - Network of Ditches (blue) and Drain tile (brown) from Brown County GIS website, 2015.

Figure 296. Lake Hanska contributing watershed, FSA 2013.

Figure 297. Lake Hanska - Dam at Outlet.

Riparian disturbance

Publicly owned lakeshore includes three public water access sites, a Wildlife Management Area along about 3 km of southern shoreline and a county park on the eastern end of the lake. The remaining lakeshore has agricultural land and areas of residential development density that has resulted in about 1-2 docks per km of shoreline, based on 2013 Google Earth imagery color aerial photography (photo date 9/30/2013). An assessment of shoreline habitat was conducted in June 2015 following Score the Shore survey (Figure 298) protocols and resulted in a mean score of 83/100, indicating the shoreline habitat is generally in good condition. Much of the shoreline has a fringe of cattails and trees in the immediate shore land area, which contributed positively to the score. Emergent vegetation, nearly all cattails, was mapped during September 2015 (Figure 299).

Figure 298. Lake Hanska - Score the Shore Survey.

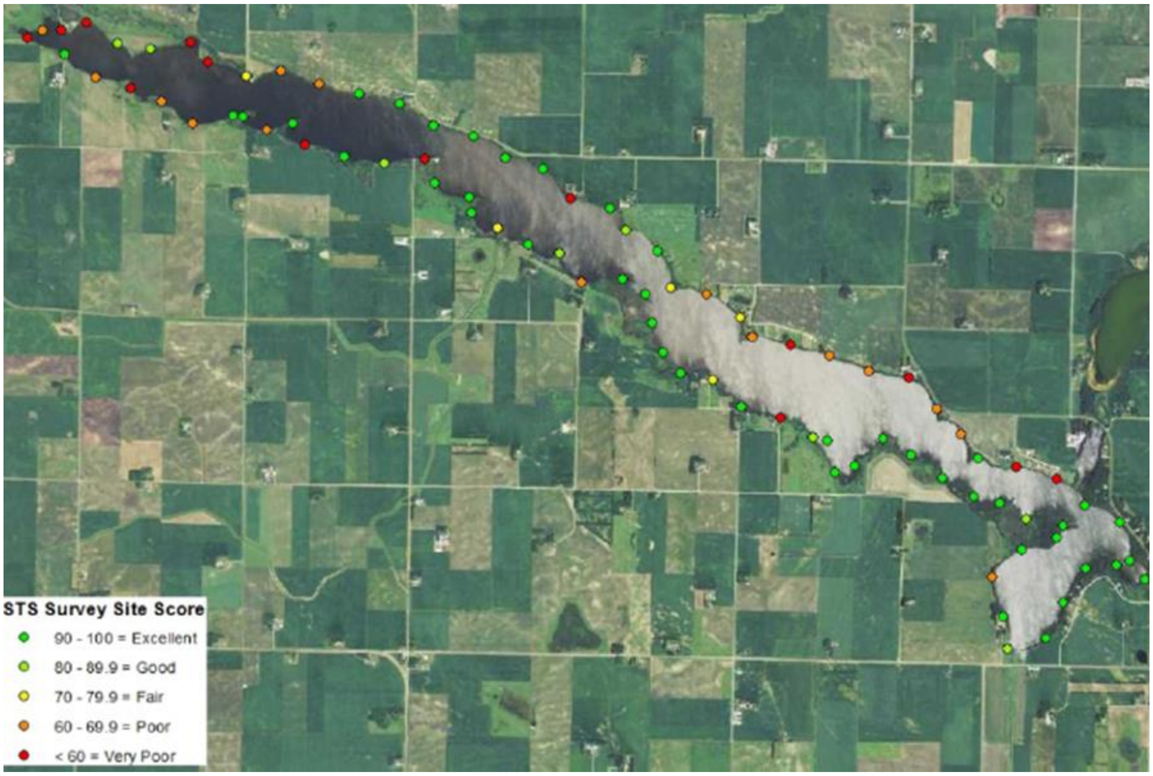
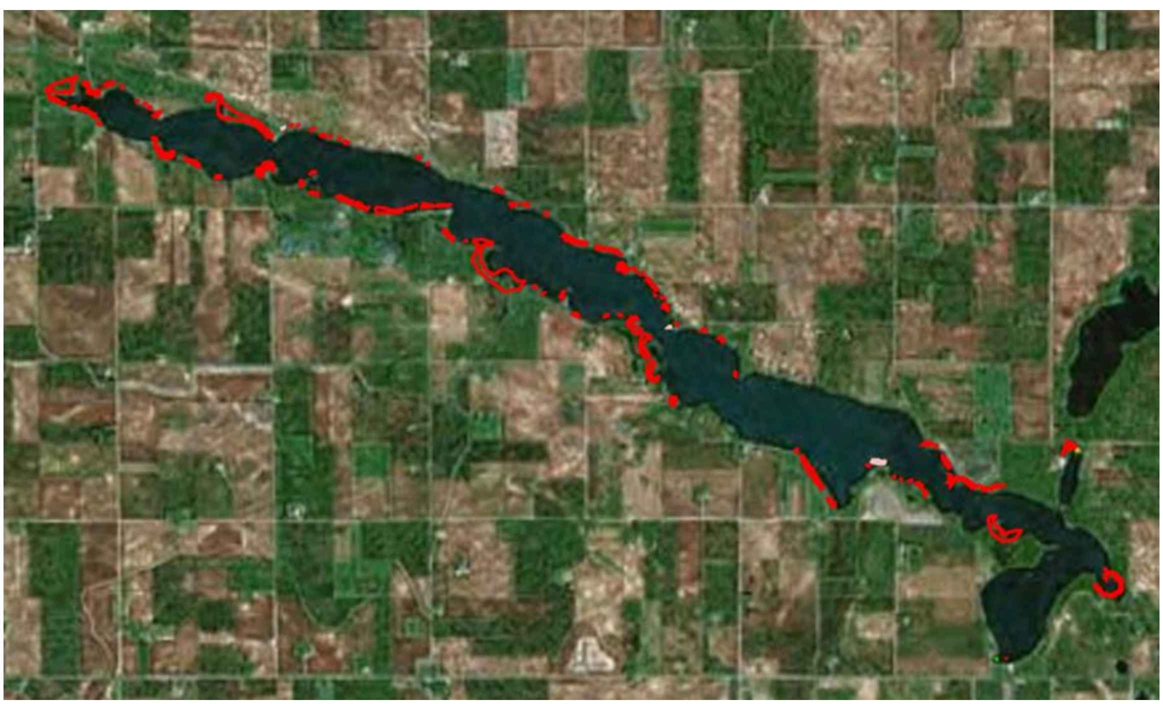


Figure 299. Lake Hanska - Emergent Vegetation Mapped, September 2015.



In-lake habitat disturbance

Hanksa Lake is long and narrow with a northwest-southeast orientation, making it vulnerable to wind fetch from prevailing winds. Maximum depth is 16 feet, but much of the lake is shallower than four feet (Gene Jeseritz, pers. communication). Waves created by wind energy can greatly affect a shallow lake. Possible affects can be a continuous churning up of bottom sediments and the subsequent lack of water clarity. A lack of water clarity, during the summer, greatly affects the abundance and species composition of aquatic vegetation that is present. The severe wind, besides creating low water clarity, can directly uproot vegetation. This type of dramatic disturbance ultimately affects fish abundance and species composition.

Lake Hanska has undergone significant manipulation for the purpose of creating waterfowl habitat, enhancing fishing, and providing other recreational opportunities. A dam was first installed in 1912, and a grade stabilization structure was installed at the outlet in 1974; the barrier was replaced in 1985. Areas of the lake were dredged from 1985-1997, impacting 355 acres. A draw-down of the lake followed by a rotenone treatment was completed in 1988-1989 in an attempt to eliminate Common Carp from the lake. Game fish were subsequently restocked into the lake, however Common Carp were again observed in 1991. An aeration system was installed in 1995, but there were several partial winterkills noted. Another draw-down was completed in 1999-2001 to reestablish emergent vegetation. Reverse aeration was attempted during the draw-down to induce a fish kill targeted at Carp and Black Bullheads. The reverse aeration did not eliminate fish and may have triggered a recruitment response of Black Bullhead. Following a peak in numbers, Black Bullhead numbers have been falling over the past decade or so. A second aeration system on the other end of the lake was installed and remains in operation. Commercial removal of fish has been documented since at least 1940 and continues to present including removal of Common Carp, Buffalo, Drum, and Bullheads. Stocking records indicate Black Crappie, Bluegill, Channel Catfish, Largemouth Bass, Northern Pike, Walleye, and Yellow Perch have been stocked since 1990. Since 2002, stocking has been limited to Walleye. No winterkill has been observed in recent years, likely due to the two aeration systems keeping a significant portion of the lake oxygenated.

The 2006 DNR Fisheries survey noted little in-lake vegetation and lots of silt. A DNR Fisheries plant transect survey was completed in August 2006. Cattail and Filamentous algae were the most frequently encountered species on 40 transects. Six submerged species were sampled, but all were noted as rare in abundance. Surveyors recorded plants to 3.5 feet of depth.

Because Lake Hanska is a designated Wildlife Lake, it has also been surveyed by DNR Wildlife. The DNR Wildlife Lake Management Plan describes conditions in the 1980s as bottom sediments primarily composed of muck, and sand along most of the shoreline. The plan describes conditions at the time as turbid water, a lack of aquatic vegetation, high numbers of “rough fish”, wind and wave action, and persistent algae blooms. The plan provides a history of aquatic plant surveys noting that a 1938 survey (Moyle) observed heavy submerged and emergent vegetation. A 1947 survey reported almost no vegetation, and a 1976 survey reported “good growths of both emergent and submerged aquatic plants”. In 1984 vegetation was described as very poor, limited to a band of emergent and sago pondweed out to less than 4 feet of depth. DNR Wildlife conducted three point-intercept plant surveys more recently after the drawdown – in July 2002 and 2003. The 2002 survey noted cattail and bulrush present around most of the shoreline and submerged vegetation found in small, scattered dense clumps in the middle portion of the lake. The 2003 survey described sago pondweed as thick in the north half of the lake in depths to 3.5 feet with overall low diversity. It also noted a cattail fringe.

Few Aquatic Plant Management permits have been issued on the lake and have been mostly limited to 15-foot channels through emergent vegetation for dock installation. Since 2005, several restoration orders have been issued, by the DNR, to land owners who had destroyed cattails adjacent to their lakeshore property without a permit.

Chemistry

According to the PCA website (April 30, 2014), data collected from 2004-2013 indicated the average secchi transparency was 1 meter, average chlorophyll A was 28 ppb, and average total phosphorus was 200 ppb – classifying the lake as hypereutrophic. There was no trend in transparency noted in recent years.

5.1.3 Lake summary

Biological data indicate the fish community of Lake Hanska is impaired by human disturbance. Although the hydrology of the area has been severely altered by draining wetlands and ditching, and the lake itself has had extensive manipulations, the lake likely had low fish species richness prior to settlement due to its shallow depth. The primary stressors that are responsible for the current impairment to aquatic life use include watershed land use and lack of in-lake fish habitat.

Watershed land use and water quality are the primary candidate stressors. These two stressors are related, as excess nutrients can be partially due to watershed disturbance. Modeling by Cross and Jacobson in Minnesota lakes suggests that total phosphorus concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area and this relationship tends to be stronger in shallow lakes (Cross and Jacobson, 2013). Additional phosphorus is associated with reductions in water clarity, oxygen levels, and submerged vegetation as well as increases in algae and abundance of tolerant fish species such as Common Carp and Black Bullhead.

In-lake habitat disturbance is likely partially responsible for the impairment. There is a lack of complex in-lake habitat which undoubtedly impacts the fish community by favoring species that do not rely on vegetated areas; submerged vegetation was noted as extremely rare in distribution in the 2006 DNR Fisheries survey. The shape and orientation of the lake make it vulnerable to wind and wave energy which likely dislodges vegetation and reduces water clarity.

Shoreline development reduces the availability and quality of shoreline habitat, but on Hanska Lake shoreline disturbance is likely a relatively small contributor to the fish impairment. Estimators of shoreland disturbance and the number of docks per kilometer of shoreline are below levels that are likely to impact fish and plant communities. Effort should be focused on protecting existing emergent vegetation and riparian buffers.

5.2 Bingham Lake (17-0007-00)

An assessment conducted in 2014 determined Bingham Lake was impaired for Aquatic Life use based on the Fish-IBI. The FIBI Tool 7 was used to calculate a score using fish data collected in 2010 and resulted in a score of nine. Nearshore sampling components were repeated in 2010 and had identical metric values that resulted in the same FIBI score (9). The impairment threshold for lakes assessed with Tool 7 is 36 and the 90% confidence interval is 27-45.

5.2.1. Biology

Fish Community: Bingham Lake falls into Lake Class 43 based on the ecological classification of Minnesota lakes used by DNR – Fisheries and is assessed with FIBI Tool 7. Lakes assessed with this tool are generally characterized as shallow (over 80% littoral), with hard water, and are primarily located in the southern and western parts of Minnesota. Many lakes assessed with Tool 7, including Bingham, would have frequent winterkill of some degree without winter aeration systems.

Diversity of insectivores, small benthic dwellers, and species associated with vegetation were all low compared to other lakes assessed with Tool 7. Tolerant species had a comparatively high diversity (4 species) and Common Carp and Black Bullhead accounted for 99% of biomass in the trap net sample. Walleye, which are stocked regularly, were the most abundant species by biomass in the gill net sample, but the total biomass of top carnivores (other than walleye) was lower than expected. The Fish IBI score was low because all metrics scored poorly.

Fisheries management activities on Bingham Lake (DNR-Fisheries Lake Files, 2015) have included fish stocking, fish removal, DO monitoring, and aeration to prevent winterkill. Commercial harvest of carp and bullhead occurred from 1971-1993. An aeration system was installed in 1986 to prevent winterkill, although low oxygen levels historically occurred infrequently. The system has been used intermittently and the lake last experienced winterkill conditions in 2014 (after the IBI surveys used for this assessment). Summer fish kills can also occur on the lake when the decomposition of algae consumes the available DO, most recently in 2008.

Since 1979, the lake has been stocked with Walleye (fry, fingerlings, yearlings, and adults), Largemouth Bass (fingerlings), Yellow Perch (adults), Black Crappie (fingerlings and adults), Bluegill (adults), and Northern Pike (fingerlings, yearlings, and adults). A Northern Pike spawning area was developed on the southwest side of the lake in the early 1970's, although no increase in recruitment was observed in the lake. The basin was subsequently modified to rear Northern Pike fingerlings for stocking into other lakes in the area. The current management plan calls for regular Walleye fry stocking with supplemental stocking of Yellow Perch and Black Crappie as needed.

Plant Community: A tool to evaluate aquatic life use standards in lakes based on aquatic plant community data is currently being developed but was not available at the time of this assessment. The current plant community indices were designed to respond to nutrient impairment, but do not describe impairments to the nearshore fringe plant community (emergent and/or floating-leaf). No recent plant survey information is available for Bingham Lake, although a transect survey was completed by DNR in 2002 as part of a fisheries assessment. Data from this survey indicate the aquatic plant community was below an impairment threshold identified for similar lakes in the ecoregion based on species richness (Radomski and Perleberg, 2012).

5.2.2. Data evaluation for each Candidate Cause

Watershed disturbance

The contributing watershed has a watershed to lake size ratio of about 5:1 Figure 300 There are shallow lakes located within the watershed but there is no surface water connection to any other game fish lake. Watershed land cover remained stable between 2001 and 2011 based on National Land Cover Datasets (WHAF, 2016). Most of the land cover within the watershed is considered disturbed by human activities and includes cultivated crops (70%) and developed land (6.5%). Cropland is dominated by corn and soybean (Figure 301). The few wetlands that remain account for about 1% of the land cover in the contributing watershed (Figure 302).

Figure 300. Bingham Lake Contributing Watershed Color Aerial Photo, 2013 FSA.

Figure 301. Contributing Watershed Land Cover and Crop Type Summary Bingham Lake, 2011 NLCD.

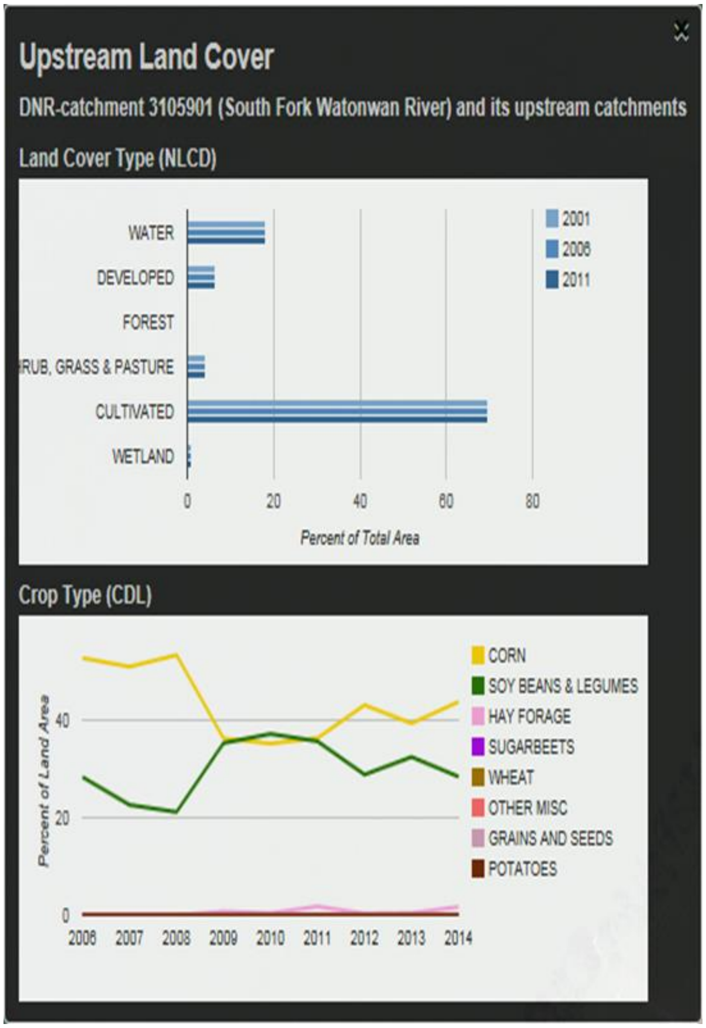
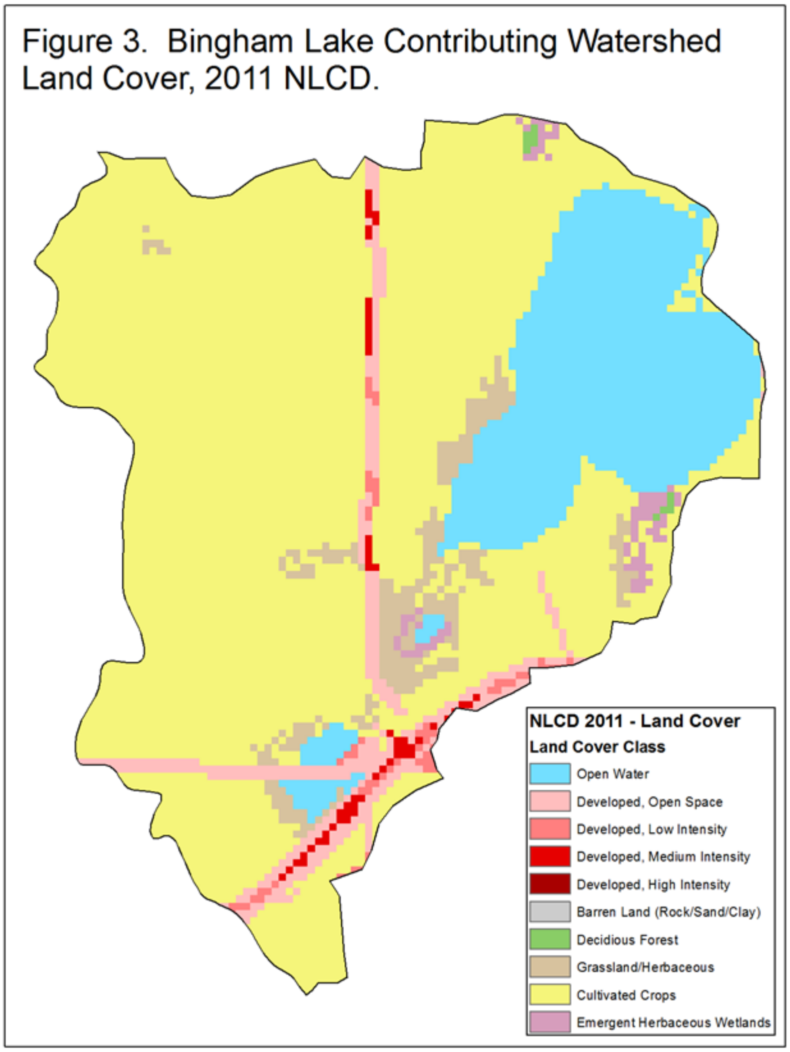


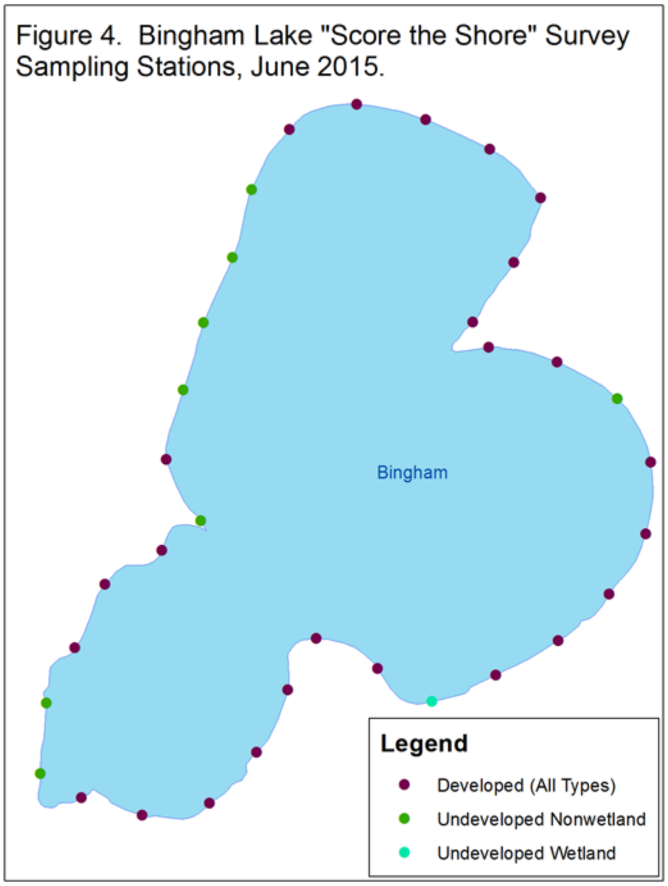
Figure 302. Bingham Lake Contributing Watershed Land Cover, 2011 NLCD.



Riparian disturbance

Bingham Lake is 270 acres in size with a maximum depth of 10 feet and 3.2 miles of shoreline. Lakeshore ownership is primarily private although there is some state owned shoreline in the southwest corner of the lake, a state owned public water access site on the point on the east shore, and a small parcel owned by the City of Bingham on the east side of the lake. Privately owned shoreline is primarily used for agricultural production with some residential development in the northeast and south portions of the lake. Based on 2013 Farm Service Agency (FSA) color aerial photography 14 docks were visible in the lake, or less than
3 docks per kilometer of shoreline. Impervious surfaces account for just 3% of the land cover within 1000 feet of the lake. An assessment of riparian habitat was conducted in June 2015 following “Score the Shore” survey protocols and resulted in an overall lake wide score (which range from 0 to 100) of 87 with 74% (25 of 34) of sample sites categorized as developed based on the land use observed (Figure 303).

Figure 303. Bingham Lake "Score the Shore" Survey Sampling Stations, June 2015.



In-lake habitat disturbance

Algae dominate the plant community and can grow to densities that impact recreational use of the lake. The Bingham Lake Association was issued permits for lake wide control of algae with copper sulfate from 2001 to 2007, although control did not occur each year. No permits to control rooted aquatic vegetation have been issued to individuals or the association of this lake. Although aquatic plant survey data is limited, DNR area fisheries staff has noted that submerged macrophytes have decreased considerably since the 1985 survey.

Chemistry

Water quality data for Bingham Lake has been collected by MPCA and local partners regularly since 1986. The lake was included on the 2010 draft 303(d) impaired waters list for excess nutrients based on MPCA monitoring. The lake is hypereutrophic and the overall Trophic State Index calculated from recent monitoring data (since 2004) is 71. Total phosphorous (TP) concentrations averaged 158 ppb, above the standard of 90 ppb for this ecoregion. Water clarity varies considerably from year to year, but transparency data does not show a trend in either direction.

5.2.3. Lake summary

Biological data indicate the fish and aquatic plant communities of Bingham Lake are impaired by human disturbance. Some potential stressors identified in this report appear to be responsible for the impairment to aquatic life use. Although the hydrology of the area has been severely altered by draining wetlands and ditching, the lake likely had low fish species richness prior to settlement due to its position in the watershed, isolation, and shallow depth.

A fish community dominated by bullhead and carp, along with excess nutrient loads, contributes to the overall poor water quality through the re-suspension of sediments and phosphorus. Bullhead and carp can reduce water clarity by agitating the lake bottom which can inhibit the growth of rooted aquatic vegetation and alter water chemistry. Excess nutrients can also lead to an abundant algae community which can cause nuisance conditions. While the Bingham Lake Association has been issued permits to use copper sulfate for algae control in the past, these treatments were not necessary every year a permit was issued. No permits for algae control have been issued since 2007. There is also no evidence that vegetation removal is responsible for the impairment since there are no records of permitted destruction of vegetation.

The riparian area has been altered by human activities but the scale of this disturbance does not appear to be a significant stressor to the fish community of Bingham Lake. Estimators of shoreland disturbance, the number of docks per kilometer of shoreline and the percentage of impervious surface close to the lake, are below levels that impact fish and plant communities. “Score the Shore” survey protocols (Perleberg D., et al, 2015) were developed by DNR-Ecological and Water Resources Division (EWR) in 2013 and adopted for use by DNR-Fisheries for the 2015 field season to assess riparian lake habitat. Therefore, few lakes in the Watonwan River Watershed have been surveyed using this technique. However, the scores from surveys completed statewide (about 200 surveys) have ranged from 37 to 99 with an average of 74. The score for Bingham Lake was 88 which is considered “good” riparian habitat by DNR-EWR based on lakes sampled to date.

Watershed disturbance is a likely candidate stressor based on current conditions. Agricultural uses account for about 70% of the land within the watershed with corn and soybean the primary crops produced. Residential and commercial development including roads accounts for an additional 6.5% of the land cover within the watershed. Modeling in Minnesota lakes suggests that total phosphorus concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area and this relationship tends to be stronger in shallow lakes (Cross and Jacobson, 2013). Additional phosphorus is associated with reductions in water clarity, oxygen levels, and submerged vegetation as well as increases in algae and abundance of tolerant fish species such as Common Carp and Black Bullhead.

DNR-Fisheries (2013) analysis classified the lake’s watershed as having the potential for partial restoration based on the current amount of land use disturbance and land protection. While full restoration may not be an achievable goal at this time, actions that restore natural watershed processes should help the fish community inhabiting the lake.

5.3 Mountain Lake (17-0003-00)

Impairment: An assessment conducted in 2014 determined Mountain Lake was impaired for Aquatic Life use based on the Fish-IBI (FIBI). The FIBI Tool 7 was used to calculate a score using fish data collected in July 2014 and resulted in a score of 14. Nearshore sampling components were repeated in August 2014 and resulted in the same FIBI score (14). Only one metric differed between the two surveys as one less tolerant species was sampled in August. The impairment threshold for Tool 7 is 36 and the 90% confidence interval is 27-45.

5.3.1 Biology

Fish Community: Mountain Lake falls into Lake Class 43 based on the ecological classification of Minnesota Lakes used by DNR – Fisheries and is assessed with FIBI Tool 7. Lakes assessed with this tool are generally characterized as shallow (over 80% littoral), with hard water, and are primarily located in the southern and western parts of Minnesota. Many lakes assessed with Tool 7, including Mountain Lake, would have frequent winterkill of some degree without winter aeration systems.

Diversity of insectivores, small benthic dwellers, and species associated with aquatic vegetation were all low compared to other lakes assessed using FIBI Tool 7 and influenced the score negatively. Nearshore sampling catch also had a lower than expected proportion of individuals from species associated with aquatic vegetation. Other metrics that contributed to the low FIBI score were a low biomass of insectivorous species and high biomass of tolerant species from the trap net sample. Biomass of carnivores (other than walleye) in gill nets was also comparatively low. The only FIBI metric that scored above average for Tool 7 lakes was the metric considering the number of tolerant species sampled.

Fisheries management activities on Mountain Lake have included fish stocking, fish removal, DO monitoring, and aeration to prevent winterkill (DNR-Fisheries Lake Files, 2015). Fish toxicants have been applied to the lake on two occasions since the late 1950's to kill all of the fish and last occurred in 1998. The purpose of these treatments was to remove the existing fish community, which had become dominated by tolerant and/or non-native species, and reestablish desirable game fish species through stocking. No attempts were made to reintroduce non-game fish species back into the lake.

Occasional winterkill events contributed to boom and bust fishing cycles until the addition of an aeration system in the winter of 1983-84 which has helped maintain a more stable fish community. Since 1979, the lake has been stocked with Walleye, Largemouth Bass, Yellow Perch, Black Crappie, Bluegill, and Northern Pike at various frequencies and life stages. The current management plan calls for regular Walleye fingerling stocking with supplemental stocking of Northern Pike as needed.

Plant Community: A tool to evaluate aquatic life use standards in lakes based on aquatic plant community data is currently being developed but was not available at the time of this assessment. The current plant community indices were designed to respond to nutrient impairment and resulting loss in water clarity, but do not describe impairments to the nearshore fringe plant community (emergent and/or floating-leaf). A point-intercept plant survey was conducted on Mountain Lake by DNR Fisheries staff in 2009. Data from this survey indicate the aquatic plant community is above an impairment threshold identified for similar lakes in the ecoregion (Radomski and Perleberg, 2012).

5.3.2 Data evaluation for each Candidate Cause

Watershed disturbance

The contributing watershed has a watershed to lake size ratio of about 28:1 (Figure 304). There is one game fish lake (Eagle Lake) within the watershed located to the west and connected via an unnamed stream. The lake outlet joins the Watonwan River about 0.6 miles downstream from the lake. Watershed land cover remained stable between 2001 and 2011 based on National Land Cover Datasets (WHAF, 2016). Most of the land cover within the watershed is considered disturbed by human activities and includes cultivated crops (79%) and developed land (10%). Cropland is dominated by corn and soybean (Figure 305). There are also approximately five permitted animal feedlot facilities that produce pigs within the watershed. The few wetlands that remain account for about 1.6% of the land cover in the contributing watershed (Figure 306).

Figure 304. Mountain Lake Contributing Watershed Color Aerial Photography, 2013 FSA.

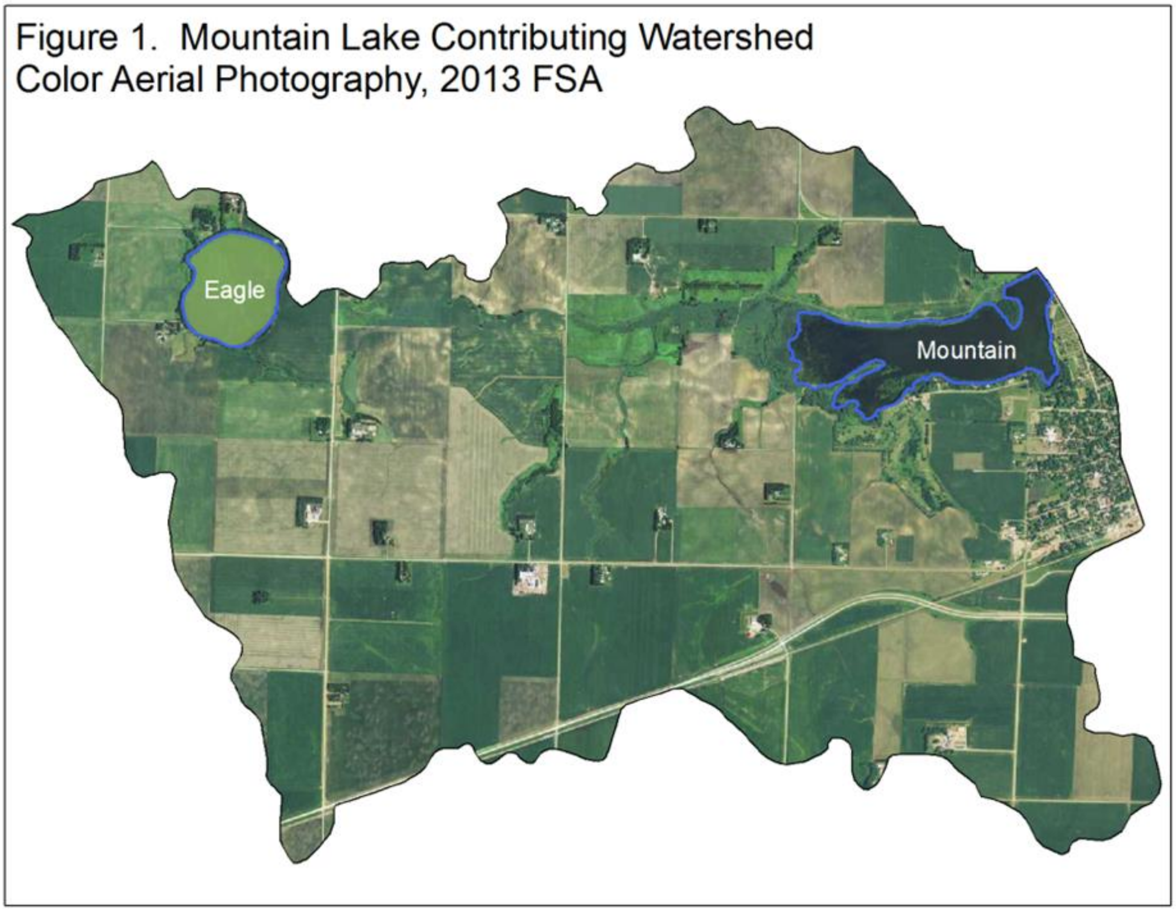


Figure 305. Contributing Watershed Land Cover and Crop Type Summary Mountain Lake, 2011 NLCD.

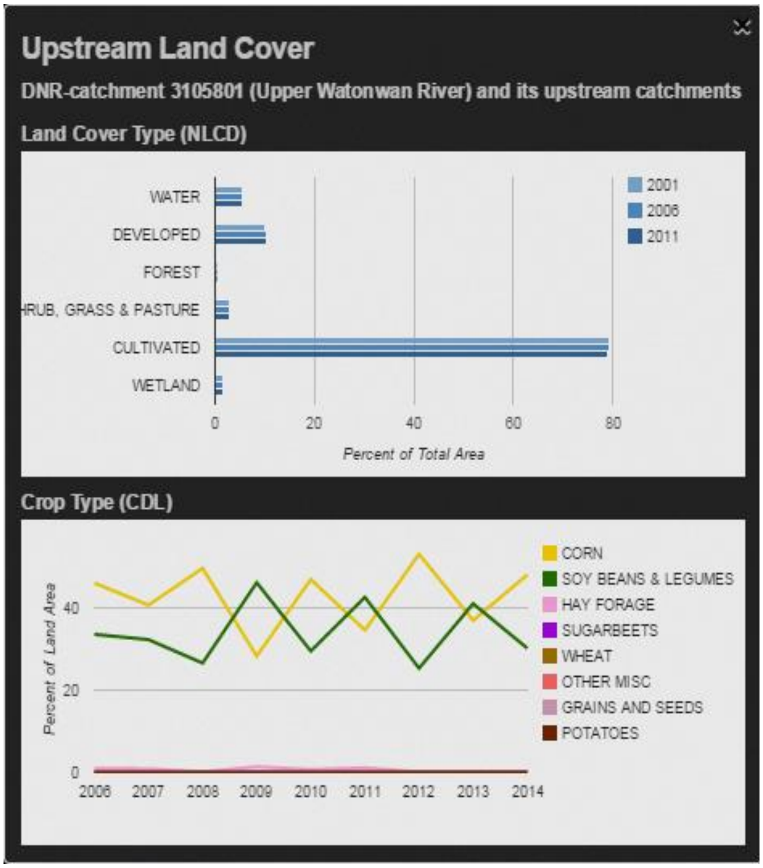
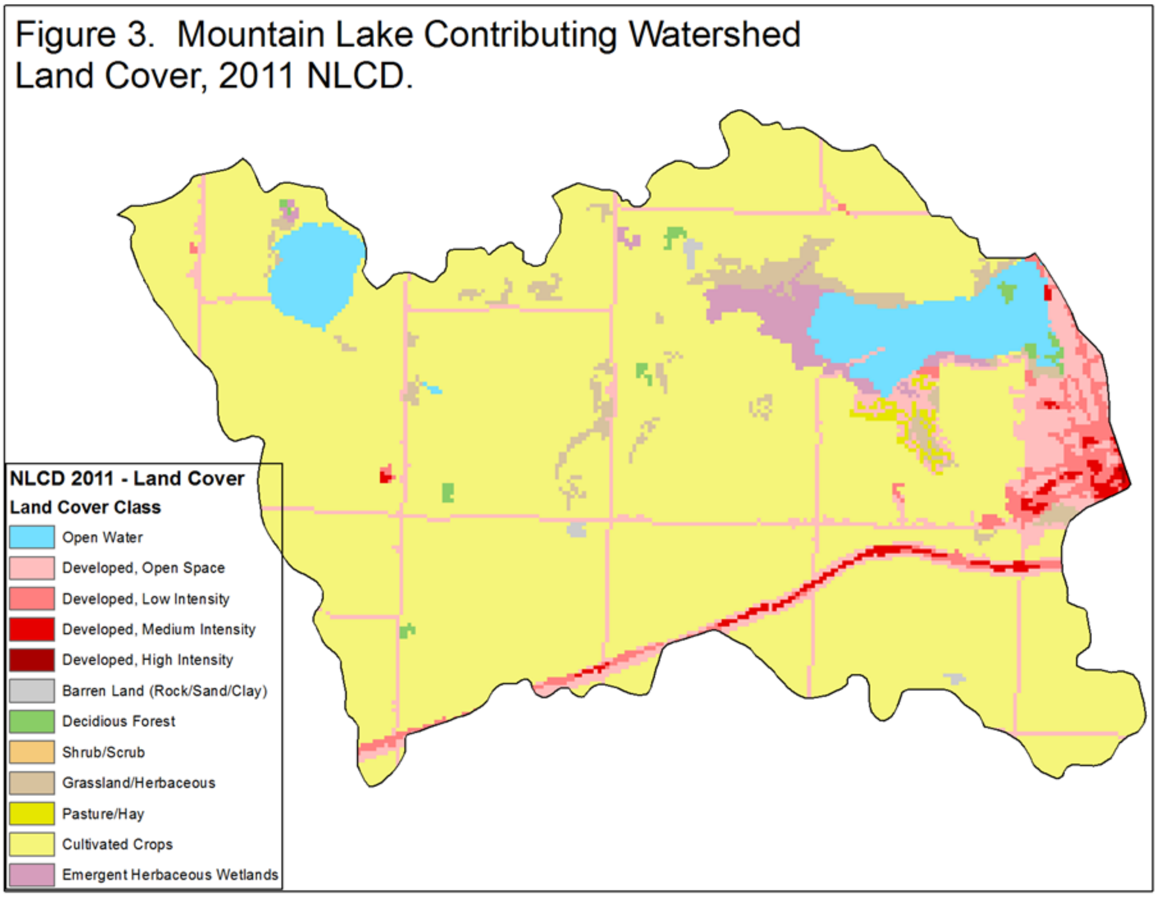


Figure 306. Mountain Lake Contributing Watershed Land Cover, 2011 NLCD.

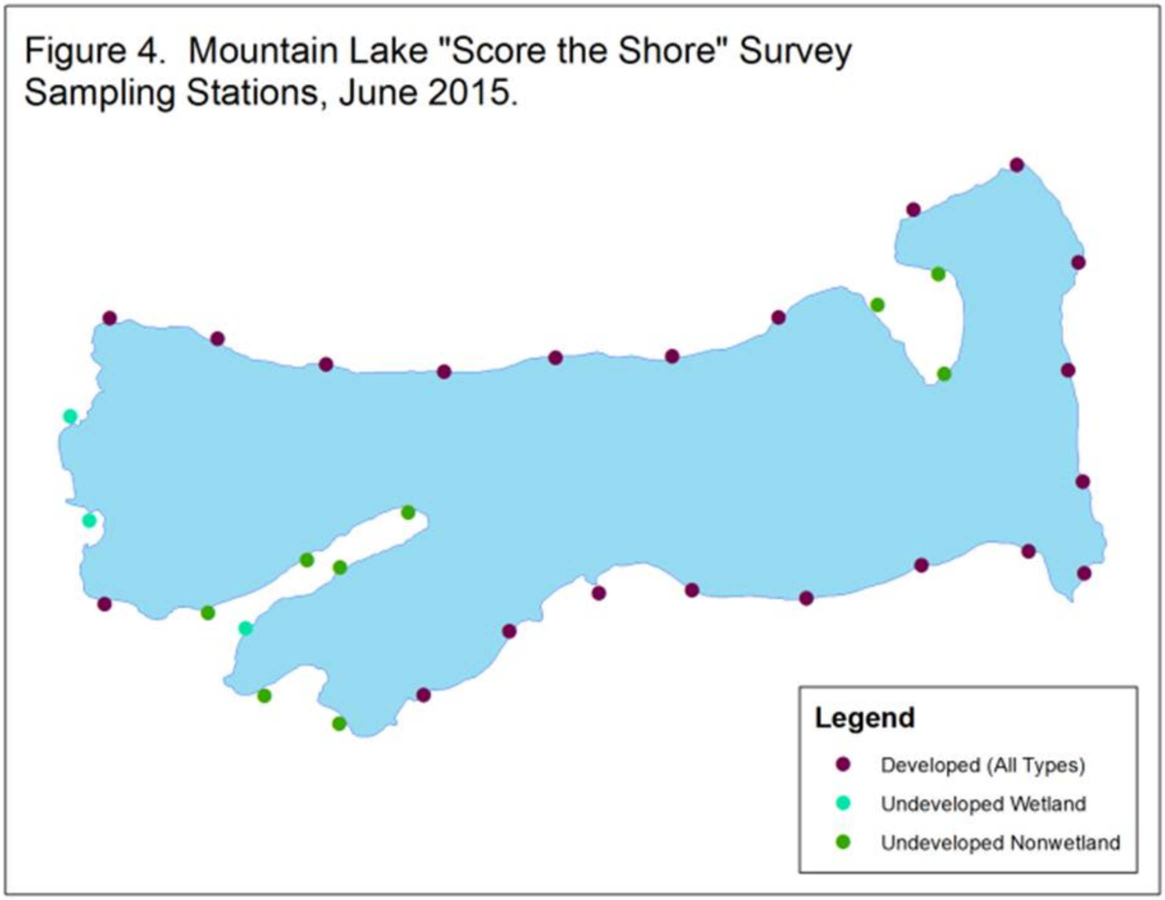


Riparian disturbance

Mountain Lake is 241 acres in size with a maximum depth of 7 feet and 4.4 miles of shoreline. Most of the shoreline is in public ownership with a small amount of private property on the south side of the lake making up less than 10% of the lakeshore. Public land uses include wildlife management, public water access, fishing access, a golf course, and a paved trail that loops around all but the south shore of the lake. Privately owned shoreline contains residential development. Based on 2013 FSA color aerial photography there were six docks in the lake, or less than one dock per kilometer of shoreline. Impervious surfaces, which include roads, homes, and areas with turf grass, account for 21% of the land cover within 1000 feet of the lake and cultivated crops make up another 39%.

An assessment of riparian habitat was conducted in June 2015 following DNR's "Score the Shore" survey protocols and resulted in an overall lake wide score (which range from 0 to 100) of 74 with 64% (21 of 33) of sample sites categorized as developed based on the land use observed (Figure 307). Lake wide scores by habitat component (which range from 0 to 33) were 19 for the Shoreland zone, 28 for the Shoreline zone, and 28 for the Aquatic zone.

Figure 307. Mountain Lake "Score the Shore" Survey Sampling Stations, June 2015.



In-lake habitat disturbance

Mountain Lake was created in 1938 when a dam was constructed on a tributary of the Watonwan River. The current structure is a concrete fixed crest spillway that was installed in 2007. Fisheries management activities have impacted the lake habitat directly and indirectly. Improved water clarity following carp and bullhead removal in 1998 resulted in increased abundance of rooted aquatic plants which provide fish habitat. However, a majority of the vegetation was non-native Curlyleaf Pondweed that can grow to densities that inhibit fishing and boating. Aquatic plant management permits were issued for chemical control of up to 100 acres between 2002 and 2009 with a goal of reducing the abundance of Curlyleaf Pondweed and increasing native species. While the results of these activities achieving the goal are unclear the treatments did provide some recreational benefit. Permits are currently issued for mechanical control of up to 100 acres of vegetation with the goal of maintaining fishing and boating opportunities.

Chemistry

Water quality data for Mountain Lake has been collected by MPCA and local partners regularly since 1989. The lake is considered eutrophic based on the overall Trophic State Index of 63 calculated from recent monitoring data (since 2004) but is not listed as impaired for excess nutrients. The lake was included in the "Appendix A" impaired waters list for waterbodies as part of the Statewide Mercury TMDL in 1998. Water clarity varies considerably from year to year, but transparency data does not show a trend in either direction.

5.2.3 Lake summary

Biological data indicate the fish communities of Mountain Lake are impaired by human disturbance. Some of potential stressors identified in this report appear to be responsible for the impairment to aquatic life use. Comparisons to the historic pre-settlement fish community are not possible due to lack of data since the lake did not exist prior to 1938. The lake likely has low species richness potential due to its position in the watershed, relative isolation, and shallow depth.

Fisheries management activities have directly impacted the fish community. While chemical reclamation has not been performed since 1998, walleye fingerling stocking does occur every other year. In addition to providing angling opportunities, stocking walleye provides an additional predator on black bullhead to help control their population. Both stocking and removal efforts are successful to varying degrees and time frames at restructuring the fish community that can become dominated by bullhead but neither technique has permanent impact. FIBI Tool 7 does not include Walleye in the top carnivore metric used in scoring because of the high likelihood these fish are stocked and therefore their relative abundance is not responding to habitat changes or limitations.

Similarly, aquatic plant management activities impact fish habitat directly but are not likely to have lasting effects on the fish community. Rules governing aquatic plant management permitting are intended to maintain adequate fish habitat by limiting the amount of control that can occur in a single year. There are concerns that repeated chemical treatments may result in more permanent changes to the aquatic plant community but there is no consensus at this time.

Watershed and riparian land use are the most likely candidate stressors to the fish community of Mountain Lake. Modeling in Minnesota lakes suggests that total phosphorus concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area and this relationship tends to be stronger in shallow lakes (Cross and Jacobson, 2013). Additional phosphorus is associated with reductions in water clarity, oxygen levels, and submerged vegetation as well as increases in algae and abundance of tolerant fish species such as Common Carp and Black Bullhead. In addition, FIBI scores for lakes assessed with Tool 7 have a negative relationship to TP as well as urban and agricultural land uses (Bacigalupi J., 2015 personal communication). Analysis revealed that 89% of the land within the contributing watershed of Mountain Lake is considered disturbed (WHAF, 2016).

Riparian land use has positive and negative attributes. While there is some natural cover around most of the lake, the buffer may not be wide enough to retain all of the natural functions of undisturbed lakeshore. Urban development and cultivated agriculture combine to make up 60% of the land use within 1000 feet of the lake. “Score the Shore” survey protocols (Perleberg D., et al, 2015) were developed by DNR-EWR in 2013 and adopted for use by DNR-Fisheries for the 2015 field season to assess riparian lake habitat. Therefore few lakes in the Watonwan River Headwaters have been surveyed using this technique. However, the scores from surveys completed statewide (about 200 surveys) have ranged from 37 to 99 with an average of 74, equal to the score for Mountain Lake. Component scores indicate the habitat in the Shoreland zone, the area above the bank and within 150 feet of the lake, has been altered the most and could be improved.

The DNR-Fisheries (2013) analysis classified the lake’s watershed as having the potential for partial restoration based on the current amount of land use disturbance and land protection. While full restoration may not be an achievable goal at this time, actions that reduce total phosphorus entering the lake or improve the quality of the riparian habitat should help the fish community inhabiting the lake.

5.4 Fish Lake, 32-0018-00, Jackson County

An assessment conducted in 2014 determined Fish Lake was impaired for Aquatic Life use based on the Fish IBI (FIBI). The Group 2 FIBI Tool was used to calculate a score using fish data collected in 2011 and resulted in a score of 36. The impairment threshold for Group 2 lakes is 45 and the 90% confidence interval for Group 2 lakes is 36-54.

5.4.1 Biology

Fish Community: Basin characteristics place Fish Lake in lake class 24, which is scored with the Fish IBI Tool 2. Lakes scored with Tool 2 are characterized as having areas of deep water (less than 80% littoral), irregular shorelines, and hard water. Note that Fish Lake is a bit atypical of Group 2 lakes in that it is slightly shallower, and more significantly, in a drainage basin with lower fish species richness, and the lake is geographically isolated. For these reasons, the fish survey data was also scored using the Tool 4 and 7 FIBIs, the respective scores were below impairment thresholds for each Tool.

The diversity of intolerant species, insectivores, cyprinids, small benthic dwellers, and vegetation-dwelling species were all low compared to other Group 2 lakes. However as noted above, the Watonwan Watershed has lower species richness than more northerly watersheds, and there are few records of intolerant species in the Watonwan Watershed which limits the expectation of sampling diverse non-game cyprinid and darter species. Furthermore, given the historic reclamation and limited opportunities for recolonization of intolerant species to Fish Lake, the intolerant and cyprinid species richness metrics are likely not the best indicators on Fish Lake and the proportional metrics are worth discussion.

One intolerant species (smallmouth bass) was captured and dominated the nearshore catch (39% of nearshore individuals captured). Four tolerant species were captured. Black bullheads and common carp were a significant portion of the biomass in the gillnets. Common Carp comprised 22% of the gill net biomass and Black Bullhead accounted for 19% of the gill net biomass. Bigmouth buffalo and green sunfish, while present, did not dominate in any of the sampling gears. Walleye, which are stocked every other year, dominated the gill net catch (51% by biomass). Channel catfish were most abundant by biomass in the trap net catch (65% by biomass) and Black Crappie were the second most abundant by number and biomass. Smallmouth bass (39% of nearshore individuals) and bluegill (27% of nearshore individuals) were the dominant species collected during nearshore sampling; note that the overall number of fish sampled was low, only 100 fish were sampled during nearshore sampling. Five Johnny Darters were sampled. The only cyprinids sampled were Emerald Shiners and Spotfin Shiners. Overall there was only one species sampled that is classified as vegetation-dwelling per the IBI statewide classification (Northern Pike), although other species were sampled that certainly rely on or have higher populations in lakes with higher quality vegetation (such as Bluegill and Pumpkinseed).

Fisheries management activities on Fish Lake have consisted of reclamation, stocking fish, and limited commercial removal of Common Carp and Buffalo. The lake was reclaimed in 1959. Walleye have been stocked since 1979 and from 1990-2005, Black Crappie, Channel Catfish, Northern Pike, and Smallmouth Bass were occasionally stocked. Only Walleye have been stocked since 2005. Fish Lake does not have a history of winterkill and is not aerated.

Plant Community: A tool to evaluate aquatic life use standards in lakes based on aquatic plant community data was developed by Radomski and Perleberg (2012). The Radomski and Perleberg 2012 plant community indices were designed to respond to nutrient impairment and resulting loss in water clarity, but do not describe impairments to the nearshore fringe plant community (emergent and/or floating-leaf). A transect plant survey on Fish Lake was completed by DNR Fisheries in 2011. One submerged plant species was sampled – Coontail and two emergent plant species (Cattail and River Bulrush). The species richness and FQI scored below the thresholds for plant assessment (Radomski and Perleberg, 2012). Two older plant surveys found higher species richness and FQI: the 2002 survey was below both thresholds and the 1994 survey was slightly above for species richness but below for FQI.

5.4.2 Data evaluation by Candidate Cause

Watershed disturbance

Fish Lake drains east into the South Fork of the Watonwan River and via the Watonwan River to the Blue Earth River and into the Minnesota River near the city of Mankato. A fixed crest dam is located at the outlet of the lake and serves as a fish barrier. There is a county-owned lake level control structure in the fishway at the lakeshore that manages water levels. According to the DNR Fisheries Management staff, water level management at the current time is to create a full pool within Fish Lake. Previous management actions included periodic "draw-downs" where the lake levels were manipulated due to downstream wetland (NE of the lake) draining and management.

The contributing watershed for Fish Lake is small (ratio of watershed to lake size is about 4:1), and includes no upstream lakes and two intermittent streams. The stream on the southwest side of the lake has an embankment dam with an outlet culvert. The stream channel between the upstream wetland and the reservoir no longer exists as the channel has been plowed to convert the land to agricultural uses. Therefore, when flowing, water from the upstream wetland flows overland in the vicinity of the old stream channel.

About 67% of the contributing watershed land cover is classified as cultivated and 5% developed (NLCD 2011) (Figure 308). The percent of developed and cultivated land cover remained unchanged from 2001 – 2011 (NLCD) (Figure 2). Corn and soybeans/legumes was the most common crop type in alternating years from 2006-2014 within the contributing watershed. Few wetlands remain in the contributing watershed (about 2% of landcover), but the acreage of wetlands has been stable from 2001-2011. Impervious surface (NLCD 2011) is limited to a few roads and mostly riparian residences. There is one permitted feedlot in the contributing watershed (MNPCA Feedlots ArcGIS layer 4/2015) adjacent to the intermittent stream flowing into the southwest corner of Fish Lake.

Riparian disturbance

Fish Lake is a relatively deep lake for southwestern Minnesota, with an average depth of about 15 feet and a maximum depth of 26 feet. About 50% of the lake is littoral, less than 15 feet in depth.

A public boat access and Obie Knutson Park are located on the south side of the lake. There is development into residential lots on the west end shore of the lake. Where there is not residential development, a majority of the shore land is farmed to within about 100 feet of shore based on aerial imagery measurements available on Google Earth version 7.1.2.2041.

Fisheries Lake IBI program staff conducted an assessment of lakeshore habitat of Fish Lake on June 2, 2015 following Score the Shore survey protocols. The assessment consisted of 27 survey sites and resulted in a mean lake wide habitat score of 77 out of 100, indicating overall lakeshore conditions are fair. Lake wide mean habitat scores by zone (out of 33.3 possible) were good for the Shoreland (26.5) and Aquatic (26.8) zones, while the Shoreline (24.1) zone score was fair. Sites classified as developed (24 of 27 sites) based on observed land use, had a mean habitat score of 76 while 3 undeveloped sites had a mean habitat score of 90. See Figure 310.

Fisheries Lake IBI program staff mapped emergent and floating-leaf aquatic plant stands on Fish Lake on September 14, 2015. Only two small areas of cattail were mapped with an additional area noted as having a small fringe of sparse cattails along shore. See Figure 311.

The DNR Fisheries Lake Management Plan notes that some bank erosion occurs during high water levels causing loss of property and sedimentation in the lake.

Figure 308. Fish Lake-2011 NLCD Land Cover.

Figure 309. Fish Lake-Contributing watershed land use and crop type.

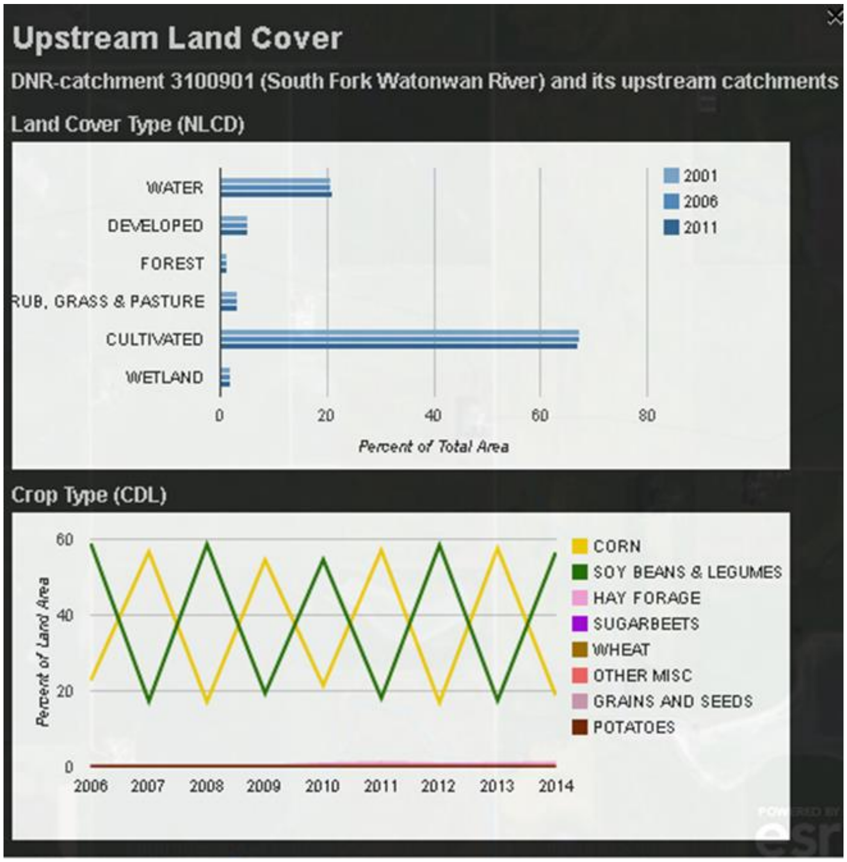


Figure 310. Fish Lake Locations of water quality sampling.

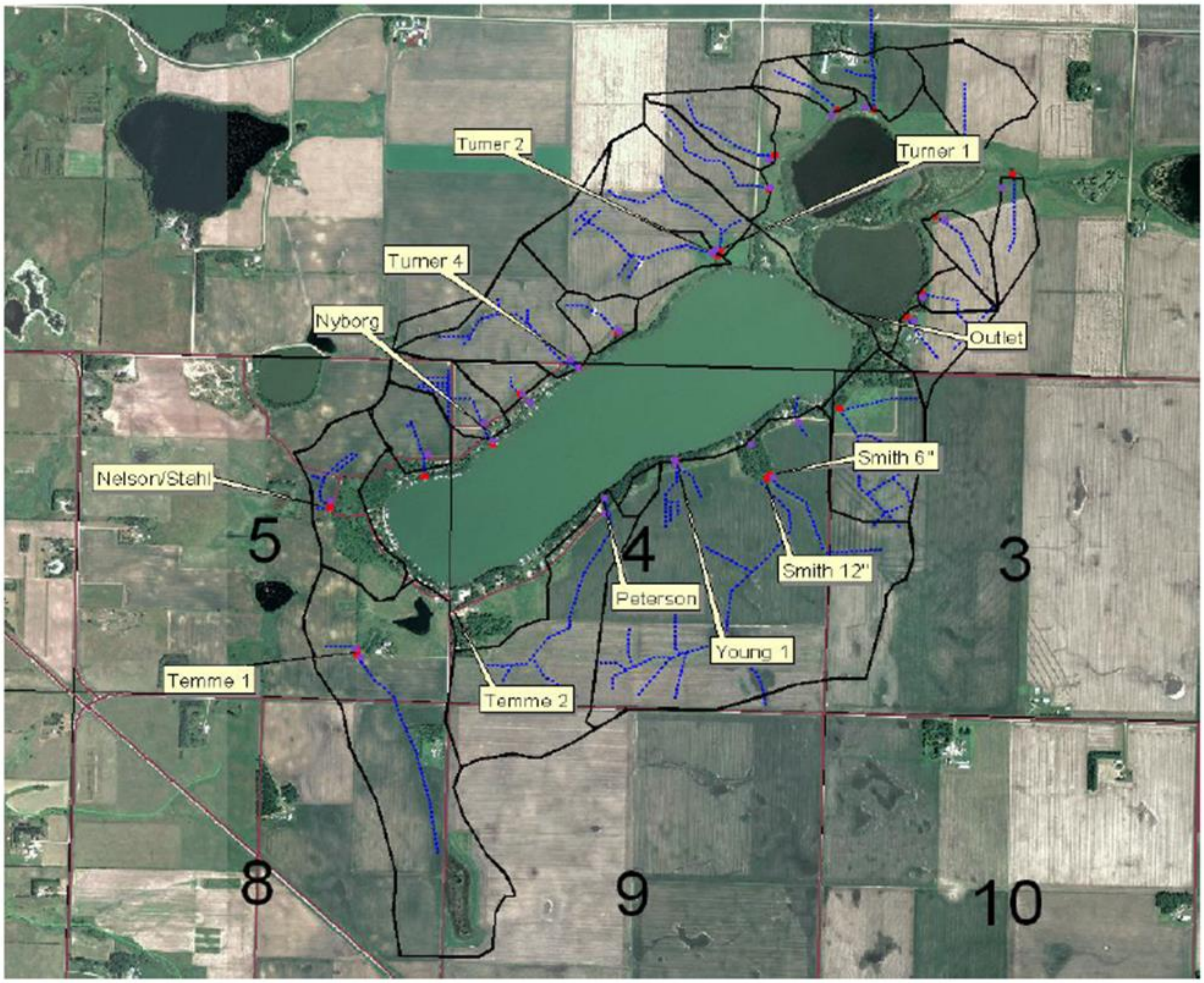


Figure 311. Fish Lake– Score the Shore Survey.

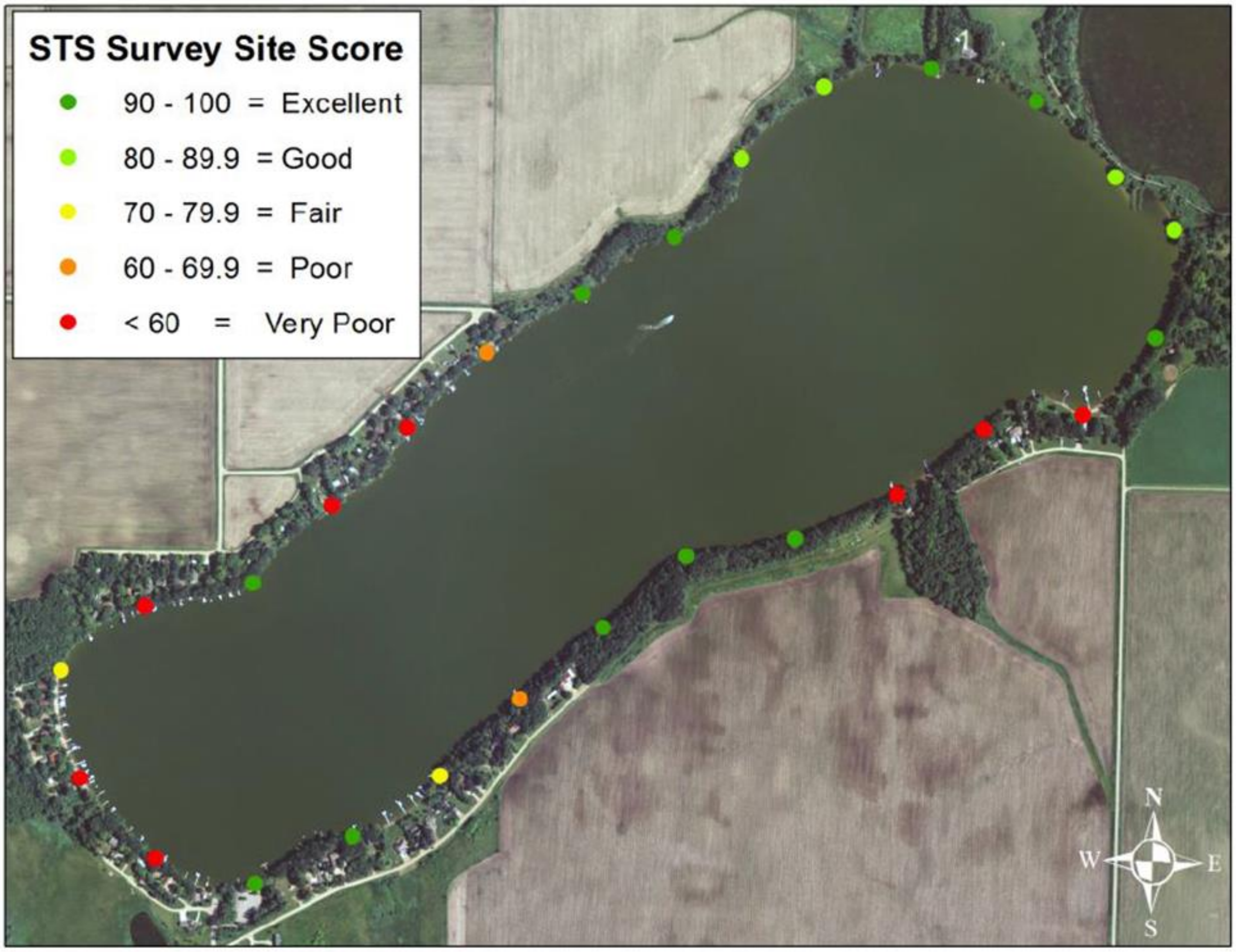


Figure 312. Fish Lake– Emergent Vegetation Mapped, September 2015.

In-lake habitat disturbance

The Fish Lake Lake Association applies for an Aquatic Management Permit most years to treat the lake for algae however according to the 2012 DNR Fisheries Lake Management Plan, the permit has not been used frequently in recent years.

Algae dominate the plant community. Aquatic plants have been rare in the three most recent surveys (1994 – 2011), likely as a result of stable water levels, perturbation by carp, sediment suspension, and poor water clarity. A transect plant survey on Fish Lake was completed by DNR Fisheries in 2011 and found very poor vegetated habitat for fish. One submerged plant species, Coontail, was sampled and two emergent plant species (Cattail and River Bulrush). Coontail was sampled at April 20, transects and Cattail and River Bulrush were sampled at one transect. All species were noted as rare during the survey. DNR Fisheries Management staff noted that they have noted an increase in coontail within the lake since 2012. This could be due to drought conditions improving water clarity due to decreased runoff.

According to the 2011 DNR Fisheries survey, available spawning habitat was good for Smallmouth Bass and Yellow Perch, fair for Walleye and poor for Northern Pike. Lack of vegetation limits spawning opportunities for northern pike and high periphyton limits walleye and other lithophilic fishes. Half-log spawning structures were installed in shallow water in 1993 and 2006 to augment smallmouth bass natural reproduction. Downed woody habitat was noted in the water at about half of the Score the Shore sites in 2015.

Chemistry

According to the PCA website (April 13, 2016), data collected from 2006-2015 indicated the average secchi transparency was two meters, average chlorophyll A was 17 ppb, and average total phosphorus was 39 ppb. It was assessed for recreation in 209 and standards were met for all assessed parameters.

The Jackson/Cottonwood SWCD received a Clean Water Legacy Drainage Grant to construct bioreactors on tile lines feeding into Fish Lake to reduce the amount of sediment, nitrogen, and phosphorus entering Fish Lake. The project is described in a Clean Water Fund report (2011). Thousands of feet of sub-surface drainage tile associated with 10 unprotected in-field surface tile intakes were identified that outleted via 21 tile outlets directly to Fish Lake. Seventeen denitrifying bioreactors and alternative tile intakes were installed to treat the water prior to its entry into the lake. The bioreactors combined to prevent 61.6 pounds of phosphorus and 3,621.5 pounds of nitrogen and the associated sediment from reaching Fish Lake each year according to the SWCD. In addition, four grade stabilizations and a water diversion structure were installed to reduce sediment delivery to the lake.

Water quality information has been collected by DNR Fisheries staff in the inlets and outlets of the bioreactors to assess the nutrient loading into the reactors and their treatment effects, as well as within the lake most years from 2011 - 2015. Sampling events were limited but can provide some insight into nutrient delivery to the lake. There are many other variables that make interpretation of the data difficult including drought, decay of wood chips, and bypass frequency of the bioreactors. Data was summarized by Windom Fisheries in the table below. See Figure 3 for locations where water samples were taken.

Table 362. Chemistry Results for Fish Lake.

Year	Sample	Total P	Chl A	TDS	TSS	Nitrite + Nitrate	Orthophosphorus
1959	Lake	0.24	-	-	-	0.042	
1984	Lake	0.067	-	293	-	-	
1990	Lake	0.063-0.067	26.3	-	-	-	
1991	Lake	0.047-0.089	64.7	-	-	-	
1994	Lake	0.023	51.3	352	-	-	
2002	Lake	0.038	10	364	-	-	
2011	Ag. Tiles	0.016-0.11	-	-	0.1-58	0.4-20.9	0.007-0.094
2011	Lake	0.0563	91.3	252	-	-	
2013	Lake	0.064	2.9	284	-	-	
2014	Ag. Tiles	0.014-0.151	-	-	0.01-19.6	<0.4-19.8	0.017-0.129
2014	Lake	0.044-0.069	-	-	1.5-10.0	<0.4	0.009-0.034
2015	Lake	0.087-0.095	3.89-10.1 -		12.4-15.2	<0.4	0.028-0.031
2015	Ag. Tiles	0.048-0.229	0.2-1.7	-	1.9-26.8	7.46-17.6	0.033-0.135
Expected Values		0.065-0.15	30.0-80.0	NA	7-18	0.01-0.02 (<1 EPA)	NA

5.4.3 Lake summary

Biological data indicate the fish community of Fish Lake are impaired by human disturbance. Some potential stressors identified in this report appear to be responsible for the impairment to aquatic life use, including water quality and nutrient loading from watershed disturbance, resuspension of sediments by fish, and impacted riparian habitat. Although the hydrology of the area has been severely altered by draining wetlands and ditching, the lake likely had low fish species richness prior to settlement due to its position in the watershed and isolation.

Watershed disturbance is a likely candidate stressors based on current conditions. Agricultural uses account for about 67% of the land within the watershed with corn and soybean the primary crops produced. Residential and commercial development including roads accounts for an additional 5% of the land cover within the watershed. Modeling in Minnesota lakes suggests that total phosphorus concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area and this relationship tends to be stronger in shallow lakes (Cross and Jacobson, 2013). Additional phosphorus is associated with reductions in water clarity, oxygen levels, and submerged vegetation as well as increases in algae and abundance of tolerant fish species such as Common Carp and Black Bullhead. Significant efforts are underway in the watershed to reduce sediment and nutrient loading, and additional monitoring and time will determine impacts to water quality and aquatic habitat.

Bullhead and carp are common and likely contributes to reduced water quality through the re-suspension of sediments and phosphorus. Bullhead and carp can reduce water clarity by agitating the lake bottom which can inhibit the growth of rooted aquatic vegetation and alter water chemistry. Excess nutrients can also lead to an abundant algae community which can cause nuisance conditions. While the Fish Lake Association has been issued permits to use copper sulfate for algae control in the past, these treatments were not completed every year a permit was issued.

The riparian area has been altered by human activities at a scale of this disturbance that likely is a stressor to the fish community of Fish Lake. Estimators of shoreland disturbance, the number of docks per kilometer of shoreline and the Score the Shore survey score, are similar to levels that influence fish metrics based on preliminary research (J. Bacigalupi and D. Dustin, 2015). Score the Shore survey protocols (Perleberg D., et al, 2015) were developed by DNR-EWR in 2013 and adopted for use by DNR-Fisheries for the 2015 field season to assess riparian lake habitat. Therefore few lakes in the Watonwan River Watershed have been surveyed using this technique. However, the scores from surveys completed statewide (about 200 surveys) have ranged from 37 to 99 with an average of 74 compared to a score of 76 for Fish Lake. DNR-EWR classify a score of 76 to be a “fair score” for shoreline habitat.

The DNR-Fisheries (2013) analysis classified Fish Lake’s Watershed as having the potential for partial restoration based on the current amount of land use disturbance and land protection. While full restoration may not be an achievable goal at this time, actions that restore natural watershed processes should help the fish community inhabiting the lake.

5.5 Long (83-0040-00)

An assessment conducted in 2014 determined Long Lake was impaired for Aquatic Life use based on the Fish IBI. The FIBI Tool 7 was used to calculate a score using fish data collected from a June 2010 game fish survey and nearshore sampling components completed in August 2010 by area fisheries staff and resulted in a score of 11. Nearshore sampling components were also completed in July 2010 by program staff as a repeat survey and resulted in a similar FIBI score (12). Only one metric differed between the two surveys as one more insectivorous species was sampled in August. The impairment threshold for Tool 7 lakes is 36 and the 90% confidence interval is 27-45.

5.5.1 Biology

Fish Community: Long Lake falls into Lake Class 43 based on the ecological classification of Minnesota lakes used by DNR – Fisheries and is assessed with FIBI Tool 7. Lakes assessed with this tool are generally characterized as shallow (over 80% littoral), with hard water, and are primarily located in the southern and western parts of Minnesota.

Diversity of insectivores, small benthic dwellers, and species associated with vegetation were all low compared to other Tool 7 lakes based on 2010 sampling. Tolerant species had a comparatively high diversity (4 species) and Common Carp and Black Bullhead accounted for 55% of biomass in the trap net sample. Presence of Fathead Minnow, a tolerant species, is thought to be the result of human introduction due to the popularity of the species as bait for angling. The total biomass of top carnivores (other than walleye which are stocked regularly) from the gill net sample was also lower than expected. The Fish IBI score was low because all metrics scored poorly.

Fisheries management activities on Long Lake (DNR-Fisheries Lake Files, 2015) have included fish stocking and removal. Walleye (fry, fryling, and fingerling), Northern Pike (fingerling and adult), Yellow Perch, Largemouth Bass, Bluegill and Black Crappie have all been stocked in the past at various frequencies and densities. The current plan calls for Walleye stocking in two out of three years. Carp and bullhead were removed from the lake by state crews and commercial operators periodically from 1922 to 1985. The amount of fish removed varied widely with up to 30,000 pounds removed in a single year.

Plant Community: A tool to evaluate aquatic life use standards in lakes based on aquatic plant community data is currently being developed but was not available at the time of this assessment. The current plant community indices were designed to respond to nutrient impairment, but do not describe impairments to the nearshore fringe plant community (emergent and/or floating-leaf). No recent plant survey information is available for Long Lake, although a transect survey was completed by DNR in 2002 as part of a fisheries assessment. Data from this survey indicate the aquatic plant community was equal to an impairment threshold identified for similar lakes in the ecoregion based on species richness (Radomski and Perleberg, 2012).

5.5.2 Data evaluation for each Candidate Cause

Watershed disturbance

The contributing watershed has a watershed to lake size ratio of about 6:1 (Figure 313). There are shallow lakes located within the watershed that have no direct surface water connection and there are no other game fish lakes upstream. Watershed land cover remained stable between 2001 and 2011 based on National Land Cover Datasets (WHAF, 2016). Most of the land cover within the watershed is considered disturbed by human activities and includes cultivated crops (69%) and developed land (8.6%). Cropland is dominated by corn and soybean (Figure 314). Wetlands account for about 6% of the land cover in the contributing watershed (Figure 315).

Figure 313. Long Lake Contributing Watershed Color Aerial Photo, 2013 FSA.

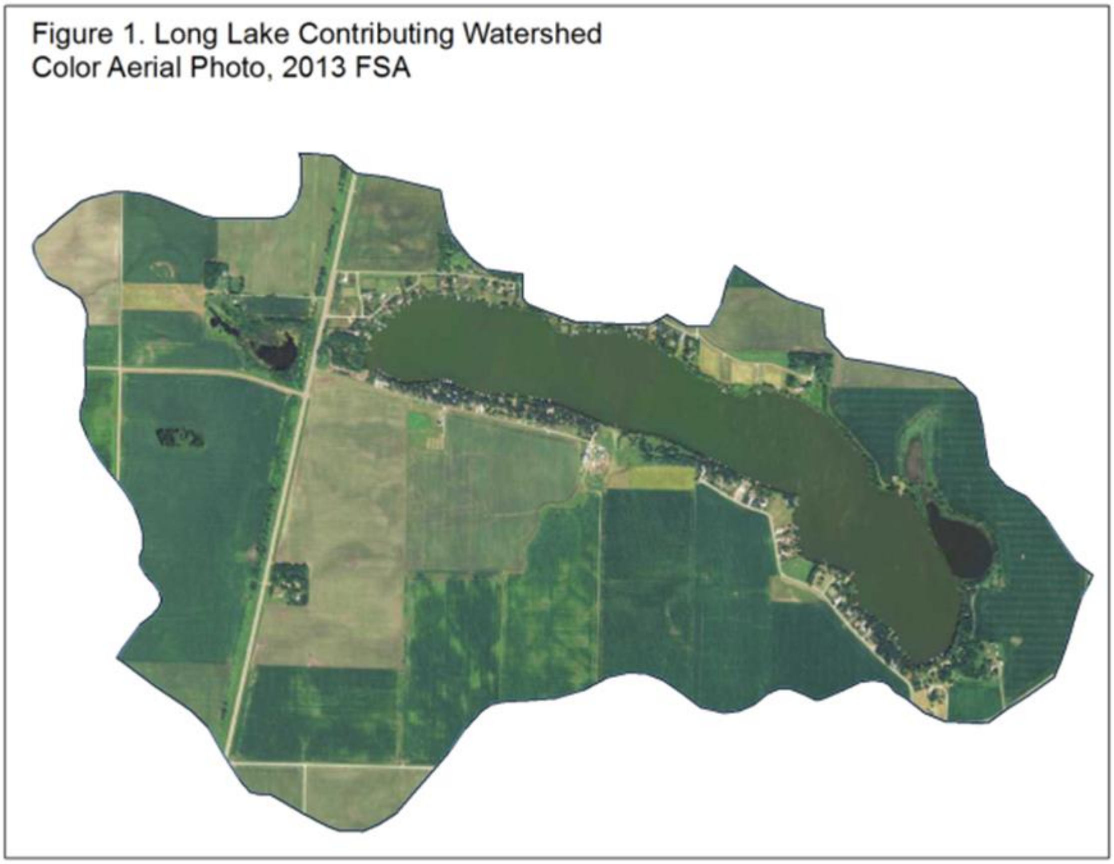


Figure 314. Contributing Watershed Land Cover and Crop Type Summary Long Lake, 2011 NLCD.

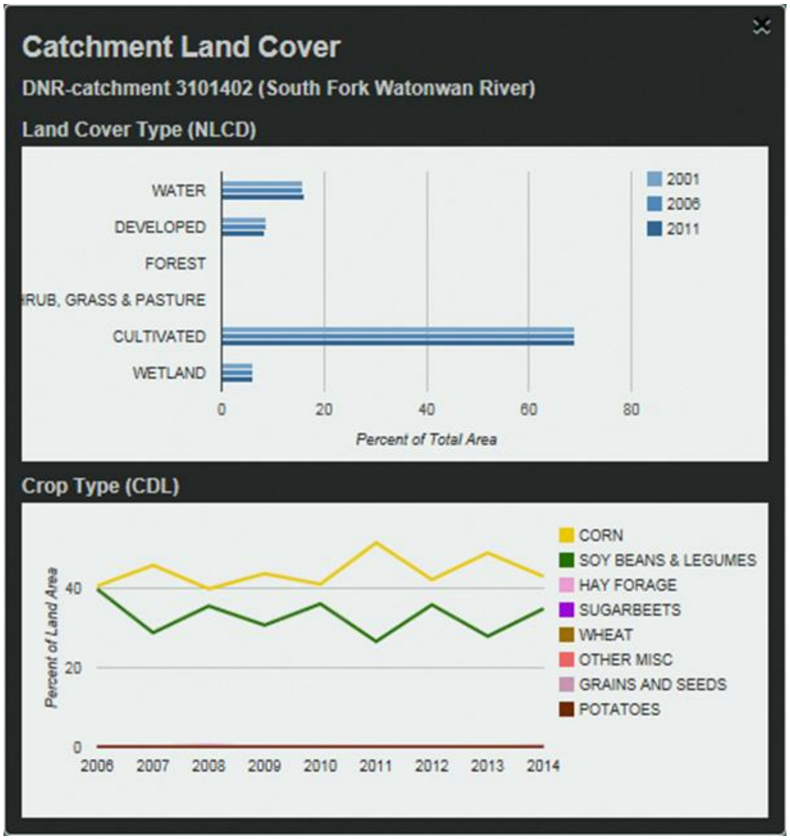


Figure 315. Long Lake Contributing Watershed Land Cover, 2011 NLCD.

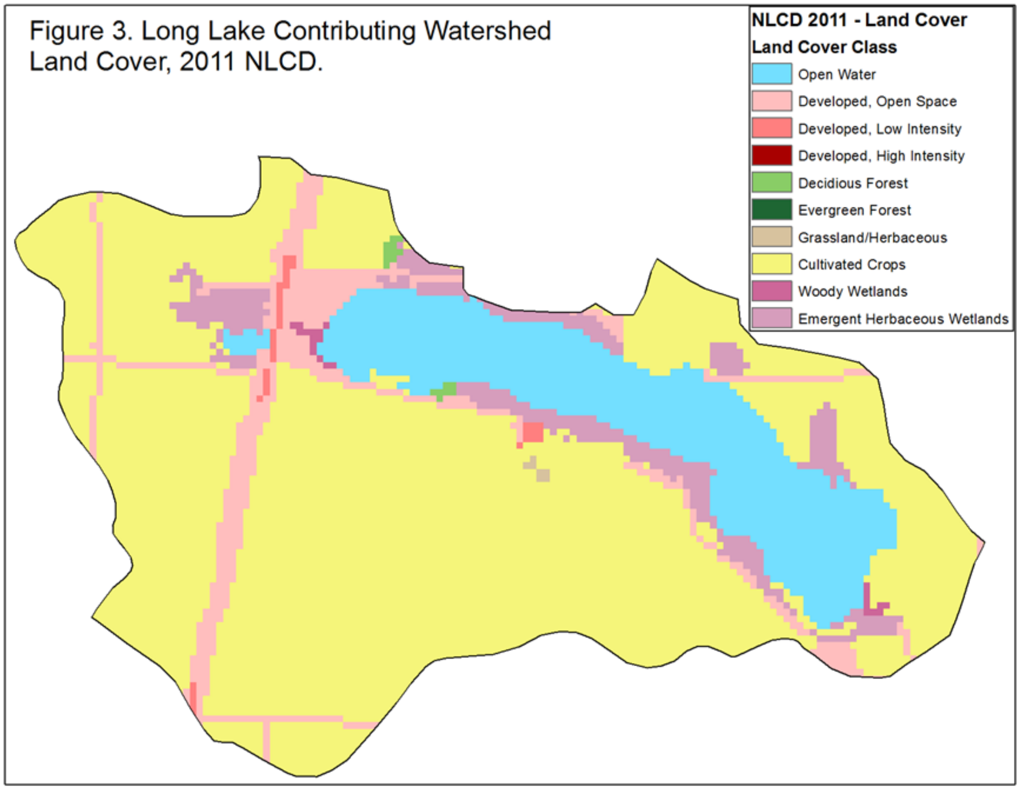
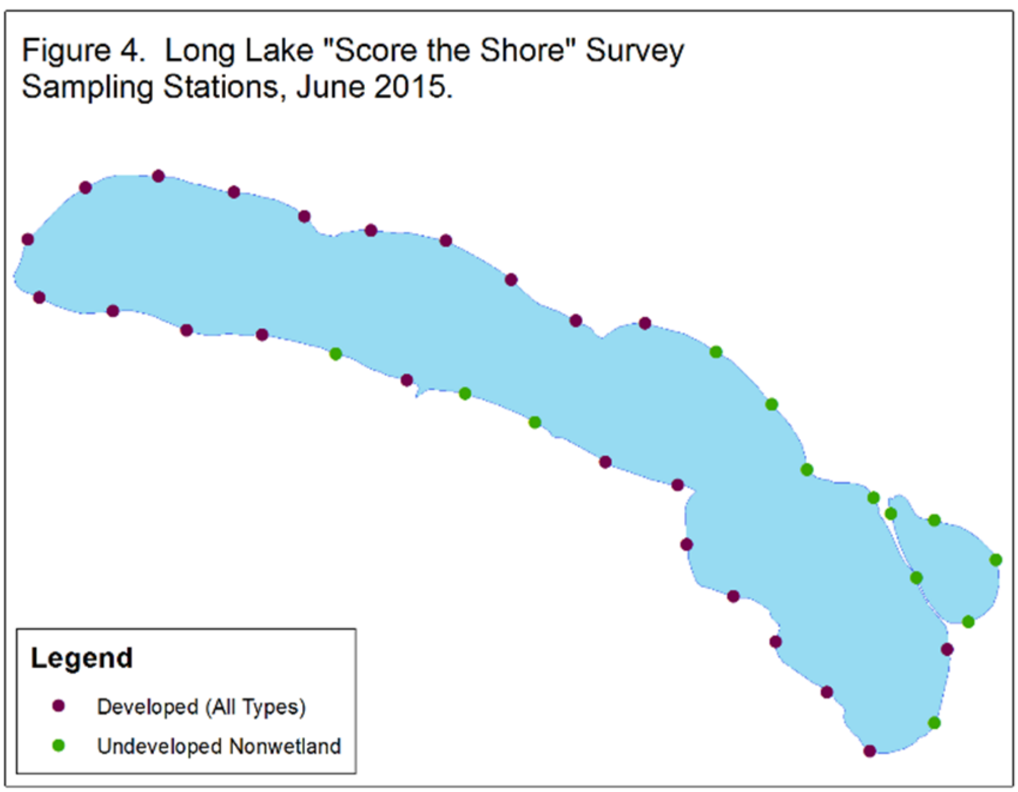


Figure 316. Long Lake "Score the Shore" Survey Sampling Stations, June 2015.



Riparian disturbance

Long Lake is 263 acres in size with a maximum depth of 13 feet and 4.7 miles of shoreline. Lakeshore ownership is primarily private although there is a state owned public water access site and county park facility on the west shore. Privately owned shoreline is primarily used for residential development with some agricultural production in the southeast portions of the lake. There is also a farm with a feedlot on the south shore that is currently (2015) permitted for 83 animal units, primarily cows. Based on 2013 FSA color aerial photography there were 94 docks in the lake, or about 12 docks per kilometer of shoreline. An assessment of riparian habitat was conducted in June 2015 following "Score the Shore" survey protocols and resulted in an overall lake wide score (which range from 0 to 100) of 71 with 64% (23 of 36) of sample sites categorized as developed based on the land use observed (Figure 316). Lake wide scores by habitat component (which range from 0 to 33) were 21 for the Shoreland zone, 24 for the Shoreline zone, and 26 for the Aquatic zone.

In-lake habitat disturbance

A twin bay reinforced concrete dam with metal stop logs was constructed at the outlet of the lake between 1937 and 1940. An open ditch with pipeline and pump house was also constructed during the same time to provide water from the Watonwan River during dry periods. These structures were designed to control lake levels and have altered natural water level fluctuations.

Algae can dominate the plant community and grow to densities that impact recreational use of the lake is some years. The Long Lake Homeowners Association has been issued aquatic plant management permits annually for lake wide control of algae with copper sulfate since 2001. No permits to control rooted aquatic vegetation have been issued on this lake.

Chemistry

Water quality data for Long Lake has been collected by MPCA and local partners since the 1980's. Based on monitoring data collected since 2004 the lake has an overall Trophic State Index of 60 and is considered eutrophic. The TSI based on TP levels was 53. Water clarity varies considerably from year to year, but transparency data does not show a trend in either direction.Historically the pump used to provide water from the Watonwan River has been used only during years with dry spring conditions and pumping has occurred in six of the years since 2000.

5.5.3 Lake summary

Biological data indicate the fish community of Long Lake is impaired by human disturbance. Although the hydrology of the area has been altered by draining wetlands and ditching, the lake likely had low fish species richness prior to settlement due to its shallow depth and position at the top of the watershed. The presence of channel catfish in fisheries assessments may indicate the potential for fish movement from downstream sources or across watershed boundaries since the species has never been stocked by DNR fisheries staff. Based on these factors it is not likely that a loss of connectivity is a significant stressor of the fish community.

Current management activities regulated by DNR that can impact the fish community or habitat include fish stocking and removal, aquatic plant management permitting, and water use permitting. Fish removal has not been performed since the 1980's and walleye are the only species being stocked into the lake regularly. FIBI Tool 7 does not include Walleye in the top carnivore metric from gill net catch data. While the Long Lake Homeowners Association has been issued aquatic plant management permits to use copper sulfate for algae control in the past, these treatments followed permit guidelines intended to minimize the impact to the game fish community. In addition, the current DNR permit that regulates pumping of water from the Watonwan River includes limitations to the quantity, timing, and duration intended to minimize the impact to lake water chemistry. TP levels are below the threshold for lakes in this ecoregion which suggests the current management activities are likely not a significant stressor of the fish community.

Some potential stressors identified in this report appear to be responsible for the impairment to aquatic life use. Watershed disturbance is a likely candidate stressor based on current conditions. Agricultural uses account for about 69% of the land within the watershed with corn and soybean the primary crops produced. Residential and commercial development including roads accounts for an additional 8.6% of the land cover within the watershed. Modeling in Minnesota lakes suggests that total phosphorus concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area and this relationship tends to be stronger in shallow lakes (Cross and Jacobson, 2013).

The riparian area of Long Lake has been altered by human activities and the scale of this disturbance appears to be a significant stressor to the fish community. Estimators of riparian disturbance, the number of docks per kilometer of shoreline and the lake wide Score the Shore survey score, are near threshold levels believed to impact the fish community. “Score the Shore” survey protocols (Perleberg D., et al, 2015) were developed by DNR-EWR in 2013 and adopted for use by DNR-Fisheries for the 2015 field season to assess riparian lake habitat. Although few lakes in the Watonwan River watershed have been surveyed using this technique scores from surveys completed statewide (about 200 surveys) have ranged from 37 to 99 with an average of 74. The score for Long Lake was 71, which is considered “fair” riparian habitat by DNR-EWR based on lakes sampled to date. Component scores indicate the habitat in the Shoreland and Shoreline zones has been altered and could be improved.

The DNR-Fisheries (2013) analysis classified the lake’s watershed as having the potential for partial restoration based on the current amount of land use disturbance and land protection. While full restoration may not be an achievable goal at this time, actions that mitigate the effects of watershed disturbance and restore riparian habitat should help the fish community inhabiting the lake.

6. Conclusions

6.1 Summary of probable stressors

The stressors for the biological impairments in the Watonwan River Watershed are listed in the table below. The most common stressor in the watershed was degraded habitat, followed by altered hydrology, Nitrogen and TSS. Six locations were identified to be stressed by longitudinal connectivity. While low DO and eutrophication were only identified as stressors in a single reach. A more detailed version of this table with potential sources/pathways and locations where additional monitoring is needed can be found in Table 8.3 in the the Appendix.

Table 6.1. Summary of probable stressors in the Watonwan River Watershed

Stream Name	AUID	Biological Impairment	Stressors								
			Low DO	Eutrophication	Nitrogen	High turbidity/TSS	Lack of Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity	Ammonia
Upper Watonwan River 10 HUC											
Unnamed Creek (Mountain Lake Inlet)	07020010-505	Macroinvertebrates	-	O	•	-	•	o	-	-	-
Watonwan River	07020010-566	Both	o	O	•	o/•	•	•	-	-	-
Watonwan River	07020010-567	Fish	-	O	-	•	•	•	-	-	-
North Fork Watonwan River 10 HUC											
Unnamed Creek	07020010-583	Both	-	O	•	o	•	•	-		-
Unnamed Creek	07020010-549	Both	-	O	•	o	•	•	-	-	-
NF Watonwan River	07020010-564	Both	o	O	•	o	•	•	o	-	-
NF Watonwan River	07020010-565	Fish	o	O	-	o	•	•	-	-	-
St James Creek 10 HUC											
Unnamed Creek	07020010-552	Both	o	O	o	o	•	o	o	-	
Butterfield Creek	07020010-516	Both	o	•	•	•	•	•	•	o	o

Stream Name	AUID	Biological Impairment	Stressors								
			Low DO	Eutrophication	Nitrogen	High turbidity/TSS	Lack of Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity	Ammonia
South Fork Watonwan River 10 HUC											
Unnamed Creek	07020010-561	Both	o	O	•	o	•	•	o	-	-
JD 1	07020010-579	Both	o	O	•	o	•	•	•	-	-
JD1	07020010-580	Fish	o	O	o	o	•	•	o	-	-
JD1	07020010-581	Fish	o	O	o	o	•	•	•	-	-
South Fork Watonwan River	07020010-569	Fish	o	O	o	o	•	•	•	-	-
South Fork Watonwan River	07020010-568	Both	o	O	o/•	•	•/o	•	•	-	-
South Fork Watonwan	07020010-547	Fish	o	O	o	•	•	•	o	-	-
Willow Creek	07020010-571	Both	-/o	O	•	o/•	•	•	o	-	-
South Fork Watonwan River	07020010-517	Both	o	O	•	•	•	•	-	-	-
Stream Name	**AUID**		**Stressors**								

Stream Name	AUID	Biological Impairment	Stressors								
			Low DO	Eutrophication	Nitrogen	High turbidity/TSS	Lack of Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity	Ammonia
		Biological Impairment	Low DO	Eutrophication	Nitrogen	High turbidity/TSS	Lack of Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity	Ammonia
South Fork Watonwan River 10 HUC continued											
Spring Brook	07020010-540	Both	o/-	o	o	o	•	o	o	-	-
Perch Creek 10 HUC											
Mink Creek	07020010-577	Both	o/-	o	•	-/o	•	•	o	-	-
Unnamed Creek	07020010-557	Fish	-	o	o	-	•	•	o	-	-
Perch Creek	07020010-524	Both	-	o	o/•	•	•	•	•	-	-
Unnamed Creek	07020010-526	Both	o/•	o	o/•	o	•	•	o	o	-
Spring Branch Creek	07020010-574	Fish	o	o	-	o	•	•	o	-	-

Stream Name	AUID	Biological Impairment	Stressors								
			Low DO	Eutrophication	Nitrogen	High turbidity/TSS	Lack of Habitat	Altered Hydrology	Connectivity	Chloride/Conductivity	Ammonia
Perch Creek	07020010-523	Fish	-	o	o	●	●	o	-	-	-
Lower Watonwan River 10 HUC											
Watonwan River	07020010-563	Fish	-	o	o	●	●	o	-	-	-
Watonwan River	07020010-511	Both	o/-	o	o	●	●	o	-	-	-
Watonwan River	07020010-510	Both	o/-	o	o	●	●/o	o	-	o	-
County Ditch 78	07020010-559	Both	o	o	o/●	-	●/o	o	-	-	-
Watonwan River	07020010-501	Both	o/-	o	-/o	o/●	●	o	-	-	-

● = stressor; o = inconclusive stressor; - = not a stressor, blanks not assessed (no data)

Note, when a single assessment is listed where two assemblages were impaired both indicators are impaired for the stressor.

Note, where a different assessment is made for each of the two impaired indicators within a reach the assessment is split by a /, assessment for fish is to the left, macroinvertebrates assessment is to the right (except for nitrate which is primarily a stressor of macroinvertebrates).

6.2 Recommendations

The present health of biological communities within the Watonwan River Watershed can be attributed to the effects of multiple stressors. Within the watershed the most common stressors identified were degraded habitat conditions and impacts of altered hydrology. These stressors are largely tied to past and present landuse activities in the watershed. Watersheds that have a high degree of human alteration seem most at risk for not only habitat and altered hydrology stress, but TSS and nutrient issues as well which were apparent within the Watonwan.

Along with altered hydrology, lack of adequate water storage on the watershed's landscape, and limited quality vegetative buffers along stream riparian zones are drivers of bank erosion. These root causes of erosion are causing elevated levels of both suspended and bedded sediment.

Bedded sediment is affecting the habitat availability, and the undercutting of stream-banks is contributing to the influx of fine sediment. Areas of severe erosion were present in the watershed. Suspended sediment and bedded sediment are closely connected and need to be addressed together. The aquatic communities would benefit from a decrease in fine sediment; the multiple causes of bank erosion need to be addressed. Increased drainage creates flashy flow events; where high and low flows are amplified. During increased drainage and higher flows, water moves quickly through the Watonwan drainage eroding banks as they make their way downstream.

Limited buffers and agricultural soil protection after crops are harvested and before spring planting are established also allow sediments to be carried right into streams through wind and bank erosion. Tile drainage also serves as direct sources of nutrient enrichment from agricultural field to drainage ditch and stream.

While eutrophication was not a primary stressor in the reach, ideal conditions appear present for potential nutrient enrichment to exist in the watershed, including streams with poor shading, high temperatures and little shade and elevated nutrient levels. Phosphorus, chlorophyll-a, DO flux values were commonly above the proposed water quality standards in areas, and pH values exceed the standard. Intercepting and removing nutrient inputs as much as possible should be pursued throughout the entire watershed.

Overall, the stressors will need to be addressed in various ways to restore biological conditions within the watershed. Table 8.3 in the Appendix shows not only more detail on potential sources and pathways, but also includes areas where additional monitoring would be useful to help better understand inconclusive stressors. The DNR recommends that restoration efforts focus attention on sources not symptoms of watershed issues (bank stability, etc.). Important practices to implement in the watershed include: increasing water storage, proper culvert and bridge sizing, riparian buffers with deep roots, and restoring connectivity and natural stream channels. Protection efforts are needed not only during spring runoff events, but year round to prevent wind erosion keep agricultural soils on the fields and out of surface waterways. Future protection efforts in the watershed should also include making improvements to streams that were just above impairment thresholds in an attempt to curb future impairments.

7. References

Allan, J. 1995. Stream Ecology: structure and function of running waters. Dordrecht, Netherlands: Kluwer Academic Publishers. 388 pp.

Camargo, J., & Alonso, A. 2006. Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: a global assessment. Environment International 32, 831-849.

Cormier S., S. Norton, G. Suter and D. Reed-Judkins. 2000. Stressor Identification Guidance Document. U.S. Environmental Protection Agency, Washington D.C., EPA/822/B-00/025. http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/biocriteria/upload/stressorid.pdf

Davis, J. 1975. Minimal Dissolved Oxygen Requirements of Aquatic Life with Emphasis on Canadian Species: A Review. Journal of the Fisheries Research Board of Canada, 32(12), 2295-2331.

Cross, Timothy K. and Peter C. Jacobson, 2013. Landscape factors influencing lake phosphorus concentrations across Minnesota, Lake and Reservoir Management, 29:1, 1-12.

Doudoroff, P. and C.E. Warren. 1965. Dissolved oxygen requirements of fishes. Biological Problems in Water Pollution: Transactions of the 1962 Seminar. 999-WP-25. Cincinnati, Ohio: Taft Sanitary Engineering Center, U.S. Public Health Service, Health Service Publication.

Erman, D.C. and F.K. Ligon. 1988. Effects of discharge fluctuation and the addition of fine sediment on stream fish and macroinvertebrates below a water filtration facility. Environmental Management 12(1), 85-97.

Grabda, E., Einszporn-Orecka, T., Felinska, C., & Zbanysek, R. (1974). Experimental methemoglobinemia in trout. Acta Ichtyologica Et Piscatoria 4, 43-71.

Gray, L. J., & Ward, J. V. 1982. Effects of sediment releases from a reservoir on stream macroinvertebrates. Hydrobiologica 96, 177-184.

U.S. EPA. 2010. Causal Analysis/Diagnosis Decision Information System (CADDIS). Physical Habitat. Retrieved, from https://www.epa.gov/caddis-vol2/caddis-volume-2-sources-stressors-responses-physical-habitat

Heiskary, S., Bouchard, D., & Markus, D. 2013. Minnesota Nutrient Criteria Development for Rivers. St. Paul: Minnesota Pollution Control Agency.

DNR-Fisheries, 2013. Fish Habitat Plan: A Strategic Guidance Document. Minnesota Department of Natural Resources, Section of Fisheries. 500 Lafayette Road. Saint Paul, MN 55155-4040.

DNR-Fisheries Lake Files, 2015. Historic management plans and survey reports of Bingham Lake from DNR-Fisheries Windom Area Office. Minnesota Department of Natural Resources, Section of Fisheries. 175 County Road 26, Windom, MN 56101-1868.

DNR. 2014. Watonwan River Watershed Hydrology, Connectivity, and Geomorphology Assessment Report. Minnesota Department of Natural Resources, Division of Ecological and Water Resources.

Minnesota Pollution Control Agency (MPCA). 2008. Draft Biota TMDL Protocols and Submittal Requirements. Minnesota Pollution Control Agency, St. Paul, MN. http://www.pca.state.mn.us/index.php/view-document.html?gid=8524

MPCA. 2013. Nitrogen in Minnesota Surface Waters. St. Paul: Minnesota Pollution Control Agency.

MPCA.2016. Zumbro River Watershed Stressor Identification Report. https://www.pca.state.mn.us/sites/default/files/wq-ws5-07040004a.pdf.

MPCA. 2016. Watonwan River Watershed Monitoring and Assessment report. https://www.pca.state.mn.us/sites/default/files/wq-ws3-07020010b.pdf.

MPCA and MSUM. (2009b). State of the Minnesota River, Summary of Surface Water Quality Monitoring 2000-2008.

Munawar, M. N. 1991. A method for evaluating the impacts of navigationally induced suspended sediments from the Upper Great Lakes connecting channels on the primary productivity. Hydrobiologia, 219, 325-332.

Murphy, M. L. 1981. Effects of canopy modification and accumulated sediment on stream communities. Trans. Am. Fish. Soc., 110, 469–478.

Nebeker, A. V., S.E. Dominguez, G.A. Chapman, S.T. Onjukka, and D.G. Stevens. 1991. Effects of low dissolved oxygen on survival, growth and reproduction of Daphnia, Hyallella and Gammarus. Environmental Toxicology and Chemistry, 373-379.

Newcombe, C. P., & MacDonald, D. D. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11, 72-82.

Pekarsky, B. L. 1984. Predator-prey interactions among aquatic insects. In V. H. Resch, & D. M. Rosenberg, The Ecology of Aquatic Insects (pp. 196-254). NY: Praeger Scientific.

Perleberg, Donna, P. Radomski, S. Simon, K. Carlson, and J. Knopik. 2015. Minnesota Lake Plant Survey Manual, for use by DNR Fisheries Section and EWR Lakes Program. Minnesota Department of Natural Resources. Ecological and Water Resources Division. Brainerd, MN. 82 pp. and appendices.

Poff, N. L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime: A paradigm for river conservation and restoration. Bioscience 47(11), 769-784.

Radomski, Paul and Donna Perleberg. 2012. Application of a versatile aquatic macrophtye integrity index for Minnesota lakes. Ecological Indicators, 20 (2012): p 252-268.

Raleigh, R. L. 1986. Habitat suitability index models and instream flow suitability curves: brown trout. Biological report 82. U.S. Fish and Wildlife Service.

Rosenberg, D., & Wiens, A. 1978. Effect of sediment addition on macrobenthic invertebrates in a northern Canadian river. Water Research 12, 753-763.

Runkel, et al. 2013. Geologic controls on nitrate in Southeastern Minnesota streams. Minnesota Geological Survey.

U.S. EPA. 2010. Causal Analysis/Diagnosis Decision Information System (CADDIS). Environmental Protection Agency. Office of Research and Development, Washington, DC. Available online at http://www.epa.gov/caddis.

WHAF (Watershed Health Assessment Framework) online tool, 2016. http://arcgis.dnr.state.mn.us/ewr/whaf/Explore/

Wilcox, R. J., & Nagels, J. W. 2001. Effects of aquatic macrophytes on physico-chemical conditions of three contrasting lowland streams: a consequence of diffuse pollution from agriculture? Water Science and Technology 43(5), 163-168.

8. Appendix

Strength of Evidence scoring and analysis was completed for each AUID in the Watonwan Watershed and is available upon request.

Table 8.1 Values used to score evidence in the Stressor Identification Process.

Rank	Meaning	Caveat
+++	*Convincingly supports*	*but other possible factors*
++	*Strongly supports*	*but potential confounding factors*
+	*Some support*	*but association is not necessarily causal*
0	*Neither supports nor weakens*	*(ambiguous evidence)*
-	*Somewhat weakens support*	*but association does not necessarily reject as a cause*
--	*Strongly weakens*	*but exposure or mechanism possible missed*
---	*Convincingly weakens*	*but other possible factors*
R	*Refutes*	*findings refute the case unequivocally*
NE	*No evidence available*	
NA	*Evidence not applicable*	
D	*Evidence is diagnostic of cause*	

Table 8.2 Strength of Evidence Scores for various types of evidence.

Types of Evidence	**Possible values, high to low**
Evidence using data from case	
Spatial / temporal co-occurrence	+, 0, ---, R
Evidence of exposure, biological mechanism	++, +, 0, --, R
Causal pathway	++, +, 0, -, ---
Field evidence of stressor-response	++, +, 0, -, --
Field experiments / manipulation of exposure	+++, 0, ---, R
Laboratory analysis of site media	++, +, 0, -
Temporal sequence	+, 0, ---, R
Verified or tested predictions	+++, +, 0, -, ---, R
Symptoms	D, +, 0, ---, R
Evidence using data from other systems	
Mechanistically plausible cause	+, 0, --
Stressor-response relationships in other field studies	++, +, 0, -, --
Stressor-response relationships in other lab studies	++, +, 0, -, --
Stressor-response relationships in ecological models	+, 0, -
Manipulation of exposure experiments at other sites	+++, +, 0, --
Analogous stressors	++, +, -, --
Multiple lines of evidence	
Consistency of evidence	+++, +, 0, -, --
Explanatory power of evidence	++, 0, -

Table 8.3 Expanded summary of stressor table.

			Probable Sources and Pathways	DO/Eutrophication					Nitrate			TSS						Habitat							Altered Hydrology/Connectivity						Chloride			Ammonia	
AUID	Stream Name	Biological Stations	Impaired For	Wetland Influence	Excess Phosphorous	Algae/Plant Shift	Unidentified	Additional Monitoring?	Tile Drainage/Land Use	Point Sources	Additional Monitoring?	Flow Alteration/Connectivity	Streambank Erosion	Altered	Urbanization	Local Land Use or Pasture	Additional Monitoring?	Flow Alteration/Connectivity	Pasturing/ Lack of Riparian	Altered	Bedded Sediment	Erosion	Lack of Cover/Other Habitats	Additional Monitoring?	Dams/Impoundments	Road Crossings/Culverts	Water Withdrawal	Altered	Tile Drainage/Landuse	Additional Monitoring?	Urbanization/Road Salt	Wastewater or Industrial	Additional Monitoring?	Wastewater or Industrial	Additional Monitoring?
Upper Watonwan River																																			
505	Unnamed Creek (Mountain Lake Inlet)	91MN098	MIBI		x			x	x					x					x	x	x		x					x	x	x					
566	Watonwan River	13MN148, 13MN146, 01MN047, 13MN115	FIBI, MIBI	m	m	x		x	x	x		x	x					x	x		x	x						x	x			x	x	m	
567	Watonwan River	13MN166, 97MN018, 13MN106	FIBI				x	x	x			x	x	x				x	x	x	x	x	x					x	x						
North Fork Watonwan River																																			
583	Unnamed Creek	10EM071	FIBI, MIBI		x	m		x	x			x	x	x			x	x	x	x	x	x	x					x	x						
549	Unnamed Creek	13MN123	FIBI, MIBI		x			x	x			x		x		x	x	x	x	x		x	x					x	x						
564	North Fork Watonwan River	13MN165, 13MN107, 13MN136	FIBI, MIBI		m	m		x	x			x	x	x			x	x	x	x	x	x				m		x	x	x					
565	North Fork Watonwan River	13MN133	FIBI		x			x	x			x	x	x			x	x		x		x				m	x	x	x						
St. James Creek																																			
552	Unnamed Creek	13MN153	FIBI, MIBI			x		x	x		x			x	m		x		x	x	m		x			m		x	x	x					
516	Butterfield Creek	13MN128, 13MN105, 13MN156, 13MN125	FIBI, MIBI		x	x		m	x	x		x	x	x				x	x	x	x	x	x			m		x	x	x		x	x	m	x
South Fork Watonwan River																																			
561	Unnamed Creek	13MN124	FIBI, MIBI				x	x	x			x	x	m		x	x	x	x	m	x	x	x			m		x	x	m					
579	Judicial Ditch 1	13MN154, 91MN097	FIBI, MIBI				x	x	x	x		x	x	x			x	x	x	x	x	x	x		x	m		x	x			x		m	
580	Judicial Ditch 1	03MN061	FIBI		x	x		x	x	x	x	x		x			x	x		x	x		x			m		x	x	m		x		m	
581	Judicial Ditch 1	13MN110	FIBI		x			x	x		x	x	x	x			x	x	x	x	m	x	x			x		x	x						
569	South Fork Watonwan River	13MN164	FIBI		x			x	x		x	x	x	x			x	x	x	x	x	x	x			m		x	x						
568	South Fork Watonwan River	13MN109	FIBI, MIBI		m			x	x			x	x			x	x	x	x		x	x			x	m			x						
547	South Fork Watonwan River	13MN134	FIBI		x			x	x		x	x	x				x	x			x	x			m	m			x						
571	Willow Creek	13MN119, 03MN062, 13MN180	FIBI, MIBI		x	x		x	x			x	x			x	x	x	x		x	x	x			m			x						

			Probable Sources and Pathways	DO/Eutrophication					Nitrate			TSS						Habitat							Altered Hydrology/Connectivity						Chloride			Ammonia	
				Wetland Influence	Excess Phosphorous	Algae/Plant Shift	Unidentified	Additional Monitoring?	Tile Drainage/Land Use	Point Sources	Additional Monitoring?	Flow Alteration/Connectivity	Streambank Erosion	Altered	Urbanization	Local Land Use or Pasture	Additional Monitoring?	Flow Alteration/Connectivity	Pasturing/ Lack of Riparian	Altered	Bedded Sediment	Erosion	Lack of Cover/Other Habitats	Additional Monitoring?	Dams/Impoundments	Road Crossings/Culverts	Water Withdrawal	Altered	Tile Drainage/Landuse	Additional Monitoring?	Urbanization/Road Salt	Wastewater or Industrial	Additional Monitoring?	Wastewater or Industrial	Additional Monitoring?
517	South Fork Watonwan River	13MN142, 90MN099, 97MN013, 13MN101	FIBI, MIBI		x			x	x			x	x			x		x	x		x	x	x						x						
540	Spring Brook	13MN131			m			x	x			x	m	x						x	x	m				m		x	x	x					
Perch Creek																																			
577	Mink Creek	13MN118	FIBI, MIBI		x			x	x			x	x	x			x	x	x	x	x	x				m		x	x						
557	Unnamed Creek (Judicial Ditch 72)	13MN144	FIBI		x			x	x		x	x	x	x				x		x	x	x				m		x	x						
524	Perch Creek	13MN143, 13MN129	FIBI, MIBI		x	m		x	x			x	x						x		x	x	x			m			x						
526	Unnamed Creek	13MN158	FIBI, MIBI		x	m		x	x	x		x	m	x			x	x	x	x	x	m	x			m		x	x			x	x	x	
574	Spring Branch Creek	13MN150, 13MN137, 13MN139	FIBI		x	x		x	x		x	x	x	x			x	x	x	x	x	x	x		x	m		x	x						
523	Perch Creek	01MN015, 97MN013	FIBI		x			x	x		x		x								m	x	x			m			x	x					
Lower Watonwan River																																			
563	Watonwan River	13MN145	FIBI		x			x	x	x	x		x								x	x							x	x		x		x	
511	Watonwan River	01MN052, 13MN135	FIBI, MIBI		x			x	x		x		x	x							x	x	x						x	x					
510	Watonwan River	13Mn161, 13MN162, 13MN130	FIBI, MIBI		x	m		x	x	x	x		x	x					x		x	x	x						x	x		x	x	x	
559	County Ditch 78	13MN120	FIBI, MIBI		x	m		x	x				x	x					x	x		x	x					x	x	x					
501	Watonwan River	03MN068, 90MN100	FIBI, MIBI		x	m		x	x		x		x								x	x	m						x	x					

Biological metrics used in the Watonwan River Watershed

Table 8.4 Biological metrics included in the SID process. Metric description	Explanation	Expected response to stress	
Fish			
BedFdFrim	Relative abundance of benthic feeders	Benthic feeders feed from benthic environments and are found with clean gravel substrates	*Decrease*
BenInsect-Tol	Relative abundance that are non-tolerant benthic insectivore species (excludes tolerant species)	Benthic insectivores feed from benthic environments and are found with clean gravel substrates	*Decrease*
Centr-Tol	Relative abundance of Centrarchids (excludes tolerant species)	Centrarchids are members of the sunfish family and are intolerant to elevated levels of suspended sediment	*Decrease*
Darter	Relative abundance of darter species	Darters require riffle habitat and are considered sensitive to water quality degradation	*Decrease*
DarterSculpSuc	Relative abundance that are darter, sculpin & round bodied sucker species	Darter, sculpin, and round bodied suckers require shallow riffle habitats	*Decrease*
DetNWQTX	Relative abundance of taxa that are detritivores	Detritivores are bottom feeders of detritus (dead and decomposing organic matter)	*Decrease*
DomTwo	Combined relative abundance of two most abundant taxa	Taxa richness decreases with water quality degradation and become dominated by a few species	*Increase*
Exotic	Richness of exotic species	Exotic species are often tolerant of water quality degradation	*Increase*
General	Relative abundance that are generalist species	Generalist species are tolerant of water quality degradation	*Increase*
Hdw-Tol	Relative abundance that are headwater species (excludes tolerant species)	Headwater species are sensitive to changes in flow and habitat	*Decrease*
Herbv	Relative abundance that are herbivore species	Herbivorous species eat only plants	*Decrease*
Insect-Tol	Relative abundance that are insectivorous (excludes tolerant species)	Insectivore species are dependent on a stable invertebrate food base	*Decrease*
InsectCyp	Relative abundance that are insectivorous Cyprinids	Insectivore minnows are dependent on a stable invertebrate food base	*Decrease*
Intolerant	Relative Abundance of intolerant species	Abundance of intolerant taxa is inversely related to presence of stressors	*Decrease*
Metric description	**Explanation**	**Expected response to stress**	
LithFrim	Relative Abundance of lithophilic spawners	Quantities of lithophilic spawners require clean	*Decrease*

Table 8.4 Biological metrics included in the SID process. Metric description	**Explanation**	**Expected response to stress**	
		coarse substrates for spawning	
Llvd	Relative Abundance of long-lived species	Sufficient quantities of long-lived taxa indicate more stable environmental conditions and communities less influenced by physical stressors	*Decrease*
MA>3 years-Tol (MA>3Pct)	Relative abundance of females of mature age >=3 excluding tolerant taxa	Species that have late maturity require stable conditions	*Decrease*
Minnows-TolPct	Relative abundance that are Cyprinidae (minnows) (excludes tolerants)	Many minnow species are sensitive to water quality degradation	*Decrease*
NestGuarding	Relative abundance of nest-guarding species	Species that do not require coarse substrate for nests	Increase
NumPerMeter-Tol	Number of individuals per meter of stream sampled (excludes individuals of tolerant species)	A healthy stream system has higher levels of non-tolerant fish present	Decrease
Omnivorous Fish	Relative abundance that are omnivore species	Omnivorous species eat both plants and animals. They are tolerant of degradation	*Increase*
Perciform	Relative abundance of the order Perciformes	The order Perciformes includes sunfish, perch, and walleye. Sediment effects the growth of smallmouth bass	*Decrease*
Percfm-Tol	Relative Abundance of Perciformes (excludes tolerant species)	Perch like fish which are sensitive to elevated quantities of suspended sediment	*Decrease*
Pioneer	Relative abundance of pioneer species	Pioneering species are more adept to moving into recently disturbed habitats, an abundance of pioneering taxa could be an indication of recent stress in an aquatic environment	*Increase*
Piscivore	Relative abundance that are piscivore species	The presence of piscivores may indicate a stable system that supports lower trophic level organisms such as benthic macroinvertebrates and fish. Proper substrate will also benefit piscivores	*Decrease*
Pioneer	Relative abundance that are pioneer species	Pioneer species are able to thrive in unstable environments and are the first to invade after disturbance	*Increase*

Table 8.4 Biological metrics included in the SID process. Metric description	Explanation	Expected response to stress	
Riffle	Relative abundance that are riffle-dwelling species	Riffle dwelling species are important indicators of available riffle habitat	*Decrease*
Sensitive	Relative abundance that are sensitive species	Species that are sensitive to disturbance. Often the first species to disappear	*Decrease*
SLithFrim	Relative abundance of simple lithophils	Simple lithophilic spawners require clean gravel or cobble substrates for reproductive success	*Decrease*
SLithop	Relative abundance that are simple lithophilic spawners	Simple lithophilic spawners require clean gravel or cobble substrates for reproductive success	*Decrease*
SLvd	Relative abundance of short-lived species	High quantities of short-lived species in a sample could indicate an imbalance of community structure and presence of recent stressors	*Increase*
SSpnTx	Relative abundance that are serial spawning species	Species that attain reproductive maturity at a very young age. The number of fast maturing individuals increases with disturbance	*Increase*
Taxa count	Taxa richness of sample	Overall diversity drops in the presence of biological stressors	*Decrease*
Tol	Relative abundance that are tolerant species	Tolerant fish species are able to survive generally adverse stream conditions	*Increase*
VTolTx	Relative abundance that are very tolerant species	Species that survive the most disturbed conditions	*Increase*
Wetland-Tol	Relative abundance that are wetland species	Wetland species thrive in low gradient systems dominated by a wetland riparian zones	*Decrease*
Macroinvertebrates			
Burrower	Relative abundance of burrowers in subsample	Burrower species “burrow” in fine sediment indicating potential siltation in riffles	*Increase*
Climber	Relative abundance of climbers in subsample	Climber species use habitat such as overhanging vegetation or woody debris	*Decrease*
Metric description	**Explanation**	**Expected response to stress**	
Clinger	Relative abundance of climbers in subsample	Clinger species attach to rock or woody debris. Clingers may decrease in stream reaches with homogeneous	*Decrease*

Table 8.4 Biological metrics included in the SID process. Metric description	**Explanation**	**Expected response to stress**	
		substrate composition, velocity, and depth.	
Collector-Filterer	Relative abundance of collector-filterers in subsample	Collector-Filterer species filter organic material from the water	*Decrease*
Collector-gatherer	Relative abundance of collector-gatherers in subsample	Collector-gatherer species scavenge on stream bottoms feeding on detritus, dead organisms and other food particles lodged between rocks or in deep pools	*Decrease*
Dominant2Invert Taxa	Relative abundance of dominant two taxa in subsample	Taxa richness decreases with water quality degradation and becomes dominated by a few species	*Increase*
DomFiveCH	Relative abundance of dominant five taxa in subsample (excluding all chironomids)	Taxa richness decreases with water quality degradation	*Increase*
Ephemeroptera	Taxa richness/Relative Abundance of Ephemeroptera (baetid taxa treated as one taxon)	Ephemeroptera are commonly referred to as mayflies, many species are often considered as indicators of water quality because of their specific habitat requirements and sensitivities to water quality condtions.	*Decrease*
EPT	Relative abundance of Ephemeroptera, Plecoptera & Trichoptera individuals in subsample	EPT are a sensitive group of macroinvertebrates commonly used to measure overall health	*Decrease*
HBI_MN	A measure of pollution based on tolerance values	A measure of pollution based on tolerance values assigned to each individual taxa developed by Chirhart, modification of Hilsenhoff Biotic Index for Minnesota, increasing scores indicate increasing potential for stress	*Increase*
Intolerant2	Taxa richness of macroinvertebrates with tolerance values less than or equal to 2, Using MN TVs	Abundance of intolerant taxa decreases with increasing presence of stressors	*Decrease*
Intolerant2less	Taxa richness of macroinvertebrates with tolerance values less than or equal to 4 (excluding intolerant chironomid and baetid taxa), using MN TVs	Abundance of intolerant taxa decreases with increasing presence of stressors	*Decrease*

Table 8.4 Biological metrics included in the SID process. Metric description	Explanation	Expected response to stress	
Macroinvertebrate Taxa Count	Taxa richness of macroinvertebrates	Overall diversity drops in the presence of biological stressors	*Decrease*
Metric description	**Explanation**	**Expected response to stress**	
Legless	Relative abundance of legless individuals in subsample	Legless macroinvertebrates are tolerant species like midges/worms, and snails	*Increase*
Odonata	Relative abundance of Odonata (dragonflies) individuals in subsample	Odonata are a good indicator of water quality	*Decrease*
Plectoptera	Relative abundance of Plecoptera (stoneflies) individuals in subsample	Presence of Plecoptera is a sign of good water quality which require high DO levels	*Decrease*
POET	Taxa richness of Plecoptera, Odonata, Ephemeroptera, & Trichoptera	Stoneflies, Dragonflies, Mayflies, and Caddisflies which are all sensitive to pollution	*Decrease*
Predator	Taxa richness of predators	Predators are an important part of a stream ecosystem that eat other animals	*Decrease*
Sprawler	Relative abundance of sprawler individuals in subsample	Sprawlers live on the surface of floating plants or fine sediments. Many are adapted to keep respiratory surfaces free of silt	*Increase or Decrease*
Swimmer	Relative abundance of swimmer individuals in subsample	Swimmers require low velocity water and their abundance or decline indicate change in water flow or pools	*Decrease*
TaxaCountAllChir	Total taxa richness of macroinvertebrates	A healthy stream system has a variety of macroinvertebrates present. The number increases with habitat availability and water quality	*Decrease*
Tolerant2ChTx	Relative percentage of taxa with tolerance values equal to or greater than 6	Tolerant macroinvertebrate species are able to survive generally adverse stream conditions	*Increase*
TrichoperaTaxa	Taxa richness of Trichoptera	Presence of Trichoptera is a sign of good water quality	*Decrease*
TrichopteraChTx	Relative percentage of taxa belonging to Trichoptera (caddisflies)	Presence of Trichoptera is a sign of good water quality	*Decrease*
TrichopterawoHydro (TrichwoHydro)	Relative abundance of non-hydropsychid Trichoptera individuals in subsample	Trichoptera that do not spin nets and are most sensitive to pollution	*Decrease*
VeryTolerant2Pct	Relative abundance (%) of macroinvertebrate	Proliferation of very tolerant taxa is good indication of	*Increase*

Table 8.4 Biological metrics included in the SID process. Metric description	Explanation	Expected response to stress	
	individuals in subsample with tolerance values equal to or greater than 8, Using MN TVs	abundance biological stress in a reach	