Stressor Identification

August 2021

Sauk River Watershed Cycle 2 Stressor Identification Report

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

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Document number: wq-iw8-38q

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Key terms and abbreviations

AOP	Aquatic Organism Passage Program
CADDIS	Causal Analysis/Diagnosis Decision Information System
DNR	Minnesota Department of Natural Resources
DO	Dissolved Oxygen
EPA	U.S. Environmental Protection Agency
IBI	Index of Biotic Integrity
MPCA	Minnesota Pollution Control Agency
MSHA	Minnesota Stream Habitat Assessment
SID	Stressor Identification
TALU	Tiered Aquatic Life Uses
TIV	Tolerance Index Value
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
WRAPS	Watershed Restoration and Protection Strategy

Introduction

Since 2008, 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. These scores are then compared to the appropriate IBI thresholds (stream class), which are determined by the type and location of the stream or river that was sampled. If the fish or macroinvertebrate IBI score fails to meet the standards set by the stream class, it is termed a "biological impairment" and is placed on the EPA's impaired wasters list. If biological impairments are found, stressors to the aquatic community must be identified.

Stressor identification (SID) 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 probable factors causing harm to aquatic life. SID is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act. Information on the SID process can be found on the United States Environmental Protection Agency's (EPA) website http://www.epa.gov/caddis/. Specific information on Minnesota's processes for SID in streams can be found on MPCA's webpage "Is Your Water Stressed". Minnesota Department of Natural Resources (DNR) has a similar webpage for lakes - "Stressors to Biological Communities in Minnesota's Lakes".

This report details the SID process for the Sauk River Watershed, following the second cycle of biological monitoring. This report also contains SID work that was completed after the first cycle of watershed monitoring, on stations that were channelized. Until the Tiered Aquatic Life Uses (TALU) assessment process was written into rule in 2014, the MPCA did not have the tools to assess channelized streams. Therefore the stations that were sampled in 2008 on channelized streams, were not assessed until the TALU criteria were finalized, and therefore, were not included in the Cycle I SID Report (MPCA 2012).

Overview of the Sauk River Watershed

The Sauk River Hydrologic Unit Code (HUC)-8 watershed (07010202) is divided into 32 HUC-12 subwatersheds (Figure 1). Within the first cycle of watershed monitoring, a biological station was placed at the outlet of the HUC 14, 12, 10, and 8 levels in an attempt to monitor each HUC-8 watershed in an unbiased manner. As the MPCA moved into the second cycle of monitoring, efforts were scaled back in an attempt to provide the ability to sample stations that were local priorities, while still monitoring at a sufficient level to detect change. Therefore, a biological monitoring station was placed at the outlet of each of the HUC-12 subwatersheds, with a preference to sample stations that had existing data from the Cycle I monitoring efforts (Figure 2).

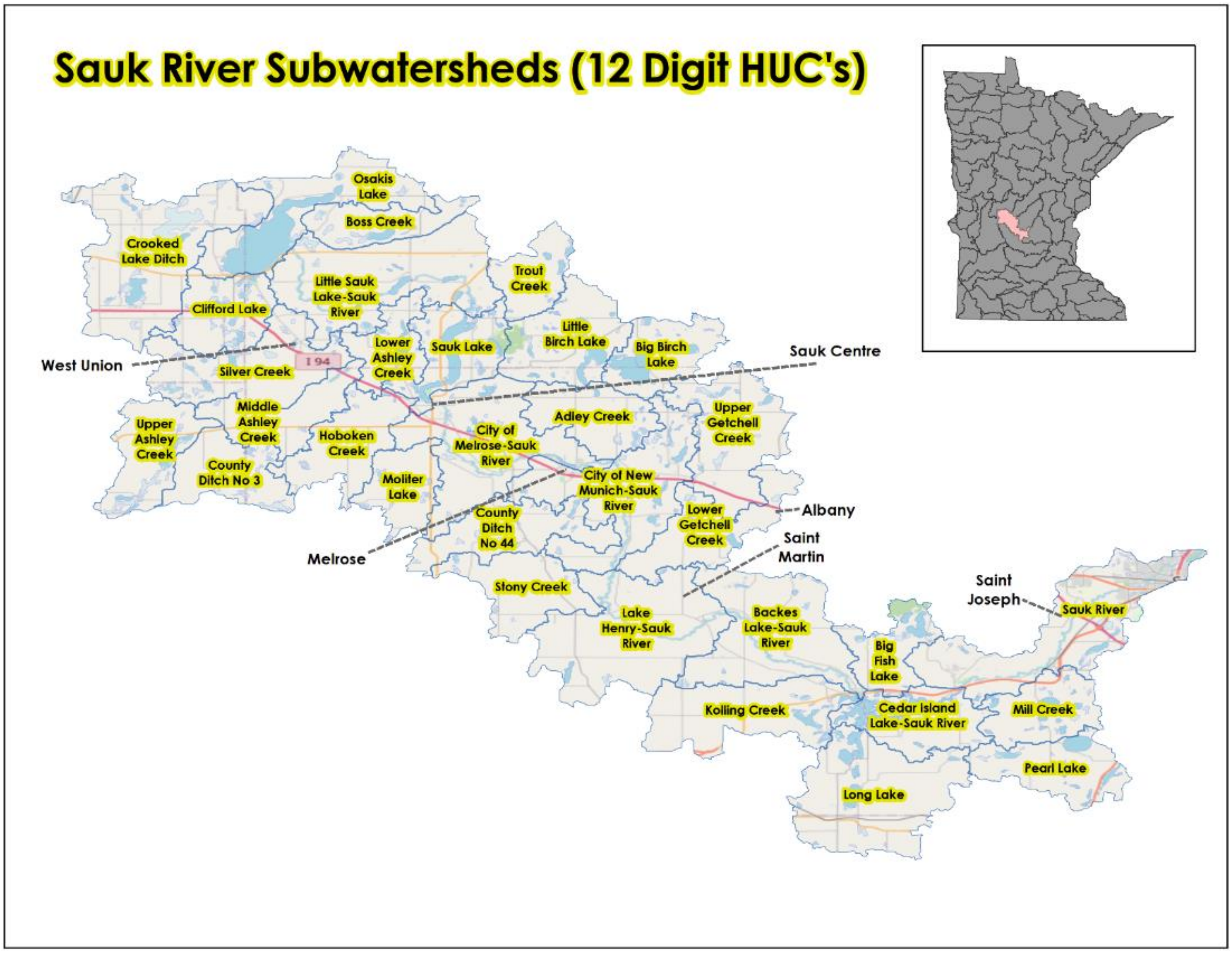
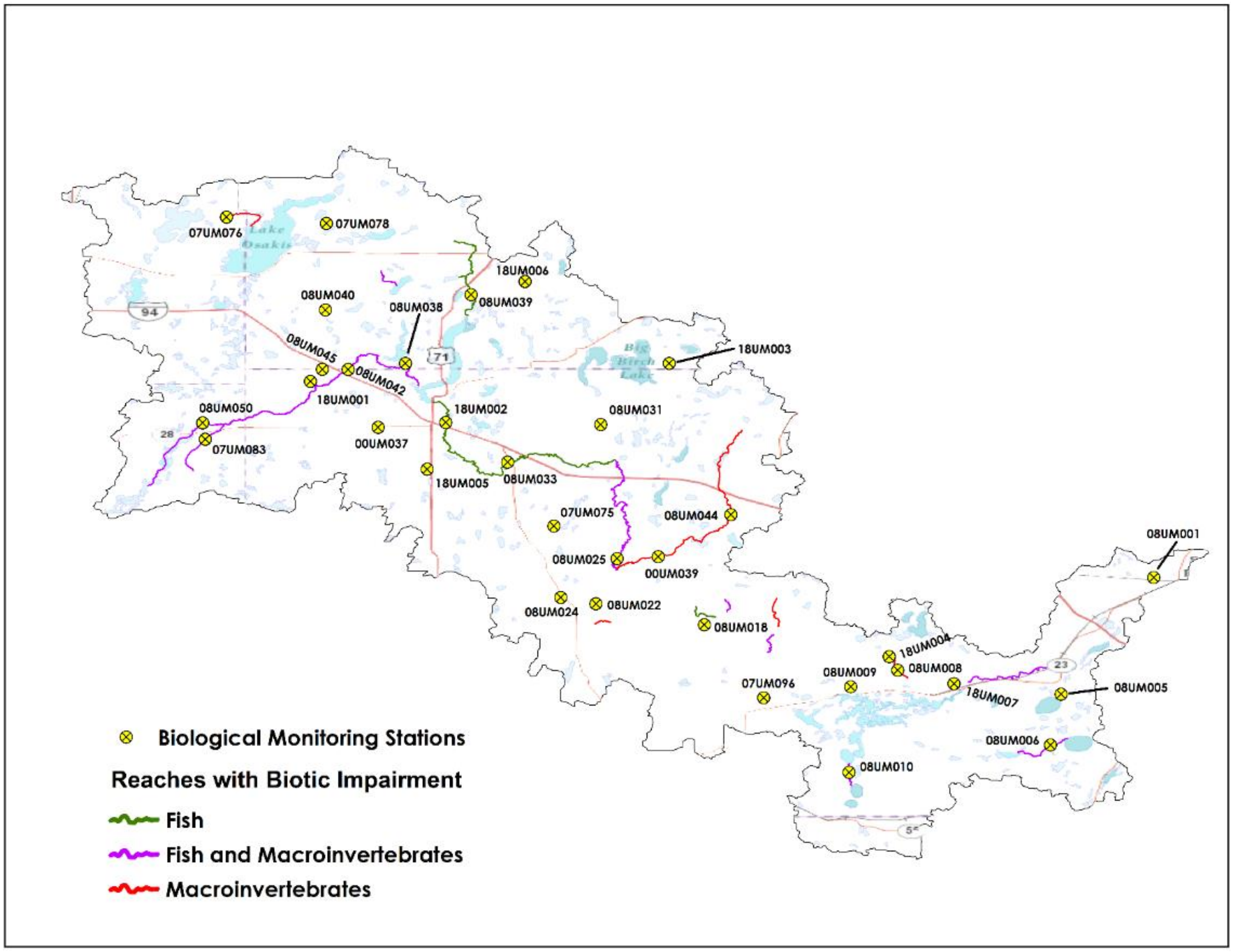


Figure 1. HUC-12 Subwatersheds within the Sauk River HUC-8 Watershed.

Figure 2. Biological Monitoring Stations and Biological Impairments within the Sauk River Watershed



Biologically-impaired streams

Biological sampling from the cycle II monitoring effort resulted in seven stream reaches being assessed as having impaired fish and/or macroinvertebrate communities. In addition to the seven new impairments from the Cycle II monitoring, 18 stream reaches that were sampled in the first cycle, but were deferred due to being channelized, were also assessed as impaired. These reaches were brought into the Cycle II SID process, due to the new biological impairments, and are listed below.

Stream impairment investigations

- Crooked Lake Ditch (AUID 07010202-552)- Macroinvertebrates, Fish, Dissolved Oxygen (DO), TSS
- Crooked Lake Ditch (AUID 07010202-581)- Fish, DO
- Crooked Lake Ditch (AUID 07010202-637)- Macroinvertebrates, Fish, DO, Nutrients
- Boss Creek (AUID 07010202-589)- Macroinvertebrates, Fish, DO
- Tributary to Little Lake Osakis (AUID 07010202-638)- Fish
- Unnamed Creek (AUID 07010202-592)- Fish
- Pope County Ditch 6 (AUID 07010202-521)- Fish
- Silver Creek (AUID 07010202-640)- Macroinvertebrates, Fish, DO
- Unnamed Creek (AUID 07010202-613)- Fish
- Unnamed Creek (AUID 07010202-624)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-647)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-733)- Macroinvertebrates, Fish
- Adley Creek (AUID 07010202-527)- Fish, DO
- Stearns County Ditch 44 (AUID 07010202-723)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-654)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-615)- Macroinvertebrates, Fish, DO
- Getchell Creek (AUID 07010202-727)- Fish, DO
- Getchell Creek (AUID 07010202-729)- Macroinvertebrates, Fish, DO
- Stony Creek (AUID 07010202-724)- Fish
- Stony Creek (AUID 07010202-725)- Macroinvertebrates, Fish
- Tributary to Stony Creek (AUID 07010202-655)- Fish
- Unnamed Creek (AUID 07010202-657)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-735)- Macroinvertebrates, Fish
- Unnamed Creek (AUID 07010202-633)- Macroinvertebrates, Fish

The SID data collection, analysis, and recommendations for each of these impaired AUIDS will be discussed and sorted into HUC-12 subwatersheds for the duration of this report.

Crooked Lake Ditch Subwatershed

The Crooked Lake Ditch Subwatershed covers over 38,000 acres, located just east of Alexandria (Figure 3). The vast majority of the streams within the subwatershed have been straightened, although a few short sections of natural channel remain. Notable streams within the subwatershed include Fairfield Creek and three sections of Crooked Lake Ditch (AUID -637, -581, -552).

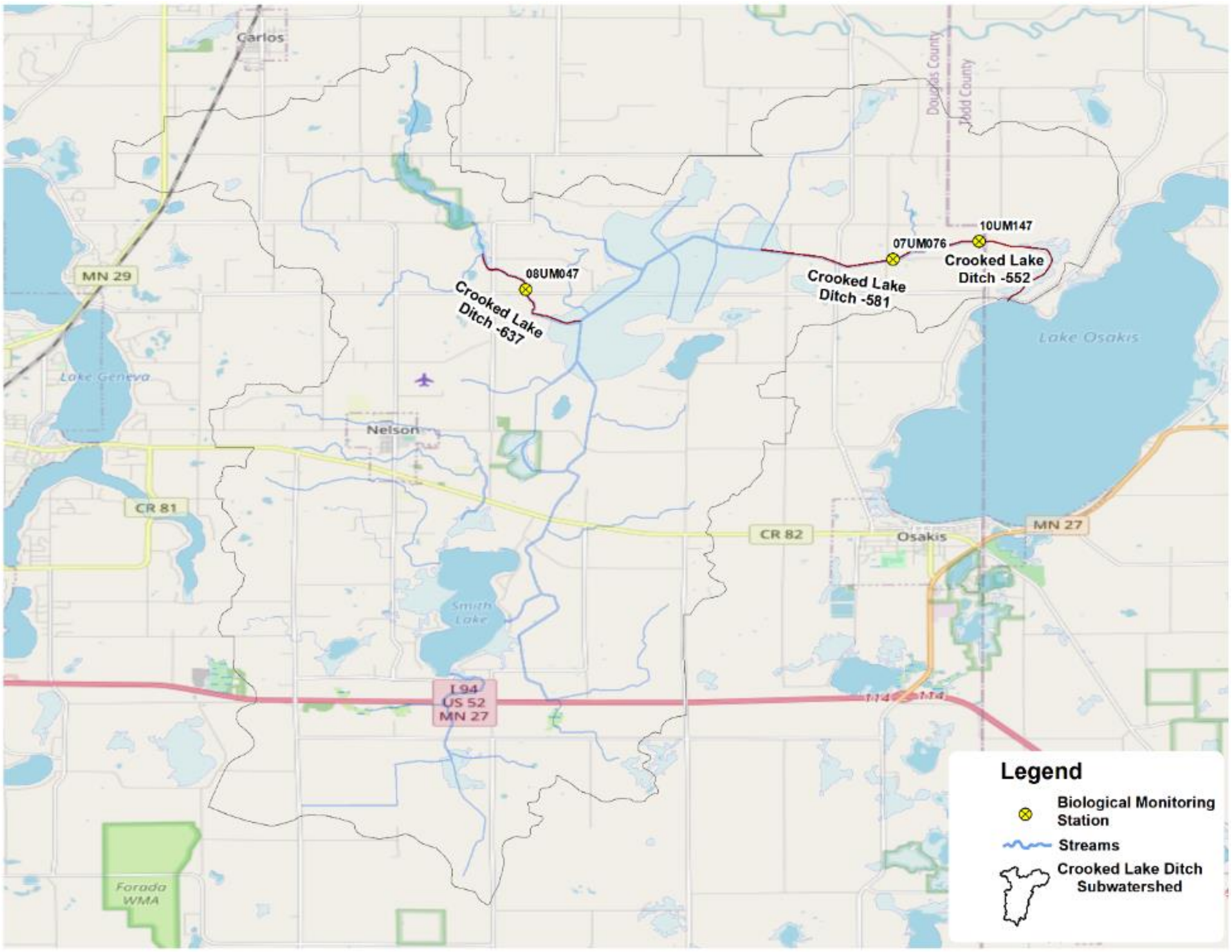


Figure 3. Biological monitoring stations in the Crooked Lake Ditch Subwatershed.

The land use within the Crooked Lake Ditch Subwatershed is dominated by cropland (57%), followed by hay/pasture (17%), and wetlands (12.8%) (Figure 4). Nelson is the only city located within the subwatershed.

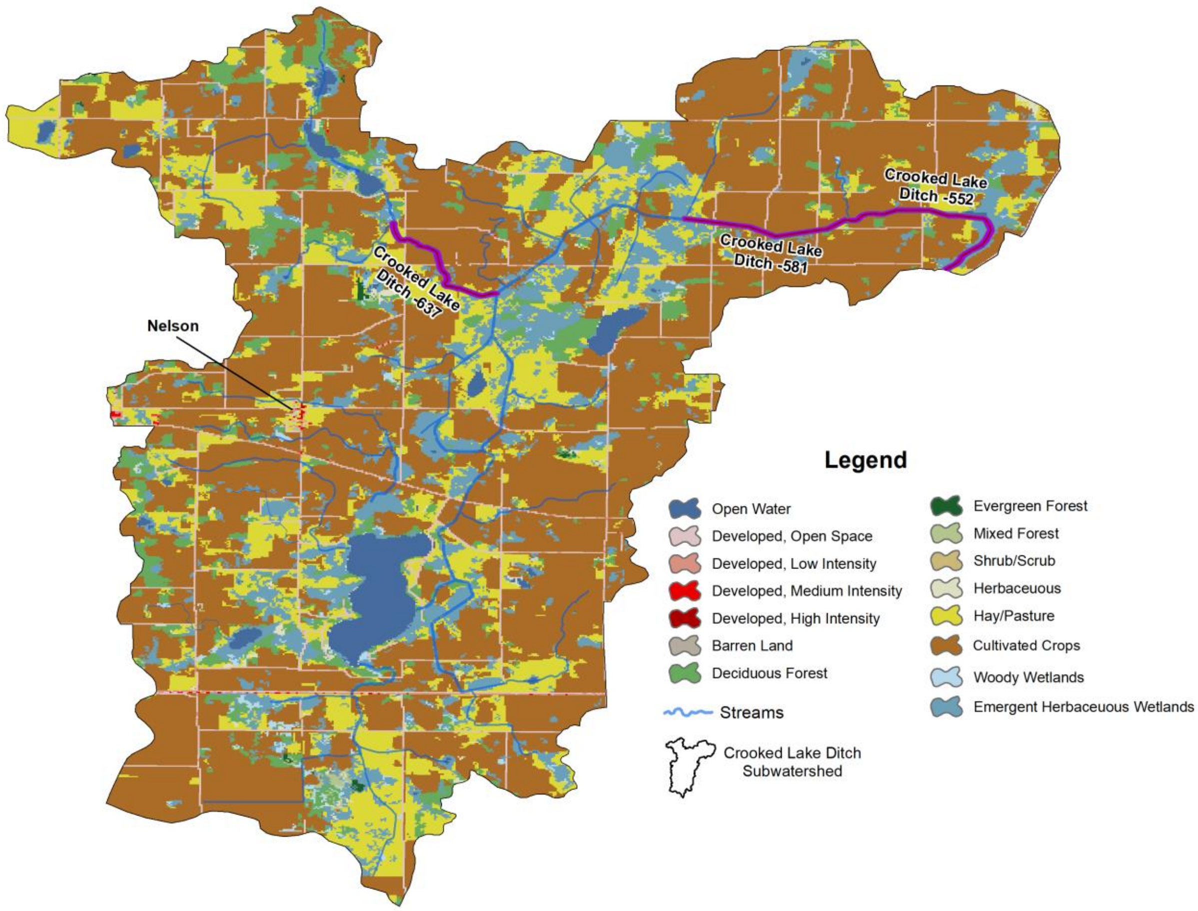


Figure 4. Land use in the Crooked Lake Ditch Subwatershed.

Crooked Lake Ditch (07010202-637)

Impairment: This upstream portion of Crooked Lake Ditch (AUID -637) flows for 1.7 miles before reaching its confluence with Fairfield Creek, 2.5 miles northeast of Nelson. The channel has been channelized throughout the entire 1.7 mile reach. There is one biological monitoring station (08UM047) on AUID -637 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The use attainability analysis (UAA) process determined that Crooked Lake Ditch should be assessed under the modified use criteria, due to poor habitat. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate class is class 5 (Southern Streams Riffle/Run). In addition to the fish and macroinvertebrate impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Crooked Lake Ditch (07010202-581)

Impairment: This middle portion of Crooked Lake Ditch (AUID -581) flows for 1.7 miles from Calvary Road NE to just downstream of Ottertail Trail northeast, 4 miles North of Osakis. The channel has been channelized throughout the entire reach. There is one biological monitoring station (07UM076) located on this reach, which was sampled for fish and macroinvertebrates in 2007, 2008, and 2018. The UAA process determined that Crooked Lake Ditch should be assessed under the modified use criteria, due to the habitat loss from the historic ditching process. This assessment resulted in a new fish impairment. The fish stream class is class 5 (Northern Streams) and the macroinvertebrate class is class 6 (Southern Forest Streams Glide/Pool). In addition to the fish impairment, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Crooked Lake Ditch (07010202-552)

Impairment: This downstream portion of Crooked Lake Ditch (AUID -552) flows for 2.3 miles from just downstream of Ottertail Trail northeast to Osakis Lake, 3.5 miles North of Osakis. The channel has been channelized throughout the entire reach. There is one biological monitoring station (10UM147) located on this reach, which was sampled for fish and macroinvertebrates in 2010, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. There is also a historic biological monitoring station that was sampled in 2000 (00UM072), but was not used in the most recent assessment. The UAA process determined that although this section of Crooked Lake Ditch is channelized, it should be assessed under the general use criteria. This assessment resulted in a new fish impairment. The fish stream class is class 5 (Northern Streams) and the macroinvertebrate class is class 6 (Southern Forest Streams Glide/Pool). In addition to the fish impairment, there is an existing macroinvertebrate impairment from 2006. DO and total suspended solids (TSS) were also not meeting standards and will likely be added to the 2022 impaired waters list.

Analyses

The downstream AUID on Crooked Lake Ditch (-552) was evaluated for SID within the first SID report, in 2012 (MPCA 2012). Within this report it was determined that excessive nutrients (phosphorus), TSS, and the lack of habitat due to channelization were all stressors to the aquatic life within Crooked Lake Ditch (Judicial Ditch 2) (MPCA 2012). Due to the upstream AUIDs being channelized, these assessments were not available in the first cycle; however, the same stressors that were identified in the first cycle apply to -637 and -581. These stressors are confirmed, as -637 is impaired for low DO and nutrients, and -581 is impaired for DO and has elevated phosphorus.

In addition to the chemical stressors, the culvert off CR 73 northeast is a fish barrier under moderate to low flow (Figure 5), as the culvert is perched by ~8 inches during moderate flow.

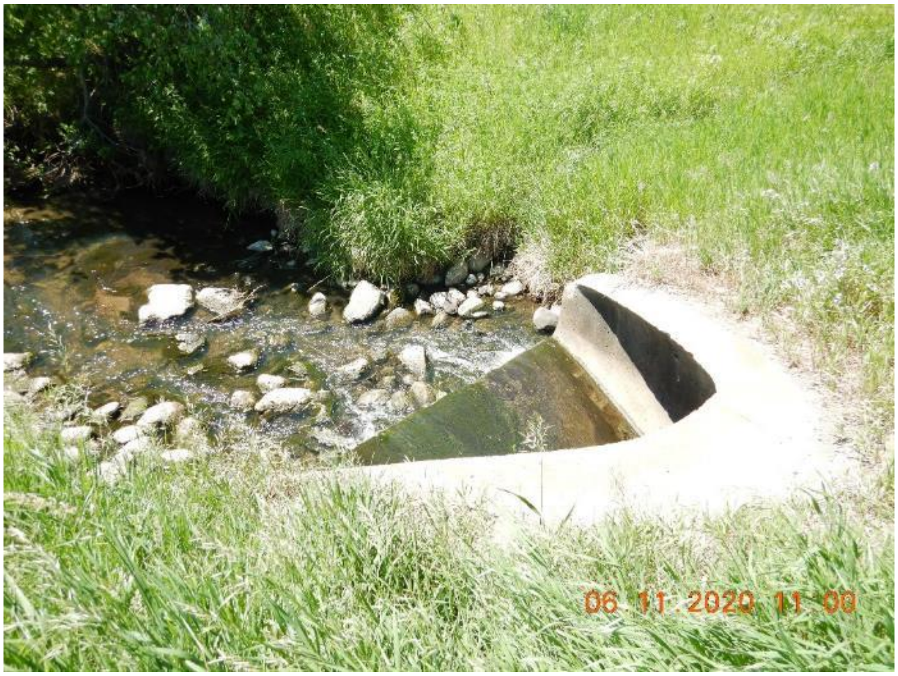


Figure 5. Perched Culvert off CR 73 NE, on AUID -637.

Boss Creek Subwatershed

The Boss Creek Subwatershed covers just under 11,500 acres, located 7 miles northeast of Osakis (Figure 6). Over half of the streams within the subwatershed have been straightened, although a few sections of natural channel remain. Notable streams within the subwatershed include Baugh Creek and Boss Creek.

Figure 6. Biological monitoring station within the Boss Creek Subwatershed.

The land use within the Boss Creek Subwatershed is dominated by cropland (45%), followed by wetlands (24.4%) (Figure 7).

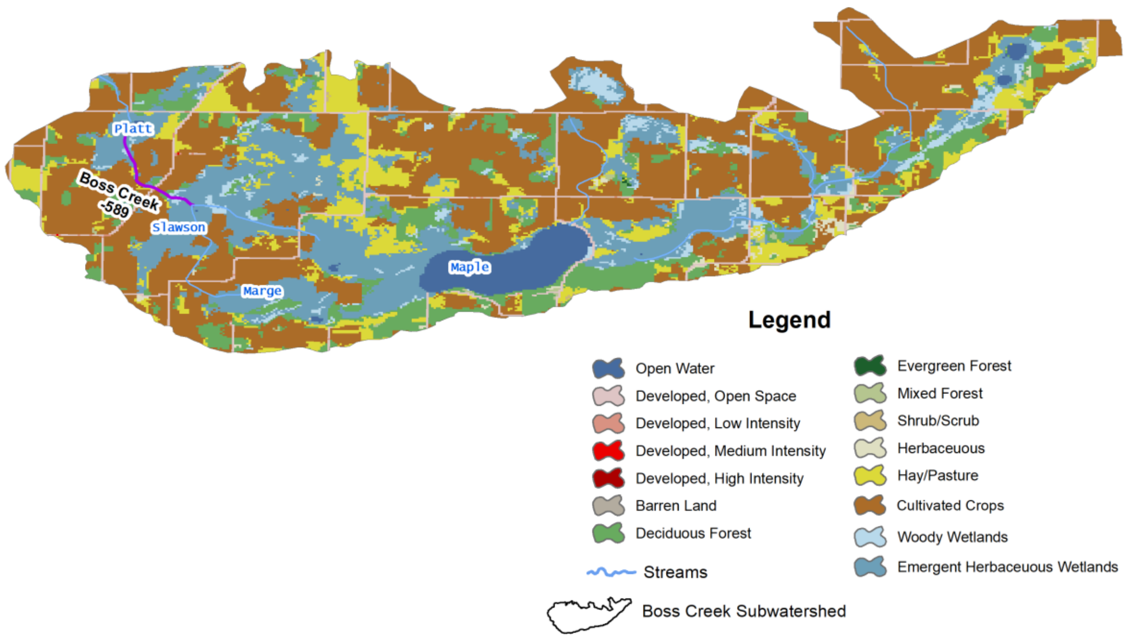


Figure 7. Land use within the Boss Creek Subwatershed.

Boss Creek (07010202-589)

Impairment: Boss Creek (AUID -589) flows for 1 mile from Baugh Creek to Platt Lake, before eventually flowing into Lake Osakis, 6.5 miles northeast of Osakis. Boss Creek has been channelized throughout the entire reach. There is one biological monitoring station (07UM078) that was sampled for fish and macroinvertebrates in 2008 and 2018 (Figure 6). Boss Creek was assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Boss Creek should be assessed under the modified use criteria. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 7 (Low Gradient) and the macroinvertebrate class is class 5 (Southern Streams Glide/Pool). In addition to the fish and macroinvertebrate impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

A small dataset has been collected at 07UM078 (S003-302) in 2019 (Table 1).

Table 1. Water chemistry data collected at S003-302 from 2019. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S003-302.

Parameter	Sample Count	Samples Not Meeting the Respective Standard	Applicable Standard	Average	Minimum	Maximum
TP	4	2	0.100 mg/L	0.1 mg/L	0.04 mg/L	0.21 mg/L
DO	15	13	5.0 mg/L	2.85 mg/L	0.87 mg/L	7.13 mg/L
TSS	1	0	30.0 mg/L	4.4 mg/L	4.4 mg/L	4.4 mg/L
Water Temp	15	N/A	N/A	17.48° C	8.92° C	24.88° C
Sp. Conductivity	14	N/A	N/A	339.96 µS	316 µS	373.8 µS

Nutrients – Phosphorus

Phosphorus values from the limited dataset on Boss Creek (Table 1), shows that the average total phosphorus (TP) is right at the Central Region River Nutrient standard (0.100 mg/L) with an average value of 0.100 mg/L. The highest TP values collected on Boss Creek occurred mid-summer (0.108 mg/L; 0.209 mg/L), and the lower values occurred in the spring (0.035 mg/L) and fall (0.049 mg/L). Although the dataset is limited, there is evidence that TP can become elevated during the summer months. It is possible that these elevated values are coming from the landscape or from the upstream wetlands.

Dissolved Oxygen

DO data was collected throughout the summer of 2019 at S003-302 (Table 1). These data show that the DO levels within Boss Creek drop well below the 5 mg/L standard from June through August, reaching a low of 0.87 mg/L (Table 1, Figure 8). 87% of the DO samples were below the standard, with several samples collected during the daily minimum, just after sunrise. Only two samples were above the standard, with one collected in the early spring, and the other just above the threshold at 5.11 mg/L. Due to the poor DO levels in Boss Creek, the creek was listed as impaired for DO, and indicates that Boss Creek lacks sufficient DO to sustain healthy fish and macroinvertebrate communities, and therefore, insufficient DO is a primary stressor to the aquatic life in Boss Creek.

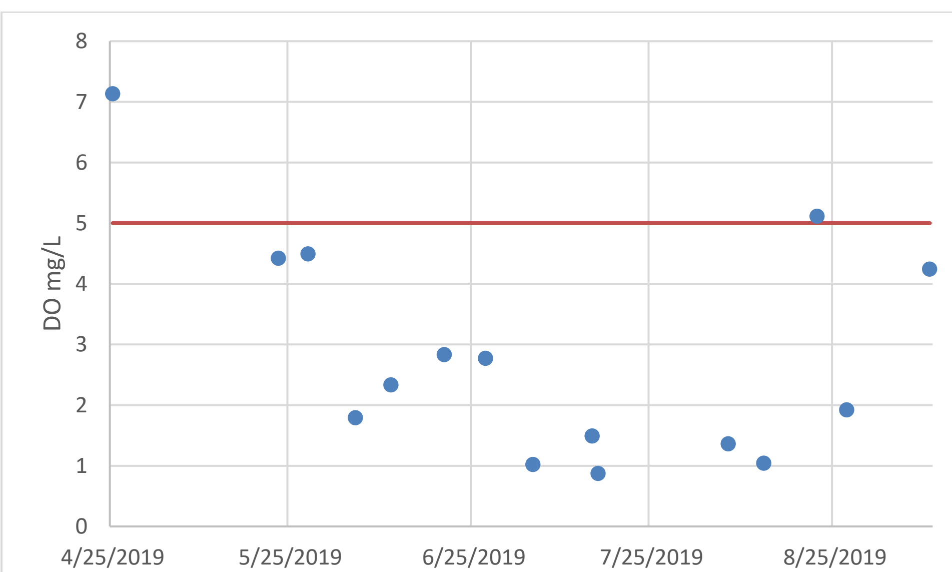


Figure 8. Dissolved oxygen levels within Boss Creek, collected during instantaneous sonde readings.

Total suspended solids

TSS data for Boss Creek is limited to one sample (4.4 mg/L) (Table 1), which was well below the standard of 30 mg/L. TSS does not appear to be a stressor to the aquatic life in Boss Creek, but due to the limited TSS data, TSS is an inconclusive stressor at this time.

Conductivity

Specific conductivity was within range throughout the grab samples in 2019 (Table 1), and does not appear to be a stressor to the aquatic life within Boss Creek.

Temperature

Temperature data collected during the historic monitoring at S003-302 (Table 1) showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as poor on Boss Creek, through several Minnesota Stream Habitat Assessment (MSHA) evaluations at the biological monitoring samples (Table 2). Due to the historic channelization of Boss Creek, and poor MSHA score, the assessment of Boss Creek was brought into the UAA process. It was determined that the habitat of Boss Creek has degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Boss Creek was assessed using the Modified Use TALU criteria.

Table 2. MSHA results for Boss Creek.

MSHA Component	Avg. Score	Maximum Poss. Score
Land Use	2.3	5
Riparian	12.5	14
Substrate	7.48	28
Cover	12.4	18
Channel Morphology	9.2	35
Total MSHA Score	43.88	100

Although the average MSHA score was low overall, two categories scored particularly low as noted in Table 2. Substrate was the first low scoring component of the MSHA score, as indicated by the dominance of silt. Healthy fish communities need coarse substrate in order to build nests and spawn. Excessive fine sediment also affects juvenile fishes, as the sediment is stirred into the water column creating TSS, it can easily tear sensitive juvenile fish gills. Similarly, many sensitive macroinvertebrates also have specialized gills that are used to breathe DO. Excessive fine sediments can damage these gills, similar to juvenile fishes, making the creek inhabitable for sensitive species.

Channel morphology was another low scoring component of the MSHA evaluation. The MSHA indicated that there was no channel depth variability, no sinuosity, and poor channel development (no riffles or pools). Fish and macroinvertebrates need channel depth variability to use as cover from predation and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the creek throughout the summer, especially during high flow events, which can flush these communities downstream. The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity, pools, and riffles. Lack of habitat is a stressor to the aquatic life in Boss Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Boss Creek, and the entire subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Boss Creek has been straightened along the entire length of the AUID. Historically, Boss Creek was comprised of multiple wetlands and small stream channels (Figure 9), which did not have a direct connection with Osakis Lake.

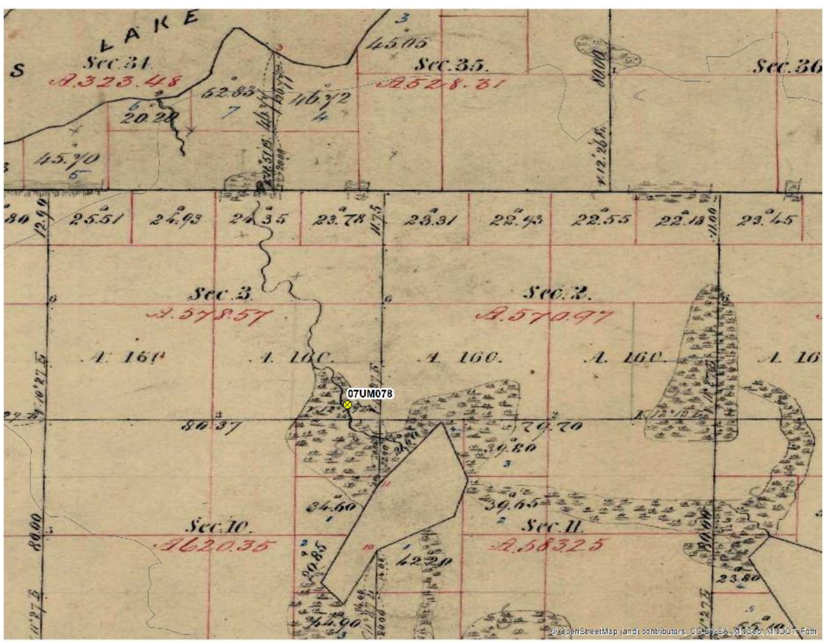


Figure 9. Historic flow pattern of Boss Creek.

As the channel was altered to drain the landscape, a new channel was created starting from Maple Lake and ending in Lake Osakis. This new channel cut through multiple wetlands, creating a direct connection between the two lakes. A 1939 air photo (Figure 10) shows the channel alteration that occurred prior to 1939. This channel alteration accelerates stream flow, resulting in higher flows during precipitation events which achieves the agricultural land use drainage goals, but causes instability. Water leaves the landscape quickly, resulting in periods of higher flow than what would have naturally occurred. As the landscape drains, water that was once held in the upstream wetlands is flushed downstream, carrying low DO water throughout the reach. Then, as these flows quickly drain, the flow regime quickly transitions to low flow, reaching near stagnant conditions during the dry portions of the summer.

Figure 10. 1939 aerial photograph of Boss Creek. Credit: DNR.

Due to the channelization of Boss Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the biological monitoring sampling pictures and MSHA evaluations of stream bank condition, the banks appear to be stable and not actively eroding. The current channel size is most likely much larger than the historic stream channels that existed prior to the channelization, and is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion. It is possible that this excess sediment would have historically settled out within the upstream wetlands, but due to the channelization, the sediment is flushed downstream during precipitation events. Therefore, altered hydrology has played a role in stressing the aquatic life in Boss Creek, and is considered a stressor.

Connectivity

There are two road crossings between the biological monitoring station and Lake Osakis. The culvert crossings by 07UM078 off CR 37 and the crossing by 210st street do not appear to be fish barriers. However, it is possible that Platt Lake, between 07UM078 and Osakis Lake, is a potential connectivity barrier (Figure 11), as the lake has increased in size throughout the last 100 years.

Figure 11. Boss Creek flow pattern through Platt Lake. Credit: Google 2013.

In addition, the channel that was created to the west of Platt Lake is completely filled in by wetland vegetation. It appears that the wetland nature of Platt Lake is absorbing the flow from Boss Creek, and then rarely flows to the north, into Osakis Lake. This lack of a defined channel connecting Platt Lake and Osakis Lake, could be a connectivity barrier to the fish within Boss Creek. Therefore, connectivity is considered to be a potential stressor to the fish in Boss Creek, but additional work to determine the present flow pattern of Boss Creek through Platt Lake would be needed to determine if it is actively blocking fish passage.

Stressor signals from biology

Fish

Fish were sampled four times from 2007 through 2018 as part of the cycle I and cycle II watershed monitoring efforts. The total number of fish species collected varied between one and four total species, with the Central Mudminnow dominating all of the samples. The Central Mudminnow is one of the most pollution tolerant fish species within the State of Minnesota. All of the other fish species that were collected are also considered tolerant of pollutants.

Tolerance index values (TIV) were calculated for Boss Creek using the fish community. The TSS TIV found that the fish community has an 83% average probability of coming from a stream that is meeting the TSS standard. No fish species that are considered to be tolerant or sensitive of elevated TSS were found within any of the fish samples, indicating a weak TSS signal from the biology. Therefore, the fish community response to TSS combined with the low TSS values in the grab sampling, TSS is not considered a stressor to the fish community in Boss Creek at this time.

DO TIV scores were also calculated for Boss Creek using the fish communities. This calculation indicated that the fish community has an average probability of only 2% of coming from a stream that was meeting the DO standard. All of the fish collected within the four samples are considered to be very tolerant of low DO, indicating that low DO is a stressor to the fish community within Boss Creek.

Phosphorus tolerance of the fish community was also investigated in Boss Creek using the fish species characteristics. Over 90% of the fish collected within all four samples are considered tolerant or very tolerant of elevated phosphorus. As for sensitive species, no fish that are sensitive or intolerant of elevated phosphorus were found within the samples. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species indicates that phosphorus may be a stressor to the fish community within Boss Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 and 2018 as part of the watershed monitoring efforts. 88.9% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 44.4% of the community was considered to be very tolerant of pollutants. Similarly, the 2018 macroinvertebrate community was comprised of 84.2% tolerant taxa and 47.4% very tolerant taxa. Two tolerant taxa (*Oligochaeta*; *Chironomus*) dominated both samples.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2008 sample, no intolerant taxa, five tolerant taxa, and three very tolerant taxa were collected (Table 3). As for the 2018 sample, no intolerant taxa, five tolerant taxa, and four very tolerant taxa were collected (Table 3). Overall the macroinvertebrate community within Boss Creek indicates that TSS may be a stressor, with the absence of intolerant taxa, and the presence of multiple tolerant and very tolerant taxa collected. TSS is considered a stressor to the macroinvertebrate community in Boss Creek

DO tolerance was also investigated using the macroinvertebrate communities. Ten taxa that are considered to be tolerant and eight taxa that are very tolerant of low DO were found within the 2008 sample (Table 3). As for the 2018 sample, 10 tolerant taxa and 6 very tolerant taxa were collected. No DO intolerant taxa were collected in either sample. Therefore, low DO does appear to be a stressor to the macroinvertebrates in Boss Creek.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. In the 2008 sample, three intolerant, 4 tolerant, and three very tolerant taxa were collected in Boss Creek (Table 3). Similarly, in the 2018 sample, three intolerant, five tolerant, and three very tolerant taxa were collected (Table 3). The overall macroinvertebrate community is indicating some nitrogen intolerance with the presence of multiple very tolerant taxa. Nitrogen does not appear to be a stressor to the macroinvertebrate community in Boss Creek.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, 11 tolerant taxa and 6 very tolerant taxa were collected (Table 3). As for the 2018 sample, 10 tolerant taxa, and 6 very tolerant taxa were collected (Table 3). These tolerance indicators within the macroinvertebrate community indicate that phosphorus may be a stressor to the macroinvertebrate community.

Table 3. Macroinvertebrate tolerance indicators within Boss Creek.

Sample Year	Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	0	5	3
2018	TSS	0	5	4
2008	DO	0	10	8
2018	DO	0	10	6
2008	Nitrogen	3	4	3
2018	Nitrogen	3	5	4
2008	Phosphorus	0	11	6
2018	Phosphorus	0	10	6

Composite conclusion from biology

The fish and macroinvertebrates are indicating that low DO is a stressor to the aquatic life within Boss Creek.

Biological response to TSS as a stressor in Boss Creek produced conflicting results. The fish indicate that elevated TSS is not a stressor, and the macroinvertebrates indicate that TSS is a stressor. However, more weight was put on the macroinvertebrate response due to the fish species not having a documented sensitivity to TSS.

Elevated phosphorus has the potential to be a stressor to the aquatic life within Boss Creek, as shown by the dominance of phosphorus tolerant fish species and macroinvertebrate taxa. However, more TP data would be needed to make a final determination.

Inorganic nitrogen does not appear to be a stressor to the biology.

Conclusions about stressors

The primary stressor to the biology within Boss Creek is the lack of a stable and healthy DO regime. Poor DO within Boss Creek is the result of multiple contributing factors; flow regime modification, upstream connection with wetlands, and excessive algal and macrophyte growth fueled by excessive nutrients (phosphorus). Dredging and straightening of the stream channel for drainage has changed the natural flow regime in Boss Creek. Historically, Boss Creek did not exist, and was only a series of very small streams through vast wetlands. As part of the legal ditching process, a new channel was created between Maple Lake and Osakis Lake. This new channel preforms as designed, by accelerating stream flow, resulting in higher flows during precipitation events. This achieves the agricultural land use drainage goals, but causes instability. As water leaves the landscape quickly, the creek experiences periods of higher flow. Anoxic water is held within the upstream wetlands, as a result of natural decomposition process. Due to the channel alteration and high flows that drain the landscape, this anoxic water that would naturally settle within the wetland, is flushed downstream, reducing the DO levels within the creek. As flows quickly drain, the flow regime quickly transitions to low flow, further reducing the capacity to maintain healthy DO levels.

This flow alteration, combined with excessive nutrients, further compounds the DO issue in Boss Creek. Algae and macrophytes utilize the excess nutrients, resulting in excessive growth completely covering the entire stream channel (Figure 12). During the daylight hours these plants photosynthesize and produce oxygen, and then consume that same DO after sundown, causing large fluctuations in the DO regime. This unstable DO has allowed fish species like the Central Minnow and macroinvertebrate taxa like the *Oligochaeta* worms to thrive within Boss Creek. However, it has impeded the ability for more sensitive species like the Hornyhead Chub to survive.

Figure 12. Boss Creek in July 2019.

An additional stressor to the biology within Boss Creek is elevated phosphorus. The excess nutrient levels are not only contributing to the DO instability, but are directly impacting the fish and macroinvertebrates. Multiple fish species and macroinvertebrate taxa that are tolerant to elevated phosphorus where found within the 2008 and 2018 samples.

Altered hydrology is another stressor to the biology in Boss Creek. Poor sinuosity, poor channel development, and fine sediment were noted within the MSHA assessment. These are the result of channel over widening and the creation of a new channel through large wetlands. Sensitive fish and macroinvertebrates require coarse substrate and good channel morphology to survive and reproduce. However, good sinuosity and the pools and riffles that naturally occur within streams and rivers, do not exist in Boss Creek by design. As for the substrate in Boss Creek, due to creating a channel through several wetlands, silt has covered all of the coarse substrates that would exist naturally.

Connectivity of Boss Creek to Lake Osakis is another potential stressor to the fish community. However, further investigation of the present flow pattern of Boss Creek through Platt Lake would be needed to determine if it is actively blocking fish passage.

Recommendations

Compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Stream restoration to a smaller channel with a sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Additional monitoring of TP values in Boss Creek would be advantageous for reducing the nutrient input from Boss Creek into Osakis Lake. This may also include further investigation into the present flow pattern of Boss Creek through Platt Lake.

Lake Osakis Subwatershed

The Osakis Lake Subwatershed covers just under 24,000 acres, including the city of Osakis (Figure 13). Almost all of the streams within the subwatershed have been straightened, although one short section of natural channel remains. Osakis Lake makes up the majority of the subwatershed, but several small tributary streams are present. The main tributary stream is located within the northeast portion of the subwatershed, and flows into Osakis Lake.

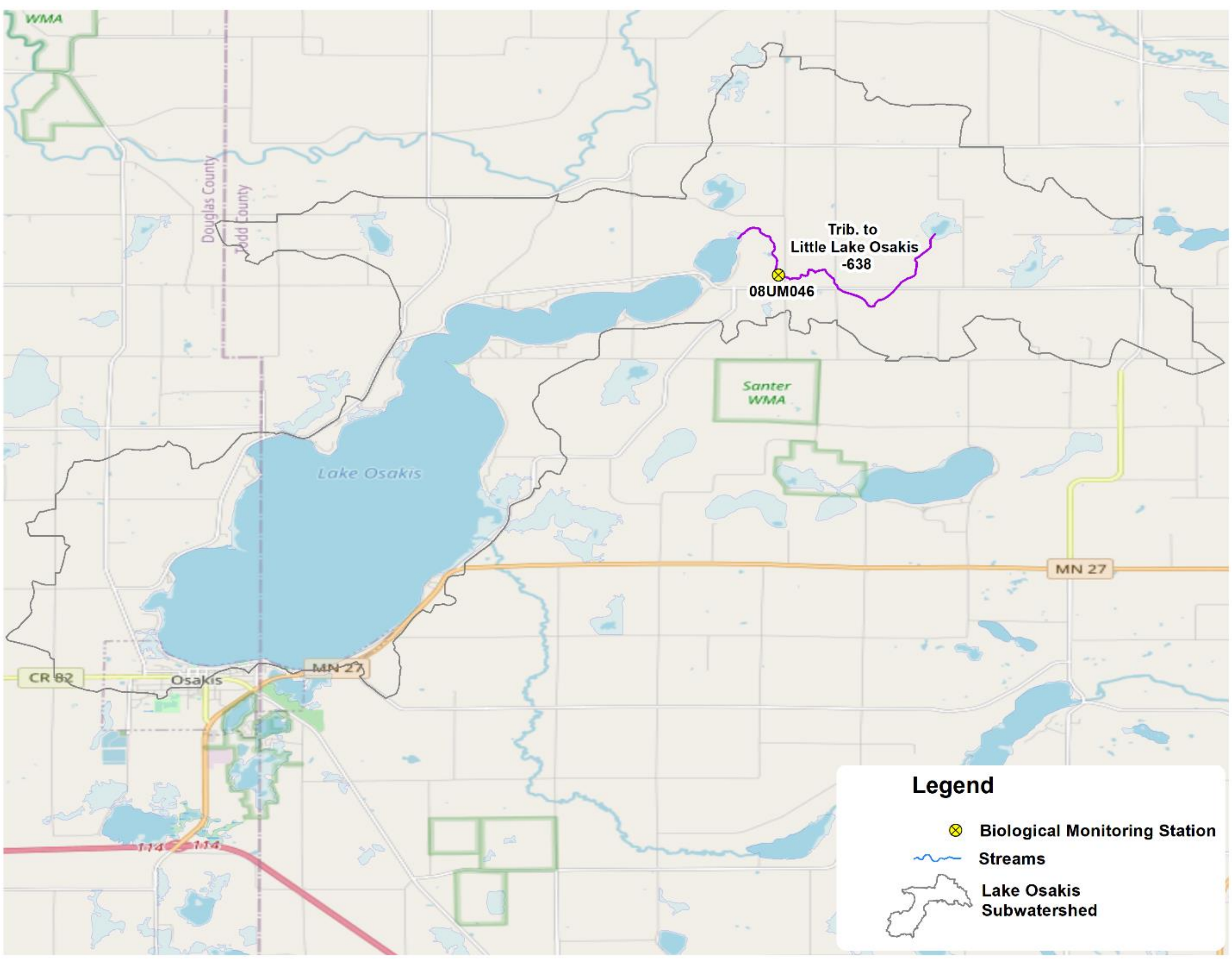


Figure 13. Biological monitoring station within the Lake Osakis Subwatershed.

The land use within the Lake Osakis Subwatershed is dominated by cropland (32%) and open water (27.6%) (Figure 14).

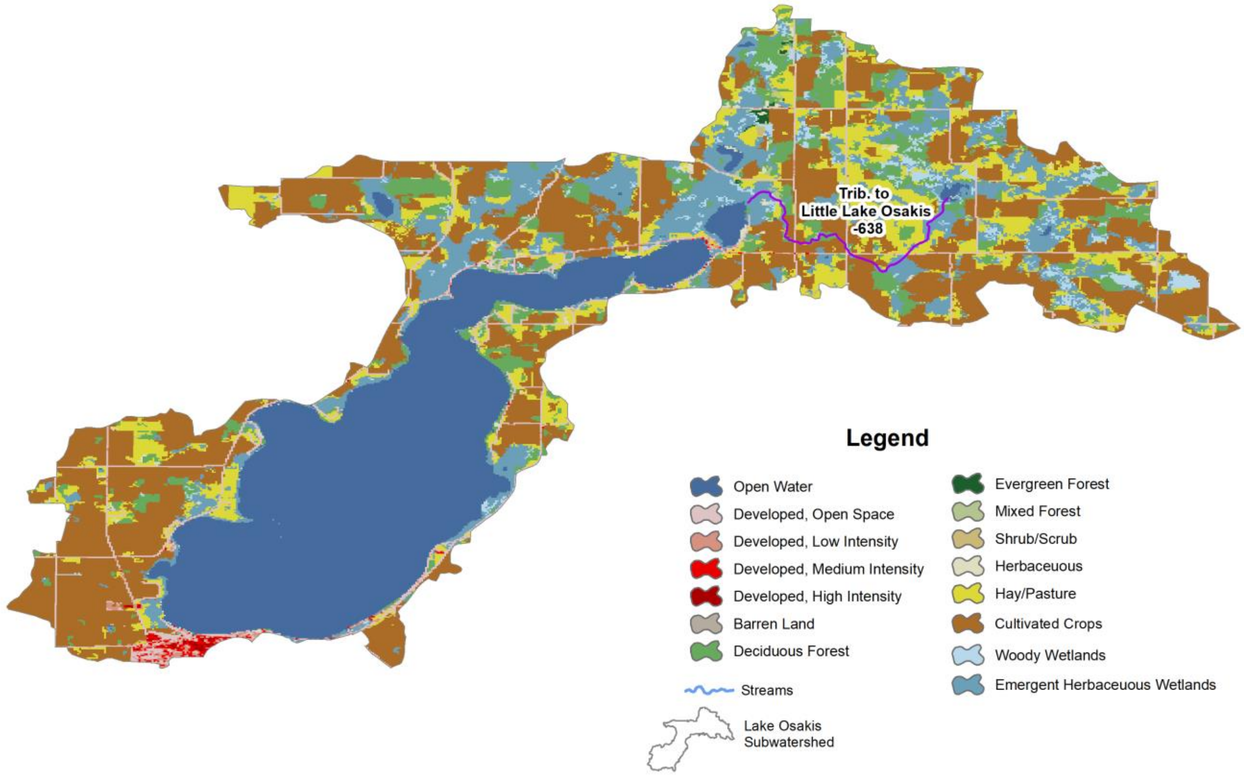


Figure 14. Land use within the Lake Osakis Subwatershed.

Tributary to Little Lake Osakis (07010202-638)

Impairment: The main Tributary to Little Lake Osakis (AUID -638) flows for 3.7 miles from Unnamed Lake (77-0168-00) to Little Lake Osakis, 8 miles northeast of Osakis. This tributary is mostly channelized throughout the entire reach. There is one biological monitoring station (08UM046) that was sampled for fish in 2008 (Figure 13). The Tributary to Little Lake Osakis was assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that the Tributary to Little Lake Osakis should be assessed under the general use criteria, due to good habitat. This assessment resulted in a new impairment for fish. The fish stream class is class 6 (Northern Headwaters). Macroinvertebrates were also sampled in 2008, but dry stream conditions prohibited the data from being used for assessment.

Data and Analyses

Chemistry

Water chemistry data has been collected at 08UM046 (S006-157) in 2010, 2019, and 2020 (Table 4).

Table 4. Water chemistry data at S006-157 from 2010, 2019, and 2020. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S006-157.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	15	6	0.100 mg/L	0.10 mg/L	0.037 mg/L	0.31 mg/L
DO	25	3	5.0 mg/L	7.99 mg/L	2.65 mg/L	12.13 mg/L
Inorganic nitrogen	15	N/A	N/A	0.16 mg/L	0.06 mg/L	0.25 mg/L
TSS	3	0	30.0 mg/L	5.07 mg/L	3.2 mg/L	8.4 mg/L
Sp. Conductivity	24	N/A	N/A	451.98 µS	233 µS	567 µS
Water Temp	25	N/A	N/A	16.77° C	2.01° C	23.72° C

Nutrients – Phosphorus

Phosphorus values within the Tributary to Little Lake Osakis are elevated with an average TP value that is right at the Central Region River Nutrient standard (0.100 mg/L) with a value of 0.102 mg/L (Table 4). Although only 6 of the 15 samples were above the standard, TP levels were elevated, reaching a maximum value of 0.31 mg/L. These data suggest that there is a potential for eutrophication to occur.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite)

Inorganic nitrogen levels within the Tributary to Little Lake Osakis were low in 2010, 2019, and 2020 (Table 4), with a maximum value of 0.31 mg/L. Inorganic nitrogen does not appear to be a stressor to the aquatic life in the Tributary to Little Lake Osakis.

Dissolved Oxygen

DO data was collected from the Tributary to Little Lake Osakis in 2010, 2019, and 2020 (Table 4). The 2010 data was limited to a few samples; however, 22 samples were collected throughout the summers of 2019 and 2020. Eighty-eight percent of the DO samples were above the 5 mg/L standard with three exceptions. One value was below the standard in 2019 and two values were below the standard in 2020. A sonde was also placed within the stream in the summer of 2019 from 7/31/2019 through 8/7/2019. DO levels were above the standard throughout the entire deployment (Figure 15).

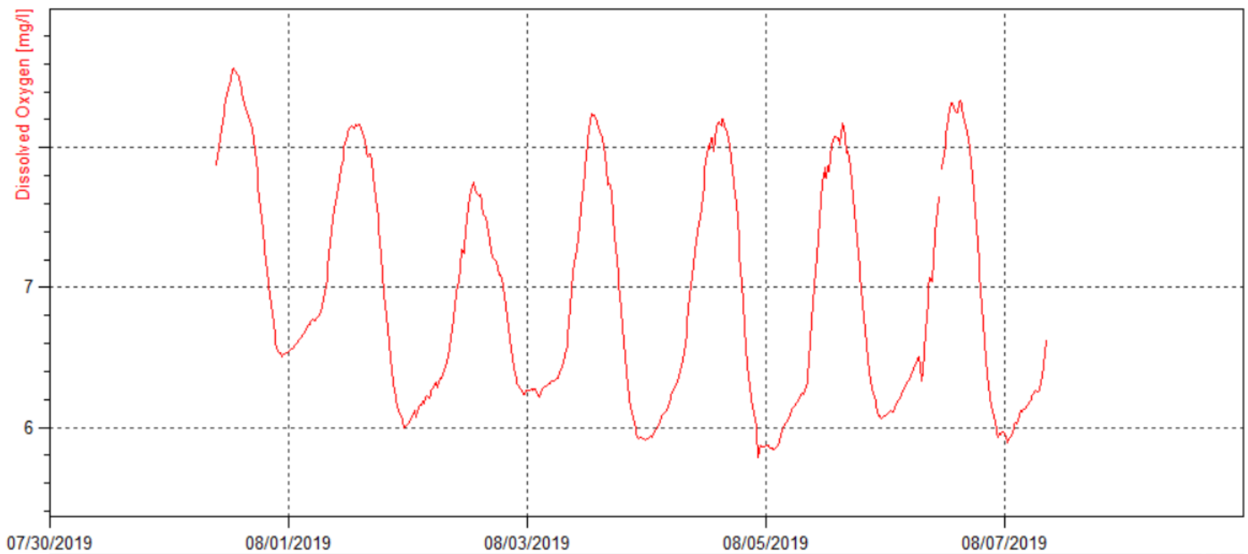


Figure 15. Dissolved oxygen levels during a continuous sonde deployment in the Tributary to Little Lake Osakis.

DO levels during the sonde deployment were above the standard, and most of the DO values collected at the grab samples were above the standard; however, three values fell below the standard. These values were collected during periods of high flow, and could indicate that the DO levels within the Tributary to Little Lake Osakis can fall below the standard during high precipitation events. The overall DO values within the Tributary to Little Lake Osakis do not indicate an impairment for DO at this time, but low DO levels during precipitation events could be a stressor to aquatic life.

Total suspended solids

TSS levels within the Tributary to Little Lake Osakis were low in all of the years that were sampled (Table 4). The highest value was 8.4 mg/L, which is well below the threshold of 30 mg/L. TSS does not appear to be a stressor to the aquatic life in the Tributary to Little Lake Osakis.

Conductivity

Specific conductivity was within range throughout the grab samples (Table 4) and the sonde deployment in 2019, and does not appear to be a stressor to aquatic life within the Tributary to Little Lake Osakis.

Temperature

Temperature data collected during the grab samples at S006-157 (Table 4) and during the sonde deployment in 2019 showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

73% of the Lake Osakis Subwatershed has been channelized; however, the biological monitoring station (08UM046) was located on a natural stream section. Habitat was examined using the MSHA evaluation at the fish sample in 2008, which indicated that the habitat in the Tributary to Little Lake Osakis is of good quality for aquatic life (Table 5).

Table 5. MSHA scores from the fish sample on the Tributary to Little Lake Osakis.

MSHA Component	Unnamed Creek	Maximum Poss. Score
Land Use	0	5
Riparian	11	14
Substrate	17.4	28
Cover	12	18
Channel Morphology	26	35
Total MSHA Score	66.4 = Good	100

Several categories of the MSHA score that are important for aquatic life scored well. These categories included substrate and channel morphology. Clean coarse substrate (cobble; gravel) was noted throughout the sampling reach. Sensitive fish require coarse substrate to build nests during spawning. Sensitive macroinvertebrates also require coarse substrate, which allows sensitive taxa a hard surface in which to attach to feed without being washed downstream during high precipitation events.

Channel morphology also scored well within the Tributary to Little Lake Osakis. Depth variability, channel stability, sinuosity, and well-defined riffles, pools, and runs were all noted as good within the MSHA evaluation. These habitat features also provide spawning habitat and refuge during high precipitation events. At this time, lack of habitat does not appear to be a stressor to the aquatic life in the Tributary to Little Lake Osakis at the biological monitoring station; however, the channel is showing signs of potential degradation in the future. Mobile fine sediment was noted in 2019 by SID staff, as silt had covered the sonde during the continuous sonde deployment in 2019. It also appears that this is a dumping site for trash and animals. Trash was noted in the stream in July of 2019 (Figure 16) and a dead cow passed through the culvert in June of 2019 (Figure 16). Therefore, the habitat of the Tributary to Little Lake Osakis appears to be vulnerable to future degradation.

Figure 16. Dead cow passing through culvert, June 2019 and Trash in the steam July 2019.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of the Tributary to Little Lake Osakis, and the entire Lake Osakis Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. The Tributary to Little Lake Osakis has been almost entirely straightened, with only a short natural section remaining. Additionally, large changes to the landscape have included the development of several excavated pits that have been connected to the stream channel (Figure 17; Figure 18). These pits have directed the flow, which was designed to be connected to Little Lake Osakis, to fill the pits with water. This has created a disconnect between the Tributary to Little Lake Osakis and Little Lake Osakis, which has blocked water from reaching Little Lake Osakis.

Figure 17. 1991 Aerial Photo of the Tributary to Little Lake Osakis, credit Google Earth.

Figure 18. 2016 Aerial Photo of the Tributary to Little Lake Osakis.

Due to the channelization within most of the Tributary to Little Lake Osakis stream reach, the stream does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish sample, the banks appear to be actively eroding. Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, with several wetlands making up the downstream portion of the channel. Also, the historic channel size was most likely smaller than the current channel size, with the downstream portion not having a direct connection with Little Lake Osakis. The new channel suggests that the hydrology has been altered after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). Altered hydrology has played a role in stressing the aquatic life in the Tributary to Little Lake Osakis, and is considered a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several private road crossings further downstream on the Tributary to Little Lake Osakis. The culvert crossing by 08UM046 off 161st Ave does not appear to be a fish barrier. The next downstream crossing consists of two separate private road crossings that are located right next to each other. It is possible that these culverts may be fish barriers, but would need to be investigated on private property to make a final determination. In addition to these crossings, the excavated pits that have diverted the water, are fish barriers. These pits have significantly reduced the ability for fish passage from Little Lake Osakis. Therefore, connectivity is a primary stressor within the Tributary to Little Lake Osakis.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort, resulting in a fish community that consisted of four species. The most dominant species within the sample was the Central Mudminnow, which is one of the most pollution tolerant fish species within the State of Minnesota. All of the other fish species that were collected are also considered tolerant of pollutants.

TIV were calculated for Unnamed Creek using the fish community. The TSS TIV found that the fish community has a 78% probability of coming from a stream that is meeting the TSS standard. Of the four fish species collected in 2008, none were considered to be intolerant or tolerant to elevated TSS. Therefore, the fish community found within the Tributary to Little Lake Osakis, combined with the low TSS values in the grab sampling, TSS is not considered a stressor to the fish community in the Tributary to Little Lake Osakis at this time.

DO TIV scores were also calculated for the Tributary to Little Lake Osakis using the fish communities. This calculation indicated that the fish community from 2008 had only a 3% probability of coming from a stream that was meeting the DO standard. All four species that were collected in the Tributary to Little Lake Osakis are considered tolerant of low DO, and two of those species are considered to be very tolerant of low DO. These analyses indicate that the fish community may be impacted by low DO levels, but more data will need to be collected during high flow events to make that determination.

Phosphorus tolerance of the fish community was also investigated in the Tributary to Little Lake Osakis using the fish species characteristics. All four species that were collected in the Tributary to Little Lake Osakis are considered tolerant of elevated phosphorus, and two of those species are considered to be very tolerant of elevated phosphorus. No species that are intolerant to elevated phosphorus were collected within the fish sample. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community in the Tributary to Little Lake Osakis.

Macroinvertebrates

A macroinvertebrate sample was attempted in 2008 as part of cycle I watershed monitoring efforts; however, dry stream conditions impeded the ability to use the macroinvertebrate data for assessment.

Composite conclusion from biology

One of the potential stressors to the fish within the Tributary to Little Lake Osakis is the reduction in DO levels during high precipitation events. The fish community is dominated by low DO tolerant species, suggesting that DO may be a stressor. However, most of the DO data suggests that DO levels are above the standard, with the exception of the samples collected after high precipitation events. Additional DO sampling after high precipitation events is needed to determine if low DO is a stressor to the fish community in the Tributary to Little Lake Osakis. However, the most likely culprit for the low DO tolerant fish species, is due to the connectivity barriers caused by the excavated pits. Therefore, connectivity is considered to be the primary stressor within the Tributary to Little Lake Osakis.

Elevated phosphorus is a secondary stressor to the fish within the Tributary to Little Lake Osakis.

Recommendations

Routing the stream flow back to the stream channel to bypass the excavated pits would make the biggest impact to the Tributary to Little Lake Osakis, by allowing fish to pass from Little Lake Osakis to the biological monitoring station.

Compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Little Sauk Lake – Sauk River Subwatershed

The Little Sauk Lake – Sauk River Subwatershed covers just under 36,000 acres, including Little Sauk Township (Figure 19). The streams in the subwatershed are mostly natural at 52%, mainly consisting of the Sauk River mainstem. However, many of the tributary streams (34%) flowing into the Sauk River have been channelized.

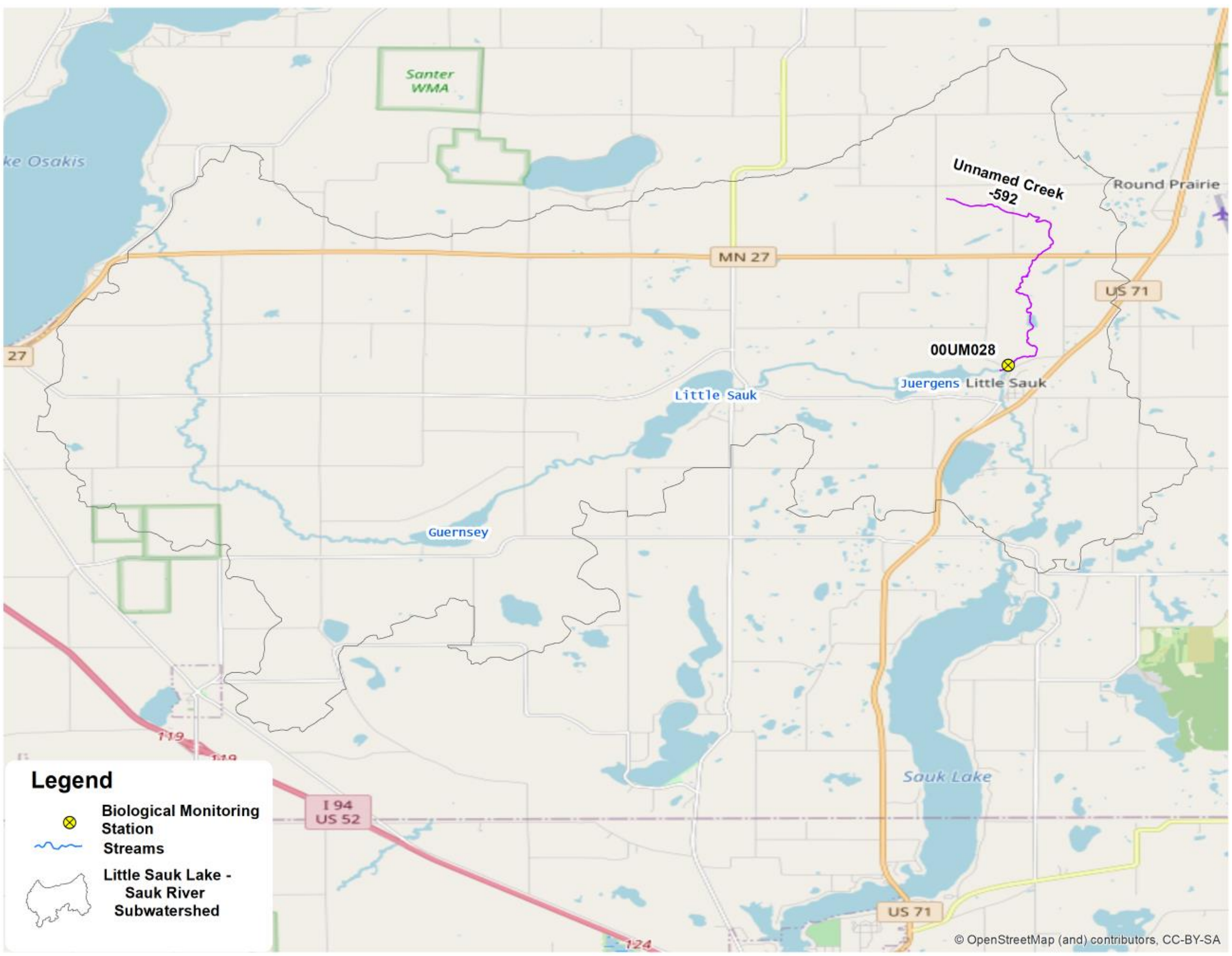


Figure 19. Biological monitoring station in the Little Sauk Lake-Sauk River Subwatershed.

The land use within the Little Sauk Lake – Sauk River Subwatershed is dominated by cropland (50.4%), followed by forest land (14.8%) and wetlands (12.5%) (Figure 20).

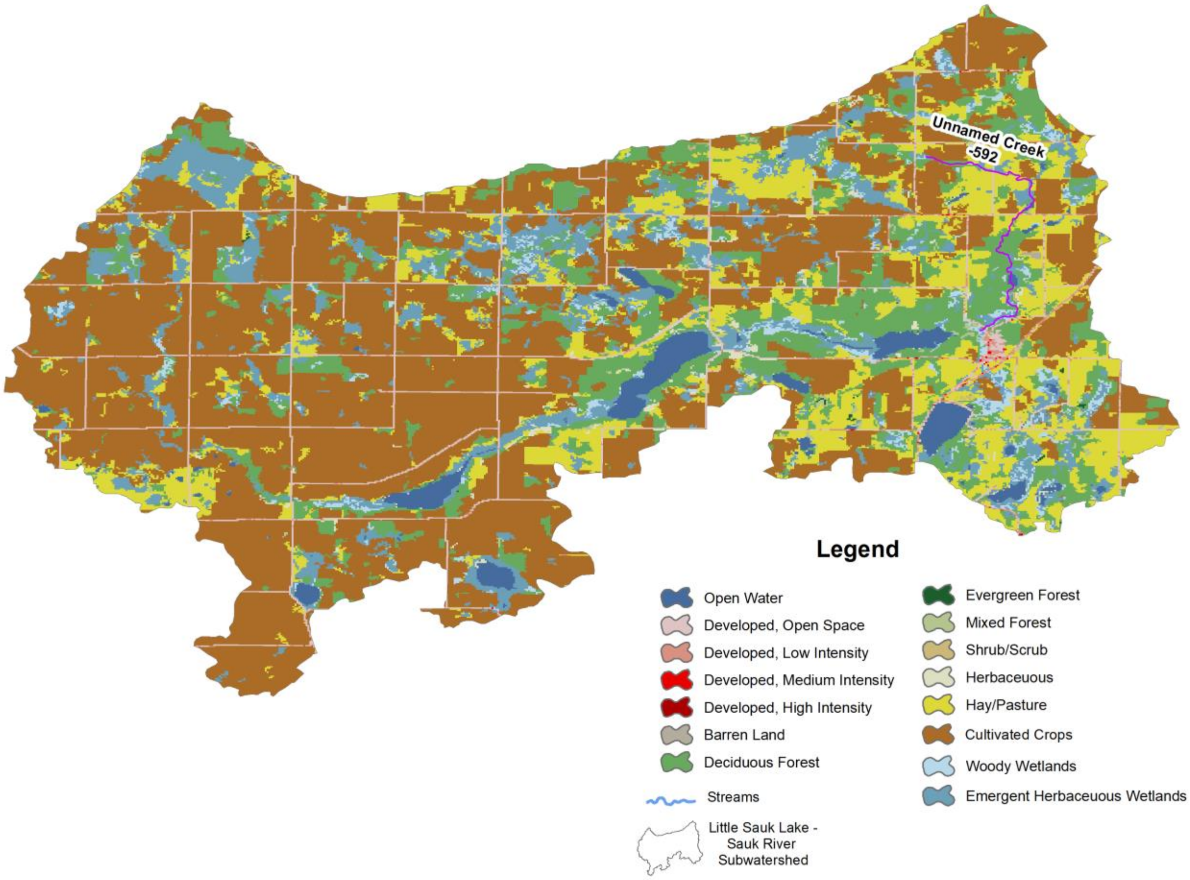


Figure 20. Land use in the Little Sauk Lake-Sauk River Subwatershed.

Unnamed Creek (07010202-592)

Impairment: Unnamed Creek (AUID -592) flows for four miles before reaching the Sauk River, just north of Little Sauk. Unnamed Creek is natural, and has not been straightened. There is one biological monitoring station (00UM028) that was sampled for fish and macroinvertebrates in 2010 (Figure 19). These data were assessed in 2012, which resulted in a new impairment for fish.

Data and Analyses

Chemistry

Water chemistry data for Unnamed Creek is limited to a continuous sonde deployment that was deployed for a week at the beginning of August in 2019.

Dissolved Oxygen

Continuous DO data within Unnamed Creek were collected during a sonde deployment over an eight day period during the summer of 2019 (Figure 21). These data indicated that the DO levels were all above the 5 mg/L standard, suggesting that the DO levels within Unnamed Creek are at healthy levels throughout most of the summer.

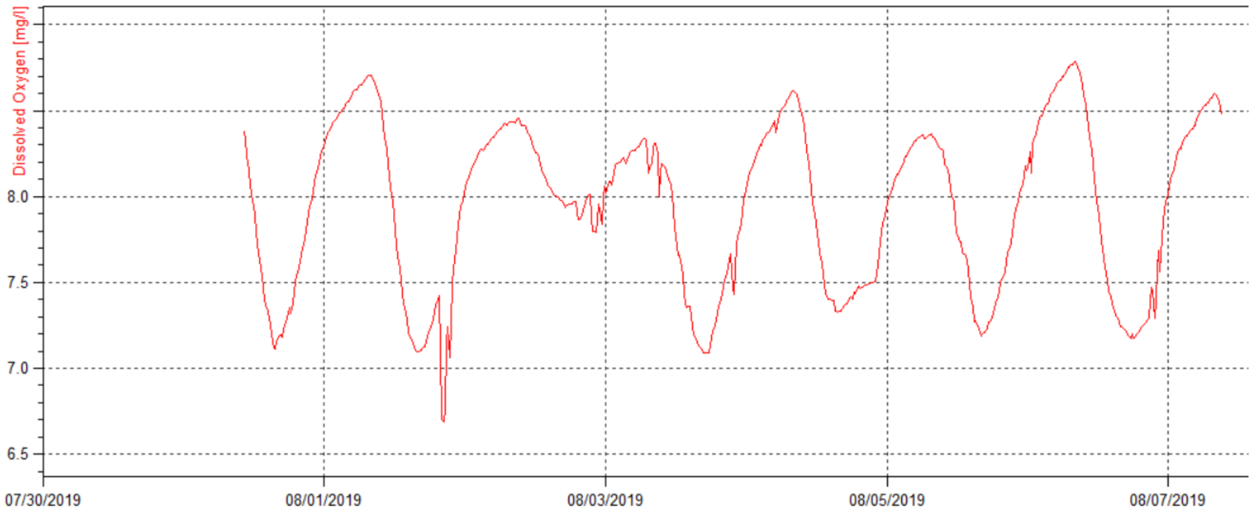


Figure 21. Continuous DO data collected in Unnamed Creek in 2019.

Temperature

Temperature data collected during the sonde deployment in 2019 showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Unnamed Creek, through an MSHA evaluation during the fish sample (Table 6) but although the overall habitat rating was fair, coarse substrate and quality channel morphology were noted. Therefore, habitat does not appear to be a stressor to the fish community within Unnamed Creek.

Table 6. MSHA Evaluation for Unnamed Creek during the 2010 fish sample.

MSHA Component	Unnamed Creek	Maximum Poss. Score
Land Use	5	5
Riparian	15	15
Substrate	13.1	27
Cover	13	17
Channel Morphology	15	36
Total MSHA Score	61.1 = Fair	100

Stressor signals from biology

The fish community collected within Unnamed Creek in 2010 was limited to 13 total fish, with Largemouth Bass being the most dominant. All of the fish collected within the sample are considered to be tolerant of pollutants. However, the sampling crew noted that it was difficult to see the fish within the creek at the time of sampling due to reed canary grass overlying the creek from a recent hail storm.

Macroinvertebrates were also sampled in 2010; however, the macroinvertebrate community contained sensitive and tolerant taxa, which led to an IBI score that was above the threshold.

The fish TIV scores for Unnamed Creek, indicated that the fish community was dominated by fish species that are tolerant of low DO; however, the macroinvertebrate TIV scores indicated that 10 taxa, which are intolerant to low DO were present. Similarly, all of the fish species collected were considered tolerant or very tolerant to elevated phosphorus and nitrogen, but the macroinvertebrate sample contained a healthy mixture of intolerant and tolerant taxa.

Recommendations

Due to the conflicting response to chemical stressors, and habitat not appearing to be a stressor, the stressor to the fish community within Unnamed Creek is inconclusive at this time. It is suggested that fish should be resampled in Unnamed Creek to determine if the fish are truly not meeting standards.

Pope County Ditch 6 (County Ditch No 3) Subwatershed

The Pope County Ditch 6 Subwatershed (also known as County Ditch No 3) covers just under 15,000 acres, ending in the city of Westport (Figure 22). Ninety-seven percent of the streams in the subwatershed have been channelized.

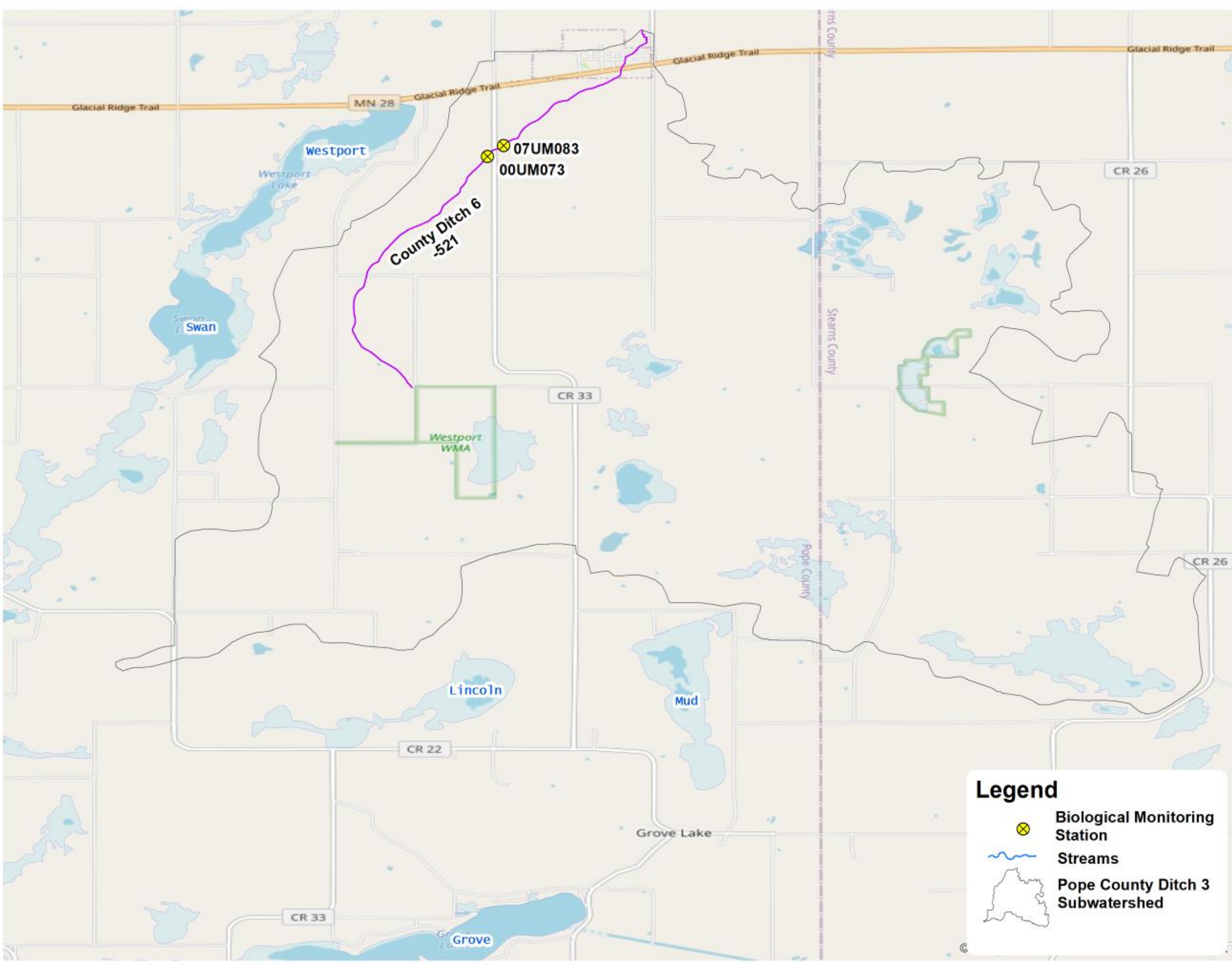


Figure 22. Biological monitoring station in the Pope County Ditch 6 Subwatershed.

The land use within the Pope County Ditch 6 Subwatershed is dominated by cropland (62.5%), followed by wetlands (17.5%) and rangeland (15.4%) (Figure 23).

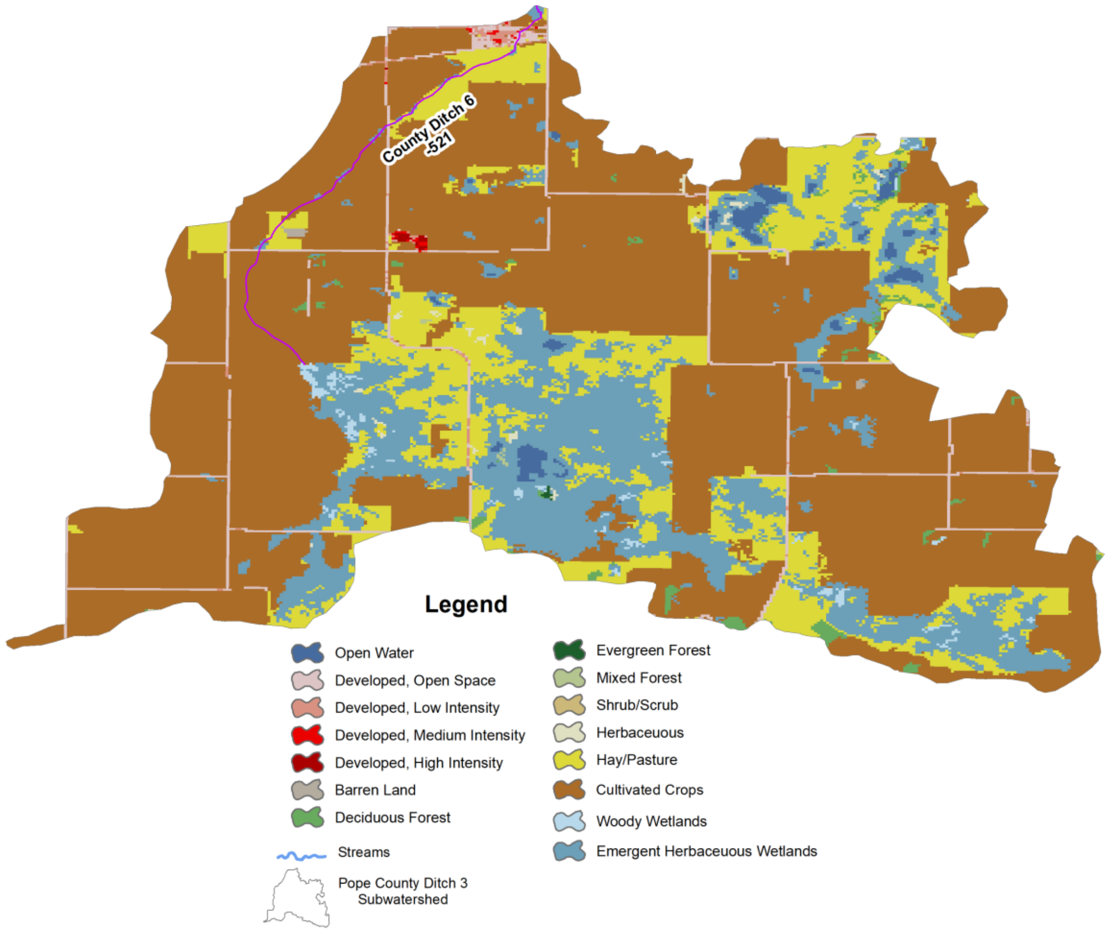


Figure 23. Land use in the Pope County Ditch 6 Subwatershed.

County Ditch 6 (07010202-521)

Impairment: County Ditch 6 (AUID -521) flows for 4.2 miles from Unnamed Creek at the outlet of Westport wildlife management area, to the confluence with Ashley Creek, just outside of Westport. County Ditch 6 has been channelized throughout the entire reach. There is one biological monitoring station (07UM083) that was sampled for fish and macroinvertebrates in 2008 and 2018 (Figure 22). There is also a historic station (00UM073) that was sampled for fish and macroinvertebrates in 2000. The fish class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 7 (Prairie Streams Glide/Pool). The assessments from the historic sampling resulted in a fish impairment. Recent sampling has confirmed the fish impairment, and also indicated that the macroinvertebrates in County Ditch 6 are meeting standards. During the assessment review process, data were reviewed through TALU due to the channelization of County Ditch 6. The UAA process through TALU determined that County Ditch 6 should be assessed under the modified use criteria, due to the habitat loss from the historic ditching practices.

Data and Analyses

Chemistry

Water chemistry data has been collected at 07UM083 (S006-156 (2010) and S010-596 (2019)) (Table 7).

Table 7. Water chemistry data collected at S006-156 and S010-596. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S006-156 https://webapp.pca.state.mn.us/surface-water/station/S010-596

Parameter	Sample Count	Samples Not Meeting the Respective Standard	Applicable Standard	Average	Minimum	Maximum
TP	7	3	0.100 mg/L	0.14 mg/L	0.046 mg/L	0.28 mg/L
DO	19	1	5.0 mg/L	8.42 mg/L	4.66 mg/L	11.72 mg/L
Inorganic nitrogen	7	N/A	N/A	3.00 mg/L	0.92 mg/L	5.7 mg/L
TSS	2	1	30.0 mg/L	25.1 mg/L	7.2 mg/L	43 mg/L
Water Temp	20	N/A	N/A	15.40° C	3.72° C	26.07° C
Sp. Conductivity	19	N/A	N/A	597.26 µS	231 µS	769 µS

Nutrients – Phosphorus

Phosphorus values from the dataset collected on County Ditch 6 (Table 7) shows that the average TP is just above the Central Region River Nutrient standard (0.100 mg/L), at 0.136 mg/L. 43% of the TP values collected across the dataset were above the standard, with a maximum value of 0.282 mg/L. Although the data is limited to seven samples, these data suggest that there is a potential for eutrophication to occur.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite)

Inorganic nitrogen data were collected in 2010 and 2019 (Table 7). The average value was 3.0 mg/L, and the maximum value was 5.7 mg/L. These data indicate that the inorganic nitrogen levels are elevated at times, but are likely not a stressor to aquatic life.

Dissolved Oxygen

DO data were collected in 2010 and 2019 on County Ditch 6 (Table 7). The 2010 dataset is limited to three samples, but the 2019 dataset has 16 samples. The DO levels within the 2010 dataset had 1 reading that was just below the standard of 5 mg/L at 4.66 mg/L, and all of the DO values within the 2019 dataset were above the threshold.

In addition to the DO values collected during the chemistry samples, a sonde was deployed in County Ditch 6 from 7/31/2019 through 8/7/2019 (Figure 24). Most of the DO data collected during the sonde deployment was above the standard; however, the overnight values on 8/4/2019 and 8/5/2019 were below the standard.

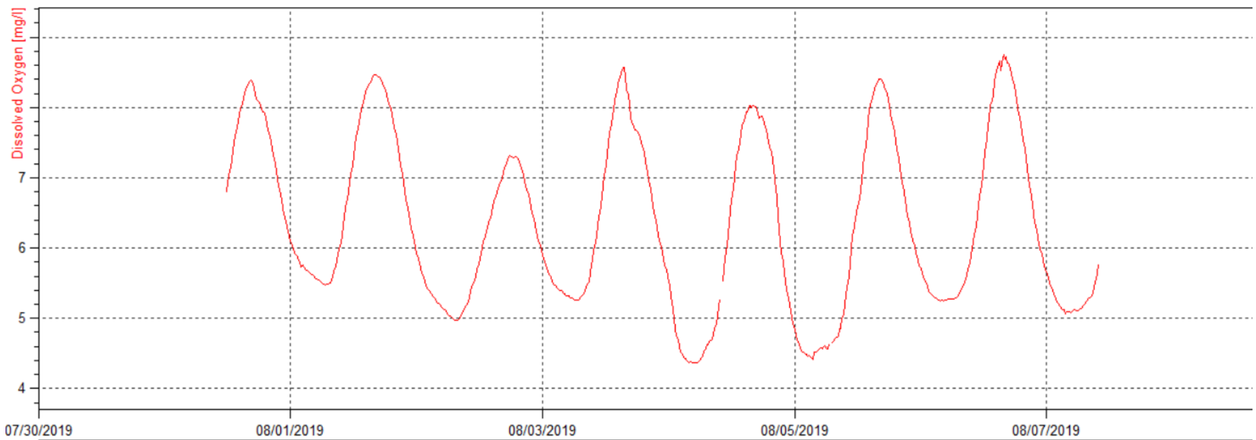


Figure 24. Continuous DO data collected on County Ditch 6, in 2019.

The low DO levels within the sonde dataset could be linked to macrophyte and algal growth. Algae and macrophytes utilize excess nutrients, resulting in excessive growth covering the stream channel (Figure 25).

Figure 25. Eutrophic conditions within County Ditch 6.

During the daylight hours these plants photosynthesize and produce oxygen, and then consume that same DO after sundown, causing fluctuations, and eventual periods of low DO overnight. Therefore the overnight DO levels are a potential stressor to the fish within County Ditch 6.

Total suspended solids

TSS data for County Ditch 6 is limited to two samples collected in 2019 (Table 7). One sample was above the 30 mg/L standard at 43 mg/L and the other sample was below the standard at 7.2 mg/L. The elevated value of 43 mg/L indicates that elevated TSS could be a stressor to the fish community within County Ditch 6. However, due to the limited dataset, TSS is an inconclusive stressor at this time.

Conductivity

Specific conductivity was within range during the chemistry samples (Table 7) and the sonde deployment in 2019, and is not considered a stressor within County Ditch 6.

Temperature

Temperature data collected during the chemistry samples (Table 7), and the 2019 sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as poor on County Ditch 6, through MSHA evaluations during the biological monitoring samples (Table 8). Due to the historic channelization of County Ditch 6, and poor MSHA score, the assessment of County Ditch 6 was brought into the UAA process. It was determined that the habitat has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, County Ditch 6 was assessed using the Modified Use TALU criteria.

Table 8. MSHA evaluations during the fish and macroinvertebrate samples on County Ditch 6.

MSHA Component	6/19/2007	8/21/2007	7/16/2008	7/31/2018	8/8/2018	Maximum Poss. Score
Land Use	0	0	0.75	0	0	5
Riparian	11	9.5	11	10	9.5	14
Substrate	11	14	9	8	7	28
Cover	12	12	1	12	12	18
Channel Morphology	11	7	10	6	5	35
Total MSHA Score	45	42.5	31.75	36	33.5	100

The lowest scoring category within all of the MSHA evaluations was channel morphology. These evaluations indicated that there was no channel depth variability, no sinuosity, and poor channel development (no riffles and small pools). Fish and macroinvertebrates need channel depth variability to use as cover from predation and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the ditch throughout the summer, especially during high flow events, which can flush these communities downstream. The lack of good channel morphology is caused by the channelization of the ditch, as the manipulation of the channel has been designed to move water quickly, by mechanically removing pools, riffles, channel depth variability, and sinuosity. Therefore, poor habitat is a stressor to the aquatic life in County Ditch 6.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of the entire Pope County Ditch 6 Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. County Ditch 6 has been straightened along the entire length of the AUID.

Due to the channelization of County Ditch 6, the ditch does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluations of stream bank condition during the fish and macroinvertebrate samples, the banks appear to be stable and not actively eroding. The MSHA evaluation for erosion noted that both banks were not eroding. Reviewing historical aerial photography shows that the channel did not exist historically, suggesting that County Ditch 6 was dredged to drain the upstream wetlands and excess water off of the landscape during the shift from forestland to agriculture. Although successful in achieving the landscape drainage goals, the creation of a stream channel where there was not a channel historically impedes the ability for the channel to provide the habitat quality that would occur naturally. Due to the ditch having lower quality habitat, the TALU modified use criteria were used in the aquatic life assessments of County Ditch 6. However, although the modified use criteria were used in the assessments, habitat within County Ditch 6 has degraded even below the lower standards of the modified use criteria. Therefore, altered hydrology has played a role in stressing the aquatic life in County Ditch 6, and is considered a stressor.

In 2019, a water level logger was placed in County Ditch 6 to monitor the flow throughout the summer. These data indicated that there is perennial flow within the channel throughout the summer, and therefore, lack of perennial flow does not appear to be a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road crossings further downstream on County Ditch 6. The culvert crossing by 07UM083 off County Road 33 does appear to be a fish barrier. SID staff noted that the culvert was perched by one foot, and does become a barrier under low flow; however, 07UM083 was located on the downstream side of the culvert, so this culvert is not likely affecting the fish samples collected at 07UM083. It is possible that the other road crossings may be fish barriers, but reviewing aerial photography, it appears as though the culverts are properly placed to allow for fish passage. However, it cannot be ruled out unless all crossings are examined.

Stressor signals from biology

Fish

Fish were initially sampled in 2007 and 2008 as part of the cycle I watershed monitoring effort and then sampled again in 2018 for the second cycle of monitoring. Throughout both monitoring cycles, fish were sampled a total of four times from 2007 to 2018. The number of fish species collected within each sample ranged between two and eight total species, with the Central Mudminnow dominating all four samples. All of the fish species collected within all four samples are considered tolerant to pollutants, with Central Mudminnows being labeled as one of the most tolerant fish species within the State of Minnesota.

TIV were calculated for County Ditch 6 using the fish communities collected within the four samples. The TIV for TSS within County Ditch 6, indicated that the fish communities had a range of 68% to 84% probability of coming from a stream that was meeting the TSS standard. One of the fish species within the 2018 sample was considered to be sensitive to elevated TSS, but all of the other species that were collected within any of the samples, were not considered to be tolerant or sensitive to elevated TSS. Therefore, the fish community response to TSS is inconclusive, but is indicating that TSS is not a stressor to the fish community within County Ditch 6 at this time.

DO TIV scores were also calculated for County Ditch 6 using the fish communities. The TIV scores indicated that the fish communities had a range of between a 2% and 9% probability of coming from a stream that was meeting the DO standard. Within all four samples, most of the fish species collected were considered to be tolerant or very tolerant of low DO, and none of the fish species collected were intolerant or sensitive to low DO. Due to the dominance of low DO tolerant species, and the low probability of the fish communities coming from a stream that is meeting the DO standard, DO is considered a stressor to the fish community within County Ditch 6.

Phosphorus tolerance of the fish community was also investigated in County Ditch 6 using the fish species characteristics. On average, 85% of the fish collected within County Ditch 6 were considered tolerant to elevated phosphorus. Almost all of the fish species collected were considered to be tolerant or very tolerant to elevated phosphorus, and none of the species collected were considered to be intolerant or sensitive to elevated phosphorus. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community in County Ditch 6.

Macroinvertebrates

Macroinvertebrates were also sampled in 2007 and 2018 as part of the watershed monitoring efforts. Although the macroinvertebrate community within County Ditch 6 is not currently impaired, the samples were used to aid in the identification of potential stressors to the fish community. Ninety-seven percent of the macroinvertebrate community that was sampled in 2007 was comprised of taxa that are considered to be tolerant of pollutants, and 59% of the community was considered to be very tolerant of pollutants. Similarly, the 2018 macroinvertebrate community was comprised of 79.5% tolerant taxa and 46% very tolerant taxa. One tolerant taxa (*Hyalella*) dominated both samples.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2007 sample, 1 intolerant taxa, 10 tolerant taxa, and 7 very tolerant taxa were collected (Table 9). As for the 2018 sample, 1 intolerant taxa, 7 tolerant taxa, and 4 very tolerant taxa were collected (Table 9). Overall the macroinvertebrate community within County Ditch 6 indicates that although TSS is not currently a primary stressor, if TSS values rise within County Ditch 6, it may become a stressor.

DO tolerance was also investigated using the macroinvertebrate communities. In 2007, 1 intolerant taxa, 12 tolerant taxa, and 7 very tolerant taxa were collected. As macroinvertebrates were resampled in 2018, the 1 intolerant taxa had disappeared, but the 12 tolerant taxa and 7 very tolerant taxa remained (Table 9). The disappearance of the intolerant taxa, combined with the dominance of tolerant and very tolerant taxa, indicates that low DO is a stressor to the macroinvertebrate community within County Ditch 6. This low DO signature by the macroinvertebrate community may further suggest that low DO is a stressor to the fish community.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2007 sample, 1 intolerant taxa, 18 tolerant taxa and 13 very tolerant taxa were collected (Table 9). In 2018, the one intolerant taxa that was present in 2007 disappeared. Fifteen tolerant taxa and seven very tolerant taxa were also collected in 2018. These tolerance indicators within the macroinvertebrate community indicate that phosphorus is a stressor to the macroinvertebrate community within County Ditch 6, and may further suggest the elevated phosphorus is a stressor to the fish community.

Table 9. Macroinvertebrate TIV indicators within County Ditch 6.

Sample Year	Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2007	TSS	1	10	7
2018	TSS	1	7	4
2007	DO	1	12	7
2018	DO	0	12	7
2007	Phosphorus	1	18	11
2018	Phosphorus	0	15	7

Composite conclusion from biology

The fish and macroinvertebrates in County Ditch 6 are indicating that low DO and elevated phosphorus are stressors to the aquatic life within County Ditch 6.

TSS does not appear to be a stressor to the biology.

Conclusions about stressors

Low DO during precipitation events appears to be a stressor to the fish community within County Ditch 6 as indicated by the dominance of low DO fish species within the fish samples. Although the macroinvertebrates are not currently impaired in County Ditch 6, the macroinvertebrate TIV scores provide more evidence that DO is a stressor. However, a majority of the DO samples collected during the chemistry samples and during the 2019 sonde deployment were above the standard. The only values within the dataset that were below the standard occurred just after precipitation events. Therefore the available data suggests that County Ditch 6 is meeting the DO standard, but the biological response indicates that it is a stressor. Additional DO data should be collected during and after precipitation events in order to fully understand the DO regime within County Ditch 6.

The phosphorus dataset collected on County Ditch 6 is limited; however, these data show that phosphorus is elevated with an average value of 0.136 mg/L. The biological response to these elevated phosphorus values can be seen in both the fish and macroinvertebrate TIVs. The fish samples were dominated by fish species that are well adapted to live in environments with elevated phosphorus. No fish species that are intolerant to elevated phosphorus, and many that are tolerant to elevated phosphorus were collected in County Ditch 6. Similarly, the macroinvertebrate samples were dominated by taxa that are tolerant to elevated phosphorus. Elevated phosphorus is a primary stressor to the fish community, and may cause a macroinvertebrate impairment in the future.

Insufficient habitat within County Ditch 6 is another primary stressor to the fish community. Poor sinuosity, poor channel development, and fine sediment were noted within the MSHA assessments. These habitat features are required by sensitive fish and macroinvertebrates to survive and reproduce. However, good sinuosity and channel features like pools and riffles that would occur naturally, do not exist in County Ditch 6 due to the channel not existing before the dredging of the channel. Similarly, coarse substrate that would naturally occur has been buried in sand and silt due to dredging the channel through wetlands, and the ditch lacking the channel morphology and stream power to flush fine sediment from the coarse substrate. The habitat within County Ditch 6 achieves the drainage goals of the landscape, but due to the dredging process, does not provide sufficient habitat for sensitive fishes.

Recommendations

Careful consideration to runoff from local fields would be advantageous for County Ditch 6. Phosphorus levels are elevated, and if mitigated, could make the biggest impact to the creek.

Continued compliance with the Buffer Law will help avoid erosion issues. Most of the ditch has a nice wide buffer, which has allowed the ditch channel and banks to remain stable, with little erosion.

Stream restoration to a sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Silver Creek Subwatershed

The Silver Creek Subwatershed covers 24,800 acres, and includes the city of West Union (Figure 26). 67.5% of the streams in the subwatershed have been channelized.

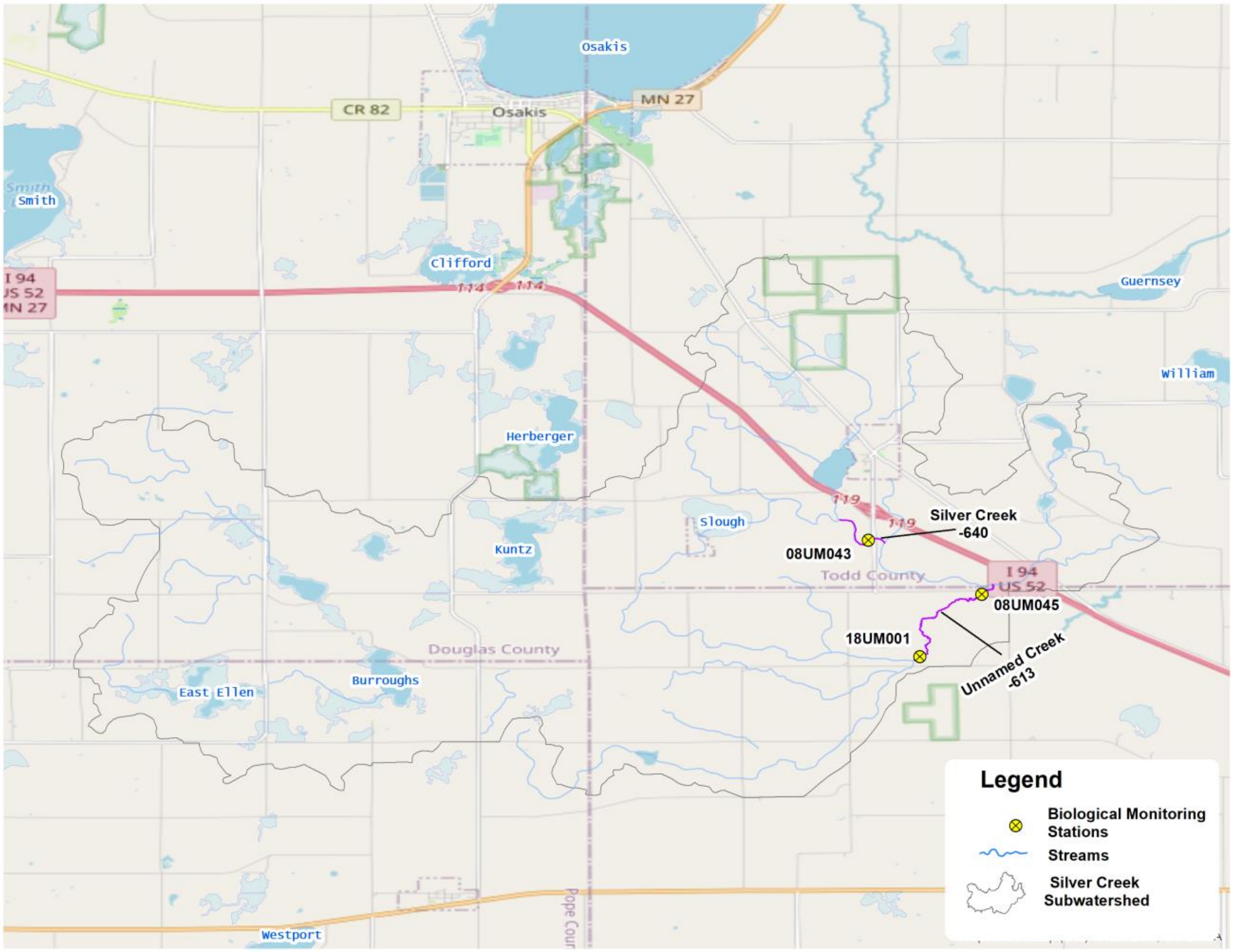


Figure 26. Biological monitoring stations in the Silver Creek Subwatershed.

The land use within the Silver Creek Subwatershed is dominated by cropland (73.6%), followed by wetlands (9.0%) and rangeland (8.6%) (Figure 27).

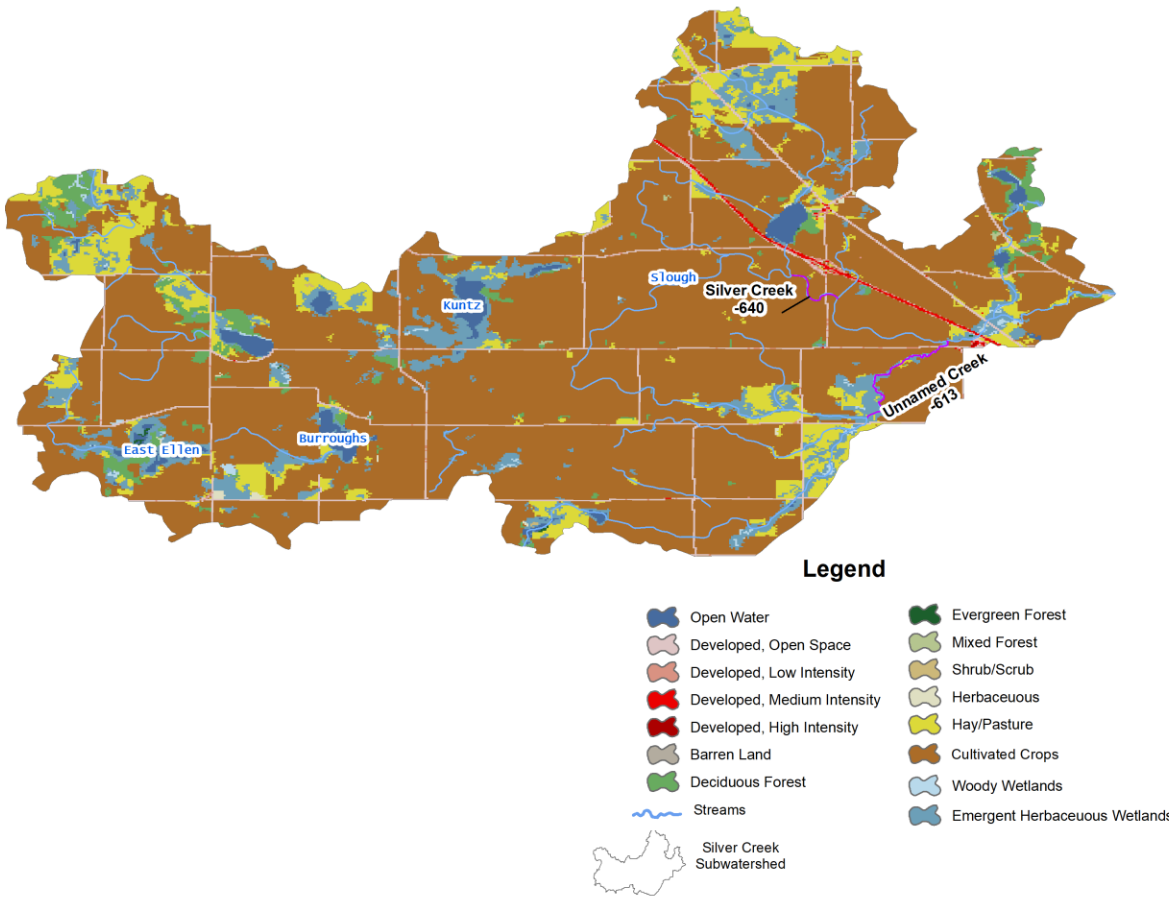


Figure 27. Land use in the Silver Creek Subwatershed.

Silver Creek (07010202-640)

Impairment: The headwaters portion of Silver Creek (AUID -640) flows for ¾ of a mile from the outlet of West Union Lake to the confluence with Unnamed Creek, 2 miles southeast of West Union (Figure 26). This section of Silver Creek has been channelized. There is one biological monitoring station (08UM043) on AUID -640 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams for aquatic life. The UAA process determined that Silver Creek should be assessed under the modified use criteria. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 7 (Prairie Streams Glide/Pool). In addition to the fish and macroinvertebrate impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

Water chemistry data has been collected at 08UM043 (S010-909) in 2019 (Table 10).

Table 10. Water chemistry data collected at S010-909. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S010-909.

Parameter	Sample Count	Sample Count Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	6	4	0.100 mg/L	0.14 mg/L	0.06 mg/L	0.27 mg/L
DO	17	0	5.0 mg/L	9.44 mg/L	6.4 mg/L	13.4 mg/L
Inorganic nitrogen	7	N/A	N/A	6.26 mg/L	3.9 mg/L	9.5 mg/L
TSS	4	1	30.0 mg/L	15.15 mg/L	3.6 mg/L	31 mg/L
Water Temp	14	N/A	N/A	18.95° C	10.01° C	28.37° C
Sp. Conductivity	13	N/A	N/A	744.85 µS	653.0 µS	866.0 µS

Nutrients – Phosphorus

Phosphorus values from the limited dataset collected in Silver Creek (Table 10) shows that the average TP is above the Central Region River Nutrient standard (0.100 mg/L), at 0.141 mg/L. 67% of the TP values collected were above the standard, with a maximum value of 0.266 mg/L. These data suggest that there is a potential for eutrophication to occur.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite)

Inorganic nitrogen levels are elevated in Silver Creek, with an average value of 6.26 mg/L, and a maximum value of 9.5 mg/L (Table 10). These data indicate that the inorganic nitrogen levels are elevated at times, and suggest that there is a potential for eutrophication to occur.

Dissolved Oxygen

DO data was collected on Silver Creek in 2019 (Table 10), which produced values that were all above the standard. DO data was also collected during a continuous sonde deployment, which was deployed for one week from 8/14/2019 to 8/20/2019 (Figure 28).

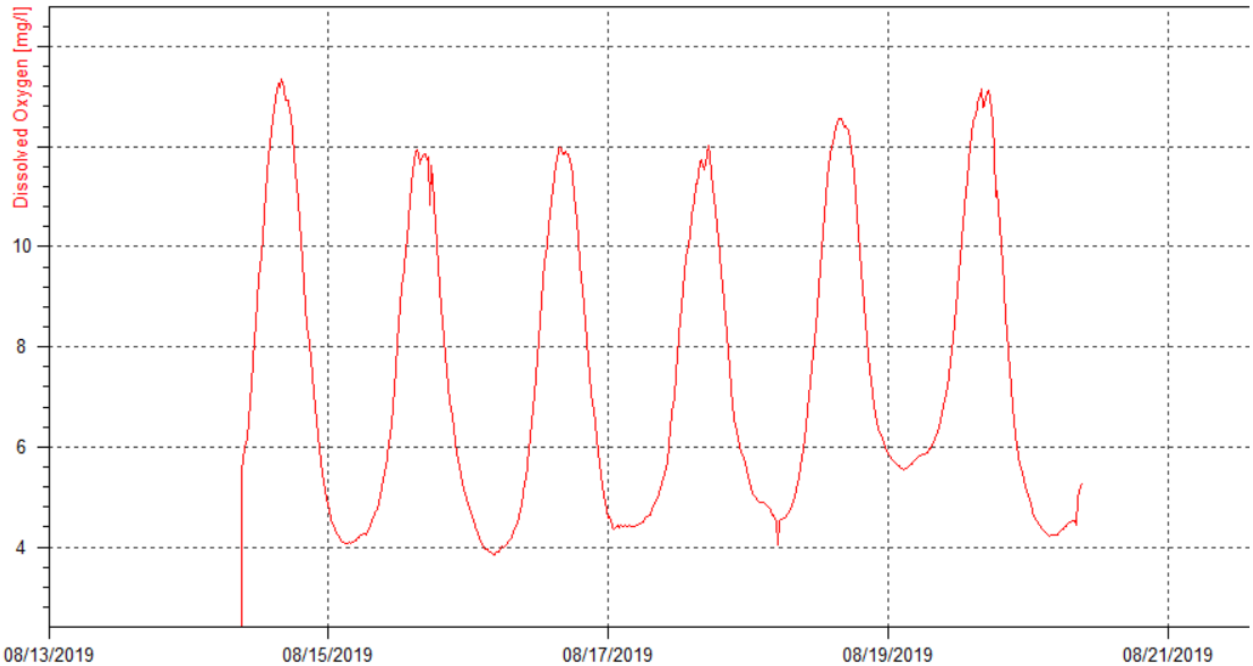


Figure 28. Continuous DO data collected in Silver Creek in 2019.

These data showed a 31% exceedance rate of the 5 mg/L standard with low values ranging from 3.85 mg/L to 4.37 mg/L. These data also showed large fluctuations in the DO levels, from less than 4 mg/L to over 10 mg/L. These data indicated that the elevated TP and Inorganic nitrogen may be causing eutrophication, and as a result, Silver Creek was listed as impaired for DO. Therefore, due to the evidence of an unstable DO regime, DO is considered a stressor to the aquatic life in Silver Creek.

Total suspended solids

Four TSS samples were collected on Silver Creek in 2019. Of the samples collected, only one was above the 30 mg/L standard at 31 mg/L (Table 10). Due to the limited data and the overall low TSS levels, TSS is not considered a stressor to the aquatic life in Silver Creek at this time.

Conductivity

Specific conductivity was within range during the 2019 sampling (Table 10) and the sonde deployment in 2019, and does not appear to be a stressor to the aquatic life in Silver Creek

Temperature

Temperature data collected during the chemistry samples (Table 10), and the 2019 sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Silver Creek, through MSHA evaluations during the biological monitoring samples (Table 11). Due to the historic channelization of Silver Creek, and fair MSHA score, the assessment of Silver Creek was brought into the UAA process. It was determined that the habitat of Silver Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Silver Creek was assessed using the Modified Use TALU criteria, and therefore, the loss of habitat is a stressor to the aquatic life within Silver Creek.

Table 11. MSHA evaluations within Silver Creek.

MSHA Component	June Fish Sample	July Fish Sample	Maximum Poss. Score
Land Use	0	0	5
Riparian	7	9.5	14
Substrate	16.45	15	28
Cover	11	12	18
Channel Morphology	16	21	35
Total MSHA Score	50.45 = Fair	57.5 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Silver Creek. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Historically, the upper portion of Silver Creek (AUID -640) did not exist, and the channel was created by dredging a channel through a series of wetlands, starting at the outlet of West Union Lake. This new channel connected West Union Lake to the lower portion of Silver Creek, a connection that did not exist historically.

Due to the channelization of Silver Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. Silver Creek was dredged to drain the upstream wetlands and excess water off of the landscape during the shift from forestland to agriculture. Although successful in achieving the landscape drainage goals, the creation of a stream channel where there was not a channel historically impedes the ability for the channel to provide the habitat quality that would occur naturally. Therefore, altered hydrology has played a role in stressing the aquatic life in Silver Creek, and is considered a stressor.

In 2020, a water level logger was placed in Silver Creek to monitor the stream level throughout the summer. The water level within the channel becomes critically low at several points throughout the summer. At 0.45 feet, there is no flow within the stream, and the water level logger data suggests that there was a significant amount of time that the stream stopped flowing in July of 2020 (Figure 29). Therefore, lack of perennial flow is a stressor within Silver Creek.

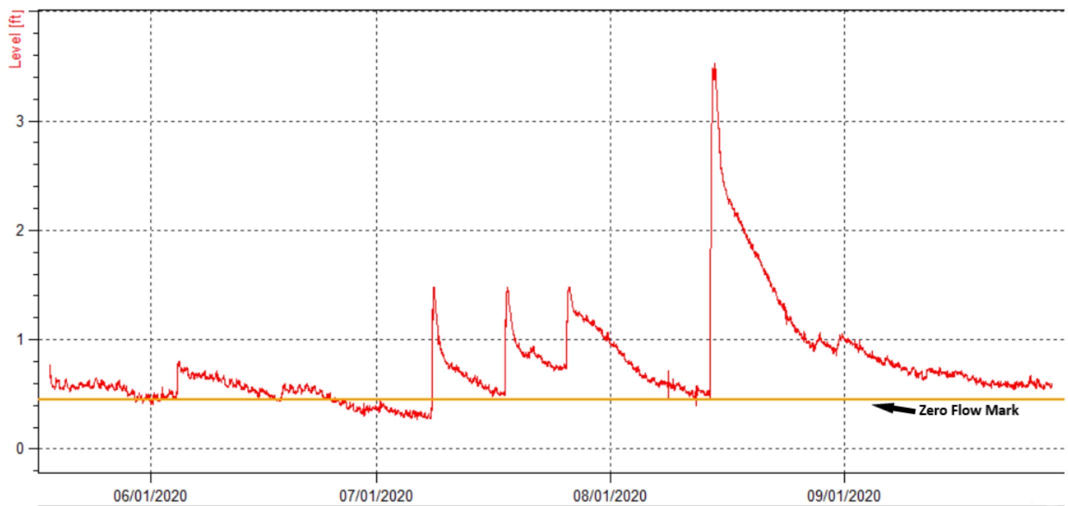


Figure 29. Water levels within Silver Creek, in 2020.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Silver Creek. The culvert crossing by 08UM043 off CR 91 does not appear to be a fish barrier. However, the rock grade control that has been placed on the downstream side of the culvert is a fish barrier at medium to low flow (Figure 30).

Figure 30. Boulders and cobbles acting as a grade control, downstream of CR 91.

In addition to the grade control, it is possible that several field crossings may be fish barriers. Reviewing aerial photography, shows several field crossings that have very small culverts as noted by the change in channel size on the upstream sides of the culverts. These occur on private property, but would need to be investigated for fish passage before they can be ruled out. Due to the grade control, and the resulting low water levels within Silver Creek, connectivity is a stressor to the aquatic life within Silver Creek.

Stressor signals from biology

Fish

Fish were sampled twice in 2008 as part of the cycle I watershed monitoring effort, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The June fish sample contained 14 species, with Fathead Minnows dominating the sample. In July, the fish sample was repeated, and only 3 species (Fathead Minnow, Central Mudminnow, and Creek Chub) and 12 total fish remained. All of these species are considered to be tolerant.

TIV were calculated for Silver Creek using the fish communities collected in 2008. The TIV for TSS within Silver Creek using the June fish sample, found that the fish community had a 14% probability of coming from a stream that was meeting the TSS standard. This probability rose to 33% when the July sample was used for the calculation. In the June sample, one species that is sensitive to elevated TSS and one species that is tolerant to elevated TSS were collected. However, in the July sample, none of the species collected were considered to be sensitive or tolerant of TSS. Therefore the fish community response is indicating that TSS is a stressor to the fish community; however, only one of the grab samples was above the standard at 31 mg/L. Further TSS monitoring is needed to determine if TSS is a stressor in Silver Creek; however, the fish barrier is the likely culprit for the lack of sensitive fishes.

DO TIV scores were also calculated for Silver Creek using the fish communities. This calculation indicated that the June fish community had an 18% probability of coming from a stream that was meeting the DO standard, and then dropped to 11% following the July sample. No fish that are intolerant or sensitive to low DO were collected in either sample, and almost all of the species that were collected were tolerant or very tolerant to low DO. The fish community tolerance to low DO in Silver Creek, combined with the fluctuating DO regime indicates that low DO is a primary stressor to the aquatic life in Silver Creek.

Nitrogen tolerance within the fish community was also investigated for Silver Creek. The fish community collected in June had two species that are sensitive to elevated nitrogen, and six species that are tolerant to elevated nitrogen. However, in the July sample, only two tolerant species remained. No nitrogen intolerant fish species were collected in June or July. The prevalence of nitrogen tolerant fish species in both samples, combined with the elevated nitrogen values within the 2019 grab samples, indicates that elevated nitrogen has the potential to become a stressor to the fish community in Silver Creek, if levels continue to rise.

Phosphorus tolerance of the fish community was also investigated in Silver Creek using the fish species characteristics. One sensitive, seven tolerant, and four very tolerant fish species were collected within the June fish sample. However, in the July sample, only two tolerant and one very tolerant fish species remained. No phosphorus intolerant fish species were collected in June or July. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated phosphorus values in the 2019 grab samples indicates that phosphorus is a stressor to the fish community in Silver Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 part of the cycle I watershed monitoring effort. 91.7% of the macroinvertebrate community was comprised of taxa that are considered to be tolerant of pollutants, and 58.3% of the community was considered to be very tolerant of pollutants. *Oligochaete* worms dominated the macroinvertebrate sample, and are considered to be highly tolerant.

TSS taxa tolerance was investigated using the macroinvertebrate communities. No intolerant taxa, five tolerant taxa, and three very tolerant taxa were collected within the sample (Table 12). Therefore, the macroinvertebrate community response is indicating that TSS is a stressor; however, only one of the grab samples was above the standard at 31 mg/L. Further TSS monitoring is needed to determine if TSS is a stressor to the aquatic life in Silver Creek.

DO tolerance was also investigated using the macroinvertebrate communities. Thirteen taxa that are considered to be tolerant of low DO, and eight taxa that are very tolerant to low DO were found within the sample (Table 12). No DO intolerant taxa were collected. Therefore, low DO does appear to be affecting the macroinvertebrate community, and is a primary stressor.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. In the sample, 2 intolerant, 13 tolerant, and 9 very tolerant taxa were collected in Silver Creek (Table 12). This nitrogen response by the macroinvertebrates, combined with the elevated nitrogen values within the 2019 grab samples, indicates that elevated nitrogen has the potential to become a stressor to the macroinvertebrate community in Silver Creek, if levels continue to rise.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. Within the sample, 15 tolerant taxa and 10 very tolerant taxa were collected (Table 12). The prevalence of tolerant taxa, and the absence of intolerant taxa indicates that phosphorus is a stressor to the macroinvertebrate community.

Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
TSS	0	5	3
DO	0	13	8
Nitrogen	2	13	9
Ammonia	1	12	8
Phosphorus	0	15	10

Table 12. Macroinvertebrate TIV indicators within Silver Creek.

Composite conclusion from biology

Connectivity and lack of perennial flow are the primary stressors to the fish and macroinvertebrates in Silver Creek. Removal of the grade control off CR 91 would make the biggest impact to Silver Creek.

The fish and macroinvertebrates in Silver Creek are indicating that low DO and elevated phosphorus are stressors to the aquatic life within Silver Creek.

Inorganic nitrogen may become a stressor to the fish and macroinvertebrates, if levels continue to rise.

TSS also appears to be a stressor to the biology; however, the grab samples are limited and more will need to be collected to make a final determination.

Recommendations

Elevated nutrients are a primary stressor within Silver Creek, through toxicity and eutrophication. Efforts should be made to manage nutrient input from the landscape and from the un-sewered community in West Union.

Redesign the grade control structure downstream of CR 91, to allow for fish passage.

Unnamed Creek (07010202-613)

Impairment: Unnamed Creek (AUID -613) flows for 1.9 miles from the headwaters at 440th Street, to the confluence with the headwaters section of Silver Creek (640), located upstream of CR 182. This reach drains 25 square miles, and has been partially channelized. There are two biological monitoring stations (08UM045, 18UM001) on Unnamed Creek that have been sampled for fish and macroinvertebrates (Figure 26). Biological monitoring station 08UM045 is located on the downstream portion of the reach, on a section of natural channel. This station was sampled in 2008 and was repeated in 2018. The other station (18UM001) is located further upstream on Unnamed Creek on a channelized portion of the reach. This station was sampled for fish and macroinvertebrates in 2018. The 2008 data was assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the general use criteria. The most recent assessment of Unnamed Creek resulted in a new fish impairment. The fish class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 5 (Southern Streams Riffle/Run).

Data and Analyses

Chemistry

The upstream tributary ditches flowing into AUID -613 were investigated in the summer of 2020.

Water chemistry and Secchi tube readings were collected after a precipitation event to evaluate run off conditions, within the headwaters of Unnamed Creek and Silver Creek (Table 13; Figure 31).

Table 13. Water chemistry data collected on the Silver Creek tributary ditches.

Station	Water Temperature	DO	Sp. Conductivity	Secchi Tube Reading
Target Trib #1	20.86° C	6.14 mg/L	686 µS	14 cm
Target Trib #2	N/A	N/A	N/A	N/A
Target Trib #3	24.06° C	3.43 mg/L	181.8 µS	10 cm

Figure 31. Tributary ditches, upstream of Silver Creek and Unnamed Creek that were sampled off CR 189 and 470th Ave.

The target #1 station had a DO reading that was just above the standard at 6.14 mg/L and a Secchi reading that was 14 cm (Table 13). The next station (target #2) did not have a definable channel, and was covered in cattails, which impeded the ability to take a quality reading (Table 13). However, the final station (target #3) was able to be sampled, and had a DO reading below the standard at 3.43 mg/L and a Secchi reading of 10 (Table 13). Sediment was actively running off of fields and flowing along 470th Avenue, ending up in the target #3 station (Figure 32; Figure 33; Figure 34).

Figure 32. Sediment runoff from a field close to Unnamed Creek.

Figure 33. Sediment runoff from a field close to Unnamed Creek.

Figure 34. Tributary ditch carrying the sediment to the headwaters of Unnamed Creek and Silver Creek.

Historical water chemistry data has also been collected at 08UM045 (S003-884) from 2004 through 2008 (Table 14).

Table 14. Water chemistry data collected at S003-884. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S003-884.

Parameter	Sample Count	Sample Count Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	13	13	0.100 mg/L	0.22 mg/L	0.1 mg/L	0.53 mg/L
DO	16	5	5.0 mg/L	7.71 mg/L	2.9 mg/L	12.9 mg/L
TSS	10	2	30.0 mg/L	12.0 mg/L	2.0 mg/L	39.0 mg/L
Water Temp	16	N/A	N/A	14.01° C	4.8° C	21.2° C

Nutrients – Phosphorus

Phosphorus values from the large dataset collected on Unnamed Creek (Table 14), and collected during the 2008 fish sample, shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is nearly double the standard at 0.220 mg/L. All of the TP values collected across the dataset were all above the standard, with a maximum value of 0.528 mg/L. These data suggest that there is a strong potential for eutrophication to occur.

Dissolved Oxygen

DO data was collected on Unnamed Creek during the chemistry samples in 2019 (Table 14), and during a continuous sonde deployment in 2020. The DO data collected during instantaneous sonde readings at the chemistry samples showed that the DO within Unnamed Creek can drop below the 5 mg/L standard (Table 14), with values as low as 2.9 mg/L. However, the continuous sonde deployment showed different results, with all of the collected values above the standard (Figure 35). The low readings, combined with the elevated TP may be causing eutrophication to occur, and could explain the variable DO levels. Therefore, due to the evidence of an unstable DO regime, DO is considered a secondary stressor to the aquatic life in Unnamed Creek.

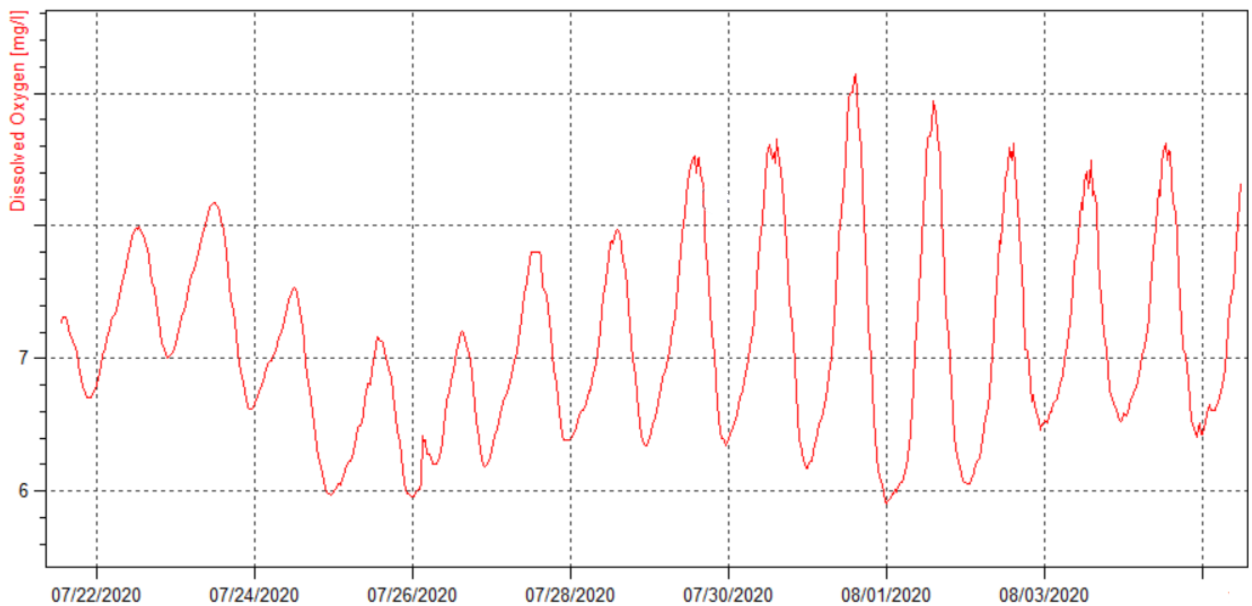


Figure 35. Continuous DO data collected on Unnamed Creek in 2020.

Transparency and suspended solids

TSS data were collected from 2005-2008 at S003-884 (Table 14). TSS values were almost entirely below the threshold, with the exception of two samples. Although these data indicate that TSS is relatively low in Unnamed Creek, the Secchi readings within the upstream tributary ditches indicate that TSS could be a stressor. More data is needed to make a final determination on TSS as a stressor within Unnamed Creek.

Conductivity

Specific conductivity was within range throughout the sonde deployment in 2020, and does not appear to be a stressor to aquatic life within Unnamed Creek.

Temperature

Temperature data collected during the historic monitoring at S003-884 (Table 14) and during the sonde deployment in 2019 showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was evaluated during the fish and macroinvertebrate samples collected at 08UM045 and 18UM001 (Table 15), through MSHA evaluations.

Table 15. MSHA habitat evaluations collected on Unnamed Creek.

MSHA Component	08UM045 2008 Fish Sample	08UM045 2018 Macroinvertebrate Sample	18UM001 Fish Sample	18UM001 August Macroinvertebrate Sample	18UM001 September Macroinvertebrate Sample	Maximum Poss. Score
Land Use	0	2	2.5	2.5	5	5
Riparian	9.5	6.5	9.5	6	10	14
Substrate	16.1	16	11	12	7	28
Cover	14	15	6	7	11	18
Channel Morphology	26	12	2	5	5	35
Total MSHA Score	65.6 = Fair	51.5 = Fair	31 = Poor	32.5 = Poor	38 = Poor	100

Habitat was classified as poor at the upstream station (18UM001), which has been channelized, and fair in the downstream station (08UM045) which has remained natural. Although the overall MSHA scores are low, the lowest scoring category for both of the biological monitoring stations was bank stability. The stream banks at both stations were noted as highly unstable, with the evidence of complete bank failure in several areas (Figure 36; Figure 37; Figure 38). The channelization from the upstream portion of the stream has accelerated stream flow to aid in landscape drainage. Although successful in draining the landscape quickly, the additional flow has scoured the stream banks throughout the reach. In addition to the bank instability, substrate embeddedness values indicated that the sediment coming from the unstable banks has settled out within the stream channel, completely burying coarse substrate with a layer of sand and silt. Therefore, habitat is considered a stressor to the aquatic life within Unnamed Creek.

Figure 36. Bank failure in the upstream portion of Unnamed Creek, spring 2018.

Figure 37. Bank failure at 08UM045.

Figure 38. Bank failure at 08UM045, with crop field planted to stream edge.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek, Silver Creek, and the entire subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands.

Utilizing the pictures and MSHA evaluations of stream bank condition during the fish and macroinvertebrate samples, the banks appear to be actively eroding. The MSHA evaluation for erosion ranged from moderate (50% to 75%) to severe (75% to 100%). Reviewing historical aerial photography shows that the pre-settlement channel in the upstream portion of the reach was sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the historic channel size, but is showing signs that the channel is widening due to unnatural bank erosion. Therefore, altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road crossings further downstream on Unnamed Creek. The culvert crossing by 08UM045 off Stearns Line Road, and all of the other crossings all the way to Sauk Lake were examined, and the crossings do not appear to be fish barriers. However, there are several low head dams (MPCA 2012) and an old road crossing (Figure 39) located on Ashley Creek that may impede the ability for larger fishes to reach Unnamed Creek and Silver Creek.

Figure 39. Old road crossing, upstream of CR 11.

Stressor signals from biology

Fish

Fish were initially sampled in 2008 at 08UM045 as part of the cycle I watershed monitoring effort. This sample yielded 12 total species, with almost all of the species considered to be tolerant. Fathead Minnows were the most dominate species collected, and are 1 of the most tolerant fish species within the State of Minnesota. The fish within Unnamed Creek were resampled in 2018, but were sampled further upstream in the AUID on a channelized portion of the stream (18UM001). This new station was chosen to be sampled due to being more representative of the subwatershed, which has been mostly channelized. The 2018 fish sample collected at 18UM001, yielded 11 total species, with all of the species considered to be tolerant. Central Mudminnows and Fathead Minnows dominated the sample, and are considered to be very tolerant.

TIV were calculated for Unnamed Creek using the fish communities collected in 2008 and 2018. The TIV for TSS within Unnamed Creek using the 2008 fish sample, found that the fish community had a 19.6% probability of coming from a stream that was meeting the TSS standard. Of the 12 fish species collected in 2008, none were considered to be intolerant, sensitive, or tolerant to TSS. As for the 2018 fish sample, the TSS TIV indicated that the fish community had a 55.6% probability of meeting the TSS standard, but no species with documented TSS tolerance sensitivity were collected within the sample. Due to the fish community lacking species that have documented sensitivity to TSS, the fish community response to TSS is inconclusive.

DO TIV scores were also calculated for Unnamed Creek using the fish communities. This calculation indicated that the fish community from 2008 had a 31% probability of coming from a stream that was meeting the DO standard. Six of the fish species collected are considered to be tolerant of low DO and species are considered very tolerant of low DO. This score dropped further with the 2018 fish community with a 6.6% probability. Six of the fish species collected in 2018 are considered to be tolerant of low DO, and four other species are considered to be very tolerant of low DO. The combined fish samples indicate that DO is a stressor to the fish community within Unnamed Creek.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Five fish species collected in the 2008 sample are considered to be tolerant of elevated phosphorus, and two of the species collected are very tolerant elevated phosphorus. Only one of the species from the 2008 sample was sensitive to elevated phosphorus. Similarly, 5 tolerant fish species, and three very tolerant fish species were collected in the 2018 sample. None of the species collected in 2018 were considered to be intolerant. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species in 2018, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community in Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were sampled five times throughout 2008 and 2018 as part of the watershed monitoring efforts. Both of the biological stations (08UM045; 18UM001) were sampled in 2018. On average, 81.4% of the macroinvertebrate community that was sampled was comprised of taxa that are considered to be tolerant of pollutants, and 45.4% of the community was considered to be very tolerant of pollutants. The macroinvertebrate community within Unnamed Creek is currently meeting standards, but TIVs were calculated in an attempt to help identify stressors to the fish community.

TSS taxa tolerance was investigated using the macroinvertebrate communities. On average, 1 intolerant taxa, 9.8 tolerant taxa, and 3.6 very tolerant taxa were collected within Unnamed Creek (Table 16). Due to the prevalence of macroinvertebrate taxa that have a tolerance to elevated TSS, the macroinvertebrate community is indicating that TSS may be a stressor, but more data is needed to an official determination.

DO tolerance was also investigated using the macroinvertebrate communities. On average, 2 very intolerant taxa, 3.2 intolerant taxa, 3.6 tolerant taxa, and 2.2 very tolerant taxa were collected within Unnamed Creek (Table 16). The macroinvertebrate community is indicating that the DO within Unnamed Creek is not a stressor, due to the prevalence of several very intolerant taxa. This is conflicting with the fish community, and could be further evidence that DO is not a primary stressor within Unnamed Creek, but is a secondary stressor due to the low DO values and fish TIV scores.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. On average, 0.8 intolerant taxa, 9 tolerant taxa, and 4.2 very tolerant taxa were collected within Unnamed Creek (Table 16). These tolerance indicators within the macroinvertebrate community lend support for phosphorus as a stressor to the fish community, due to the dominance of tolerant macroinvertebrate taxa.

Table 16. Macroinvertebrate TIV indicators for Unnamed Creek.

Parameter	# Very Intolerant	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
TSS-2008	0	4	8	3
TSS-2008	0	0	6	3
TSS-2018	0	1	14	7
TSS-2018	0	0	8	5
TSS-2018	0	0	13	0
DO-2008	4	5	4	4
DO-2008	3	2	5	4
DO-2018	1	4	2	1
DO-2018	0	1	4	1
DO-2018	2	4	3	1
TP-2008	0	2	10	4
TP-2008	0	0	12	6
TP-2018	0	2	7	2
TP-2018	0	0	7	4
TP-2018	0	0	9	5

Composite conclusion from biology

The fish and macroinvertebrates are indicating that Phosphorus is a stressor to the aquatic life within Unnamed Creek.

DO is a secondary stressor, as the fish are indicating that DO is a stressor, but the macroinvertebrates are not.

Elevated TSS is impacting the fish and macroinvertebrates within Unnamed Creek, and is considered a secondary stressor.

Poor habitat due to channelization is the primary stressor to the fish community within Unnamed Creek.

Recommendations

Compliance with the Buffer Law will help avoid erosion issues. There are multiple banks that are failing due to erosion in the headwaters of Unnamed Creek and near the biological monitoring station. Some row crop fields are right to the stream edge, and if the banks continue to erode, may cause a TSS impairment in the future.

Careful consideration to runoff from local fields would be advantageous for Unnamed Creek. Elevated nutrient levels are causing eutrophication.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Hoboken Creek Subwatershed

The Hoboken Creek Subwatershed covers 16,800 acres, eventually draining into Sauk Lake in Sauk Centre (Figure 40). 96.6% of the streams in the subwatershed have been channelized.

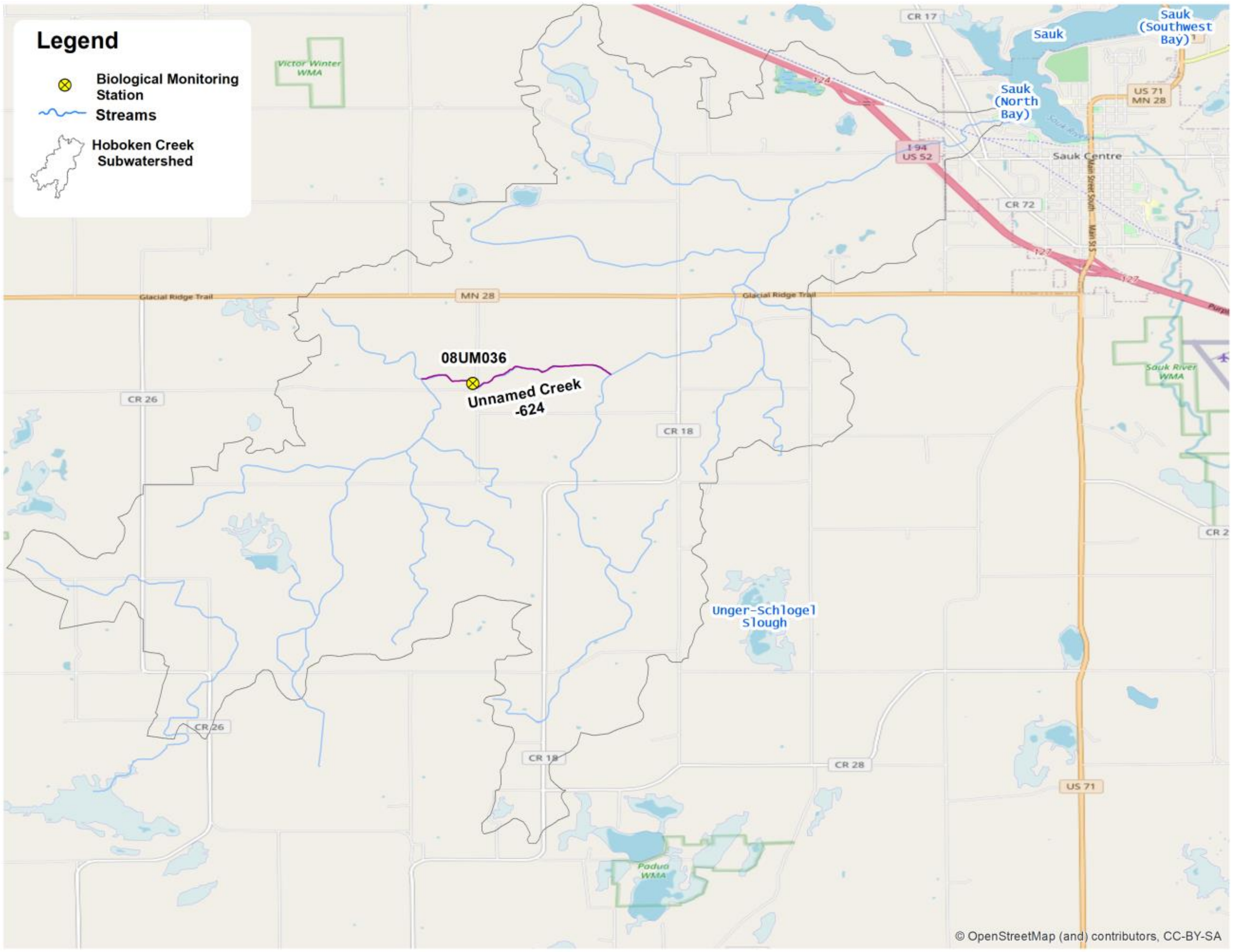


Figure 40. Biological monitoring station in the Hoboken Creek Subwatershed.

The land use within the Hoboken Creek Subwatershed is dominated by cropland (83.6%), followed by rangeland (5%) and wetlands (4.5%) (Figure 41).

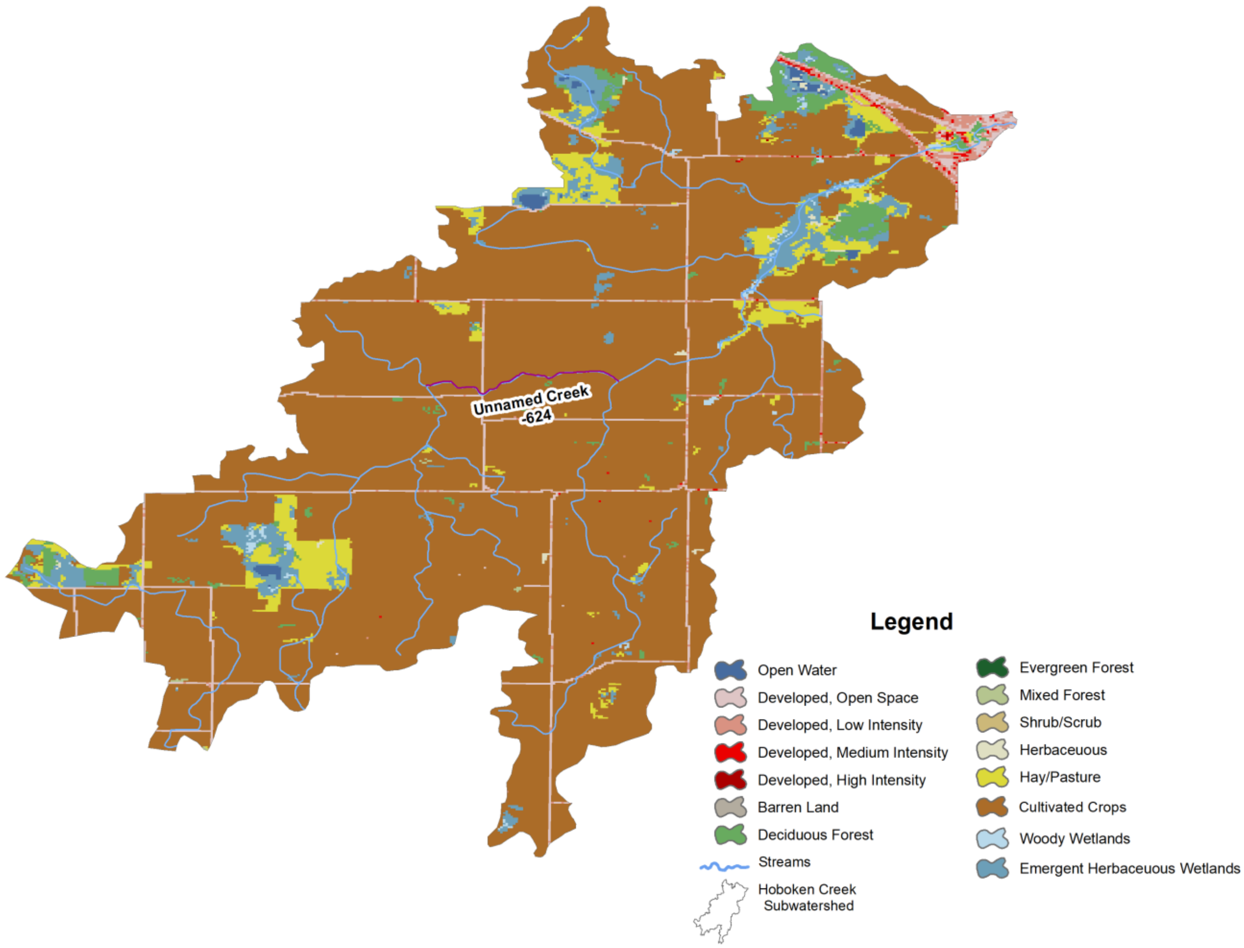


Figure 41. Land use in the Hoboken Creek Subwatershed.

Unnamed Creek (07010202-624)

Impairment: Unnamed Creek (AUID -624) flows for 1.7 miles, 5 miles southwest of Sauk Centre (Figure 40). The entire reach of Unnamed Creek has been channelized. There is one biological monitoring station (08UM036) on AUID -624 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the general use criteria, due to Unnamed Creek having fair habitat. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 5 (Southern Stream Riffle/Run).

Data and Analyses

Chemistry

Water chemistry data has been collected at S003-876 from 2004 through 2008 (Table 17).

Table 17. Water chemistry data collected at S003-876. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S003-876.

Parameter	Sample Count	Sample Count Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	13	10	0.100 mg/L	0.22 mg/L	0.01 mg/L	0.7 mg/L
DO	16	2	5.0 mg/L	9.29 mg/L	3.7 mg/L	14.11 mg/L
TSS	13	1	30.0 mg/L	15.02 mg/L	1.0 mg/L	80.0 mg/L
Water Temp	19	N/A	N/A	13.83° C	2.55° C	22.5° C

Nutrients – Phosphorus

Phosphorus values collected within the historic dataset (Table 17), shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is double the standard at 0.22 mg/L. 77% of the TP values collected across the dataset were all above the standard, with a maximum value of 0.70 mg/L. These data suggest that there is a strong potential for eutrophication to occur.

Dissolved Oxygen

DO data was collected within Unnamed Creek from 2007 through 2008 (Table 17; Figure 42). These data indicate that the DO levels within Unnamed Creek are above the standard of 5 mg/L throughout most of the dataset, except for two values.

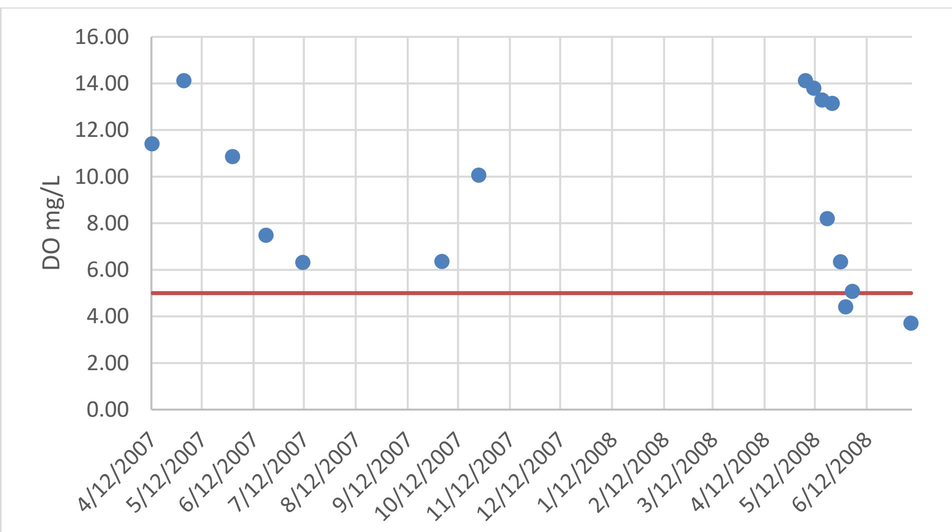


Figure 42. DO data collected in 2007 and 2008 in Unnamed Creek.

In addition to the historic grab samples, a continuous reading sonde was deployed within Unnamed Creek for one week from 7/31/2019 to 8/7/2019. These data were all above the standard, throughout the deployment (Figure 43). Overall, DO does not appear to be a primary stressor; however, during periods of low flow the stream may experience periods of low DO levels as noted within the historic dataset.

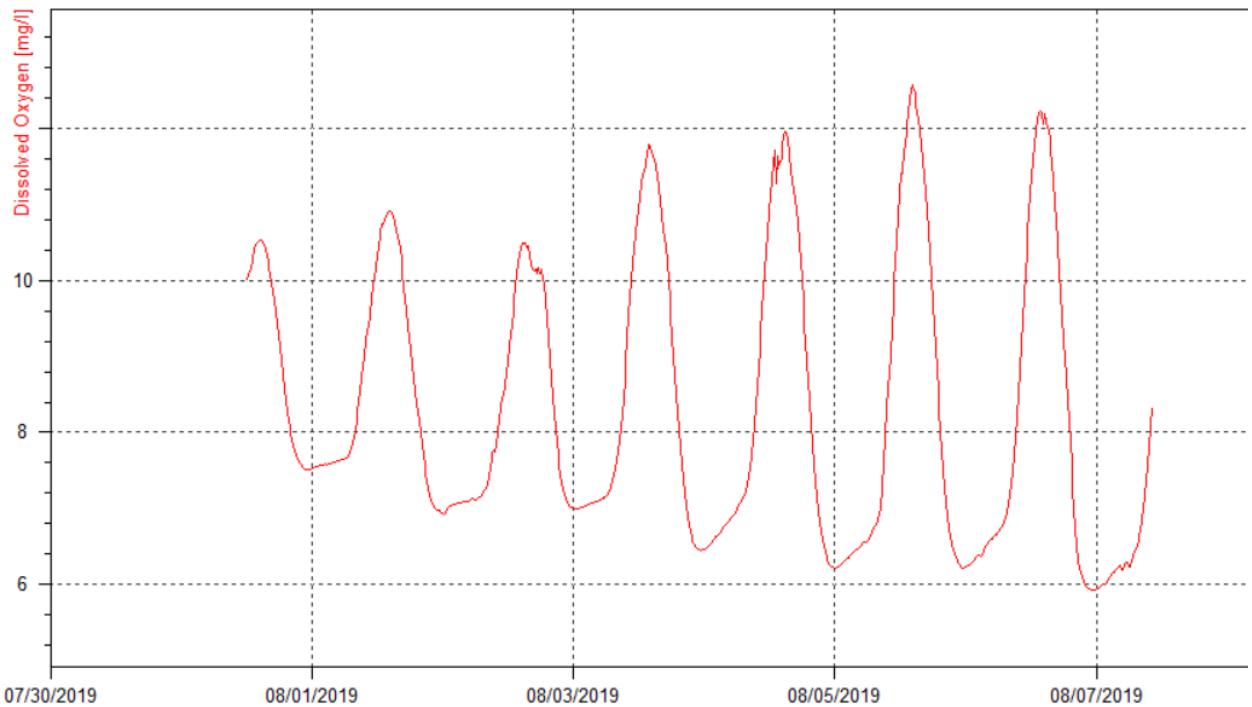


Figure 43. Continuous DO data collected in 2019 in Unnamed Creek.

Total suspended solids

TSS data were collected from 2005 through 2007 on Unnamed Creek. TSS values were almost entirely below the threshold, with the exception of one sample (Table 17). TSS does not appear to be a stressor to the aquatic life in Unnamed Creek.

Conductivity

Specific conductivity was within range during the sonde deployment in 2019, and does not appear to be a stressor to the aquatic life within Unnamed Creek.

Temperature

Temperature data collected during the chemistry samples (Table 17), and the 2019 sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair in Unnamed Creek, through MSHA evaluations during the fish samples (Table 18). During the first fish sample in June, the crew experienced equipment issues, and were not able to complete the sample, but did complete an MSHA evaluation. This original score was averaged with the MSHA score that was collected during the fish resample in July. Although the average MSHA score was classified as fair, most of the categories scored well, indicated by the presence of coarse substrate (Figure 44) and good channel morphology. Therefore, habitat does not appear to be a stressor within Unnamed Creek.

Table 18. Average MSHA score collected in Unnamed Creek.

MSHA Component	Avg. MSHA Score	Maximum Poss. Score
Land Use	0	5
Riparian	9.5	14
Substrate	17.5	28
Cover	9.5	18
Channel Morphology	24	35
Total MSHA Score	60.5 = Fair	100

Figure 44. Good quality habitat within Unnamed Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek and the entire subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been straightened along the entire length of the AUID.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion noted that there was no erosion present. Reviewing historical aerial photography shows that there was not a channel that historically existed, suggesting that the hydrology has been altered after the landscape shift to agriculture and the resulting channel enhancements related to that practice (drainage).

In addition to the channelization of Unnamed Creek, impoundments have altered the hydrology and drainage of Unnamed Creek. Field rock has been used to dam the stream, creating a pond upstream of CR 18 (Figure 45).

Figure 45. Field rock impoundment upstream of CR 18.

A water level logger was placed in Unnamed Creek in the summer of 2020 to determine if the creek maintains perennial flow throughout the summer. These data indicate that the water levels within Unnamed Creek are highly variable (Figure 46). The water level at the biological monitoring station is minimal until a precipitation event. As the levels rise with a precipitation event, the impoundment acts as a grade control, and holds back water. Therefore, altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

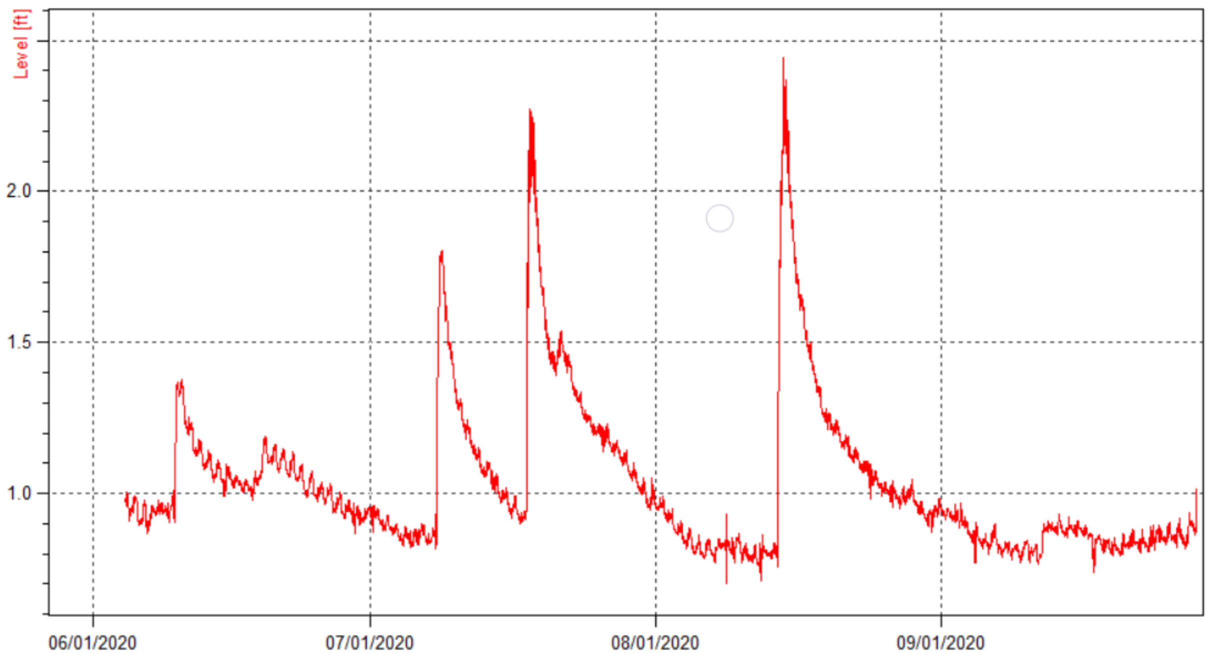


Figure 46. Water level within Unnamed Creek in the summer of 2020.

Connectivity

There is one road crossing close to the biological monitoring station, off CR 183 that does not appear to be a fish barrier. However, the impoundment that is located off CR 18 is a fish barrier, and is considered to be a primary stressor to the fish community within Unnamed Creek.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort. A total of six fish species were collected within the fish sample in 2008. All of the fish collected were considered to be tolerant, with Central Mudminnows dominating the sample.

TIV were calculated for Unnamed Creek using the fish communities collected in 2008. The TIV for TSS within Unnamed Creek using the 2008 fish sample, found that the fish community had a 78.8% probability of coming from a stream that was meeting the TSS standard. None of the fish collected within the sample have a recorded sensitivity to TSS. Therefore, less weight was placed on the TSS TIVs for the SID process. Due to the lower confidence in the TSS TIVs and the low TSS values collected in most of the historic dataset, TSS is not considered to be a stressor in Unnamed Creek.

DO TIV scores were also calculated for Unnamed Creek using the fish communities. This calculation indicated that the fish community from 2008 had a 9.5% probability of coming from a stream that was meeting the DO standard. One of the fish species collected was considered to be tolerant of low DO, and two species were considered very tolerant of low DO. The low TIV scores from the fish community are indicating that DO may be a stressor within Unnamed Creek; however, the DO data collected during the grab samples and sonde deployment suggest that the DO levels within Unnamed Creek are at healthy levels. Therefore, the low DO TIV scores are most likely the result of the impoundment creating periods of low flow conditions, temporarily depleting DO. Consequently, the altered flow conditions caused by the impoundment is considered to be the primary stressor.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Two fish species collected in the 2008 sample are considered to be tolerant of elevated phosphorus, and none of the six total species collected are intolerant of elevated phosphorus. The prevalence of tolerant species and the absence of intolerant species combined with the elevated phosphorus values collected within the historic dataset, indicates that phosphorus is a stressor to the fish community in Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 part of the cycle I watershed monitoring effort. 76.9% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 30.7% of the community was considered to be very tolerant of pollutants. *Dubiraphia* riffle beetles, which are considered to be mildly intolerant taxa, dominated the macroinvertebrate sample; however, *Caenis* mayflies and *Oligochaeta* worms were also collected in high numbers and are considered to be tolerant.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2008 sample, one intolerant taxa and six tolerant taxa were collected (Table 19). Overall the macroinvertebrate community within Unnamed Creek indicates that TSS is not a primary stressor, as intolerant taxa were collected.

DO tolerance was also investigated using the macroinvertebrate communities. Two intolerant taxa, 10 tolerant taxa, and 4 very tolerant taxa were found within the 2008 sample (Table 19). 23% of the macroinvertebrate community was considered to be tolerant to low DO. The moderate sensitivity to low DO shown by the macroinvertebrate community may indicate that DO is a stressor within Unnamed Creek. However, the DO data collected during the grab samples and sonde deployment suggest that the DO levels within Unnamed Creek are at healthy levels. Therefore, similar to the fish community, the low DO TIV scores are most likely the result of the impoundment creating periods of low flow conditions, temporarily depleting DO. Consequently, the altered flow conditions caused by the impoundment is considered to be the primary stressor.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, 1 intolerant, 12 tolerant taxa and 4 very tolerant taxa were collected (Table 19). These tolerance indicators within the macroinvertebrate community indicate that phosphorus is a secondary stressor to the macroinvertebrate community with only one intolerant taxa collected.

Table 19. Macroinvertebrate TIV indicators in Unnamed Creek.

Sample Year	Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	1	6	0
2008	DO	2	10	4
2008	Phosphorus	1	12	4

Composite conclusion from biology

The fish and macroinvertebrates in Unnamed Creek are indicating that low DO and elevated phosphorus are stressors to the aquatic life within Unnamed Creek. However, these chemical stressors may be inflated due to the impoundment that has been established downstream of the biological monitoring station.

TSS does not appear to be a stressor to the biology.

Recommendations

The impoundment that has been placed within Unnamed Creek, off CR 18, is the primary stressor to the aquatic life within Unnamed Creek. Currently, the DNR is working with local landowners to remove the impoundment. This removal will make the biggest impact to the biology within Unnamed Creek, by stabilizing the flow pattern, and allowing for fish passage.

Moliter Lake Subwatershed

The Moliter Lake Subwatershed covers 11,600 acres, ending in the Sauk River WMA (Figure 47). There are 92.4% of the streams in the subwatershed that have been channelized.

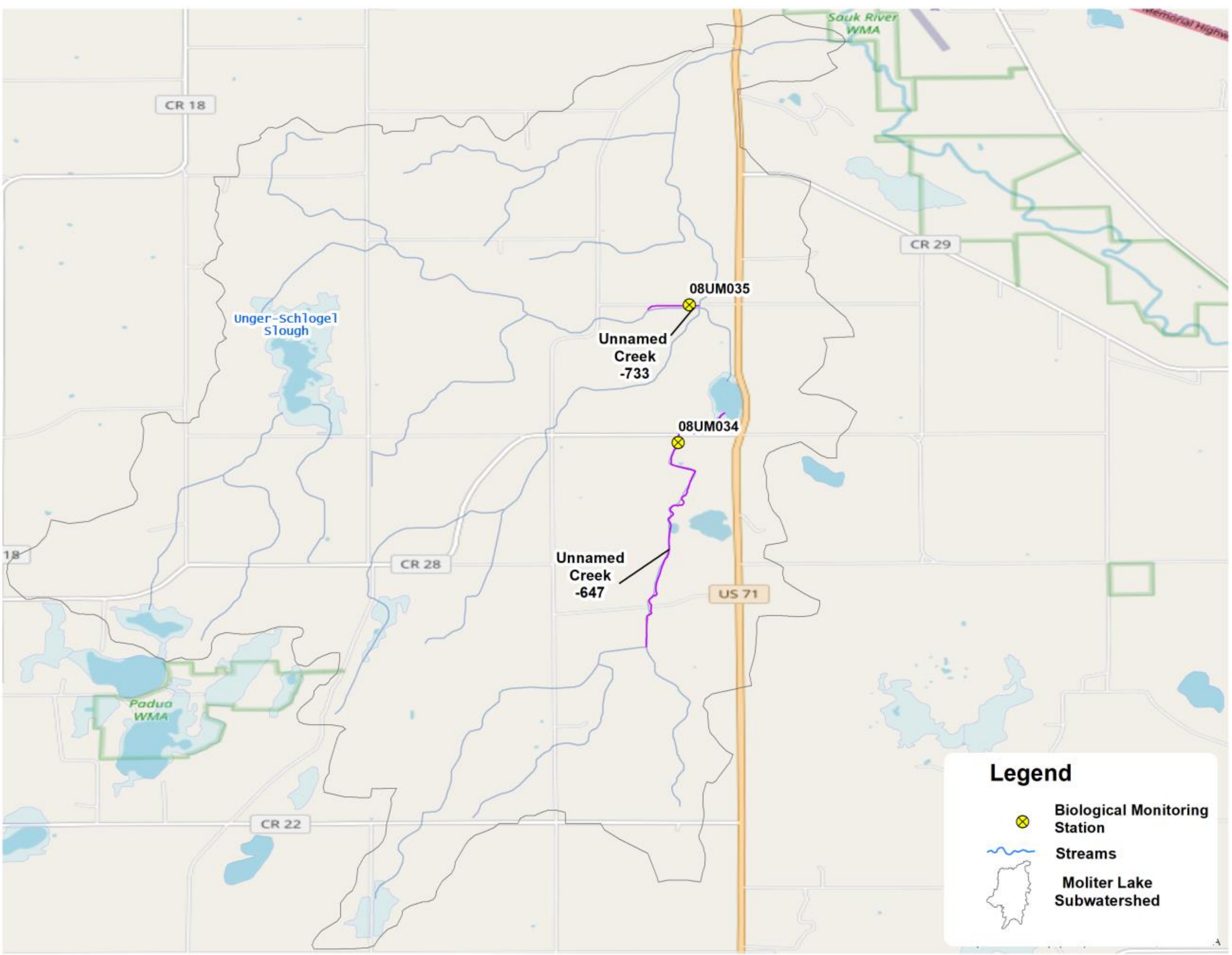


Figure 47. Biological monitoring stations in the Moliter Lake Subwatershed.

The land use within the Moliter Lake Subwatershed is dominated by cropland (82.7%), followed by wetlands (6.2%) and rangeland (4.6%) (Figure 48).

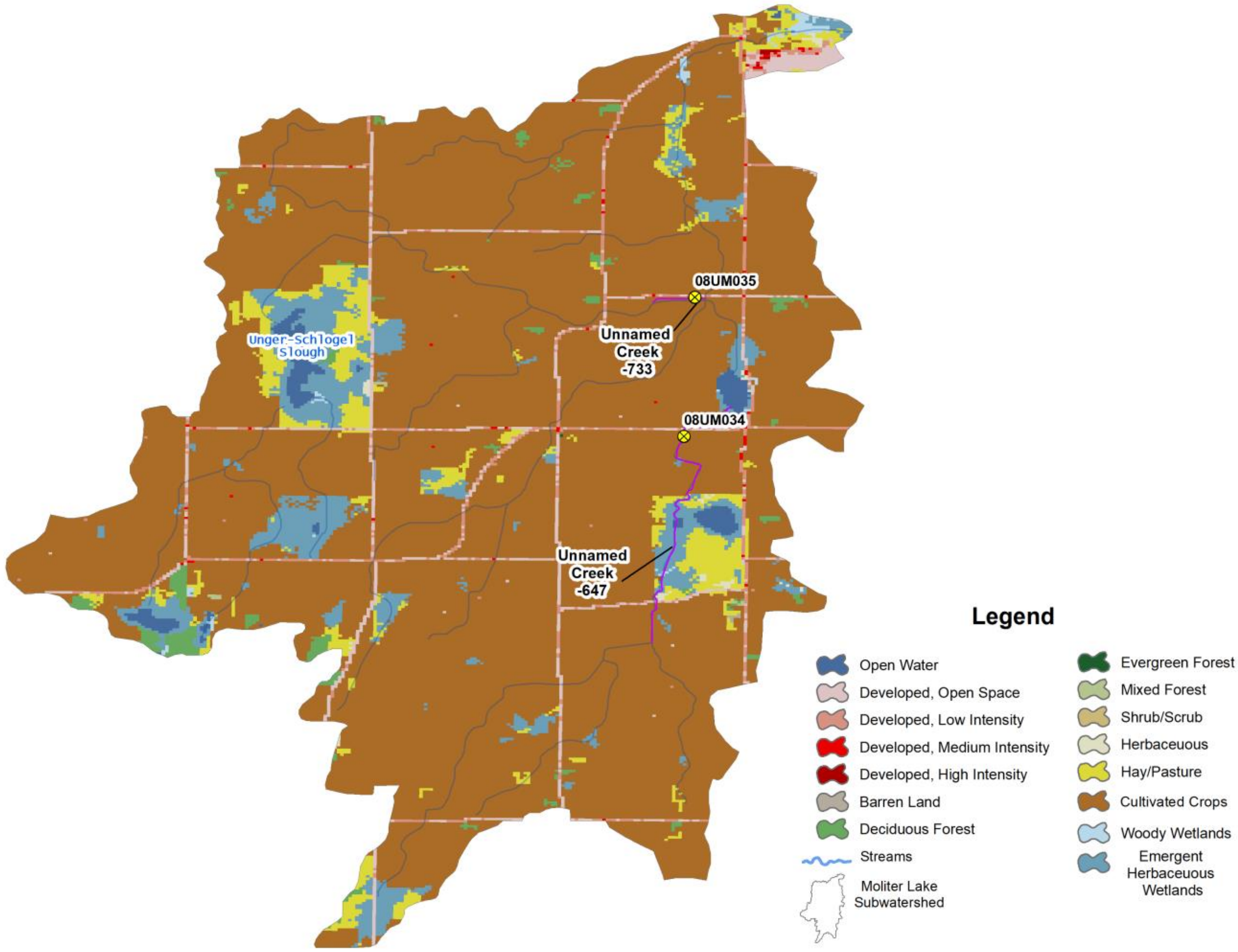


Figure 48. Land use in the Moliter Lake Subwatershed.

Unnamed Creek (07010202-733)

Impairment: Unnamed Creek (AUID -733) flows for 0.3 of a mile, 1.5 miles south of Sauk Centre (Figure 47). The entire reach of Unnamed Creek has been channelized. There is one biological monitoring station (08UM035) on AUID -733 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the modified use criteria. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 5 (Southern Stream Riffle/ Run).

Data and Analyses

Chemistry

Water chemistry data has been collected at S010-903 in 2019 (Table 20).

Table 20. Water chemistry data collected at S010-903. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S010-903.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	4	3	0.100 mg/L	0.15 mg/L	0.06 mg/L	0.25 mg/L
DO	12	0	5.0 mg/L	8.87 mg/L	6.23 mg/L	11.23 mg/L
Inorganic nitrogen	4	N/A	N/A	4.68 mg/L	2.0 mg/L	9.2 mg/L
TSS	1	0	30.0 mg/L	20.0 mg/L	20.0 mg/L	20.0 mg/L
Water Temp	15	N/A	N/A	18.35° C	10.61° C	25.55° C
Sp. Conductivity	14	N/A	N/A	608.8 µS	515 µS	701 µS

Nutrients – Phosphorus

Phosphorus values from the limited dataset collected on Unnamed Creek (Table 20) shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), at 0.15 mg/L. Although the dataset is limited, there is evidence that TP can become elevated, as 75% of the TP values collected across the dataset were all above the standard, and a maximum value of 0.25 mg/L. These data suggest that there is a potential for eutrophication to occur.

Nutrients – Inorganic nitrogen

Inorganic nitrogen data were collected in 2019 on Unnamed Creek. These data indicate that the Inorganic nitrogen levels within Unnamed Creek are elevated (Table 20), and have the potential to be a stressor to aquatic life. However, the elevated inorganic nitrogen values pose a bigger threat to the overall health to aquatic life through eutrophication caused by the elevated nutrients. Therefore, inorganic nitrogen is a contributing factor to the overall stress of the aquatic life within Unnamed Creek, but is not considered a primary stressor.

Dissolved Oxygen

DO data was collected from Unnamed Creek throughout the summer of 2019. These data show that the DO levels within Unnamed Creek were above the 5 mg/L standard throughout the summer of 2019 (Table 20). Therefore, DO does not appear to be a stressor to the aquatic life within Unnamed Creek.

Total suspended solids

One TSS sample was collected from Unnamed Creek in 2019 with a value of 20 mg/L (Table 20). This value was below the standard of 30 mg/L, but since the dataset is limited to one sample, the evaluation of TSS as a stressor within Unnamed Creek is inconclusive at this time.

Conductivity

Specific conductivity was within range during the 2019 sampling (Table 20). Therefore, specific conductivity does not appear to be a stressor to aquatic life within Unnamed Creek.

Temperature

Temperature data collected during the chemistry samples (Table 20), showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Unnamed Creek, through an MSHA evaluation during the fish sample in 2008 (Table 21). Due to the historic channelization of Unnamed Creek, and fair MSHA score, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the Modified Use TALU criteria.

Table 21. MSHA evaluation during the 2008 fish sample on Unnamed Creek.

MSHA Component	Unnamed Creek	Maximum Poss. Score
Land Use	0	5
Riparian	8.5	14
Substrate	17.8	28
Cover	11	18
Channel Morphology	14	35
Total MSHA Score	51.3 = Fair	100

Channel morphology was the lowest scoring component of the MSHA evaluation. The MSHA indicated that there was no sinuosity, moderate channel stability, and fair channel development (small riffles and small pools). The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity and channel features such as pools and riffles. Therefore, lack of habitat is a stressor to the aquatic life in Unnamed Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek. The most significant historical changes to the landscape have been the land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been straightened along the entire length of the AUID.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks appear to be actively eroding (Figure 49).

Figure 49. Bank instability at Unnamed Creek in 2008.

The MSHA evaluation for erosion ranged from moderate (25% to 50%) to heavy (50% to 75%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from unnatural bank erosion. Altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Unnamed Creek. The culvert crossing by 08UM035 off 380th Street does appear to be a fish barrier at moderate to low flow. As can be seen in Figure 50, the culvert is perched and does not allow for fish passage.

Figure 50. Perched culvert downstream of 380th Street.

In addition to the culvert off 380th Street, it appears as though the culverts under several field crossings are fish barriers (Figure 51; Figure 52), as the channel is over-widened, but it cannot be ruled out unless all crossings are examined. Due to the perched culvert off 380th Street, connectivity is a primary stressor to the aquatic life within Unnamed Creek.

Figure 51. Field crossing with poorly placed culvert on Unnamed Creek.

Figure 52. Field crossing with poorly placed culvert on Unnamed Creek.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort. The fish sample from 2008 yielded a total of five species, with Fathead Minnows being the most dominate. Of the five species collected, four species were tolerant and one species was sensitive (Northern Redbelly Dace).

TIV were calculated for Unnamed Creek using the fish communities collected in 2008. The TIV for TSS within Unnamed Creek using the 2008 fish sample, found that the fish community had a 34.5% probability of coming from a stream that was meeting the TSS standard. Of the six fish species collected in 2008, one of the species is sensitive to TSS, and all of the other species are not sensitive or tolerant of TSS. Due to only one species having a sensitivity to TSS, less weight was placed on the TSS TIVs for the SID process. Due to the lower confidence in the TSS TIVs and the low TSS values collected in most of the historic dataset, TSS is not considered to be a stressor in Unnamed Creek.

DO TIV scores were also calculated for Unnamed Creek using the fish communities. This calculation indicated that the fish community from 2008 had an 18.3% probability of coming from a stream that was meeting the DO standard. Four of the fish species collected are considered to be very tolerant of low DO. The dominance of low DO tolerant fish species indicates that DO is a stressor to the fish community within Unnamed Creek.

Nitrogen tolerance within the fish community was also investigated for Unnamed Creek. The fish community collected in 2008 had one species that is sensitive to elevated nitrogen, and three species that are tolerant to elevated nitrogen. No nitrogen intolerant fish species were collected in 2008. The prevalence of nitrogen tolerant fish species indicates that elevated nitrogen may be affecting the fish community within Unnamed Creek. However, the overall impact of elevated nitrogen, as noted in the 2019 samples, has the greatest effect on the aquatic life of Unnamed Creek through eutrophication.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Three fish species collected in the 2008 sample are considered to be tolerant of elevated phosphorus, and two species were very tolerant. None of the five total species collected were intolerant of elevated phosphorus. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species indicates that phosphorus may be a stressor to the fish community in Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 part of the cycle I watershed monitoring effort. 75.7% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 38.8% of the community was considered to be very tolerant of pollutants. *Caenis* mayflies, which are considered to be tolerant, dominated the sample.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2008 sample, two intolerant taxa, seven tolerant taxa, and one very tolerant taxa were collected (Table 22). Therefore, the macroinvertebrate community within Unnamed Creek indicates that TSS is not a primary stressor, as multiple intolerant taxa were collected.

DO tolerance was also investigated using the macroinvertebrate communities. Two very intolerant taxa, three intolerant taxa, six tolerant taxa, and two very tolerant taxa were found within the 2008 sample (Table 22). Due to the presence of very intolerant taxa, low DO does not appear to be a stressor to the macroinvertebrate community within Unnamed Creek.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. In the 2008 sample, 2 intolerant, 22 tolerant, and 14 very tolerant taxa were collected in Unnamed Creek (Table 22). The overall macroinvertebrate community is indicating some nitrogen intolerance with the presence of multiple tolerant and very tolerant taxa. However, intolerant taxa are also present, suggesting that elevated nitrogen is not a primary stressor within Unnamed Creek, but could be contributing to eutrophication.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, nine tolerant taxa and three very tolerant taxa were collected (Table 22). These tolerance indicators within the macroinvertebrate community indicate that phosphorus may be a stressor to the macroinvertebrate community with no intolerant taxa collected.

Table 22. Macroinvertebrate tolerance indicators in Unnamed Creek.

Sample Year	Parameter	# Very Intolerant taxa	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	0	2	7	1
2008	DO	2	3	6	2
2008	Nitrogen	0	2	22	14
2008	Phosphorus	0	0	9	3

Composite conclusion from biology

Elevated phosphorus has the potential to be a stressor to the aquatic life within Unnamed Creek, as shown by the dominance of phosphorus tolerant fish species and macroinvertebrate taxa. However, more TP data would be needed to make a final determination.

The biological communities within Unnamed Creek yielded mixed signals to low DO as a stressor. The fish community is indicating that DO is a stressor, and the macroinvertebrate community is indicating that low DO is not a stressor. This is most likely an indicator that the perched culvert is impeding more sensitive fishes from reaching the stream, as the restriction of the culvert is blocking passage at high flows and the perched culvert is blocking passage at moderate to low flows.

Excessive nutrients are stressors to the aquatic life within Unnamed Creek. Phosphorus values were elevated within the dataset, and the resulting biological response can be seen within the fish and macroinvertebrate TIV scores. Similarly, inorganic nitrogen levels were elevated in some of the samples within the dataset, and multiple tolerant fish species and macroinvertebrate taxa were collected. These elevated nutrient levels, indicate that there is a potential for eutrophication to occur within Unnamed Creek.

The biological response to low TSS indicates that TSS is not a stressor within Unnamed Creek; however, due to the limited datasets, more data would need to be collected at low and high flows to confirm that determination.

Recommendations

Replace the culvert off 380th Street with an Aquatic Organism Passage Program (AOP) culvert to allow for fish passage.

Careful consideration to runoff from local fields would be advantageous for Unnamed Creek. Elevated nutrient levels may begin to cause eutrophic conditions, and if mitigated, could make an impact to the creek. However, more DO data would needed to be collected to confirm that eutrophication is occurring. If Unnamed Creek is a priority to local water planning, the MPCA SID staff would be available to collect the additional data needed to make a final determination.

Unnamed Creek (07010202-647)

Impairment: Unnamed Creek (AUID -647) flows for 2.3 miles starting just upstream of 357th Street and ending downstream of CR 28, 5 miles south of Sauk Centre (Figure 47). The entire reach of Unnamed Creek has been channelized. There is one biological monitoring station (08UM034) on AUID -647 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the modified use criteria. This assessment resulted in new impairments for both fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 7 (Prairie Streams Glide/Pool).

Data and Analyses

Chemistry

Water chemistry data has been collected at S010-902 from 2019 (Table 23).

Table 23. Water chemistry collected at S010-902. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S010-902.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	5	4	0.100 mg/L	0.37 mg/L	0.06 mg/L	0.92 mg/L
DO	16	0	5.0 mg/L	8.36 mg/L	5.73 mg/L	11.05 mg/L
Inorganic nitrogen	6	N/A	N/A	3.5 mg/L	0.12 mg/L	11.0 mg/L
TSS	1	1	30.0 mg/L	330.0 mg/L	330.0 mg/L	330.0 mg/L
Water Temp	17	N/A	N/A	17.45° C	8.18° C	25.61° C
Sp. Conductivity	16	N/A	N/A	738.63 µS	665 µS	815 µS

Nutrients – Phosphorus

Phosphorus values collected on Unnamed Creek in 2019 (Table 23) shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is three times the standard at 0.37 mg/L. 80% of the TP values collected across the dataset were all above the standard, with a maximum value of 0.92 mg/L. These data suggest that there is a strong potential for eutrophication to occur.

Nutrients – Inorganic nitrogen

Inorganic nitrogen data were collected in 2019 on Unnamed Creek. These data indicate that the inorganic nitrogen levels within Unnamed Creek are elevated (Table 23), and have the potential to be a stressor to aquatic life. However, the elevated inorganic nitrogen values pose a bigger threat to the overall health to aquatic life through eutrophication caused by the elevated nutrients. Therefore, inorganic nitrogen plays a role in stressing the fish and macroinvertebrates within Unnamed Creek, but is not considered a primary stressor.

Dissolved Oxygen

DO data was collected from Unnamed Creek 2019. These data show that the DO levels within Unnamed Creek were above the 5 mg/L standard throughout the summer of 2019 (Table 23). However, these values were not collected at the daily minimum, and due to the eutrophic conditions of Unnamed Creek (excessive algal and macrophyte growth) (Figure 53) DO levels may drop overnight. Therefore, low DO cannot be ruled out as a stressor within Unnamed Creek, and more data (continuous sonde deployment) would need to be collected to make a final determination.

Figure 53. Heavy algal and macrophyte growth within Unnamed Creek, signaling eutrophication.

Total suspended solids

One TSS sample was collected from Unnamed Creek in 2019 (Table 23), with a value that was 11x the standard of 30 mg/L at 330 mg/L. This sample indicates that TSS is a stressor to the aquatic life within Unnamed Creek; however, due to only having one sample, TSS is considered to be a secondary stressor at this time.

Conductivity

Specific conductivity was within range during the 2019 sampling (Table 23). Therefore, specific conductivity does not appear to be a stressor to aquatic life within Unnamed Creek.

Temperature

Temperature data collected during the grab samples (Table 23) showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as poor in Unnamed Creek, through MSHA evaluations during the fish samples (Table 24). During the first fish sample in June, the crew experienced equipment issues, and were not able to complete the sample, but did complete an MSHA evaluation. This original score was averaged with the MSHA score that was collected during the fish resample in July. Due to the historic channelization of Unnamed Creek, and fair MSHA score, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the Modified Use TALU criteria.

Table 24. Average MSHA score within Unnamed Creek.

MSHA Component	Avg. MSHA Score	Maximum Poss. Score
Land Use	0	5
Riparian	8	14
Substrate	3.5	28
Cover	12.5	18
Channel Morphology	11.5	35
Total MSHA Score	35.5 = Poor	100

The overall habitat of Unnamed Creek was rated as poor; however, two of the lower scoring categories are particularly important for aquatic life, substrate and channel morphology. Substrate is an important component of overall stream habitat, as sensitive fish and macroinvertebrates require clean coarse substrate, while silt and muck were the only substrates that were found.

Channel morphology was another low scoring component of the MSHA evaluation. The MSHA indicated that there was no channel depth variability, no sinuosity, and poor channel development (no riffles and small pools). Fish and macroinvertebrates need channel depth variability to use as cover for prey and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the creek throughout the summer, especially during high flow events which can flush these communities downstream. The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity, pools, and riffles. Lack of habitat is a stressor to the aquatic life in Unnamed Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek and the entire subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been straightened along the entire length of the AUID.

In 2019, a water level logger was placed in Unnamed Creek to monitor the water level throughout the summer. These water level data indicated that there is perennial flow within the channel throughout the summer, and therefore, flow does not appear to be a stressor.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion noted that there was no erosion. Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment and nutrients from the landscape. Altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

Connectivity

There are several crossings on Unnamed Creek, and the connected tributaries that were investigated for potential fish barriers. The culvert crossing by 08UM034 off 380th Street was investigated in 2019, and does not appear to be a fish barrier. However, at the next downstream crossing, off 380th Street, the culvert is perched and is a fish barrier during moderate to low flow conditions (Figure 54).

Figure 54. Perched culvert off 380th Street is a barrier at moderate (left) and low (right) flow.

In addition to this culvert issue, the same field crossings that may be blocking fish passage to AUID -733, are also blocking fish passage to Unnamed Creek. Therefore connectivity is a primary stressor to the aquatic life within Unnamed Creek.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort. The fish sample yielded a total of five species, with Central Mudminnows being the most dominate. Of the five species collected, four species were tolerant and one species was sensitive (Northern Redbelly Dace).

TIV were calculated for Unnamed Creek using the fish communities collected in 2008. The TIV for TSS within Unnamed Creek using the 2008 fish sample, found that the fish community had a 48.8% probability of coming from a stream that was meeting the TSS standard. Of the five fish species collected in 2008, one of the species is sensitive to TSS, and all of the other species are not sensitive or tolerant of TSS. Due to only one species having a sensitivity to TSS, less weight was placed on the TSS TIVs for the

SID process. Due to the lower confidence in the TSS TIVs, TSS response by the fish community is inconclusive at this time. However, the elevated TSS within the grab sample indicates that TSS is a stressor to the fish community within Unnamed Creek, but more data will need to be collected at high and low flows to confirm TSS as a stressor.

DO TIV scores were also calculated for Unnamed Creek using the fish communities. This calculation indicated that the fish community from 2008 had a 6% probability of coming from a stream that was meeting the DO standard. Four of the fish species collected are considered to be very tolerant of low DO, and the only other species is considered to be tolerant of low DO. The dominance of low DO tolerant fish species indicates that DO is a stressor to the fish community within Unnamed Creek.

Nitrogen tolerance within the fish community was also investigated for Unnamed Creek. The fish community collected in 2008 had one species that was sensitive to elevated nitrogen, and two species that were tolerant to elevated nitrogen. No nitrogen intolerant fish species were collected in 2008. The prevalence of nitrogen tolerant fish species indicates that elevated nitrogen may be affecting the fish community within Unnamed Creek. However, the overall impact of elevated nitrogen, as noted in the 2019 samples, has the greatest effect on the aquatic life of Unnamed Creek through eutrophication.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Four fish species collected in the 2008 sample were considered to be tolerant of elevated phosphorus, and two of those species were very tolerant. None of the five total species collected were intolerant of elevated phosphorus. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species indicates that phosphorus is a stressor to the fish community in Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 part of the cycle I watershed monitoring effort. 82.4% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 52.9% of the community was considered to be very tolerant of pollutants. *Oligochaeta* worms, which are considered to be tolerant, dominated the sample.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2008 sample, no intolerant taxa, 10 tolerant taxa, and five very tolerant taxa were collected (Table 25). Therefore, the macroinvertebrate community response to TSS, combined with the elevated TSS within the grab sample indicates that TSS is a stressor to the macroinvertebrate community within Unnamed Creek. However, due to the dataset limited to one sample, more data will need to be collected at high and low flows to confirm TSS as a stressor.

DO tolerance was also investigated using the macroinvertebrate communities. No intolerant taxa, 19 tolerant taxa, and 11 very tolerant taxa were found within the 2008 sample (Table 25). Due to the dominance of low DO tolerant and very tolerant taxa, low DO does appear to be a stressor to the macroinvertebrate community within Unnamed Creek.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. In the 2008 sample, 2 intolerant, 14 tolerant, and 9 very tolerant taxa were collected in Unnamed Creek (Table 25). The overall macroinvertebrate community is indicating some nitrogen intolerance with the presence of multiple tolerant and very tolerant taxa. However, intolerant taxa are also present, suggesting that elevated nitrogen is not a primary stressor within Unnamed Creek, but could be contributing to eutrophication.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, 20 tolerant taxa and 14 very tolerant taxa were collected (Table 25). These tolerance indicators within the macroinvertebrate community indicate that phosphorus is a stressor to the macroinvertebrate community with no intolerant taxa collected.

Table 25. Macroinvertebrate tolerance indicators in Unnamed Creek.

Sample Year	Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	0	10	5
2008	DO	0	19	11
2008	Nitrogen	2	14	9
2008	Phosphorus	0	20	14

Composite conclusion from biology

The fish and macroinvertebrates in Unnamed Creek are indicating that low DO and elevated TSS are stressors to the aquatic life within Unnamed Creek. However, due to the limited datasets, more data would need to be collected to confirm that DO and TSS are stressors.

Excessive nutrients are stressors to the biology within Unnamed Creek. Phosphorus values were elevated within the dataset, and the resulting biological response can be seen within the fish and macroinvertebrate TIV scores. Similarly, inorganic nitrogen levels were elevated in some of the samples within the dataset, and multiple tolerant fish species and macroinvertebrate taxa were collected. These elevated nutrient levels, combined with the excessive algal and macrophyte growth, indicates that eutrophication is occurring within Unnamed Creek.

Recommendations

Replace the culvert off 380th Street with an AOP culvert to allow for fish passage.

Careful consideration to runoff from local fields would be advantageous for Unnamed Creek. Elevated nutrient levels are causing eutrophic conditions, and if mitigated, could make an impact to the creek. However, due to the limited TP and DO datasets, more DO data would need to be collected to confirm that eutrophication is occurring. Similarly, TSS appears to be a stressor, as seen by the TSS value that was 11x the standard. However, more TSS data would need to be collected during low and high flows to confirm that TSS is truly stressing the biological communities within Unnamed Creek. If Unnamed Creek is a priority to local water planning, the MPCA SID staff would be available to collect the additional data needed to make a final determination.

Adley Creek Subwatershed

The Adley Creek Subwatershed covers 15,000 acres, eventually draining into the Sauk River 1.8 miles east of Melrose (Figure 55). 73% of the streams in the subwatershed have been channelized.

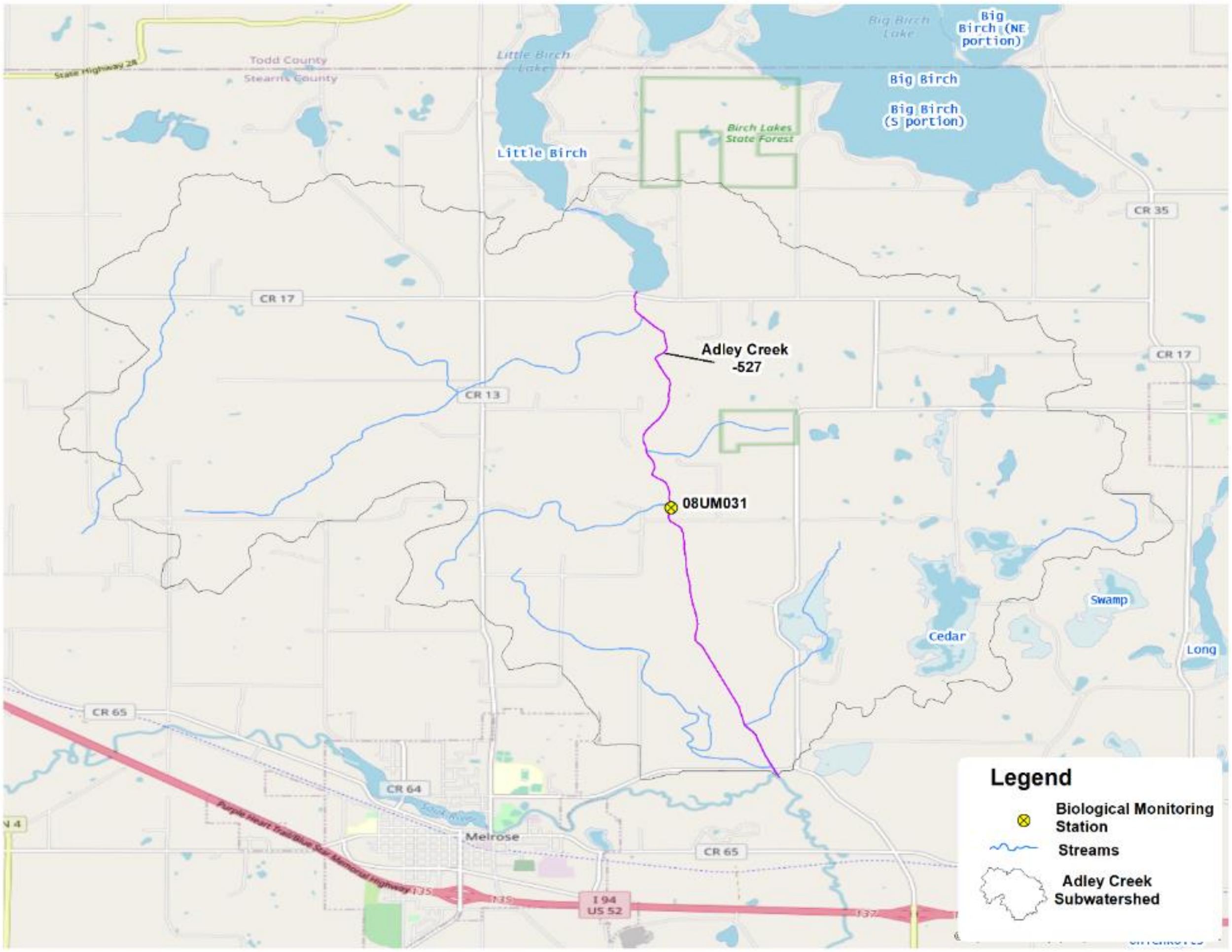


Figure 55. Biological monitoring station in the Adley Creek Subwatershed.

The land use within the Adley Creek Subwatershed is dominated by cropland (61.3%), followed by rangeland (12.9%) and wetlands (10.6%) (Figure 56).

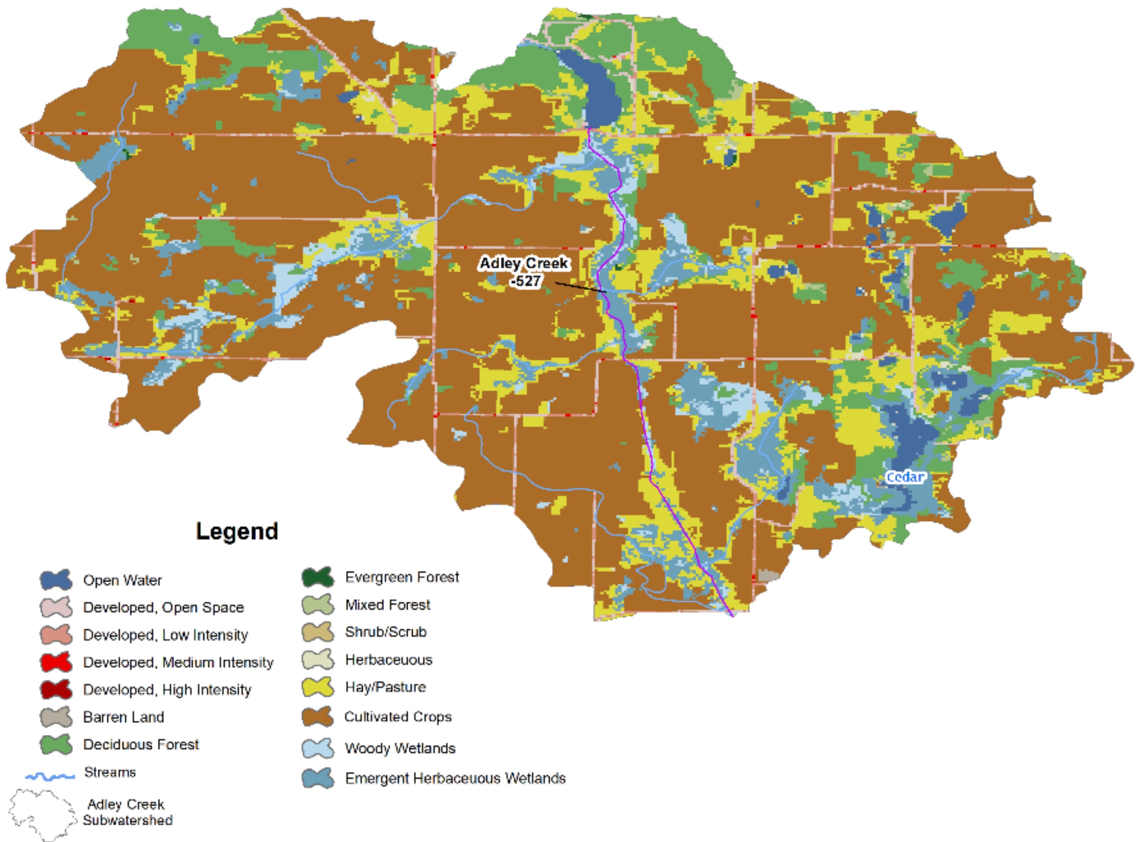


Figure 56. Land use in the Adley Creek Subwatershed.

Adley Creek (07010202-527)

Impairment: Adley Creek (AUID -527) flows for 4.8 miles starting at the outlet of Sylvia Lake and ends at the confluence with the Sauk River, 1.8 miles east of Melrose (Figure 55). Adley Creek has been channelized throughout the entire 4.8 mile stretch. There is one biological monitoring station (08UM031) on AUID -527 that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Adley Creek should be assessed under the general use criteria, due to fair habitat. This assessment resulted in a new impairment for fish. The fish stream class is class 5 (Northern Streams) and the macroinvertebrate stream class is class 6 (Southern Forest Streams Glide/ Pool). Adley Creek was resampled in 2018 for fish and macroinvertebrates. These data confirmed the original assessment, with fish still failing to meet standards, and the macroinvertebrates meeting standards. In addition to the fish impairment, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

Water chemistry data has been collected at S008-429 from 2015-2020 (08UM031) and at the outlet of the watershed (S000-369) from 2005-2014 (Table 26).

Table 26. Water chemistry data collected at S008-429 (08UM031) and at the outlet of the subwatershed (S000-369). Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S008-429 https://webapp.pca.state.mn.us/surface-water/station/S000-369.

S008-429						
Parameter	**Sample Count**	**# of Samples Above the Respective Threshold**	**Applicable Standard**	**Average**	**Minimum**	**Maximum**
TP	75	2	0.100 mg/L	0.05 mg/L	0.02 mg/L	0.24 mg/L
DO	69	15	5.0 mg/L	7.69 mg/L	2.29 mg/L	17.49 mg/L
Inorganic nitrogen	75	N/A	N/A	0.54 mg/L	0.08 mg/L	1.4 mg/L
TSS	75	0	30.0 mg/L	2.77 mg/L	1.0 mg/L	16.0 mg/L
Water Temp	69	N/A	N/A	18.39° C	2.22° C	25.57° C
Sp. Conductivity	69	N/A	N/A	462.15 µS	347.6 µS	730.6 µS
S000-369						
Parameter	**Sample Count**	**# of Samples Above the Respective Threshold**	**Applicable Standard**	**Average**	**Minimum**	**Maximum**
TP	123	26	0.100 mg/L	0.10 mg/L	0.01 mg/L	0.69 mg/L
DO	120	4	5.0 mg/L	9.11 mg/L	0.7 mg/L	14.29 mg/L
Inorganic nitrogen	23	N/A	N/A	0.83 mg/L	0.03 mg/L	2.56 mg/L
Ammonia	80	N/A	N/A	0.176 mg/L	0.02 mg/L	1.45 mg/L
TSS	122	8	30.0 mg/L	10.08 mg/L	1.0 mg/L	70.0 mg/L
Water Temp	114	N/A	N/A	17.4° C	0.11° C	28.56° C
Sp. Conductivity	31	N/A	N/A	438.35 µS	311 µS	493 µS

Nutrients – Phosphorus

Phosphorus values from the large dataset collected on Adley Creek (Table 26) shows that the average TP at the biological monitoring site, is low at 0.05 mg/L, with only two samples over the Central Region River Nutrient standard (0.100 mg/L). However, the phosphorus values at the outlet station, were elevated with an average value of 0.096 mg/L. 21.1% of the TP values collected across the dataset in the outlet station were all above the standard, with a maximum value of 0.69 mg/L. These data suggest that there is a potential for eutrophication to occur.

Nutrients – Ammonia and Inorganic nitrogen

Ammonia data were collected from 2005-2013 at S000-369 (Table 26). Throughout the large dataset, ammonia values are low within Adley Creek. However, there are elevated values during snowmelt (March). These high values have the potential to be a stressor to aquatic life, as these springtime elevated values effect the macroinvertebrate community, which utilize the stream year round.

Inorganic nitrogen data were also collected within both chemistry stations (Table 26). Throughout these datasets, inorganic nitrogen levels were low, with maximum values of 1.4 mg/L and 2.56 mg/L. Therefore, inorganic nitrogen does not appear to be a contributing factor to the aquatic life stressors within Adley Creek.

Dissolved Oxygen

DO data was collected from Adley Creek from 2005-2014 at S000-369 and from 2015-2020 at S008-429. These data show that the DO levels within Adley Creek drop well below the 5 mg/L standard from June through August during each year that was sampled, reaching a low of 2.29 mg/L and 0.70 mg/L (Table 26). These data led to the new low DO impairment for Adley Creek that will be listed within the 2022 impaired waters list. Therefore, these DO levels have indicated that low DO is a stressor to the aquatic life within Adley Creek.

Total suspended solids

TSS data were collected from 2005-2014 at S000-369 and from 2015-2020 at S008-429 (Table 26). TSS values were almost entirely below the threshold, with the exception of eight samples collected within the outlet station. Some of these higher samples could be linked to snowmelt. TSS does not appear to be a stressor to the aquatic life in Adley Creek.

Conductivity

Specific conductivity was within range throughout the sampling at both chemistry stations (Table 26). Therefore, specific conductivity does not appear to be a stressor to aquatic life within Adley Creek.

Temperature

Temperature data collected during grab samples (Table 26), showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Adley Creek, through MSHA evaluations during the biological monitoring samples (Table 27). Due to the historic channelization of Adley Creek, and fair MSHA score, the assessment of Adley Creek was brought into the UAA process. It was determined that the habitat of Adley Creek has been degraded due to the historic channelization; however, the habitat has not degraded to a point where it cannot support good quality habitat for aquatic life. Therefore, Adley Creek was assessed using the General Use TALU criteria. Due to the higher scoring categories within the MSHA score, habitat is not considered to be a stressor.

Table 27. Average MSHA score collected in Adley Creek.

MSHA Component	Avg. MSHA Score	Maximum Poss. Score
Land Use	0.8	5
Riparian	10.3	14
Substrate	15.3	28
Cover	13.7	18
Channel Morphology	16.3	35
Total MSHA Score	56.4 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have altered the natural hydrology and geomorphology of Adley Creek. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Adley Creek has been straightened along the entire length of the AUID.

Due to the channelization of Adley Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluations noted that there was little to no erosion, mostly due to the wetland nature of the stream banks. Reviewing historical aerial photography shows that the pre-settlement channel was sinuous, suggesting that the hydrology has been changed after the landscape shift to agriculture and the resulting channel enhancements related to that practice (drainage). Overall, the current channel size is most likely similar to the current channel size; however, the channel has been over widened throughout the AUID due to cattle access (Figure 57). A Rosgen level 1 survey was completed at the biological monitoring station on Adley Creek, and noted that the stream width was 42.9 feet wide. The stream width doubled in size on the downstream end of the CR 169 culvert to 87.7 feet wide. This over widening of the channel is the result of the culvert altering the stream slope, and scouring the sediment on the downstream side of CR 169. The cattle trampling has exacerbated the issue, by removing the riparian vegetation and further widening the channel.

Figure 57. Channel over widening in Adley Creek due to cattle trampling.

These portions of the AUID that are over widened due to cattle access, have caused a reduction in habitat quality. Substrate at the biological monitoring station was dominated by sand and gravel; however, the gravel is completely embedded under sand and silt due to cattle trampling just downstream of the monitoring station. In addition to the loss of substrate quality, excess sediment has washed into the creek during precipitation events through the raw stream banks created from the cattle access points. These small portions of cattle access may explain the increase in TSS at the subwatershed outlet chemistry station. Therefore, altered hydrology through channelization and habitat loss by cattle access are considered to be the primary stressors to the aquatic life within Adley Creek.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Adley Creek. The culvert crossing by 08UM031 off CR 169 does not appear to be a fish barrier. Almost all of the culverts from 08UM031 to the end of the AUID appear to be undersized when viewing aerial photography. Therefore, connectivity is considered to be a secondary stressor.

Stressor signals from biology

Fish

Fish were initially sampled in 2008 as part of the cycle I watershed monitoring effort and then sampled again in 2018 for the second cycle of monitoring. The fish sample from 2008 yielded a total of 28 species, with White Suckers being the most dominate. Ninety-two percent of the fish species that were collected are considered to be tolerant of pollutants. Similarly, the 2018 fish sample contained seventeen species, and was also dominated by White Suckers. Ninety-four percent of the fish species within the 2018 sample are considered to be tolerant to pollutants.

TIV were calculated for Adley Creek using the fish communities collected in 2008 and 2018. The TIV for TSS within Adley Creek using the 2008 fish sample, found that the fish community had a 58.8% probability of coming from a stream that was meeting the TSS standard. Of the 28 fish species collected in 2008, 1 species was considered intolerant to elevated TSS, 2 species were sensitive to elevated TSS, and 3 species were tolerant of elevated TSS. As for the 2018 fish sample, the TSS TIV indicated that the fish community had a 54% probability of meeting the TSS standard. One species was considered to be sensitive to elevated TSS, and one species was considered to be tolerant to elevated TSS. Altogether, the fish community is indicating a mild sensitivity to TSS within Adley Creek. Therefore fish community response combined with the low TSS values in the grab sampling, TSS is not considered a stressor to the fish community in Adley Creek at this time.

DO TIV scores were also calculated for Adley Creek using the fish communities. This calculation indicated that the fish community from 2008 had a 63.1% probability of coming from a stream that was meeting the DO standard. However, 12 of the fish species collected are considered to be tolerant of low DO, and five species are considered very tolerant of low DO. This score dropped further with the 2018 fish community with a 42.4% probability. Ten of the fish species collected in 2018 were considered to be tolerant of low DO, and eight species were considered to be very tolerant of low DO. The combined fish samples indicate that DO is a stressor to the fish community within Adley Creek.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. One of the fish species collected in the 2008 sample was considered to be intolerant of elevated phosphorus, three species were sensitive, eight species were tolerant, and four species were very tolerant. Similarly, one of the species collected in the 2018 sample was intolerant of elevated phosphorus, one was sensitive, five were tolerant, and three were very tolerant. The prevalence of elevated phosphorus tolerant and intolerant species, indicates that phosphorus is not a primary stressor to the fish community in Adley Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 and 2018 as part of the watershed monitoring efforts. 60.7% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 17.8% of the community was considered to be very tolerant of pollutants. Similarly, the 2018 macroinvertebrate community was comprised of 68.4% tolerant taxa and 31.6% very tolerant taxa. The tolerant taxa *Simulium* dominated both samples, but the overall IBI scores were above the threshold, indicating that the macroinvertebrates are meeting standards within Adley Creek.

Although the macroinvertebrates are meeting standards at this time, chemical tolerance within the macroinvertebrate community was used to help identify stressors to the fish community. The first tolerance value that was utilized was TSS taxa tolerance. In the 2008 sample, two very intolerant, three intolerant taxa, four tolerant taxa, and zero very tolerant taxa were collected (Table 28). As for the 2018 sample, one very intolerant, five intolerant taxa, eight tolerant taxa, and three very tolerant taxa were collected (Table 28). Overall the macroinvertebrate community within Adley Creek indicates that TSS is not a primary stressor, as multiple very intolerant taxa were collected.

DO tolerance was also investigated using the macroinvertebrate communities. Two taxa that were considered to be very intolerant to low DO, two intolerant taxa, eight tolerant taxa, and two very tolerant taxa were found within the 2008 sample (Table 28). These numbers dropped considerably with the 2018 sample, as noted by the loss of very intolerant and intolerant taxa, and with the dominance of tolerant and very tolerant taxa. Low DO does appear to be affecting the macroinvertebrate community, although not indicating an impairment for the macroinvertebrates at this time. However, the community is showing a downward trend, and may become impaired in the near future. This is also further indication that low DO is a stressor to the fish community.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, two taxa that were considered to be very intolerant to elevated phosphorus, four intolerant, seven tolerant, and three very tolerant taxa were collected (Table 28). As for the 2018 sample, one very intolerant taxa, four intolerant taxa, eight tolerant taxa, and three very tolerant taxa were collected. These tolerance indicators within the macroinvertebrate community suggest that phosphorus is not a stressor to the aquatic life within Adley Creek, with several very intolerant taxa collected.

Table 28. Macroinvertebrate tolerance indicators in Adley Creek.

Sample Year	Parameter	# Very Intolerant	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	2	3	4	0
2018	TSS	1	5	8	3
2008	DO	2	2	8	2
2018	DO	0	0	11	3
2008	Nitrogen	3	7	8	4
2018	Nitrogen	2	6	16	12
2008	Phosphorus	2	4	7	3
2018	Phosphorus	1	4	8	3

Composite conclusion from biology

The fish and macroinvertebrates in Adley Creek are indicating that low DO is a primary stressor to aquatic life.

TSS, phosphorus, and inorganic nitrogen do not appear to be primary stressors to the aquatic life within Adley Creek at this time.

Conclusions about stressors

One of the primary stressors to the biology within Adley Creek is the lack of a stable and healthy DO regime. Poor DO within Adley Creek is the result of multiple contributing factors, including channel modification and excessive nutrient levels. Wetlands can naturally contain water that is low in DO due to the decomposition of organic matter, which consumes oxygen. Historically, Adley Creek was a sinuous stream that naturally flowed through a wetland; however, due to the channelization, the channel was dug deeper, causing the wetland riparian to drain oxygen deprived water into the creek. The DO regime within Adley Creek is further impacted by excess nutrients from cattle that have access to the creek. These nutrients cause excessive macrophyte and algal growth that completely covers the entire stream channel (Figure 58). During the daylight hours these plants photosynthesize and produce oxygen, in excess of 17 mg/L, and then consume that same DO after sundown, causing large fluctuations in the DO regime. This unstable DO has allowed fish species like the White Sucker to thrive within Adley Creek. Similarly, although the macroinvertebrate community is not impaired at this time, there are signals of stress with *Simulium* taxa dominating the macroinvertebrate samples.


Figure 58. Macrophyte growth within Adley Creek.

Habitat loss from the historic channelization and cattle trampling is another stressor to the biology in Adley Creek. Portions of Adley Creek are over widened due to cattle access, causing a reduction in habitat quality. Substrate at the biological monitoring station was dominated by sand and gravel; however, the gravel is completely embedded under sand and silt due to cattle trampling just downstream of the monitoring station. In addition to the loss of substrate quality, excess sediment has washed into the creek during precipitation events through the raw stream banks created from the cattle access points. These small portions of cattle access may explain the increase in TSS at the subwatershed outlet chemistry station.

Recommendations

Fencing off the creek from cattle access would be advantageous to the overall health of Adley Creek. This would allow the riparian vegetation to regrow, in compliance with the buffer law, limiting the amount of sediment that is washed downstream during precipitation events. Removing the cattle from the stream would also aid in preventing the excess nutrients that are fueling macrophyte growth, leading to unstable DO conditions. Finally, Adley Creek also has an *E. coli* impairment, and removing the cattle from the stream would help to reduce the *E. coli* levels within the creek.

The culvert crossing near the biological monitoring station is reducing the stream slope, and has caused scouring on the downstream side of the crossing. Future replacement of this culvert and the other field crossing culverts along Adley Creek would be advantageous.

Stearns County Ditch 44 Subwatershed

The Stearns County Ditch Subwatershed covers 17,600 acres eventually draining into the Sauk River 5.8 miles southeast of Melrose (Figure 59). 84% of the streams within the subwatershed have been channelized.

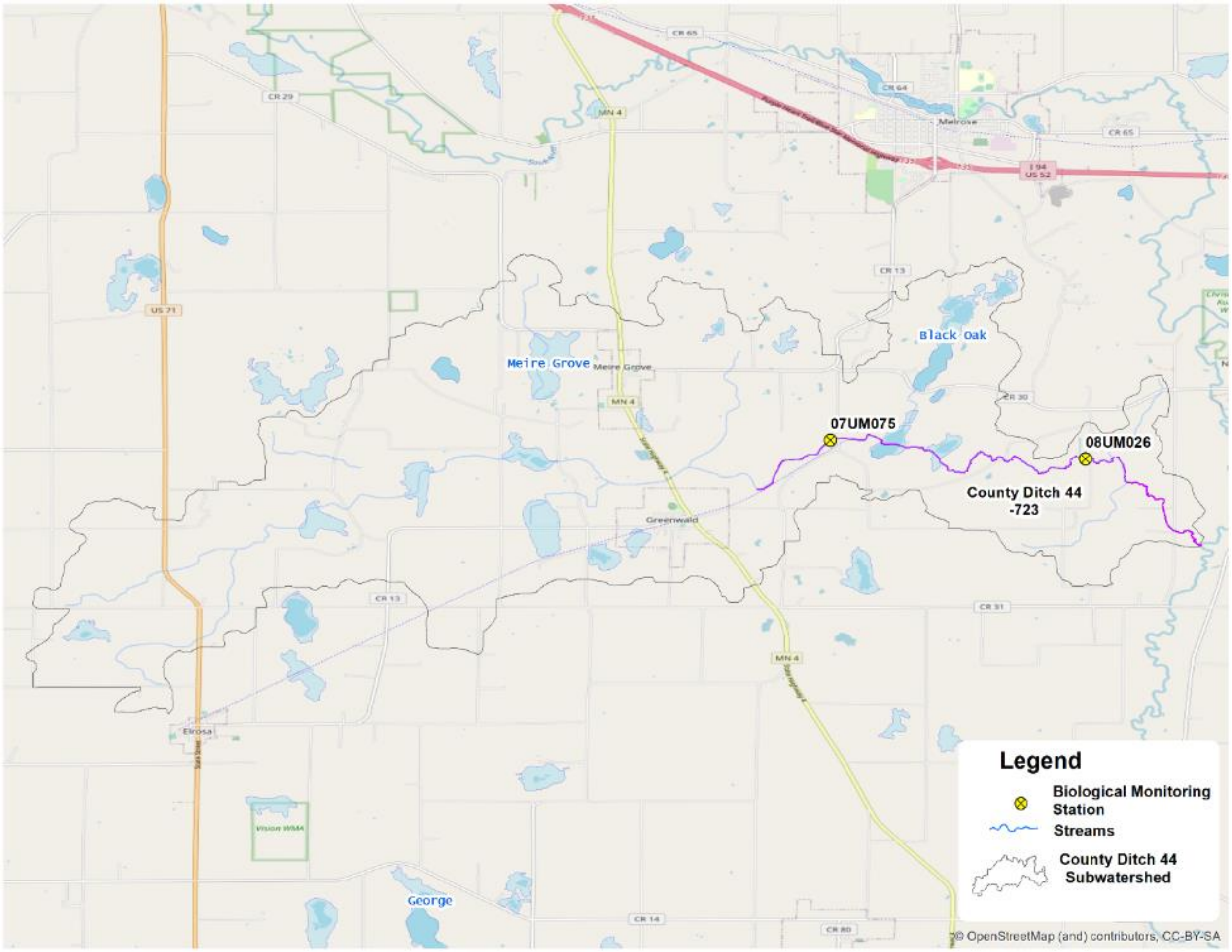


Figure 59. Biological monitoring stations in the Stearns County Ditch 44 Subwatershed.

The land use within the Stearns County Ditch 44 Subwatershed is dominated by cropland (77%), followed by rangeland (7%) and wetlands (6.3%) (Figure 60).

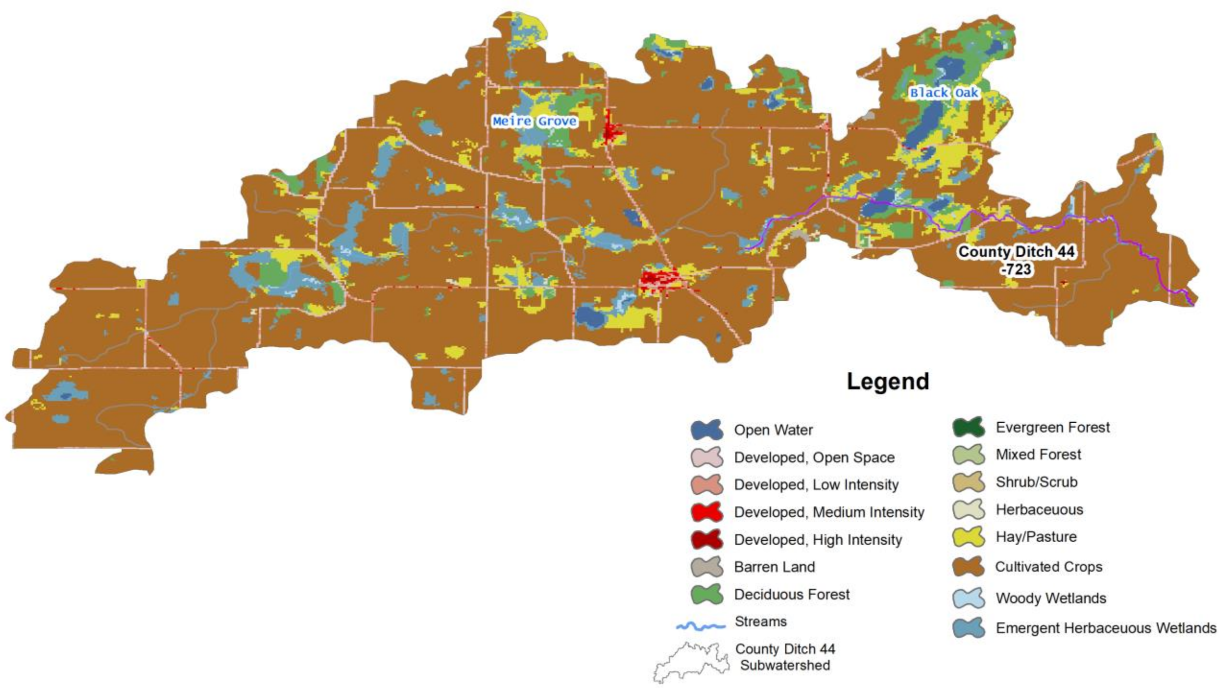


Figure 60. Land use in the Stearns County Ditch 44 Subwatershed.

Stearns County Ditch 44 (07010202-723)

Impairment: Stearns County Ditch 44 (AUID -723) flows for 6.7 miles starting from the confluence with Unnamed Creek just downstream of Hwy 4 in Greenwald, to the Sauk River 5.5 miles southeast of Melrose. County Ditch 44 has been channelized throughout the entire reach. There are two biological monitoring stations (07UM075, 08UM026) that have been sampled on County Ditch 44. Station 07UM075 was sampled in 2007 and 2018, while 08UM026 was sampled in 2008. Assessments for County Ditch 44 were initially completed in early 2018 as part of the TALU assessment process for assessing channelized stream, and then repeated in 2020. The UAA process determined that County Ditch 44 should be assessed under the general use criteria, due to fair habitat. These assessments resulted in new impairments for fish and macroinvertebrates. The fish stream class 5 (Northern Streams) and the macroinvertebrate stream class is class 6 (Southern Forest Streams Glide/ Pool).

Data and Analyses

Chemistry

Water chemistry data has been collected at S000-703, located at the outlet of the subwatershed (Table 29).

Table 29. Water chemistry data collected at S000-703. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S000-703.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	4	3	0.100 mg/L	0.12 mg/L	0.07 mg/L	0.15 mg/L
DO	18	0	5.0 mg/L	8.56 mg/L	6.8 mg/L	11.04 mg/L
Inorganic nitrogen	4	N/A	N/A	2.23 mg/L	1.4 mg/L	3.7 mg/L
TSS	3	0	30.0 mg/L	5.7 mg/L	3.6 mg/L	7.2 mg/L
Water Temp	18	N/A	N/A	18.5° C	11.57° C	25.24° C
Sp. Conductivity	17	N/A	N/A	667 µS	598 µS	764 µS

Nutrients – Phosphorus

Phosphorus values from the dataset collected on County Ditch 44 (Table 29) shows that the average TP is just above the Central Region River Nutrient standard (0.100 mg/L), with a value of 0.120 mg/L. 75% of the TP values collected across the dataset were all above the standard, with a maximum value of 0.150 mg/L. These data suggest that there is a potential for eutrophication to occur.

Nutrients – Nitrate and Nitrite

Inorganic nitrogen data were collected within County Ditch 44 in 2019 (Table 29). Throughout the limited dataset, inorganic nitrogen levels were relatively low, with maximum value of 3.7 mg/L. Therefore, inorganic nitrogen does not appear to be a contributing factor to the aquatic life stressors within County Ditch 44.

Dissolved Oxygen

DO data was collected from County Ditch 44 throughout the summer of 2019 during instantaneous readings and the continuous sonde deployments. The sondes were deployed at 07UM075 and at the outlet of the subwatershed. These data show that the DO levels within County Ditch 44 are all above the 5 mg/L standard from June through August (Table 29; Figure 61; Figure 62). Therefore, low DO does not appear to be a primary stressor to the aquatic life within County Ditch 44.

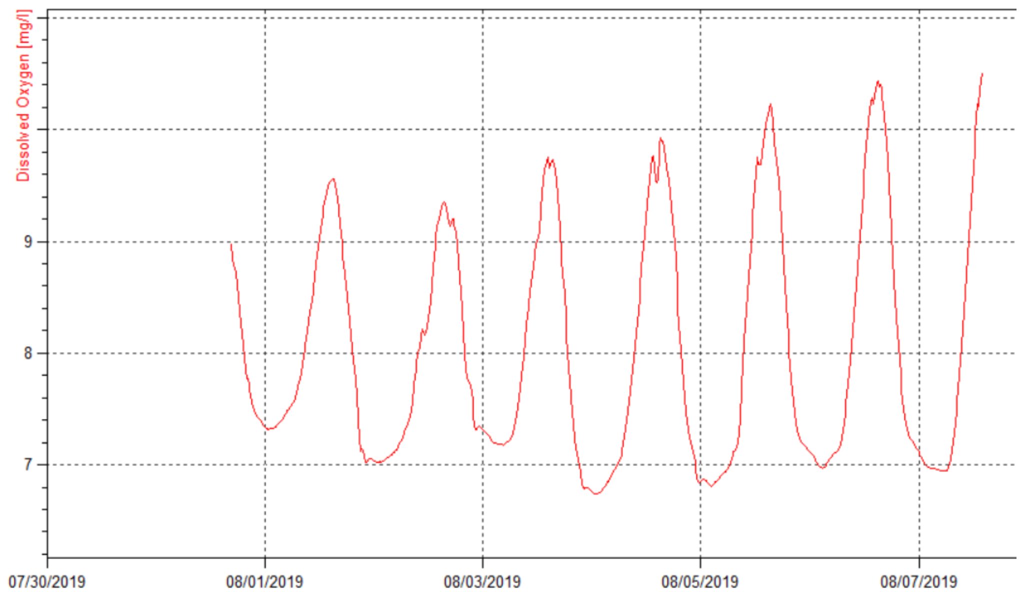


Figure 61. Continuous DO data collected at 07UM075 in 2019.

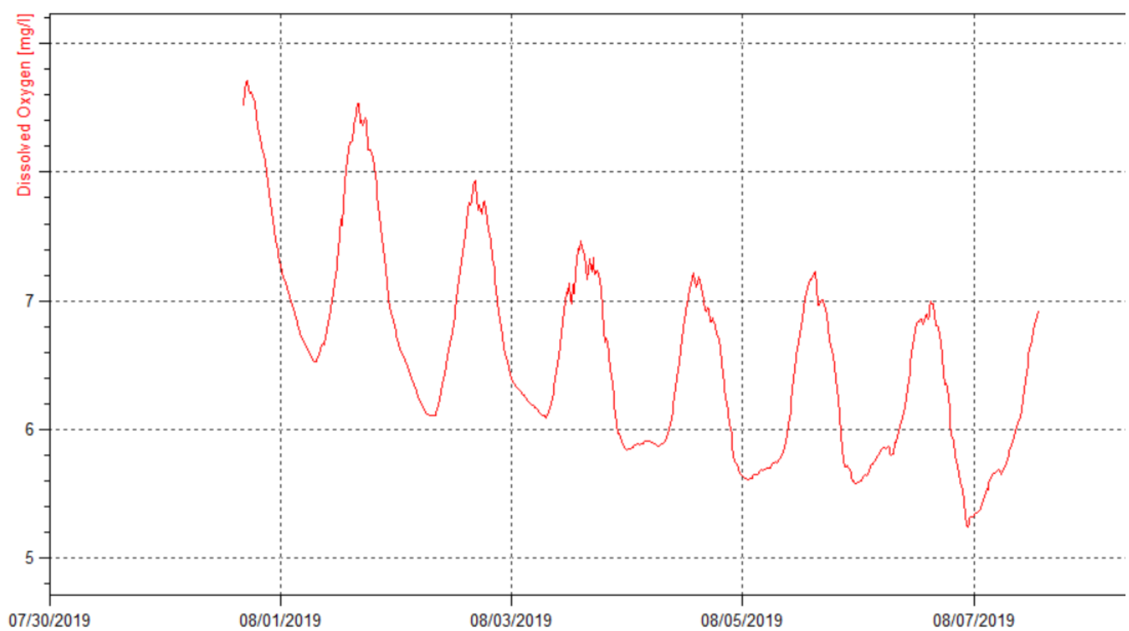


Figure 62. Continuous DO data collected at the outlet of the Stearns County Ditch 44 Subwatershed outlet.

Total suspended solids

Three TSS samples were collected from County Ditch 44 in the summer of 2019. All three samples were below the standard of 30 mg/L (Table 29). These data are limited, but do not indicate that elevated TSS is a stressor to the aquatic life within County Ditch 44.

Conductivity

Specific conductivity was within range during the 2019 sampling (Table 29) and the sonde deployment. Therefore, specific conductivity does not appear to be a stressor to aquatic life within County Ditch 44.

Temperature

Temperature data collected during grab samples (Table 29), and the 2019 sonde deployments, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on County Ditch 44, through MSHA evaluations during the biological monitoring samples (Table 30). Due to the historic channelization of County Ditch 44, and fair MSHA score, the assessment of County Ditch 44 was brought into the UAA process. It was determined that the habitat of the ditch has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Due to the fair habitat, County Ditch 44 was assessed using the General Use TALU criteria. Therefore, with the General Use designation and several good attributes noted within the MSHA scores, habitat does not appear to be a stressor to the aquatic life within County Ditch 44.

Table 30. MSHA scores collected on Stearns County Ditch 44.

MSHA Component	07UM075 Avg. MSHA Score	08UM026	Maximum Poss. Score
Land Use	0	1.5	5
Riparian	11	12	14
Substrate	19.4	15.1	28
Cover	12.7	14	18
Channel Morphology	20.3	18	35
Total MSHA Score	63.4 = Fair	60.6 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of County Ditch 44. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. County Ditch 44 has been straightened in the headwaters to just downstream of Elrings Lake. The remaining portions of County Ditch 44 from Elrings Lake to the confluence with the Sauk River, is a mixture of channelized and natural stream sections.

Due to the channelization of County Ditch 44, the ditch does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion ranged from none to light (5% to 25%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage).

In 2020, a Rosgen level 1 survey was completed on County Ditch 44. This survey identified that bedded sediments were a stressor within the ditch, as the sand bottom ranged between 1 to 1.5 feet deep. Additionally, the sand substrate appeared mobile as dunes were identified throughout the reach. Mobile sediment is not conductive to macroinvertebrates that this in the stream substrate. In addition to the mobile sand sediments, several beaver dams were also identified close to 08UM026 (Figure 63).

Figure 63. Beaver activity, located just downstream of 08UM026.

Altered hydrology is a primary stressor to the aquatic life in County Ditch 44, due to the bedded sediment and beaver activity.

Connectivity

There is one road crossing close to the biological monitoring stations and several road crossings further downstream on County Ditch 44. The culvert crossing by 07UM075 off Overton Road and the culvert crossing by 08UM026 off Overdale Road do not appear to be fish barriers. It is possible that the other road crossings may be fish barriers, but reviewing aerial photography, it appears as though the culverts are properly placed to allow for fish passage. Although the crossings do not appear to be fish barriers, beaver activity is prevalent throughout County Ditch 44, and is considered to be a barrier. Therefore, connectivity is a primary stressor to the aquatic life within County Ditch 44.

Stressor signals from biology

Fish

Fish were initially sampled in 2007 at 07UM075 and in 2008 at 08UM026 as part of the cycle I watershed monitoring effort. In 2018, 07UM075 was resampled for the second cycle of monitoring. The fish sample from 2007 yielded a total of 13 species, with Central Mudminnows and White Suckers being the most dominate. Similarly, the 2008 sample contained a total of 10 species, and was also dominated by White Suckers. In 2018, the fish sample contained eight species, and was dominated again by Central Mudminnows and White Suckers. All of these fish species collected within the samples on County Ditch 44 are considered to be tolerant of pollutants.

TIV were calculated for County Ditch 44 using the fish communities collected in 2007, 2008 and 2018. The TIV for TSS within County Ditch 44 using the fish samples, found that the fish communities had a 76.5% (2007), 66.9% (2008), and 73.2% (2018) probability of coming from a stream that was meeting the TSS standard. Out of all of the fish species collected in the three samples, none of the species were considered to be sensitive or tolerant of TSS. Therefore, the TSS TIVs were not able to be used for the SID process within County Ditch 44. Due to the lower confidence in the TSS TIVs and the low TSS values collected, TSS is not considered to be a stressor in County Ditch 44.

DO TIV scores were also calculated for County Ditch 44 using the fish communities. These calculations indicated that the fish communities had a 44.7%, 39.5%, and 7.8% probability of coming from a stream that was meeting the DO standard. On average, 5.3 fish species were tolerant of low DO and 4.3 fish species were very tolerant of low DO. No fish that are intolerant or sensitive to low DO were found within any of the samples. The dominance of low DO tolerant fish species indicates that DO is a stressor to the fish community within County Ditch 44. However, the DO data collected during the grab samples and the two sonde deployments indicates that the DO levels are healthy in County Ditch 44. Therefore, the lack of sensitive fishes within the sample is most likely due to the fish barriers.

Phosphorus tolerance of the fish community was also investigated in County Ditch 44 using the fish species characteristics. On average, 4.3 fish species were tolerant of elevated phosphorus and 2 fish species were very tolerant of elevated phosphorus. No fish that are intolerant or sensitive to elevated phosphorus were found within any of the samples. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species indicates that phosphorus may be a stressor to the fish community in County Ditch 44.

Macroinvertebrates

Macroinvertebrates were also sampled in 2007 at 07UM075 and in 2008 at 08UM026 as part of the cycle I watershed monitoring effort. In 2018, 07UM075 was resampled for the second cycle of monitoring. 76.7% (2007), 75.8% (2008), and 68.8% (2018) of the macroinvertebrate communities that were sampled were comprised of taxa that are considered to be tolerant of pollutants. Similarly, 46.5% (2007), 45.4% (2008), and 28.1% (2018) of the macroinvertebrate communities were considered to be very tolerant of pollutants. *Hyalella*, which are considered to be tolerant, dominated all three samples.

TSS taxa tolerance was investigated using the macroinvertebrate communities. On average, 0 very intolerant taxa, 1.6 intolerant taxa, 10.3 tolerant taxa, and 5.6 very tolerant taxa were collected within County Ditch 44 (Table 31). Therefore, the macroinvertebrate community within Unnamed Creek indicates that TSS is not a primary stressor, as multiple intolerant taxa were collected.

DO tolerance was also investigated using the macroinvertebrate communities. On average, 2.3 very intolerant taxa, 4 intolerant taxa, 7.7 tolerant taxa, and 3 very tolerant taxa were collected within County Ditch 44 (Table 31). Due to the presence of very intolerant taxa, low DO does not appear to be a stressor to the macroinvertebrate community within County Ditch 44.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. On average, 0 very intolerant taxa, 0.7 intolerant taxa, 11 tolerant taxa, and 5.7 very tolerant taxa were collected within County Ditch 44 (Table 31). These tolerance indicators within the macroinvertebrate community indicate that phosphorus may be a stressor to the macroinvertebrate community with no very intolerant taxa, and only one intolerant taxa collected.

Table 31. Macroinvertebrate tolerance indicators within Stearns County Ditch 44.

Sample Year	Parameter	# Very Intolerant	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2007	TSS	0	2	12	5
2008	TSS	0	0	12	8
2018	TSS	0	3	7	4
2007	DO	2	4	10	5
2008	DO	2	2	10	3
2018	DO	3	6	3	1
2007	Phosphorus	0	0	15	7
2008	Phosphorus	0	0	13	9
2018	Phosphorus	0	2	5	1

Composite conclusion from biology

Elevated phosphorus has the potential to be a stressor to the aquatic life within County Ditch 44, as shown by the dominance of phosphorus tolerant fish species and macroinvertebrate taxa. However, more TP data would be needed to make a final determination.

Connectivity barriers are blocking fish passage and causing unstable flow conditions, which have impacted both the fish and macroinvertebrates.

TSS and DO do not appear to be stressors to the fish and macroinvertebrates.

Recommendations

Beaver management on County Ditch 44 would make the biggest impact to the ditch. The MSHA scores are indicating that good quality habitat is available within the ditch, but the unstable flow and blockages due to the beaver activity have impeded the ability of sensitive fish and macroinvertebrates to inhabit the ditch.

City of New Munich – Sauk River Subwatershed

The city of New Munich – Sauk River Subwatershed covers 30,800 acres, including 13 miles of the Sauk River mainstem from Adley Creek to Getchell Creek (Figure 64). This subwatershed is surrounded by multiple cities, including Melrose, Meire Grove, Greenwald, and New Munich. 69.5% of the streams and rivers in the subwatershed have been channelized.

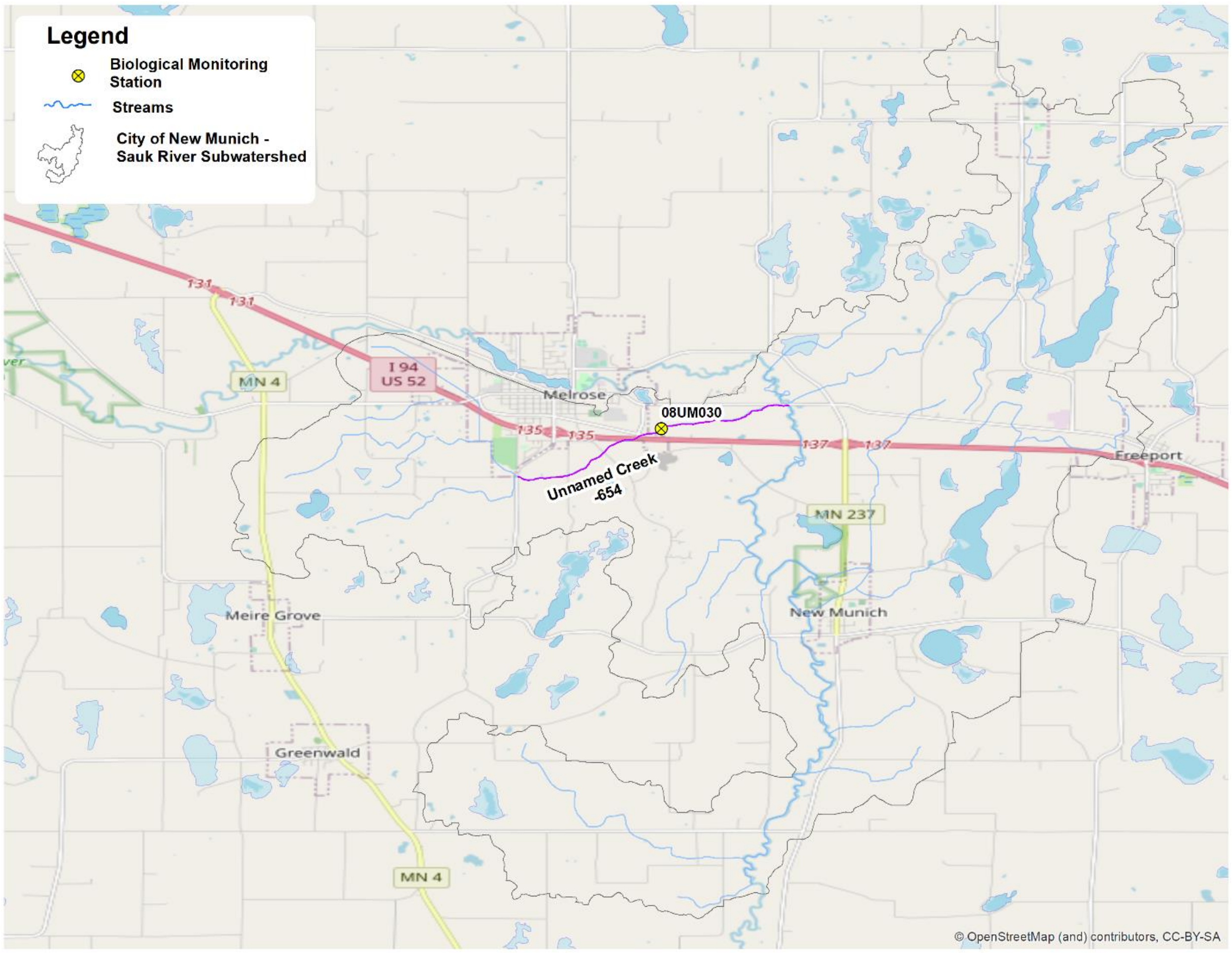


Figure 64. Biological monitoring station in the City of New Munich-Sauk River Subwatershed.

The land use within the City of New Munich – Sauk River Subwatershed is dominated by cropland (64%) followed by rangeland (11.4%) and wetlands (8.2%) (Figure 65).

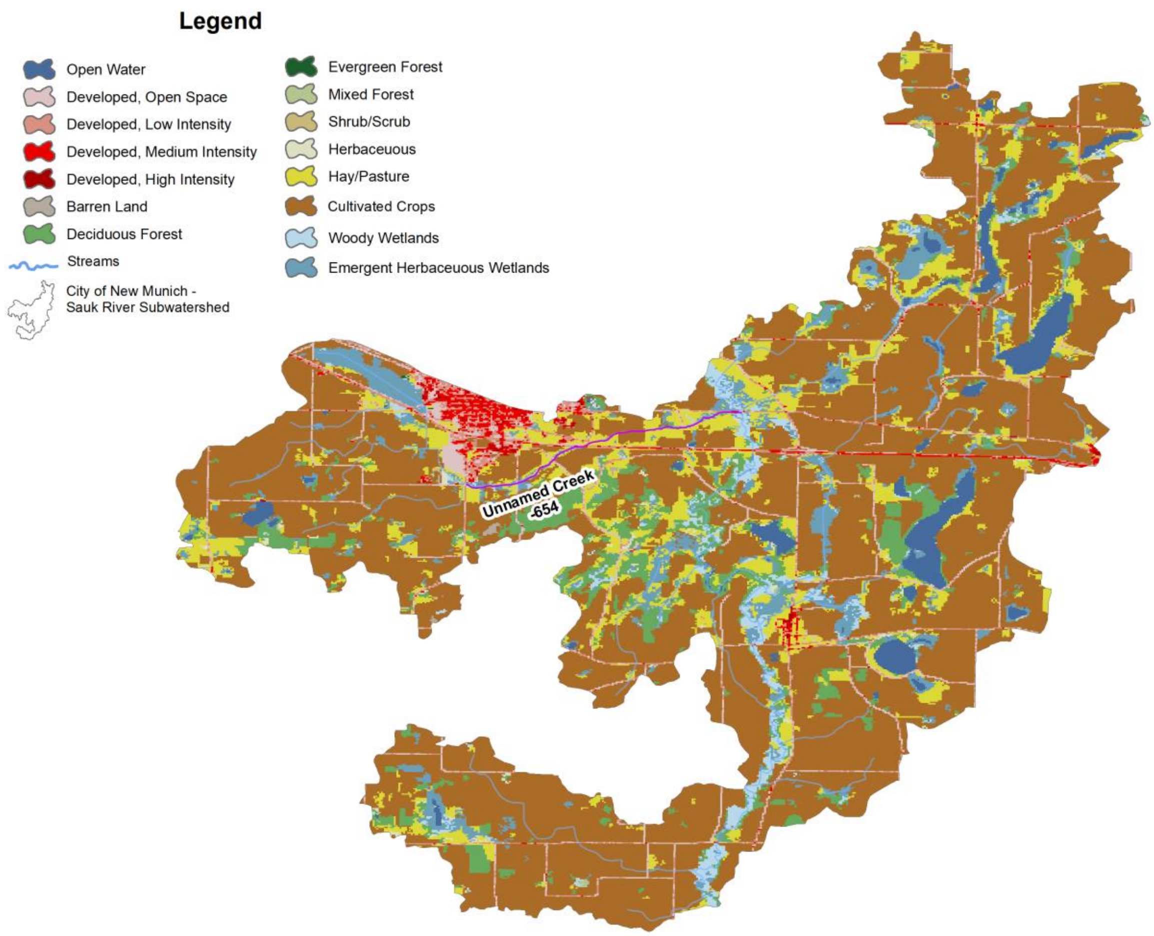


Figure 65. Land use in the City of New Munich-Sauk River Subwatershed.

Unnamed Creek (07010202-654)

Impairment: Unnamed Creek (AUID -654) flows for 3.1 miles from CR 13 to the confluence with the Sauk River, upstream of CR 65 just east of Melrose. Unnamed Creek has been channelized throughout the entire reach (Figure 64). There is one biological monitoring station (08UM030) on Unnamed Creek that was sampled in 2008, and assessed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the general use criteria, due to fair habitat. This assessment resulted in new impairments for fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 7 (Prairie Streams Glide/ Pool).

Data and Analyses

Chemistry

Water chemistry data collected on Unnamed Creek is limited to a continuous sonde deployment from 7/31/2019 to 8/7/2019. DO data were collected throughout the sonde deployment, which indicated that the DO values within Unnamed Creek drop below the 5 mg/L standard (Figure 66), as 21% of the DO values were below the standard. Due to these data, DO appears to be a primary stressor to the aquatic life within Unnamed Creek.

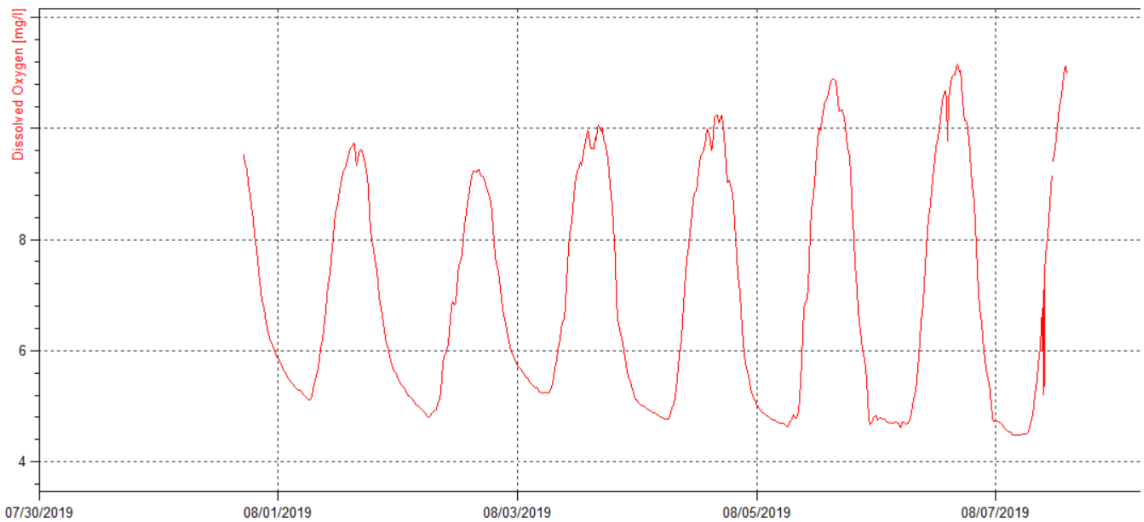


Figure 66. Continuous DO data collected on Unnamed Creek in 2019.

Temperature and conductivity data were also collected during the sonde deployment. No temperature or conductivity values that were collected would be considered problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Unnamed Creek, through an MSHA evaluation during the fish sample in 2008 (Table 32). Due to the historic channelization of Unnamed Creek, and fair MSHA score, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the General Use TALU criteria. Although the overall MSHA score was fair, multiple categories scored well, including channel morphology and substrate. Due to these categories scoring well, the MSHA score indicates that habitat is not a stressor within Unnamed Creek.

Table 32. MSHA score for Unnamed Creek, 2008.

MSHA Component	08UM026	Maximum Poss. Score
Land Use	0	5
Riparian	12	14
Substrate	18.8	28
Cover	6	18
Channel Morphology	28	35
Total MSHA Score	64.8 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been straightened along the entire length of the AUID.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation noted that there was no erosion (<5%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). Altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, but is not considered a primary stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Unnamed Creek. The culvert crossing by 08UM030 off East Kraft Drive does not appear to be a fish barrier. It is possible that the other road and field crossings may be fish barriers. Looking at the small crossings from the biological monitoring station to the Sauk River confluence, there are several culverts that appear to be fish barriers (Figure 67). Therefore, connectivity appears to be a stressor to the fish community; however, it cannot be confirmed unless all crossings are examined.

Figure 67. Potential culvert barriers on Unnamed Creek, credit Google Earth.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort. This sample yielded a total of four species, with Central Mudminnows being the most dominate. All four species are considered to be tolerant of pollutants, with Central Mudminnows being labeled as one of the most tolerant fish species within the State of Minnesota, with the ability to breathe atmospheric oxygen.

Due to the limited chemistry dataset, TIV were calculated for Unnamed Creek, but were only calculated for DO. This calculation indicated that the fish community from 2008 had a 5.9% probability of coming from a stream that was meeting the DO standard. Two of the fish species that were collected, were considered to be tolerant of low DO, and the other two species were considered to be very tolerant of low DO. Therefore, the fish sample indicates that DO is a primary stressor to the fish community within Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 as part of the watershed monitoring effort. 88.4% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 52% of the community was considered to be very tolerant of pollutants. Tolerant *Physa* snails dominated the sample.

DO TIVs were also calculated using the macroinvertebrate community. Ten taxa that are considered to be tolerant of low DO were found within the 2008 sample and five very tolerant taxa were found in the sample. No DO intolerant, or very intolerant taxa were collected in the sample. Similar to the fish community, low DO does appear to be a primary stressor to the macroinvertebrate community within Unnamed Creek.

Composite conclusion from biology

The fish and macroinvertebrates in Unnamed Creek are indicating that low DO is the primary stressor to the aquatic life within Unnamed Creek.

Recommendations

Mitigating the DO issue will have the greatest impact on Unnamed Creek.

Several culverts appear to be fish barriers. It is recommended that these be evaluated and replace with AOP approved culverts.

Continued compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer, which has contributed to the stable banks.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Upper Getchell Creek Subwatershed

The Upper Getchell Creek Subwatershed covers 24,400 acres, ending in Getchell Lake four miles west of Albany (Figure 68). There are 90.6% of the streams in the Subwatershed that have been channelized.

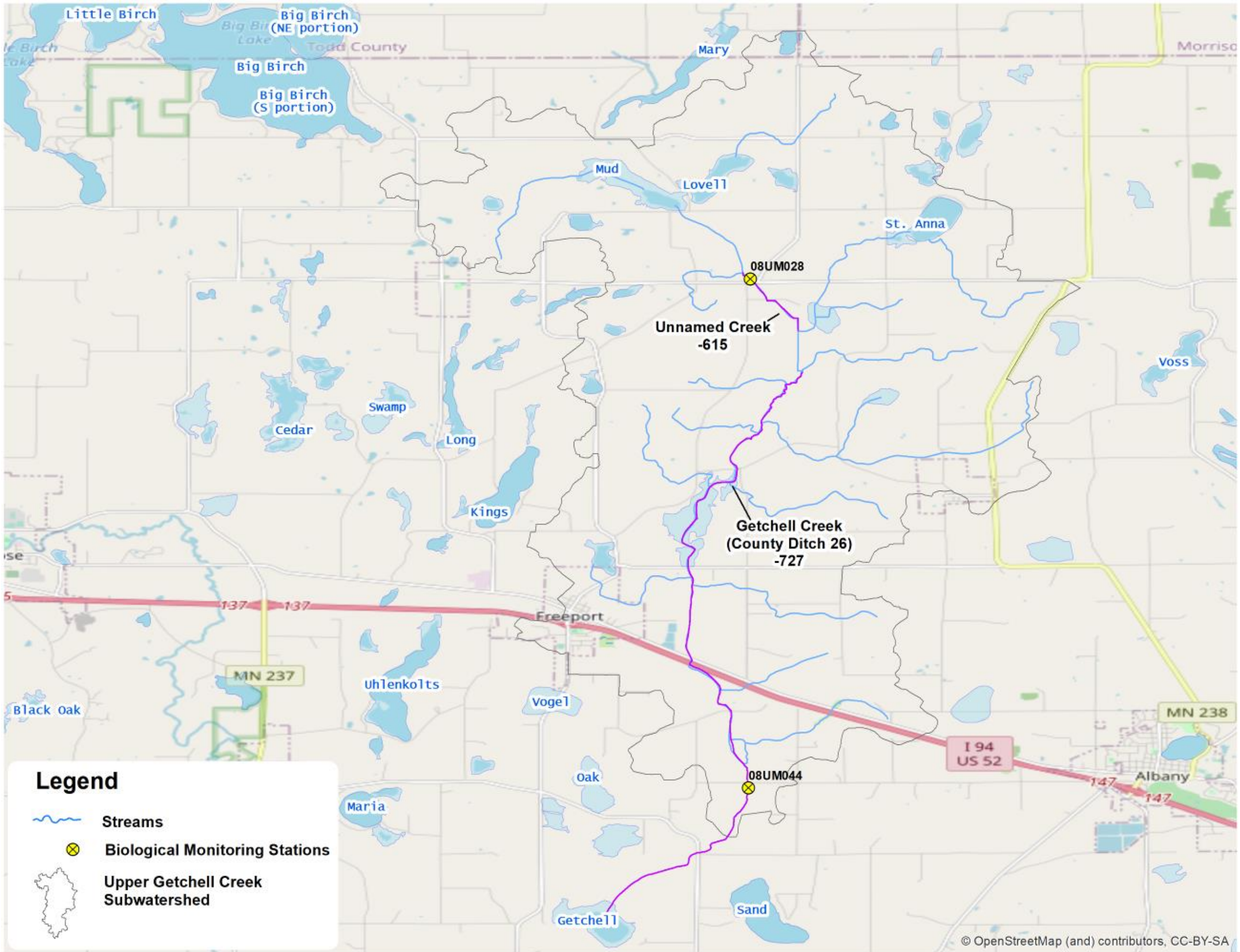


Figure 68. Biological monitoring stations in the Upper Getchell Creek Subwatershed.

The land use within the Upper Getchell Creek Subwatershed is dominated by cropland (73.2%) followed by wetlands (8%) and rangeland (8%) (Figure 69).

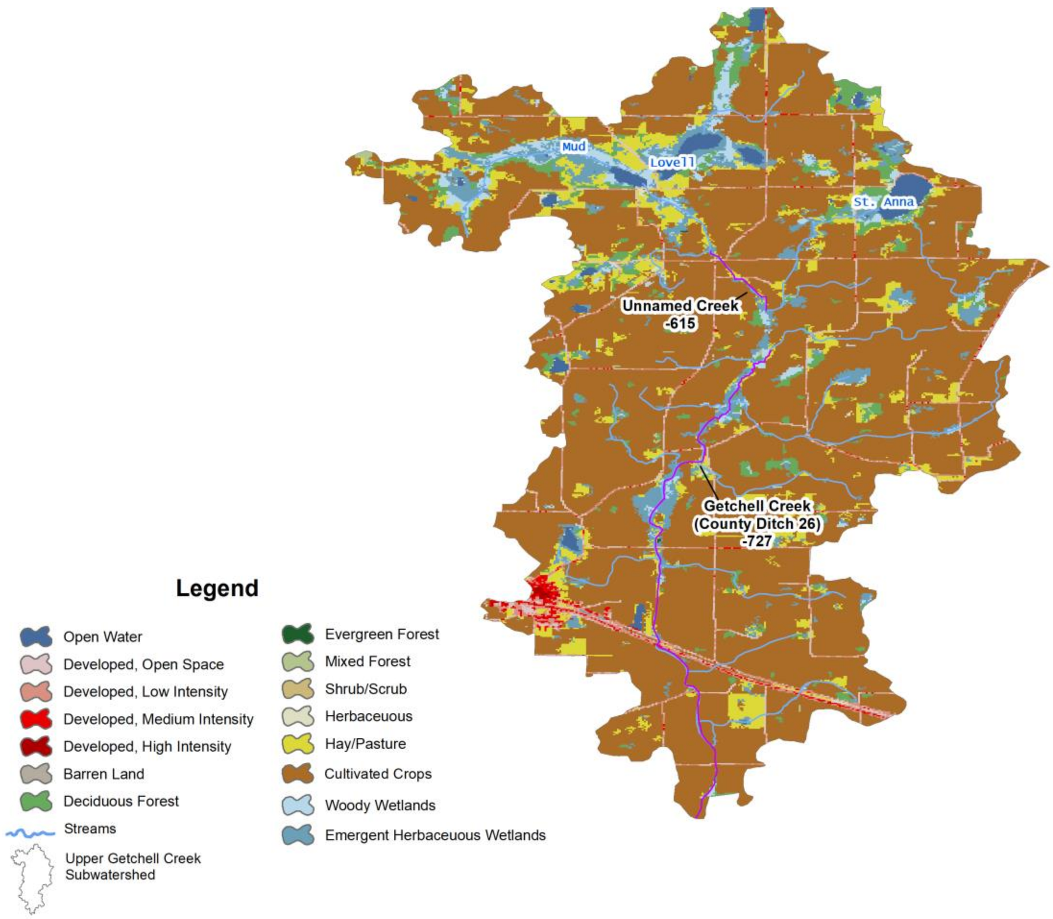


Figure 69. Land use in the Upper Getchell Creek Subwatershed.

Unnamed Creek (07010202-615)

Impairment: Unnamed Creek (AUID -615) flows for one mile from just upstream of CR 17 to the confluence with Getchell Creek, 4.5 miles northeast of Freeport, forming the headwaters of Getchell Creek (Figure 68). Unnamed Creek has been channelized throughout the entire reach. There is one biological monitoring station (08UM028) that was sampled on AUID -615 in 2008, and assessed in 2018 as part of the TALU assessment process for channelized streams. The UAA process determined that Unnamed Creek should be assessed under the modified use criteria, due to poor habitat. This assessment resulted in new impairments for fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 6 (Southern Forest Streams Glide/ Pool). In addition to the biological impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

Water chemistry data has been collected at 08UM028 (S003-895) from 2005-2009 (Table 33).

Table 33. Water chemistry data collected at S003-895. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S003-895.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	68	68	0.100 mg/L	0.31 mg/L	0.11 mg/L	1.2 mg/L
DO	69	23	5.0 mg/L	6.67 mg/L	1.86 mg/L	15.5 mg/L
Ammonia	68	N/A	N/A	0.28 mg/L	0.04 mg/L	3.35 mg/L
TSS	71	2	30.0 mg/L	6.67 mg/L	1.0 mg/L	36.0 mg/L
Water Temp	69	N/A	N/A	14.88° C	0.22° C	25.7° C

Nutrients – Phosphorus

Phosphorus values from the large dataset collected on Unnamed Creek (Table 33) shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is three times the standard at 0.31 mg/L. All of the TP samples collected from 2005 through 2009 are above the standard, with a maximum value of 1.2 mg/L. These data suggest that there is a strong potential for eutrophication to occur.

Nutrients – Ammonia

Ammonia values are elevated on Unnamed Creek (Table 33) and could reach levels that are toxic to aquatic life. The dataset indicated that the highest levels of ammonia occur during spring to early summer (March through June), with the highest values occurring during snowmelt. These elevated values have the potential to impact aquatic life within Unnamed Creek as higher levels of ammonia can be lethal. During the early spring when ammonia values are most elevated, macroinvertebrates are the most affected as the fish will not utilize the creek until water temperatures begin to rise. Therefore, the elevated ammonia values pose a bigger threat to the overall health to aquatic life through eutrophication caused by the elevated nutrients.

Dissolved Oxygen

DO data was collected from 2005 through 2009 at S003-895. These data show that the DO levels within Unnamed Creek drop well below the 5 mg/L standard from June through August during each year that was sampled, reaching a low of 1.86 mg/L (Table 33; Figure 70).

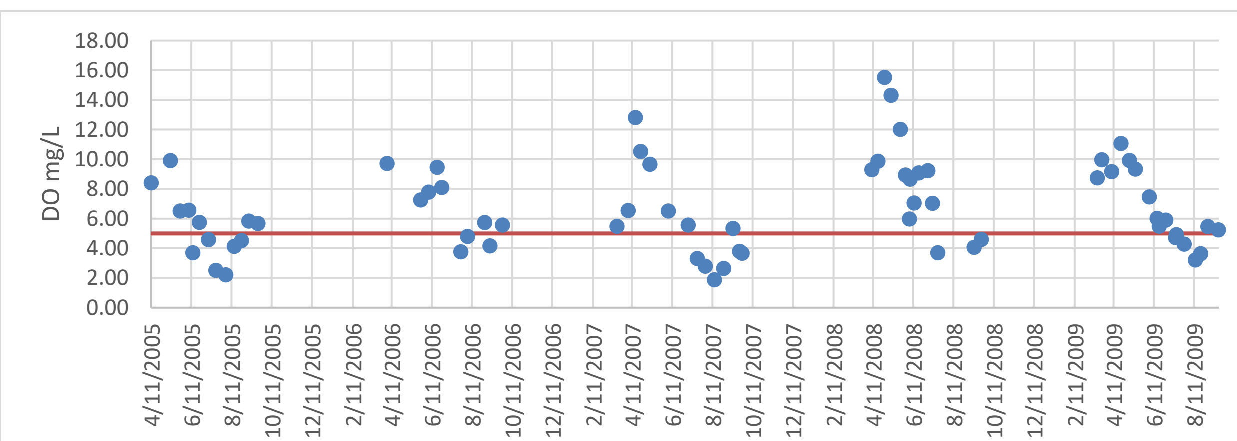


Figure 70. Instantaneous DO data collected on Unnamed Creek.

The increase in DO levels in late August could signal the presence of eutrophication, produced through the photosynthesis of large algal mats (Figure 71).

Figure 71. Algal mat growth in Unnamed Creek, 2019.

A sonde was deployed at S003-895 (08UM028) from 7/31/2019 to 8/7/2019. All DO levels were below the 5 mg/L threshold throughout the deployment (Figure 72), resulting in a new DO impairment on Unnamed Creek. These data suggest that Unnamed Creek lacks sufficient DO to sustain healthy fish and macroinvertebrate communities, and therefore, low DO is a primary stressor to the aquatic life in Unnamed Creek.

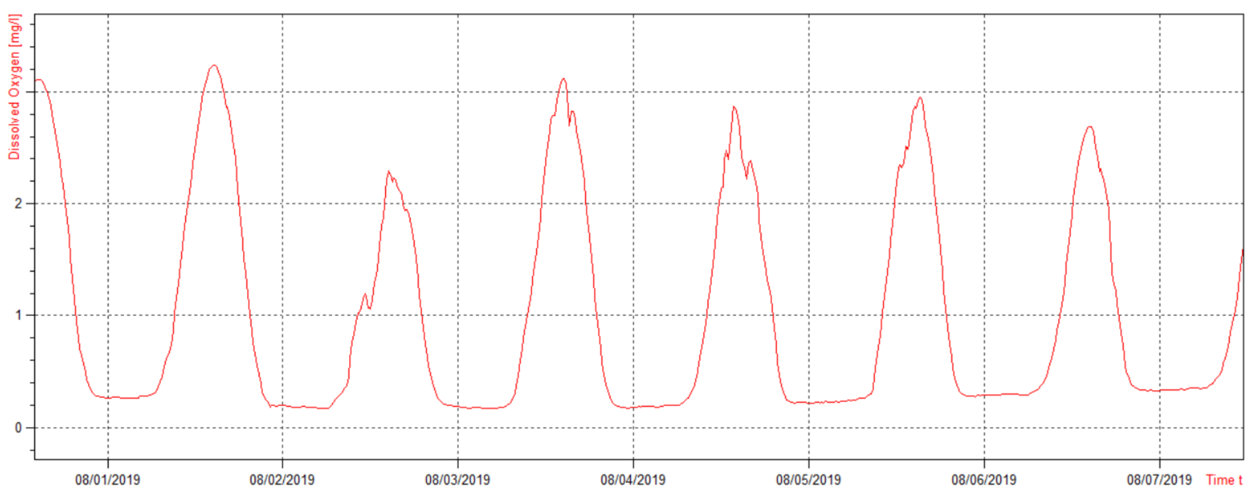


Figure 72. Continuous DO data collected on Unnamed Creek in 2019.

Total suspended solids

TSS data were collected from 2005 through 2009 on Unnamed Creek (Table 33). TSS values were almost entirely below the threshold, with the exception of two samples (Figure 73). Some of these higher samples could be linked to snowmelt. TSS does not appear to be a stressor to the aquatic life in Unnamed Creek.

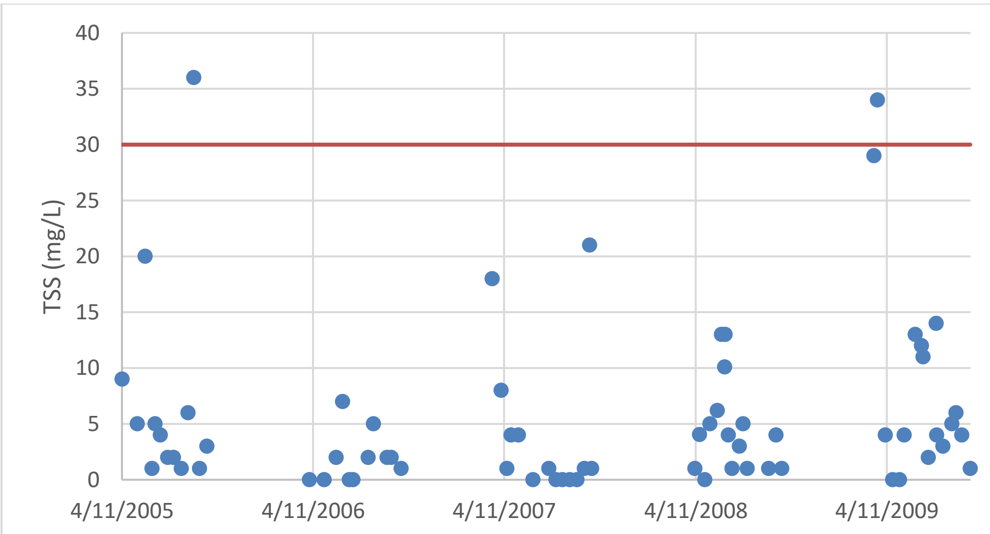


Figure 73. TSS data collected on Unnamed Creek, 2005-2009.

Conductivity

Specific conductivity was within range throughout the sonde deployment in 2019, and does not appear to be a stressor to aquatic life within Unnamed Creek.

Temperature

Temperature data collected during the historic monitoring at S003-895 (Table 33) and during the sonde deployment in 2019 showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as poor on Unnamed Creek, through an MSHA evaluation during the fish sample (Table 34). Due to the historic channelization of Unnamed Creek, and poor MSHA score, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the Modified Use TALU criteria.

MSHA Component	Unnamed Creek	Maximum Poss. Score
Land Use	3	5
Riparian	11.5	14
Substrate	3	28
Cover	10	18
Channel Morphology	12	35
Total MSHA Score	39.5 = Poor	100

Table 34. MSHA evaluation for Unnamed Creek, collected during the fish sample in 2008.

Although the MSHA score was low overall, two categories scored particularly low as noted in Table 34. Substrate was the first low scoring component of the MSHA score, as indicated by the dominance of silt and detritus substrates. Healthy fish communities need coarse substrate in order to build nests and spawn. Excessive fine sediment also affects juvenile fishes, as the sediment is stirred into the water column creating TSS, it can easily tear sensitive juvenile fish gills. Similarly, many sensitive macroinvertebrates also have specialized gills that are used to breathe DO. Excessive fine sediments can damage these gills, similar to juvenile fishes, making the creek inhabitable. This sediment would have historically settled out within the upstream wetlands, but due to the channelization, the sediment is flushed downstream during precipitation events.

Channel morphology was another low scoring component of the MSHA evaluation. The MSHA indicated that there was no channel depth variability, no sinuosity, and poor channel development (no riffles and small pools). Fish and macroinvertebrates need channel depth variability to use as cover from predators and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the creek throughout the summer, especially during high flow events, which can flush these communities downstream. The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity and connecting the channel to the upstream wetlands. Therefore, poor habitat is a stressor to the aquatic life in Unnamed Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek, and the entire Upper Getchell Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been straightened along the entire length of the AUID. Additionally, large changes have been made upstream of the AUID as well. Figure 74 shows a comparison between the historical plat map and present day. Two lakes (Mud Lake and Lovell Lake) do not appear on the historical plat map, and appear to have been excavated. The channelization of Unnamed Creek and several other channels can also be seen, including several channels that appear to not have previously existed.

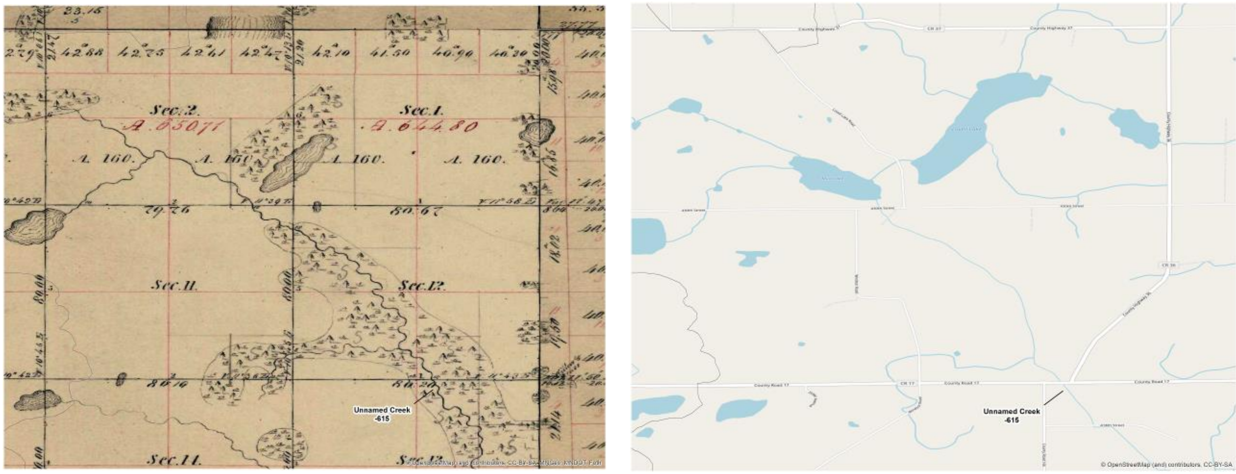


Figure 74. Historical plat map of Unnamed Creek compared to present day.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and the MSHA evaluation of stream bank condition during the fish sample, the banks appear to be stable and not actively eroding. Reviewing historical aerial photography shows that the pre-settlement channel was small and very sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion. It is possible that this excess sediment would have historically settled out within the upstream wetlands, but due to the channelization, the sediment is flushed downstream during precipitation events. Therefore, altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Getchell Creek. The culvert crossing by 08UM028 off CR 17 does not appear to be a fish barrier. It is possible that the other road and field crossings may be fish barriers, but there are only a few fish species that were found on the downstream section of Getchell Creek that were not found in Unnamed Creek, so connectivity does not appear to be a stressor to the fish in Unnamed Creek. However, it cannot be ruled out unless all crossings are examined.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort, resulting in a fish community that consisted of six species. The most dominant species within the sample was the Central Mudminnow, which is one of the most pollution tolerant fish species within the State of Minnesota. All of the other fish species that were collected are also considered tolerant of pollutants.

TIV were calculated for Unnamed Creek using the fish community. The TSS TIV found that the fish community has a 79% probability of coming from a stream that is meeting the TSS standard. As for the DO TIV score, the calculation indicated that the fish community has only a 3% probability of coming from a stream that is meeting the DO standard. These analyses indicate that the fish community is heavily impacted by low DO levels, but not likely stressed from elevated TSS.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Of the six species collected, three were considered to be tolerant to elevated phosphorus, and one was very tolerant. No fish species that are intolerant of phosphorus were collected within the fish sample. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community within Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 as part of the cycle I watershed monitoring effort. 91% of the macroinvertebrate community was comprised of taxa that are considered to be tolerant of pollution, and 25% of the community was considered very tolerant of pollution. Eight taxa within the sample are considered tolerant of low DO, and no taxa that require health DO levels were found in the sample. Overall, no macroinvertebrate taxa that are intolerant of pollution were found within this sample.

Similar to the fish sample, TIV were calculated for Unnamed Creek using the macroinvertebrate community. The TSS TIV found that the macroinvertebrate community has a 68% probability from coming from a stream that is meeting the TSS standard. As for the DO TIV score, the calculation indicated that the macroinvertebrate community has a 35% probability of coming from a stream that is meeting the DO standard. These analyses indicate that the macroinvertebrate community is likely stressed by low DO levels, and mildly stressed from elevated TSS.

Phosphorus tolerance values were also calculated using the macroinvertebrate community. In the 2008 sample, 1 intolerant, 12 tolerant taxa, and 7 very tolerant taxa were collected. Due to the dominance of tolerant taxa, combined with the elevated TP values, indicates that phosphorus is a stressor to the macroinvertebrate community with only one intolerant taxa collected.

Composite conclusion from biology

The fish and macroinvertebrates in Unnamed Creek are indicating that low DO is a stressor to both communities. TSS and ammonia may be slightly affecting the macroinvertebrates, but not the fish community. This may be due to the timing of the high TSS and ammonia levels. TSS and ammonia are highest in early spring, when the fish are still in larger rivers. In general, fish tend to move into smaller water during the late spring to early summer to spawn. Therefore, it is possible that the fish may not be in Unnamed Creek when TSS and ammonia levels are elevated. However, long-lived macroinvertebrates inhabit smaller streams year round, and may not be able to escape the periods of elevated TSS and ammonia, which could explain the lower TIV probabilities for macroinvertebrates.

Phosphorus is a stressor to the fish and macroinvertebrates within Unnamed Creek.

Conclusions about stressors

Low DO within Unnamed Creek is the result of multiple contributing factors. The historic channelization, which connected the excavated upstream lakes with Getchell Creek, allows for low DO water to easily flow downstream, when historically there were fewer stream channels and only small wetlands. Water which was once held in the wetlands, is now flushed out during precipitation events. This is affecting the biological communities, as seen by the DO tolerant species found within the biological samples. Central Mudminnow was the dominant fish species with the fish sample on Unnamed Creek. This species has adapted to thrive in environments that have low DO levels and warmer temperatures, with the ability to breathe in atmospheric oxygen. The abundant Central Mudminnow population, compared to the dwindling populations of other fish species indicates that DO is a stressor to the fish within Unnamed Creek. All of the other fish species that were sampled within Unnamed Creek were also tolerant of DO, but these fishes were found in lower numbers than the more tolerant Central Mudminnow.

Similarly, the most dominant macroinvertebrate taxa (67%) sampled within the biological sample was *Hyalella*. *Hyalella*, similar to the Central Mudminnow, have adapted to survive in streams with low DO levels (Irving et al. 2004). Other taxa within the macroinvertebrate sample were also tolerant of low DO, including the *Caenis* mayfly, which is specifically adapted to survive in low DO streams with silty sediments, using specialized operculate gill coverings (Mackie 2004). The dominance of the DO tolerant macroinvertebrate taxa further indicates that DO is a stressor to the biological communities within Unnamed Creek.

Channelization has also impacted habitat within Unnamed Creek, as indicated by the MSHA score. Poor sinuosity, poor channel development, and fine sediment were noted within the MSHA assessment. Fine sediments can prohibit sensitive fish species from colonizing within a stream, and no sensitive fish species were collected within the fish sample. Hornyhead Chubs are a sensitive fish species which were found in other nearby streams, but were not collected within Unnamed Creek. Hornyhead Chubs, and similar fish species, require clean coarse gravel in which to spawn. Fine silt and muck is the most dominant substrate type within Unnamed Creek, as indicated by the MSHA score. This sediment would have historically settled out within the upstream wetlands, but due to the channelization, the sediment is flushed downstream during precipitation events. This process has caused the gravel beds that fish like the Hornyhead Chub utilize for spawning, to become embedded in fine sediment. This loss of spawning habitat prohibits the ability for more sensitive fish species to spawn and survive within Unnamed Creek, indicating that excessive sedimentation is a stressor to the fish community in Unnamed Creek.

Macroinvertebrates are also sensitive to habitat degradation. In general, mayflies have specialized gills that require clean water that is free of floating fine sediment. However, *Caenis* mayflies are specially adapted to survive in streams with fine sediments, using operculate plates to guard the gills from the abrasive sediment (Mackie 2004). *Caenis* were abundant within the macroinvertebrate sample in Unnamed Creek, and very few sensitive taxa were collected. The prevalence of *Caenis* within the macroinvertebrate sample, with the absence of sensitive taxa indicates that excess sedimentation is a stressor to the macroinvertebrates within Unnamed Creek.

Recommendations

The official length of the Unnamed Creek AUID is only one mile; however, the upstream portion of the stream to Mud Lake should also be considered. Compliance with the Buffer Law will help avoid erosion issues. Due to the wetland nature of the headwaters of Unnamed Creek, most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Manure application on fields located close the headwaters of Unnamed Creek and the small ditches that flow into Lovell Lake and Mud Lake, should be applied at least 300 feet away from the water. Snowmelt run off with manure could explain the high levels of ammonia and TSS found in the early spring samples.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Getchell Creek (County Ditch 26) (07010202-727)

Impairment: Getchell Creek (AUID -727) flows for 9.4 miles from just downstream of the previous AUID (Unnamed Creek -615). This section of Getchell Creek has been channelized throughout the entire 9.4 mile stretch, allowing the Creek to cross the subwatershed boundary (Figure 68). There is one biological monitoring station (08UM044) that was originally sampled on AUID -727 in 2008, and then repeated in 2018. Assessments for Getchell Creek were initially completed in early 2018 as part of the TALU assessment process for assessing channelized streams, and then repeated in late 2020. The UAA process determined that Getchell Creek should be assessed under the modified use criteria. These assessments resulted in a new impairment for fish. The fish class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 6 (Southern Forest Streams Glide/ Pool). In addition to the biological impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

Water chemistry data has been collected at several stations along this section of Getchell Creek from 2007 to 2009 and 2019 to 2020 (S004-626, S004-627, and S010-910) (Table 35).

Table 35. Water chemistry data collected at S004-626, S004-627, and S010-910. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S004-626 https://webapp.pca.state.mn.us/surface-water/station/S004-627 https://webapp.pca.state.mn.us/surface-water/station/S010-910.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	99	97	0.100 mg/L	0.37 mg/L	0.05 mg/L	1.29 mg/L
DO	111	20	5.0 mg/L	8.23 mg/L	0.21 mg/L	18.82 mg/L
Inorganic nitrogen	7	N/A	N/A	2.54 mg/L	0.39 mg/L	5.5 mg/L
Ammonia	95	N/A	N/A	0.30 mg/L	0.01 mg/L	2.64 mg/L
TSS	92	5	30.0 mg/L	9.43 mg/L	1.0 mg/L	116.0 mg/L
Water Temp	112	N/A	N/A	17.12° C	1.0° C	25.67° C
Sp. Conductivity	16	N/A	N/A	619.82 µS	488.1 µS	910 µS

Nutrients – Phosphorus

Phosphorus values from the large dataset collected on Getchell Creek (Table 35) shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is three times the standard at 0.36 mg/L. 98% of the TP values collected across the dataset were all above the standard, with a maximum value of 1.29 mg/L. These data suggest that there is a strong potential for eutrophication to occur. The elevated DO flux data from the July 2020 continuous sonde deployment also suggests eutrophication. DO flux greater than 3.5 mg/L/day suggest that the stream is impacted by elevated nutrient concentrations. During the sonde deployment DO flux ranged from 6 to 10 mg/L/day.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite) and Ammonia

Ammonia data were collected from 2007 to 2009 and Inorganic nitrogen data were collected in 2019 on Getchell Creek (Table 35). These data indicate that the ammonia and inorganic nitrogen levels within Getchell Creek are high in the spring (March through May), with the highest values occurring during snowmelt. These high values have the potential to be a stressor to aquatic life. Similar to Unnamed Creek (AUID -615) in the headwaters of Getchell Creek, these springtime elevated values can have the greatest effect upon the macroinvertebrates as the fish will not utilize the creek until water temperatures begin to rise. Therefore, the elevated Ammonia and Inorganic nitrogen values pose a bigger threat to the overall health to aquatic life through eutrophication caused by the elevated nutrients.

Dissolved Oxygen

DO data was collected from Getchell Creek from 2005-2009 and from 2019-2020. These data show that the DO levels within Getchell Creek drop well below the 5 mg/L standard from June through August during each year that was sampled, reaching a low of 0.21 mg/L (Table 35; Figure 75).

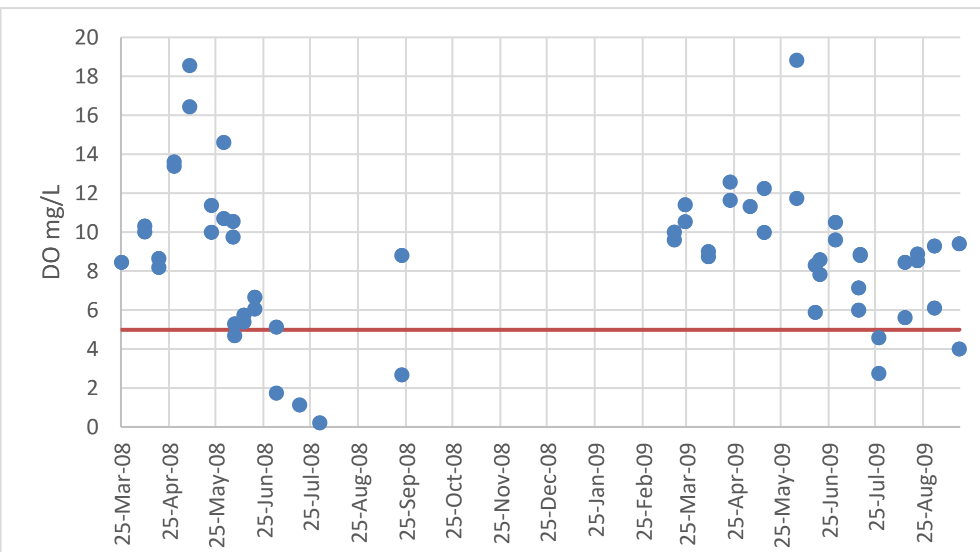


Figure 75. Instantaneous DO data collected on Getchell Creek in 2008 and 2009.

In addition to the instantaneous sonde readings, a sonde was deployed at S003-289 during the summers of 2019 and 2020 (Figure 76; Figure 77). These data also show that the DO levels drop well below the standard. Therefore, DO appears to be a primary stressor to the aquatic life within Getchell Creek.

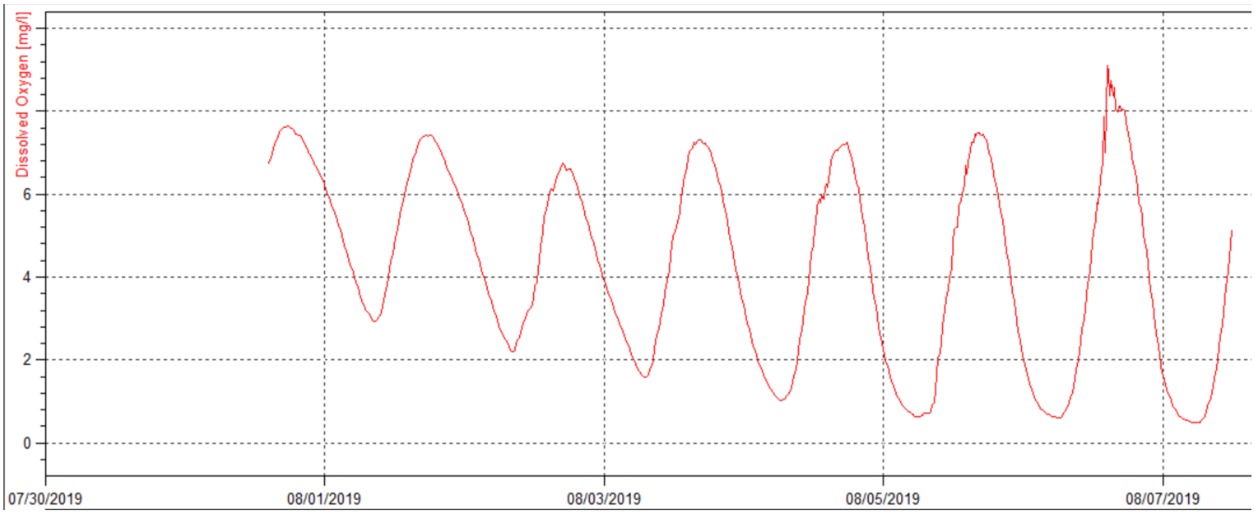


Figure 76. Continuous DO data collected on Getchell Creek in 2019.

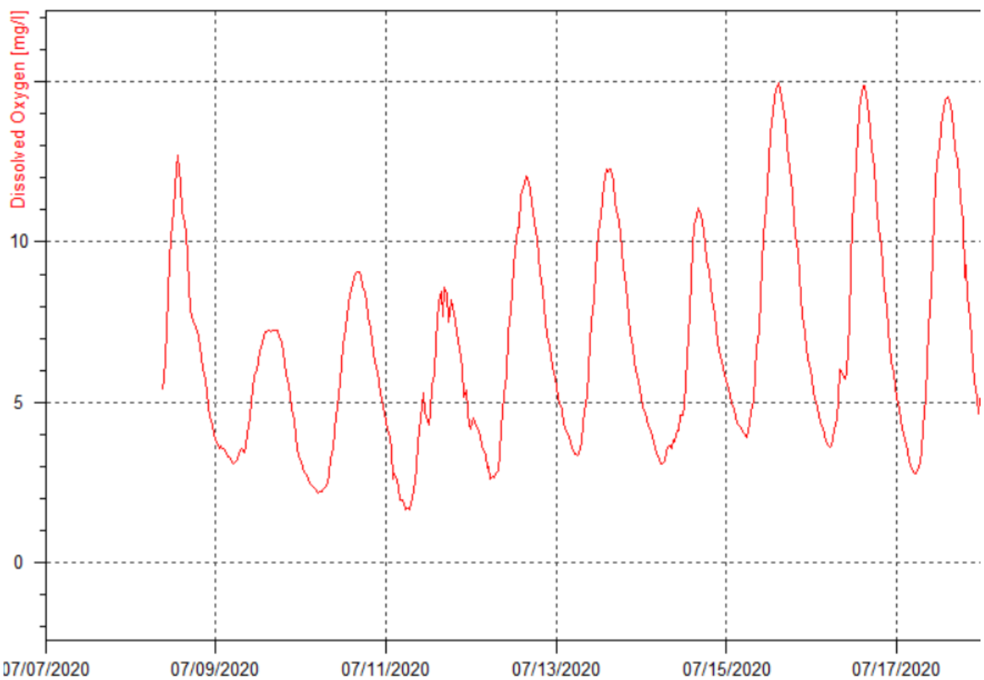


Figure 77. Continuous DO data collected on Getchell Creek in 2020.

Total suspended solids

TSS data were collected from 2007 to 2009, and 2019 to 2020 on Getchell Creek (Table 35). TSS values were almost entirely below the threshold, with the exception of two samples. Some of these higher samples could be linked to snowmelt. Overall, TSS does not appear to be a stressor to the aquatic life in Getchell Creek.

Conductivity

Specific conductivity was within range during the 2019 sampling (Table 35) and the sonde deployment in 2020. One high value was noted (910 µS) in 2019, but was most likely linked to a high precipitation event, and the other values appear to be within range. Therefore, specific conductivity does not appear to be a stressor to aquatic life within Getchell Creek.

Temperature

Temperature data collected during grab samples (Table 35), and the 2020 sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Getchell Creek, through MSHA evaluations during the fish and macroinvertebrate samples (Table 36). Due to the historic channelization of Getchell Creek, and fair MSHA score, the assessment of Getchell Creek was brought into the UAA process. It was determined that the habitat of Getchell Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Getchell Creek was assessed using the Modified Use TALU criteria.

Table 36. Average MSHA score for Getchell Creek.

MSHA Component	Avg. MSHA Score	Maximum Poss. Score
Land Use	0.5	5
Riparian	9.3	14
Substrate	11.6	28
Cover	13.3	18
Channel Morphology	7.6	35
Total MSHA Score	42.3 = Fair	100

The overall habitat of Getchell Creek was rated as fair; however, substrate and channel morphology scored poorly. Substrate is an important component of overall stream habitat, as sensitive fish and macroinvertebrates require clean coarse substrate. Sand and silt were the dominate substrates that were found, with small patches of gravel noted. The over-widening of the stream channel due to the channelization has caused severe erosion, leading to excess sediment (sand) filling in historic larger portions of coarse gravel. In the summer of 2020, the MPCA SID staff noted the presence of the small gravel patches next to the culvert crossing off 350th street (Figure 78). Common Shiners and Creek Chubs were seen attempting to use these small sections of gravel to spawn in the early summer, but were ultimately unsuccessful as the excessive algal and macrophyte growth covered these few remaining gravel beds (Figure 79).

Figure 78. Small patch of gravel in Getchell Creek.

Figure 79. Gravel patch choked out by excess algal and macrophyte growth.

Channel morphology was another low scoring component of the MSHA evaluation. The MSHA indicated that there was no channel depth variability, no sinuosity, and poor channel development (no riffles and small pools). Fish and macroinvertebrates need channel depth variability to use as cover from predation and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the creek throughout the summer, especially during high flow events which can flush these communities downstream. The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity and connecting the channel to the upstream wetlands. Therefore, lack of habitat is a stressor to the aquatic life in Getchell Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek, Getchell Creek, and the entire Upper Getchell Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Getchell Creek has been straightened along the entire length of the AUID.

Due to the channelization of Getchell Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks appear to be actively eroding. The MSHA evaluation for erosion ranged from light (25% to 50%) to severe (75% to 100%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion. Getchell Creek is also receiving sediment from Unnamed Creek (AUID -615), which forms the headwaters of the creek. Altered hydrology has played a role in stressing the aquatic life in Unnamed Creek, and is considered a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Getchell Creek. The culvert crossing by 08UM044 off 350th Street does not appear to be a fish barrier. It is possible that the other road and field crossings may be fish barriers, but reviewing aerial photography, it appears as though the culverts are properly placed to allow for fish passage. However, it cannot be ruled out unless all crossings are examined.

Stressor signals from biology

Fish

Fish were initially sampled in 2008 as part of the cycle I watershed monitoring effort and then sampled again in 2018 for the second cycle of monitoring. The fish sample from 2008 yielded a total of nine species, with White Suckers being the most dominate. All nine species are considered to be tolerant of pollutants. Similarly, the 2018 fish sample contained eight species, and was dominated by Fathead Minnows. All eight of these fish species are considered to be tolerant of pollutants, with Fathead Minnows being labeled as one of the most tolerant fish species within the State of Minnesota.

TIV were calculated for Getchell Creek using the fish communities collected in 2008 and 2018. The TIV for TSS within Getchell Creek using the 2008 fish sample, found that the fish community had a 46% probability of coming from a stream that was meeting the TSS standard. Of the nine fish species collected in 2008, none were considered to be intolerant or sensitive to TSS, and only one species was considered tolerant of TSS. No species that are considered very tolerant of TSS were collected. As for the 2018 fish sample, the TSS TIV indicated that the fish community had only a 27.5% probability of meeting the TSS standard, but no species with documented TSS tolerance sensitivity were collected within the sample. Altogether, the fish community is indicating a mild sensitivity to TSS within Getchell Creek. One TSS tolerant species and no TSS intolerant species were collected throughout the two sampling years, indicating a weak TSS signal from the biology. Therefore fish community response combined with the low TSS values in the grab sampling, TSS is not considered a stressor to the fish community in Getchell Creek at this time.

DO TIV scores were also calculated for Getchell Creek using the fish communities. This calculation indicated that the fish community from 2008 had a 64% probability of coming from a stream that was meeting the DO standard. However, five of the seven fish species collected are considered to be tolerant of low DO, and two species are considered very tolerant of low DO. This score dropped further with the 2018 fish community with a 30.1% probability. Three of the fish species collected in 2018 are considered to be tolerant of low DO, and three other species are considered to be very tolerant of low DO. The combined fish samples indicate that DO is a stressor to the fish community within Getchell Creek.

Nitrogen tolerance within the fish community was also investigated for Getchell Creek. The fish community collected in 2008 had five species that are considered tolerant to elevated nitrogen, resulting in 82.3% of the sample having a tolerance to elevated nitrogen. Similarly, 89% of the fish species within the 2018 sample are considered to be tolerant of elevated nitrate, with six species being considered tolerant of elevated nitrate and one very tolerant of elevated nitrate. No nitrogen intolerant fish species were collected in 2008 or 2018. The prevalence of nitrogen tolerant fish species in both samples indicates that elevated nitrogen is affecting the fish community, but the biggest impact from the elevated inorganic nitrogen is through eutrophication.

Phosphorus tolerance of the fish community was also investigated in Getchell Creek using the fish species characteristics. Five fish species collected in the 2008 sample are considered to be tolerant of elevated phosphorus, and none of the nine total species collected are intolerant of elevated phosphorus. Similarly, three tolerant fish species were collected in the 2018 sample and none of the eight total species collected are intolerant. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community in Getchell Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 and 2018 as part of the watershed monitoring efforts. 84% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 48% of the community was considered to be very tolerant of pollutants. Similarly, the 2018 macroinvertebrate community was comprised of 82.8% tolerant taxa and 41.4% very tolerant taxa. Two tolerant taxa (*Hyalella*; *Caenis*) dominated both samples.

TSS taxa tolerance was investigated using the macroinvertebrate communities. In the 2008 sample, one intolerant taxa to elevated TSS, six tolerant taxa, and two very tolerant taxa were collected (Table 37). As for the 2018 sample, two intolerant taxa, seven tolerant taxa, and two very tolerant taxa were collected (Table 37). Overall the macroinvertebrate community within Getchell Creek indicates that TSS is not a primary stressor, as multiple intolerant taxa were collected.

DO tolerance was also investigated using the macroinvertebrate communities. Five taxa that are considered to be tolerant of low DO were found within the 2008 sample and eight tolerant taxa were found in the 2018 sample (Table 37). No DO intolerant taxa were collected in either sample. Low DO does appear to be affecting the macroinvertebrate community, although not indicating an impairment for the macroinvertebrates at this time. However, the community is showing a downward trend, and may become impaired in the near future. This also further indicates that low DO is a stressor to the fish community.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. In the 2008 sample, 2 intolerant, 11 tolerant, and 6 very tolerant taxa were collected in Getchell Creek (Table 37). Similarly, in the 2018 sample, 2 intolerant, 12 tolerant, and 7 very tolerant taxa were collected (Table 37). Although the nitrogen levels are not near the level that is considered to be toxic to aquatic life, the overall macroinvertebrate community is indicating some nitrogen tolerance with the presence of multiple very tolerant taxa.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. In the 2008 sample, eight tolerant taxa and three very tolerant taxa were collected (Table 37). As for the 2018 sample, one intolerant taxa, eight tolerant taxa, and four very tolerant taxa were collected (Table 37). These tolerance indicators within the macroinvertebrate community indicate that phosphorus is a stressor to the macroinvertebrate community with only one intolerant taxa collected.

Table 37. Macroinvertebrate tolerance indicators in Getchell Creek.

Sample Year	Parameter	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	TSS	1	6	2
2018	TSS	2	7	2
2008	DO	0	5	0
2018	DO	0	8	0
2008	Nitrogen	2	11	6
2018	Nitrogen	2	12	7
2008	Phosphorus	0	8	3
2018	Phosphorus	1	8	4

Composite conclusion from biology

The fish and macroinvertebrates in Getchell Creek are indicating that low DO and elevated phosphorus are stressors to the aquatic life within Getchell Creek.

Inorganic nitrogen may be impacting the fish and macroinvertebrates, but poses the biggest threat through eutrophication.

TSS does not appear to be a stressor to the biology.

Conclusions about stressors

One of the primary stressors to the biology within Getchell Creek is the lack of a stable and healthy DO regime. Poor DO within Getchell Creek is the result of multiple contributing factors; channel modification, upstream connection with wetlands, and excessive algal and macrophyte growth fueled by excessive nutrients (inorganic nitrogen and phosphorus). Dredging and straightening of the stream channel for drainage, with the addition of tile drainage systems, has changed the natural flow pattern in Getchell Creek. This channel alteration accelerates stream flow, resulting in higher flows during precipitation events, which achieves the agricultural land use drainage goals, but causes instability. Water leaves the landscape quickly, and the stream experiences periods of higher flow with the influx of oxygen deprived water, reducing the DO levels within the stream. As flows quickly drain, the flow pattern quickly transitions to low flow, further reducing the capacity to maintain healthy DO levels. Additionally, during these high flow periods the lower DO water that is held in the upstream ditches (Unnamed Creek – AUID -615) and lakes, is flushed down into the lower portions of Getchell Creek. This flow alteration, combined with excessive nutrients, further compounds the DO issue in Getchell Creek. Algae and macrophytes utilize the excess nutrients, resulting in excessive growth completely covering the entire stream channel. During the daylight hours these plants photosynthesize and produce oxygen, in excess of 18 mg/L, and then consume that same DO after sundown, causing large fluctuations in the DO regime. This unstable DO has allowed fish species like the Fathead Minnow and White Sucker to thrive within Getchell Creek. However, it has impeded the ability for more sensitive species like the Hornyhead Chub to survive. Similarly, although the macroinvertebrate community is not impaired at this time, there are signals of stress with *Hyalella* and *Caenis* taxa dominating the macroinvertebrate samples.

Additional stressors to the biology within Getchell Creek are elevated phosphorus and inorganic nitrogen. The excess nutrient levels are not only contributing to the DO instability, but are directly impacting the fish and macroinvertebrates. Multiple fish species and macroinvertebrate taxa that are tolerant to elevated phosphorus where found within the 2008 and 2018 samples. Similarly, a few nitrogen intolerant macroinvertebrate taxa were sampled in Getchell Creek, but many tolerant macroinvertebrate taxa and fish species dominated the samples.

Habitat loss from the historic channelization practices is another stressor to the biology in Getchell Creek. Poor sinuosity, poor channel development, and fine sediment were noted within the MSHA evaluations. These are the result of channel over widening and the physical habitat removal during the dredging process. Sensitive fish and macroinvertebrates require coarse substrate and good channel morphology to survive and reproduce. However, the pools and riffles have been manually removed, and the coarse substrate has been buried in sand and silt from the erosion and manipulation of the stream banks.

Recommendations

Careful consideration to runoff from local fields would be advantageous for Getchell Creek. Elevated nutrient levels are causing eutrophication, and if mitigated, could make the biggest impact to the creek.

Compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Lower Getchell Creek Subwatershed

The Lower Getchell Creek Subwatershed covers 17,100 acres from just north of Albany to the Sauk River, four miles south of New Munich (Figure 80). There are 87.5% of the streams in the subwatershed that have been channelized, including most of Getchell Creek.

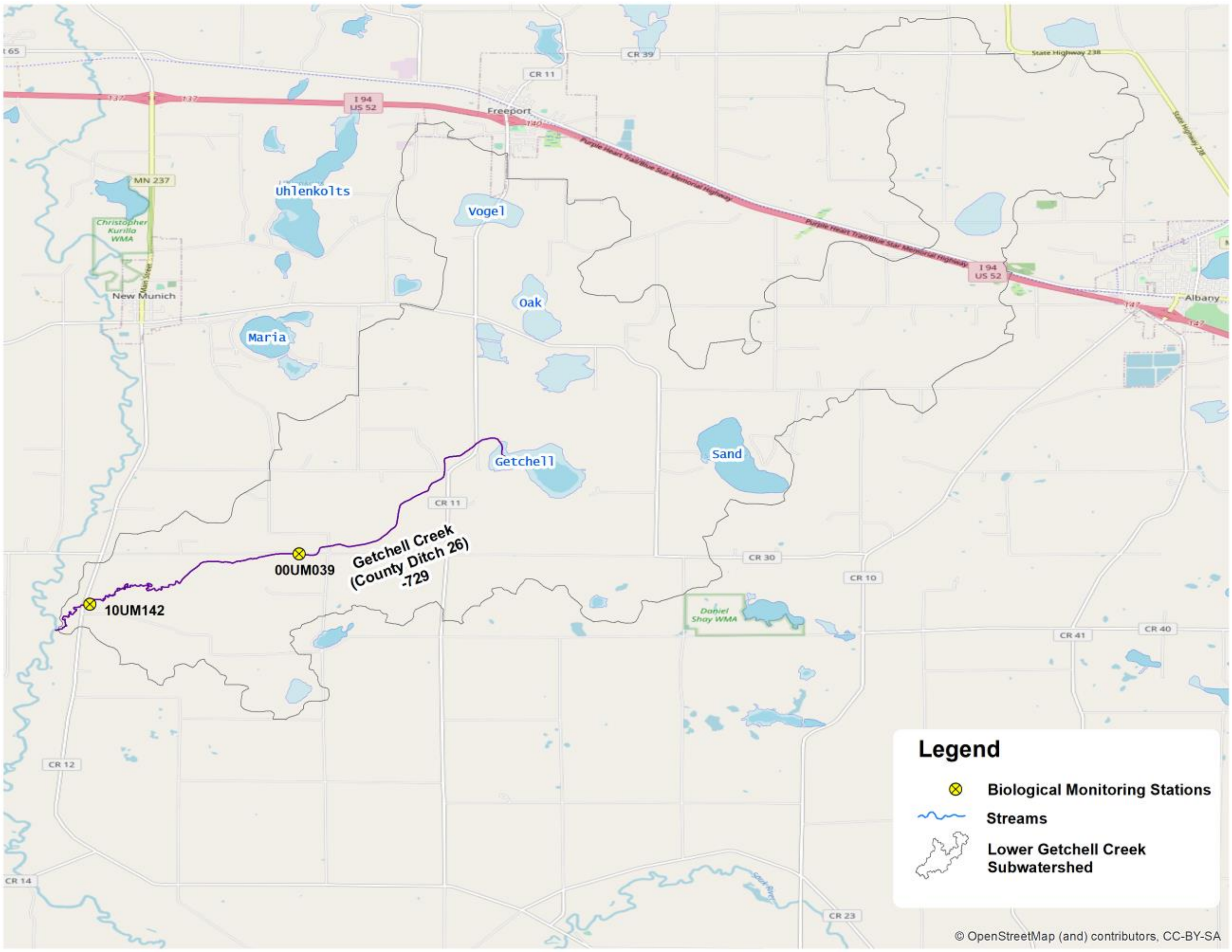


Figure 80. Biological monitoring stations in the Lower Getchell Creek Subwatershed.

The land use within the Lower Getchell Creek Subwatershed is dominated by cropland (79.2%) followed by barren land (6.5%) and wetlands (4.8%) (Figure 81).

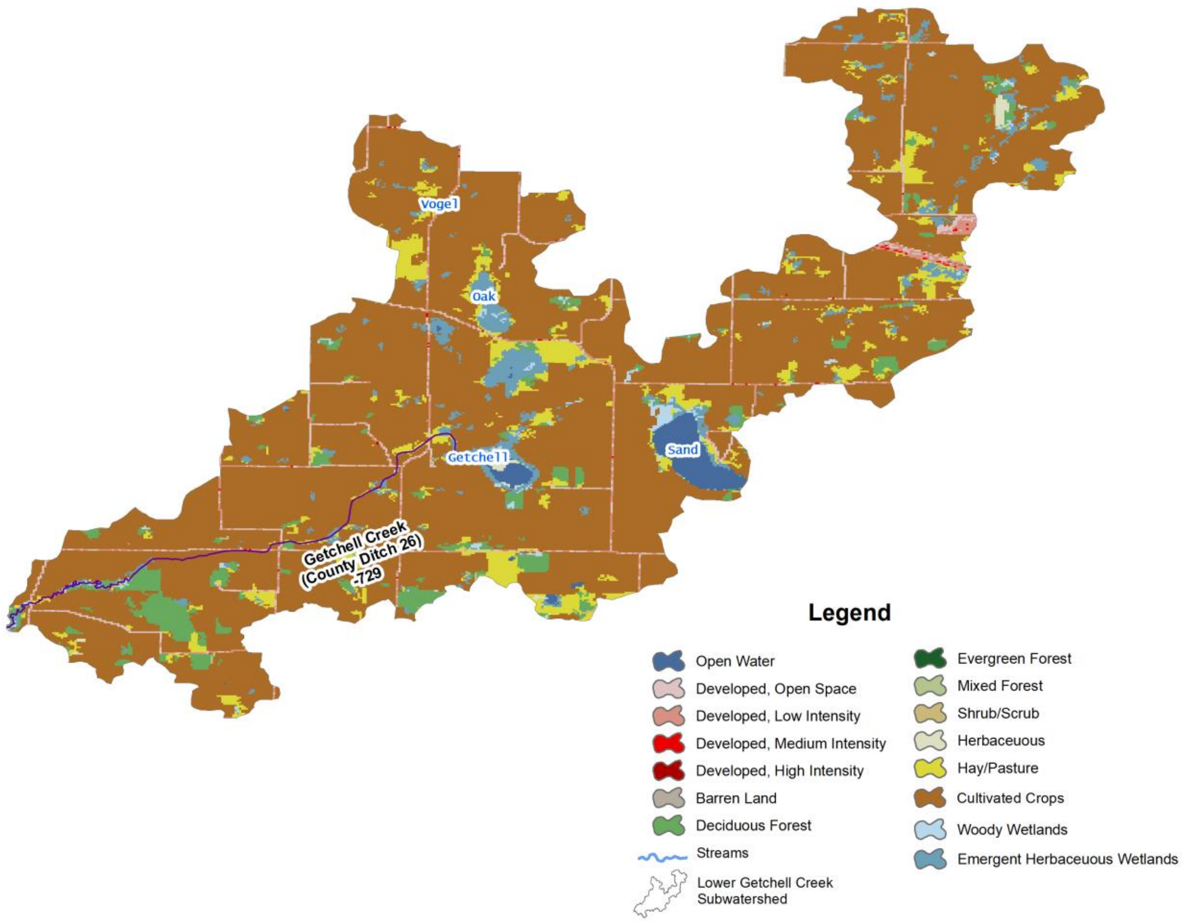


Figure 81. Land use in the Lower Getchell Creek Subwatershed.

Getchell Creek (County Ditch 26) (07010202-729)

Impairment: Getchell Creek (County Ditch 26) (AUID -729) flows for 6.3 miles, starting in Getchell Lake east of New Munich, and ending in the Sauk River south of New Munich (Figure 80). There are two biological monitoring stations (00UM039, 10UM142) that have been sampled on the downstream portion of Getchell Creek (AUID -729). Biological monitoring station 00UM039 was sampled for fish and macroinvertebrates in 2008 and repeated in 2018, while station 10UM142 was only sampled in 2010. Assessments were completed in early 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Getchell Creek should be assessed under the general use criteria, due to fair habitat. However, Getchell Creek is channelized throughout most of the reach, and was cleaned out after the initial round of sampling.

Historic assessments from 2006 indicated that the macroinvertebrates in Getchell Creek were not meeting standards, and were listed as impaired. Assessments were repeated in 2020, using the 2018 fish and macroinvertebrate data, resulting in a new fish impairment. The fish stream class is class 5 (Northern Streams) and the macroinvertebrate stream class is class 5 (Southern Streams Riffle/Run). In addition to the biological impairments, DO was also not meeting standards, and will likely be added to the 2022 impaired waters list.

Data and Analyses

Chemistry

Water chemistry data has been collected at S003-389 (00UM039) from 1995-2020 (except 2014) (Table 38).

Table 38. Water chemistry data collected at S003-289. Data from 2004-2013, 2015-2020 are displayed. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S003-289.

Parameter	Sample Count	# of Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
TP	190	186	0.100 mg/L	0.33 mg/L	0.07 mg/L	1.31 mg/L
DO	183	33	5.0 mg/L	8.71 mg/L	3.06 mg/L	21.36 mg/L
Inorganic nitrogen	89	N/A	N/A	1.27 mg/L	0.03 mg/L	8.58 mg/L
Ammonia	75	N/A	N/A	0.20 mg/L	0.01 mg/L	1.5 mg/L
TSS	188	12	30.0 mg/L	12.89 mg/L	0.5 mg/L	186 mg/L
Water Temp	166	N/A	N/A	17.63° C	0.0° C	26.63° C
Sp. Conductivity	103	N/A	N/A	601.07 µS	403 µS	910 µS

Nutrients – Phosphorus

Phosphorus values from the large dataset collected on Getchell Creek (Table 38) shows that the average TP is well above the Central Region River Nutrient standard (0.100 mg/L), with a value that is three times the standard at 0.33 mg/L. 98% of the TP values collected across the dataset were all above the standard, with a maximum value of 1.31 mg/L. These data suggest that there is a strong potential for eutrophication to occur.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite) and Ammonia

Ammonia data were collected from 2004 through 2011 and Inorganic nitrogen data were collected from 2008 and 2015 through 2020 on Getchell Creek (Table 38). These data indicate that the ammonia and inorganic nitrogen levels within Getchell Creek are elevated in the spring (March through May), with the highest values occurring during snowmelt. These high values have the potential to be a stressor to aquatic life. Similar to Unnamed Creek (AUID -615) in the headwaters of Getchell Creek and the upper portion of Getchell Creek (AUID -727), these springtime elevated values can have the greatest effect upon the macroinvertebrates as the fish will not utilize the creek until water temperatures begin to rise. Therefore, the elevated ammonia and inorganic nitrogen values pose a bigger threat to the overall health to aquatic life through eutrophication caused by the elevated nutrients.

Dissolved Oxygen

DO data was collected from Getchell Creek from 2005 through 2020 (except 2014). These data show that the DO levels within Getchell Creek drop well below the 5 mg/L standard from June through August during each year that was sampled, reaching a low of 3.06 mg/L (Table 38; Figure 82).

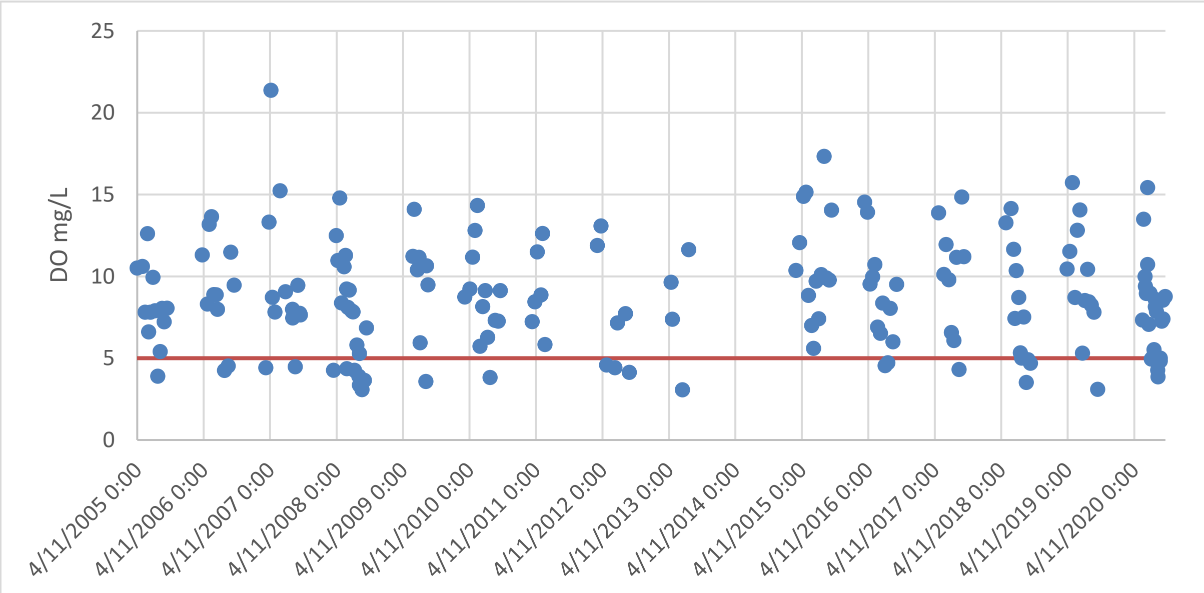


Figure 82. Instantaneous DO data collected on Getchell Creek.

In addition to the instantaneous sonde readings, a sonde was deployed at S003-389 during the summer of 2020 from 7/8/2020 through 7/21/2020 (Figure 83). These data also show that the DO levels drop well below the standard. Therefore, DO appears to be a primary stressor to the aquatic life within Getchell Creek.

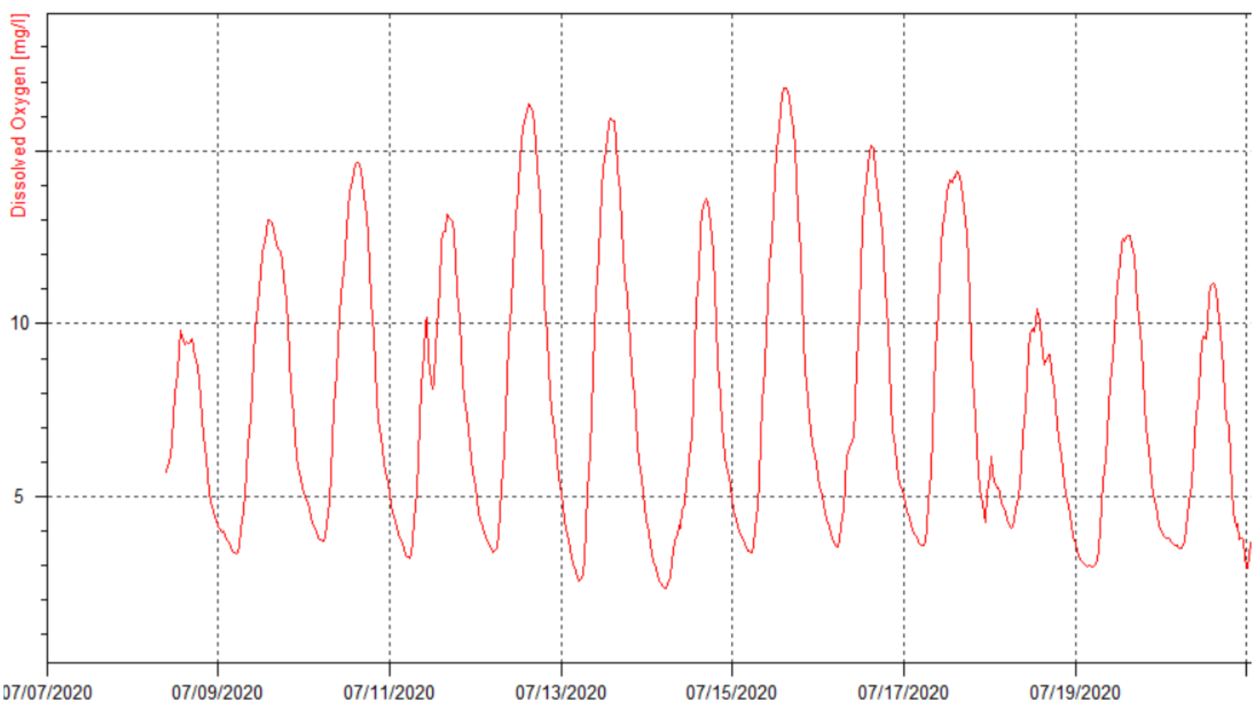


Figure 83. Continuous DO data collected on Getchell Creek in 2020.

Total suspended solids

TSS data were collected from 2004 through 2020 (except 2014) on Getchell Creek (Table 38). TSS values were almost entirely below the threshold, with the exception of 12 samples (Figure 84). Some of these higher samples could be linked to snowmelt, but most occur during the summer months. Although there were only 12 samples that were above the standard, these values were very elevated, reaching 186 mg/L. Getchell Creek was maintained and cleaned out from 2012 to 2017, and it is possible that these elevated values were collected during active clean out activities.

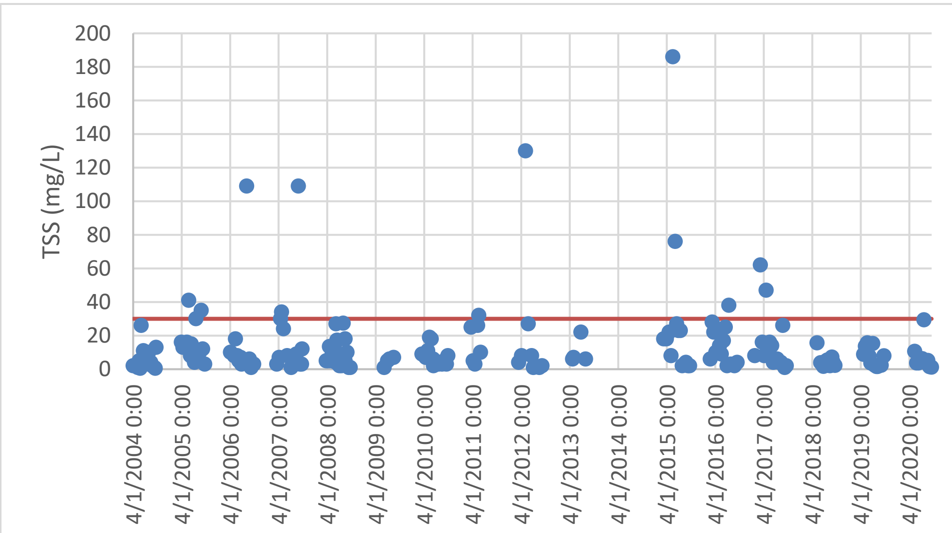


Figure 84. TSS data collected on Getchell Creek.

Conductivity

Specific conductivity was within range in the instantaneous sonde readings (Table 38) and the sonde deployment in 2020. One high value was noted (910 µS) in 2020, but was most likely linked to a high precipitation event, and the other values appear to be within range. Therefore, specific conductivity does not appear to be a stressor to aquatic life within Getchell Creek.

Temperature

Temperature data collected during the instantaneous sonde readings (Table 38), and the 2020 sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was initially classified as fair (MSHA score >45 and <65) to good (MSHA score >66) during the first round of monitoring in 2008 at 00UM039 and 10UM142 in 2010 (Table 39). However, Getchell Creek was part of a ditch clean out plan, which re-dredged parts of the stream channel. After the cleanout was finished in 2017, the creek was sampled for fish and macroinvertebrates in 2018. MSHA assessments were completed during these samples, which indicated that the channel morphology of the creek has changed since 2008 and 2010. Pools, riffles, and runs were all noted in the initial MSHA results, but the 2018 results revealed that the riffles had been removed and the pools were almost all filled in with sediment. As a result of the loss of these habitat types, the channel development and depth variability categories of the MSHA channel morphology assessment dropped significantly. Therefore, lack of habitat is a stressor to the aquatic life in Getchell Creek.

Table 39. MSHA evaluations for Getchell Creek.

MSHA Component	00UM039 2008 Fish Sample	00UM039 2010 Fish Sample	00UM039 Early 2018 Fish Sample	00UM039 Late 2018 Fish Sample	00UM039 Macroinvertebrate Sample	10UM142 2010 Fish Sample	Maximum Poss. Score
Land Use	0	0	1.5	1	1	0	5
Riparian	9	10.5	6.5	7	3.5	10	14
Substrate	18.8	18.5	21.7	19	19	17.4	28
Cover	16	13	13	11	13	11	18
Channel Morphology	21	26	8	6	6	22	35
Total MSHA Score	64.8	68	50.7	44	42.5	60.4	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Getchell Creek, and the entire Lower Getchell Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the historic channelization of the natural streams. Getchell Creek has been straightened along most of the AUID, with a small portion near the Sauk River remaining natural. Due to the historic and most recent channelization of Getchell Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks are showing signs of erosion. The MSHA evaluation for erosion indicated the erosion as light (25% through 50%), but the bank appear to be recovering with evidence of perennial grasses in areas that were bare after the clean out. In 2012, the banks of Getchell Creek were examined by the MPCA SID staff and it was determined that due to cattle access in several areas of the creek, the banks were actively eroding (MPCA 2012). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion. Getchell Creek is also receiving sediment from the upstream section of Getchell Creek and Unnamed Creek (AUID -615) which forms the headwaters of the creek. Therefore, altered hydrology has played a role in stressing the aquatic life in Getchell Creek, and is considered a stressor.

Connectivity

There are road crossings close to the biological monitoring stations and several road and cattle crossings further downstream on Getchell Creek. The culvert crossing by 00UM039 off CR 176 and the bridge over CSAH 12 at 10UM142 do not appear to be fish barriers. The cattle crossing off CR 176 also does not appear to be a barrier. Therefore connectivity does not appear to be a stressor to the aquatic life in Getchell Creek.

Stressor signals from biology

Fish

Fish were sampled at 00UM039 (2008; 2010) and 10UM142 (2010) as part of the cycle I watershed monitoring effort. The 2008 FIBI score for 00UM039 was one point above the general use IBI threshold, while the 2010 IBI score was 6 points below the threshold. Station 10UM142 is farther downstream, and was sampled once in 2010, which produced an IBI score that was right at the impairment threshold of 47. Some sensitive species have been found in this reach (Longnose Dace, Blacknose Shiner, Hornyhead Chub, Logperch), but the fish community is numerically dominated by more tolerant species (White Sucker, Common Shiner). Assessments using these fish data indicated that the fish community was right on the edge of impairment, but was not listed as impaired at that time. In 2018, 00UM039 was resampled as part of the cycle II watershed monitoring effort. Two separate fish samples were collected as part of this monitoring. Similar to 2008 and 2010, 18 species were collected during the first sample, with some sensitive species collected (Longnose Dace, Hornyhead Chub, Logperch), but the fish community is numerically dominated by more tolerant species (Blacknose Dace and Fathead Minnow). In July of 2018, an additional fish survey was collected at the same station which yielded a similar sample community. The resulting IBI scores were both well below the threshold. A notable decline in sensitive species such as Hornyhead Chub is evident between the 2010 and 2018 samples, with the complete disappearance of Blacknose Shiner in 2018. This decline in the fish community resulted in a new fish impairment in 2020.

Tolerance probabilities for TSS were calculated for Getchell Creek using the fish communities collected in 2008, 2010, and 2018. The probability of the fish community coming from a stream that is meeting the TSS standard was relatively high (72%) in 2008, and slightly declined in 2018 (62%; 65%). Although the percentages dropped, several TSS intolerant and sensitive fish species were captured in all of the fish samples. Therefore fish community response combined with the low TSS values in the grab sampling, TSS is not considered a stressor to the fish community in Getchell Creek at this time.

Tolerance probabilities for DO were also calculated for Getchell Creek using the fish communities. Interestingly, the DO probability percentages remained relatively high across all of the samples, yet no DO intolerant species were collected. Also, a few low DO sensitive fish were collected, but several species (8) considered to be tolerant or very tolerant (5) to low DO were collected in all of the samples. Although the tolerance probability percentage is relatively high for some of the fish samples, low DO does appear to be a stressor with no low DO intolerant fish and several low DO tolerant fish collected.

Nitrogen tolerance within the fish community was also investigated for Getchell Creek. On average, 5.9% of the fish species collected are sensitive to elevated nitrogen. However, an average of 61% of the fish are tolerant, and an average of 8.4% of the fish are very tolerant of elevated nitrogen. No nitrogen intolerant fish were collected, and an average of eight tolerant fish were collected in Getchell Creek. The prevalence of nitrogen tolerant fish species in both samples indicates that elevated nitrogen is affecting the fish community, but the biggest impact from the elevated inorganic nitrogen is through eutrophication.

Phosphorus tolerance of the fish community was also investigated in Getchell Creek using the fish species characteristics. Throughout all five fish samples, an average of two species that are sensitive to elevated phosphorus were collected. Similarly, an average of three tolerant species and two very tolerant species were also collected. No fish species that are intolerant of phosphorus were collected in any of the five fish samples. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values, indicates that phosphorus is a stressor to the fish community in Getchell Creek.

Macroinvertebrates

Macroinvertebrates were sampled six times throughout 2008, 2011, and 2018 as part of the watershed monitoring efforts. On average, 79.8% of the macroinvertebrate communities that were sampled were comprised of taxa that are considered to be tolerant of pollutants, and an average of 39.4% of the community was considered to be very tolerant of pollutants. The most dominate taxa collected a 00UM039 was *Hyalella* and the most dominate taxa collected at 10UM142 was *Simulium*. These taxa are considered very tolerant.

TSS taxa tolerance was investigated using the macroinvertebrate communities. Multiple macroinvertebrate taxa that are intolerant of elevated TSS were collected during all six samples (Table 40). However, these samples were dominated by taxa that considered tolerant or very tolerant of elevated TSS. Overall the macroinvertebrate community within Getchell Creek indicates that TSS may be a stressor, but is not conclusive as both intolerant and tolerant taxa were prevalent in the samples.

DO tolerance was also investigated using the macroinvertebrate communities. Similar to the TSS tolerance indicators, multiple macroinvertebrate taxa that are intolerant of low DO were collected during all six samples (Table 40). However, these samples were dominated by taxa that considered tolerant or very tolerant of low DO. Overall the macroinvertebrate community within Getchell Creek indicates that low DO may be a stressor, but is not conclusive as both intolerant and tolerant taxa were prevalent in the samples.

Additionally, nitrogen tolerance was investigated within the macroinvertebrate communities. Multiple macroinvertebrate taxa that are intolerant of elevated nitrogen were collected during all six samples (Table 40). However, these samples were dominated by taxa that are considered tolerant or very tolerant of elevated nitrogen. Overall the macroinvertebrate community within Getchell Creek indicates that elevated nitrogen maybe a stressor, but is not conclusive as both intolerant and tolerant taxa were prevalent in the samples. The elevated nitrogen values are most likely affecting the macroinvertebrate community, but the biggest impact from the elevated inorganic nitrogen is through eutrophication.

The final tolerance indicator that was investigated within the macroinvertebrate community was phosphorus tolerance. During the initial sampling in 2008, no taxa that are considered intolerant to elevated phosphorus were found in Getchell Creek (Table 40). However, a few intolerant taxa were collected in the later samples (2011; 2018). Although these few intolerant taxa were collected in the later samples, all of the macroinvertebrate samples from Getchell Creek were dominated by taxa that are considered either tolerant or very tolerant of elevated phosphorus. These tolerance indicators within the macroinvertebrate community indicate that phosphorus is a stressor to the macroinvertebrate community.

Table 40. Macroinvertebrate tolerance indicators within Getchell Creek.

Bio. Station	Sample Date	Parameter	# of Intolerant taxa	# of Tolerant taxa	# of Very Tolerant taxa
00UM039	8/26/2008	DO	2	9	5
00UM039	8/26/2008	DO	1	9	3
00UM039	9/27/2011	DO	1	13	6
10UM142	9/27/2011	DO	3	5	1
00UM039	8/21/2018	DO	3	8	0
00UM039	8/26/2008	Nitrogen	2	13	0
00UM039	8/26/2008	Nitrogen	3	12	7
00UM039	9/27/2011	Nitrogen	7	17	14
10UM142	9/27/2011	Nitrogen	4	12	7
00UM039	8/21/2018	Nitrogen	2	16	12
00UM039	8/26/2008	Phosphorus	0	11	4
00UM039	8/26/2008	Phosphorus	0	12	6
00UM039	9/27/2011	Phosphorus	2	17	10
10UM142	9/27/2011	Phosphorus	1	10	6
00UM039	8/21/2018	Phosphorus	2	10	3
00UM039	8/26/2008	TSS	0	10	4
00UM039	8/26/2008	TSS	1	11	4
00UM039	9/27/2011	TSS	2	16	7
10UM142	9/27/2011	TSS	1	10	5
00UM039	8/21/2018	TSS	2	11	5

Composite conclusion from biology

The fish and macroinvertebrates in Getchell Creek are indicating that low DO and elevated phosphorus are stressors to the aquatic life within Getchell Creek.

Inorganic nitrogen may be impacting the fish and macroinvertebrates, but the biggest impact from the elevated inorganic nitrogen is through eutrophication.

TSS does not appear to be a stressor to the biology.

Conclusions about stressors

One of the primary stressors to the biology within Getchell Creek is the lack of a stable and healthy DO regime. Poor DO within Getchell Creek is the result of multiple contributing factors; flow regime modification, upstream connection with wetlands, and excessive algal and macrophyte growth fueled by excessive nutrients (inorganic nitrogen and phosphorus). Dredging and straightening of the stream channel for drainage, with the addition of tile drainage systems, has changed the natural flow pattern in Getchell Creek. This channel alteration accelerates stream flow, resulting in higher flows during precipitation events, which achieves the agricultural land use drainage goals, but causes instability. Water leaves the landscape quickly, and the stream experiences periods of higher flow with the influx of oxygen deprived water reducing the DO levels within the stream. As flows quickly drain, the flow regime quickly transitions to low flow, further reducing the capacity to maintain healthy DO levels. Additionally, during these high flow periods the lower DO water that is held in the upstream ditches (Unnamed Creek – AUID -615) and lakes, is flushed down into the lower portions of Getchell Creek. This flow alteration, combined with excessive nutrients, further compounds the DO issue in Getchell Creek. Algae and macrophytes utilize the excess nutrients, resulting in excessive growth completely covering the entire stream channel. During the daylight hours these plants photosynthesize and produce oxygen, in excess of 21.36 mg/L, and then consume that same DO during after sundown, causing large fluctuations in DO. This unstable DO has allowed fish species like the Fathead Minnow and White Sucker to thrive within Getchell Creek. However, it has impeded the ability for more sensitive species like the Hornyhead Chub to survive. Similarly, although the macroinvertebrate community is not impaired at this time, there are signals of stress with *Hyalella* dominating the macroinvertebrate samples.

Additional stressors to the biology within Getchell Creek are elevated phosphorus and inorganic nitrogen. The excess nutrient levels are not only contributing to the DO instability, but are directly impacting the fish and macroinvertebrates. Multiple fish species and macroinvertebrate taxa that are tolerant to elevated phosphorus where found within the 2008, 2010, 2011, and 2018 samples. Similarly, a few nitrogen intolerant macroinvertebrate taxa were sampled in Getchell Creek, but many tolerant macroinvertebrate taxa and fish species dominated the samples.

Habitat loss from the historic channelization practices is another stressor to the biology in Getchell Creek. Poor sinuosity, poor channel development, and fine sediment were noted within the MSHA evaluation. These are the result of channel over widening and the physical habitat removal during the dredging process. Sensitive fish and macroinvertebrates require coarse substrate and good channel morphology to survive and reproduce. However, the pools and riffles have been manually removed, and the coarse substrate has been buried in sand and silt from the erosion and manipulation of the stream banks.

Recommendations

Careful consideration to runoff from local fields would be advantageous for Getchell Creek. Elevated nutrient levels are causing eutrophication, and if mitigated, could make the biggest impact to the creek.

Compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Stony Creek Subwatershed

The Stony Creek Subwatershed covers 16,500 acres from just northeast of Elrosa to the Sauk River, two miles NE of Spring Hill (Figure 85). There are 80.2% of the streams in the subwatershed that have been channelized, including all of the streams upstream of Hwy 4.

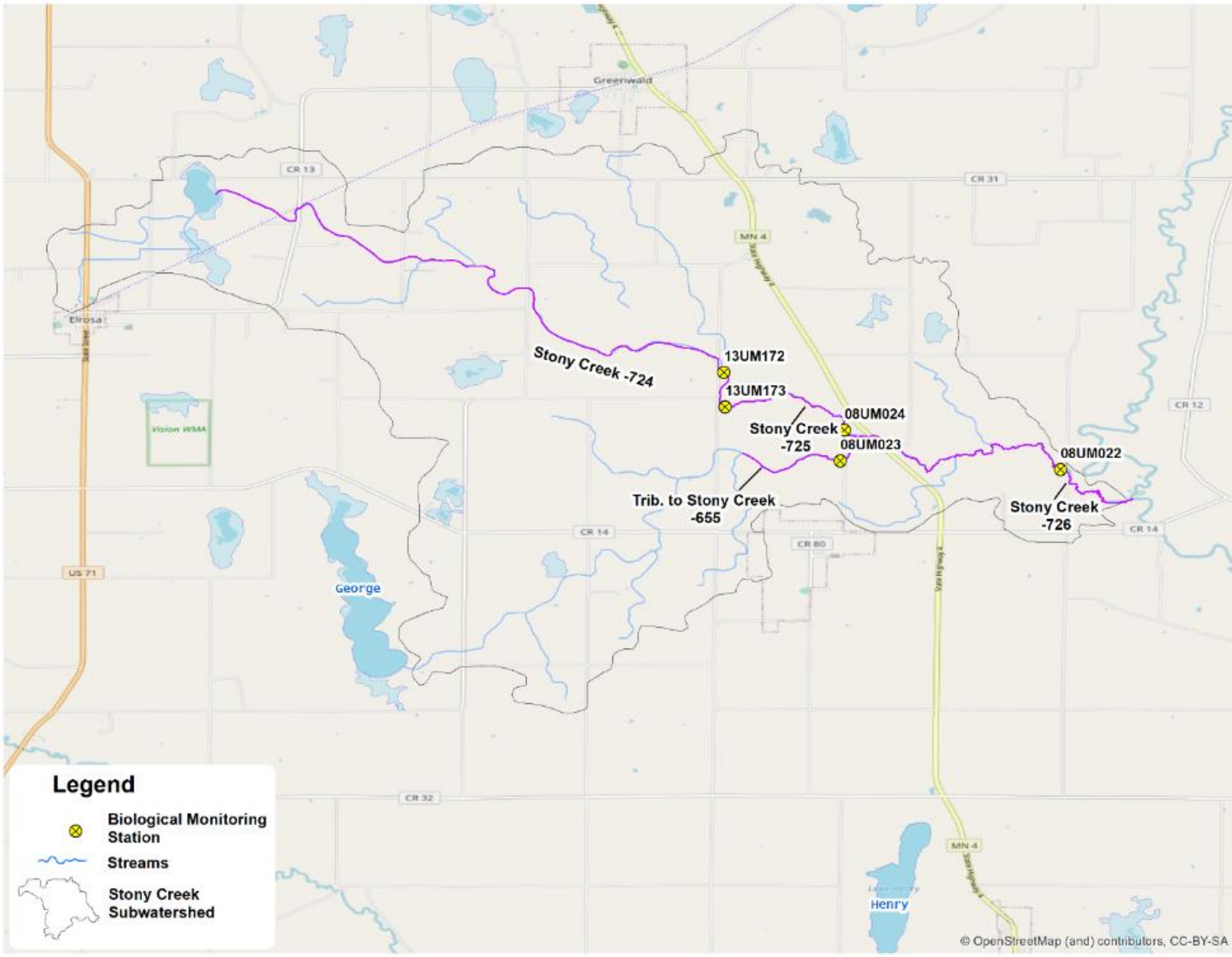


Figure 85. Biological monitoring stations in the Stony Creek Subwatershed.

The land use within the Stony Creek Subwatershed is dominated by cropland (86.3%) followed by wetlands (4.2%) (Figure 86).

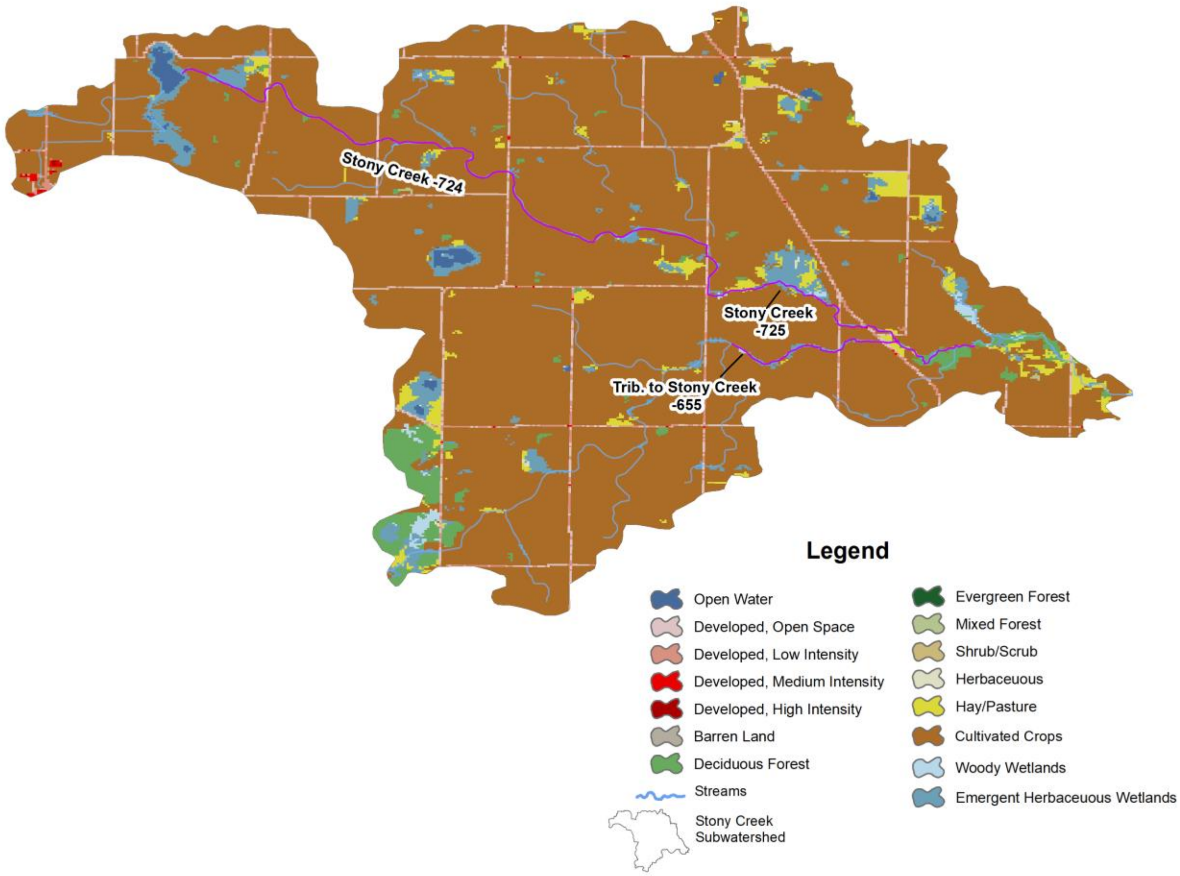


Figure 86. Land use in the Stony Creek Subwatershed.

Stony Creek (07010202-724)

Impairment: Stony Creek (AUID -724) flows for 6.6 miles from Unnamed Lake (73-0261-00) to just downstream of 353rd Avenue, two miles northwest of Spring Hill (Figure 85). This section of Stony Creek has been channelized throughout the entire reach. There are two biological monitoring stations (13UM172, 13UM173) that were originally sampled on AUID -724 for fish in 2013. Macroinvertebrates were not sampled. Assessments were completed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Stony Creek should be assessed under the modified use criteria. These assessments resulted in a new impairment for fish. The fish class at station 13UM172 is class 7 (Low Gradient) and the fish class at station 13UM173 is class 6 (Northern Headwaters).

Data and Analyses

Chemistry

Water chemistry has been collected at S012-609 (13UM172) with instantaneous sonde readings in the summer of 2020 (Table 41).

Table 41. Water chemistry data collected at S012-609. Full dataset available at https://webapp.pca.state.mn.us/surface-water/station/S012-609.

Parameter	Sample Count	Sample Count Above the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
DO	16	0	5.0 mg/L	7.98 mg/L	5.05 mg/L	16.11 mg/L
Conductivity	16	N/A	N/A	790.3 µS	297.9 µS	1036.0 µS
Water Temp	16	N/A	N/A	18.44° C	10.44° C	22.69° C

Dissolved Oxygen

DO data was collected from Stony Creek in 2020. These data show that the DO levels within Stony Creek are above the 5 mg/L throughout the summer (Table 41). Therefore, DO does not appear to be a stressor to the aquatic life within Stony Creek.

Conductivity

Specific conductivity was within range during the 2020 sampling (Table 41). One high value was noted (1036 µS) in 2020, but was most likely linked to a high precipitation event, and the other values appear to be within range. Therefore, specific conductivity does not appear to be a stressor to aquatic life within Stony Creek.

Temperature

Temperature data collected on Stony Creek in 2020 (Table 41), showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Stony Creek, through MSHA evaluations during the fish samples in 2013 (Table 42). Due to the historic channelization of Stony Creek, and fair MSHA score, the assessment of Stony Creek was brought into the UAA process. It was determined that the habitat of Stony Creek has been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization.

Table 42. MSHA evaluations on Stony Creek in 2013.

MSHA Component	13UM172	13UM173	Maximum Poss. Score
Land Use	0	0	5
Riparian	12	15	14
Substrate	9	20	28
Cover	10	14	18
Channel Morphology	7	16	35
Total MSHA Score	38 = Fair	65 = Fair	100

The overall habitat of Stony Creek was rated as fair; however, two of the lower scoring categories are particularly important for aquatic life, substrate and channel morphology. Substrate is an important component of overall stream habitat, as sensitive fish and macroinvertebrates require clean coarse substrate. Sand and silt were the dominate substrates that were found, with small patches of gravel noted at the downstream station. Channel morphology was another low scoring component of the MSHA evaluation. The MSHA indicated that there was no channel depth variability, poor/fair sinuosity, and poor/fair channel development (poorly defined riffles and small pools). Fish and macroinvertebrates need channel depth variability to use as cover from predation and refuge during high precipitation events. No change in the channel depth combined with no sinuosity and poor channel development impedes the fish and macroinvertebrates ability to inhabit the creek throughout the summer, especially during high flow events, which can flush these communities far downstream. The lack of good channel morphology is caused by the channelization of the creek, as the manipulation of the channel has been designed to move water quickly, by mechanically removing channel sinuosity and connecting the channel to the upstream wetlands. Therefore, lack of habitat is a stressor to the aquatic life in Stony Creek.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Stony Creek, and the entire Stony Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Stony Creek has been straightened along the entire length of the AUID.

Due to the channelization of Stony Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion was rated as none (<5%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion.

In addition to the channelization of Stony Creek, road crossings and the construction of a concrete weir have altered the natural hydrology of the creek. The culverts at the 353rd Avenue crossing are stacked, and the bottom culvert has been plugged with sediment (Figure 87). Therefore, the water level needs to rise to the upper culvert in order to pass through. As the water reaches this culvert during precipitation events, a cyclone appears and the water is quickly flushed downstream (Figure 88). Due to the channelization of the stream channel and the crossing issues, altered hydrology has played a role in stressing the aquatic life in Stony Creek, and is considered a stressor.

Figure 87. Low flow conditions at the culvert crossing near 13UM172.

Figure 88. High flow conditions at the culvert crossing near 13UM172.

Connectivity

There is one road crossing close to the biological monitoring station (353rd Ave) and several road and field crossings further downstream on Stony Creek. The culverts at the 353rd Avenue crossing are fish barriers, as during low flow the overall flow is almost nonexistent, and during high flow the culverts become velocity barriers.

In addition to the culvert barrier off 353rd Avenue, the culvert crossing at the downstream AUID (-725) has a small weir that is a fish barrier that is blocking passage between AUID -724 and -725 off 343rd Avenue (Figure 89).

Figure 89. Weir structure upstream of the 343rd culvert crossing on Stony Creek.

It is possible that the other road and field crossings may be fish barriers, but reviewing aerial photography, it appears as though the culverts are properly placed to allow for fish passage. Overall, due to the fish barriers, connectivity is a primary stressor within Stony Creek.

Stressor signals from biology

Fish

Fish were initially sampled in 2013 at 13UM172 and 13UM173 as part of the cycle I watershed monitoring effort. The fish sample from 13UM172 yielded a total of seven species, with Fathead Minnows being the most dominate. All seven species are considered to be tolerant of pollutants. Similarly, the 13UM173 fish sample contained six species, and was also dominated by Fathead Minnows. All six of these fish species are considered to be tolerant of pollutants, with Fathead Minnows being labeled as one of the most tolerant fish species within the State of Minnesota.

DO TIV scores were calculated for Stony Creek using the fish communities. This calculation indicated that the fish community from 13UM172 had a 16.1% probability of coming from a stream that was meeting the DO standard. Four of the seven fish species collected are considered to be very tolerant of low DO. Similarly the 13UM173 fish community had a 21.1% probability of coming from a stream that was meeting the DO standard. Three of the fish species collected in 13UM173 are considered to be very tolerant of low DO. The combined fish samples indicate that DO is a stressor to the fish community within Stony Creek; however, the DO sampling indicates that DO is not a stressor. Therefore, more DO data would need to be collected in Stony Creek to make a final determination; however, the fish barriers could be blocking sensitive fishes from reaching AUID -724.

Macroinvertebrates

Macroinvertebrates were not sampled on Stony Creek.

Composite conclusion from biology

Lack of habitat due to altered hydrology and connectivity are the primary stressors to the fish community within Stony Creek.

The fish within Stony Creek are indicating that DO is a stressor; however, DO levels were good during the instantaneous sonde readings.

Macroinvertebrates were not sampled on Stony Creek.

Recommendations

Replace the culverts off 353rd Avenue with an AOP approved design, to allow for sediment and fish passage to the upstream portions of the Creek.

Remove the weir that is upstream of the 343rd Avenue crossing.

Stony Creek (07010202-725)

Impairment: Stony Creek (AUID -725) flows for 2.3 miles, starting just upstream of 343rd Avenue at the end of the previous section of Stony Creek (AUID -724). AUID -725 ends just downstream of its confluence with AUID -655, Tributary to Stony Creek (Figure 85). There is one biological monitoring station (08UM024) that was sampled for fish and macroinvertebrates in 2008, and then repeated in 2018. Assessments were completed in early 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Stony Creek should be assessed under the general use criteria, due to fair habitat. It was also determined that Stony Creek should be considered a coldwater stream, due to cold water temperatures and previous trout water management by DNR. These assessments resulted in new impairments for fish and macroinvertebrates. In 2020, the assessment of Stony Creek was repeated using the 2018 biological monitoring data. These assessments confirmed the fish and macroinvertebrate impairments. The fish class is class 11 (Northern Coldwater) and the macroinvertebrate stream class is class 9 (Southern Coldwater).

Data and Analyses

Chemistry

Water chemistry data has been collected at 08UM024 (S010-893) in the summer of 2020.

Table 43. Water chemistry data collected at S010-893. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S010-893.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
DO	18	2	5.0 mg/L	8.45 mg/L	4.38 mg/L	11.67 mg/L
Water Temp	18	N/A	N/A	15.72° C	3.31° C	19.87° C
Sp. Conductivity	18	N/A	N/A	766.91 µS	383.2 µS	889.0 µS

Dissolved Oxygen

DO data was collected from Stony Creek in 2020. These data show that 88.8% of the DO values within the instantaneous sonde reading dataset (Table 43) were above the 7 mg/L standard. In addition to the instantaneous readings, a continuous sonde was placed in the creek from 7/21/2020 to 8/5/2020. 55.7% of the DO values within the continuous sonde dataset were above the standard, indicating that the DO levels within Stony Creek frequently drop below the standard. Due to the DO levels within Stony Creek not meeting standards, DO is a stressor to the aquatic life within Stony Creek.

Transparency and suspended solids

Due to the TSS impairment at the downstream AUID (-726) Secchi readings were collected during the instantaneous sonde readings. Almost all of the Secchi readings were >100 cm in clarity, with three exceptions. During precipitation events, the clarity in Stony Creek dropped significantly, with Secchi readings of 7cm and 10 cm (Figure 90). Therefore, due to the downstream TSS impairment, and the low Secchi reading, TSS is considered to be a secondary stressor in AUID -725. However, more TSS data should be collected on -725 during precipitation events, to determine if TSS is above the standard.

Figure 90. Secchi tube reading from Stony Creek after a storm event in July 2020.

Conductivity

Specific conductivity was within range during the instantaneous sonde readings (Table 43) and during the sonde deployment. Therefore, specific conductivity does not appear to be a stressor to aquatic life within Stony Creek.

Temperature

Temperature data collected during the instantaneous sonde readings (Table 43), and the sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair on Stony Creek, through MSHA evaluations during the biological monitoring samples (Table 44). Due to the historic channelization of Stony Creek, and fair MSHA score, the assessment of Stony Creek was brought into the UAA process. It was determined that the habitat of Stony Creek has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Stony Creek was assessed using the General Use TALU criteria. Due to some of the categories scoring well, including channel morphology and substrate, habitat is not considered to be a stressor within Stony Creek.

Table 44. Average MSHA score on Stony Creek.

MSHA Component	Avg. Score 08UM024	Maximum Poss. Score
Land Use	0	5
Riparian	10	14
Substrate	21.1	28
Cover	12	18
Channel Morphology	19.5	35
Total MSHA Score	62.6 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Stony Creek and the entire Stony Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Stony Creek has been straightened along the entire length of the AUID.

Due to the channelization of Stony Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion noted that no erosion was present. Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from the landscape or unnatural bank erosion. Therefore, altered hydrology has played a role in stressing the aquatic life in Stony Creek, and is considered a secondary stressor.

In 2020, a water level logger was placed in Stony Creek to monitor the flow throughout the summer. These data indicated that there is perennial flow within the channel throughout the summer, and therefore, flow does not appear to be a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on Stony Creek. The culvert crossing by 08UM024 off 343rd Avenue does not appear to be a fish barrier. However, the weir that has been placed upstream of the culvert that is a fish barrier to -724, is also a barrier to -725 (Figure 89). It is possible that the other road and field crossings may be fish barriers, but reviewing aerial photography, it appears as though the culverts are properly placed to allow for fish passage. Due to the weir, connectivity is a primary stressor to the aquatic life within Stony Creek.

Stressor signals from biology

Fish

Fish were initially sampled twice in 2008 as part of the cycle I watershed monitoring effort and then sampled again in 2018 for the second cycle of monitoring. The first fish sample from 2008 yielded a total of seven species, with Fathead Minnows being the most dominate. Two Brook Trout were also captured within this sample. All of the species that were collected, besides the Brook Trout, are considered to be tolerant of pollutants. The second sample in 2008 contained a total of six species, with Creek Chubs dominating the sample. No Brook Trout were collected within this sample, and all six species are considered to be tolerant of pollutants. Similarly, the 2018 fish sample contained seven species, and was dominated by Fathead Minnows. No Brook Trout were collected, and six of the seven fish species were considered to be tolerant of pollutants, with Fathead Minnows being labeled as one of the most tolerant fish species within the State of Minnesota.

DO TIV scores were calculated for Stony Creek using the fish communities. This calculation indicated that the fish community from 08UM024 had a 44.7% (08 First Sample), 58.6% (08 Second Sample), and 33.7% (2018 Sample) probability of coming from a stream that was meeting the DO standard. All of the fish species that were collected within the three samples were considered to be tolerant or very tolerant of low DO, with the exception of the two Brook trout that were collected in the first 2008 sample. The fish TIV scores combined with the low DO values within the sonde deployment, indicates that DO is a stressor to the fish community within Stony Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2008 and 2018 as part of the watershed monitoring efforts. 71.4% of the macroinvertebrate community that was sampled in 2008 was comprised of taxa that are considered to be tolerant of pollutants, and 30.9% of the community was considered to be very tolerant of pollutants. Similarly, the 2018 macroinvertebrate community was comprised of 90.9% tolerant taxa and 42.4% very tolerant taxa. *Ceratopsyche* and *Hyalella* dominated the 2008 sample and *Micropsectra* dominated the 2018 sample.

DO tolerance was investigated using the macroinvertebrate communities. Both macroinvertebrate samples contained a healthy mix of very intolerant and tolerant taxa (Table 45), which indicated that DO is not a stressor to the macroinvertebrate community.

Table 45. Macroinvertebrate DO tolerance indicators in Stony Creek.

Sample Year	Parameter	# Very Intolerant	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008	DO	3	5	9	3
2018	DO	2	4	6	1

Composite conclusion from biology

The fish within Stony Creek indicate that DO is a stressor, and the DO was below the threshold for cold water streams for a good portion of the dataset. However, the macroinvertebrate community indicated that DO is not a stressor within Stony Creek, with a healthy mixture of very intolerant and tolerant taxa. Therefore, it is likely that connectivity is the primary stressor within Stony Creek, which has impeded the ability for sensitive fishes to reach upstream of 343rd Avenue.

Recommendations

Removal of the weir upstream of 343rd Avenue would make the biggest impact for Stony Creek.

Careful consideration to runoff from local fields would be advantageous for Stony Creek. Elevated TSS levels are causing a TSS impairment downstream, and maybe impacting -725.

Compliance with the Buffer Law will help avoid erosion issues. Most of the creek has a nice wide buffer although, there are places where row crop fields are close to the creek.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Tributary to Stony Creek (07010202-655)

Impairment: The Tributary to Stony Creek flows for 1.5 miles from 353rd Avenue to the confluence with Stony Creek, downstream of Hwy 4 (Figure 85). There is one biological monitoring station (08UM023) that was sampled for fish in 2008. Macroinvertebrates were not sampled due to low water conditions in 2008. Assessments for Tributary to Stony Creek were completed in 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Tributary to Stony Creek should be assessed under the general use criteria, due to fair habitat. This assessment resulted in a new impairment for fish. The fish class is class 6 (Northern Headwaters).

Data and Analyses

Chemistry

Water chemistry data has been collected at 08UM023 (S010-892) in the summer of 2020 (Table 46).

Table 46. Water chemistry data collected at S010-893. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S010-892.

Parameter	Sample Count	Samples Exceeding the Respective Threshold	Applicable Standard	Average	Minimum	Maximum
DO	17	1	5.0 mg/L	8.42 mg/L	4.96 mg/L	10.83 mg/L
Water Temp	17	N/A	N/A	18.94° C	11.37° C	22.88° C
Sp. Conductivity	17	N/A	N/A	661.91 µS	491.5 µS	780 µS

Dissolved Oxygen

DO data was collected from the Tributary to Stony Creek in 2020. These data show that 94.1% of the DO values within the instantaneous sonde reading dataset (Table 46) were above the 5 mg/L standard. In addition to the instantaneous readings, a continuous sonde was placed in the creek from 7/21/2020-8/5/2020. These data confirmed that the DO levels are above the standard within the Tributary to Stony Creek. Due to the DO levels within the Tributary to Stony Creek meeting standards, DO is not a stressor to the aquatic life within the Tributary to Stony Creek.

Conductivity

Specific conductivity was within range during the instantaneous sonde readings (Table 46) and during the sonde deployment. Therefore, specific conductivity does not appear to be a stressor to aquatic life within the Tributary to Stony Creek.

Temperature

Temperature data collected during the instantaneous sonde readings (Table 46), and the sonde deployment, showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as good on the Tributary to Stony Creek, through MSHA evaluations during the fish sample (Table 47). Due to the historic channelization of the Tributary to Stony Creek, the assessment of the Tributary to Stony Creek was brought into the UAA process. It was determined that the habitat of the Tributary to Stony Creek has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Tributary to Stony Creek was assessed using the General Use TALU criteria. Due to the high MSHA score, including good channel morphology and substrate scores, habitat is not a stressor to the aquatic life in the Tributary to Stony Creek.

Table 47. MSHA evaluation of the Tributary to Stony Creek, at the fish sample in 2008.

MSHA Component	Tributary To Stony Creek	Maximum Poss. Score
Land Use	0	5
Riparian	13	14
Substrate	17.9	28
Cover	12	18
Channel Morphology	33	35
Total MSHA Score	75.9 = Good	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of the Tributary to Stony Creek, and the entire Stony Creek Subwatershed. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. The Tributary to Stony Creek has been straightened along the entire length of the AUID.

Historically, the Tributary to Stony Creek was short and sinuous (Figure 91), but the reach has been extended to drain the southwestern portion of the subwatershed (Figure 92).

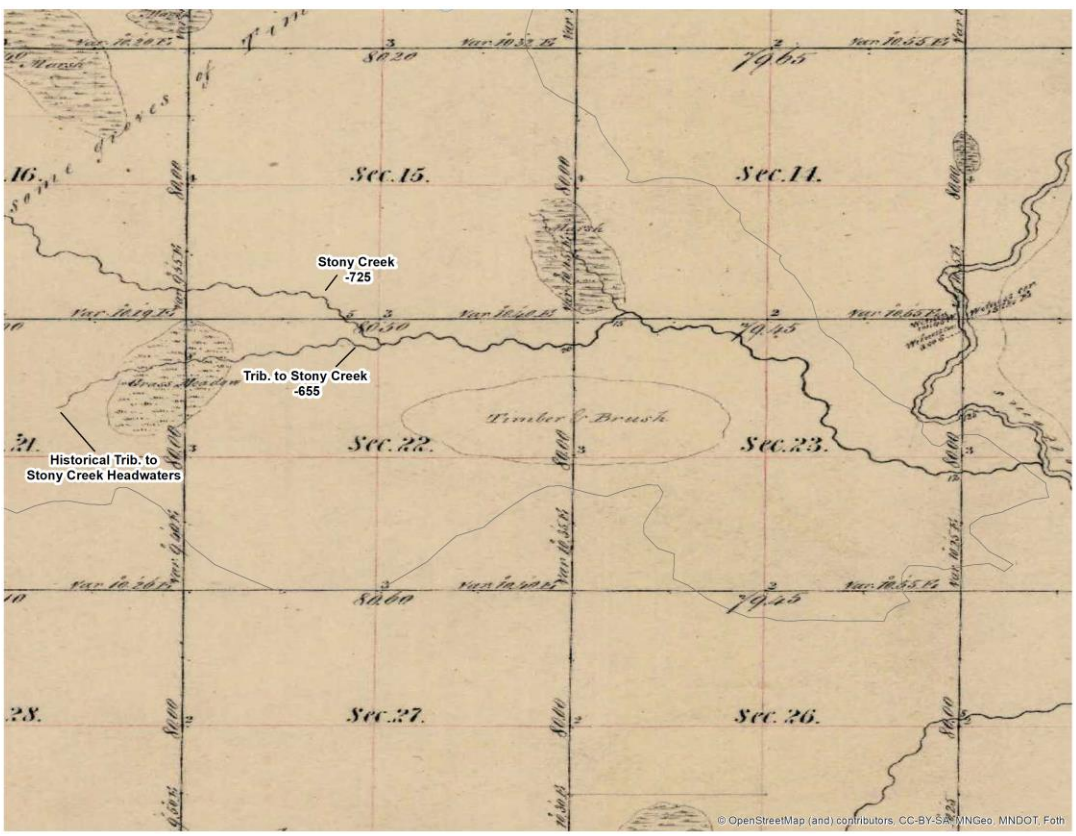


Figure 91. Historical flow pattern of the Tributary to Stony Creek, pre-settlement.

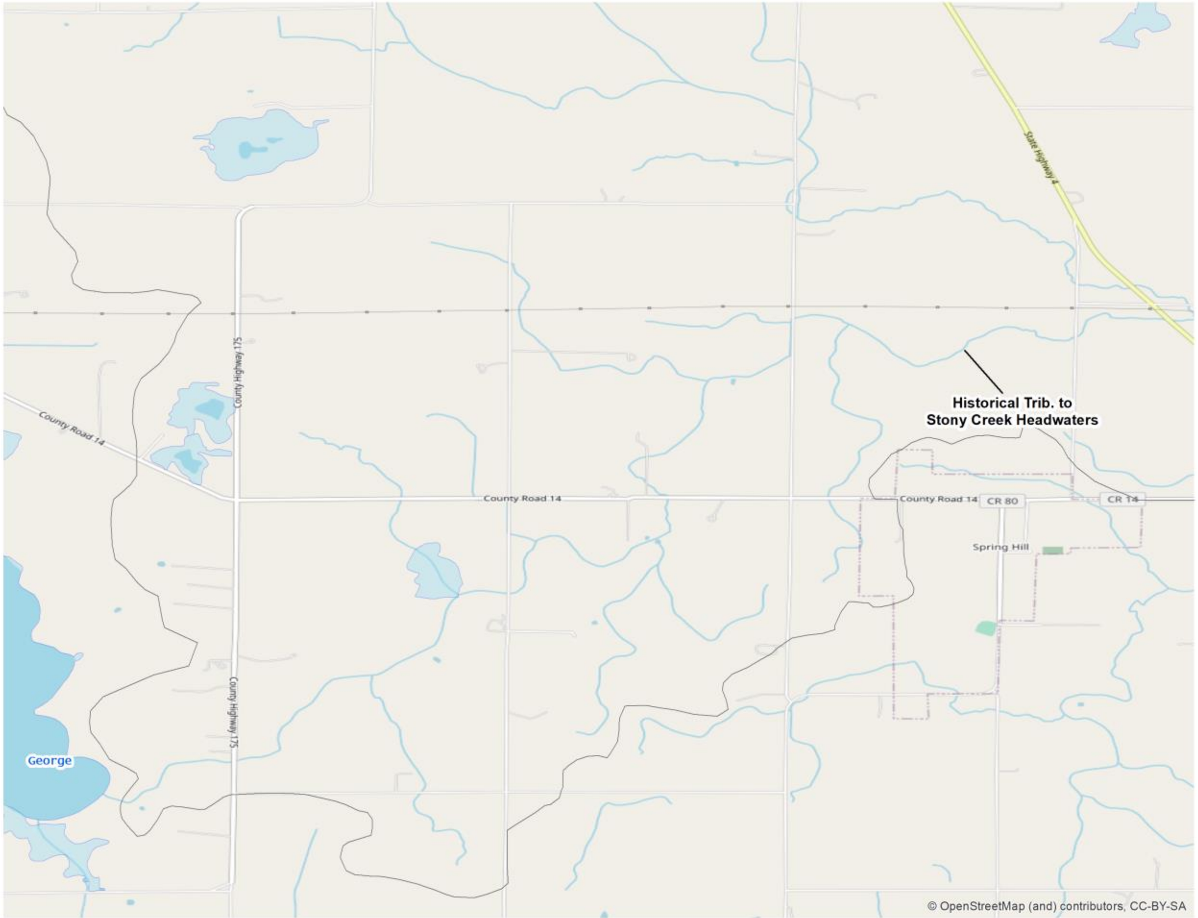


Figure 92. Modern day flow pattern of the Tributary to Stony Creek.

In addition to the new drainage ditches that were connected to the headwaters of Tributary to Stony Creek, an impoundment was formed at the headwaters of the historic channel (Figure 93).

Figure 93. Impoundment on the Tributary to Stony Creek, located at the historical creek headwaters.

The additional flow from the headwater ditches is collected in the pool above the impoundment. During precipitation events, the water washes over the impoundment, carrying sediment downstream as can be seen but the additional sediment filling in the culvert crossing by 08UM023 (Figure 94).

Figure 94. Suspended sediment after a storm event, and the resulting plugging of the culvert.

As the additional flow continues downstream, it reaches AUID -725, and then becomes AUID -726. Although the downstream reaches of Stony Creek have remained natural, the banks have become unstable (MPCA 2012) near the confluence with the Sauk River. This instability may have been caused by the additional flow from the headwaters of the Tributary to Stony Creek that would not have naturally reached Stony Creek. Therefore, altered hydrology has played a role in stressing the aquatic life in the Tributary to Stony Creek, and is considered a stressor.

In 2020, a water level logger was placed in the Tributary to Stony Creek to monitor the flow throughout the summer. These data indicated that there is perennial flow within the channel throughout the summer, and therefore, flow does not appear to be a stressor.

Connectivity

There is one road crossing close to the biological monitoring station and several road and field crossings further downstream on the Tributary to Stony Creek. The culvert crossing by 08UM023 off 343rd Avenue does not appear to be a fish barrier at this time; however, it is filling in with sediment and may become a barrier in the future. Reviewing aerial photography, there was a field crossing that appeared to be a barrier when the fish sample was collected in 2008; however, that crossing has been removed. Therefore, it is possible that the fish that would have been blocked from accessing the Creek in 2008, now have the ability to reach the biological monitoring station. Due to this blockage, connectivity is considered a stressor to the fish community that was collected in 2008.

Stressor signals from biology

Fish

Fish were sampled in 2008 as part of the cycle I watershed monitoring effort. This sample contained a total of eight species, with Creek Chubs being the most dominate. All eight species are considered to be tolerant of pollutants.

DO TIV scores were calculated for the Tributary to Stony Creek using the fish communities. This calculation indicated that the fish community had a 65.3% probability of coming from a stream that was meeting the DO standard. Four of the species that were collected were considered to be tolerant of low DO and three species were considered to be very tolerant of low DO. The fish sample indicates that DO is a stressor to the fish community within the Tributary to Stony Creek; however, the DO sampling indicates that DO is not a stressor.

Macroinvertebrates

Macroinvertebrates were not able to be effectively sampled in the Tributary to Stony Creek, due to low water levels in August of 2008.

Composite conclusion from biology

The fish within the Tributary to Stony Creek indicate that DO is a stressor; however, the DO was at healthy levels during the sonde deployment. Due to the good DO levels, the most likely cause of the absence of sensitive fish species was the failed field crossing that was blocking fish passage. Altered hydrology and connectivity are the primary stressors within the Tributary to Stony Creek.

Recommendations

Removal of the impoundment downstream of 353rd Avenue would help to mitigate the flushing of sediment downstream during high flow events.

A new fish sample would be beneficial to determine if the removal of the failed field crossing downstream of 343rd Avenue has helped to restore fish passage to the biological monitoring station.

Careful consideration to runoff from local fields would be advantageous for the Tributary to Stony Creek. Elevated TSS levels are causing a TSS impairment downstream, and maybe impacting -724.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Stony Creek (07010202-726)

Impairment: The furthest downstream AUID on Stony Creek (-726) was assessed in 2018 as part of the TALU assessment process for assessing channelized streams (Figure 85). The UAA process determined that Stony Creek should be assessed under the general use criteria, due to fair habitat. This assessment resulted in a new impairment for TSS. Following the 2018 biological monitoring, it was determined that fish were also failing to meet standards. The fish class is class 6 (Northern Headwaters).

Although the impairments were officially identified in 2018 and 2020, SID within Stony Creek was completed for AUID -726 in 2012 (MPCA 2012). The 2012 SID report indicated that sediment from the failing stream banks due to cattle trampling was the primary stressor for AUID -726. Due to the new TSS impairment and the fish community indicating that TSS is a stressor, no new SID field work was completed for this AUID.

Lake Henry-Sauk River Subwatershed

The Lake Henry-Sauk River Subwatershed covers 37,800 acres from 5 miles north of Paynesville to 6 miles northwest of St. Martin (Figure 95). 55.3% of the streams in the subwatershed have been channelized.

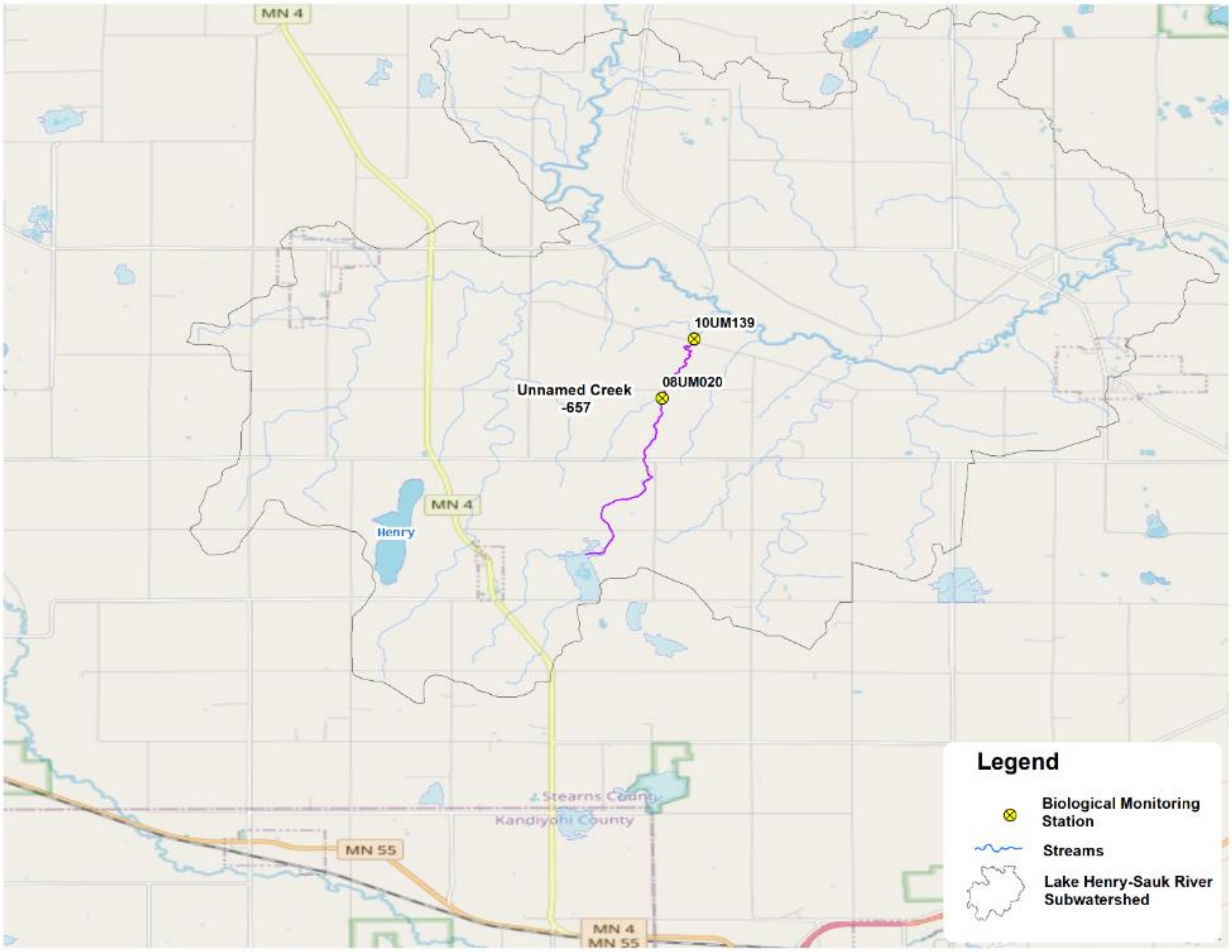


Figure 95. Biological monitoring stations in the Lake Henry-Sauk River Subwatershed.

The land use within the Lake Henry-Sauk River Subwatershed is dominated by cropland (82.1%) followed by rangeland (5.8%) and wetlands (4.2%) (Figure 96).

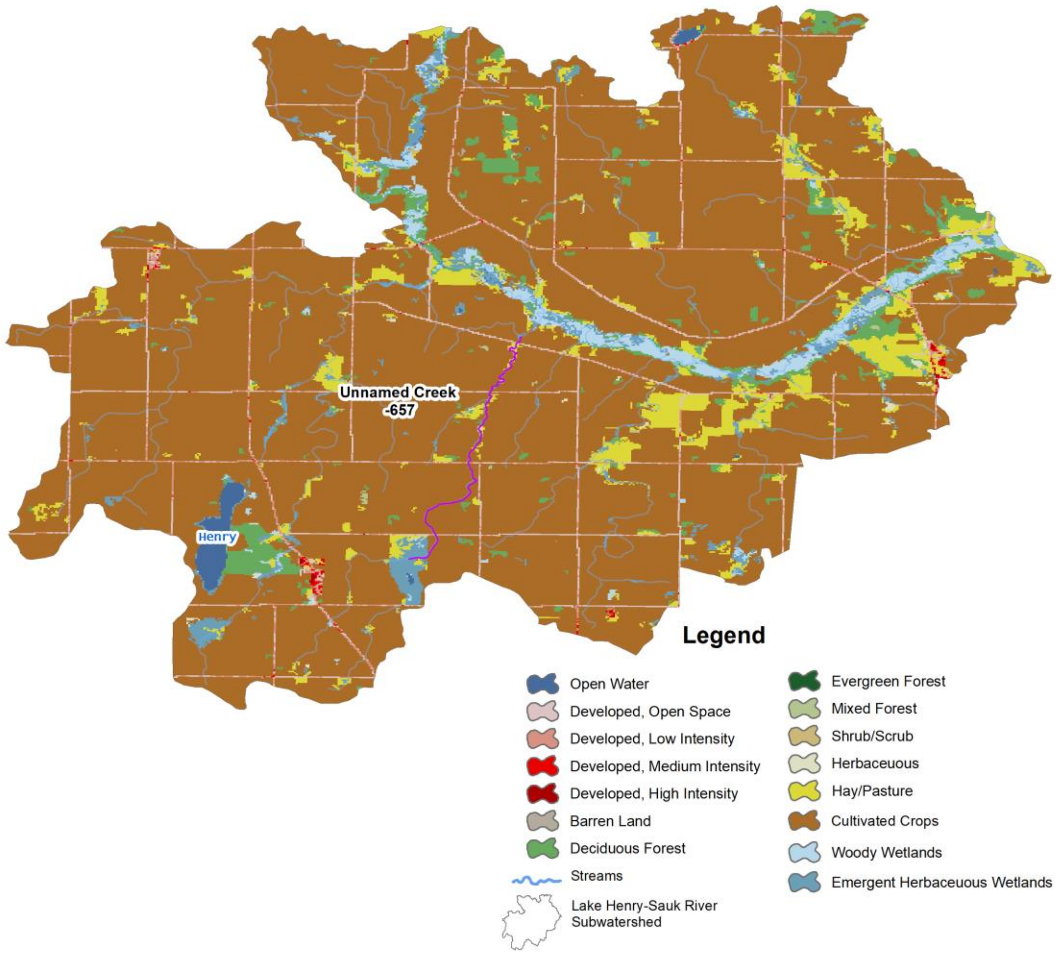


Figure 96. Land use in the Lake Henry-Sauk River Subwatershed.

Unnamed Creek (07010202-657)

Impairment: Unnamed Creek (AUID -657) flows for 4.2 miles from Unnamed Lake (73-0412-00) to just upstream of the confluence with the Sauk River (Figure 95). There are two biological monitoring stations (08UM020, 10UM139) that were sampled on Unnamed Creek. Biological monitoring station 08UM020 was sampled in 2008 and 10UM139 was sampled in 2010. Assessments were completed in early 2018 as part of the TALU assessment process for assessing channelized streams. The UAA process determined that Unnamed Creek should be assessed under the general use criteria, due to fair habitat. These assessments resulted in new impairments for fish and macroinvertebrates. The fish class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 7 (Prairie Streams Glide/Pool).

Data and Analyses

Chemistry

Water chemistry data is limited to a continuous sonde deployment from 7/31/2019 through 8/7/2019. DO data were collected throughout the sonde deployment, which indicated that the DO values within

Unnamed Creek were above the 5 mg/L threshold (Figure 97). Therefore, DO does not appear to be a stressor to the aquatic life within Unnamed Creek.

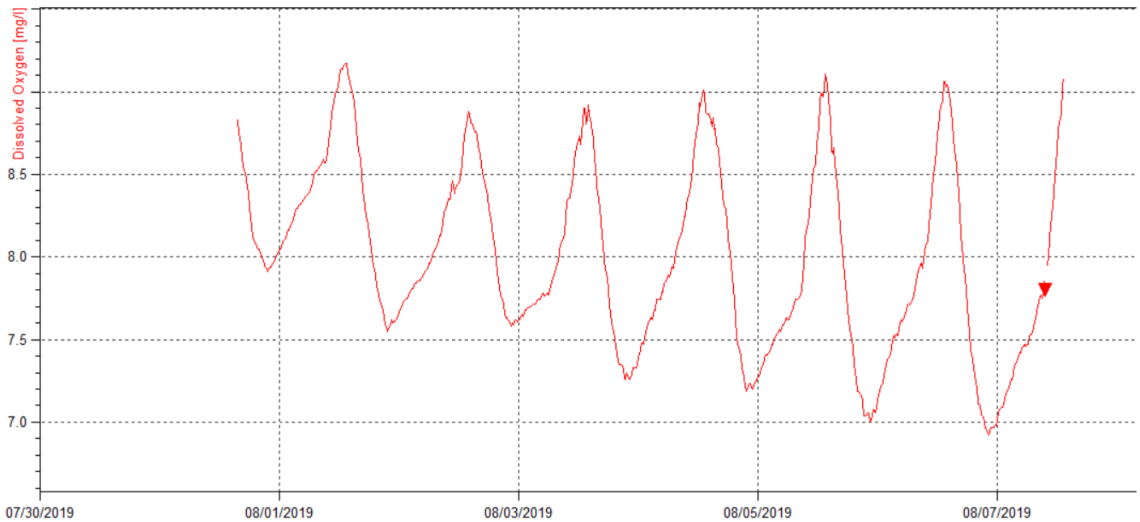


Figure 97. Continuous DO data collected in Unnamed Creek in 2019.

Temperature and conductivity data were also collected during the sonde deployment. No temperature or conductivity values that were collected would be considered problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as good/fair on Unnamed Creek, through MSHA evaluations during the fish samples in 2008 and 2010 (Table 48). Habitat at the upstream station (08UM020) scored higher than the downstream station (10UM139) due to the presence of coarse substrate at 08UM020. Due to the historic channelization of Unnamed Creek, and good/fair MSHA scores, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the General Use TALU criteria. Although the overall MSHA score was fair, multiple categories scored well, including channel morphology and substrate. Due to these categories scoring well, the MSHA score indicates that habitat is not a stressor within Unnamed Creek.

Table 48. MSHA evaluations on Unnamed Creek.

MSHA Component	08UM020	10UM139	Maximum Poss Score
Land Use	1.5	1	5
Riparian	14	6	14
Substrate	17.6	10.35	28
Cover	11	7	18
Channel Morphology	25	18	35
Total MSHA Score	69.1 = Good	42.35 = Fair	100

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek. The most significant historical changes to the landscape have been land conversion from mature forests to cultivated fields and the channelization of the natural streams and wetlands. Unnamed Creek has been almost entirely straightened, with only a small portion of the stream upstream of Sauk Valley Road remaining natural.

Due to the channelization of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks do not appear to be actively eroding. The MSHA evaluation for erosion ranged from no erosion (<5%) to little erosion (5-25%). Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). Historically, the outlet of Unnamed Creek was sinuous, and met the Sauk River downstream of Sauk Valley Road (Figure 98).

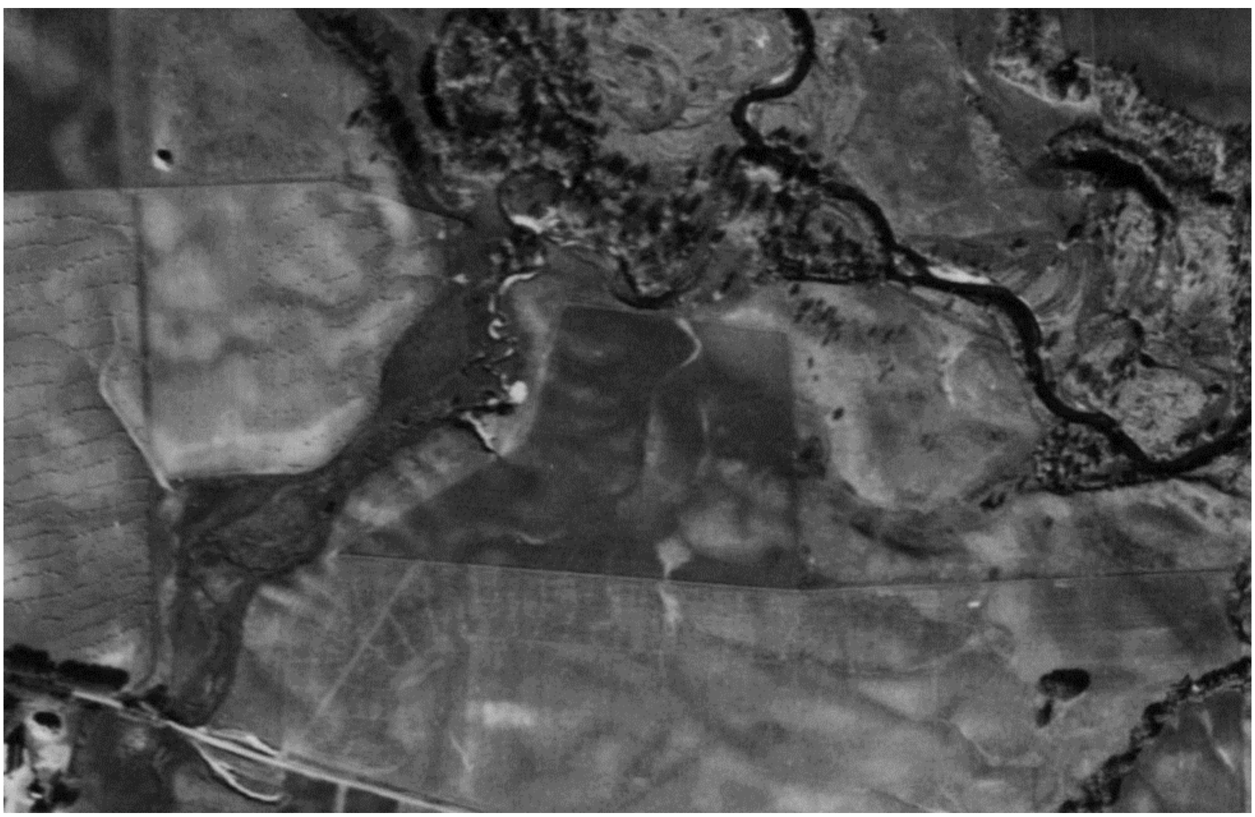


Figure 98. Historical flow pattern of Unnamed Creek. http://maps.dnr.state.mn.us/airphotos/usda/bjn/y1938/bjn03063.jpg.

Since the channelization of Unnamed Creek (post 1938), the outlet of the Creek has been straightened to flow straight east. The channelization of the Creek, combined with the natural channel evolution (natural moving of the river bends) of the Sauk River, has created a disconnect between Unnamed Creek and the Sauk River right before the confluence. Flow coming from Unnamed Creek is split between two channels, as can be seen in the spring 2018 aerial photo (Figure 99).

Figure 99. Unnamed Creek present day flow pattern. Credit: 2018 Stearns County.

This flow alteration, combined with the accelerated flows from the channelization, has led to very low to no flow within the creek by midsummer (Figure 100). In 2020, a water level logger was placed in Unnamed Creek to monitor the flow throughout the summer. These data indicated that the flow becomes critically low from July to September.

Figure 100. Present day mid-summer flow pattern for Unnamed Creek. Credit: Google Earth.

In addition to the channelization, cattle have been allowed to access Unnamed Creek upstream of Sauk Valley Road, which has caused the banks to become unstable (Figure 101). These unstable banks have caused excessive sediment to migrate downstream (Figure 102), which has contributed to the loss in habitat quality from 08UM020 to 10UM139.


Figure 101. Cattle access near 10UM139.

Figure 102. Sediment runoff due to cattle access.

Due to the channelization and cattle trampling within Unnamed Creek, altered hydrology is considered a primary stressor.

Connectivity

There is one field crossing and one road crossing close to 08UM020 that are both considered to be barriers. The field crossing that is close to 08UM020 appears to have been useable in 2005 (Figure 103), but failed shortly after. More recent aerial photography shows that the culverts and the fill that was used for the crossing has been compromised, and is creating a barrier to fish passage (Figure 103).

Figure 103. 2005 and 2013 aerial photographs of Unnamed Creek. Credit Google Earth.

In addition to the field crossing barrier, the culvert off 260th Street is also a barrier to fish passage. The culvert is oversized, and has been placed at a steep slope which has caused a scour pool to occur on the downstream end of the culvert, leaving the culvert perched (Figure 104).

Figure 104. Sour pool, downstream of 260th Street.

In addition to the steep slope that is causing the scour pool, water depth through the culvert is also causing a fish barrier in the spring (Figure 106) and in the fall (Figure 105). The water level logger that was placed within the Creek to determine water levels throughout the summer was located in the scour pool downstream of the perched culvert. These data indicated that the water level from July through September was almost dry, and was too low for fish to pass through the culvert.

Figure 106. 260th Street culvert crossing, spring 2020.

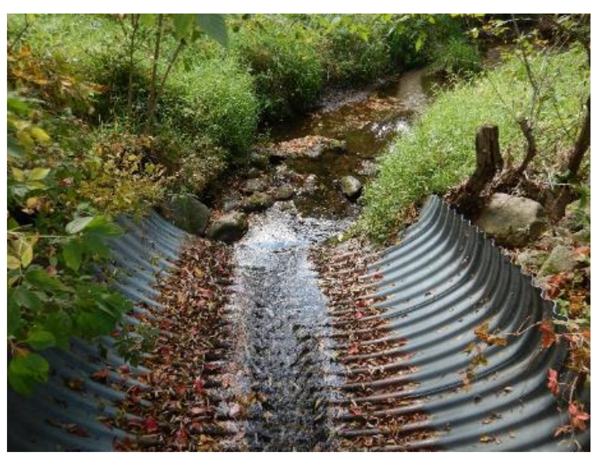


Figure 105. 260th Street culvert crossing, fall 2020.

In addition to the culvert issues, the cattle access by the downstream road crossing (Figure 101) is also causing a barrier to fish passage through aggradation. Therefore, connectivity is considered a primary stressor to the aquatic life within Unnamed Creek.

Stressor signals from biology

Fish

Fish were initially sampled in 2008 at 08UM020 and in 2010 at 10UM139 as part of the cycle I watershed monitoring effort. The fish sample from 2008 yielded a total of five species, with Brook Stickleback being the most dominate. All five species are considered to be tolerant of pollutants, with Brook Stickleback and Central Mudminnows being labeled as one of the most tolerant fish species within the State of Minnesota. Similarly, the 2010 fish sample contained a total of eight species, with Creek Chubs and White Suckers being the most dominate. All of the fish collected were considered to be tolerant. White Suckers and Northern Pike were collected in the downstream station (10UM139), but were not collected within the upstream station (08UM020). This may be an indication that the fish barriers are blocking the fish passage of the larger fish species to the upstream station.

Due to the limited chemistry dataset, TIV were calculated for Unnamed Creek, but were only calculated for DO. This calculation indicated that the fish community from 2008 had a 15.4% probability of coming from a stream that was meeting the DO standard. Two of the fish species that were collected, were considered to be tolerant of low DO, and two other species were considered to be very tolerant of low DO. In contrast, the fish community from the 2018 sample had a 78.9% probability of coming from a stream that was meeting the DO standard. Two of the fish species that were collected, were considered to be tolerant of low DO, and one other species was considered to be very tolerant of low DO. The lower probability within the upstream station is most likely the result of the barriers blocking more sensitive fishes from accessing the quality upstream habitat, instead of indicating a DO problem. DO levels collected during the sonde deployment indicated that the DO levels are healthy within Unnamed Creek. Therefore, DO is not a primary stressor to the fish community within Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were also sampled in 2010 at 10UM139 as part of the cycle I watershed monitoring effort. 85% of the macroinvertebrate community that was sampled in 2010 was comprised of taxa that were considered to be tolerant of pollutants, and 45% of the community was considered to be very tolerant of pollutants. Tolerant Chironomids (*Thienemannimyia*; *Micropsectra*) dominated the sample.

DO TIVs were also calculated using the macroinvertebrate community. Eleven taxa that are considered to be tolerant of low DO were found within the 2010 sample and five very tolerant taxa were found in the sample. No DO intolerant, or very intolerant taxa were collected in the sample. Similar to the fish community, low DO does appear to be a stressor to the macroinvertebrate community; however, lack of a stable flow regime due to the barriers, is most likely inhibiting sensitive taxa from living in Unnamed Creek.

Composite conclusion from biology

There are multiple barriers that are blocking fish passage and impacting the flow regime on Unnamed Creek. White Suckers and Northern Pike were collected within the downstream station, but were missing at the upstream station, indicating that these barriers are impacting fish passage.

The fish and macroinvertebrates in Unnamed Creek are indicating that low DO is a stressor; however, DO levels within the Creek are at healthy levels.

Recommendations

Replacing the culvert at the 260th Street crossing with an AOP design would be beneficial to Unnamed Creek. Removing the failed field crossing just upstream of 260th Street would also be beneficial.

Fence the cattle out of the Creek upstream of the Sauk Valley Road crossing.

Backes Lake-Sauk River Subwatershed

The Backes Lake-Sauk River Subwatershed covers 31,450 acres from 4 miles southeast of New Munich, to the Sauk Chain of Lakes in Richmond (Figure 107). 56.7% of the streams in the subwatershed have been channelized.

Figure 107. Biological monitoring station in the Backes Lake-Sauk River Subwatershed.

The land use within the Backes Lake-Sauk River Subwatershed is dominated by cropland (72.5%) followed by rangeland (8.8%) and wetlands (7.6%) (Figure 108).

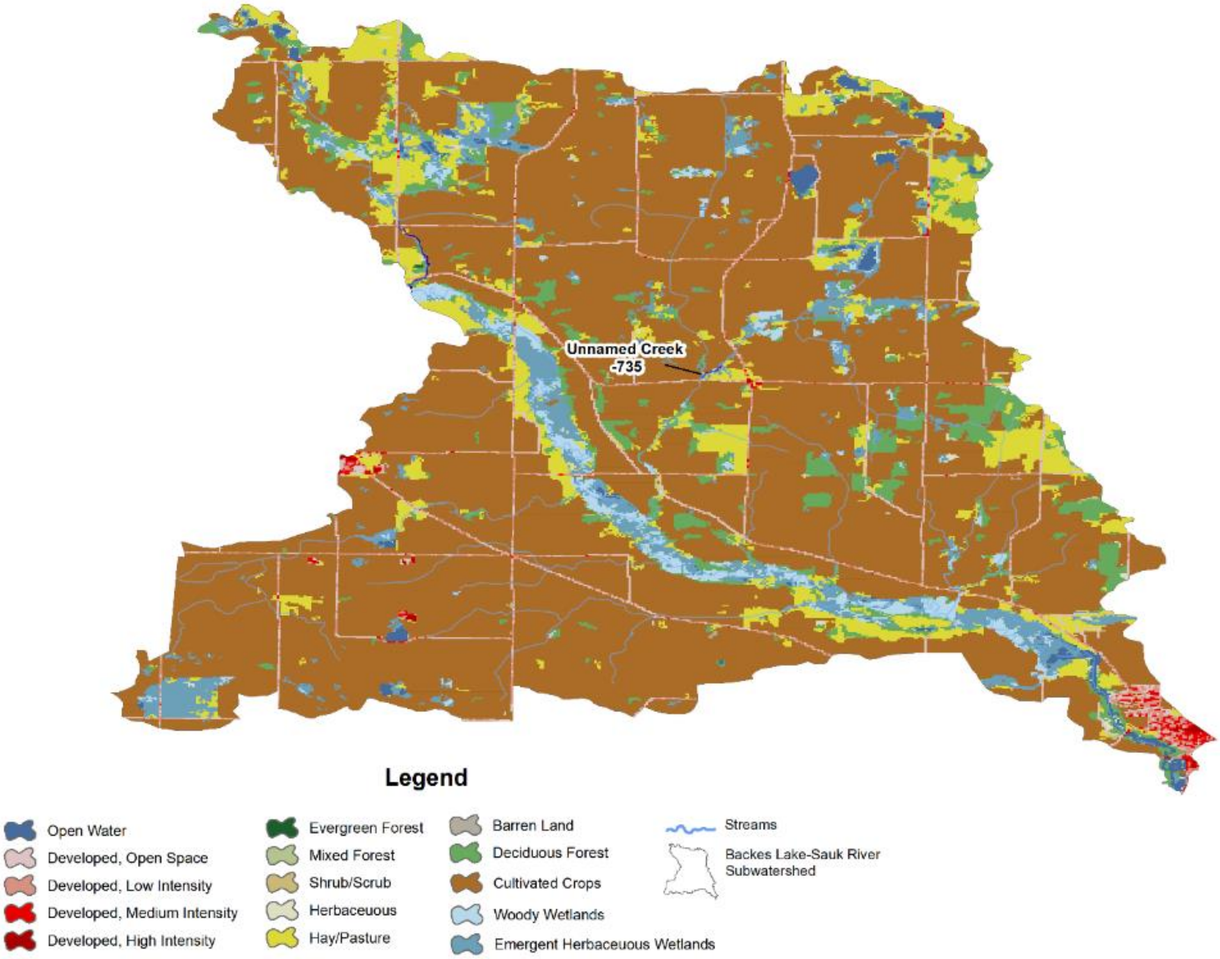


Figure 108. Land use in the Backes Lake-Sauk River Subwatershed.

Unnamed Creek (07010202-735)

Impairment: Unnamed Creek (AUID -735) flows for 0.3 of a mile to the Sauk River, 6 miles northeast of Richmond (Figure 107). There was one biological monitoring station (10UM140) that was sampled in 2010. AUID -735 was combined with the upstream section of Unnamed Creek (AUID -734), when the biological sampling took place in 2010. Assessments were deferred until the TALU assessment process for the Sauk River Watershed were completed in 2018. During the UAA process, AUID -735 was split from the upstream portion of Unnamed Creek as the upstream portion was channelized. The resulting assessment for AUID -735 added new impairments for fish and macroinvertebrates. The fish stream class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 5 (Southern Streams Riffle/Run).

Data and Analyses

AUID -735 is located just upstream of -555 and -556. -555 and -556 were evaluated for SID within the first SID report, in 2012 (MPCA 2012). Within this report it was determined that habitat was the primary stressor to the aquatic life, due to cattle access. Therefore, due to 10UM140 being located just upstream of these AUIDs, and within an active pasture, it was determined that the stressor that were identified in 2012 are also applicable to -735. In addition to habitat as a stressor, the culvert off CSAH 42 also appears to be a fish barrier under moderate to low flow due to the cattle trampling.

Big Fish Lake Subwatershed

The Big Fish Lake Subwatershed covers 11,760 acres from just north of Big Fish Lake to just east of Richmond (Figure 109). 71.9% of the streams in the subwatershed have been channelized.

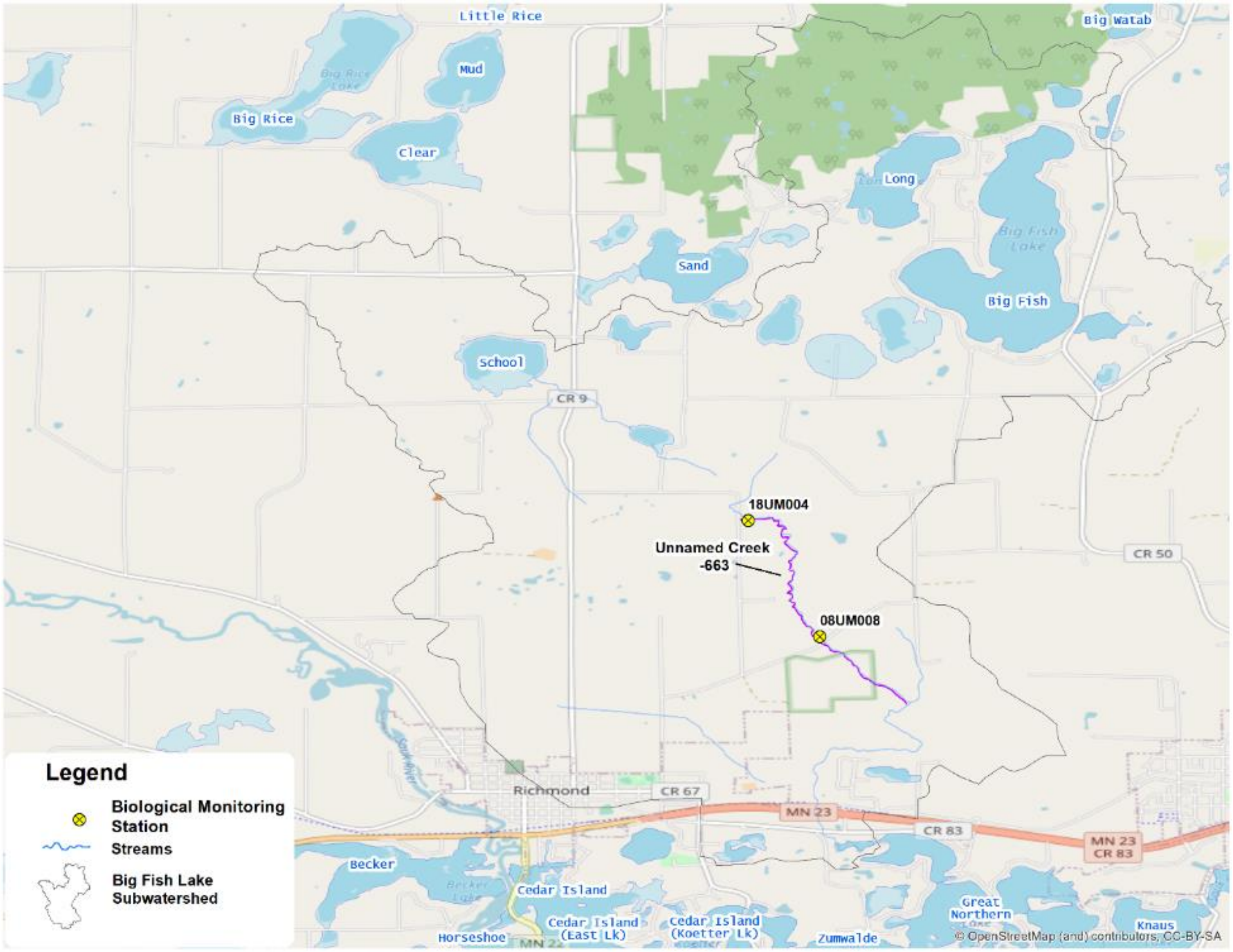


Figure 109. Biological monitoring stations in the Big Fish Lake Subwatershed.

The land use within the Big Fish Lake Subwatershed is dominated by cropland (39.4%) followed by forest (19.7%) and rangeland (14.9%) (Figure 110).

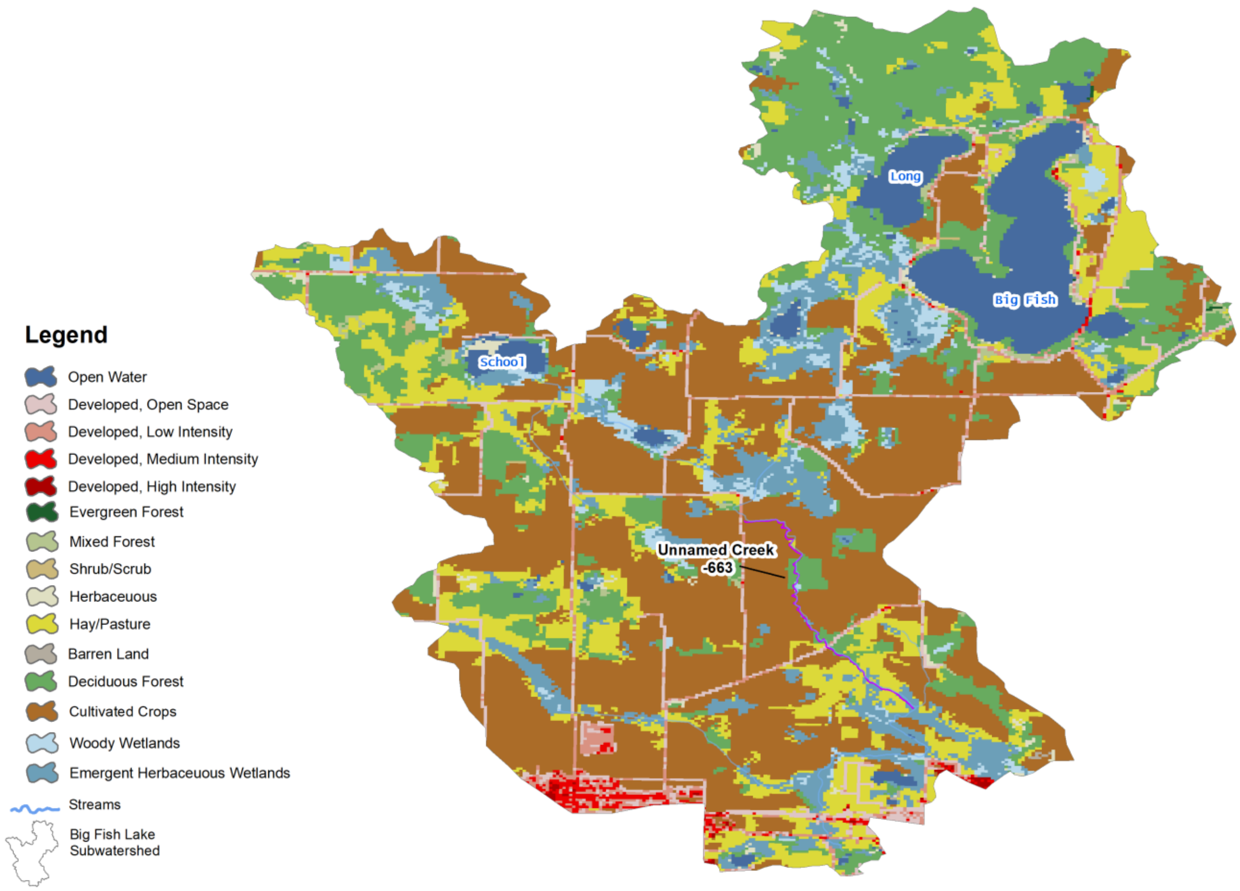


Figure 110. Land use in the Big Fish Lake Subwatershed.

Unnamed Creek (07010202-663)

Impairment: Unnamed Creek (AUID -663) flows for 2.3 miles, 1.5 miles northeast of Richmond (Figure 109). There are two biological monitoring stations (08UM008, 18UM004) that were sampled on Unnamed Creek. Assessments were completed in 2011 and 2020, resulting in fish and macroinvertebrate impairments. The fish class is class 6 (Northern Headwaters) and the macroinvertebrate stream class is class 5 (Southern Streams Riffle/Run).

Data and Analyses

Chemistry

Water chemistry data has been collected at each of the biological monitoring stations (18UM004; S016-361) (08UM008; S010-881) and at a small tributary near 18UM004 (S016-362) (Table 49).

Table 49. Water chemistry data collected at S016-361, S010-881, and S016-362. Full datasets available at https://webapp.pca.state.mn.us/surface-water/station/S016-361 https://webapp.pca.state.mn.us/surface-water/station/S010-881 https://webapp.pca.state.mn.us/surface-water/station/S016-362.

18UM004						
Parameter	**Sample Count**	**Sample Count Above the Respective Threshold**	**Applicable Standard**	**Average**	**Minimum**	**Maximum**
TP	3	2	0.100 mg/L	0.187 mg/L	0.097 mg/L	0.333 mg/L
DO	4	3	5.0 mg/L	4.6 mg/L	4.0 mg/L	5.72 mg/L
Ammonia	3	N/A	N/A	0.113 mg/L	0.07 mg/L	0.17 mg/L
Inorganic Nitrogen	3	N/A	N/A	0.08 mg/L	0.0 mg/L	0.23 mg/L
Conductivity	4	N/A	N/A	434.03 µS	287.6 µS	614.0 µS
Water Temp	4	N/A	N/A	19.32° C	16.79° C	22.03° C
Small Tributary						
Parameter	**Sample Count**	**Sample Count Above the Respective Threshold**	**Applicable Standard**	**Average**	**Minimum**	**Maximum**
TP	2	2	0.100 mg/L	0.38 mg/L	0.22 mg/L	0.53 mg/L
DO	2	1	5.0 mg/L	5.0 mg/L	4.35 mg/L	5.66 mg/L
Ammonia	2	N/A	N/A	0.05 mg/L	0.0 mg/L	0.1 mg/L
Inorganic Nitrogen	2	N/A	N/A	0.8 mg/L	0.0 mg/L	1.6 mg/L
Conductivity	2	N/A	N/A	428 µS	242 µS	614 µS
Water Temp	2	N/A	N/A	19.72° C	16.67° C	22.79° C
08UM008						
Parameter	**Sample Count**	**Sample Count Above the Respective Threshold**	**Applicable Standard**	**Average**	**Minimum**	**Maximum**
TP	8	2	0.100 mg/L	0.100 mg/L	0.05 mg/L	0.23 mg/L
DO	22	0	5.0 mg/L	8.79 mg/L	7.21 mg/L	9.76 mg/L
Ammonia	3	N/A	N/A	0.0 mg/L	0.0 mg/L	0.0 mg/L
Inorganic Nitrogen	8	N/A	N/A	1.71 mg/L	0.22 mg/L	3.7 mg/L
Conductivity	22	N/A	N/A	485.69 µS	394 µS	616 µS
Water Temp	22	N/A	N/A	16.47° C	9.17° C	22.85° C

Nutrients – Phosphorus

Phosphorus values from the small dataset collected on Unnamed Creek (Table 49) shows that the average TP is above the Central Region River Nutrient standard (0.100 mg/L) at all three stations. The highest TP values occurred within upstream stations, with the highest reading coming from the tributary stream with a value of 0.534 mg/l. These data suggest that there is a strong potential for eutrophication to occur.

Nutrients – Inorganic nitrogen (Nitrate and Nitrite)

Inorganic nitrogen data collected within Unnamed Creek indicates that the nitrogen levels are low, and therefore, are not considered to be a stressor at this time (Table 49).

Dissolved Oxygen

DO data was collected from Unnamed Creek in 2019 and 2020 (Table 49). These data indicate that the DO levels fluctuate from the upstream portion of Unnamed Creek to the downstream portion. In the headwaters, at station 18UM004 and the tributary station the DO values were below the 5 mg/L standard. However, the downstream portion of the AUID, had DO levels that were above the standard. 18UM004 is just downstream of a wetland, which could be contributing to the lower DO levels. Therefore, low DO is considered to be a stressor within the upstream portion of Unnamed Creek.

Conductivity

Specific conductivity was within range during the 2019 and 2020 sampling (Table 49). Therefore, specific conductivity does not appear to be a stressor to aquatic life within Getchell Creek.

Temperature

Temperature data collected in 2019 and 2020 (Table 49), showed no temperature readings that would be problematic for fish or macroinvertebrates.

Habitat

Habitat

Habitat was classified as fair/good on Unnamed Creek, through MSHA evaluations during the biological monitoring samples (Table 50). Due to the historic channelization at the upstream biological monitoring station, and fair MSHA score, the assessment of Unnamed Creek was brought into the UAA process. It was determined that the habitat of Unnamed Creek has not been degraded to a point where it cannot support good quality habitat for aquatic life, as a result of channelization. Therefore, Unnamed Creek was assessed using the General Use TALU criteria.

Table 50. Average MSHA scores at 18UM004 and 08UM008.

MSHA Component	18UM004 Avg Score	08UM008 Avg Score	Maximum Poss Score
Land Use	0.75	0.833	5
Riparian	10.5	11.16	14
Substrate	13	19.68	28
Cover	9.5	11.66	18
Channel Morphology	12.5	22.66	35
Total MSHA Score	46.25 = Fair	65.99 = Good	100

18UM004 had fair habitat and 08UM008 had good habitat, as noted by the increase in MSHA scores from upstream to downstream. The upstream station (18UM004) scored lower in multiple categories, including substrate and channel morphology. Due to the channelization at the upstream station, the channel has been over-widened and the banks are actively eroding. This has led to excessive sediment (sand) covering the coarse substrate. This coarse substrate is still available to the aquatic life within the downstream natural portion of the AUID, but is showing signs of receiving excess sediment from the upstream erosion (Figure 112; Figure 111). Therefore, due to the excessive sand covering the coarse substrate in the upstream station, habitat is a considered a stressor to the aquatic life within Unnamed Creek.

Figure 112. Stream bank condition at the upstream station.

Figure 111. Stream bank condition at the downstream station.

Hydrology and geomorphology

Over time, there have been many changes on the landscape that have changed the natural hydrology and geomorphology of Unnamed Creek. The most significant historical changes to the landscape have been the land conversion from mature forests and wetlands to cultivated fields and pastures, and the channelization of the natural streams. Historically, Unnamed Creek flowed just south of School Lake near 260th Street (Figure 113).

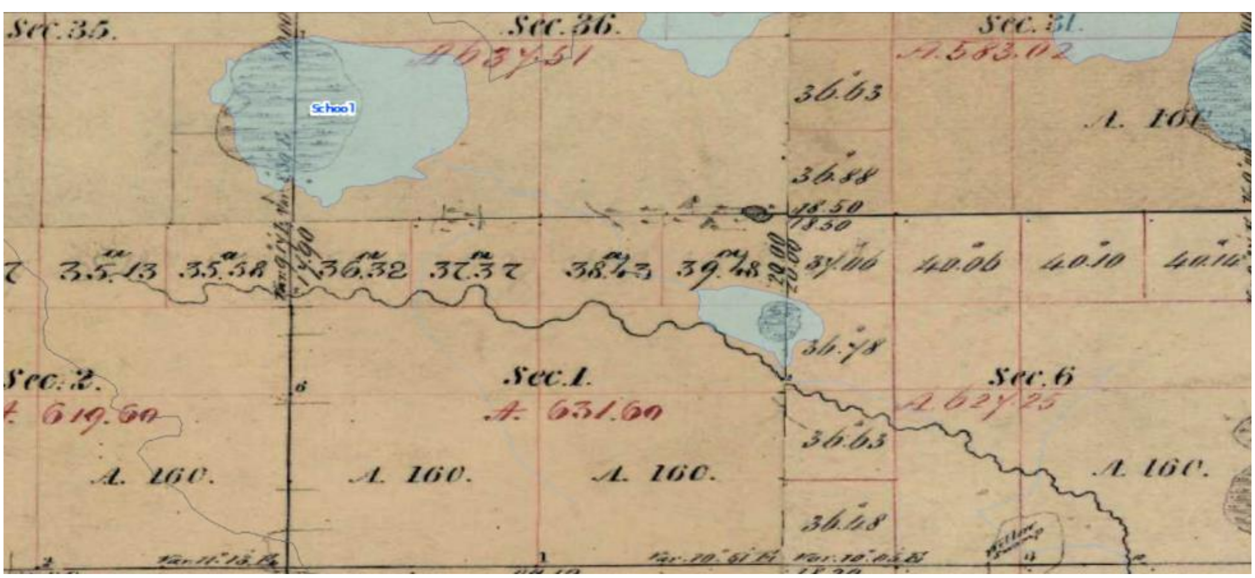


Figure 113. Historical flow pattern of Unnamed Creek.

After settlement, the channel was channelized to flow from School Lake to an open wetland (just upstream of Hunter Road), before meeting the natural channel downstream of 188th Ave (Figure 114).

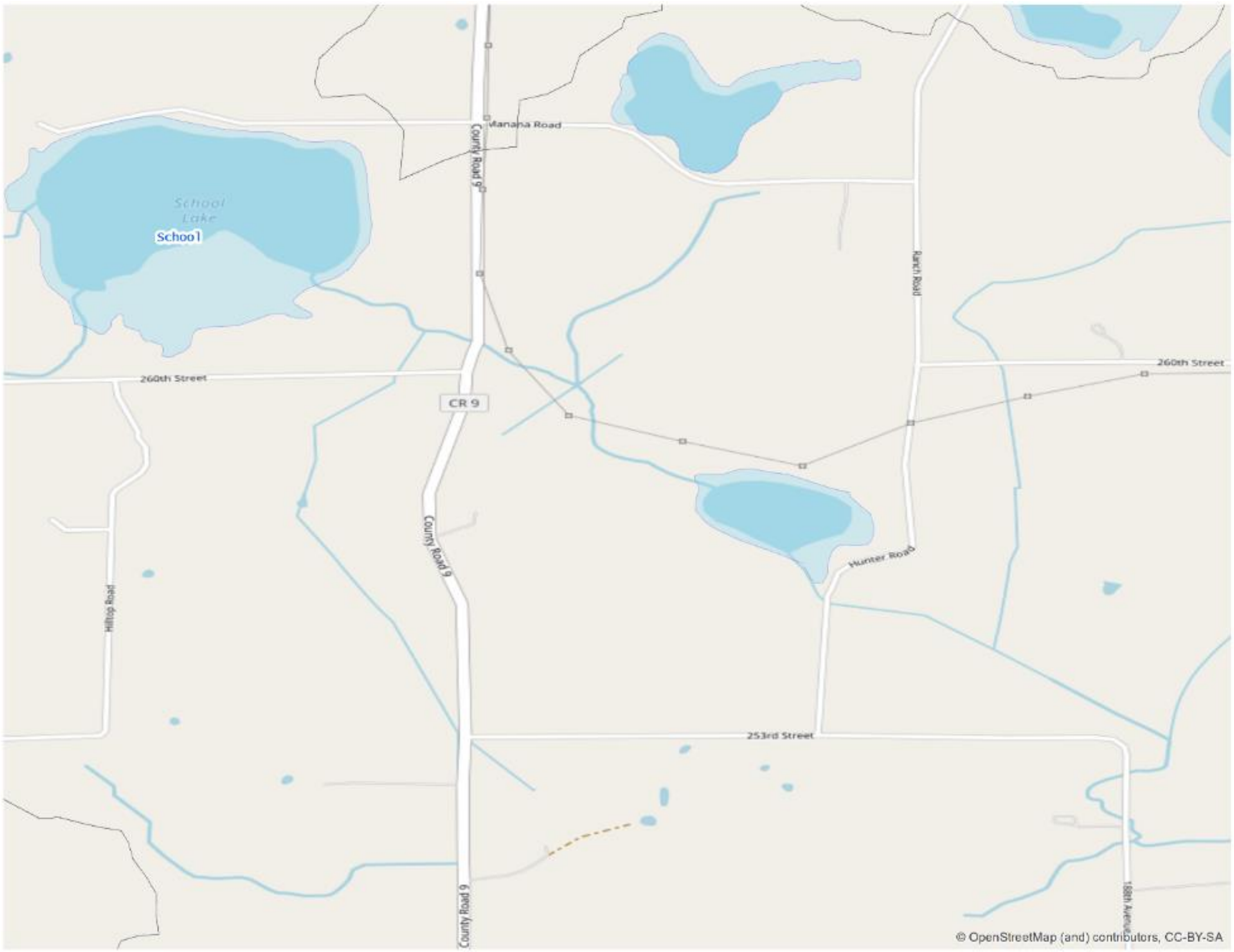


Figure 114. Present day flow pattern of Unnamed Creek.

Due to the channelization of the upstream portion of Unnamed Creek, the creek does not have a natural stream pattern that can be assessed for stability. Utilizing the pictures and MSHA evaluation of stream bank condition during the fish and macroinvertebrate samples, the banks appear to be actively eroding. The MSHA evaluation for erosion ranged from little (5% to 25%) at the downstream station to moderate (25% to 50%) at the upstream station. Reviewing historical aerial photography shows that the pre-settlement channel was small and sinuous, suggesting that the hydrology has been changed after the landscape change to agriculture and the resulting channel enhancements related to that practice (drainage). The current channel size was most likely similar to the current channel size, but is showing signs that the channel is receiving excess sediment from unnatural bank erosion. In addition to the eroding banks at the upstream station, the channel was rerouted through several wetlands during the channelization. This has caused the low DO water that would naturally settle out within the wetland (due to the natural decomposition of organic material, consuming oxygen) to flow downstream. This flushing of low DO downstream, could explain the low DO levels at 18UM004. Therefore, due to the over-widened channel causing the stream banks to erode, which has covered coarse substrate in sand, and the low DO water coming from the upstream wetlands due to the channelization, altered hydrology is considered a primary stressor within Unnamed Creek.

Connectivity

There are road crossings close to the biological monitoring stations and several road and field crossings on Unnamed Creek, before it reaches Schneiders Lake. The culvert crossings by 18UM004 off 188th Avenue and by 08UM008 off Glenwood Road do not appear to be fish barriers. However, reviewing aerial photography, there does appear to be an impoundment on Unnamed Creek, north of 178th Avenue on a private residence that is a barrier (Figure 115). This barrier could explain the absence of larger fish species, such as Northern Pike, within the biological monitoring stations upstream. Due to this impoundment, connectivity is a stressor to the aquatic life within Unnamed Creek.

Figure 115. Potential impoundment on Unnamed Creek, north of 178th Ave. Credit: Google Earth.

Stressor signals from biology

Fish

Fish were initially sampled in 2008 at 08UM008 as part of the cycle I watershed monitoring effort and then sampled again in 2018 at 08UM008 and 18UM004 for the second cycle of monitoring. The fish sample from 2008 was not available for assessments due to the fish crew experiencing equipment issues. However, the 2018 fish sample at 08UM008 yielded a total of 11 species, with Northern Redbelly Dace being the most dominate. Eighty-two percent of the fish species collected were considered to be tolerant of pollutants. Similarly, the 2018 fish sample at 18UM004 contained 11 species, and was also dominated by Northern Redbelly Dace. 90.9% of the fish species collected, were considered to be tolerant of pollutants.

TIV were calculated for Unnamed Creek using the fish communities collected in 2018. The TIV for TSS within Unnamed Creek using the 2018 fish sample, found that the fish community at 08UM008 had a 79.9% probability of coming from a stream that was meeting the TSS standard. Of the 11 fish species collected at 08UM008, 1 of the species was considered to be sensitive to TSS, and the other species were not considered to be tolerant or intolerant of elevated TSS. As for the fish sample at 18UM004, the

TSS TIV indicated that the fish community had a 69.4% probability of meeting the TSS standard, but only one species collected was sensitive to TSS and all of the other species were not considered to be tolerant or intolerant of elevated TSS. Altogether, the fish community is indicating a mild sensitivity to TSS within Unnamed Creek. One TSS sensitive species and no TSS intolerant or tolerant species were collected throughout the two samples, indicating a weak TSS signal from the biology. Therefore, TSS is not considered a stressor to the fish community in Unnamed Creek at this time.

DO TIV scores were also calculated for Unnamed Creek using the fish communities. This calculation indicated that the fish community from 08UM008 had a 12.7% probability of coming from a stream that was meeting the DO standard. Seven of the 11 fish species collected are considered to be tolerant of low DO, and five species were considered very tolerant of low DO. This probability dropped to a 10.0% probability with the 18UM004 fish community. Seven of the fish species collected were considered to be tolerant of low DO, and four species were considered to be very tolerant of low DO. The combined fish samples indicate that DO is a stressor to the fish community within Unnamed Creek.

Phosphorus tolerance of the fish community was also investigated in Unnamed Creek using the fish species characteristics. Five fish species collected in the 08UM008 sample were considered to be tolerant of elevated phosphorus, and four species were very tolerant to elevated phosphorus. None of the 11 total species collected were intolerant of elevated phosphorus. Similarly, five tolerant fish species were collected in the 18UM004 sample and four species were very tolerant of elevated phosphorus. None of the 11 total species collected were intolerant. The prevalence of elevated phosphorus tolerant species and the absence of intolerant species, combined with the elevated TP values in the tributary station, indicates that phosphorus is a stressor to the fish community in Unnamed Creek.

Macroinvertebrates

Macroinvertebrates were sampled in 2008 at 08UM008, and in 2018 at 08UM008 and 18UM004 as part of the watershed monitoring efforts. In 2008, 70% of the macroinvertebrate community that was sampled at 08UM008 was comprised of taxa that are considered to be tolerant of pollutants, and 32.5% of the community was considered to be very tolerant of pollutants. In 2018, the macroinvertebrate community was comprised of 63.0% tolerant taxa and 25.9% very tolerant taxa at 08UM008, and 74.5% tolerant taxa and 39.2% very tolerant taxa at 18UM004. *Polypdeilum*, a tolerant chironomid, dominated the 2008 sample at 08UM008. In 2018, *Cheumatopsyche*, a sensitive stonefly dominated the sample at 08UM008, and the tolerant taxa *Polypdeilum* and *Hyalella* dominated the 18UM004 sample.

Taxa tolerance for TSS, DO, and phosphorus was investigated using the macroinvertebrate communities for Unnamed Creek. These tolerance indicators suggest that TSS, DO, and phosphorus are not stressors to the macroinvertebrate community within Unnamed Creek, with the presence of a healthy mixture of very intolerant and tolerant taxa (Table 51).

Table 51. Macroinvertebrate tolerance indicators in Unnamed Creek.

Sample Year	Parameter	# Very Intolerant	# Intolerant taxa	# Tolerant taxa	# Very Tolerant taxa
2008 (08UM008)	TSS	2	3	8	4
2018 (08UM008)	TSS	1	3	3	1
2018 (18UM004)	TSS	1	2	11	3
2008 (08UM008)	DO	4	7	6	3
2018 (08UM008)	DO	4	7	1	1
2018 (18UM004)	DO	2	6	9	5
2008 (08UM008)	Phosphorus	1	4	11	5
2018 (08UM008)	Phosphorus	1	4	3	2
2018 (18UM004)	Phosphorus	1	2	14	9

The macroinvertebrate IBI scores were just below the threshold. Additional monitoring at both stations is necessary to justify a delisting and to better understand the thermal potential of this stream. Given the supporting macroinvertebrate community at 18UM004 and the M-IBI scores from 08UM008 being within the lower confidence interval this stream is categorized as nearly/barely impaired. Therefore, SID efforts focused on the fish community, which may indicate that the downstream barrier is the primary stressor to the fish community.

Composite conclusion from biology

The fish in Unnamed Creek are indicating that low DO and elevated phosphorus are stressors to the aquatic life within Unnamed Creek. However, these do not appear to be affecting the macroinvertebrates. This could be further indication that the downstream impoundment is blocking fish passage, and may be causing the low fish IBI scores.

TSS does not appear to be a stressor to the fish and macroinvertebrates within Unnamed Creek.

Recommendations

Careful consideration to runoff from local fields would be advantageous for Unnamed Creek. Elevated nutrient levels are present within the Creek, with the biggest input coming from a small tributary stream off 188th Avenue. Establishing buffers around the small tributaries flowing into Unnamed Creek would be beneficial.

Removal of the downstream impoundment would ensure that fish have access to the upstream portions of Unnamed Creek.

Stream restoration to the historic sinuous pattern would be a way to improve habitat. However, in order to restore the stream channel, it would require additional land that is currently utilized for agriculture.

Overall stressor summary table

Table 52. Overall stressors identified within the Sauk River Watershed.

Identified Stressors												
Stream	**AUID**	**Aquatic Life Impairment**	**DO**	**TP**	**Nitrate toxicity**	**TSS**	**Connectivity**	**Altered Hydrology**	**Habitat**	**Flow**	**No definitive Stressor**
Crooked Lake Ditch	-552	M-Inverts, Fish, DO, TSS	•	•		•		○	•		
Crooked Lake Ditch	-581	Fish, DO	•	○				○	•		
Crooked Lake Ditch	-637	M-Inverts, Fish, DO	•	○				○	•		
Boss Creek	-589	M-Inverts, Fish, DO	•	◊			◊	•	•		
Tributary to Little Lake Osakis	-638	Fish	◊	X			•	•			
Unnamed Creek	-592	Fish							?		•
Pope County Ditch 6	-521	Fish	•	•		◊		•	•	•	
Silver Creek	-640	M-Inverts, Fish, DO	•	•	◊	◊	•	•	•	•	
Unnamed Creek	-613	Fish	X	•		◊	○	•	•		
Unnamed Creek	-624	M-Inverts, Fish		•			•	◊			
Unnamed Creek	-647	M-Inverts, Fish	?	•		•	•	•	•		
Unnamed Creek	-733	M-Inverts, Fish	?	◊	○		•	•	•		

Identified Stressors											
Stream	**AUID**	**Aquatic Life Impairment**	**DO**	**TP**	**Nitrate toxicity**	**TSS**	**Connectivity**	**Altered Hydrology**	**Habitat**	**Flow**	**No definitive Stressor**
Adley Creek	-527	Fish, DO	•	◊			X	•			
Stearns County Ditch 44	-723	M-Inverts, Fish		◊			•	•			
Unnamed Creek	-654	M-Inverts, Fish	•				◊				
Unnamed Creek	-615	M-Inverts, Fish, DO	•	•				•	•		
Getchell Creek	-727	Fish, DO	•	•				•	•		
Getchell Creek	-729	M-Inverts, Fish, DO	•	•	o			•	•		
Stony Creek	-724	Fish					•	•	•		
Stony Creek	-725	M-Inverts, Fish	◊			?	•	•			
Tributary to Stony Creek	-655	Fish					•	•			
Unnamed Creek	-657	M-Inverts, Fish					•	•			
Unnamed Creek	-735	M-Inverts, Fish					•		•		
Unnamed Creek	-633	M-Inverts, Fish	•	•			X	•	•		

O A "root cause" stressor, which leads to consequences that become the direct stressors.

◊ Possible contributing root cause.

• Determined to be a direct stressor.

X A secondary stressor.

? Inconclusive

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