

Snake River Watershed

Stressor Identification Update

March 2021



Purpose

Water monitoring is essential to determining whether lakes and streams meet water quality standards designed to ensure that waters are fishable and swimmable. The stressor identification (SID) process looks at specifically why fish and bug communities are suffering. The purpose of Cycle 2 (C2) SID work is to perform SID in a way that supports follow-up watershed restoration and protections strategy (WRAPS) efforts and local water planning and implementation efforts, with an emphasis on meeting local partner needs, protection of biotic integrity, and identifying changes in biotic condition.

The Snake River Watershed has many opportunities for recreation such as fishing, canoeing, and camping. Identifying impairments and stressors help guide where to implement restoration best management practices and where to protect healthy streams that will help to preserve them for future generations.

What have we learned about stream health and stressors in the Snake River Watershed?

The Snake River Watershed has impairment issues related to dissolved oxygen (DO) and eutrophication in the Mission and Mud Creek subwatersheds. Much of this can be attributed to low gradient wetland areas, and to a smaller extent agricultural land use, which can allow for excess algal and plant growth reducing already limited DO levels.

Habitat, altered hydrology, and connectivity were also significant issues in the watershed. The studied areas showed these stressors present in four of the six studied subwatersheds. These stressors were often connected, as issues like stream channelization, perched culverts, and beaver dams were significant contributors to sedimentation, lack of coarse substrates, and limited fish habitat features. Fixing these problem areas should be a high priority to see improvement.

Overall in the Snake River Watershed, there was not a statistically significant change in the Index of Biotic Integrity (IBI) values for fish or macroinvertebrates from 2006 to 2017. The average fish IBI (FIBI) scores went down by 2.4 points, while the average macroinvertebrate IBI (MIBI) score decreased by one point.

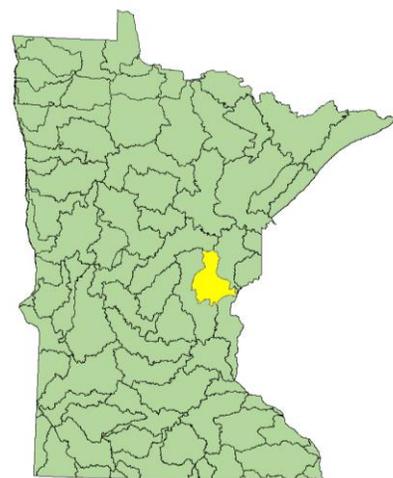


Figure 1. Snake River Watershed

Water quality conditions remained relatively similar to the first cycle of watershed work. Sediment and nitrate levels in the watershed remained low, however, nutrients were elevated in many lakes and some of the targeted streams for C2 SID monitoring. Stressors identified like DO, habitat, and altered hydrology/connectivity from the first assessment have remained.

For additional information on the updated conditions of the watershed, see the [Snake River Watershed-St. Croix Basin: Water Assessment and Trends Update](#).

Part 1: Snake River Watershed SID Summary Results

Cycle 1 (C1) monitoring and early SID reporting in the Snake River Watershed was limited to [Ann River](#), [Mud Creek](#), and the [Groundhouse River](#) (EPA 2004), while some additional water chemistry information was collected in Mission Creek and a few other streams. Some of this previous work helped inform and contributed to the analysis for C2 monitoring. Extensive continuous DO monitoring was done along Mission Creek during C1.

Cycle 2 Biological Impairment Summary

- Zero new fish and two new macroinvertebrate impairments were identified during C2 assessment.
- Bear Creek, Ann River, Groundhouse River, and South Fork Groundhouse River are no longer considered impaired due to their fish community. New and better information resulted in fish impairment designation corrections. The fish impairment to Mission Creek remains and was furthered studied in this document.
- Groundhouse River, Ann River, Mission Creek, South Fork Groundhouse River, and Knife River are no longer considered impaired due to their macroinvertebrate community. New and better information resulted in macroinvertebrate designation corrections.
- A 4C Recategorization was completed and approved for Snake River (-508), demonstrating that the fish impairment is not pollutant-related.

Cycle 2 Stressor Identification: Areas of focus

The Snake River Watershed is a mid-sized watershed and the SID process focused on several areas to gain additional information needed. The following list of streams were studied during the SID process in C2 and are further detailed in this report. These streams were selected based on impairment status, previous SID work, and local stakeholder input. Some streams needed additional information to understand stressor connections, while others needed information on source assessment for prioritization. Some were new impairments and some were old impairments that have had some information collected on them prior. The amount of information collected in each subwatershed was highly variable depending on the information needed.

- Mission Creek (07030004-547, -548)
- Pokegama Creek (07030004-532)
- Snake River (Upper) (07030004-508)
- Unnamed Creek (Trib to Mud Creek) (07030004-563)
- Bear Creek (07030004-552)
- Mud Creek (07030004-567)

Part 2: Cycle 2 Stressor Identification Stream Reaches

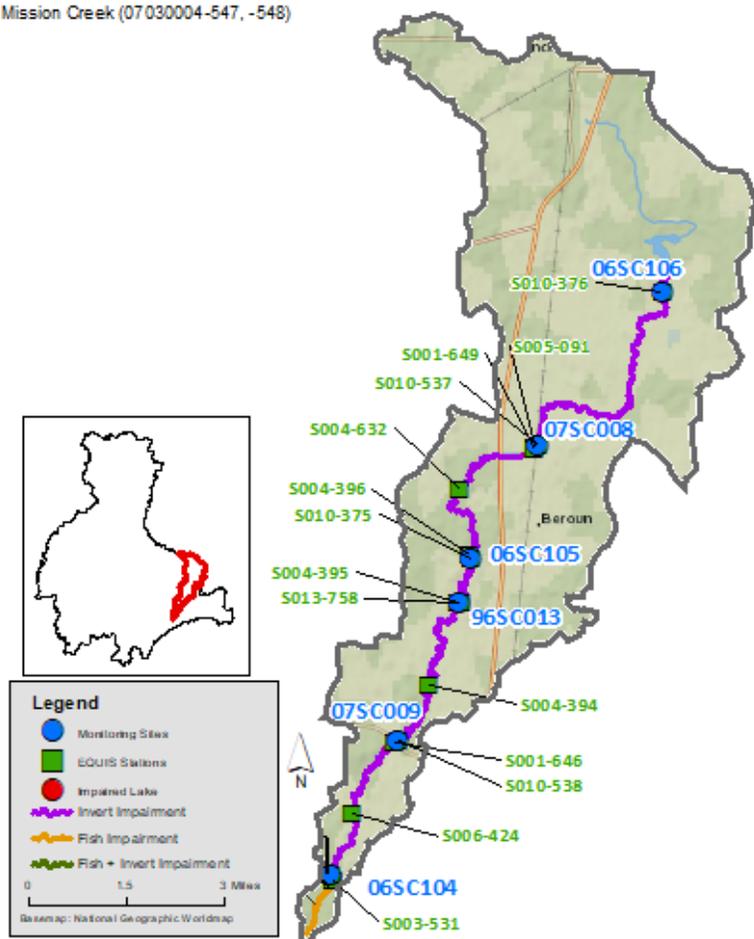
Mission Creek (07030004-547, -548)

Biological Community Summary

Mission Creek (-547, -548) is designated as impaired for aquatic life use due to the fish community condition. The fish community was sampled in 2006, 2007, and 2017, 2006 through 2017 at five different biological stations. The FIBI scores ranged from 0 to 56, with the FIBI scores being the highest in the upper portion of the reach. The FIBI score did show a significant improvement from 2006 (0) to 2017 (41.8). However, at site 06SC105, the FIBI score did lower just over eight points between the two sampling cycles. All of these sites and visits had high amounts of headwater tolerant species, as well as having very few sensitive individuals. These results limited the FIBI scores throughout stream reach. New and better information has led to the previous macroinvertebrate impairment designation to be corrected and it is no longer listed as impaired.

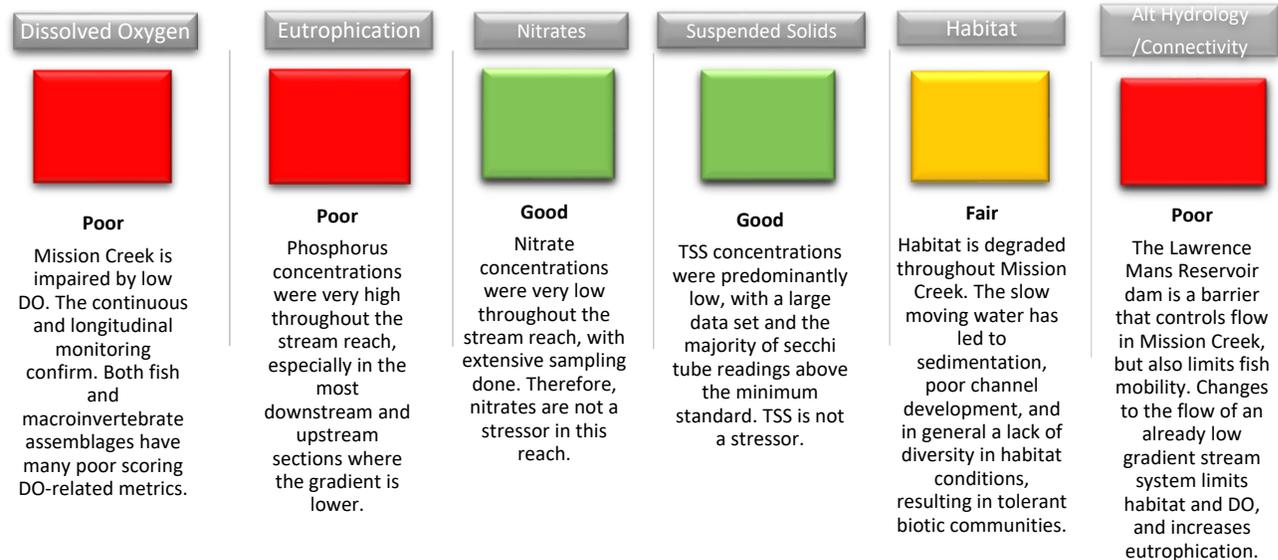
Mission Creek Subwatershed

Mission Creek (07030004-547, -548)



What stressors are of concern?

Additional SID monitoring in the Mission Creek Subwatershed occurred during C1 with a focus on DO and the current DO impairment. However, a formal SID study was not completed that listed the stressors in this reach. C2 SID work focused on and identified DO, eutrophication, habitat, and flow connectivity/alteration as stressors. The goal of C2 SID work was to get additional longitudinal information related aquatic life and those stressors associated.



Summary of stream health in Mission Creek

Additional biological and water chemistry information throughout Mission Creek has identified additional focus areas for DO, eutrophication, habitat, and altered hydrology/connectivity stress in Mission Creek. Prioritization of future work should consider these stressor impacts at various locations in the watershed.

- DO and eutrophication issues are prevalent throughout Mission Creek, but especially at the end downstream of County Highway 11. DO concentrations tend to drop to harmful levels and fluctuate greatly, which negatively impacts aquatic life. Phosphorus concentrations increase downstream of County Highway 11 resulting in excessive plant growth (Figure 2). The proximity of agricultural fields along with the low gradient nature of the stream allows for eutrophic conditions. Best management practices to prevent phosphorus from entering the stream system in this section, as well as upstream, are needed.
- Habitat conditions were considered fair throughout Mission Creek, with the habitat scores slightly higher in upper Mission Creek. Factors limiting the habitat along this reach were the light stream shading, moderate to severe embeddedness, silt and detritus substrates, only slow moving water, sometimes limited depth variability, and poor to fair channel development.
- Altered hydrology/connectivity is a significant issue in Mission Creek. The low gradient nature of this subwatershed already has limited water movement, which can lead to poor habitat, increased sedimentation, as well as eutrophic conditions. The Lawrence Mans Reservoir also has a dam that can limit the amount of flow downstream and prevent fish migration to the headwaters of the watershed. Mission Creek had very low numbers of migratory fish individuals present. Further study of the continuing need viability of the dam and reservoir may be needed to address this stressor.



Figure 2: Excess plant growth in Lower Mission Creek.

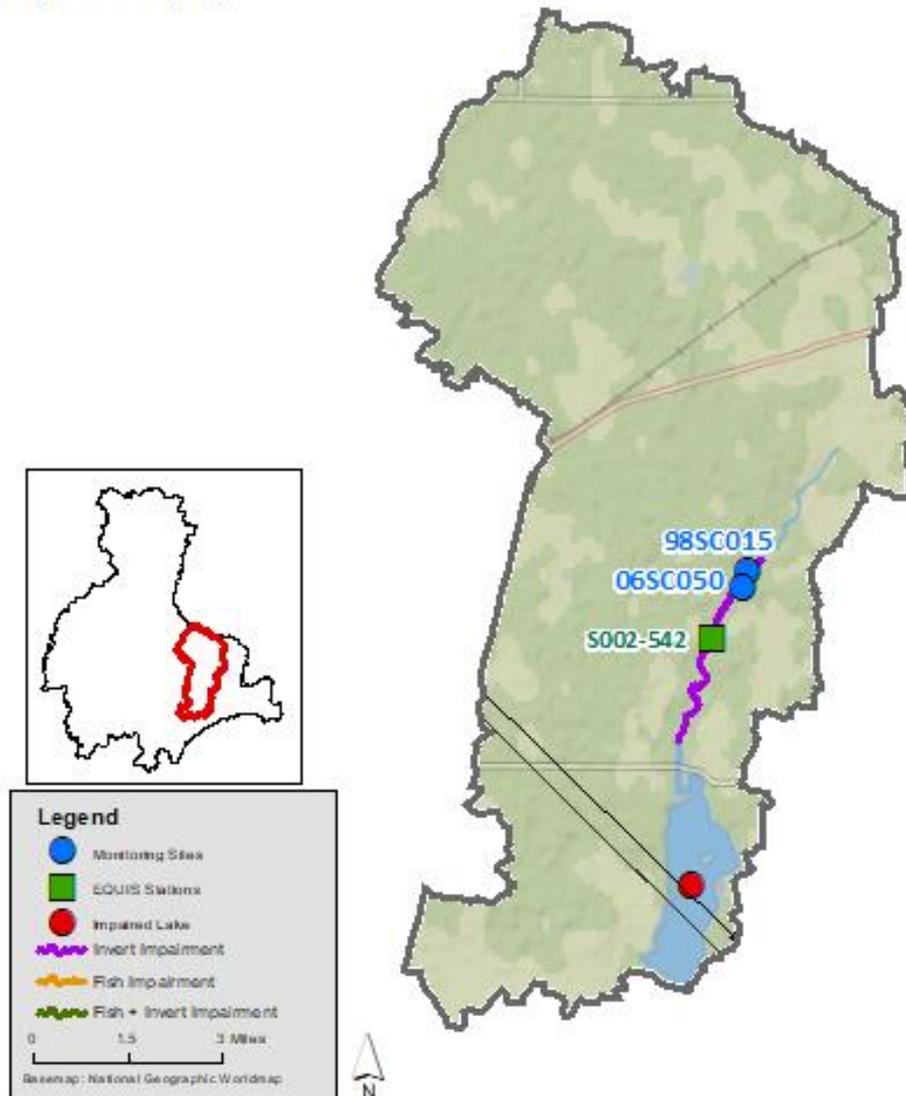
Pokegama Creek (07030004-532)

Biological Community Summary

Pokegama Creek (-532) is a 4.15-mile reach that is impaired for aquatic life use due to the degraded macroinvertebrate assemblage. The macroinvertebrate IBI scores ranged from 31.1 to 35.3 at sites 98SC015 and 06SC042. These scores were both below their respective class thresholds. The vast majority of the macroinvertebrate metrics comprising the MIBI scored below average.

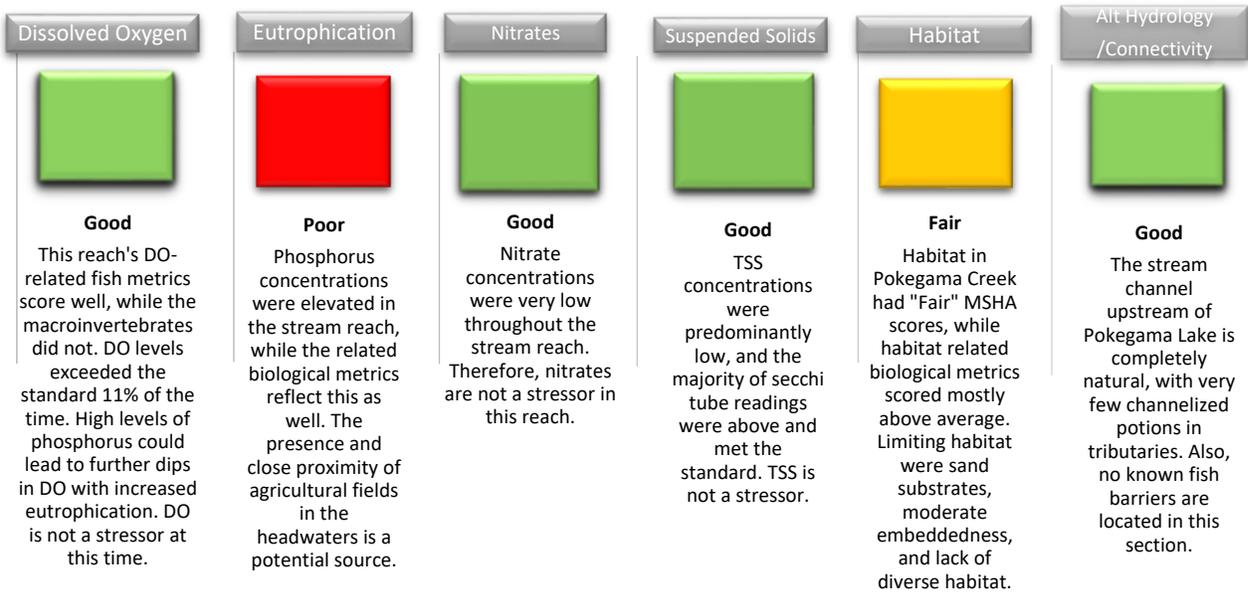
Pokegama Creek Subwatershed

Pokegama Creek (-532)



What stressors are of concern?

SID work was not completed in Pokegama Creek during C1 SID. The goal of C2 SID work was to get additional longitudinal information on DO, eutrophication, and stream transparency. Eutrophication was the only identified stressor, while DO and habitat could potentially become stressors if conditions worsen.



Summary of stream health in Pokegama Creek

Additional biological and water chemistry information throughout Pokegama Creek identified additional focus areas for eutrophication issues, with DO and habitat being potential stressors in the future. Prioritization of future work should consider these stressor impacts at various locations in the watershed.

- Downstream of Pokegama Creek, Pokegama Lake was listed for a nutrient impairment in 2004. Due to high phosphorus levels, this impairment remains. Pokegama Creek is a significant tributary to this lake. This reach also showed elevated phosphorus levels from the headwaters to the downstream portions. These elevated concentrations are likely due to the proximity of wetland areas as well as some areas of agriculture.
- Habitat conditions were considered fair throughout Pokegama Creek. Limiting the habitat at this site were the light stream shading, presence of sand substrates in over half of the reach, moderate embeddedness, limited depth variability, no riffles present, and fair channel development. Habitat improvement projects could help further develop and provide more diversity to the biotic communities in this reach.

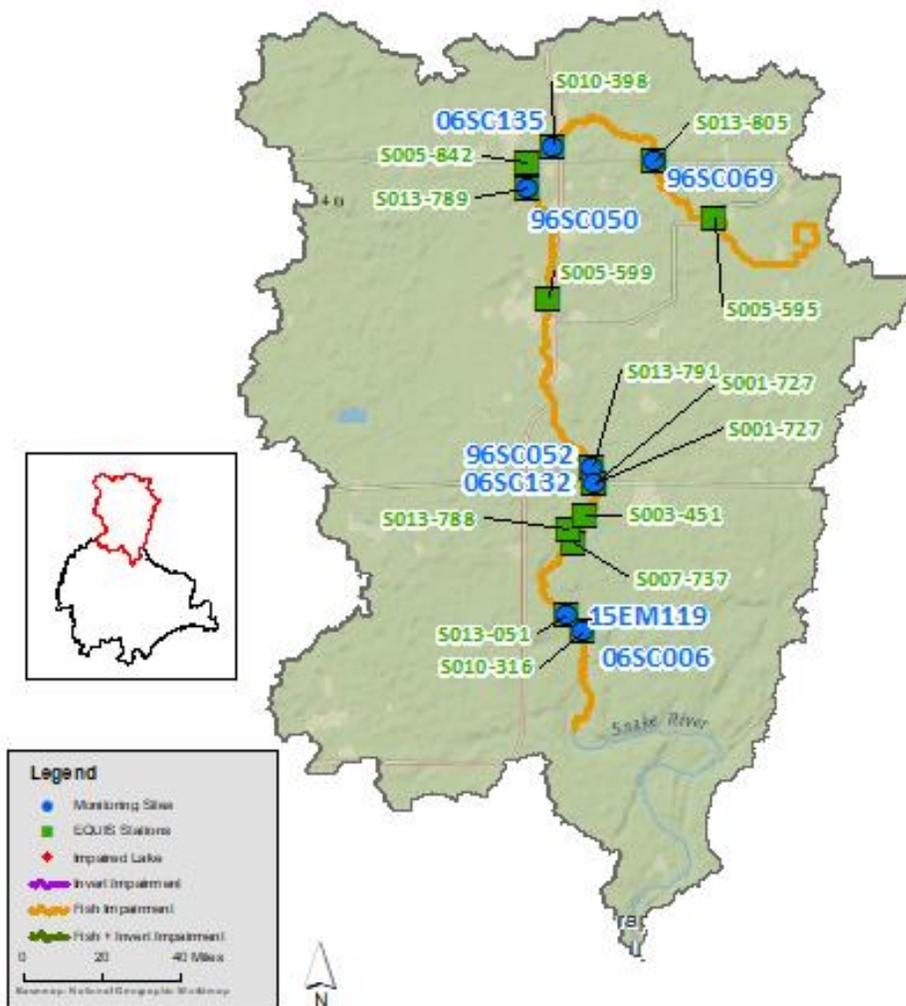
Snake River (07030004-508)

Biological Community Summary

Snake River (-508) is a 31.99-mile reach that is impaired for aquatic life use due to the low fish assemblage score. In the far headwaters of this subwatershed is where the FBI scores drop dramatically. The low gradient, channelized section of Snake River, located north of McGrath at site 06SC135, scored very poorly for fish (31) leading to the impairment designation.

Snake River Headwaters Subwatershed

Snake River (-508)



What stressors are of concern?

SID work was not completed in Snake River (-508) during C1 SID. The goal of C2 SID work was to evaluate upstream, downstream, and within the channelized section to determine if the channelization alone was causing the fish impairment. Based on the information collected and analyzed, it was determined that the channelization in this low gradient portion of Snake River led to changes in flow and habitat conditions, resulting in an aquatic life impairment.

Dissolved Oxygen	Eutrophication	Nitrates	Suspended Solids	Habitat	Alt Hydrology /Connectivity
					
Good	Good	Good	Good	Poor	Poor
This reach had low DO levels in the low gradient headwaters of this subwatershed. These levels improve downstream of the wetland like environment. The fish and macroinvertebrates score well in the DO related metrics. Therefore, DO is not a stressor.	Phosphorus concentrations occasionally exceeded the standard, however the eutrophication-related biotic metrics showed that eutrophication was not having a negative impact on the biotic communities.	Nitrate concentrations were very low throughout the stream reach with a large data set. Therefore, nitrates are not a stressor in this reach.	TSS concentrations were predominantly low, and the majority of secchi tube readings were above the standard using a large data set. Therefore, suspended solids are not a stressor.	Habitat in the Snake River is very good throughout the reach, except for the channelized section. This portions lacks many coarse substrates and faster moving water to push excess sediment downstream, resulting in habitat lacking diversity.	The channelized portion of the Snake River led to increased sediment and overall poor habitat conditions, as flow in this reach could not adequately push sediment through the stream system.

Summary of stream health in Snake River

Snake River (-508) was approved for a 4c recategorization in the summer of 2020, with the recommendation being forwarded to the U.S. Environmental Protection Agency (EPA) for final approval. For more details on this recategorization:

“Segments should be placed in Category 4c when the state demonstrates that the failure to meet an applicable water quality standard is not caused by a pollutant, but instead is caused by other types of pollution. Segments placed in Category 4c do not require the development of a total maximum daily load (TMDL). Pollution, as defined by the CWA is “the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water” (section 502(19)).” Regarding the distinction between *pollutant* and *pollution*: pollutants are generally considered the typical parameters (or their surrogates) that are measured in the water column for which loads can be calculated (e.g. phosphorus, chloride, or total suspended solids). The term *pollution* in the 4c context refers to nonpollutant alterations. It is expected that most 4c candidates will be impaired biota listings for which there is confidence in SID findings. (MPCA)

Overall, Snake River (-508) is in relatively good health. There are currently no pollutant stressors in this reach. The current fish community impairment is a direct result from the channelization in a small section of this reach many years ago. This caused changes in the flow regime, which also degraded the habitat conditions in this reach. Habitat improvement projects and/or re-meandering this stream section would likely result in improved FIBI scores.

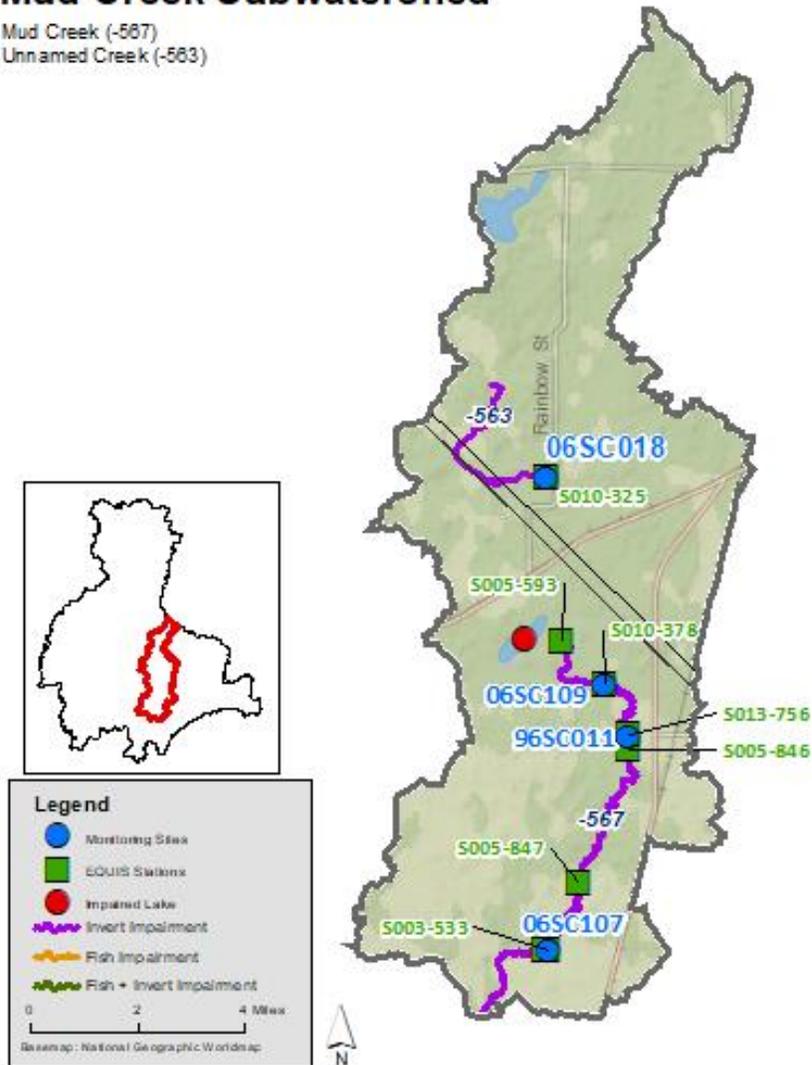
Unnamed Creek (07030004-563)

Biological Community Summary

Unnamed Creek (-563) is a 4.52-mile reach that is impaired for aquatic life use due to the low scoring macroinvertebrate assemblage at its one biological monitoring site, 06SC018. The MIBI score at 06SC018 was 30.1, with 8 of the 10 metrics comprising the MIBI, scoring poorly.

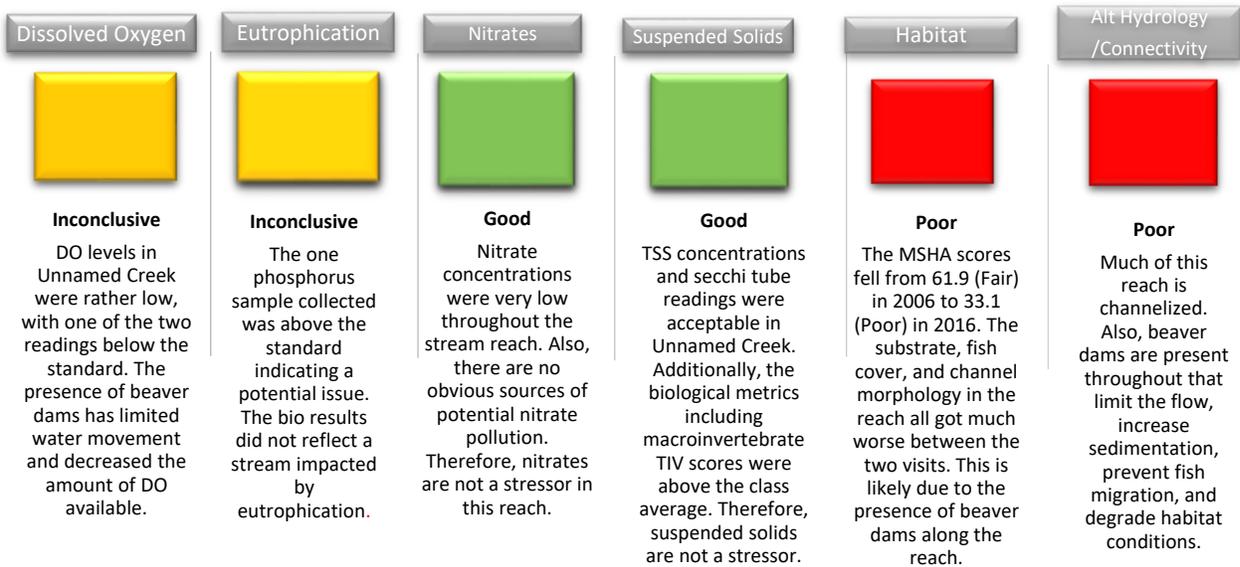
Mud Creek Subwatershed

Mud Creek (-567)
Unnamed Creek (-563)



What stressors are of concern?

SID work was not completed in Unnamed Creek during C1 SID. The goal of C2 SID work was to gather and analyze the biological and chemical data to determine the likely cause of stress to the impaired macroinvertebrate community. Habitat and Altered Hydrology/Connectivity were the identified stressors, while DO and eutrophication were inconclusive and could potentially have a negative impact on aquatic life.



Summary of stream health in Unnamed Creek

Additional analysis of the biological, water chemistry, and general stream conditions in Unnamed Creek has pointed to the importance of proper flow and connectivity. Without proper flow and connectivity, additional stressors like poor habitat occur. Prioritizing a free-flowing system in this reach could lead to significant improvements.

- Altered Hydrology and Connectivity are the driving stressors to aquatic life in Unnamed Creek. There is a series of beaver dams (Figure 3) located along this reach that is impacting the flow and sediment transportation, and degrading the habitat conditions. Beaver dam removal would likely result in improved flow, connectivity, and habitat conditions.

The habitat conditions in Unnamed Creek worsened at site 06SC018 from 2006 to 2016. This was primarily due to the increased amount of sediment along the reach. The beaver dams present are likely limiting proper sediment transport, allowing coarse substrates to be covered and degrading the overall habitat conditions. Removal of the beaver dams would likely result in improved habitat conditions in this reach.



Figure 3: Multiple beaver dams located in Unnamed Creek at site 06SC018.

- Low DO and high phosphorus concentrations in a limited number of samples indicate that both DO and eutrophication may be stressors in this reach as well. Eliminating the beaver dams along this reach will help provide those answers.

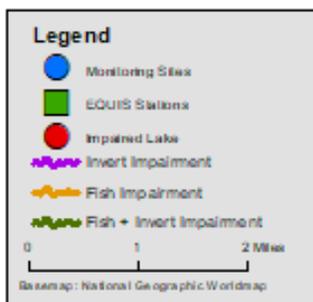
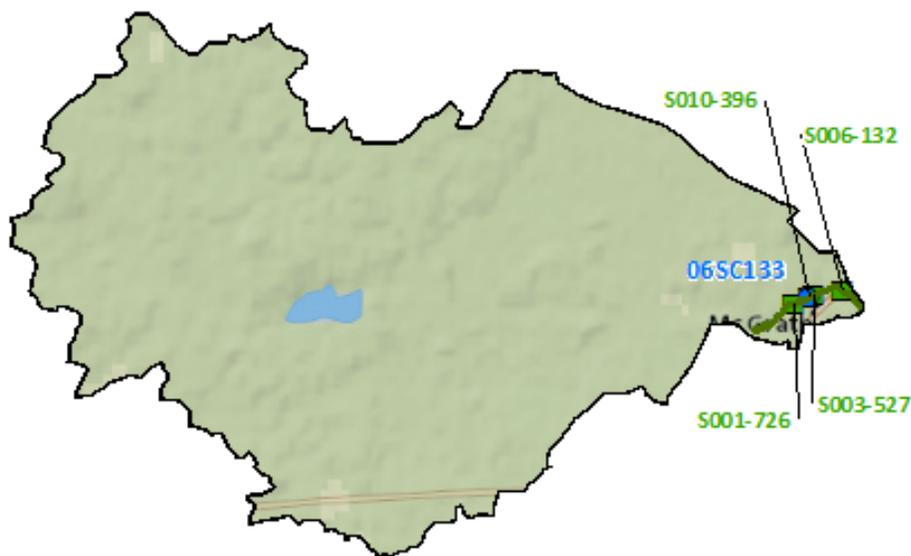
Bear Creek (07030004-552)

Biological Community Summary

Bear Creek (-552) is a 1.42 mile long reach that is impaired for aquatic life use due to the low-scoring macroinvertebrate assemblage. The macroinvertebrate assemblage at site 06SC133 was sampled in August of 2009 and 2017. The 2009 visit had an MIBI score of 55.8, while the 2017 visit had an MIBI score of only 30.1, which led to the macroinvertebrate impairment listing for this reach. The 2017 sample lacked plecoptera taxa, while also having lowering amounts of clingers, predators, and trichoptera, which limited the MIBI score.

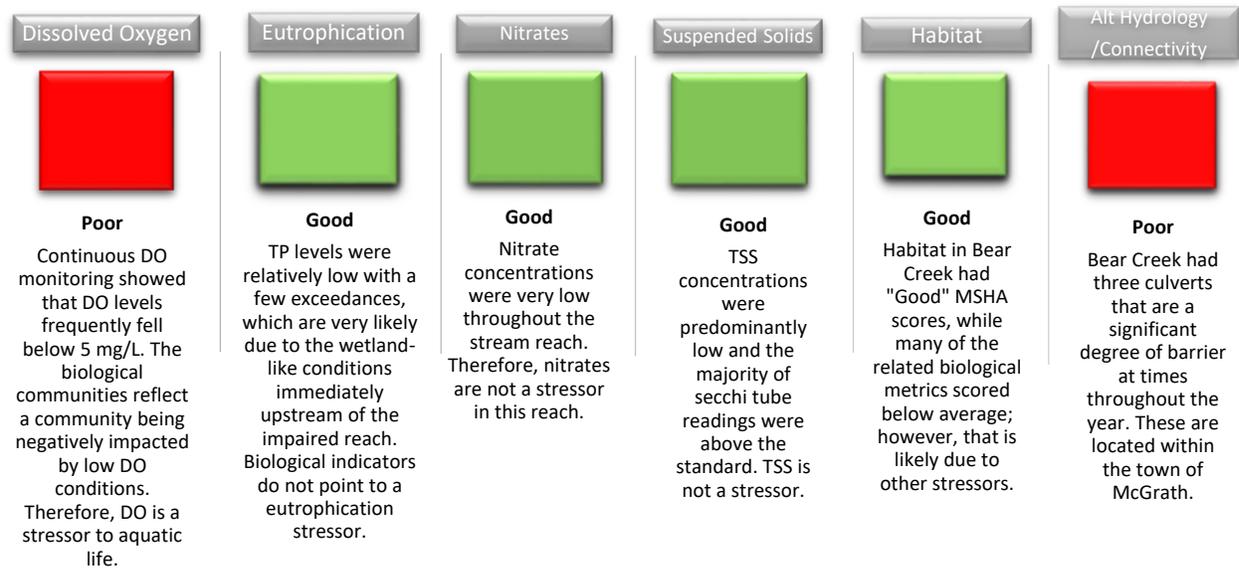
Bear Creek Subwatershed

Bear Creek (-552)



What stressors are of concern?

SID work was not completed in Bear Creek during C1 SID. The goal of C2 SID work was to get additional longitudinal and continuous information on DO, eutrophication, and stream transparency. During this work, DO, eutrophication, and flow alteration/connectivity were the identified stressors.



Summary of stream health in Bear Creek

Additional biological, water chemistry, and stream flow/passage information in Bear Creek has identified areas with DO, eutrophication, and connectivity stress within this reach. Prioritization of future work should consider these stressor impacts at various locations in the watershed.

- DO conditions in the upstream end of this reach and further into the headwaters of Bear Creek drop considerably. This is likely due to the wetland-like environment and low gradient conditions in the stream section.
- Areas of channelization in the headwaters in this watershed may cause some negative impacts further downstream in Bear Creek. A larger issue is connectivity, with three culverts designated by the Minnesota Department of Natural Resources (DNR) as Level 2, meaning they are a significant barrier during different times of the year as the culverts become perched. Fixing the designated culverts may result in considerable positive change to the biological communities in Bear Creek.
- Bear Creek is also impaired by low pH. However, further monitoring indicated that pH is not a stressor to aquatic life at this time. The low pH values are likely attributed to the wetland conditions and soils surrounding Bear Creek.

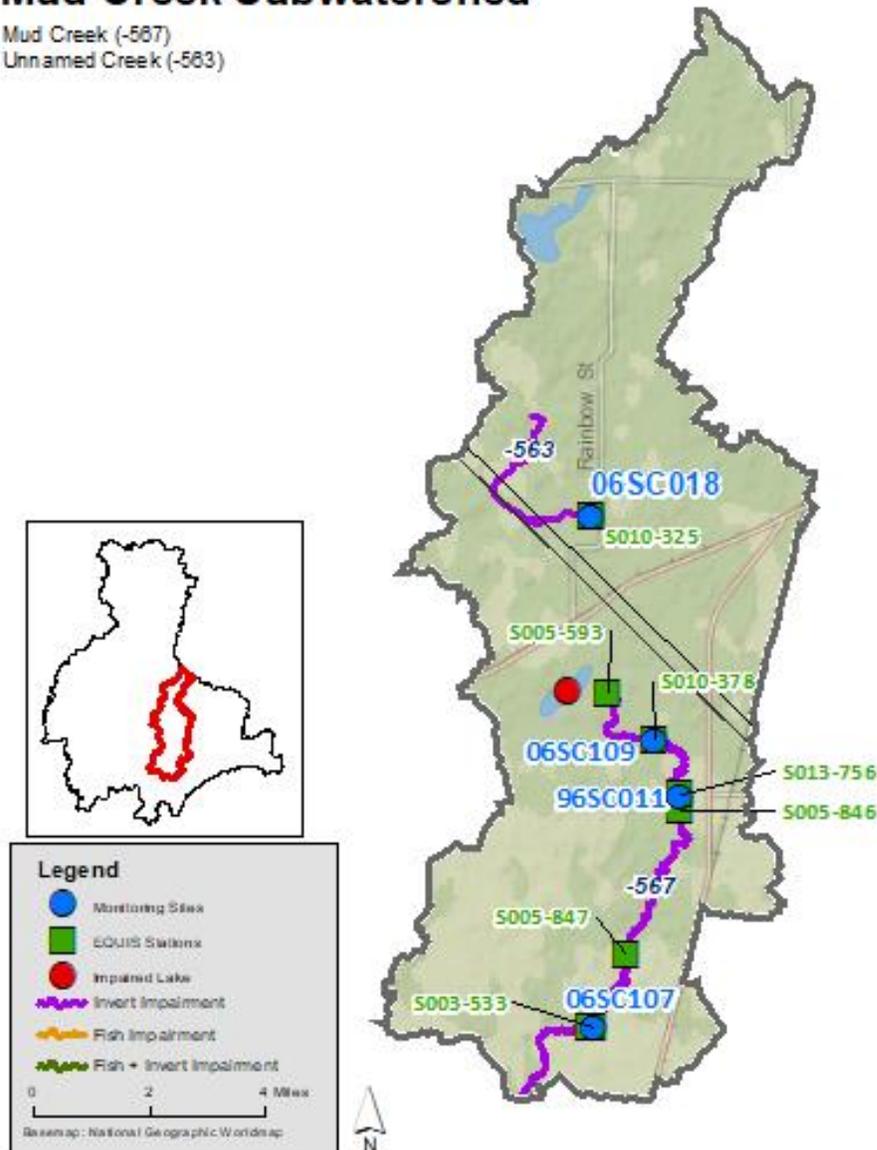
Mud Creek (07030004-567)

Biological Community Summary

Mud Creek (-567) is a 14.05-mile reach that is impaired for aquatic life use due to the low-scoring macroinvertebrate assemblage. The macroinvertebrate IBI scores at site 06SC107 ranged from 50.8 to 63.3, which is below the Class 4 threshold of 51. Site 06SC107 is located near the outlet of Mud Creek and scored slightly better than further upstream at site 06SC109. Site 06SC109 had MIB scores of 45.2 and 56.4, which were both below and above the Class 3 threshold of 53.

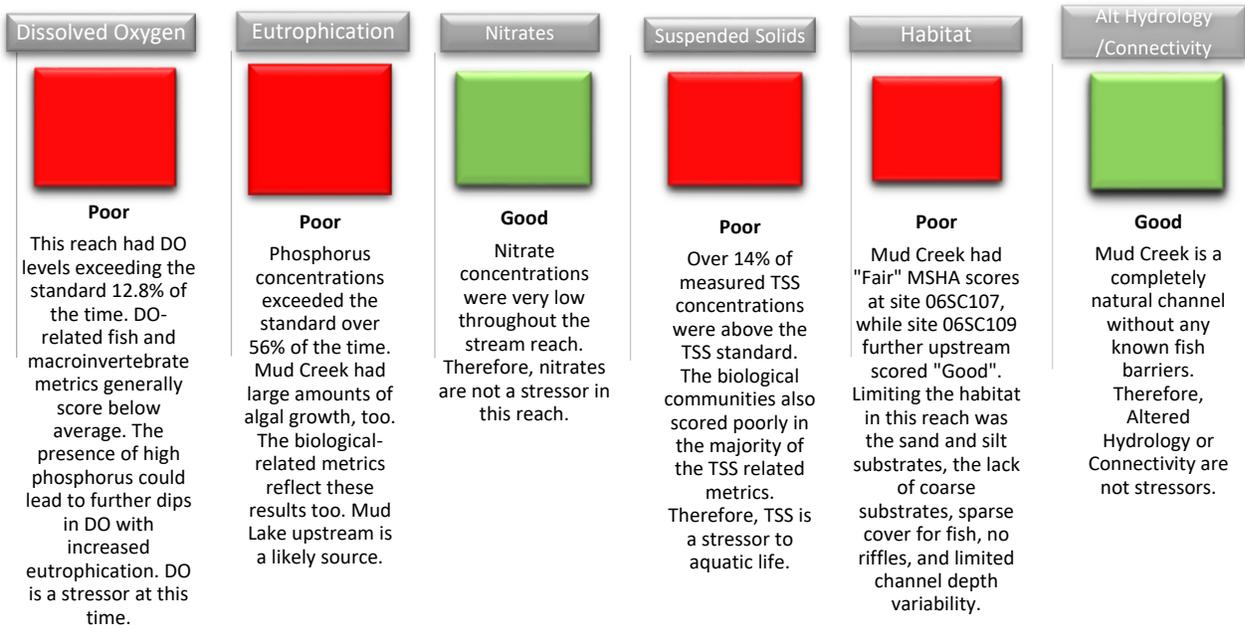
Mud Creek Subwatershed

Mud Creek (-567)
Unnamed Creek (-563)



What stressors are of concern?

SID work was not completed in Mud Creek during C1 SID. The goal of C2 SID work was to further analyze the available chemical and biological information related to aquatic life and those stressors associated. DO, eutrophication, suspended solids, and habitat were all identified as stressors.



Summary of stream health in Mud Creek

Additional analysis of biological and water chemistry information throughout Mud Creek has provided additional focus areas for addressing eutrophication issues, DO, suspended solids, and habitat. Prioritization of future work should consider these stressor impacts at various locations in the watershed.

- Upstream of Mud Creek is Mud Lake. Mud Lake is impaired due to the eutrophic conditions of the lake that violate the standards set for the ecoregion. Both elevated phosphorus and chlorophyll-a (Chl-a) concentrations confirmed this impairment. Given the close relationship that DO and eutrophication have, these sources are likely causing or contributing to the low DO and eutrophic (Figure 4) conditions that Mud Creek experiences as well. Given this impairment, the likelihood is that the sources of the excess phosphorus in Mud Creek (-567) are Mud Lake and the upstream watershed that has land use comprising of 89% hay/pasture and 6% cropland (Wenck 2013).
- Habitat conditions were much worse in the lower portion of Mud Creek. Limiting the habitat in this reach were the sand and silt substrates, the lack of coarse substrates, sparse cover for fish, no riffles, and limited channel depth variability. Habitat improvement projects could help further develop and provide more diversity to the biotic communities in this reach.
- Suspended solids are more of a secondary stressor to aquatic life in Mud Creek. Standard exceedances were just over 14%, while secchi tube readings exceeded the standard 6.25% of the time. Further monitoring of total suspended solids (TSS) and transparency, while first addressing the eutrophication issues in the watershed, is recommended.



Figure 4: Excessive plant growth in Mud Creek.

Part 3: Conclusion and Recommendations

Summary of Stressors

The stressors for the biological impairments in the Snake River Watershed are listed in Table 1. The most common stressor in the watershed was habitat (4), eutrophication (4) and flow alteration/connectivity (4), then DO (3), suspended solids (1). Nitrates and pH were ruled out as stressors when evaluated.

Table 1: Stressor determinations for the Snake River Watershed.

Stream Name	AUID	Stressors Aquatic Life Impairment	Dissolved Oxygen	Eutrophication	Nitrate	Suspended Solids	Habitat	Flow Alteration /Connectivity	pH
Cycle 2 SID (2019-2020)									
Mission Creek	07030004-547, -578	Fish, Macroinvertebrates	●	●	---	---	●	●	n/a
Pokegama Creek	07030004-532	Macroinvertebrates	---	●	---	---	---	---	n/a
Snake River	07030004-508	Fish	---	---	---	---	●	●	n/a
Unnamed Creek	07030004-563	Macroinvertebrates	o	o	---	---	●	●	n/a
Bear Creek	07030004-552	Macroinvertebrates	●	---	---	---	---	●	---
Mud Creek	07030004-567	Macroinvertebrates	●	●	---	●	●	---	n/a
Previous SID (2004-2011)									
Ann River	07030004-511	Macroinvertebrates	o	---	---	---	●	o	n/a
Groundhouse River	07030004-513	Macroinvertebrates	o	o	o	o	●	n/a	n/a
Mud Creek	07030004-566	Macroinvertebrates	●	o	---	---	●	o	---
South Fork Groundhouse River	07030004-573	Macroinvertebrates	o	o	o	o	●	n/a	n/a

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

Recommendations and Additional Monitoring

In the Snake River Watershed, the most common stressors identified were habitat, eutrophication, and flow alteration/connectivity. These stressors are largely tied to land use activities in the watershed, as well as human-caused alterations to the stream channel and flow regime. Additionally, the low gradient and wetland-like areas are also contributing to these stressors by their inability to move water through the systems allowing sedimentation, poor habitat, low DO, and eutrophic conditions. Table 2 contains recommendations of possible solutions to these stressors.

Table 2. Recommended prioritization of restoration activities relative to the stressors contributing to the biological impairment in the Snake River Watershed.

Stressor	Priority	Comment
Habitat	High	Re-establish quality riparian corridor to increase woody debris, stream stability, and stream shading. Protecting streambanks, reduce erosion and overall stream sedimentation, as well as potentially re-meandering channelized stream sections, specifically in the Upper Snake River.
DO and Eutrophication	High	Collect information as needed for streams that are lacking necessary DO and eutrophication-related information including DO flux, chl- <i>a</i> , and BOD samples, while also utilizing a variety of nutrient reducing BMPs targeting headwater reaches, and upstream lakes (Mud Lake).
Flow Alteration/Connectivity	High	Evaluate and remove/replace culverts that are perched and impeding fish movement. Removal of beaver dams will also encourage more flow that will prevent sedimentation and habitat degradation. Evaluate cost/benefit of dams within the watershed.
Suspended Solids	Medium	Focus on reducing sediment input from riparian corridor (cattle pastures) and immediate stream channel (stream banks).

For more information

WRAPS updates, including necessary TMDLs, follow the completion of the SID process. For more information, go to <https://www.pca.state.mn.us/water/watersheds/snake-river-st-croix-basin> or search for “Snake River Watershed” on the MPCA website.

Details and specific monitoring information related to the SID analysis of this report is available from the contact person below.

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