Lake Superior South Watershed Restoration and Protection Strategy Report

MINNESOTA POLLUTION CONTROL AGENCY

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Project Partners

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- University of Minnesota Sea Grant Program – Jesse Schomberg
- U. S. Environmental Protection Agency – Tom Hollenhorst

In addition, this WRAPS builds on the collaboration and stakeholder input processes that supported the One Watershed, One Plan that was completed in 2016. This effort was led by Dan Shutte from the Lake County Soil and Water Conservation District and Ilena Berg from the Cook County Soil and Water Conservation District.

Table of Contents

Tables

Figures

Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit Hydrologic Unit Code (HUC) plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

BANCS (Bank Assessment for Non-point source Consequences of Sediment): A model developed by Dave Rosgen in 1996 and adopted by the EPA in 2006 as part of the Watershed Assessment of River Stability and Sediment Supply, or WARSSS framework. The BANCS model combines Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) measurements to estimate an erosion rate. Measurements are completed at an individual bank scale and extrapolated to a reach scale. At each assessment bank, characteristics such as plant root depth and density, bank height and bank angle were used to calculate a BEHI score and the location of dominant channel flow relative to the bank or depositional properties and other channel characteristics were used to calculate a NBS score. BEHI and NBS relationship curves developed for the BANCS model were then used to calculate a bank erosion rate.

Hydrologic Unit Code (HUC): A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Lake Superior Basin is assigned a HUC4 of 0702 and the Lake Superior South Watershed is assigned a HUC8 of 07020002.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from ‘stressor’ to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

Executive Summary

The State of Minnesota has adopted a watershed approach to address the state's 80 major watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results into a 10-year cycle that addresses both restoration and protection as part of a Watershed Restoration and Protection Strategy (WRAPS) report. This WRAPS report addresses a portion of the waterbodies within the Lake Superior South (LSS) Watershed (HUC 04010102) that is located north and east of the Duluth Urban Area. The watershed constitutes 551 square miles and lies within the Northern Lakes and Forest ecoregion. Lake Superior shoreline comprises the entirety of the eastern border of the LSS Watershed. The dominant land cover is forest and wetland, and the majority of the watershed is undeveloped.

Thirty-six assessment units in the LSS Watershed were assessed by the Minnesota Pollution Control Agency (MPCA) to identify impaired waters and waters in need of protection. Seven stream reaches were identified as impaired for aquatic life and one stream reach was identified as impaired for both aquatic life and aquatic recreation. Two Lake Superior beaches are also impaired for aquatic recreation. All impaired streams and beaches require restoration activities. In addition, all lakes and streams in the watershed require protection, including those listed as impaired. Stream vulnerability based on biological integrity and lake water quality risk were considered in protection efforts. For the purposes of this WRAPS report, stream reaches and lakes vulnerable to degradation were prioritized, in addition to those with high value and high quality.

Restoration and protection strategies for implementation in the LSS Watershed aim to improve water quality in impaired streams and preserve and enhance water quality in non-impaired waters. Activities include: addressing sources of untreated wastewater (e.g., failing septic systems, leaky infrastructure), protecting and stabilizing lakeshores, improving fisheries management, stream connectivity improvements, improvements to biological integrity, invasive species control, land use planning and ordinance development, managing stormwater runoff, forest management, addressing aggregate mining issues, groundwater management, wetland management, and education and outreach activities. Targeted geographic areas for implementation were identified based on a detailed prioritization and ranking process conducted as part of the One Watershed, One Plan (1W1P) process in Lake and Cook counties and include: Beaver River, Knife River, the City of Two Harbors, Gooseberry River Watershed, Stewart River, and nearshore Lake Superior. These geographic areas are prioritized for the first 10 years of implementation.

A core team of local, state, and federal resource management agency staff supported the WRAPS process and provided valuable input. The WRAPS study summarizes and is supported by previous work including the *Lake Superior North 1W1P* (Cook and Lake counties' Soil and Water Conservation Districts 2016), *Lake Superior - South Monitoring and Assessment Report* (MPCA 2014), the *Lake Superior - South Stressor Identification Report* (MPCA 2017), *Lake Superior North and Lake Superior South Basins–Watershed Model Development Report* (Tetra Tech 2016), *Lake Superior South Total Maximum Daily Load Study* (Tetra Tech 2018), and the *Knife River Total Maximum Daily Load Study and Implementation Plan* (SSLSWCD 2010, 2011).

What is the WRAPS Report?

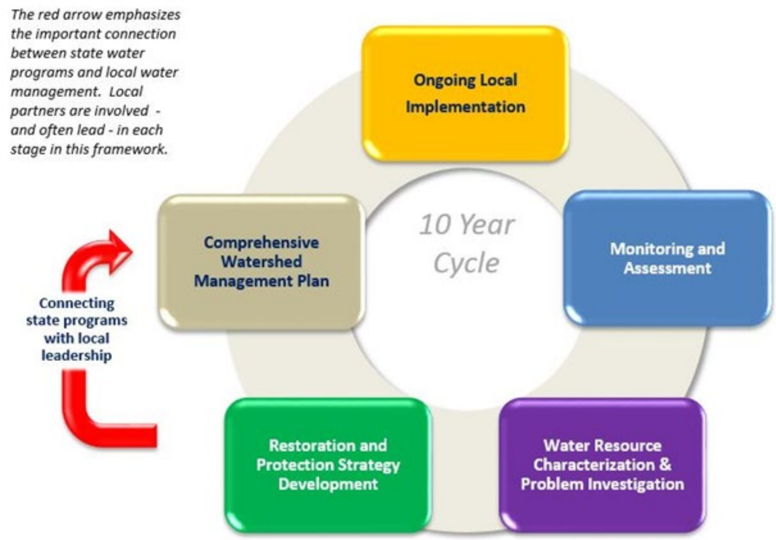

Figure 1. WRAPS 10-year cycle.

Minnesota has adopted a watershed approach to address the state's 80 major watersheds. The Minnesota Watershed Approach incorporates **water quality assessment, watershed analysis, civic engagement, planning, implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection (Figure 1).

As part of the watershed approach, the MPCA developed a process to identify and address threats to water quality in each of these major watersheds. This process is called WRAPS development. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired and Total Maximum Daily Load (TMDL) studies are developed, as they have been in the past. TMDLS are incorporated into WRAPS. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale data and other tools to identify strategies and actions for point and nonpoint source pollution that will cumulatively achieve water quality goals. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as a watershed plan to at least partially address the Environmental Protection Agency's (EPA's) Nine Minimum Elements of watershed planning, helping to qualify applicants for possible Clean Water Act Section 319 implementation funds.

The watershed approach for the LSS Watershed is unique, as Lake and Cook counties and soil and water conservation districts (SWCDs) have recently completed a watershed-based local water plan through the 1W1P process. As part of the 1W1P planning process, partner and public engagement and input was conducted. This WRAPS document summarizes and incorporates the valuable information from the 1W1P and maintains the same targeted areas for implementation over the next 10 years. This WRAPS document additionally:

- Provides updated pollutant source modeling results
- Identifies at-risk waters and unique and high value water resources for protection
- Identifies best management practices for sediment control along impaired stream reaches

- Provides a smaller scale analysis of priorities, trends, and pollution sources as it covers the smaller MPCA-defined LSS Watershed
- Summarizes and compiles relevant watershed plans within the LSS Watershed in one document
- Makes any necessary adaptations to implementation activities identified in the 1W1P due to the above additions

Purpose	• Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for future implementation planning
	• Summarize Watershed Approach work done to date including the following:
	  • *Lake Superior North One Watershed, One Plan*
	  • *Lake Superior – South Watershed Monitoring and Assessment Report*
	  • *Lake Superior South Watershed Biotic Stressor Identification*
	  • *Lake Superior North and Lake Superior South Basins—Watershed Model Development Report*
	  • *Lake Superior South Watershed Total Maximum Daily Load Study*
	  • *Knife River TMDL and Implementation Plan*

Scope	• Impacts to aquatic recreation and aquatic life in streams • Impacts to aquatic recreation in lakes and at beaches • Protection of uses in high quality water resources
Audience	• Non-profits (watershed groups, Trout Unlimited, etc.) • Local governments and soil and water conservation districts • State agencies (MPCA, DNR, BWSR, etc.) • Federal agencies (USDA, USGS, EPA, etc.) • Citizens and land-owners in the watershed

1. Watershed Background and Description

The LSS Watershed is located in northeastern Minnesota in the Lake Superior Basin, and is in the Northern Lakes and Forests ecoregion. The watershed is 624 square miles and covers portions of St. Louis and Lake Counties. In this report, “LSS Watershed” refers to the portion of the watershed north of the urbanized Duluth area (i.e., northeast of the Lester River) and constitutes 551 square miles. The urban streams within the Duluth area are being addressed as part of a separate effort (Duluth Urban Area WRAPS, concurrently under development). All of the watershed’s streams and rivers drain to Lake Superior, but there is no single “pour point” for the entire watershed (Figure 2).

The LSS Watershed contains many exceptional water resources; however, there are streams and beaches that do not met water quality standards for aquatic life and recreational uses. The watershed is 45% privately owned, leaving the majority of the land undeveloped and publicly owned (Figure 3). The dominant land cover in the LSS Watershed is forest and wetland, followed by shrub/scrub. Pasture, open water, and developed and barren land each make up less than 5% of the watershed as a whole. Urban land uses are a mix of commercial, industrial, resort and rural residential, with an active mining operation in Silver Bay. The majority of the watershed is undeveloped, with the exception of Two Harbors (population 3,745) and the town of Beaver Bay (population 181) as concentrated population centers.

Lake Superior shoreline comprises the entirety of the eastern boarder of the LSS Watershed. As such, the Great Lake has cultural, social, and economic value for its communities. For example, Lake Superior is an integral aspect of the many Native American traditions that revolve around sustenance, stories and legends. Additionally, Lake Superior’s ocean-like qualities support a strong regional tourism industry and provide shipping access to international markets, contributing to local economic prosperity.

Additional Lake Superior South Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Lake Superior South Watershed:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/rwa/?cid=nrcs142p2_023578

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the Lake Superior South Watershed:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb2.pdf

One Watershed, One Plan for the Lake Superior North Watershed:
http://www.co.lake.mn.us/document_center/SWCD_Doc_Center/Final%20Lake%20Superior%20North%20Watershed%20Comp%20Plan.pdf

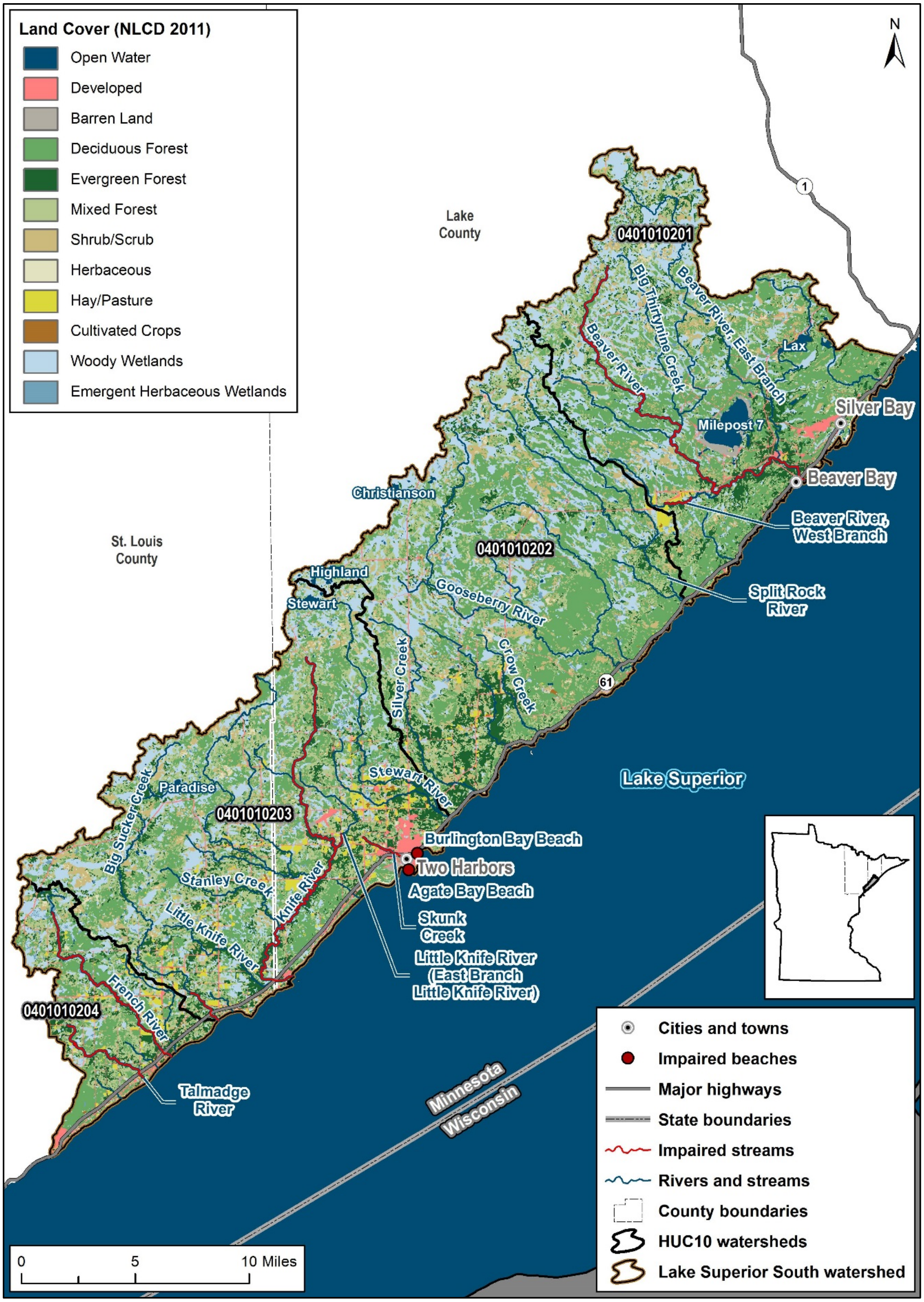

Figure 2. Land use in the LSS Watershed.

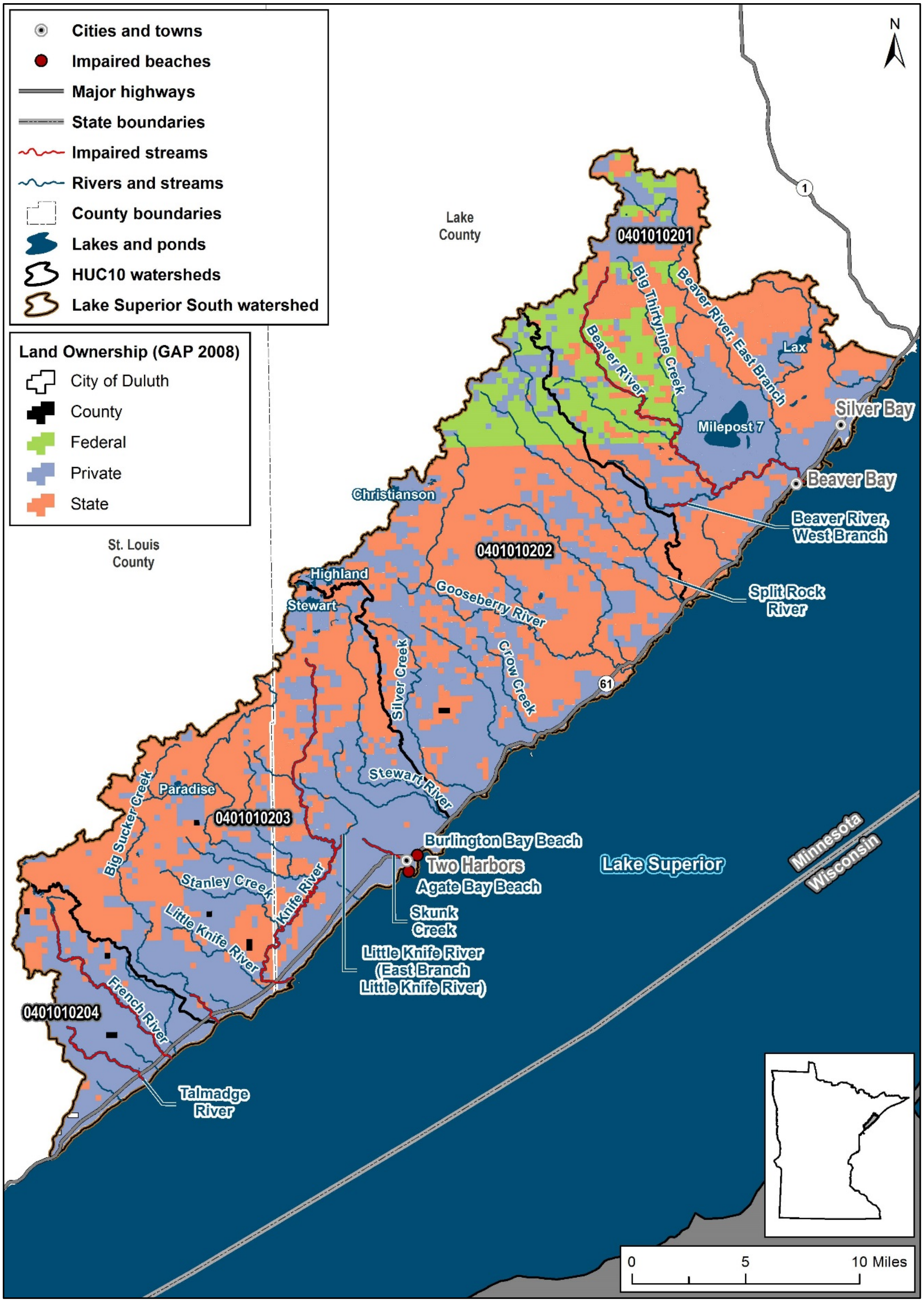

Figure 3. Land ownership in the LSS Watershed (GAP 2008).

2. Watershed Conditions

The LSS Watershed is defined by a series of small streams that transition from slower moving, meandering gravel-bed streams through wetland complexes upstream of the bluff line, to high gradient, fast moving bedrock-controlled streams near their outlets to Lake Superior. The watershed consists of several small- to medium-sized catchments, each of which drains to the western shore of Lake Superior. Fine-grained clay soils dominate the watershed. Many small wetlands are present in the watershed, with 16 lakes identified as greater than 10 acres in surface area. However, the watershed is stream-dominated with limited natural water storage and recharge. The watershed is mostly undeveloped above the escarpment and has historically been used for extractive industries such as logging, mining, and the fur trade business. Developed areas are found primarily in Two Harbors (population 3,745) and Beaver Bay (population 181), as well as along the Highway 61 lakefront.

2.1 Condition Status

The MPCA assesses water quality based on each water body's ability to support aquatic life (e.g., fish and macroinvertebrates) and aquatic recreation (e.g., fishing and swimming). Data from the water bodies are compared to state water quality standards. Water bodies that meet the standards are considered to be unimpaired and are the focus of protection efforts; water bodies that do not meet at least one target are considered to be impaired and are the focus of restoration efforts. Waters that are not yet assessed continue through a process of data collection and evaluation and can be candidates for protection work. In the LSS, there are eight impaired streams and two impaired beaches (Figure 4).

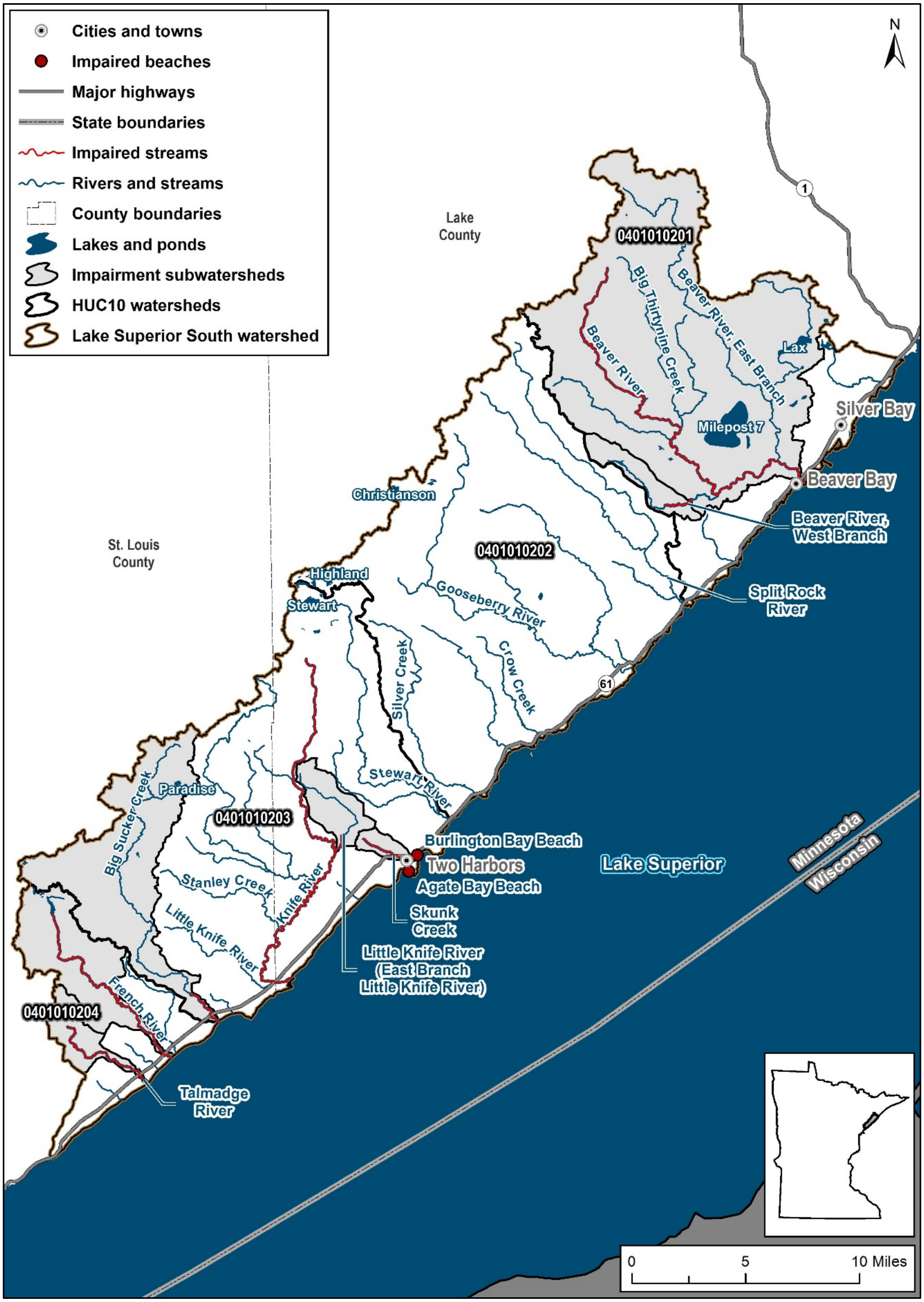

Figure 4. Impaired waters in the LSS Watershed.

Streams

Thirty-six assessment units in the LSS Watershed were assessed by the MPCA to identify impaired waters and waters in need of protection. Waters that do not meet targets for fish assemblage, macroinvertebrate assemblage, dissolved oxygen (DO), turbidity, chloride, pH, or ammonia are considered to not meet the aquatic life beneficial use. Waters that do not meet the targets for fecal indicator bacteria do not meet the aquatic recreation beneficial use; levels of the bacteria *Escherichia coli* (*E. coli*) are used to approximate the amount of fecal contamination in surface waters.

Overall, the LSS Watershed contains a number of high quality streams. Of the 36 stream reaches assessed, seven are impaired for aquatic life and one for both aquatic life and aquatic recreation (Table 1 and Figure 4). The remaining reaches meet water quality standards or were not assessed for aquatic life and aquatic recreation. *E. coil* exceedances, and average total phosphorus (TP), total suspended solids (TSS) and total nitrogen (TN) concentrations are provided in Figure 5 through Figure 8.

The number of *E. coli* exceedances at each sample site is provided in Figure 5; exceedances are presented for the individual sample water quality standard (1,260 org/100 mL). Figure 6, Figure 7 and Figure 8 summarize the average water quality data for TP, TSS, and TN. Applicable TSS water quality standards are 10 mg/L for all assessed streams, except for Skunk Creek and West Branch Knifer River; the TSS standard is 15 mg/L for these two streams. The in-stream TP standard is 0.05 mg/L. There is currently no water quality standard for nitrogen as pertains to aquatic life; however, 10 mg/L nitrate-nitrogen is used to assess for drinking water uses.

Table 1. Impairments in the LSS Watershed.

HUC10 Subwatershed	Assessment Unit (Last 3 digits)	Stream	Reach Description	Aquatic Life								Aquatic Recreation
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	NH_3	Pesticides	Bacteria
Beaver River – Frontal Lake Superior (0401010201)	501	Beaver River	Headwaters to Lake Superior	Imp	Sup	Sup	Imp	Sup	Imp	Sup	NA	Sup
	529	Palisade Creek	Unnamed Creek to Lake Superior	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	530	Beaver River, East Branch	Unnamed Creek to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	535	Beaver River, East Branch	Cedar Creek to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	572	Cedar Creek	Unnamed Lake (38-0407-00) outlet to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	577	Beaver River, West Branch	Unnamed Creek to Unnamed Creek	Imp	Imp	NA	NA	NA	NA	NA	NA	NA
	B28	Big Thirtynine Creek	Unnamed Creek to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	B44	Little Thirtynine Creek	Unnamed Creek to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA

HUC10 Subwatershed	Assessment Unit (Last 3 digits)	Stream	Reach Description	Aquatic Life								Aquatic Recreation
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	NH_3	Pesticides	Bacteria
Gooseberry River – Frontal Lake Superior (0401010202)	502	Gooseberry River	Headwaters to Lake Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	NA	Sup
	513	Silver Creek	Headwaters to Lake Superior	Sup	Sup	NA	Sup	NA	NA	NA	NA	NA
	515	Crow Creek	Headwaters to Lake Superior	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	519	Split Rock River	West Branch Split Rock River to Lake Superior	NA	NA	Sup	IF	Sup	Sup	Sup	NA	Sup
	520	West Split Rock River	Headwaters to Split Rock River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	551	Skunk Creek	T55 R10W S14, West Line to T54 R9W S16, South Line	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	554	Encampment River	T54 R10W S17, West Line to Lake Superior	IF	Sup	Sup	Sup	Sup	Sup	Sup	NA	Sup
	668	Dago Creek	Headwaters to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	740	Little Gooseberry River	Unnamed Creek to Gooseberry River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	A41	Unnamed Creek (Split Rock River Tributary)	T55 R9W S34, West Line to Split Rock River	NA	Sup	NA	NA	NA	NA	NA	NA	NA

HUC10 Subwatershed	Assessment Unit (Last 3 digits)	Stream	Reach Description	Aquatic Life								Aquatic Recreation
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	NH_3	Pesticides	Bacteria
Gooseberry River – Frontal Lake Superior (0401010202) (continued)	A44	East Split Rock River	Unnamed Creek to Unnamed Creek	Sup	Sup	Sup	Sup	Sup	Sup	Sup	NA	Sup
Knife River – Frontal Lake Superior (0401010203)	503	Stewart River	Headwaters (Stewart Lake 38-0744-00) to Lake Superior	Sup	Sup	NA	Sup	NA	NA	NA	NA	NA
	504	Knife River	Headwaters to Lake Superior	Sup	Sup	Sup	Imp	Sup	Sup	Sup	NA	Sup
	528	Skunk Creek	Headwaters to Lake Superior	NA	NA	NA	Imp	Sup	Sup	Sup	NA	Imp
	538	Knife River, West Branch	Unnamed Creek to Knife River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	555	Big Sucker Creek (Sucker River)	Unnamed Creek to Lake Superior	Sup	Sup	Sup	Imp	Sup	Sup	Sup	NA	Sup
	556	Big Sucker Creek (Sucker River)	T53 R12W S20, North Line to Unnamed Creek	Sup	Sup	NA	IF	NA	NA	NA	NA	NA
	584	Captain Jacobson Creek	T53 R12W S33, North Line to West Branch Knife River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA

HUC10 Subwatershed	Assessment Unit (Last 3 digits)	Stream	Reach Description	Aquatic Life								Aquatic Recreation
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	NH_3	Pesticides	Bacteria
Knife River – Frontal Lake Superior (0401010203) (continued)	586	Knife River, West Branch	Unnamed Creek to Captain Jacobson Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	824	Little Knife River	Unnamed Creek to Unnamed Creek	Sup	Sup	NA	Sup	NA	NA	NA	NA	NA
	840	Little Knife River (East Branch Little Knife River)	Unnamed Creek to Knife River	NA	NA	Imp	Imp	NA	Sup	NA	NA	NA
	846	Unnamed Creek (West Branch Little Knife River)	Unnamed Creek to West Branch Knife River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	887	McCarthy Creek	Unnamed Creek to Unnamed Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	A94	Little Stewart River	T53 R11W S3, West Line to Stewart River	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	B01	Brophy Creek	T53 R12W S19, North Line to Big Sucker Creek	Sup	Sup	NA	NA	NA	NA	NA	NA	NA
	C16	Knife River, West Branch	T54 R12W S36, East Line to Unnamed Creek	Sup	NA	NA	NA	NA	NA	NA	NA	NA

HUC10 Subwatershed	Assessment Unit (Last 3 digits)	Stream	Reach Description	Aquatic Life								Aquatic Recreation
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Chloride	pH	NH_3	Pesticides	Bacteria
City of Duluth – Frontal Lake Superior (0401010204)	508	Talmadge River (Talmadge Creek)	Headwaters to Lake Superior	Imp	Sup	Imp	Imp	Sup	Sup	NA	NA	IF
	698	French River	Unnamed Lake (69-182-00) to Lake Superior	Sup	Sup	Sup	Imp	Sup	Sup	NA	NA	Sup

Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore, is impaired, IF = the data collected was insufficient to make a finding, NA = not assessed

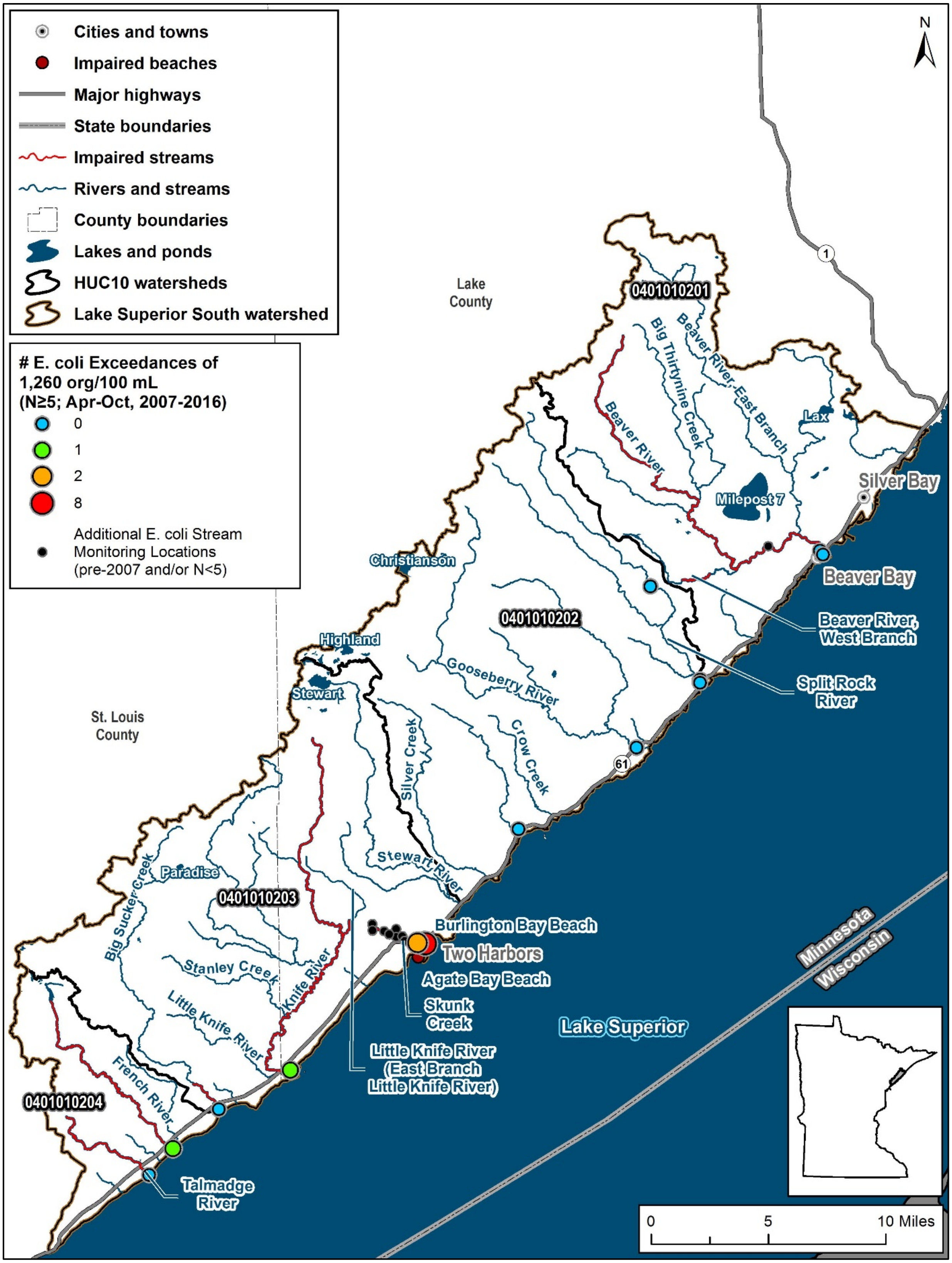

Figure 5. Stream *E. coli* exceedances in the LSS Watershed.

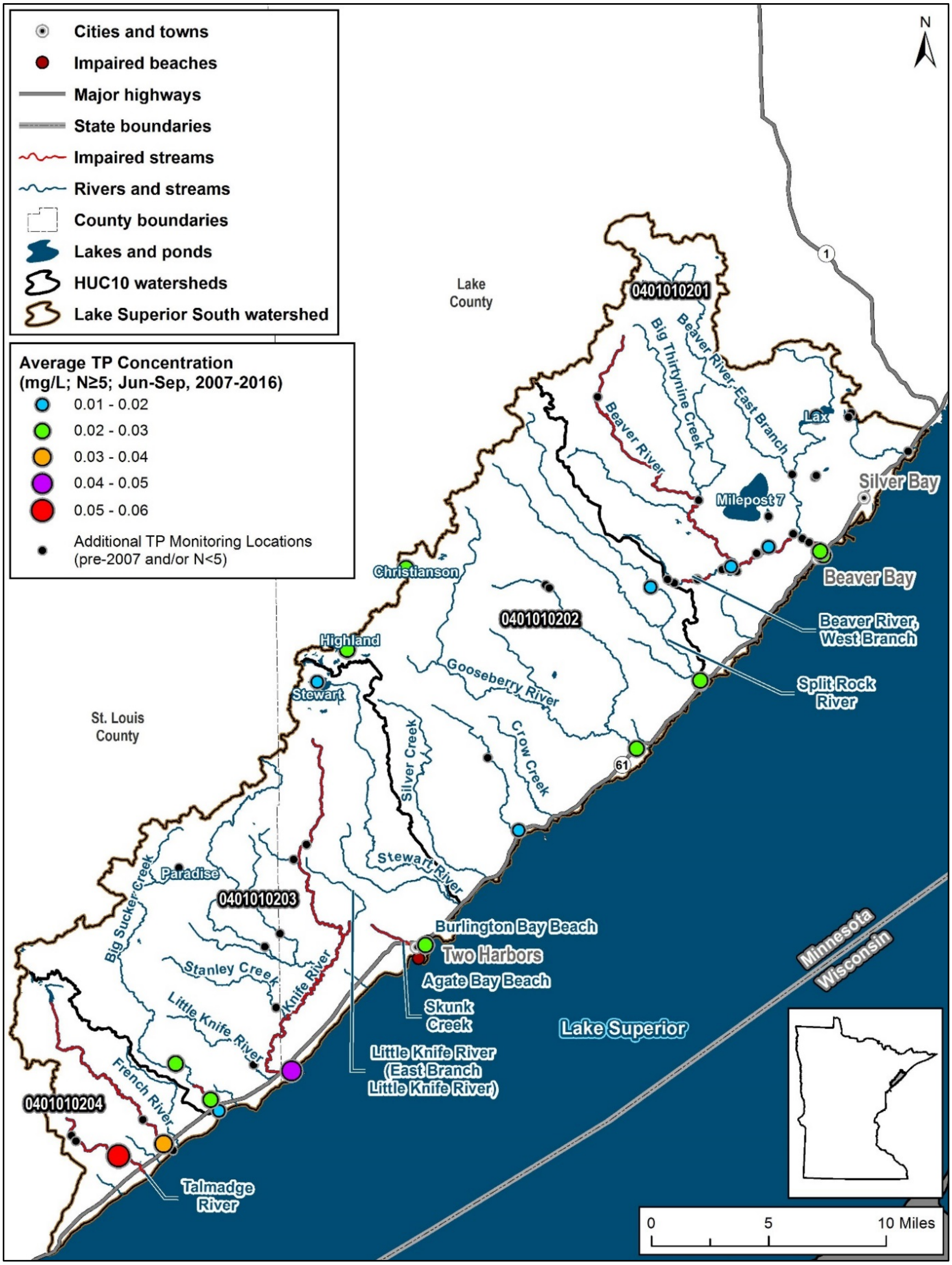

Figure 6. Average stream TP concentrations in the LSS Watershed. Average TP concentrations greater than 0.05 mg/L may be considered high.

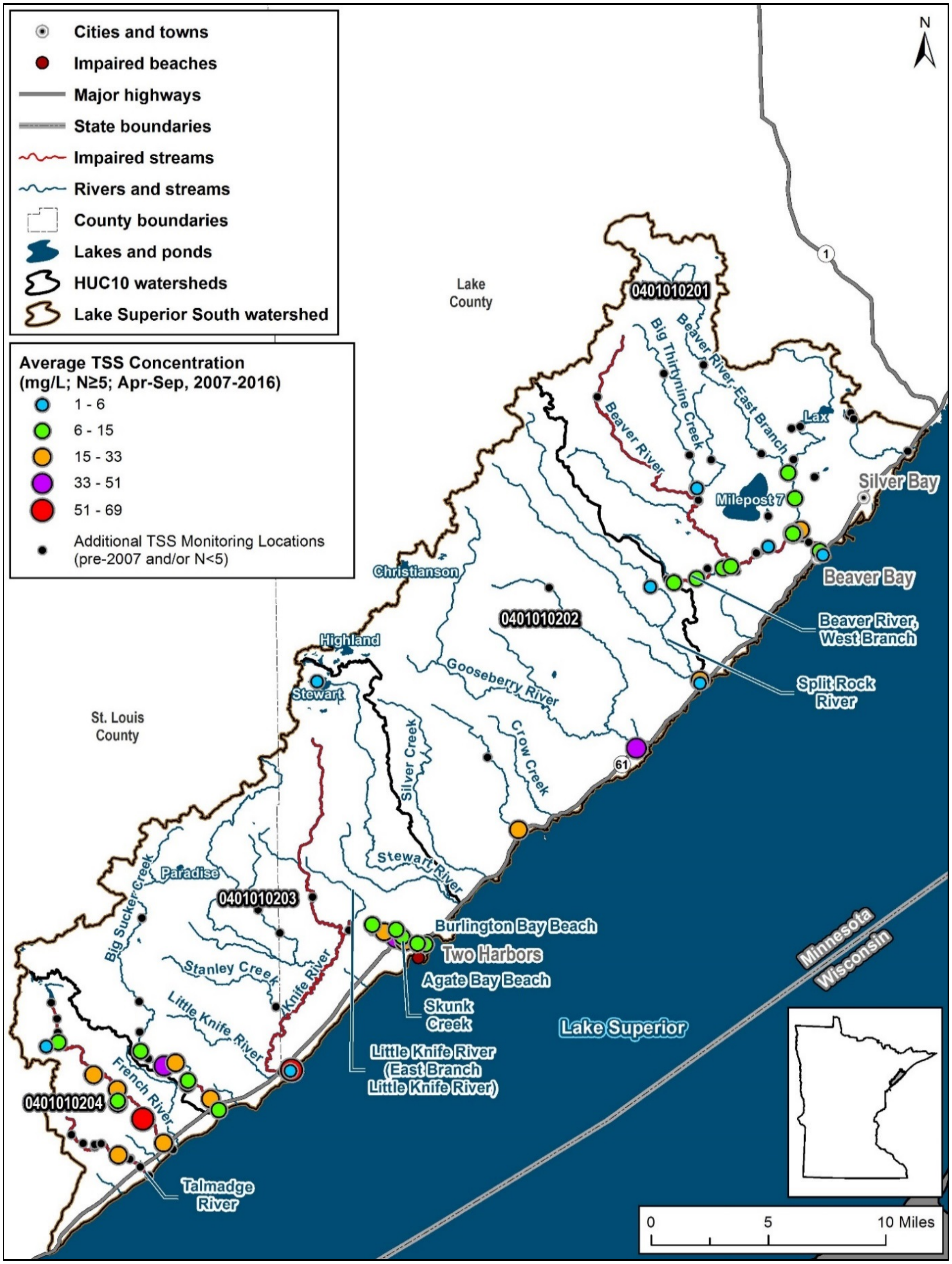

Figure 7. Average stream TSS concentrations in the LSS Watershed. Average TSS concentrations greater than 15 mg/L may be considered high.

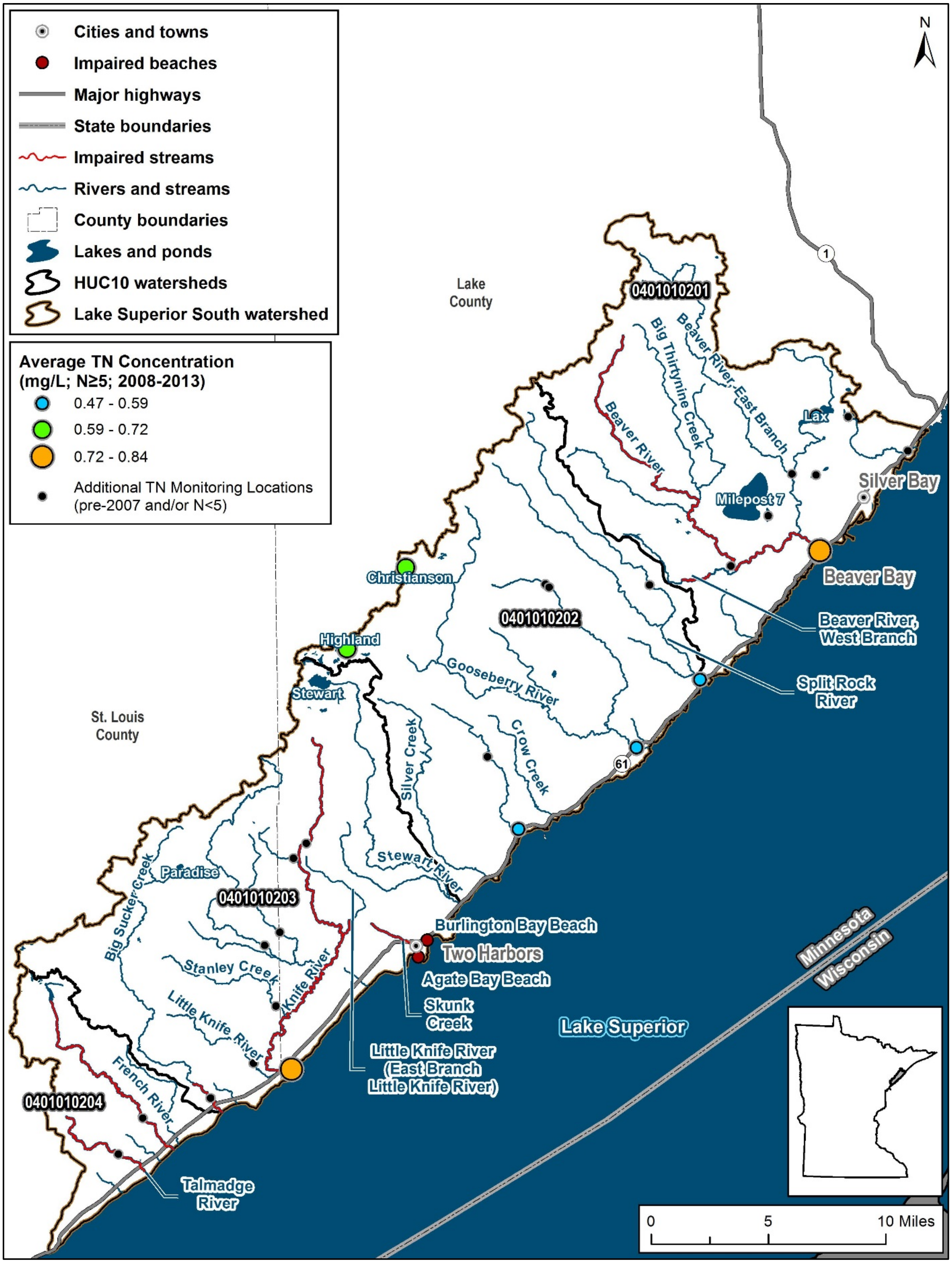

Figure 8. Average stream TN concentrations in the LSS Watershed.

Lakes

Lakes are assessed for their ability to support aquatic recreation based on the level of eutrophication. Water transparency and levels of phosphorus and chlorophyll are used to evaluate eutrophication. Phosphorus is a nutrient that plants and algae need to grow, and chlorophyll is a measure of the amount of algae in the water. Five lakes in the LSS Watershed were assessed for their ability to support aquatic recreation (Table 2). All five lakes were found to meet water quality standards and will be the focus of protection efforts. Lax, Stewart and Paradise Lake were considered to be of the highest quality (MPCA 2014).

Table 2. Lake condition in the LSS Watershed

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Beaver River – Frontal Lake Superior (401010201)	38-0406-00	Lax	Sup
Gooseberry River – Frontal Lake Superior (401010202)	38-0750-00	Christianson	Sup
	38-0753-00	Highland	Sup
Knife River – Frontal Lake Superior (401010203)	69-0007-00	Paradise	Sup
	38-0744-00	Stewart	Sup

Imp = impaired for impacts to aquatic recreation, Sup = fully supporting aquatic recreation, IF = insufficient data to make an assessment

Beaches

Elevated bacteria levels pose a human health threat, and beaches closed due to contamination can negatively impact tourism and the local economy. Routine beach monitoring to quantify bacteria levels is conducted by the Minnesota Department of Health (MDH) (and partners) at various locations as part of the Beaches Environmental Assessment and Coastal Health (BEACH) Act. This includes monitoring sites along the Lake Superior shoreline. The *E. coli* water quality standards are applicable to recreational uses of beaches between April 1 and October 31; they are documented in BEACH Act Rule and include:

- 126 organisms per 100 mL of water not to be exceeded as the geometric mean of not less than 5 samples in a calendar month and
- 235 organisms per 100 mL of water not to be exceeded by 10% of all samples taken in a calendar month, individually

Beaches are assessed according to the following procedure documented by the MPCA (2016):

> *There is a considerable amount of E. coli data collected as part of the beach monitoring program in Minnesota. Most beaches are monitored weekly from Memorial Day to Labor Day, while some are monitored twice weekly. To ensure use of the most recent data, data for the most recent 5-year period are used and assessments are made every other (odd numbered) year.*

When there are five or more samples per individual month or 30 day time period, individual monthly geometric means are calculated and compared to the 126 orgs/100mL standard for the period April 1 through October 31. If more than 10% of the geometric means calculated exceed the 126 orgs/100mL standard, or if more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.

When sampling frequency results in smaller data sets, data is aggregated by month across years. If one or more of the monthly aggregated geometric means exceeds 126 orgs/100mL, or more than 10% of the individual sample results in the entire dataset exceed the maximum criterion of 235 orgs/100mL, the AUID is assessed as not supporting.

Data from adjacent sampling sites on the same beach are combined. For sites with both tributary mouth stations and BEACH stations, data from each station are assessed separately and the results considered using best professional judgment to make an assessment decision. For sites with only tributary mouth samples, the data are assessed against the coastal recreation water standards. Streams tributary to Lake Superior with bacteria data at stations upstream of the mouth are assessed as stream AUIDs using the statewide water quality standards and methodology in part A.

A summary of *E. coli* exceedances are provided in Figure 9*. E. coli* results were observed above water quality standards at two locations in the LSS Watershed and they were ultimately placed on the 303(d) list of impaired waterbodies (Table 3).

Table 3. *E. coli* impaired beaches

Beach Name	Beach ID	Location Description
Burlington Bay Beach	04010102-C30	Near Two Harbors; Burlington Bay Beach near the outlet of Skunk Creek (impaired for *E. coli*)
Agate Bay Beach	04010102-C31	

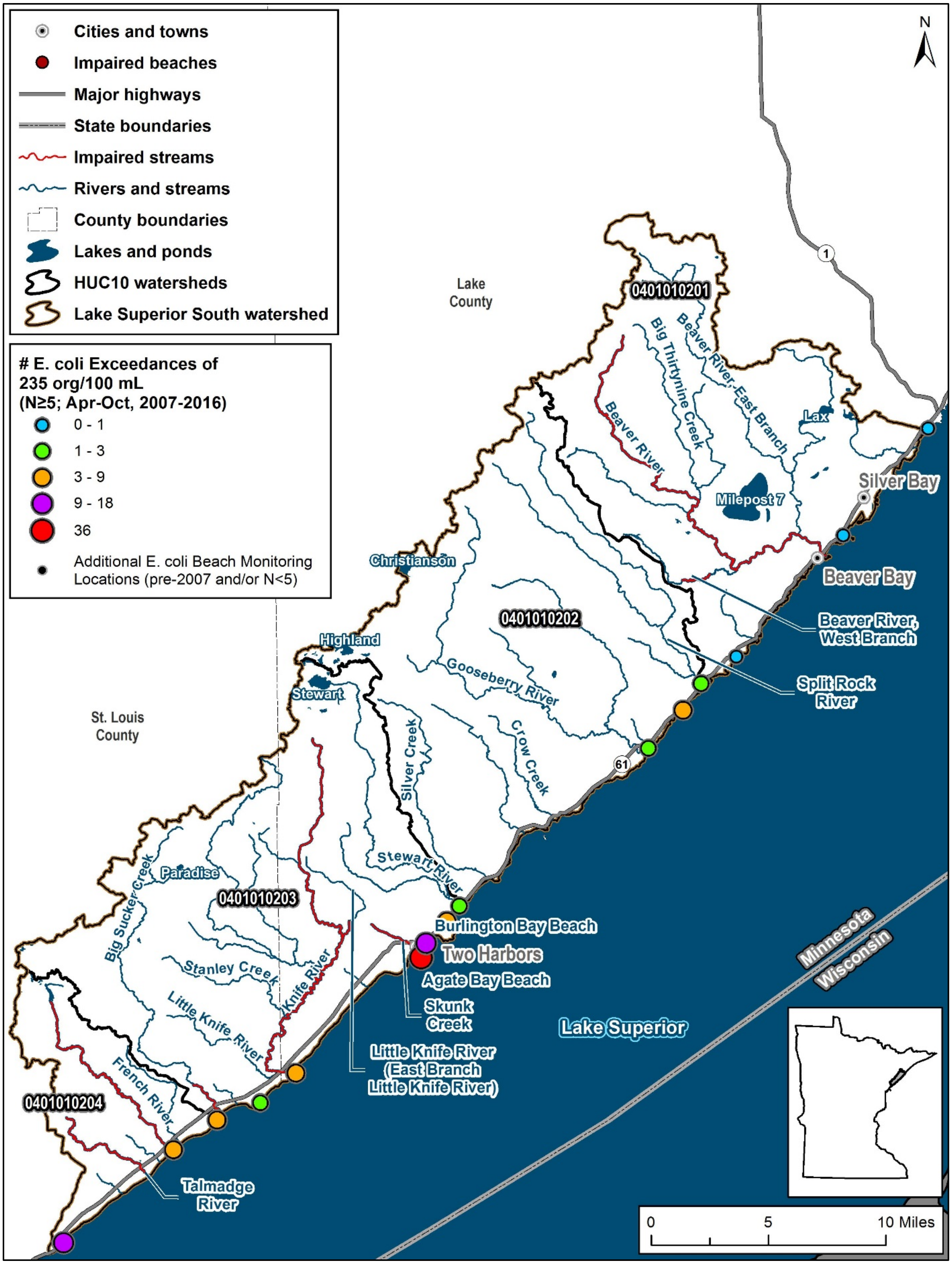

Figure 9. Beach *E. coli* exceedances in the LSS Watershed.

2.2 Water Quality Trends

Streams

Long-term water quality data (1973 through 2016) were evaluated using a combined dataset of samples collected at the sites with the longest period of record and greatest numbers of samples—the Beaver River and the Knife River. Kendall Tau correlation analyses were used to evaluate long term trends in water quality at these sites (Table 5). In the Beaver River, TSS concentrations have decreased over the long term, with concentrations relatively steady over the last 20 years (Figure 10 and Table 4). Phosphorus and ammonia concentrations have also decreased over the long term, and chloride concentrations have increased (Figure 11 and Table 4). In the Knife River, TSS concentrations have increased in the last 20 years (Figure 12), and ammonia and BOD have decreased over the long term (Table 4).

Table 4. Water quality trend analysis for the Beaver River (S000-252) and Knife River (S003-64)

Kendall-Tau correlation analysis on annual medians ($p < 0.05$). Months over which data were averaged—TSS, nitrate+ nitrite, ammonia, biochemical oxygen demand: Apr–Sep; Phosphorus: Jun–Sep; and chloride: Jan–Dec. A year of data was used only if N≥4.

Parameter	Beaver River south of CSAH-3 1.5 miles NW of Beaver Bay (S000-252)		Knife River upstream of Old US-61 at Knife River (S000-257) and Knife River downstream of US-61 (S003-642)	
	1973–2016	1995–2016	1973–2010	1998–2015
TSS	Decreasing	No trend	No trend	Increasing
Phosphorus	Decreasing	– [a]	No trend	No trend
Nitrate + nitrite	Increasing	Increasing	No trend	No trend
Ammonia (total)	Decreasing	– [a]	Decreasing	– [a]
Biochemical oxygen demand	No trend	No trend	Decreasing	No trend
Chloride	Increasing	– [a]	No trend	– [a]

a. Not enough data (less than 5 years) to evaluate trends over time.

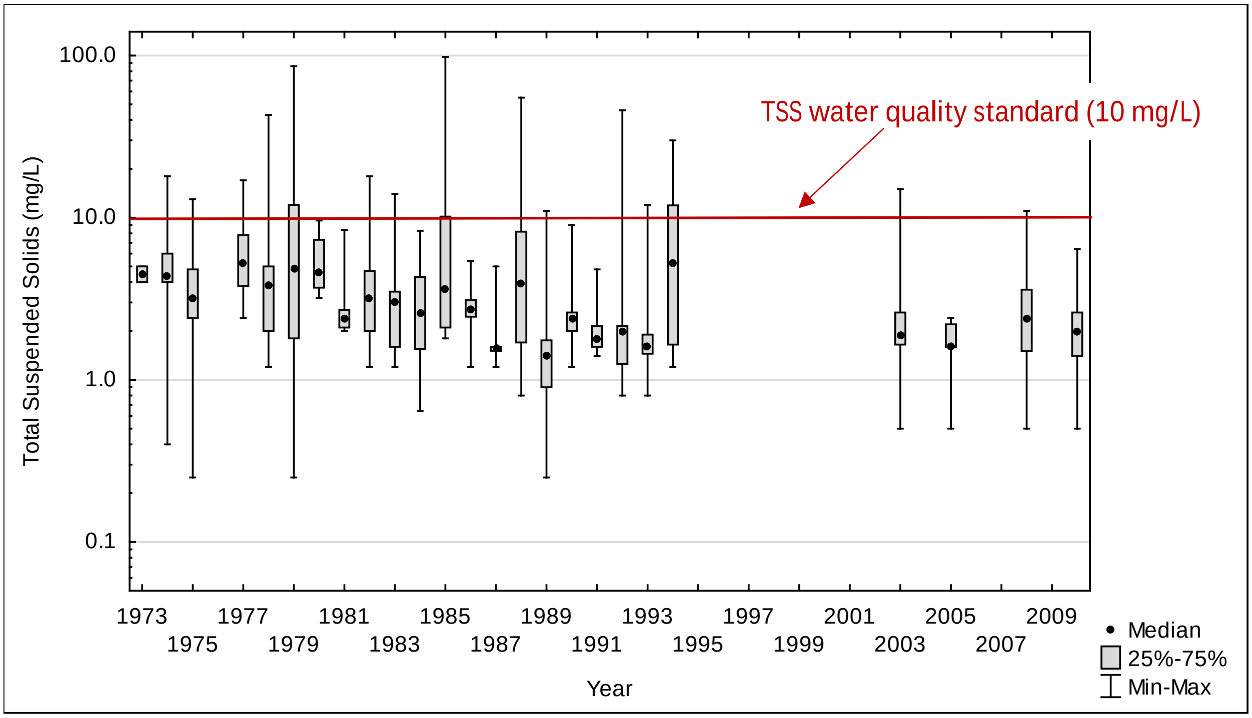

Figure 10. Total suspended solids concentrations (Apr–Sep) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252).

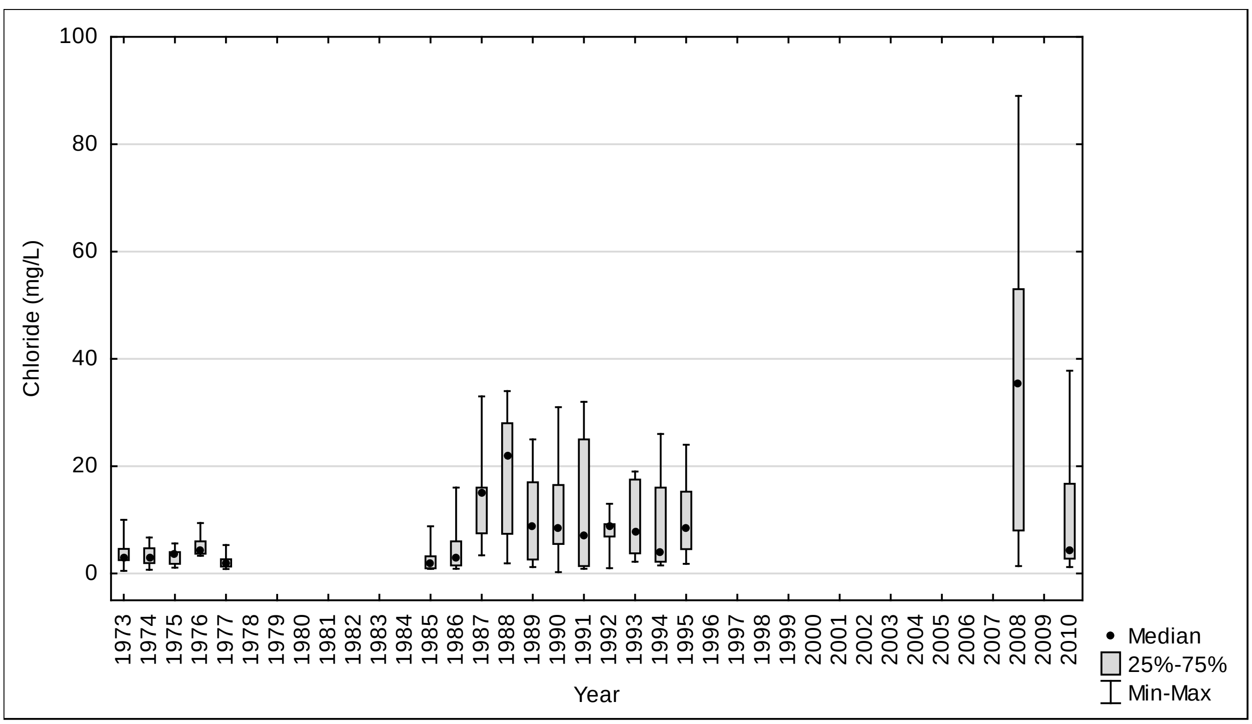

Figure 11. Chloride concentration (Jan–Dec) by year on the Beaver River south of CSAH-3, 1.5 NW of Beaver Bay (S000-252).

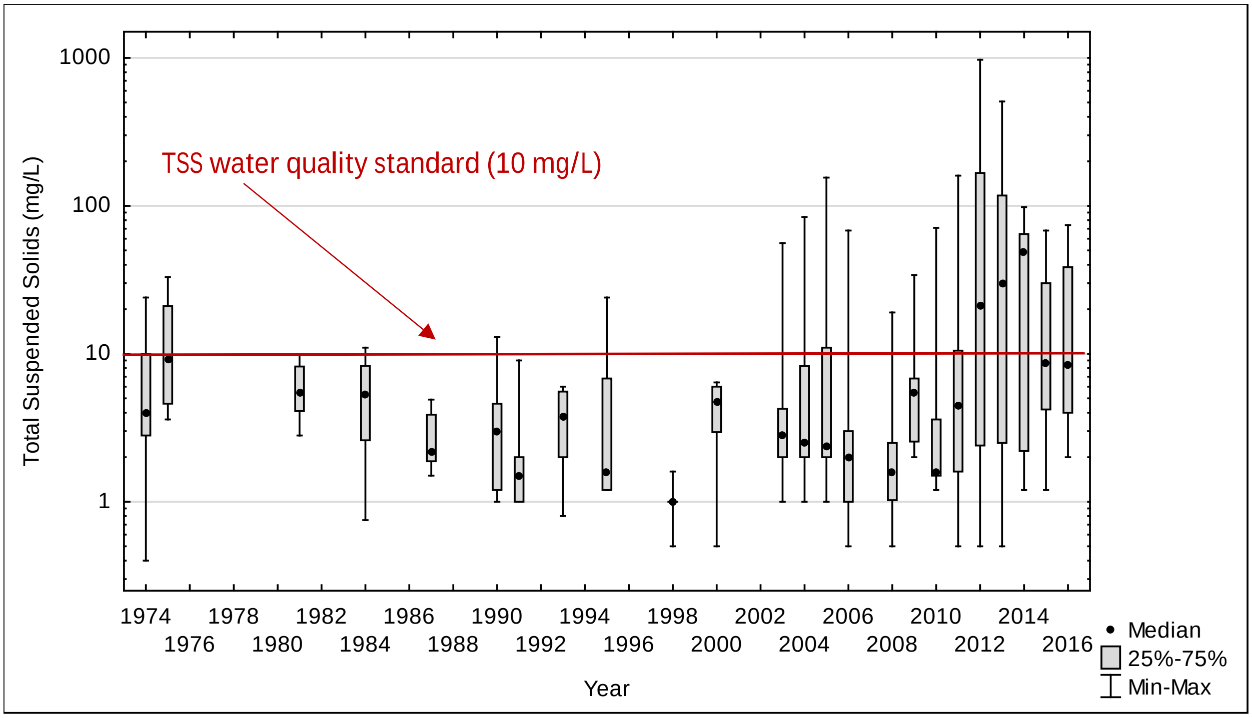

Figure 12. Total suspended solids concentrations (Apr–Sep) by year on the Knife River upstream of Old US-61 (S000-257) and downstream of US-61 (S003-642).

Lakes

Lake water quality is generally very good across the watershed. A water clarity trend analysis was conducted as part of an interagency lake prioritization effort conducted by staff from the MPCA, Minnesota Department of Natural Resources (DNR), Board of Water and Soil Resources (BWSR), Minnesota Department of Agriculture (MDA), and MDH. Only lakes with eight or more years of data were analyzed for the presence of a trend. Section 2.4 contains further information on the lake prioritization effort. Of the 10 LSS lakes included in the effort, two had sufficient data for conducting a trend analysis (Lax and Stewart). Only Stewart Lake shows evidence of a decreasing trend in clarity. The remaining lakes did not have sufficient data for a trend analysis (Table 5).

Table 5. Lake water quality trends

Lake Name	Lake ID	Impaired	Average Total Phosphorus (µg/L)	Average Transparency (m)	Trend in Clarity [a]
Bear	38040800	N	10.5	--	--
Nicado	38023000	N	11.0	--	--
Bear	38040500	N	12.9	7.25	--
Tetagouche	38023100	N	14.0	2.25	--
Bean	38040900	N	16.0	3.70	--
Paradise	69000700	N	18.0	2.42	--
Lax	38040600	N	18.2	3.21	N
Highland	38075300	N	21.7	1.50	--
Stewart	38074400	N	22.9	3.22	↓
Christianson	38075000	N	38.7	1.07	--

a. ↓: decreasing trend
N: no evidence for a trend
--: insufficient data

Beaches

E. coli concentrations along the shoreline and beach closures are a concern throughout the North Shore. Beach *E. coli* data (2003 through 2016) were evaluated to describe trends in *E. coli* concentrations. A trend of increasing *E. coli* concentration (Kendall Tau correlation analyses on geometric means, $p<0.05$) was observed at the following beach monitoring sites:

- Bluebird Landing NE of Duluth (B014)
- Stony Point NE of Duluth (B015)
- Twin Points Pub Access 15 miles NE of Two Harbors (B020)
- Split Rock River Mouth 16.5 miles NE of Two Harbors (B021)
- Silver Bay Marina in Silver Bay (B023)
- Knife River Marina SW of Two Harbors (B035)

Exceedances of the maximum *E. coli* standard were observed at all of the monitored beaches, but only two beaches in the watershed—Burlington Bay and Agate Bay—have aquatic recreation impairments due to high *E. coli*. At the two impaired beaches, the annual maximum observed *E. coli* concentration has increased in recent years (Figure 13).

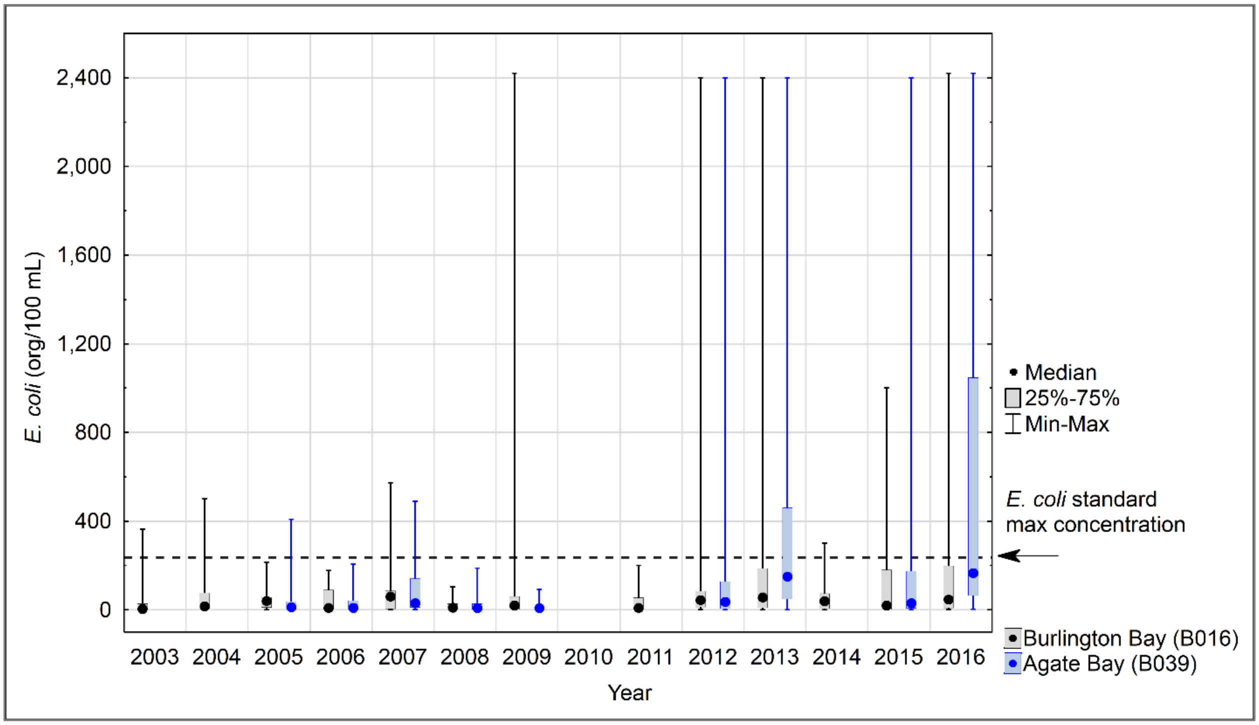

Figure 13. *E. coli* concentrations at impaired beaches.

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. The Clean Water Act and U.S. EPA regulations require that TMDLs be developed for waters that do not support their designated uses. A TMDL is a plan to attain and maintain water quality standards in waters that are not currently meeting them. There are eight impaired stream reaches (Table 6) and two impaired beaches in the LSS Watershed. Biological stressor identification is done for streams with either fish or macroinvertebrate impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g., altered hydrology, fish passage, habitat).

E. coli TMDLs were developed for the aquatic recreation impairments that are indicated by high *E. coli* concentrations. TSS TMDLs were developed for aquatic life use impairments due to turbidity or for which suspended solids were identified as a primary stressor. TMDLs were deferred due to a lack of data for impairments resulting from low DO, pH, or temperature. Non-pollutants such as altered hydrology are also not addressed by TMDLs. In addition, beach TMDLs have not yet been completed. Table 6 includes the water bodies with completed TMDLs and Appendix A provides the current pollutant loading, load reductions needed, and load and wasteload allocations from the TMDLs.

Table 6. Completed TMDLs in the LSS Watershed

HUC10 Subwatershed	Stream/Reach (AUID) or Lake (ID)	Affected Designated Use	Cause/Indicator of Impairment [a]	TMDL Pollutant(s)
Beaver River – Frontal Lake Superior (0401010201)	Beaver River (501)	Aquatic Life	Fish Index of Biotic Integrity **Turbidity/TSS** pH	TSS
	Beaver River, West Branch (577)	Aquatic Life	Fish Index of Biotic Integrity Macroinvertebrate Index of Biotic Integrity	None
Knife River – Frontal Lake Superior (0401010203)	Knife River (504)	Aquatic Life	**Turbidity**	TSS
	Little Knife River (East Branch Little Knife River; 840)	Aquatic Life	Dissolved Oxygen **Turbidity/TSS**	TSS
	Skunk Creek (528)	Aquatic Life Aquatic Recreation	**Turbidity/TSS** ***Escherichia coli***	TSS *E. coli*
City of Duluth – Frontal Lake Superior (0401010204)	Talmadge River (Talmadge Creek; 508)	Aquatic Life	Fish Index of Biotic Integrity Dissolved Oxygen **Turbidity/TSS**	TSS
	Big Sucker Creek (Sucker River; 555)	Aquatic Life	**Turbidity/TSS**	TSS
	French River (698)	Aquatic Life	**Turbidity/TSS**	TSS

a. **BOLD** – Cause or indicator of impairment that is addressed by a TMDL. The remaining cause/indicators of impairment have not yet been addressed.

TMDL studies completed in the watershed provide for detailed analysis of water quality data. For those impairments not addressed by TMDLs, additional information on stressors and water quality are provided below. In addition, pollutant source assessments are provided for pollutants of concern in the watershed including *E. coli*, phosphorus, nitrogen, and TSS.

Stressors of Biologically-Impaired Stream Reaches

Biotic impairments (i.e., aquatic macroinvertebrate or fishes bioassessments) in the Beaver River, West Branch Beaver River and Talmadge River were further evaluated for the cause of impairment as part of the stressor identification process (MPCA 2017). Table 7 summarizes the candidate causes evaluated for each biotic impaired stream. TMDLs are developed to address the primary stressors that are pollutant-based. Specifically, high levels of turbidity and TSS in Beaver River and Talmadge River are addressed by TSS TMDLs.

Table 7. Summary of probable stressors to the biota impaired streams (MPCA 2017)

Candidate Stressor	Beaver River	West Branch Beaver River	Talmadge River
Elevated water temperature	•	X	X
Low dissolved oxygen	X	•	•
Elevated ionic strength	o	--	--
pH	o	--	--
Poor habitat	•	•	•
Loss of connectivity	o	o	o
Elevated turbidity/TSS	•	o	•
Altered hydrology	o	o	•

Key: • = confirmed stressor, o = potential stressor, **X** = eliminated candidate cause, -- = not evaluated

Beaver River (04010102-501)

The Beaver River is listed as impaired due to turbidity/TSS as well as pH and fishes bioassessments. Stressor identification work (MPCA 2017) also identified elevated water temperatures and poor habitat as confirmed stressors to the biota. A TSS TMDL was completed (Tetra Tech 2018) and, as part of the stressor identification process, additional information were collected on the biota impairment (i.e., fishes bioassessment). Figure 14 identifies the continuous pH monitoring data that were collected as part of the stressor identification process (MPCA 2017). Daily fluctuations in pH upstream of Milepost 7 are mitigated by Milepost 7 surface water discharge (Figure 14), although violations of the pH standard occurred both upstream and downstream of Milepost. Continuous in-stream temperature data (MPCA 2017) were favorable to brook trout in the headwaters, and temperatures in the lower third of the watershed were marginal to poor for supporting coldwater fisheries (Figure 15).

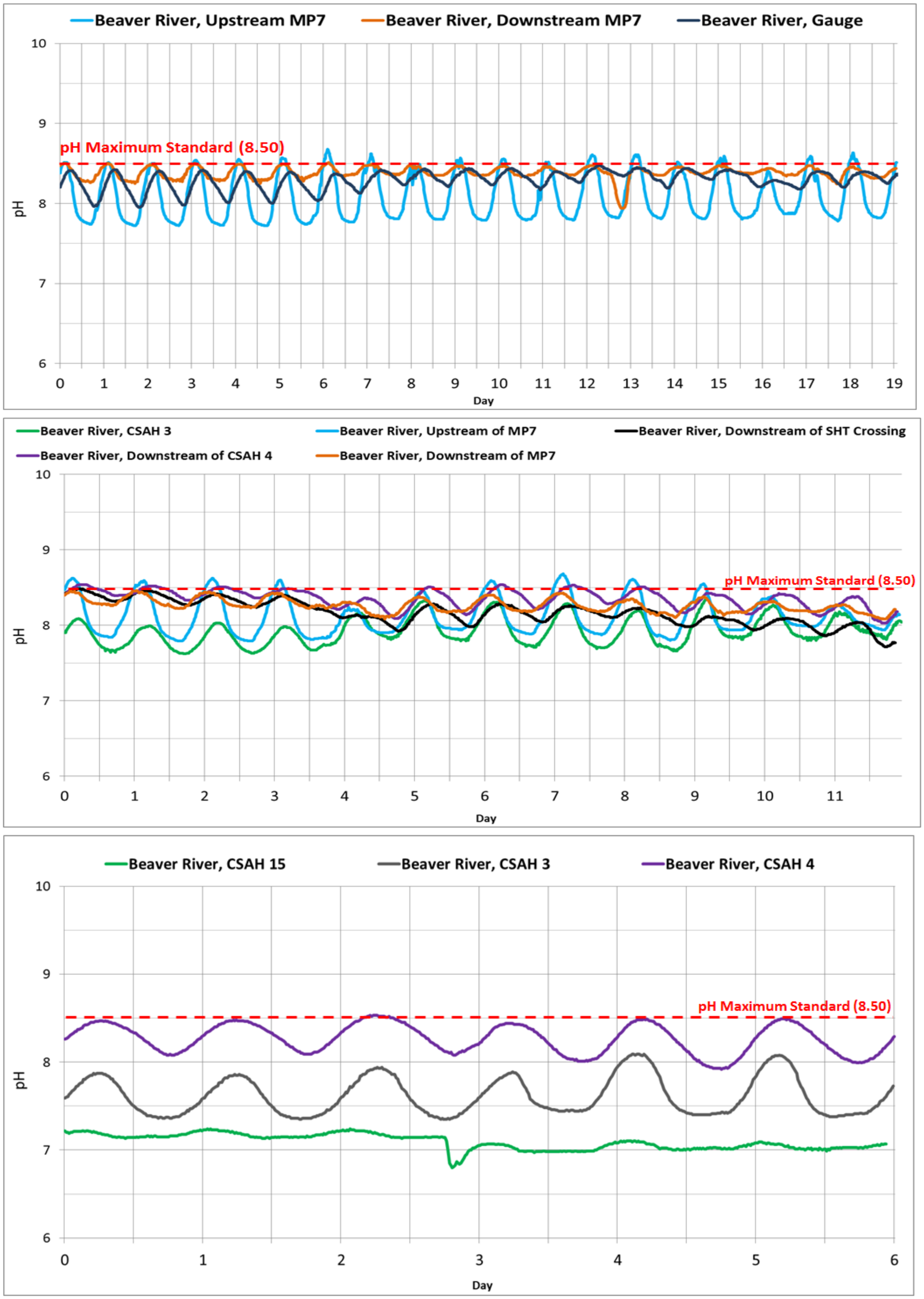

Figure 14. Continuous pH monitoring results for several Beaver River stations.

Figure from Lake Superior South Watershed Stressor Identification Report (MPCA 2017). Top: 7/22/2015–8/10/2015, middle: 8/7/2014–8/19/2014, bottom: 8/16/2013–8/22/2013.

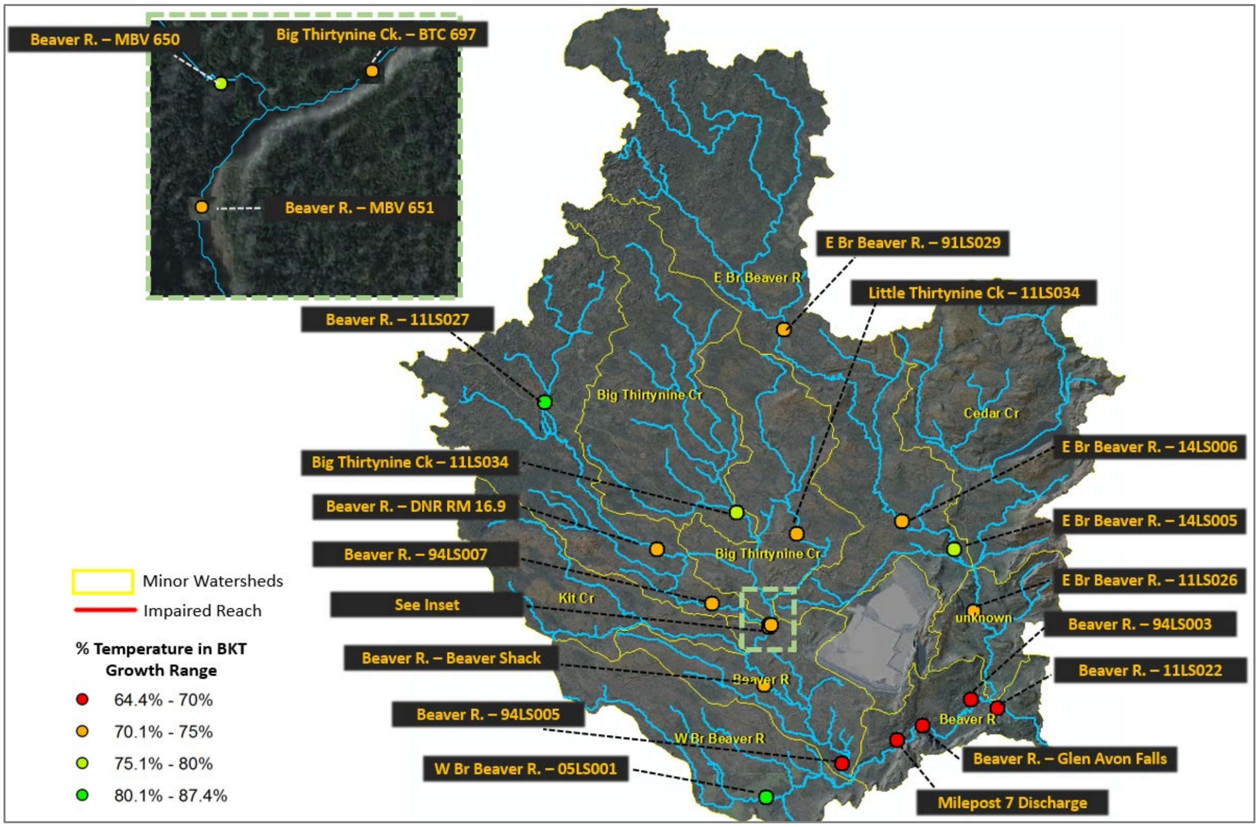

Figure 15. Percent of temperature readings in brook trout growth range for Beaver River watershed monitoring locations; June 1–August 31, 2013.
BKT = brook trout; Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

Beaver River, West Branch (04010102-577)

The West Branch Beaver River is impaired for use by aquatic macroinvertebrate and fishes bioassessments. As part of the stressor identification process, DO and elevated water temperatures were identified as stressors contributing to impairment. DO concentrations were low immediately downstream of the beaver dam located upstream of the impaired reach (site S007-364 in Figure 16). DO also fell below the standard along non-impounded reaches of the river (e.g., site S007-363 in Figure 16). The stressor identification report concludes that, “DO conditions in the West Branch Beaver River are poor for supporting brook trout and other sensitive fish species as well as DO -sensitive aquatic macroinvertebrates.”

During the monitoring period, water temperatures were favorable to brook trout at two stations, and warmer water temperatures were observed in the lower reach (Figure 17). The stressor identification report states, “Suitable temperatures for coldwater taxa are present in the West Branch Beaver River, but appear to be limited to be highly localized. Areas with lower width to depth ratios, moderate stream slope, overhanging vegetation, and unimpeded flow are correlated with suitable coldwater thermal regimes in this watershed. Our data suggests that stream temperatures in the lower two miles of the West Branch Beaver River are marginal to poor for supporting coldwater taxa."

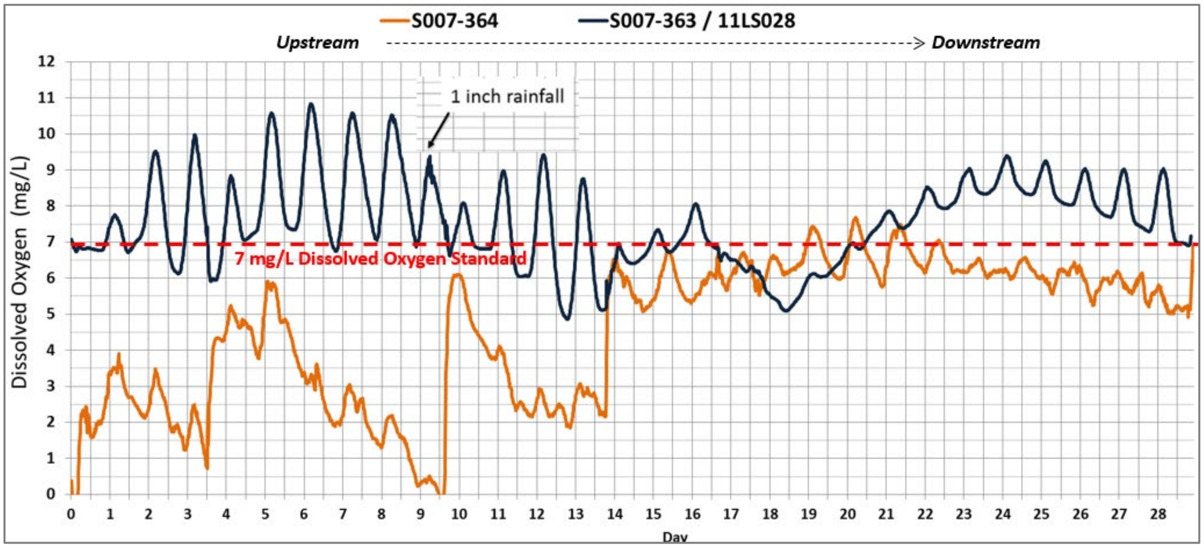

Figure 16. Dissolved oxygen concentrations, West Branch Beaver River 8/19/15–9/17/15.
Figure from Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

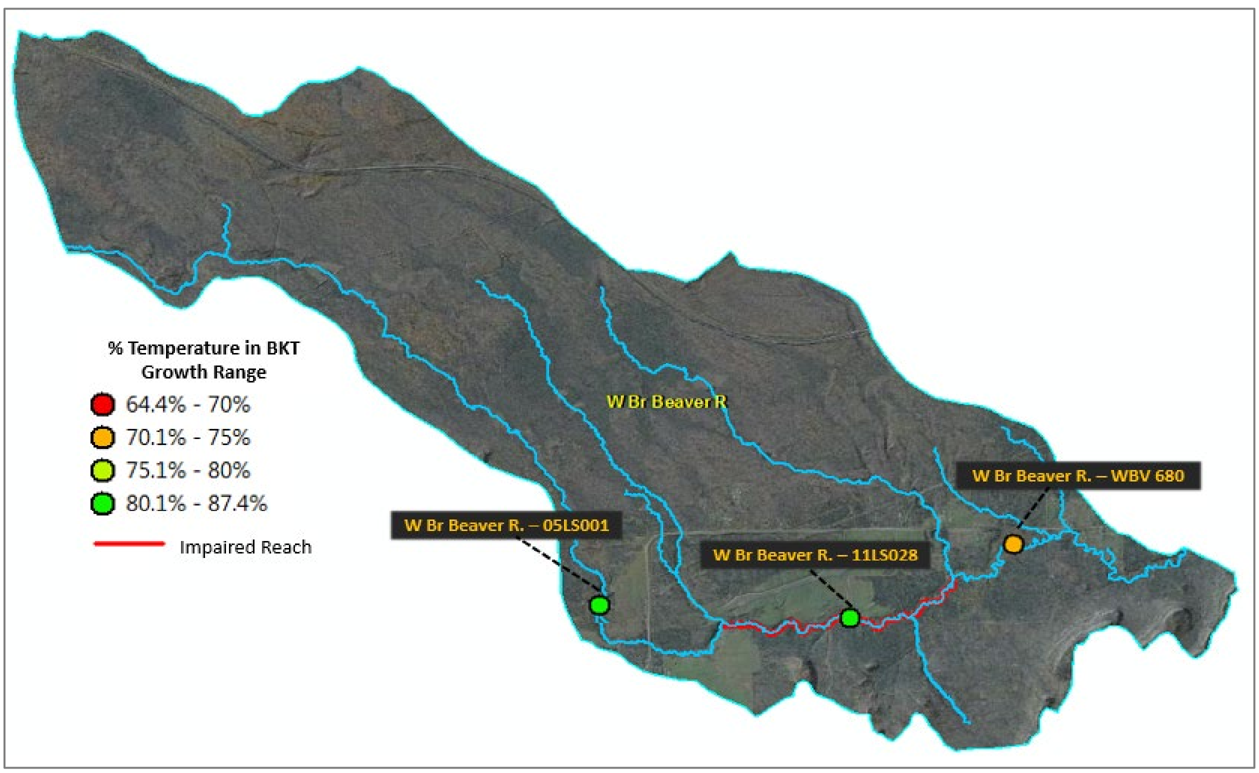

Figure 17. Percent of temperature readings in brook trout growth range for West Branch Beaver River watershed monitoring locations; June 1–August 31, 2013.
Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

Talmadge River (Talmadge Creek; 04010102-508)

The Talmadge River is listed as impaired by turbidity/TSS and low DO. A TSS TMDL was developed (Tetra Tech 2018), and DO was further evaluated as part of stressor identification work (MPCA 2017). DO concentrations were marginal to poor for sensitive aquatic life in the headwaters of the Talmadge River (S007-449, Figure 18). Downstream of a 3.5-acre reservoir created by an earthen dam, long durations of DO concentrations less than 7 mg/L were observed (S008-810, Figure 18). DO concentrations recovered somewhat at site S007-614, approximately 1.5 miles downstream, but were still rated as marginal for trout and other sensitive aquatic life at times.

Figure 18. Dissolved oxygen concentrations, Talmadge River, 8/5/2015–8/23/2015.

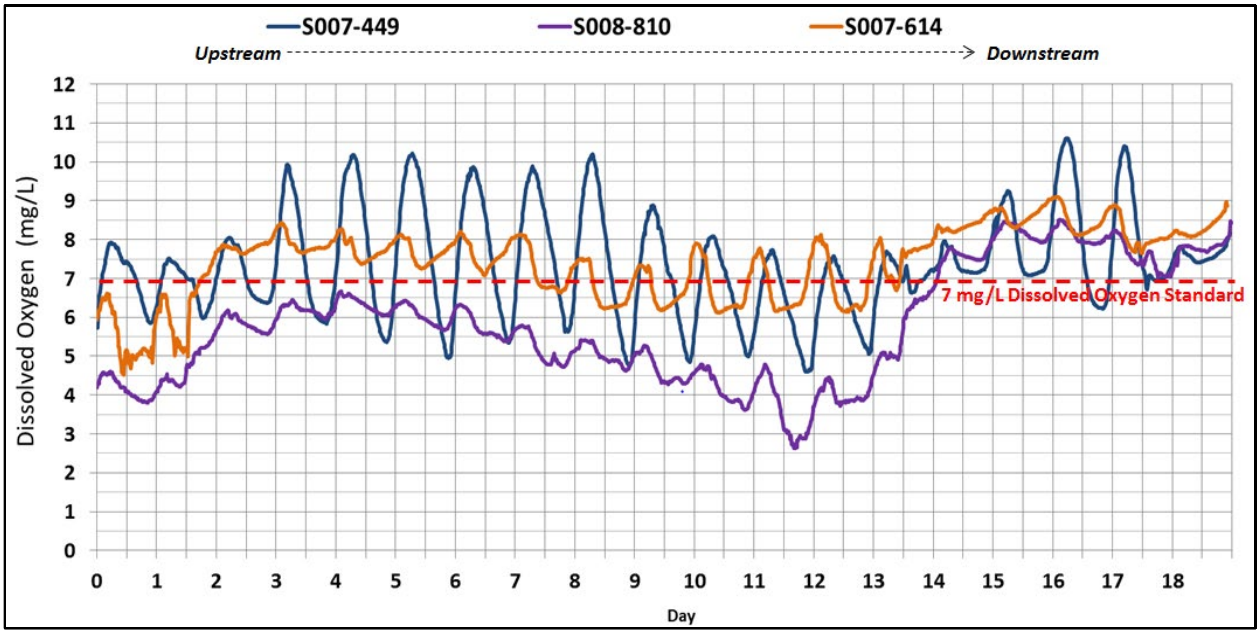

Figure from the Lake Superior South Watershed Stressor Identification Report (MPCA 2017).

Little Knife River (East Branch Little Knife River; 04010102-840)

The Little Knife River is listed as impaired by turbidity/TSS and low DO. A TSS TMDL was developed (Tetra Tech 2018). No DO data have been collected in the last 10 years. There is one historic DO monitoring station located along the impaired reach of Little Knife River. Several samples collected in 2004 and 2005 were below the standard of 7 mg/L (Figure 19). Four of the five samples below the standard were collected in August, with three in August of 2005. There is no further information available on the current status of this impairment or the cause of low DO.

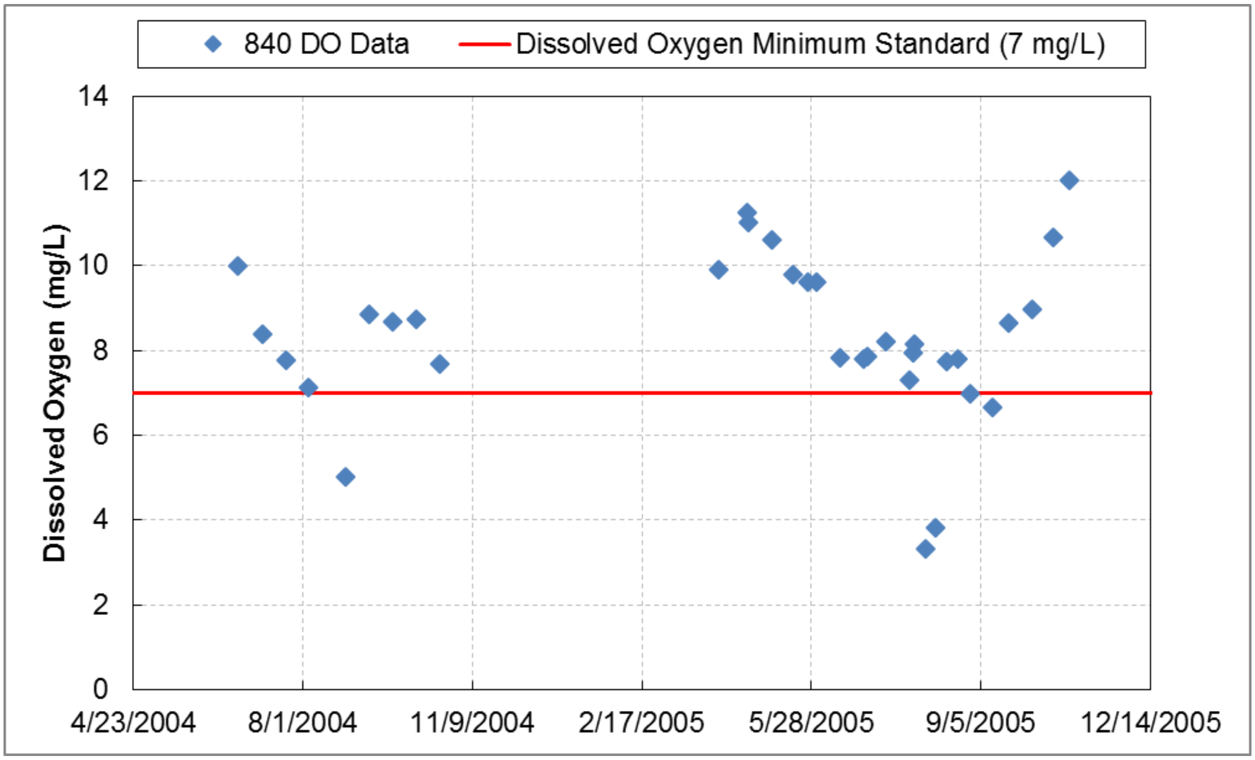

Figure 19. Dissolved oxygen data, Little Knife River (East Branch Little Knife River; AUID 04010102-840).

Pollutant Sources

A Hydrologic Simulation Platform-Fortran (HSPF) watershed model was developed to simulate watershed scale hydrology and water quality (Tetra Tech 2016). The HSPF model simulates watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land in a basin scale analysis framework.

Sediment is the main pollutant for impairment in the watershed and sources include watershed loading, near-channel erosion and to a small degree wastewater, regulated municipal separate storm sewer systems (MS4s), and industrial and construction stormwater. Figure 20 summarizes the watershed-wide upland and near-channel sources of sediment.

Eroding bluffs have been identified as a major source of sediment in many of the North Shore tributaries (Nieber et al. 2008). Loadings from bluffs in the watershed models were specified using a constant rate of replenishment to the bed sediment storage in affected reaches and are based on high risk erosion areas identified as part of a Light Detection and Ranging (LiDAR)-based bluff assessment conducted by the Natural Resources Research Institute (2015). A large number of identified bluffs along the Big Sucker Creek, French River, and Talmadge River account for the dominance of near channel sources. Skunk Creek, located in Two Harbors, has the highest proportion of sediment loads from development and roads. For most streams, the highest amount of erosion is found in the transitional area between upstream/ headwater areas that have low slopes and the high slope, bedrock-controlled areas near Lake Superior. This area tends to correspond to soils with high clay content and higher stream power.

Upland forest contributes the second highest percentage of total sediment to the watershed; it also comprises 87% of the land cover. It should be noted that on a per acre level, forest contributes a very small TSS load. Pollutant loading from subwatersheds derived from the HSPF model are presented as yields in Figure 21, Figure 22, and Figure 23 for nitrogen, phosphorus, and TSS, respectively.

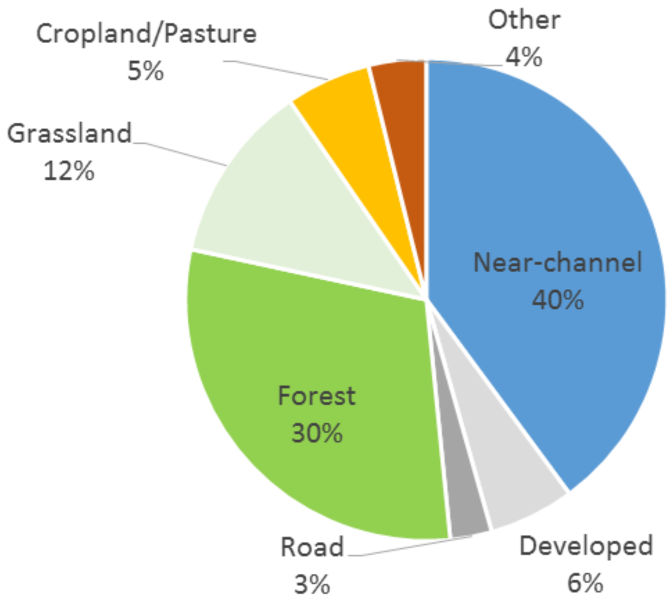

Figure 20. Sources of sediment from HSPF modeling (Tetra Tech 2016).

Sources of *E. coli* in streams and beaches are widespread and often intermittent. Threats to the watershed include stormwater runoff, wastewater effluent (point sources and individual septic systems), other wastewater collection systems (e.g., portable toilets), commercial and recreational boating, pets, birds and wildlife. Some sources pose a greater risk to human health than others. Skunk Creek, an *E. coli*-impaired stream, discharges to Lake Superior at Burlington Bay and is a likely contributor to that beach impairment.

Table 8 includes permitted point sources in the LSS Watershed. Point sources are potentially contributing to sediment impairments in the Beaver River and French River and require additional monitoring or reductions in loading. Based on HSPF modeling, point sources contribute approximately 2% of the phosphorus load and 6% of the nitrogen load in the watershed, with the remaining load from nonpoint sources. Regulated stormwater sources may also contribute to sediment loading; the Big Sucker Creek (Sucker River) watershed includes a portion of the Duluth Township's regulated MS4.

Stream crossings and culverts are likely to be affecting fish populations (i.e., physical barrier) and contributing to sediment loading through erosion in the LSS Watershed. An inventory and analysis of stream crossings and culverts was conducted by Lake County SWCD and is provided in Figure 24.

Table 8. Permitted point sources in the LSS Watershed

HUC10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit?
	Name	Permit #	Type	
Beaver River – Frontal Lake Superior (0401010201)	Beaver Bay WWTP	MN0040754	Municipal wastewater	Yes
	Best Ready Mix - Silver Bay	MNG490286	Industrial stormwater	No
	Lake County Highway Department Gravel Pits	MNG490296	Industrial stormwater	No
	Northshore Mining Co - Silver Bay	MN0055301	Industrial discharge	Yes
	Silver Bay WWTP	MN0024899	Municipal wastewater	No
Gooseberry River – Frontal Lake Superior (0401010202)	Castle Danger Demo Landfill	MNR0539TF	Industrial stormwater	No
	Hudson Aggregates LLC	MNG490220	Industrial stormwater	No
	Lake County Highway Department Gravel Pits	MNG490296	Industrial stormwater	No
	Lake County Sanitary Landfill	MNRNE3BXL	Industrial stormwater	No
	Silver Creek Township WWTP	MN0063908	Municipal wastewater	No
	Two Harbors WWTP - ISW	MNRNE3CWM	Industrial stormwater	No
Knife River – Frontal Lake Superior (0401010203)	Arrowhead Recycle Center	MNR0539TD	Industrial stormwater	No
	B&B Aggregates	MNRNE38YB	Industrial stormwater	No
	Best Ready Mix – Silver Bay	MNG490286	Industrial stormwater	No
	Builtrite Manufacturing Inc	MNR053CHH	Industrial stormwater	No
	Daniel Zeimet's Property	MNR0538RV	Industrial stormwater	No
	Lake County Highway Department Gravel Pits	MNG490296	Industrial stormwater	No
	Larsmont Cottages on Lake Superior	MN0068853	Private wastewater	No
	Louisiana-Pacific Corp – Two Harbors	MNR0539XC	Industrial stormwater	No
	Northshore Steel Inc	MNR053B9H	Industrial stormwater	No
	Richard B Helgeson Airport	MNR0539FF	Industrial stormwater	No
	Stanley LaBounty	MNR053BJJ	Industrial stormwater	No
	Two Harbors WWTP	MN0022250	Municipal wastewater	No
	Willamette Valley Co	MNRNE38FN	Industrial stormwater	No
	Wisconsin Central Ltd - Two Harbors Transshipment	MN0049018	Industrial discharge	No
City of Duluth – Frontal Lake Superior (0401010204)	MDNR French River Hatchery	MN0004413	Industrial discharge	Yes
	US EPA - MED-Duluth	MN0110914	Industrial discharge	No

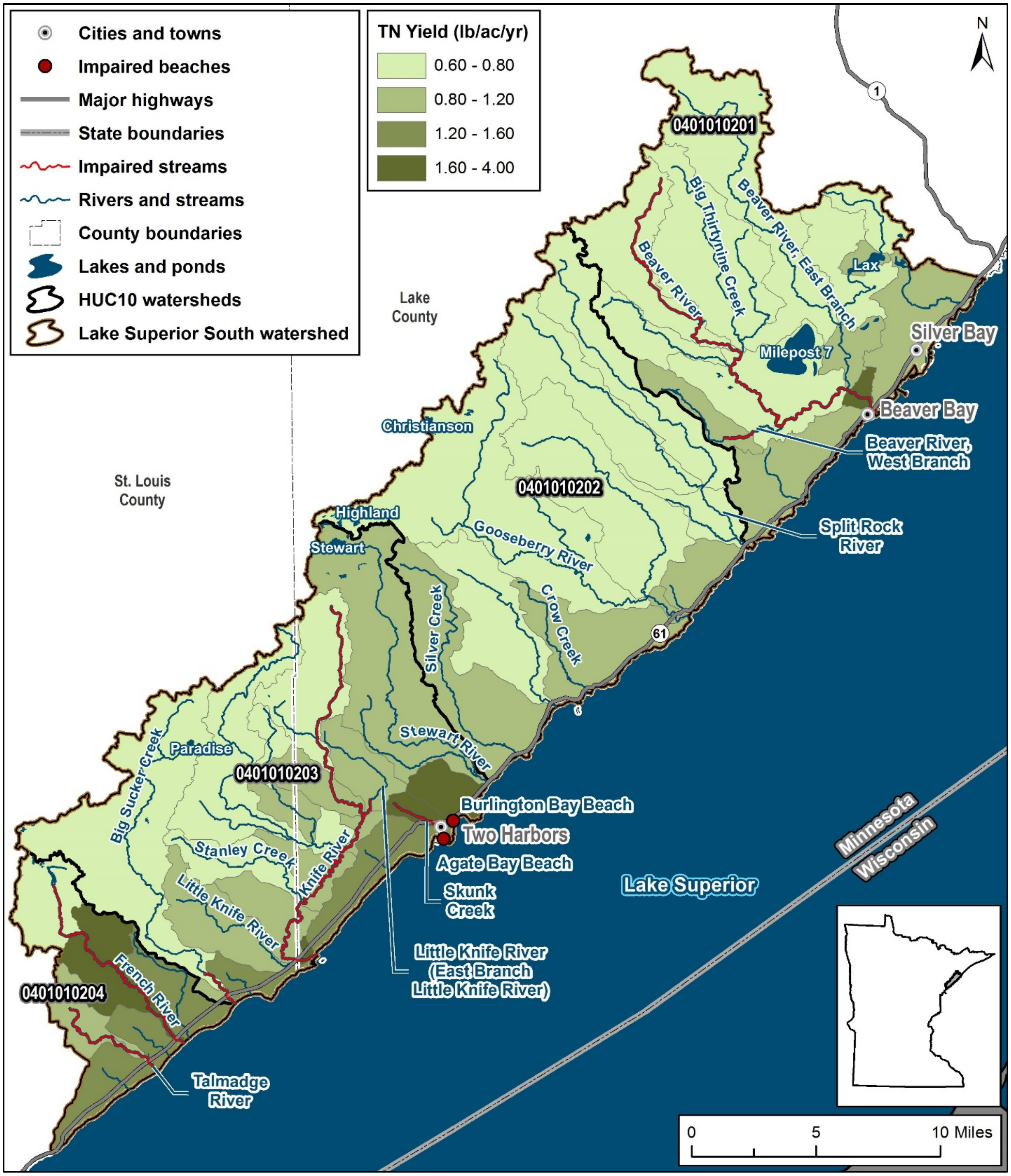

Figure 21. TN yield by HUC12 from HSPF model in LSS.

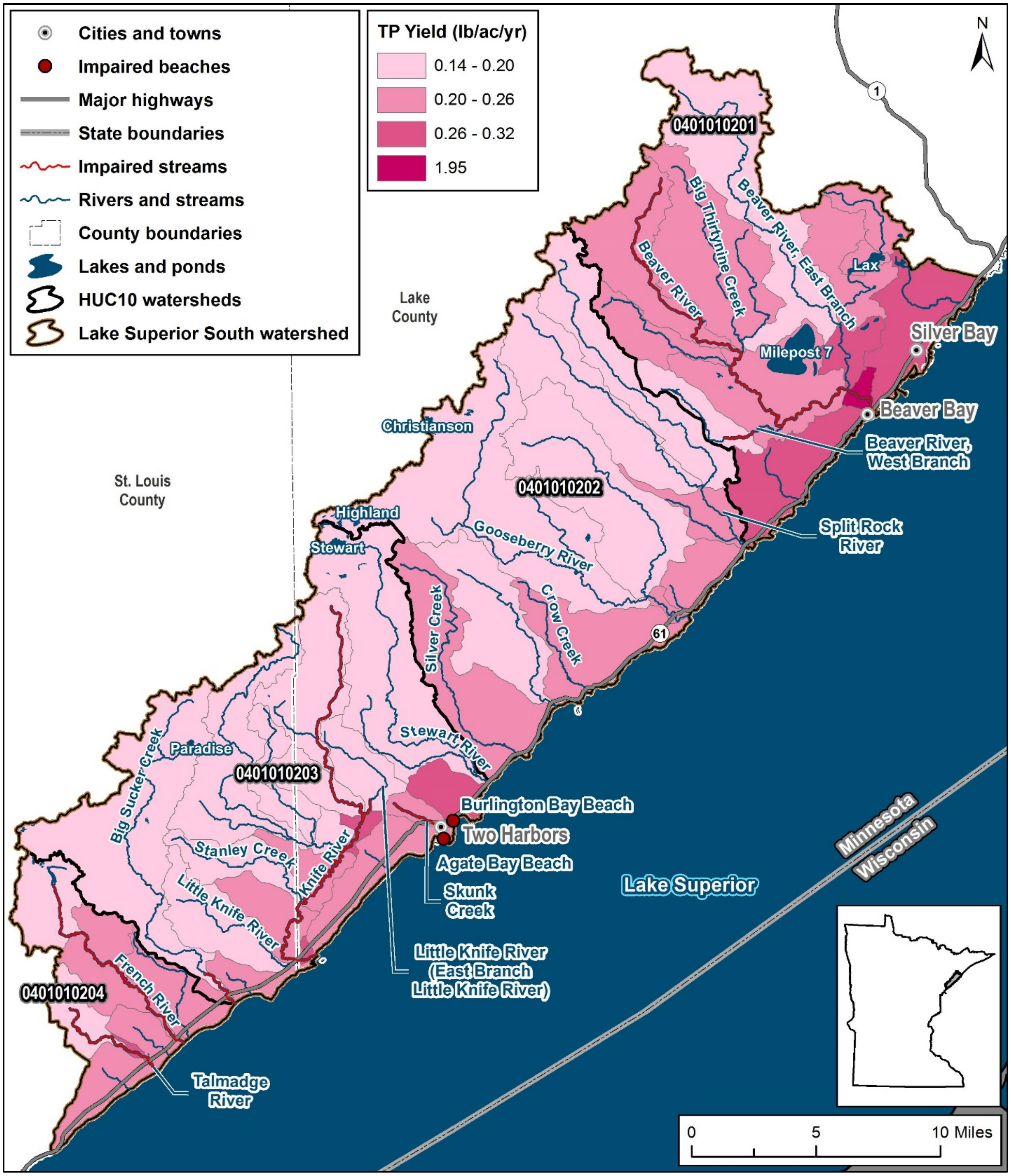

Figure 22. TP yield by HUC12 from HSPF model in LSS.

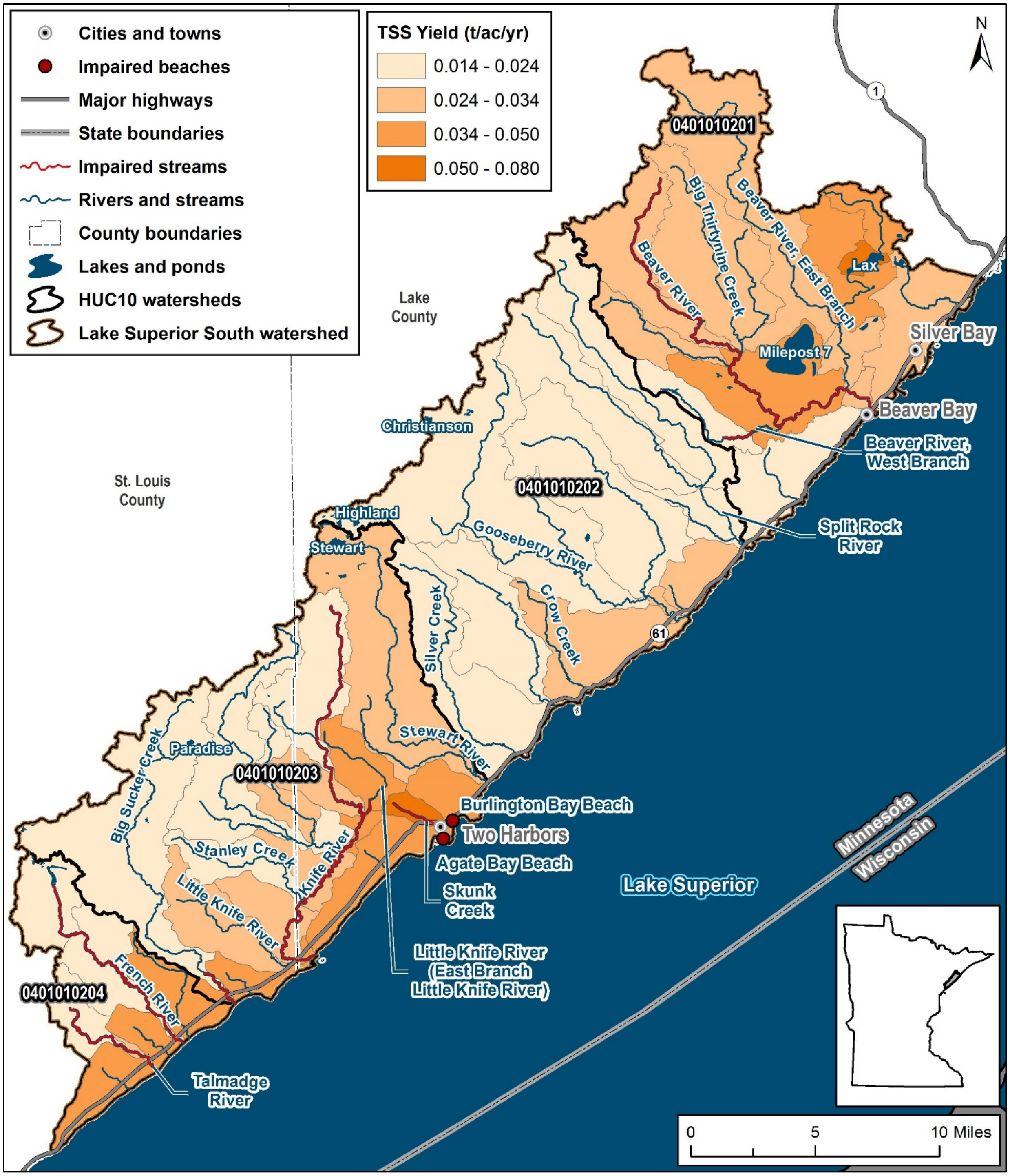

Figure 23. TSS yield by HUC12 from HSPF modeling in LSS.

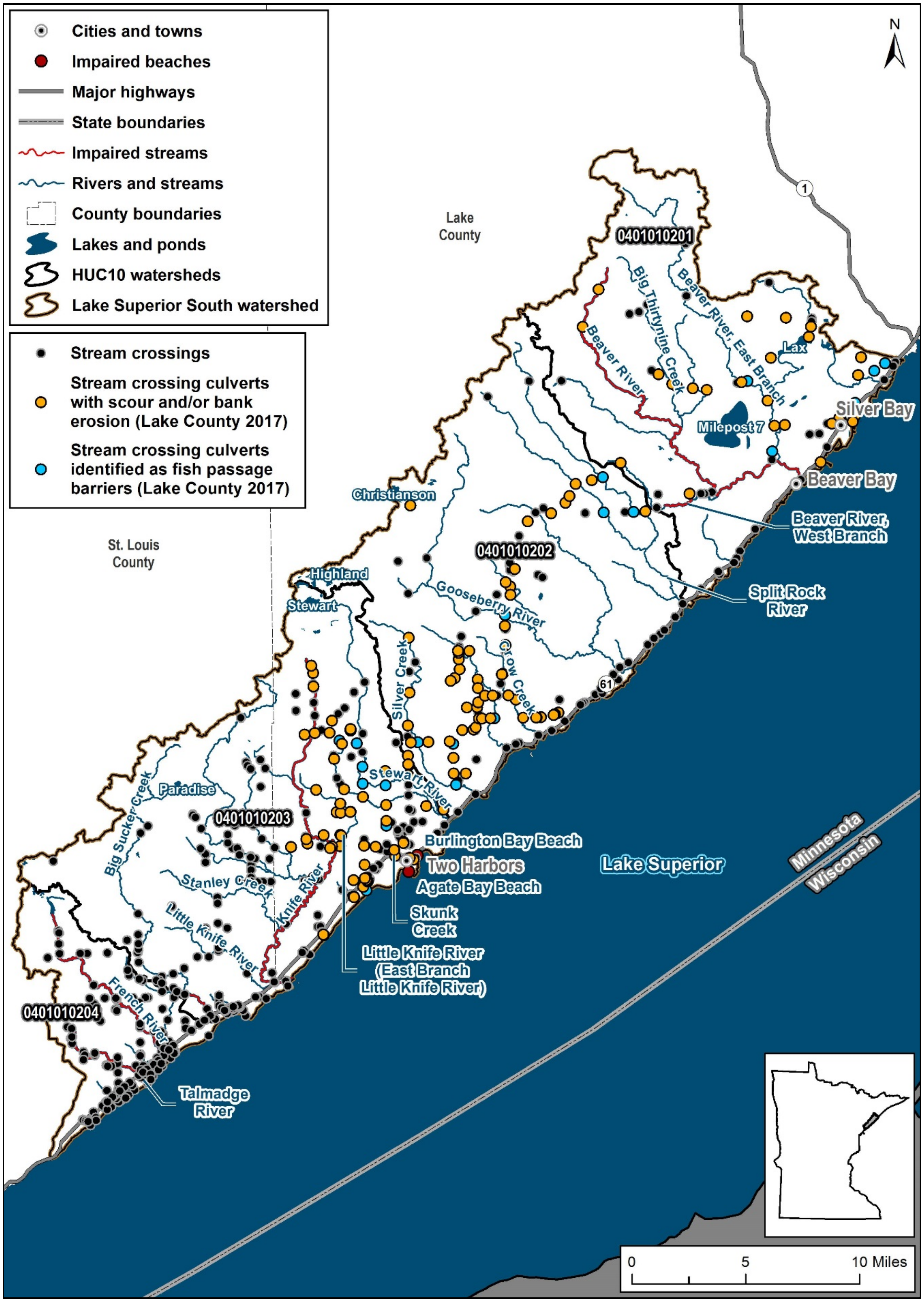

Figure 24. Stream crossings in the LSS Watershed.

2.4 Protection Considerations

All waters in the LSS Watershed require protection in some capacity, including those listed as impaired. For non-impaired waters, protection considerations are based on identifying those waters that are particularly threatened or vulnerable, as well as those that are of the highest value and quality. Protection is often implemented through land use planning and ordinances, as well as conservation practices.

Stream vulnerability was determined based on their index of biotic integrity (IBI) scores (Figure 25 and Figure 26). In the figures below, the blue markers ("> upper confidence limit") indicate streams that are comfortably meeting IBI targets. The green and purple markers ("> or < threshold") indicate streams with IBI scores that are close enough to the targets that the streams are considered threatened of becoming impaired, and the red markers ("< lower confidence limit") indicate streams that do not meet the IBI targets. The streams that are near the expected target score for either fish or macroinvertebrate IBI (green and purple markers) are unimpaired but at risk of becoming so. These streams are considered for protection because (1) they have a high potential for restoration and (2) they are potentially vulnerable to impairment in the future. It is possible that some of the lower scoring monitoring sites are due to poor monitoring site selection, physical barriers downstream, or application of a target that is not reflective of the stream condition. In the future, a Tiered Aquatic Land Uses framework may provide stream-specific IBI targets that could result in changes to this protection assessment. Those streams that are unimpaired and/or threatened based on the IBI data include:

- Palisade Creek
- Cedar Creek
- Beaver River, West Branch and East Branch
- Crow Creek
- Silver Creek
- Stewart River
- Little Stewart River
- Encampment Creek
- Unnamed Creek (tributary to Split Rock River)
- Skunk Creek
- Little Gooseberry River
- Dago Creek
- Gooseberry River
- Knife River, West Branch
- Little Knife River
- Big Sucker Creek (Sucker River)

Lakes were also analyzed for protection as part of a statewide effort. The effort developed goals for lakes that meet water quality standards, identified unimpaired lakes that are at greatest risk, and developed a preliminary priority ranking for protection efforts. Water quality risk is determined by each lake's sensitivity to increased phosphorus loading, proximity to the water quality standard, the percent of disturbed land use in the watershed, lake size, existing phosphorus levels, and whether the lake shows a declining trend in water clarity (MPCA et al. 2017). As a result of this effort, Stewart Lake (38074400) was identified for water quality protection. The statewide effort did not evaluate Lake Superior. However, Lake Superior is recognized nationally and internationally as one of world's most important freshwater lakes. In addition, Lake Superior is identified as one of the most important resources locally. Lakes identified for protection in this WRAPS include Stewart Lake and Lake Superior.

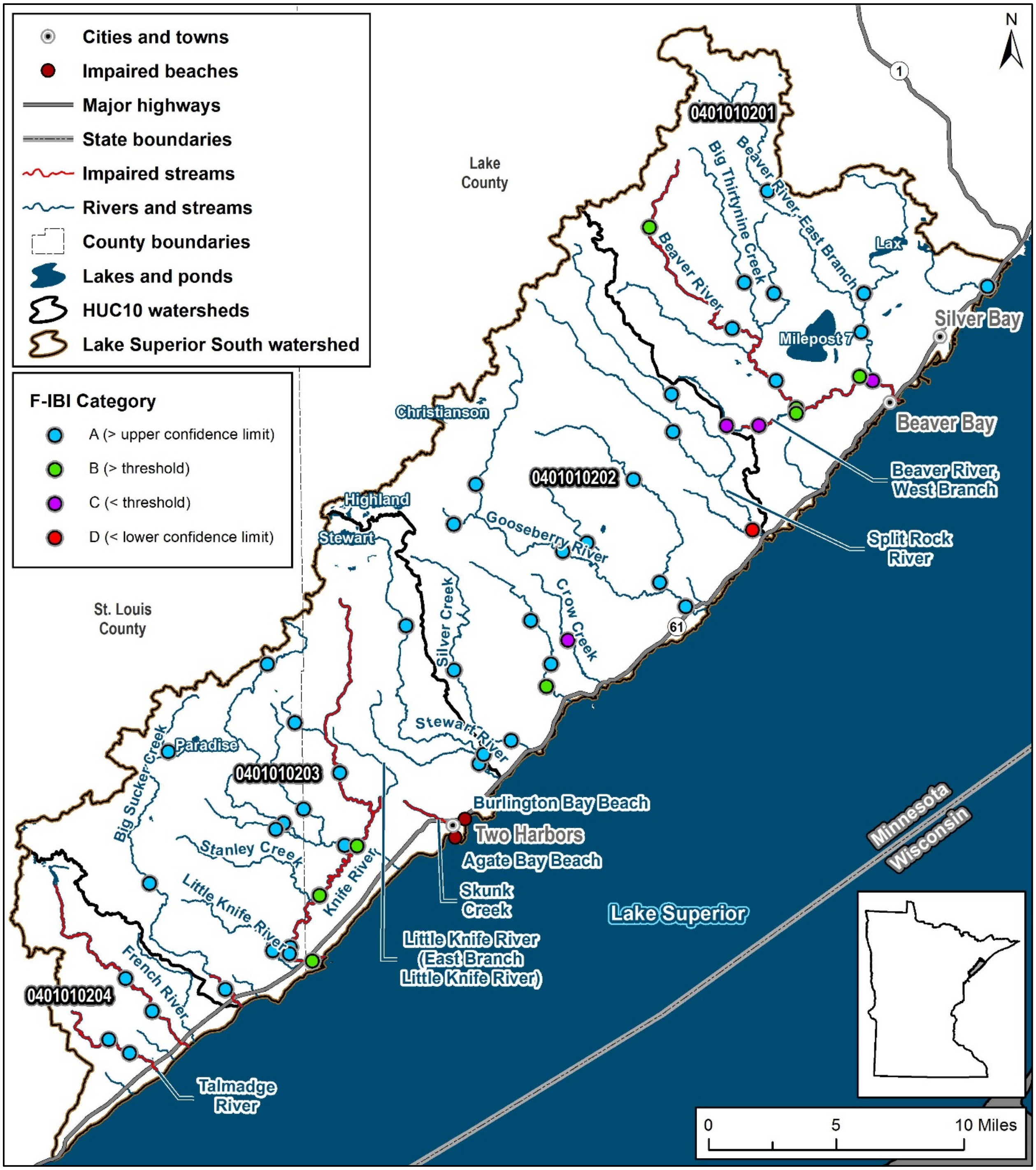

Figure 25. F-IBI categories in the LSS Watershed.

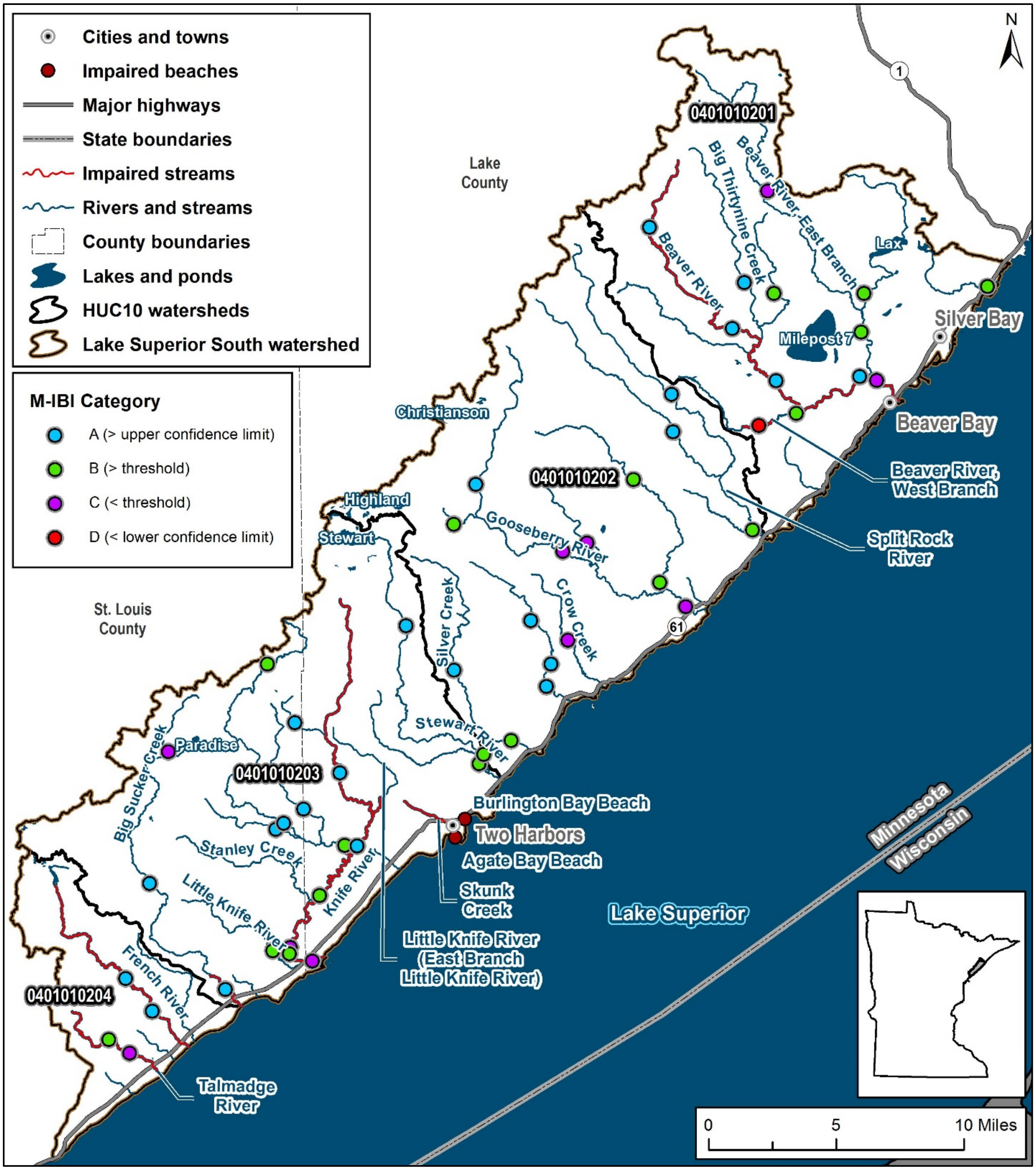

Figure 26. M-IBI categories in the LSS Watershed.

3. Prioritizing and Implementing Restoration and Protection

The LSS Watershed contains several waters in need of restoration, and numerous streams, lakes, and natural areas that are very high quality and require protection. There are also several water resources that are threatened and vulnerable to land use changes and management activities. Sediment, fecal bacteria (*E. coli*), high temperatures, low DO, pH, poor habitat, altered flow, and loss of connectivity contribute to these challenges. Restoration strategies to address these concerns are provided by stream in Section 3.3. All waters are also in need of protection; activities that promote protection typically rely on land use planning and conservation.

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources, and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of prioritization and strategy development. Because many of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed, it is imperative to create social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is part of the overall plan moving forward.

The implementation strategies, including associated scales of adoption and timelines provided in this section, are the result of existing local watershed plans and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

3.1 Targeted Geographic Areas

The primary purpose of this section is to identify targeted or critical areas in which to focus implementation activities during the first 10 years of implementation. Targeted geographic areas are identified based on a detailed prioritization and ranking process conducted as part of the 1W1P process. This process involved numerous meetings with stakeholders and reflects the local priorities in the watershed. The process also included integration of local and regional management plans, expertise from regional partnering agencies and organizations, and the use of Zonation. Zonation is a value-based model that uses a combination of individual landscape features and analyzed spatial information about these criteria to prioritize areas for conservation and restoration. From this in-depth process, priority areas for the first 10 years of implementation were identified (Table 9 and Figure 27). Three impaired streams including the Talmadge River, French River, and Big Sucker Creek were not included in the Zonation process and were not ranked for prioritization in the 1W1P. In the future, additional prioritization work should focus on evaluating all of the waters within the LSS Watershed.

In addition, a summary of point and nonpoint pollutant loading by model catchment (approximately HUC12 scale) derived from watershed modeling results is provided in Section 2.3. The results identify areas with disproportionately high loading rates of various pollutants and can be used to focus implementation activities.

Table 9. 10-Year targeted geographic areas for restoration and protection

<table>
<tr><th>Type</th><th>HUC10</th><th>Priority Area</th><th>Description
(from One Watershed, One Plan)</th></tr>
<tr><td rowspan="3">Restoration [a]</td><td>Beaver River – Frontal Lake Superior (0401010201)</td><td>Beaver River</td><td>· Includes impaired waters on the EPA 303(d) list
· Includes areas of biological significance
· Susceptible to ground water contamination</td></tr>
<tr><td rowspan="2">Knife River – Frontal Lake Superior (0401010203)</td><td>Knife River</td><td>· Included on the EPA 303(d) list of impaired waters</td></tr>
<tr><td>Two Harbors</td><td>· One of the largest municipalities in watershed
· Experiencing increased land development pressures
· Contains Skunk Creek impaired for recreation and aquatic life</td></tr>
<tr><td rowspan="3">Protection [b]</td><td>Gooseberry River – Frontal Lake Superior (0401010202)</td><td>Gooseberry River HUC10</td><td>· Only HUC10 in Lake County with no impairments
· Includes a large area of intact forests and undisturbed wetlands
· Considered a vulnerable watershed</td></tr>
<tr><td>Knife River – Frontal Lake Superior (0401010203)</td><td>Stewart River</td><td>· Concern for the impact of this watershed's discharge on the source water quality for the Two Harbors municipality
· Identified as a priority watershed in the Lake County 2005-2015 Local Water Management Plan</td></tr>
<tr><td>All</td><td>Nearshore Lake Superior</td><td>· Area with strong potential for future land development, known septic issues, and significant shoreline management issues, including the presence of a number of erosion hazard zones
· Several trout streams s flow through this area
· Includes a significant number of rare features and sites of biological significance</td></tr>
</table>

a. The French River, Talmadge River, and Big Sucker Creek are all impaired waters, however these watersheds were not evaluated as part of the 1W1P Zonation process and therefore were not included in the 1W1P prioritization. Future prioritization work should include evaluation of all waters in the LSS Watershed.
b. Note that the entire watershed requires protection.

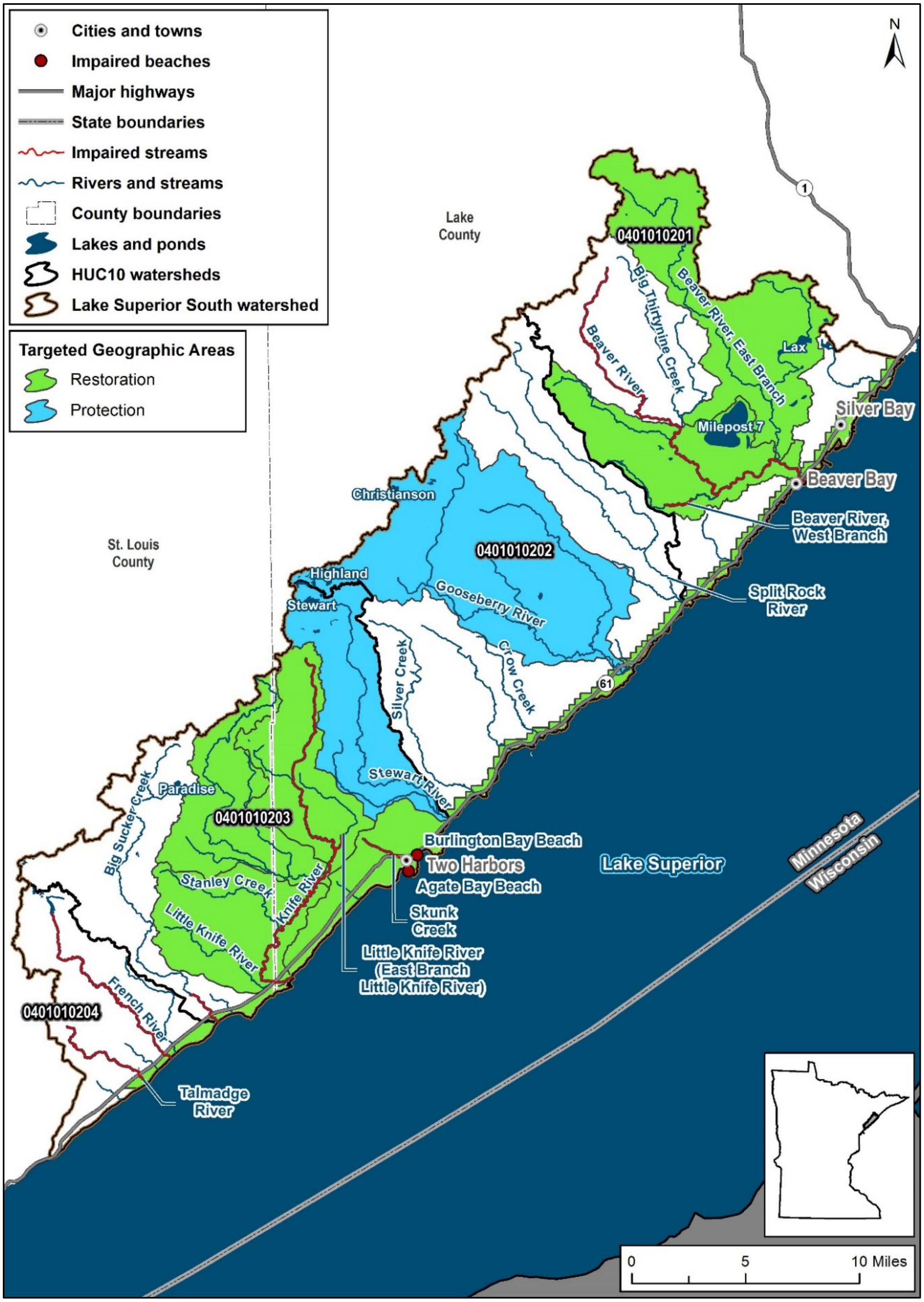

Figure 27. Targeted geographic areas.

Note that the entire watershed requires protection; targeted geographic areas focuses implementation activities over the next 10 years in select areas.

3.2 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. The MPCA has coordinated with the University of Minnesota Extension Service for years on developing and implementing civic engagement approaches and efforts for the Watershed Approach. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." Extension defines a resourceFULL decision as one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: https://extension.umn.edu/customized-education#leadership.

Figure 28. ResourceFULL process.

WRAPS Development

During the development of the LSS WRAPS, four meetings were held with the Lake Superior South Watershed Core Team for technical advice, updates, and strategy prioritization: January 24th, April 3rd, June 13th, and October 26th of 2017. Lake County and South St. Louis SWCD staff conducted a series of complimentary public engagement events ranging from homeowner workshops to hosting and interviewing guests on a local radio program. Examples of events held in the LSS include:

- Water resource management site tour (9 attendees)
- Rain garden planting workshop, Knife River (15 participants)
- Six community conversations, various locations (70+ participants)
- Culvert workshop field day (45 participants)
- Participation in St. Urho's Day in Finland (north of the watershed) and Two Harbor Heritage Day parades (7,000+ impressions)

One Watershed, One Plan for the Lake Superior North Watershed

During the development of 1W1P for the Lake Superior North, public meetings were held to create opportunities for local constituents to participate in identifying water quality concerns in the watershed, and to provide the public with background information and an overview of the 1W1P process. Broad natural resource issues were discussed to gain local insight to water quality problems. The following four issue categories were discussed:

- Reducing erosion and runoff
- Protecting/improving waters of concern

- Protecting/improving fish and wildlife habitat
- Protecting/focusing on lands of concern

Citizen input was gathered and incorporated into the planning process. For more information, see the 1W1P Section 2.2.3 and Appendix A.

Public Notice for Comments

An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from February 26, 2018 to March 28, 2018.

3.3 Restoration & Protection Strategies

The LSS Watershed transitions from the developed areas surrounding Duluth and Two Harbors northeast to the forested North Shore of Lake Superior. Because of its proximity to urban areas, this watershed is subject to development pressures, along with the effects of existing development, forestry activities, recreation, and industry. Development in the watershed results in new impervious surfaces, increases in runoff and associated pollutant loads, new roads and culvert crossings, and conveyance systems (e.g., ditches, storm sewers). The watershed is also stream-dominated, with little available runoff storage in the form of lakes and wetlands. These characteristics, combined with highly erodible soils, result in high peak flows and associated sediment concentrations. Creating opportunities for additional storage and stabilizing erodible soils are important strategies for restoration and protection. During the development of the WRAPS, existing watershed plans and assessments provided meaningful local knowledge to the selection of strategies. This section provides a summary of implementation strategies and actions for both restoration and protection. There are several strategies that apply across the entire watershed; these are provided in a watershed-wide summary table (Table 10). In an effort to coordinate and align the WRAPS document with the pre-existing local water management plan for the area, specific goals from the 1W1P that are applicable to the WRAPS document were included as restoration and protection strategies and are delineated by *italics* when applicable. Table 11 includes protection strategies specific to the nearshore area of Lake Superior. This priority area is present across the entire watershed. Strategies are then summarized at a HUC10 watershed scale, and by assessment unit for impaired waters or waters that are targeted for protection efforts in Table 12. The summary tables include the following information:

- ***Water Quality – Current Conditions:*** "Current" condition is interpreted as the baseline condition over the evaluation period for the pollutant or non-pollutant stressor identified in the previous column. Current loads represent available data sources and reference information included in Section 2.1.
- ***Water Quality – Goals / Targets and Estimated % and Load Reduction by Flow Regime:*** Includes the reductions needed to meet water quality standards, and are referenced to Appendix A that includes the TMDL summaries. Percent reductions are typically included as a range that covers the different flow regimes (e.g., reductions under high flow and dry

conditions) when a TMDL is provided for multiple flow regimes (see Appendix A). The range represents the highest and lowest reduction needed across all flow regimes.

- ***Strategy and Strategy Type:*** These columns provide the strategies to be used for both protection and restoration. Strategies outline the method, approach, or combination of approaches that could be taken to achieve or maintain water quality goals.
- ***Estimated Adoption Rates:*** These columns tie to the strategies column and generally describe the magnitude of effort that it will take to achieve the 10-year milestones and ultimate implementation goal. These estimates are meant to describe approximately "what needs to happen" but does not detail precisely "how" goal attainment will be achieved (the latter is left to subsequent planning steps). These estimates are an approximation only and subject to adaptive management. Note that some water bodies do not have any planned activity during the first 10 years. These water bodies are lower priority and activities are expected to take place in the future. The method used to derive numeric milestones for the *Streambank Stabilization* strategy was based on the following when applicable:
    - Available stream-specific geomorphic data were used to determine the linear feet of restoration needed to achieve the water quality goal associated with this strategy. Those stream segments with the highest loading rate per linear foot were prioritized for restoration.
- ***Governmental Units with Primary Responsibility:*** Identifies the governmental unit with primary responsibility. Other government entities as well as stakeholders, non-profits, and non-governmental organizations will likely support these strategies.
- ***Estimated Year to Achieve Water Quality Targets:*** This applies to the water body, specifically the year it is reasonably estimated that applicable water quality targets will be achieved. These dates are based on the level of implementation needed to achieve standards, watershed priorities, and best professional judgement. Activities related to protection efforts are ongoing.

Achieving the goals of this WRAPS will require partnerships and collaboration, in addition to financial resources. Governmental units with primary implementation responsibility include the following entities:

- MPCA
- DNR
- MDH
- BWSR
- USDA Forest Service
- Counties (Lake and St. Louis)
- SWCDs (Lake and St. Louis counties)
- Municipalities

In addition, many other partners are anticipated to participate with implementation:

- Forestry and mining interests
- Non-profits (e.g., Trout Unlimited, Sugarloaf Stewardship Association)
- Universities
- Land and business owners

Government agencies with secondary responsibilities include the MDA, USGS, EPA, USDA NRCS, and Fish and Wildlife Service. These agencies will work with private landowners and other agencies and project partners to support implementation of this WRAPS.

The proposed WRAPS will rely on available funding sources to fund projects and programs. The level of implementation proposed for the first 10 years is significantly higher than existing efforts and will require new sources of funding for local capacity and capital improvement projects. Potential funding sources for implementation activities include:

- Clean Water Fund, part of the Clean Water, Land, and Legacy Amendment
- Outdoor Heritage Fund, part of the Clean Water, Land, and Legacy Amendment
- Legislative-Citizen Commission on Minnesota Resources
- Local government cost-share and loan programs
- Minnesota Lake Superior Coastal Program
- Federal grants and technical assistance programs
- Conservation Reserve Program and NRCS cost-share programs
- Federal Clean Water Act Section 319 program for watershed improvements
- Great Lakes Restoration Initiative
- National Fish and Wildlife Foundation
- Great Lakes Protection Fund
- Minnesota Clean Water Partnership Loan Program

Table 10. Watershed wide strategies and actions proposed for the LSS Watershed

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate				Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
								Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units									
All	All	St. Louis and Lake Counties	Parameters cited in permit	-	-		Construction and Industrial Stormwater permittees—compliance with general permits								X					Ongoing
			Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Address subsurface sewage treatment systems (SSTS)	Inventory and assess the potential for septic systems/private wastewater systems to be sources of *E. coli* and nutrients. Create and maintain a database of SSTS (i.e., owner, age, installer, size, location, construction technique, maintenance records, etc.). Replace all systems deemed imminent threat to public health (e.g., straight pipes, surface seepage). Support increased compliance inspections (in addition to current point of sale inspections). Landowner focused education and outreach on septic system maintenance and compliance. Additional setbacks in sensitive areas. *Applicable 1W1P Goals:* *Provide financial assistance for SSTS upgrades.* *Implement and enforce county SSTS ordinances.*	--	Complete all SSTS work in Skunk Creek Watershed including upgrade of all systems deemed imminent threat to public health	100% compliance of SSTS in the watershed	# of septic systems	X			X					2030
						Protect and stabilize lakeshores	Shoreland survey—evaluate the shoreland and identify areas of disturbance, such as altered vegetation (e.g., lawns), bare soil, and shoreland erosion. Lakeshore revegetation and buffers.	--	Complete shoreland survey	Natural buffers around majority of lakeshore	% of buffers	X	X			X		X	X	2040
						Fisheries management	Improve riparian buffers to provide shade and remain consistent with current buffer requirements (Shoreland Management Act, MN Buffer Law). Advocate for a healthy fishery with emphasis on key species in specific locations. Provide steelhead nursery habitat. *Applicable 1W1P Goals:* *Maintain high quality and diverse fishery.*	--	Buffers for all stream reaches consistent with Buffer Law and Shoreland Management Act	Maintain flows and water levels that emulate natural conditions in all streams	% of flows and water levels					X				Ongoing

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	All	St. Louis and Lake Counties	Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Fisheries management (cont.)	*Evaluate impacts of beaver and beaver dams on cold water fisheries (water storage, flashiness, bank susceptibility, temperature).* *Maintain or enhance current brook trout populations. Identify and preserve sites that have high species diversity and/or critical habitat for fish or wildlife.* *Evaluate implications of single species management. Identify minimum standards of water levels required for in–stream biological uses.*	--	See above	See above	See above					X				Ongoing
						Increase stream connectivity	Identify/prioritize the rehabilitation of problematic road or trail and stream intersections. Upgrade and replace culverts identified as barriers to fish passage (see Figure 24) Properly size and place bridges and culverts for flow, stream stability, and fish passage. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems. *Applicable 1W1P Goals:* *Develop and maintain road construction and maintenance policies that assure free-flowing riparian systems and stream–accessible floodplains that connect Lake Superior with the headwater lakes, streams and wetlands. All stream and wetland crossings will follow the principles of MESBOAC.* *Update county and SWCD culvert standard to accommodate fish passage and larger storm events.*	--	Complete inventory of culverts in St. Louis County Updated county culvert standards	Replace all of culverts identified as barriers to fish passage on trout streams	# of culverts	X		X		X				2040
						Improve fish and macroinvertebrate IBI scores	Further evaluate cause of low IBI scores (see Figure 25 and Figure 26). Implementation activities to improve biological diversity and abundance (e.g., habitat restoration, barrier removal, etc.).	44% of macroinvertebrate IBI score > threshold 72% of fish IBI score > threshold	10-15% increase in % of sites meeting IBI use thresholds	100% of sites meeting IBI use thresholds	% of sites		X		X					2040

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	All	St. Louis and Lake Counties	Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Invasive species control	Implement County aquatic invasive species plans; Lake County and St. Louis County plans completed in 2015. Continue coordination and implementation of activities as part of Arrowhead Invasive Species collaboration. Research and develop guidance on activities to control invasive species (e.g., dwarf mistletoe) that balance watershed health.	Boat access sites have signage and information on aquatic invasive species	Implement County AIS plans	Implement County AIS plans	# of activities	X	X			X				Ongoing
						Land use planning and ordinance	Align and coordinate riparian buffer regulations at the federal/state/ and local levels. Inventory potential for tax forfeited lands, School Trust Lands, and Con Con (consolidated conservation lands) Lands to provide water quality protection or improvements; retain the ecosystem benefits provided by these lands where appropriate. Conservation easements to protect riparian, lakeshore, wetland, and high quality upland areas. Additional setbacks for lakeshore development. Utilize audit tools such as EPA's Water Quality Scorecard to systematically address ordinance deficiencies and gaps. Evaluate impacts of and increase resiliency to climate change on water resources. Develop and adopt in-stream flow targets, particularly in periods of extreme drought or low flows. Monitor and enforce no dumping regulations at popular sites for illegal dumping. Increased trash receptacles and dog waste stations on or near beaches.	--	Complete plan to address tax forfeited lands and School Trust lands into the future Complete analysis to align buffer regulations Identify gaps in current ordinances	Update all ordinances in consideration of water quality protection	# of updates	X		X						2030
						Stormwater runoff management	Implement green infrastructure practices and BMPs to increase infiltration and reduce flooding and runoff in upstream reaches. See MPCA Stormwater Manual http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs. Evaluate altered hydrology as the underlying cause of channel scour, bank instability and water quality impairments. Implement a program to disconnect impervious surfaces from conveyances or direct drainage.	Two Harbors has an existing stormwater plan, dated 2001	Update stormwater management plan in Two Harbors	Update stormwater management plans every 10 years Conduct stormwater maintenance on a regular schedule	# plan updates completed # hours conducting maintenance	X	X	X						Ongoing

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	All	St. Louis and Lake Counties	Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Stormwater runoff management (cont.)	Develop or update existing stormwater management plans. Develop and implement new guidance on ditch (public and private) maintenance activities that will minimize un-vegetated channels and associated erosion. Assess the state of existing roadside ditches and identify priority locations for ditch management (e.g., re-vegetation, armoring). Institutionalize operation and maintenance procedures for road ditches. *Applicable 1W1P Goals:* *Develop stormwater management plans on priority riparian land, including golf courses.* *Inventory, maintain and re-vegetate current ditches with native species.* *Consider and implement climate change adaptation strategies on all stormwater management projects.* *Inspect, maintain, update or replace stormwater management systems to increase lifespan.*		Update guidance on ditch management and conduct training *Develop two stormwater management plans in urban nodes of each county*	Conduct training on ditch management every 5 years Ensure all roads have adequate stormwater management that reduces sediment loading *Transition 10% of inventoried ditches in each county to native vegetation*	# of trainings % roads % of ditches	X	X	X						Ongoing
						Forestry management	Expand forestry programs to include management at small scales (e.g., properties under 20 acres). Promote and periodically revise forest stewardship plans. Develop public/private partnerships to promote forest stewardship. Develop and implement forest stewardship plans for private lands (Sustainable Forestry Incentive Act). Conduct research to find a suitable tree species to fill the ecological niche of ash trees. Inventory black ash in buffer and woody wetland areas and determine potential impact to water resources if extensive tree loss and/or removal occurs. Recognize that 100% loss is unlikely, and that survivors are valuable as carriers of genetic traits necessary for survival and reforestation Continue forestry education, outreach and training efforts.	--	Increase local forestry management technical assistance/ capacity Open lands assessment completed Ash tree inventory	Forest stewardship plans implemented on 50% of private land Open lands assessment completed every 10 years Open lands or 0-15 age class <60% at subwatershed scale Ash tree inventory	# of plans # of assessments completed % open lands # of tree inventories	X	X			X			X	Ongoing

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	All	St. Louis and Lake Counties	Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Forestry Management (cont.)	Evaluate management of forests on School Trust, Con, Con (consolidated conservation lands), tax forfeit and large tracts of privately held land. Quantify and develop protection strategies to preserve water quality and quantity benefits provided by forests (ecosystem benefits). Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, purchasing of development rights, and other conservation tools. Update forestry ordinances/guidelines and encourage compliance with MN Forest Resources Council Forest Management Guidelines. Conduct open lands assessment every 10 years. Take action to ensure subwatersheds have <60% of the land in the 0-15 year age class. Define riparian management zones and enforce regulations on soil disturbance and tree harvesting. Enforce the Shipstead-Nolan Act as it relates to timber harvests near streams (U.S. Code Title 16, Section 577). *Applicable 1W1P Goals:* *Manage the density and composition of the forest canopy to control runoff and extend snowmelt to reduce erosive stream flow volume and rate.* *Increase the local technical capacity to help landowners implement existing forestry management plans.*	--	See above	Develop and implement updated forest plan Protect prioritized areas Updated ordinances	# of implementa-tion activities % of acres protected # of ordinances	X	X			X			X	Ongoing
						Aggregate mining management	Consider factors such as location, water quality, temperature, and changes in drainage networks, lake inflow or outflow, and baseflow associated with operational and expansion plans of aggregate mining companies. *Applicable 1W1P Goals:* *Minimize environmental risks to surface waters, groundwater, groundwater dependent natural resources and rare/high quality plant communities where aggregate resources and high value biological and water resources overlap.*	--	--	Expand ordinances to address surface and groundwater interactions	# updated ordinances	X				X				2030

Waterbody and Location			Water Quality			Strategies	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	All	St. Louis and Lake Counties	Varies	Varies (see Figure 5, Figure 6, Figure 7 and Figure 8 for current water quality conditions)	Varies (see Appendix A for % reductions) Meet or exceed IBI standards in all streams	Education and outreach activities	Support watershed stewardship groups for residents and landowners. Continue education and outreach activities on conservation BMPs and implementation for landowners and county/municipal staff. Continue implementation of a watershed and water quality education and outreach program focused on riparian users/owners (lakes and streams), municipal operations, forestry activities, septic system maintenance and compliance, stakeholders and residents. Continue to educate public on deterring geese and bird feeding. *Applicable 1W1P Goals:* *Strengthen understanding of the connections of land management and the impacts both positive and negative to the water quality and aquatic ecosystems.* *Increase public education on spread and control of aquatic invasive species.*	SWCDs currently have contract for education and outreach work in the watershed	1-2 watershed stewardship groups formed Continue implementation of a watershed and water quality education and outreach program	4-5 watershed stewardship groups or partnerships formed Continue to implement watershed and water quality education and outreach programs	# of groups # of outreach efforts		X		X	X		X		Ongoing
						Wetland management	Complete assessment of wetland functions, including threshold limits for loss and impairment. Develop area-specific wetland regulations to address the unique wetland resources and functional replacement challenges. Determine priority locations for functional uplift. *Applicable 1W1P Goals:* *Identify priority areas for wetland protection activities.* *Wetland banking and mitigation activities.* *Preserve and restore/rehabilitate high quality wetland resources through the implementation of the Wetlands Conservation Act and coordination with the MN DNR Protected Waters Program and the USACE Section 404 Permitting Program.*	--	--	Complete assessment of wetland functions Priority wetlands for protection identified	% completed # identified	X	X			X		X		2030
						Groundwater / Drinking water management	Adoption of BMPs to sustainably manage surface/groundwater quantity.	--	--	Expand ordinances to address surface and groundwater interactions	# of updated ordinances	X		X		X	X			2030

Table 11. Nearshore Lake Superior protection strategies

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All	Nearshore Lake Superior	Lake and St. Louis	--	--	--	Reduce industrial/ municipal wastewater discharges	Ensure compliance with discharge permits.	--	Compliance with discharge permits	Compliance with discharge permits	Compliance rate				X					Ongoing
						Stormwater runoff management	See watershed-wide strategies Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits.	--	Survey ditches and identify priority areas for upgrades/ maintenance Identify opportunities for stormwater retrofits Implement 2 stormwater BMP projects	Ensure all roads and developed areas apply stormwater BMPs to control sediment loading	% of roads and areas	X	X	X						2040
						Forestry management	See watershed-wide strategies.	--	Complete open lands assessment Develop 2 forest stewardship plans	Conduct 0-15 year age class (open lands) assessments every 10 years Forest stewardship plans on 50% of private lands (parcels over 20 acres in size) Open lands or 0-15 age class <60% at sub-watershed scale	# of assessments completed # of plans % open lands	X	X			X			X	Ongoing
						Address subsurface sewage treatment systems (SSTS)	See watershed-wide strategies.	--	Complete inventory and inspection of SSTS in watershed Upgrade 25% of failing septic systems	Complete inventory and inspection of SSTS every 10 years 100% of SSTS in compliance	# of systems	X			X					2030

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
All (cont.)	Nearshore Lake Superior (cont.)	Lake and St. Louis (cont.)	--	--	--	Invasive species control	Implement County aquatic invasive species (AIS) plans; Lake County and St. Louis County plans completed in 2015.	Boat access sites have information on AIS	Implement County AIS plans	Implement County AIS plans	# of activities	X	X			X				Ongoing
						Land use planning and ordinance	See watershed-wide strategies. Incorporate stormwater management and the impact of imperviousness on water quality and runoff into land use planning efforts (see stormwater runoff management above). Consider increased trash receptacles and dog waste stations on beaches.	--	Identify gaps in current ordinances	Pet waste and trash receptacles at all public beaches	# of receptacles	X		X		X				2025

Protection waters

Restoration waters

Table 12. HUC10 specific strategies and actions proposed for the LSS Watershed

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Beaver River – Frontal Lake Superior (0401010201)	Beaver River (501)	Lake	Fishes bioassess-ments (elevated water temperature, poor habitat, turbidity/ TSS), turbidity/ TSS, pH **TSS TMDL**	See Table 13 and Figure 25	0-81% TSS reduction (See Table 13) FIBI and MIBI general use standards	Reduce industrial/ municipal wastewater discharges	Reduce point source loading per the Beaver River TMDL (Tetra Tech 2018). Continue to evaluate the potential for Mile Post 7 to contribute to existing impairments in the Beaver River system.	Currently meeting permit requirements	Update permits as needed	Compliance with wasteload allocations	Compliance rate				X					2043
						Streambank stabilization and riparian management	Address highest TSS loading areas identified in the Beaver River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc. Implement recommendations in the Stressor ID (MPCA 2017): · Improve trails and trail crossings at Glen Avon Falls trail to reduce sediment loading. Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit access to streams. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act contains provisions to protect native vegetation. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.	--	Stabilize 4,200 feet Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	Adaptive management; additional stream stabilization as needed Riparian buffers on all mainstream and tributary streams Upgrade all road and trail crossings causing erosion	Linear feet % with buffers % upgraded	X	X			X		X	X	2043
						Forestry management	See watershed-wide strategies.	--	Complete open lands assessment Develop 3 forest stewardship plans	Open lands assessment every 10 years	# of assessments completed	X	X			X			X	Ongoing

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate				Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
								Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units									
Beaver River – Frontal Lake Superior (0401010201) (cont.)	Beaver River (501) (cont.)	Lake	Fishes bioassess-ments (elevated water temperature, poor habitat, turbidity/ TSS), turbidity/ TSS, pH **TSS TMDL**	See Table 13 and Figure 25	0-81% TSS reduction (See Table 13) FIBI and MIBI general use standards	Forestry management (cont.)	See above	--	See above	Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at sub-watershed scale	# of plans % open lands	X	X			X			X	Ongoing
						Stormwater runoff management	See watershed-wide strategies. Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits.	--	Survey ditches and identify priority areas for upgrades/ maintenance Identify opportunities for stormwater retrofits Implement 3 stormwater BMP projects	Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading	% of roads and areas	X	X	X						Ongoing
						Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# updated	X		X						2030

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Beaver River – Frontal Lake Superior (0401010201) (cont.)	West Beaver River (577)	Lake	Aquatic macroinverte-brate bioassess-ments, fisheries bioassess-ments (low (DO), poor habitat)	See Figure 25 and Figure 26	FIBI and MIBI use standards	Implement recommendations in the Stressor ID (MPCA 2017)	Improve width/depth ratio to increase flows to support fish species habitat. Increase cover (e.g., woody debris, trees, and boulders) in riparian zones to improve fish habitat. Re-meander channelized tributaries. Address positive and negative impacts of beaver dams on fish passage, temperature, sediment transport and the potential for catastrophic release or failure.	--	Conduct geomorphic analysis to determine high priority restoration sites	Adaptive management; additional stream stabilization as needed	Linear feet		X		X					2043
	Lax Lake (38-0406-00)	Lake	--	TP = 18.2 µg/L	--	See watershed wide strategies (Table 10).														Ongoing
	All	Lake	--	--	FIBI and MIBI use standards	See watershed wide strategies (Table 10).														Ongoing
City of Duluth – Frontal Lake Superior (0401010204)	Talmadge River (Talmadge Cr) (508)	St. Louis	Dissolved oxygen (DO), fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS **TSS TMDL**	See Table 16, and Figure 25 and Figure 26	0-97% TSS reduction See Table 16 FIBI and MIBI use standards	Streambank stabilization and riparian management	Address highest TSS loading areas identified in the Talmadge River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc. Implement recommendations in the Stressor ID (MPCA 2017): · Address erosion from steep slopes in downstream waters. · Re-meander channelized headwaters. · Address impoundment at the Duluth Retriever Club. · Fix priority undersized/perched culverts to adhere to MESBOAC design procedure (MN DNR 2011). · Improve width/depth ratio to increase flows and support brook trout and other fish species habitat. · Increase cover (e.g., woody debris, trees, and boulders) in riparian zones. · Restore riffle substrate where appropriate to improve DO levels. · Address impacts of beaver dams and activity on pooling and temperature.	--	Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	1,500 feet restored Riparian buffers on all mainstream and tributary streams Upgrade all road and trail crossings causing erosion	Linear feet % with buffers % upgraded	X	X			X		X	X	2043

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
City of Duluth – Frontal Lake Superior (0401010204) (cont.)	Talmadge River (Talmadge Cr) (508) (cont.)	St. Louis	Dissolved oxygen, fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS **TSS TMDL**	See Table 16, and Figure 25 and Figure 26	0-97% TSS reduction See Table 16 FIBI and MIBI use standards	Streambank stabilization and riparian management (cont.)	Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit access to streams. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.	--	See above	See above	See above	X	X			X		X	X	2043
						Forestry management	See watershed-wide strategies.	--	--	Open lands assessment every 10 years Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at sub-watershed scale	# of plans # of assessments completed % open lands	X	X			X			X	Ongoing
						Stormwater runoff management	See watershed-wide strategies. Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits.	--	--	Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading	% of roads and areas	X	X	X						Ongoing

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
City of Duluth – Frontal Lake Superior (0401010204) (cont.)	Talmadge River (Talmadge Cr) (508) (cont.)	St. Louis	Dissolved oxygen, fisheries bioassess-ments (low dissolved oxygen, poor habitat, elevated turbidity/ TSS, altered hydrology), turbidity/ TSS **TSS TMDL**	See Table 16, and Figure 25 and Figure 26	0-97% TSS reduction See Table 16 FIBI and MIBI use standards	Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# of ordinances	X		X						2030
	French River (698)	St. Louis	Turbidity/ TSS **TSS TMDL**	See Table 15	0-95% TSS reduction (see Table 15) FIBI and MIBI use standards	Reduce industrial/ municipal wastewater discharges	Reduce point source loading per French River TMDL (Tetra Tech 2018).	--	Compliance with permits and wasteload allocations	Compliance with permits and wasteload allocations	Compliance rate			X						Ongoing
						Streambank stabilization and riparian management	Address highest TSS loading areas identified in the French River TMDL (Tetra Tech 2018) – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc. Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit access to streams. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.	--	Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	3,600 feet restored Riparian buffers on all mainstream and tributary streams Upgrade all road and trail crossings causing erosion	Linear feet % with buffers % upgraded	X	X			X		X	X	2043

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
City of Duluth – Frontal Lake Superior (0401010204) (cont.)	French River (698) (cont.)	St. Louis	Turbidity/ TSS **TSS TMDL**	See Table 15	0-95% TSS reduction (see Table 15) FIBI and MIBI use standards	Forestry management	See watershed-wide strategies.	--	--	Open lands assessment every 10 years Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at sub-watershed scale	# of assessments completed # of plans % open lands	X	X			X			X	Ongoing
						Stormwater runoff management	See watershed-wide strategies. Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits.	--	--	Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading	% of roads and areas	X	X	X						Ongoing
						Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# updated	X		X						2030
	All	St. Louis	--	--	FIBI and MIBI use standards		See watershed wide strategies (Table 10).													Ongoing

Waterbody and Location: HUC10 Subwatershed	Waterbody and Location: Water-body (ID)	Waterbody and Location: Location and Upstream Influence Counties	Water Quality: Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or conc.)	Water Quality: Goals / Targets and Estimated % Reduction	Strategies (see key below)	Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	Estimated Year to Achieve Water Quality Target
Knife River – Frontal Lake Superior (0401010203)	Big Sucker Creek (Sucker River) (555)	St. louis	Turbidity/ TSS **TSS TMDL**	See Table 14	0-96% TSS reduction (see Table 14) FIBI and MIBI use standards	Streambank stabilization and riparian management	Address highest TSS loading areas identified in the Big Sucker Creek TMDL (Tetra Tech 2018 – see the BANCS modeling results). Activities could include bank armoring, bioengineering, stream meanders, etc. Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit livestock access to streams. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.	--	Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	4,200 feet restored Riparian buffers on all mainstream and tributary streams Upgrade all road and trail crossings causing erosion	Linear feet % with buffers # upgraded	X	X			X		X	X	2043
						Forestry management	See watershed-wide strategies.	--	--	Open lands assessment every 10 years Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at sub-watershed scale	# of assessments completed # of plans % open lands	X	X			X			X	Ongoing

Waterbody and Location: HUC10 Subwatershed	Waterbody and Location: Water-body (ID)	Waterbody and Location: Location and Upstream Influence Counties	Water Quality: Parameter (incl. non-pollutant stressors)	Water Quality: Current Condition s (load or conc.)	Water Quality: Goals / Targets and Estimated % Reduction	Strategies (see key below)	Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	Estimated Year to Achieve Water Quality Target
Knife River – Frontal Lake Superior (0401010203) (cont.)	Big Sucker Creek (Sucker River) (555) (cont.)	St. louis	Turbidity/ TSS **TSS TMDL**	See Table 14	0-96% TSS reduction (see Table 14) FIBI and MIBI use standards	Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# updated	X		X						2030
	Skunk Creek (528)	Lake	*Escherichia coli* ***E. coli* TMDL**	See Table 20	24-66% reduction in *E. coli* (see Table 20)	Reduce industrial/ municipal wastewater discharges	Address overflows from Two Harbors WWTP to Skunk Creek. Upgrade leaky wastewater infrastructure in urban areas.	--	Eliminate overflows to Skunk Creek Assess wastewater infrastructure crossing Skunk Creek and tributaries	Upgrade leaky infrastructure as needed	# of upgrades			X	X					2043
						Address subsurface sewage treatment systems	See watershed-wide strategies.	--	Complete inventory and inspection of SSTS in watershed Upgrade 50% of failing septic systems	Complete inventory and inspection of septic systems every 10 years 100% of septic systems in compliance	# of septic systems	X			X					2030
						Education and outreach activities	See watershed-wide activities. Enhance pet waste management programs. Update ordinances to include enforcement of pet waste ordinances. Continue to educate public on deterring geese and bird feeding.	--	Outreach campaign that addresses *E. coli* sources Consider updating ordinances to include pet waste clean-up enforcement	Conduct focused outreach every 5-years	# of outreach efforts		X	X						Ongoing

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Skunk Creek (528) (cont.)	Lake	*Escherichia coli* ***E. coli* TMDL**	See Table 20	24-66% reduction in *E. coli* (see Table 20)	Stormwater runoff management	Update existing stormwater management plans (e.g., Two Harbors).	--	See Skunk Creek Turbidity/TSS below	See Skunk Creek Turbidity/TSS below	--	X	X	X						2043
						Monitoring	Conduct additional monitoring and microbial source tracking to identify hotspots and determine sources of *E. coli* for targeted implementation.	--	Microbial source tracking project Identify priority areas	Conduct activities as needed to address priority areas	# of activities		X	X	X		X			2043
			Turbidity/ TSS **TSS TMDL**	See Table 19	0-91% TSS reduction (see Table 19) FIBI and MIBI use standards	Streambank stabilization and riparian management	Conduct geomorphic analysis to determine high priority restoration sites. Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit access to streams. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.	--	Conduct geomorphic analysis and identify highest loading segments Stream stabilization for highest loading segments Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	Adaptive management; additional stream stabilization as needed Riparian buffers on all mainstream and tributary streams Upgrade all road and trail crossings causing erosion	Linear feet % with buffers % upgraded	X	X			X		X	X	2043
						Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# updated	X		X					X	2030

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Skunk Creek (528) (cont.)	Lake	Turbidity/ TSS **TSS TMDL**	See Table 19	0-91% TSS reduction (see Table 19) FIBI and MIBI use standards	Stormwater runoff management	See watershed-wide strategies. Update the stormwater management plan for Two Harbors. Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits. Identify and protect areas of high infiltration or storage.	--	Update Two Harbors stormwater plan Survey ditches and identify priority areas for upgrades/ maintenance Identify opportunities for stormwater retrofits Implement 4 stormwater BMP projects	Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading Update stormwater plan every 10 years	% of roads and areas # of plan updates	X	X	X						Ongoing
						Forestry management	See watershed-wide strategies.	--	Complete open lands assessment Develop 2 forest stewardship plans	Open lands assessment every 10 years Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at sub-watershed scale	# of assessments completed # of plans % open lands	X	X			X			X	Ongoing
	Little Knife River (East Branch Little Knife River; 840)	Lake	Dissolved oxygen, turbidity/ TSS **TSS TMDL**	See Table 18	Unknown reductions needed (see Table 18) FIBI and MIBI use standards	Streambank stabilization and riparian management	Conduct geomorphic analysis to determine high priority restoration sites. Conduct monitoring to determine sources of sediment and presence of low dissolved oxygen. Preserve the natural vegetation along stream corridors. Minnesota's buffer initiative requires establishment of up to 50 feet of perennial vegetation along many rivers, streams, and ditches. The Shoreland Management Act requires protection of shoreline vegetation.	--	Conduct geomorphic analysis and monitoring Stream stabilization for highest loading segments	Adaptive management; additional stream stabilization as needed Riparian buffers on all mainstream and tributary streams	Linear feet % with buffers	X	X			X		X	X	2043

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Estimated Adoption Rate: Interim 10-year Milestone	Estimated Adoption Rate: Suggested Goal	Estimated Adoption Rate: Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Little Knife River (East Branch Little Knife River; 840)	Lake	Dissolved oxygen, turbidity/ TSS **TSS TMDL**	See Table 18	Unknown reductions needed (see Table 18) FIBI and MIBI use standards	Streambank stabilization and riparian management (cont.)	Address stream crossings: · Roads and trails causing direct erosion (see Figure 24). · Add controlled stream crossings for ATVs, forest activities, etc. · Install exclusion fencing or stream crossings to limit access to streams. Coordinate with transportation departments to ensure bridge or culvert replacements are designed and constructed to eliminate fish passage and erosion problems.		Conduct annual coordination with road authorities to review stream crossing projects Buffers as required by Buffer Law	Upgrade all road and trail crossings causing erosion	% upgraded	X	X			X		X	X	2043
						Forestry management	See watershed-wide strategies.	--	Complete open lands assessment Develop 2 forest stewardship plans	Open lands assessment every 10 years Forest stewardship plans on 50% of private lands Open lands or 0-15 age class <60% at subwatershed scale	# of assessments completed # of plans % open lands	X	X			X			X	Ongoing
						Stormwater runoff management	See watershed-wide strategies. Enhance stormwater requirements to reduce peak flows and volume from impervious surfaces. Identify opportunities for stormwater practice retrofits.	--	Survey ditches and identify priority areas for upgrades or maintenance Identify opportunities for stormwater retrofits (e.g., airport, high impervious areas) Implement 2 stormwater BMP projects	Ensure all roads and developed areas have adequate stormwater management that reduces sediment loading	% of roads and areas	X	X	X						Ongoing

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Condition s (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Little Knife River (East Branch Little Knife River; 840) (cont.)	Lake	Dissolved oxygen, turbidity/ TSS **TSS TMDL**	See Table 18	Unknown reductions needed (see Table 18) FIBI and MIBI use standards	Land use planning and ordinance	See watershed-wide strategies. Consider additional setbacks or overlay districts in red clay areas or hazard areas to minimize property loss and water quality impacts. Protect riparian, wetland and high quality upland areas using easements, restrictive covenants, low impact development, tax incentives, and purchasing of development rights, and other conservation tools.	--	Identify gaps in current ordinances	Updated ordinances that protect sensitive areas	# updated	X		X						2030
	Impaired Beaches: Burlington Bay (04010102-C30) and Agate Bay (04010102-C31)	Lake	*Escherichia coli*		Reduce # of beach closings by 100%	Address *E. coli* loading from Skunk Creek to Burlington Bay	See Skunk Creek (528).					X	X	X	X		X			2043
						Reduce industrial/ municipal wastewater discharges	Ensure compliance with discharge permits.	--	Compliance with discharge permits	Compliance with discharge permits	Compliance rate				X					Ongoing
						TMDL development	Complete TMDL development for impaired beaches. Conduct microbial source tracking to determine sources of *E. coli.*	--	Complete TMDLs and implementation plan	Complete TMDLs and plan implementation	% completed				X		X			2020
						Address subsurface sewage treatment systems (SSTS)	See watershed-wide strategies.	--	Complete inventory and inspection of SSTS in watershed Upgrade 50% of failing septic systems in direct contributing area Also see Skunk Creek (528)	Complete inventory and inspection of septic systems every 10 years 100% of septic systems in compliance	# of septic systems	X			X					2030
						Monitoring	Monitor and determine potential for ballast water to be a source of *E. coli* in near shore areas and at beaches; address source as needed. Conduct microbial source tracking to determine sources of *E. coli.*	--	Microbial source tracking project Complete study on ballast water	Target source reductions as needed	# of reduction projects				X		X			Ongoing

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate												
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Impaired Beaches: Burlington Bay (-C30) and Agate Bay (-C31) (cont.)	Lake	*Escherichia coli*		Reduce # of beach closings by 100%	Land use planning and ordinance	See watershed-wide strategies. Monitor and enforce no dumping regulations. Enhance current pet waste ordinances to include enforcement. Consider increased placement of trash receptacles on beaches. Ensure availability of adequate bathroom facilities near beaches.	--	Develop plan for bathroom facilities, as needed	Updated facilities as needed to address *E. coli* sources (bathrooms, pet waste, trash)	# of new or updated facilities	X		X		X				2030
						Education and outreach activities	See watershed-wide strategies. Educate boat owners on proper disposal of waste to reduce *E. coil* loading in Lake Superior. Encourage boat owners and operators to participate in Green Marina programs. Education and outreach on reducing *E. coli* at beaches (i.e., proper waste disposal, pet waste disposal and signage to prevent feeding of wildlife). Ensure information is available at nearby campgrounds.	--	Outreach campaign that addresses sources of *E. coli*	Conduct focused outreach every 5-years	# of outreach efforts	X	X	X			X			Ongoing
	Knife River (504)	St. Louis and Lake	Turbidity **TSS TMDL**	0.01-31 tons/day TSS (SSLSCWD 2010)	0-90% TSS reduction (see Table 17) FIBI and MIBI use standards	Implement approved Knife River TMDL Implementation Plan (SSLSWCD 2011)	Land use/cover management activities: · Tree planting in open land areas · Miscellaneous runoff reduction activities in open land areas · Riparian area forest management · Upland forest management · Beaver dam inventory, monitoring and evaluation Stream bank and bluff restoration activities: · Grand control measures · Bankfull benches · Tree planting on bluffs Upland erosion control activities: · Gully stabilizations · Road ditch maintenance and re-vegetation (stormwater management) · Stormwater BMPs inventory, training and implementation · Wetland enhancement, creation and preservation		Implement according to approved Implementation Plan (SSLSWCD 2011)			X	X	X		X			X	2035

Waterbody and Location			Water Quality			Strategies (see key below)	Strategy scenario showing estimated scale of adoption to meet 10-year milestone and final water quality targets. Scenarios and adoption levels may change with additional local planning, research showing new BMPs, changing financial support and policies, and experience implementing the plan.					Governmental Units with Primary Responsibility								Estimated Year to Achieve Water Quality Target
HUC10 Subwatershed	Water-body (ID)	Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Current Conditions (load or conc.)	Goals / Targets and Estimated % Reduction		Strategy Type	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	Counties	SWCDs	Cities/Townships	MPCA	DNR	MDH	BWSR	Forest Service	
Knife River – Frontal Lake Superior (0401010203) (cont.)	Knife River (504) (cont.)	St. Louis and Lake	Turbidity **TSS TMDL**	0.01-31 tons/day TSS (SSLSCWD 2010)	0-90% TSS reduction (see Table 17) FIBI and MIBI use standards	Implement approved Knife River TMDL Implementation Plan (SSLSWCD 2011)	Outreach and education: · Education activities · Outreach through information dissemination · Training for contractors, local government unit staff and planning boards · Civic engagement / organizing · Regional agency collaboration · Incorporate the LSS TMDL and WRAPS into the North Shore Management Plan Survey, inventory and analysis activities.		See above			X	X	X		X			X	2035
	Captain Jacobson Creek (584)	St. Louis	--	--	--	Implement recommendations in the Stressor ID (MPCA 2017)	Restore connectivity and geomorphology to support resilient trout populations. Replace the CSAH 41 crossing for fish passage.	--	Upgrade crossing at CSAH 41	Upgrade crossing at CSAH 41	# of upgrades	X	X			X				2035
	McCarthy Creek (887)	Lake	--	--	--	Implement recommendations in the Stressor ID (MPCA 2017	Protect critical habitat for steelhead and Brook Trout populations.	--	--	--	--					X				Ongoing
	Stewart Lake (38-0744-00)	Lake	--	TP = 22.9 µg/L	--	See watershed wide strategies (Table 10).														Ongoing
	Paradise Lake (69-0007-00)	St. Louis	--	TP = 18.0 µg/L	--	See watershed wide strategies (Table 10).														Ongoing
	All	St. Louis and Lake	--	--	--	See watershed wide strategies (Table 10).														Ongoing
Gooseberry River – Frontal Lake Superior (0401010202)	Christianson (38-0750-00)	Lake	--	TP = 38.7 µg/L	--	See watershed wide strategies (Table 10).														Ongoing
	Highland (38-0753-00)	Lake	--	TP = 21.7 µg/L	--	See watershed wide strategies (Table 10).														
	All	Lake	--	--	--	See watershed wide strategies (Table 10).														

Protection waters | Restoration waters

4. Monitoring Plan

Monitoring of flow and water quality are needed to refine source assessments, further focus implementation activities identified as part of the watershed approach process, inform protection efforts for all unimpaired uses, and evaluate the effect of improvements for those resources that show declining trends in water quality. New data can also be used to further improve watershed modeling efforts. Monitoring is also a critical component of an adaptive management approach and can be used to help determine when a change in management is needed. This section describes recommended monitoring activities in the watershed, subject to availability of resources and priorities.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction. Accordingly, as a very general guideline, progress benchmarks are established for this watershed that assume improvements will occur resulting in a water quality pollutant concentration decline each year equivalent to approximately 3% to 4% of the starting (i.e., long-term) pollutant concentration. Factors that may mean slower progress include: limits in funding or landowner acceptance, challenging fixes (e.g., unstable bluffs and ravines, invasive species) and unfavorable climatic factors. Conversely, there may be faster progress for some impaired waters, especially where high-impact fixes are slated to occur. Monitoring efforts will also be used to evaluate water quality trends and ensure protection efforts are being effectively implemented.

Existing Monitoring

The MPCA conducted intensive monitoring throughout the watershed during 2010 and 2011 as part of the Watershed Approach. These efforts are summarized in the monitoring and assessment report (MPCA 2014). It is anticipated that the next round of intensive monitoring will begin in 2021. Several other monitoring entities exist within the watershed including:

- SWCDs
- State agencies (e.g., DNR, MDH Beach Program)
- Federal agencies (e.g., EPA, U.S. Department of Agriculture Forest Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey)
- Citizen monitors
- Site-specific monitoring led by the University of Minnesota and special interest groups

Monitoring Needs

- Monitoring of lake clarity and food web dynamics related to invasive species (i.e., zebra mussels)
- Biological surveys and assessments of headwaters of Talmadge River upstream of Lester River Road as recommended in the *LSS Stressor Identification Report* (MPCA 2017).
- Bacterial source tracking for impaired streams and beaches with *E. coli* concerns.
- Additional flow monitoring at all water quality sampling sites.

- Expanded continuous flow monitoring to more tributaries and during winter time periods to improve hydrologic modeling in the watershed, which will in turn improve pollutant loading estimates.
- Assessment of *E. coli* sources in the Skunk Creek Subwatershed, including longitudinal assessment of sources, assessment of wastewater infrastructure and potential for cross connections between sanitary and storm sewers, field evaluation, and compliance inspections for all septic systems in the watershed.
- TSS samples are needed throughout the impaired watersheds to further assess potential sources and focus implementation activities, see the LSS TMDL (Tetra Tech 2018) for more details.
- Complete geomorphic assessments on Little Knife and Skunk Creek to identify sources of sediment.

As implementation activities are conducted in the watershed, an evaluation of the before and after conditions can be useful to aid in future project planning. In addition to flow and water quality monitoring, a broader assessment of ecological function and restoration could be used to assess various components of the stream system and overall effectiveness of the implementation activity.

5. References and Further Information

Cook and Lake Counties Soil and Water Conservation Districts. 2016. One Watershed One Plan for the Lake Superior North Watershed. http://www.co.lake.mn.us/departments/soil_and_water_conservation_district/water_plan.php.

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MPCA (Minnesota Pollution Control Agency). 2016. 2016 Cycle Guidance Manual for Assessing the Quality of MN Surface Waters for Determination of Impairment 305(b) Report and 303(d) List. Minnesota Pollution Control Agency, Saint Paul, MN.

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SSLSWCD (South St. Louis SWCD). 2011. Knife River Implementation Plan for Turbidity: Total Maximum Daily Load. Prepared for the Minnesota Pollution Control Agency, St. Paul, MN. Document number wq-iw10-01c.

Tetra Tech. 2016. Lake Superior North and Lake Superior South Basins Watershed Model Development Report. Prepared for the Minnesota Pollution Control Agency, St. Paul, MN.

Tetra Tech. 2018. Lake Superior South Total Maximum Daily Load Study. Prepared for the Minnesota Pollution Control Agency, Duluth, MN. May 2018.

Lake Superior South Watershed Reports

Many of the Lake Superior South Watershed reports referenced in this watershed report are available at: https://www.pca.state.mn.us/water/watersheds/lake-superior-south

Appendix A – TMDL Summaries

TSS TMDLs

Beaver River (04010102-501)

The load duration curve and TMDL allocations for the Beaver River are presented below. Load reductions are needed under all flow regimes, with the exception of low flows. The largest reductions are needed under very high and high flow conditions.

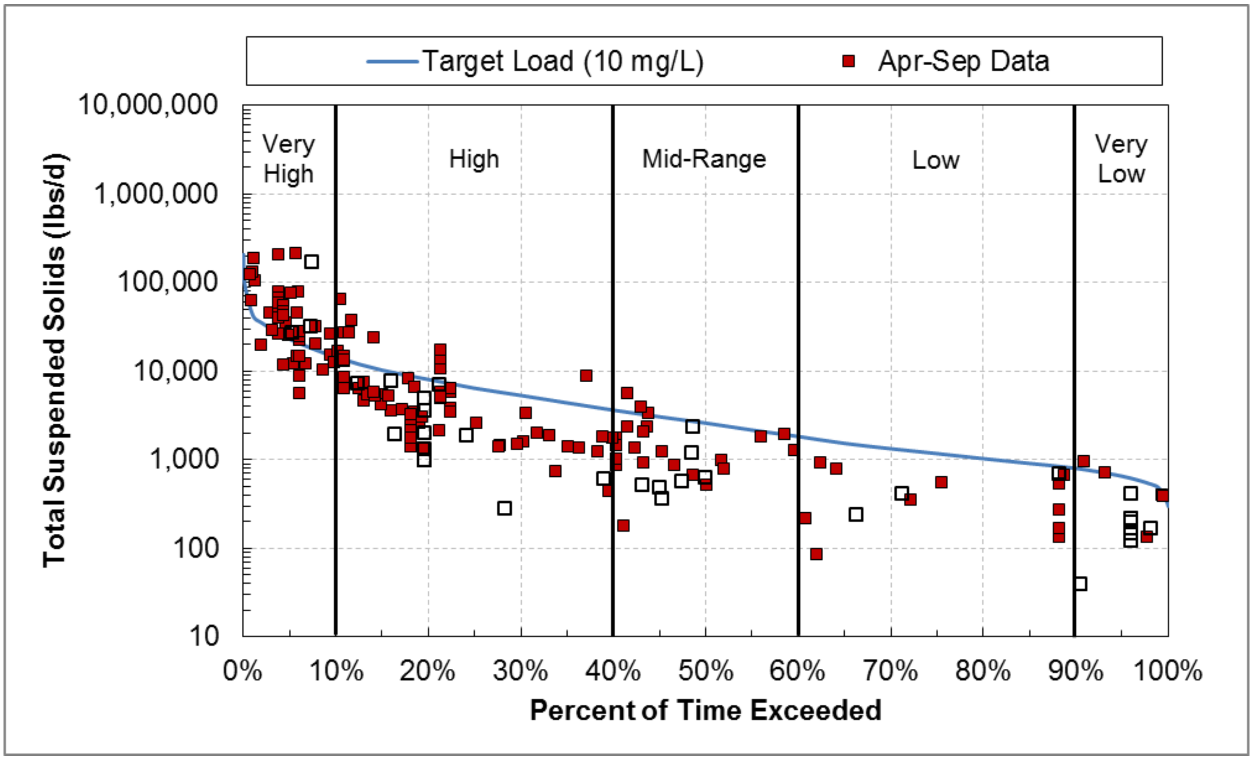

Figure 29. TSS load duration curve, Beaver River (04010102-501).
Hollow points indicate samples during months when the standard does not apply

Table 13. TSS TMDL Summary, Beaver River (04010102-501)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Beaver Bay WWTP (MN0040754) [a]	22	22	22	22	22
	Northshore Mining – Silver Bay (MN0055301) [b]	417	417	417	417	417
	Industrial Stormwater (MNR050000 and MNG490296) [c]	406	107	38	12	3
	Construction Stormwater (MNR100001) [c]	203	53	19	6	1
Load Allocation		19,678	5,184	1,839	600	144
MOS		2,303	643	259	117	65
Loading Capacity		**23,029**	**6,426**	**2,594**	**1,174**	**652**
Existing Load		120,284	16,926	3,039	785	849
Percent Load Reduction		81%	62%	15%	0%	23%

a. The WLA for Beaver Bay WWTP applies from April 1 through September 30. It is assumed that the facility's 30 mg/L TSS effluent limit is sufficient to ensure that effluent NVSS concentrations will not exceed the 10 mg/L inorganic TSS concentration which is the basis for the water quality standard. Effluent monitoring may be required to confirm this assumption.
b. The current permit limit of Northshore Mining–Silver Bay (MN0055301) is based on 20 mg/L TSS, and the WLA is based on 10 mg/L TSS. A WQBEL will need to be considered upon permit reissuance.
c. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

Big Sucker Creek (Sucker River; 04010102-555)

The load duration curve and TMDL allocation for Big Sucker Creek (Sucker River) are presented below. Load reductions are needed under very high and high flow conditions. A large load reduction of 96% is needed under very high flow conditions.

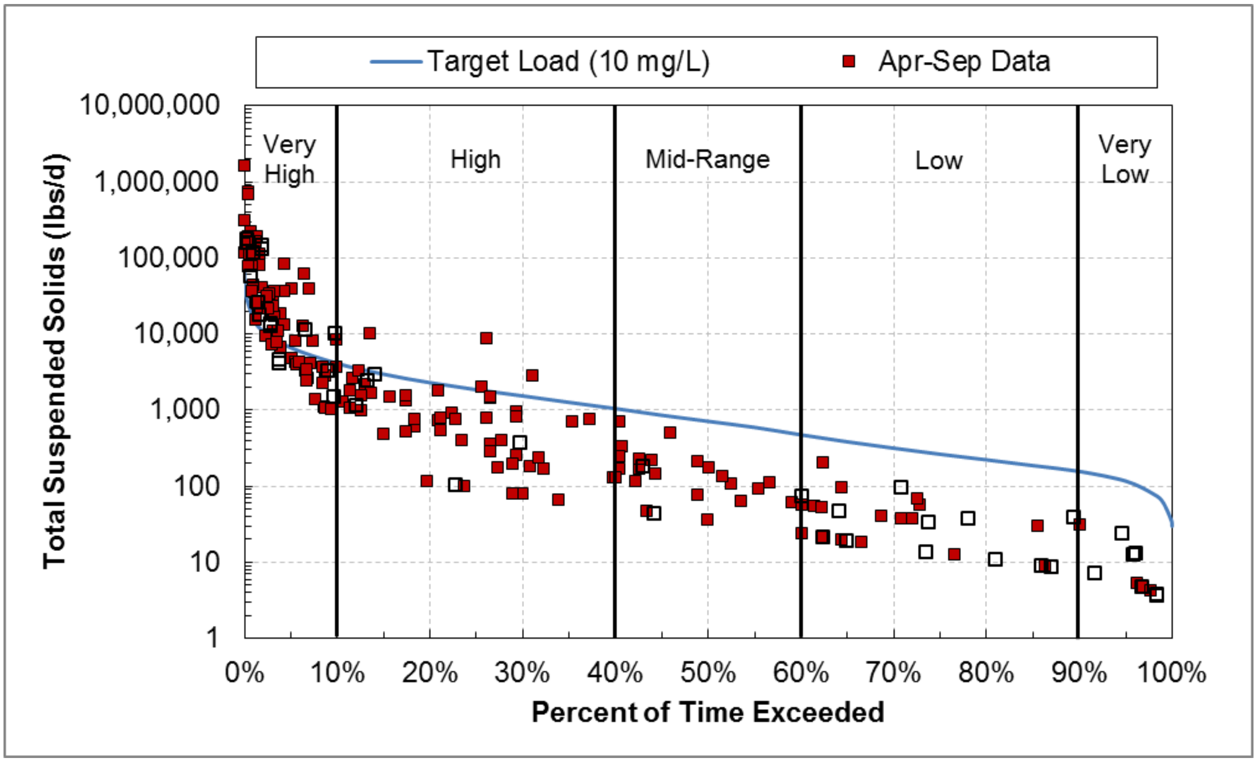

Figure 30. TSS load duration curve, Big Sucker Creek (Sucker River; 04010102-555).
Hollow points indicate samples during months when the standard does not apply

Table 14. TSS TMDL Summary, Big Sucker Creek (Sucker River; 04010102-555)

TMDL Parameter		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Duluth Township MS4 (MS400134)	4	1	0.5	0.2	0.1
	Industrial Stormwater (MNR050000) [a]	119	33	13	5	2
	Construction Stormwater (MNR100001) [a]	60	17	6	2	1
Load Allocation		5,781	1,622	623	231	102
MOS		663	186	71	26	12
Loading Capacity [b]		**6,627**	**1,859**	**714**	**264**	**117**
Existing Load		170,024	2,195	328	77	23
Percent Load Reduction		96%	15%	0%	0%	0%

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.
b. Loading capacity rounded to nearest whole number.

French River (04010102-698)

The load duration curve and TMDL allocation for the French River are presented below. Load reductions are needed under very high and high flow conditions. TSS loads decrease significantly under mid-range and low flow conditions. Samples were not collected under very low flow conditions.

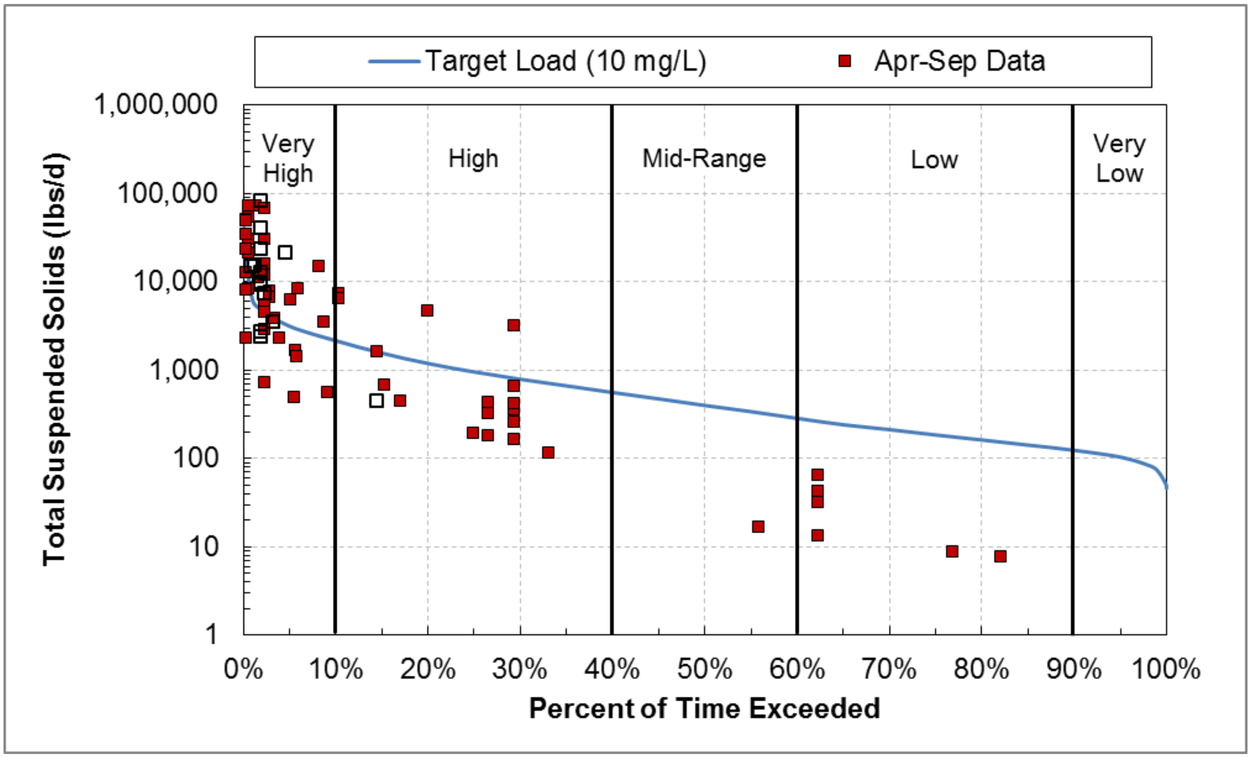

Figure 31. TSS load duration curve, French River (04010102-698).

Hollow points indicate samples during months when the standard does not apply

Table 15. TSS TMDL Summary, French River (04010102-698)

TMDL Parameter		Flow Regime				
		Very High (40–882 cfs)	High (10–40 cfs)	Mid-Range (5–10 cfs)	Low (2–5 cfs)	Very Low (0.9–2 cfs)
		TSS Load (lbs/day)				
Wasteload Allocation	DNR French River Hatchery (MN0004413) [a]	127	127	127	127	– [b]
	Duluth Township MS4	0.3	0.08	0.03	0.004	– [b]
	Industrial Stormwater (MNR050000) [c]	54	15	5	1	– [b]
	Construction Stormwater (MNR100001) [c]	27	7	2	0.4	– [b]
Load Allocation		2,626	712	226	39	– [b]
MOS		315	96	40	18	10
Loading Capacity [d]		**3,149**	**957**	**400**	**185**	**104**
90^{th} Percentile Existing Concentration (mg/L) [e]		61 mg/L				
Overall Estimated Concentration-Based Percent Reduction (%) [f]		84%				

a. The current permit limit of DNR French River Hatchery (MN0004413) is based on 30 mg/L TSS, and the WLA is based on 10 mg/L TSS. A WQBEL will need to be considered upon permit reissuance.
b. Permitted wastewater design flows exceed stream flow in the indicated flow zone. The allocations are expressed as an equation rather than an absolute number: allocation = flow contribution from a given source x 10 mg/L. See *Municipal and Industrial Wastewater* (Section 4.1.1) for more detail.
c. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.
d. Loading capacity rounded to nearest whole number.

e. The existing concentration was calculated as the 90th percentile of observed TSS concentrations from the months that the standard applies (April through September). The 90th percentile was used because the TSS standard states that the numeric criterion (10 mg/L) may be exceeded for no more than 10 percent of the time.
f. The overall estimated concentration-based percent reduction needed to meet the TMDL was calculated as the existing concentration minus the TSS standard (10 mg/L) divided by the existing concentration. This overall reduction provides a rough approximation of the overall reduction needed for the French River to meet the TMDL. It should not be construed to mean that each of the separate sources listed in the TMDL table need to be reduced by that amount.
-: No data

Talmadge River (Talmadge Creek; 04010102-508)

The load duration curve and TMDL allocation for Talmadge River (Talmadge Creek) are presented below. Load reductions are needed under very high and high flow conditions. TSS loads decrease significantly under mid-range and low flow conditions. Samples were not collected under very low flow conditions.

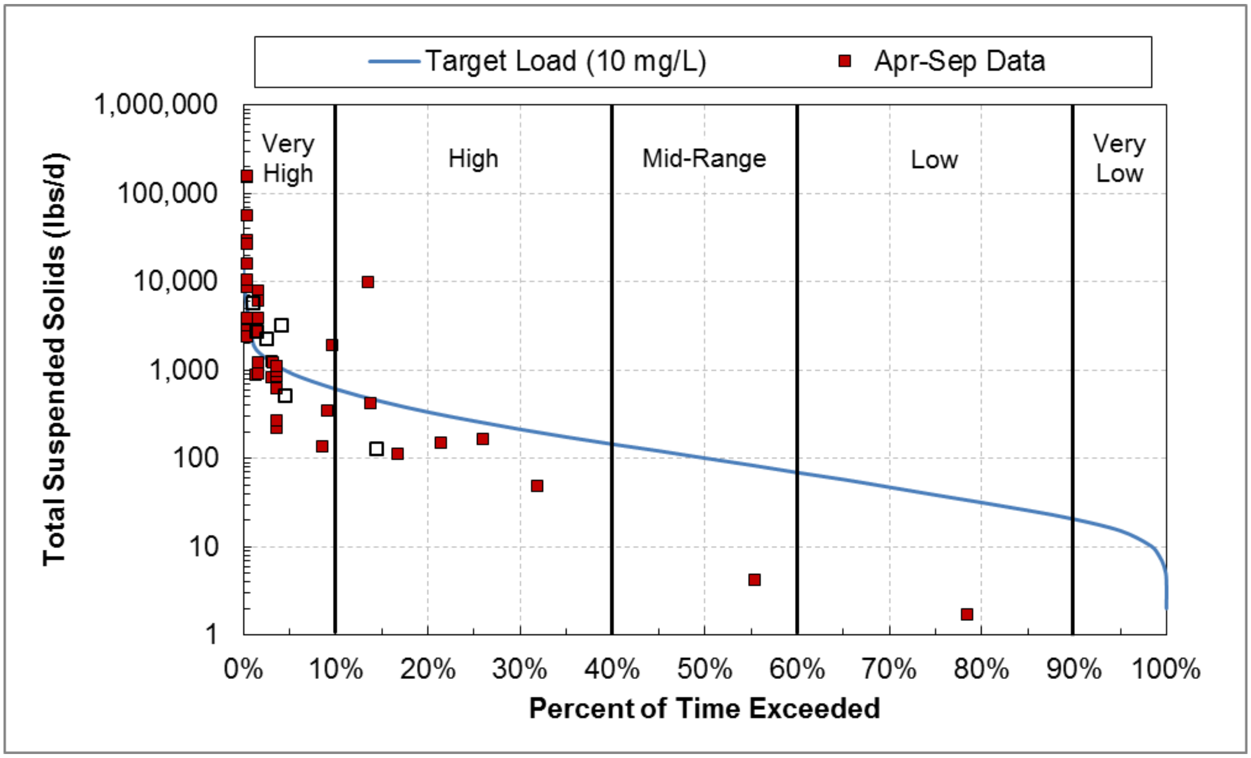

Figure 32. TSS load duration curve, Talmadge River (Talmadge Creek; 04010102-508).
Hollow points indicate samples during months when the standard does not apply

Table 16. TSS TMDL Summary, Talmadge River (Talmadge Creek; 04010102-508)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Industrial Stormwater (MNR050000) [a]	16.9	4.8	1.8	0.7	0.3
	Construction Stormwater (MNR100001) [a]	8.5	2.4	0.9	0.3	0.1
Load Allocation		821.9	231.9	88.4	33.7	13.3
MOS		94.1	26.6	10.1	3.9	1.5
Loading Capacity		**941.4**	**265.7**	**101.2**	**38.6**	**15.2**
Existing Load		28,149.7	5,024.5	4.2	1.7	-
Percent Load Reduction		97%	95%	0% [b]	0% [b]	-

-: No data

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

b. Reductions based on one sample point. Additional sampling is needed to verify existing loads.

Knife River (04010102-504)

The Knife River TMDL was developed in 2010. As described in SSLSWCD (2010):

> *…the loading capacity for the river was only exceeded in the Moist Conditions and High Flow zones of the load duration curve based on the 2004 – 2006 sampling data. A duration curve based on a regression of observed data and corresponding flow values provides an estimated curve of "observed" loads in the river. A comparison of these values against the load duration curve for the TMDL indicates that a load reduction of about 70 to 90 percent for the Moist Conditions and High Flow zones, respectively.*

Table 17. Knife River TMDL summary table (excerpted from SSLSCWD 2010)

Knife River Assimilative Capacity by Flow Zone All values in tons/day					
	High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
TMDL	5.300	0.860	0.270	0.120	0.043
WLA - Construction	0.030	0.0004	0.002	0.001	0.001
WLA – Duluth Township MS4 (Permit # MS400134)	0.427	0.066	0.031	0.011	0.004
LA	2.243	0.344	0.165	0.058	0.021
MOS	2.600	0.450	0.072	0.050	0.017

Little Knife River (East Branch Little Knife River; 04010102-840)

The load duration curve and TMDL allocation for the Little Knife River (East Branch Little Knife River) are presented below. No data collection was completed during the TMDL time period of 2007 through 2016; therefore existing loads and load reductions cannot be calculated. Data collection from 2004 through 2006 was investigated to determine potential reductions needed. Based on the older data, reductions are needed under all flow conditions except the mid-range, with the highest reductions needed under high flow conditions. New monitoring efforts should be completed within the watershed to determine existing loads and needed reductions.

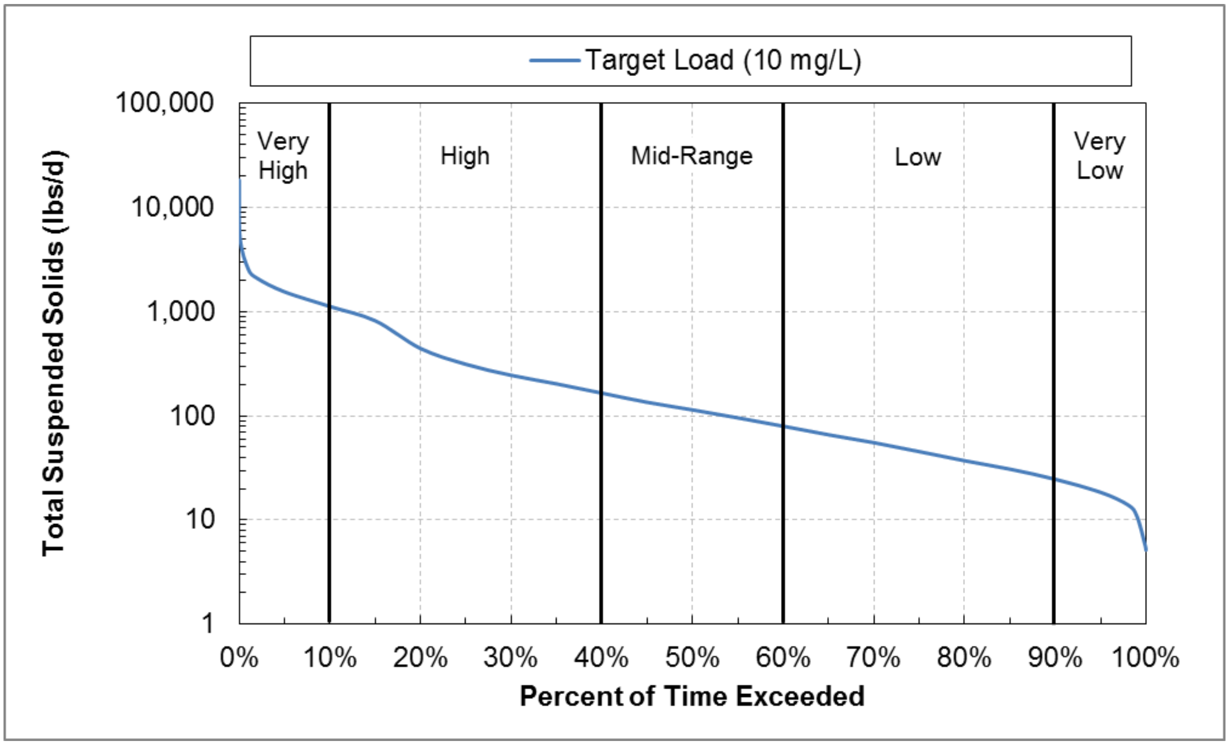

Figure 33. TSS load duration curve, Little Knife River (East Branch Little Knife River; 04010102-840).
Hollow points indicate samples during months when the standard does not apply

Table 18 . TSS TMDL Summary, Little Knife River (East Branch Little Knife River; 04010102-840)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Industrial Stormwater (MNR050000, MNR0539FF, MNG490296, and MNRNE38YB) [a]	28.0	5.6	2.1	0.8	0.3
	Construction Stormwater (MNR100001) [a]	14.0	2.8	1.0	0.4	0.2
Load Allocation		1,360.0	273.7	99.9	39.7	16.1
MOS		155.8	31.3	11.4	4.6	1.9
Loading Capacity		**1,557.8**	**313.4**	**114.4**	**45.5**	**18.5**
Existing Load		-	-	-	-	-
Percent Load Reduction		-	-	-	-	-

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

-: Data not available during the 2007-2016 TMDL time period

Skunk Creek TSS TMDL (04010102-528)

The load duration curve and TMDL allocation for Skunk Creek are presented below. Load reductions are needed under all flow regimes, with the exception of high and mid-range flows. The largest reduction is needed under very high flow conditions.

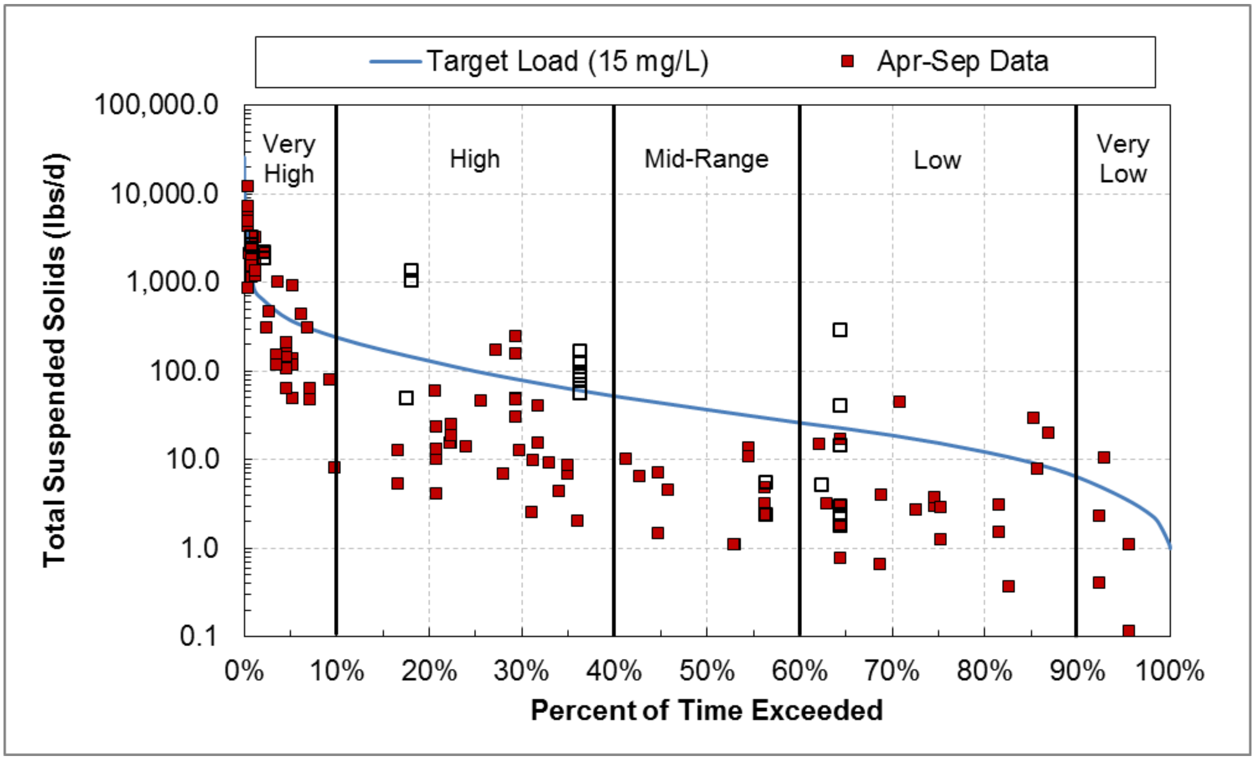

Figure 34. TSS load duration curve, Skunk Creek (04010102-528).
Hollow points indicate samples during months when the standard does not apply

Table 19. TSS TMDL Summary, Skunk Creek (04010102-528)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Industrial Stormwater (MNR050000, MNR053CHH and MNR0539TD) [a]	6.77	1.79	0.66	0.28	0.07
	Construction Stormwater (MNR100001) [a]	3.39	0.90	0.33	0.14	0.03
Load Allocation		328.44	86.87	32.10	13.48	3.21
MOS		37.62	9.95	3.68	1.54	0.37
Loading Capacity		**376.22**	**99.51**	**36.77**	**15.44**	**3.68**
Existing Load		4,179.49	54.42	10.79	20.14	7.23
Percent Load Reduction		91%	0%	0%	23%	49%

a. It is assumed that loads from permitted construction and industrial stormwater sites that operate in compliance with the permits are meeting the WLA.

E. coli TMDL

Skunk Creek *E. coli* TMDL (04010102-528)

The load duration curve and TMDL allocations for Skunk Creek are presented below. Based on the observed geometric mean load, reductions are needed under all flow conditions. The largest load reductions are needed under very high to mid-range flow conditions.

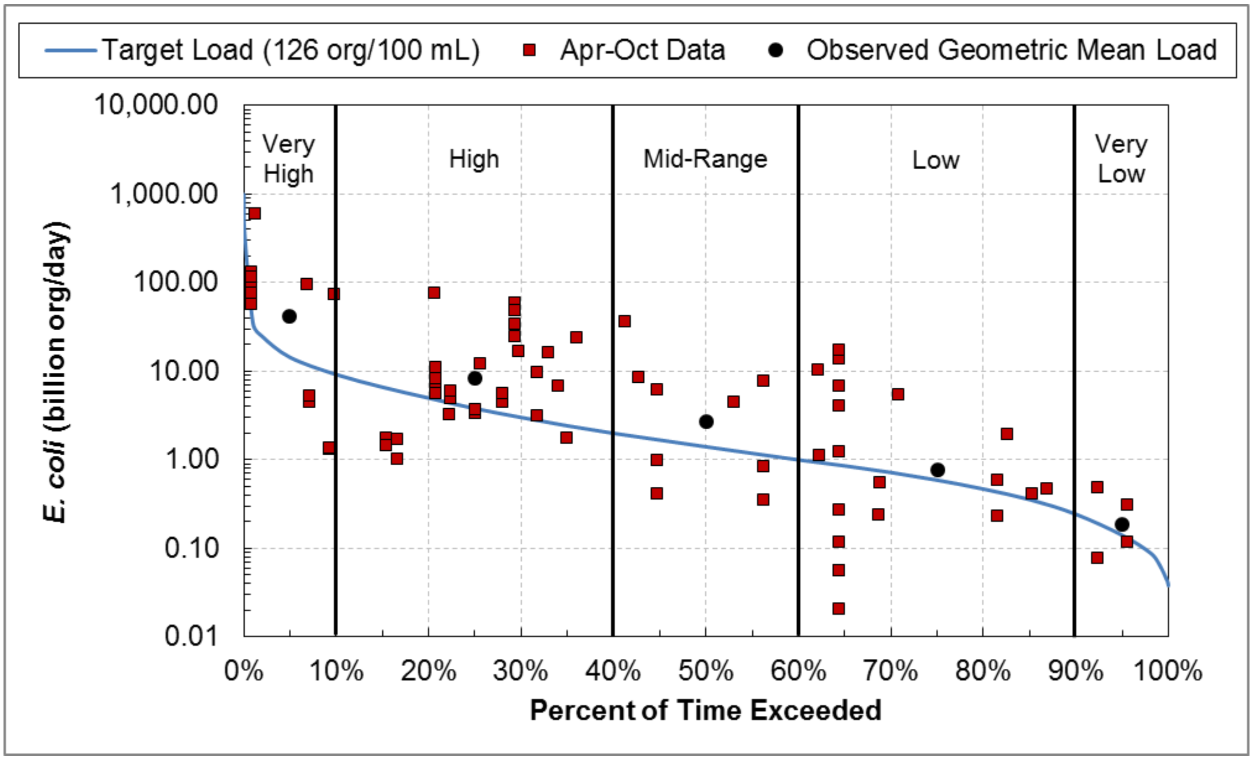

Figure 35. *E. coli* load duration curve, Skunk Creek (04010102-528).

Table 20. *E. coli* TMDL summary, Skunk Creek (04010102-528)

TMDL Parameter	Flow Regime				
	Very High	High	Mid-Range	Low	Very Low
	E. coli Load (billion org/day)				
Load Allocation	12.90	3.41	1.26	0.53	0.13
MOS	1.43	0.38	0.14	0.06	0.01
Loading Capacity	**14.33**	**3.79**	**1.40**	**0.59**	**0.14**
Existing Load	42.05	8.31	2.69	0.78	0.19
Percent Load Reduction	66%	54%	48%	24%	26%