Watershed

March 2021

Final Kettle River and Upper St. Croix River Watershed Restoration and Protection Strategy Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Key terms and abbreviations

Assessment Unit Identifier (AUID): The unique waterbody identifier for each river reach comprised of the U.S. Geological Survey (USGS) eight-digit 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 *E. coli* bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus and either chlorophyll-a or Secchi disc depth standards are not met.

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 St. Croix River Basin is assigned a HUC-4 of 0703 and the Upper St. Croix River Watershed is assigned a HUC-8 of 07030001.

Impairment: Waterbodies 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 nonpollutant 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 Kettle River and Upper St. Croix River watersheds are major watersheds located in east-central Minnesota, in the St. Croix River Basin and in the Northern Lakes and Forests ecoregion. Collectively, these watersheds drain approximately one million acres of land within Minnesota in portions of Carlton, Aitkin, Kanabec, and Pine counties. The dominant land cover in the Kettle River and Upper St. Croix River watersheds is forest and shrub, followed by wetlands. Pastureland, developed land, cultivated cropland, and open water each make up less than 10% of the watersheds. The watersheds are largely undeveloped, but do contain multiple small cities, including Sandstone, Moose Lake, and Hinckley.

The Kettle River and Upper St. Croix River watersheds contain approximately 1,700 miles of streams and rivers. Of these, 115 miles are designated as trout streams and 66 miles are considered exceptional use waters. There are 126 lakes larger than 10 acres located throughout both watersheds. Of these lakes, 17 produce wild rice, a unique resource that Minnesota produces more of than any other state. There are also two lakes (Hanging Horn and Little Hanging Horn) that are designated as cisco refuge lakes, and one lake, Grindstone Lake, that is a coldwater fishery for its ability to support lake trout populations.

From 2016 to 2018, Intensive Watershed Monitoring (IWM) was conducted by the Minnesota Pollution Control Agency (MPCA) to collect data across both watersheds for the purpose of assessing the quality of its natural water resources. Overall, the Kettle River and Upper St. Croix River watersheds have much healthier streams and lakes in comparison to most other watersheds in the state.

Fifty-seven of the 78 stream/river reaches that were assessed were found to fully support aquatic life, and 8 streams fully support aquatic recreation. Twenty streams do not support aquatic life and/or recreation, a majority of which (16 reaches) are in the Kettle River Watershed. Of those, 13 do not support aquatic life and seven do not support aquatic recreation. The streams that do not support recreation are all located in the Kettle River Watershed and show chronically elevated bacteria concentrations.

Thirty-one lakes across both watersheds were assessed as part of the IWM. Of the assessed lakes, 18 fully supported aquatic recreation and 13 did not support aquatic recreation—the aquatic recreation impairment on one lake (Rock Lake) was determined to be due to natural conditions.

Stressor Identification (SID) reports were completed for the stream aquatic life impairments (fish and macroinvertebrate communities) and a Total Maximum Daily Load (TMDL) Study was completed to address the stream and lake aquatic recreation impairments (*E. coli* and lake nutrients) in both watersheds. The SID reports identified connectivity and altered hydrology as the most common stressors to biologic communities. Connectivity stressors include both natural (beaver activity) and anthropogenic (dams, undersized/perched culverts) barriers that disrupt fish passage and connectivity. The primary altered hydrology stressor in these watersheds relates to historical ditching of peatlands, which was fairly common throughout this area, particularly the northwestern portion of the Kettle River Watershed. This ditching has caused and is causing subsequent stressors, including low dissolved oxygen (DO), water highly-stained with dissolved organic compounds, physical damage to the channel via increased erosion, and degradation of habitat by sedimentation and instability of channel features.

Priority areas for this watershed were determined based on input and professional judgement from local partners, previous planning work completed around forest stewardship in the watershed, recreational use priorities, and comparing tool and model output with existing priorities outlined in county water plans. Some of the top priorities that were identified for both watersheds include:

- Protecting and restoring water quality of high recreational use lakes;
- Maximizing existing protected lands and working to expand protection on private land in the Moose River Subwatershed through programs such as Sustainable Forest Incentive Act (SFIA) and conservation easements, and integrating stormwater best management practices (BMPs) whenever possible;
- Protecting and restoring resources in the Grindstone River Subwatershed, which has the largest percentage of rangeland land use and the lowest percentage of wetland land use in the Kettle River Watershed;
- Protecting resources with rare/sensitive species and high biological integrity, including lake sturgeon, cisco (Hanging Horn and Little Hanging Horn Lakes), and coldwater fish species such as brook, brown, and rainbow trout; and
- Protecting water quality and water levels in lakes that support wild rice.

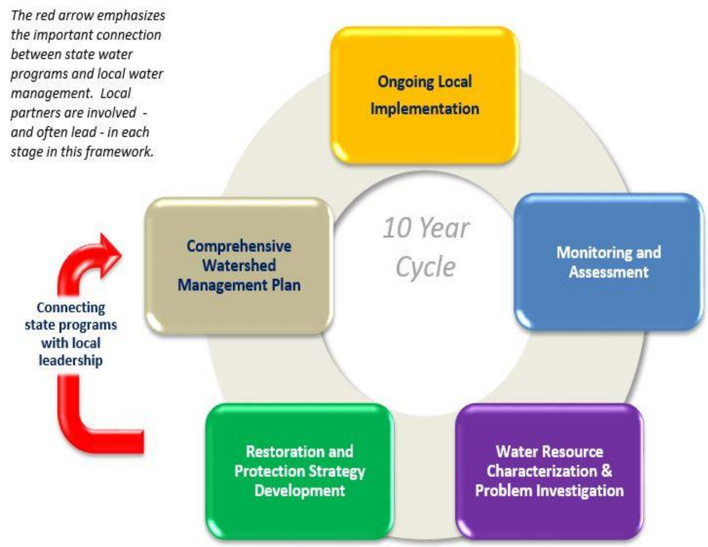
Restoration strategies for addressing the identified issues in the Kettle and Upper St. Croix River SID and TMDL reports include: addressing culverts/dams and other fish passage barriers, restoring ditched wetlands and altered stream hydrology, livestock and manure management, addressing failing septic systems in shoreland areas, and investigating and managing internal loading in certain lakes. Strategies were also identified for lakes and streams that are currently meeting water quality to maintain and improve current conditions and protect these resources from becoming degraded or impaired. Some of the protection strategies presented in this report include: promoting shoreland protection, implementing programs for forest protection, aquatic invasive species (AIS) prevention and management, managing in-lake plant and fish communities, and expanded monitoring to better assess priority resources and track potential changes and trends over time. Specific locations of resource vulnerability are identified in this report and should be used to guide this process.

This Watershed Restoration and Protection Strategy (WRAPS) document is meant to serve as a foundation of technical information that can be used to assist in development of tools and prioritization of water quality efforts by local governments, landowners, and other stakeholder groups. The information can be used to determine what strategies will be best to make improvements and protect good quality water resources, as well as focus those strategies to targeted locations.

The topics of each chapter of this report are:

- **Chapter 1** provides background information on the Kettle River and Upper St. Croix River watersheds;
- **Chapter 2** details watershed conditions based on results from IWM, SID, and TMDL calculations;
- **Chapter 3** summarizes priority areas for targeting actions to improve water quality, and geographically locates where watershed restoration and protection actions should take place; and
- **Chapter 4** documents a monitoring plan necessary to assess conditions in both watersheds.

What is the WRAPS report?



Minnesota has adopted a watershed approach to address the health of aquatic ecosystems in the state's 80 major watersheds. The Minnesota 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 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. The 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 TMDL studies are developed for them. The TMDLs are incorporated into the WRAPS reports. 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 models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, the WRAPS report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans.

Purpose

- Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning
- Summarize watershed approach work done to date including the following reports:
  - *Kettle and Upper St. Croix River Watershed Monitoring and Assessments*
  - *Kettle and Upper St. Croix River Watershed Biotic Stressor Identifications*
  - *Kettle and Upper St. Croix River Watershed Total Maximum Daily Load*

Scope

- Impacts to aquatic recreation and impacts to aquatic life in streams
- Impacts to aquatic recreation in lakes

Audience

- Local working groups (local governments, SWCDs, watershed management groups, etc.)
- State agencies (MPCA, DNR, BWSR, etc.)

1. Watershed background and description

The Kettle River and Upper St. Croix River watersheds are adjacent watersheds located in east central Minnesota, with the majority of the Upper St. Croix River Watershed located in neighboring Wisconsin. The Kettle River Watershed is approximately 673,000 acres, while the portion of the Upper St. Croix River Watershed in Minnesota is about half this size, at approximately 348,000 acres. This report only addresses the Minnesota portion of the Upper St. Croix River Watershed. Both watersheds are located in the Northern Lakes and Forest level III ecoregion, except a sliver of the Kettle River Watershed, which is located in the Northern Central Hardwood Forest level III ecoregion.

Both the Kettle River and Upper St. Croix River watersheds drain south into the St. Croix River. The Kettle River Watershed consists of six HUC-10 subwatersheds that generally drain east and west into the Kettle River, which runs from north to south until its confluence with the St. Croix River. Main streams within the Kettle River Watershed, besides the Kettle River, include the Moose Horn River, the Willow River, the Pine River, and the Grindstone River. The watershed also contains 126 lakes greater than 10 acres, 12 of which are listed by the state as impaired by nutrients. The Kettle River Watershed is located mostly within Pine and Carlton Counties (53% and 34% of the watershed, respectively), with small portions in Aitkin and Kanabec Counties (10% and 3%, respectively). The watershed covers 44 townships, 13 cities, and 1 unorganized territory. Cities include Hinckley, Sandstone, and Moose Lake. Interstate-35 roughly bisects the watershed.

The Upper St. Croix River Watershed consists of six HUC-10 subwatersheds that drain directly or almost directly into the St. Croix River. Main streams within the Upper St. Croix River Watershed include the Upper Tamarack River, the Lower Tamarack River, Crooked Creek, Sand Creek, Bear Creek, McDermott Creek, Hay Creek, and Sucker Creek. The Upper St. Croix River Watershed is located entirely in Pine County and is predominately rural, draining only 19 townships and one city (Askov). The Nemadji and St. Croix State Forests are both located within the Upper St. Croix Watershed.

Land cover in both watersheds consists largely of wetlands and forest, with some agricultural land. Both emergent and forested wetlands are abundant, although some have been ditched or altered. Forests contain a mixture of pine trees and hardwoods. Agricultural land is mostly hay fields for pasture, with some small fields of row crops. Feedlots are also scattered across the watershed. Prior to European settlement in the area, the landscape consisted almost exclusively of forests, wetlands and lakes. However, most of the original, old-growth forests were cleared in the second half of the 19th century, when the timber industry made its way to the region, attracted by the abundant pine trees for which Pine County is named. Much of this harvested land has since been re-forested, but with obviously younger forests.

Several studies, reports and plans have been written on the Kettle River and Upper St. Croix River watersheds. The MPCA has recently published monitoring reports for both watersheds: the Upper St. Croix River Monitoring and Assessment Report was published in May 2019 and the Kettle River Watershed Monitoring and Assessment Report was published in in October 2019. The Kettle River and Upper St. Croix River Watershed SID Reports were published in April 2020. The Kettle River and Upper St. Croix River Watersheds TMDL Study was completed in January 2021. In addition to these recent resources, the Minnesota Forest Resources Council published the Kettle River Landscape Stewardship Plan (KRWLSP) in April 2014 (Section 2.5).

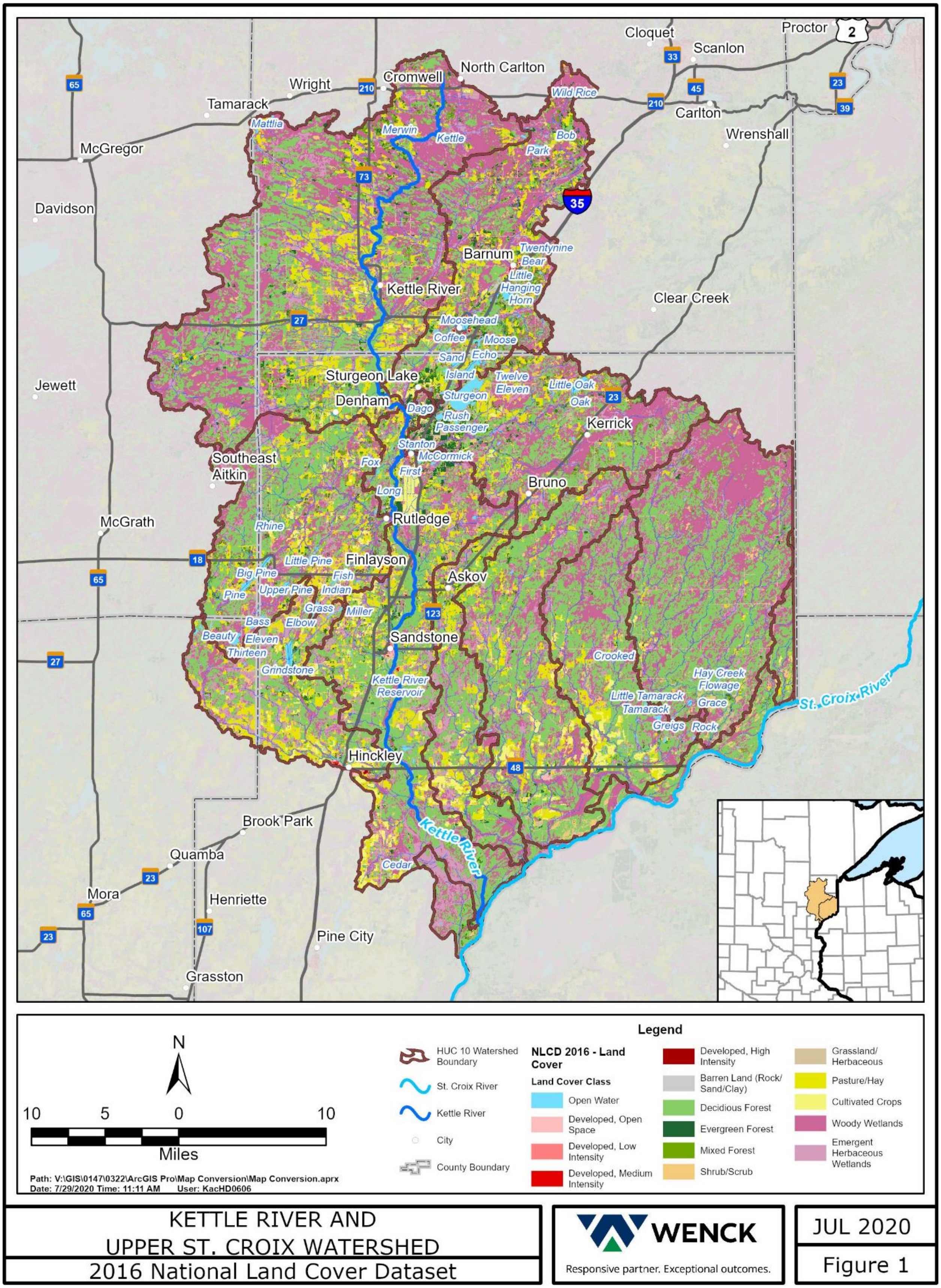


Figure 1: Land cover in the Kettle River and Upper St. Croix River Watersheds

Additional Kettle River and Upper St. Croix River Watersheds Resources

Aitkin County Water Management Plan: https://aitkincountyswcd.files.wordpress.com/2020/02/waterplan6-24-09-1.pdf

Local Watershed Management Plan: http://www.co.carlton.mn.us/ArchiveCenter/ViewFile/Item/58

Kanabec County Water Plan 2019-2028: http://www.kanabecswcd.org/wp-content/uploads/2019/02/2019-WP-draft-2-022619.pdf

Kettle River Watershed Landscape Stewardship Plan (KRWLSP): https://mn.gov/frc/docs/KettleRiverWatershed_LSP_April2014.pdf

Kettle River Watershed Monitoring and Assessment Report: https://www.pca.state.mn.us/sites/default/files/wq-ws3-07030003b.pdf

Kettle River and Upper St. Croix River Watersheds Total Maximum Daily Load (TMDL) Study for Total Phosphorus and Bacteria: https://www.pca.state.mn.us/water/watersheds/kettle-river

https://www.pca.state.mn.us/water/watersheds/upper-st-croix-river

Kettle River Watershed Stressor Identification Report: https://www.pca.state.mn.us/sites/default/files/wq-ws5-07030003.pdf

Lake Reports for Selected Lakes in Pine County (Upper Pine, Grace, Bass, Island, Long, Sturgeon, Oak, Big Pine, Tamarack, Grindstone, and county-wide watershed summary): https://www.pineswcd.com/?SEC=31A23F2C-06A5-4B4D-A15F-7F76BC375B83 (individual lakes), https://www.pineswcd.com/index.asp?SEC=207B7C60-44D4-4C0E-B24F-70C39200B2B9 (county-wide watershed summary)

Lake Reports for Selected Lakes in Carlton County (Bear, Eddy, Hanging Horn, Little Hanging Horn, Moosehead, Park, and county-wide watershed summary): https://carltonswcd.org/kettle-river-watershed

Minnesota Department of Natural Resources (DNR) Kettle River Watershed Context Report: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_35.pdf

Minnesota Department of Natural Resources (DNR) Upper St. Croix River Watershed Context Report: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_34.pdf

Minnesota Department of Natural Resources (DNR) Watershed Health and Assessment Framework (WHAF) Kettle River Watershed Report Card: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_35.pdf

Minnesota Department of Natural Resources (DNR) Watershed Health and Assessment Framework (WHAF) Upper St. Croix River Watershed Report Card: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_34.pdf

Minnesota Nutrient Planning Portal for Kettle River Watershed: https://mrbdc.mnsu.edu/mnnutrients/watersheds/kettle-river-watershed

Minnesota Nutrient Planning Portal for Upper St. Croix River Watershed: https://mrbdc.mnsu.edu/mnnutrients/watersheds/upper-st-croix-river-watershed

Pine County Local Water Management Plan: https://www.co.pine.mn.us/document_center/Departments/planning%20and%20zoning/Pine%20County%20Water%20Management%20Plan.pdf

Upper St. Croix River Monitoring and Assessment Report: https://www.pca.state.mn.us/sites/default/files/wq-ws3-07030001.pdf

Upper St. Croix River Stressor Identification Report: https://www.pca.state.mn.us/sites/default/files/wq-ws5-07030001.pdf

2. Watershed conditions

IWM was conducted in the Kettle River and Upper St. Croix River watersheds in 2016 and 2017 to determine the overall health of water resources, identify impaired waters, and identify waters in need of additional protection. Data from this IWM was combined with other available data collected within the last 10 years and used to assess waterbody health. In general, IWM results showed that most of the lakes and streams in the Kettle River and Upper St. Croix River watersheds are categorized as good to great. These results are summarized in the following sections, but more detailed results can be found in the *Kettle River Watershed Monitoring and Assessment Report* (MPCA 2019a) and the *Upper St. Croix River Watershed Monitoring and Assessment Report* (MPCA 2019b). The MPCA also developed biological SID reports for both watersheds (MPCA 2020a and MPCA 2020b). Results from these SID reports were incorporated into this report to capture the existing condition of the watershed, as well as the primary stressors to watershed resources.

Both the Kettle River and Upper St. Croix River watersheds have been divided into six HUC-10 subwatersheds in this WRAPS (Figure 2).

2.1 Condition status

This report addresses waters for protection or restoration of aquatic life uses based on the fishery, macroinvertebrate community, and DO concentration, and for aquatic recreation uses based on bacteria levels or nutrient levels and water clarity. Waters that are listed as impaired are addressed through restoration strategies and/or a defined TMDL study. Waters with biological impairments were investigated through SID work and are addressed through restoration strategies described in this report. Waters that are not impaired are addressed through protection strategies to help maintain water quality and recreation opportunities, and reverse downward trends (see Section 3.3).

The main stem Kettle and St. Croix Rivers and several lakes in the Kettle River and Upper St. Croix River watersheds have aquatic consumption impairments due to high levels of mercury (Table 1); however, this WRAPS report does not cover toxic pollutants, such as mercury and polychlorinated biphenyls (PCBs). Of the waters identified as impaired by mercury in fish tissue, 11—including the main stem St. Croix River—were included in the *Minnesota Statewide Mercury TMDL* in 2020 (MPCA 2007, MPCA 2019c). The MPCA is developing an approach to address the remaining mercury impairments that do not qualify for inclusion in the Minnesota Statewide Mercury TMDL, starting with the St. Louis River Watershed. In time, this work will expand to include other watersheds, including the Kettle River Watershed. Developing the TMDLs for mercury in these impaired waters requires a better understanding of the watershed processes that convert inorganic mercury to methylmercury. The MPCA has completed some studies and is working with the USGS as they study the effects of ditched peatland restoration on mercury and methylmercury loading in the St. Louis River Watershed, which borders the Kettle River Watershed to the north and is also located in the Northern Lakes and Forests Ecoregion. Both the Kettle River and St. Louis River watersheds contain ditched peatlands, which are believed to be a large source of mercury and methylmercury loading. While this WRAPS report does not cover toxic pollutants, BMPs to reduce soil erosion or total suspended solids (TSS) would likely also reduce total mercury releases to receiving waters because most inorganic mercury is bound to soils. The MPCA managed a research study in 2015 through 2017 on mercury loading, methylation, and food web uptake in mercury-impaired rivers not covered by the Minnesota Statewide Mercury TMDL, and when data analysis and report writing are complete, the study's results will inform future work on these impairments.

For more information on mercury impairments, see the statewide mercury TMDL on the MPCA website at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction-plan.html.

Table 1: Summary of mercury impairments in the Kettle River and Upper St. Croix River watersheds (Draft Minnesota 2020 303(d) list).

Stream or Lake	Major Watershed	AUID	Year added to 303(d) list	Included in 2020 Mercury TMDL? [a]
St Croix River (MN/WI border to Snake R)	Upper St. Croix	07030001-619	1998	**Yes**
Tamarack	Upper St. Croix	58-0024-00	1998	**Yes**
Park	Kettle	09-0029-00	2002	**Yes**
Little Hanging Horn	Kettle	09-0035-00	2002	**Yes**
Oak	Kettle	58-0048-00	2012	**Yes**
Sturgeon	Kettle	58-0067-00	1998	**Yes**
Sand	Kettle	58-0081-00	2014	**Yes**
Long	Kettle	58-0107-00	2002	**Yes**
Grindstone	Kettle	58-0123-00	2014	**Yes**
Upper Pine	Kettle	58-0130-00	1998	**Yes**
Big Pine	Kettle	58-0138-00	1998	**Yes**
Kettle River (Grindstone R to St Croix R)	Kettle	07030003-502	1998	no–target TMDL completion date 2033
Kettle River (Willow R to Pine R)	Kettle	07030003-503	1998	no–target TMDL completion date 2033
Kettle River (Moose Horn R to Willow R)	Kettle	07030003-505	1998	no–target TMDL completion date 2033
Kettle River (Birch Cr to Moose Horn R)	Kettle	07030003-506	1998	no–target TMDL completion date 2033
Kettle River (Gillespie Bk to Split Rock R)	Kettle	07030003-508	1998	no–target TMDL completion date 2033
Kettle River (Dead Moose R to Gillespie Bk)	Kettle	07030003-510	1998	no–target TMDL completion date 2033
Kettle River (Headwaters to W Br Kettle R)	Kettle	07030003-511	1998	no–target TMDL completion date 2033
Kettle River (Skunk Cr to Grindstone R)	Kettle	07030003-517	1998	no–target TMDL completion date 2033
Kettle River (Former Dam (at Sandstone) to Skunk Cr)	Kettle	07030003-519	1998	no–target TMDL completion date 2033
Kettle River (Pine R to former Dam (at Sandstone))	Kettle	07030003-528	1998	no–target TMDL completion date 2033
Kettle River (W Br Kettle R to Dead Moose R)	Kettle	07030003-529	1998	no–target TMDL completion date 2033

Stream or Lake	Major Watershed	AUID	Year added to 303(d) list	Included in 2020 Mercury TMDL? [a]
Kettle River (Split Rock R to Carlton/Pine County line)	Kettle	07030003-551	1998	no–target TMDL completion date 2033
Kettle River (Carlton/Pine County line to Birch Cr)	Kettle	07030003-552	1998	no–target TMDL completion date 2033
Hanging Horn	Kettle	09-0038-00	1998	no–target TMDL completion date 2033
Eddy	Kettle	09-0039-00	2002	no–target TMDL completion date 2033
Bass	Kettle	58-0128-00	1998	no–target TMDL completion date 2033
Moosehead	Kettle	09-0041-00	2010	no–target TMDL completion date 2023

[a] Revisions to the statewide mercury TMDL are submitted to the EPA every two years. See the draft 2020 impaired waters list for more information: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

In addition to mercury in fish tissue, the main stem St. Croix River also has an aquatic consumption impairment for PCBs in fish tissue. As PCBs were banned in the United States in 1979 (EPA 1979), it is most likely that the PCBs contributing to the impairment in the St. Croix River are from legacy sources. Fish absorb PCBs, which are fat-soluble compounds that do not break down readily—they remain in water and sediments for years (MDH 2020). The Minnesota Department of Health (MDH) has issued Safe-Eating Guidelines for fish caught from the St. Croix River, which are available online: https://www.health.state.mn.us/communities/environment/fish/index.html. As mentioned earlier, the TMDLs developed as part of this WRAPS project do not address toxic pollutants, so PCBs are not addressed directly through the restoration and protection strategies outlined in this report. Testing of fish tissues for PCBs has been completed for eight lakes within the Kettle River and Upper St. Croix River watersheds, with none of these samples resulting in detectable levels of PCBs; this suggests that contamination from PCBs is an isolated issue in these watersheds. Generally, contamination from PCBs is confined to major rivers with a history of wastewater discharge and a few lakes affected by legacy industrial wastes.

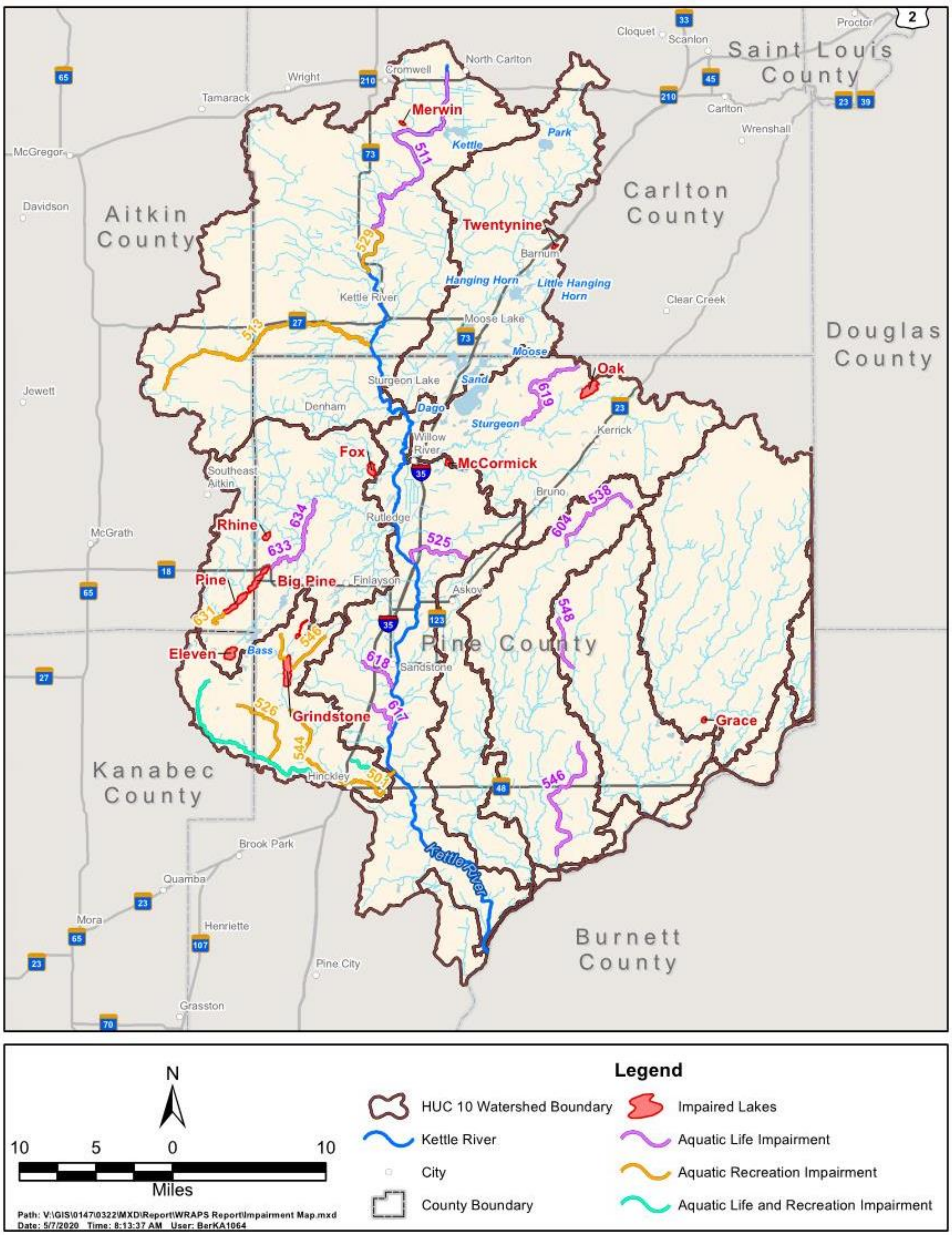


Figure 2: Impairments in the Kettle River and Upper St. Croix River watersheds; note that this map does not include aquatic consumption impairments

Streams

Seventy-eight of the 231 stream/river reaches with unique Waterbody Identification Numbers (WIDs) in the Kettle River and Upper St. Croix River watersheds have been assessed through 2017 (Tables 2 and 3). Seventy stream/river reaches were found to fully support aquatic life, and six streams fully support aquatic recreation. Twenty-one streams do not support aquatic life and/or recreation, a majority of which (17 reaches) are in the Kettle River Watershed. Of those, 13 do not support aquatic life and 10 do not support aquatic recreation. The streams that do not support recreation are all located in the Kettle River Watershed and show chronically elevated bacteria concentrations.

The following tables provide a general summary of the assessment results for the Kettle River and Upper St. Croix River watersheds. A complete list of the results of the stream assessments, which includes all available data on the stream reaches within each watershed, can be found in the Watershed Monitoring and Assessment Reports (MPCA 2019a and MPCA 2019b).

Table 2: Assessment status of river and stream reaches in the Kettle River Watershed, presented (mostly) from north to south.

HUC-10 Subwatershed	# Total WIDs	# Assessed WIDs	Aquatic Life Use		Aquatic Recreation Use		IF
			FS	NS	FS	NS	
Upper Kettle River	36	11	10	1	0	2	1
Moose River	14	7	7	0	1	0	0
Willow River	9	5	9	1	1	0	0
Pine River	22	7	22	0	1	0	3
Grindstone River	19	6	19	1	0	6	4
Lower Kettle River	23	7	3	3	3	0	1

FS = fully supporting, i.e., found to meet the water quality standard; NS = not supporting, i.e., does not meet the water quality standard, and therefore, is impaired; IF = insufficient data, i.e., the data collected was insufficient to make a finding; NA = not assessed.

Table 3: Assessment status of river and stream reaches in the Upper St. Croix River Watershed, presented (mostly) from west to east.

HUC-10 Subwatershed	# Total WIDs	# Assessed WIDs	Aquatic Life Use		Aquatic Recreation Use		IF
			FS	NS	FS	NS	
Bear Creek	12	2	2	0	0	0	1
Sand Creek	36	11	7	3	0	0	2
Crooked Creek	32	9	6	1	0	0	3
Lower Tamarack River	14	9	7	0	0	0	5
Upper Tamarack River	3	2	2	0	0	0	1
Chases Brook – St. Croix River	5	1	1	0	0	0	0

FS = fully supporting, i.e., found to meet the water quality standard; NS = not supporting, i.e., does not meet the water quality standard, and therefore, is impaired; IF = insufficient data, i.e., the data collected was insufficient to make a finding; NA = not assessed.

Lakes

Lakes are assessed for aquatic recreation uses based on ecoregion specific water quality standards for total phosphorus (TP), chlorophyll-a (chl-*a*) (i.e., the green pigment found in algae), and Secchi transparency depth. To be listed as impaired, a lake must fail to meet water quality standards for TP and either chl-*a* or secchi depth.

The Kettle River and Upper St. Croix River watersheds have several lakes with good to excellent water quality. All lakes were assessed against standards for aquatic recreation that are designed to protect lakes in the NLF Ecoregion; lakes with stream trout or lake trout populations (e.g. Grindstone Lake) were held to standards that are more stringent to protect those sensitive fish populations.

There are 126 lake basins in the Kettle River and Upper St. Croix River watersheds that have surface areas greater than 10 acres. Of these lake basins, 30 had enough water quality information to conduct a formal assessment of aquatic recreation. Eighteen lakes fully supported aquatic recreation and 12 did not support aquatic recreation (Tables 4 and 5). In the Upper St. Croix River Watershed, the impairment on Rock Lake was determined to be due to natural conditions, and therefore was not included in the TMDL report.

Since 2013, the MPCA in coordination with the DNR has substantially increased the use of biological monitoring and assessment as a means to determine and report the condition of the state's lakes. This includes sampling fish communities of multiple lakes throughout a major watershed. The fish-based lake Index of Biotic Integrity (FIBI) utilizes data from trap net and gill net surveys, which focus on the gamefish community, as well as nearshore surveys which focus on the nongame-fish community. From this data, a FIBI score can be calculated, which provides a measure of overall fish community health. The DNR developed four FIBI tools to assess many different types of lakes throughout the state. More information on the FIBI can be found at the DNR Lake Index of Biological Integrity website. (http://www.dnr.state.mn.us/waters/surfacewater_section/lake_ibi/index.html).

When biological impairments are found, stressors to the aquatic community must be identified. Nine lakes were assessed by the DNR using the FIBI in the Kettle River Watershed. No lakes in the Upper St. Croix River Watershed have been assessed using the FIBI. Of the nine lakes assessed in the Kettle River Watershed, only one lake (Oak Lake) failed to meet the aquatic life standards.

Tables 4 and 5 below summarizes the ability of the assessed lakes to support aquatic recreation uses and aquatic life in the Kettle River and Upper St. Croix River watersheds. A complete list of the results of the lake assessments can be found in the Watershed Monitoring and Assessment Reports (MPCA 2019a and MPCA 2019b).

Table 4: Assessment status of the lakes in the Kettle River Watershed, presented generally from north to south.

HUC-10 Subwatershed	Lakes >10 Acres	Aquatic Life Use		Aquatic Recreation Use		IF
		FS	NS	FS	NS	
Upper Kettle River	9	-	-	-	1	3
Moose River	27	3	-	9	1	14
Willow River	22	1	1	3	1	3
Pine River	23	3	-	3	5	5
Grindstone River	16	1	-	1	2	3
Lower Kettle River	22	-	-	-	1	4

FS = fully supporting, i.e., found to meet the water quality standard; NS = not supporting, i.e., does not meet the water quality standard, and therefore, is impaired; IF = insufficient data, i.e., the data collected was insufficient to make a finding.

Table 5: Assessment status of the lakes in the Upper St. Croix River Watershed, presented generally from west to east.

HUC-10 Subwatershed	Lakes >10 Acres	Aquatic Life Use		Aquatic Recreation Use		IF	
		FS	NS	FS	NS		
Bear Creek	0	--	--	--	--	--	
Sand Creek	1	0	0	0	0	1	
Crooked Creek	3	0	0	2	0	1	
Lower Tamarack River	3	0	0	0	2	1	
Upper Tamarack River	0	--	--	--	--	--	
Chases Brook – St. Croix River	0	--	--	--	--	--	

FS = fully supporting, i.e., found to meet the water quality standard; NS = not supporting, i.e., does not meet the water quality standard, and therefore, is impaired; IF = insufficient data, i.e., the data collected was insufficient to make a finding.

2.2 Water quality trends

Year-to-year weather variations affect water quality data; for this reason, analyzing long term data trends is important for gaining insight into changes occurring in a water body over time. In a 2014 MPCA statewide river monitoring report (MPCA 2014), Kettle River water chemistry data was analyzed for trends (Table 6) for both the long-term period of record (1967 through 2009) and recent trends (1995 through 2009). The long-term record indicates that there have been significant decreases in TSS, TP, ammonia, and biological oxygen demand, likely due to wastewater treatment upgrades. However, there have been increases in nitrates/nitrites (NO_3+NO_2) and chloride, although average concentrations of these parameters are quite low compared to other watersheds in the state, and the river still meets water quality standards.

Table 6: Water quality trends of the Kettle River near Hinckley (bridge on MN-48).
Note: Green values indicate an improving trend in water quality for that parameter while red values indicate a degrading trend in water quality for that parameter.

Parameter	Long-term trend (1967-2009)	Recent trend (1995-2009)
Total suspended solids	Decrease (-58%)	No trend
Total phosphorus	Decrease (-45%)	No trend
Nitrite/Nitrate	No trend	Increase (+46%)
Ammonia	Decrease (-83%)	No trend
Biochemical oxygen demand	Decrease (-63%)	No trend
Chloride	Increase (+159%)	Little data

In 2010, the MPCA initiated the Watershed Pollutant Load Monitoring Network (WPLMN). There are two long-term monitoring locations in the Kettle River Watershed. Users can access this data via the WPLMN browser, which shows the location of long-term monitoring sites throughout the state. It includes links to the MPCA's Environmental Data Access portal that contains all monitoring data for the entire period of record, including more recent data through 2019. When compared to the other basin and major watershed sites within the Saint Croix River Basin, the average annual TP flow-weighted mean concentrations (FWMCs) for the Kettle River are slightly elevated. Average annual TSS and NO_3+NO_2 FWMCs for the Kettle River are relatively low, as they are throughout the rest of the Saint Croix River

Basin. When compared to other basin and major watershed sites throughout Minnesota, average annual TSS, TP, and NO_3+NO_2 FWMCs for the Kettle River are lower than most. See discussion on Page 67 of the Kettle River Watershed Monitoring and Assessment Report for more information on results of the WPLMN for Kettle River.

The MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. These transparency measurements are important indicators of lake and stream health. Water clarity signifies the amount of algae or sediment in the water, which can affect plant, insect, and fish communities and impact recreational opportunities. The data collection for this work relies heavily on volunteers across the state and also incorporates any agency and partner data submitted to EQuIS. The calculated trends use a Seasonal Kendall statistical test for waters with a minimum of eight years of Secchi disk measurement in lakes and Secchi tube measurements in streams. The data that appears in this report is from the annual 2019 analysis, while the data in the Monitoring and Assessment Reports are based on analysis from 2018 data.

Citizen volunteer monitoring occurs at 22 stream locations and on 43 lakes in the Kettle River and Upper St. Croix River watersheds. There is strong evidence of a watershed-wide increasing (improving) trend in transparency based on stream measurements. Many volunteer-monitored lakes do not yet have enough data (or sufficient coverage) for watershed wide trend analysis, but individual lake analyses show that the number of increasing trends outnumber decreasing trends. Of the 19 lakes with enough data to be analyzed for trends in observed water clarity, four show an improving trend, one shows a degrading trend, five show no change, and nine lakes show no trend. Table 7 shows the lakes with improving and degrading trends in the watersheds. Of the 22 stream sites with sufficient data records to evaluate trends, three sites show an improving trend, one site shows a degrading trend, one site shows no change, four show no trend, and 13 are too clear (Secchi tube >100cm) to run a test. See Tables 7 and 8 for a list of lakes and streams that demonstrate increasing and decreasing trends; see Figure 3 and Appendix A for a complete list of waterbodies investigated for trends.

Table 7: Trends in lake transparency in the Kettle River and Upper St. Croix River watersheds.
Note: Green values indicate an improving trend while red values indicate a degrading trend

HUC-10 Subwatershed	Lake Name	AUID	Trend
Moose River	Little Hanging Horn	09003500	Improving
Willow River	Sturgeon	58006700	Improving
Willow River	Eleven	58006800	Improving
Pine River	Rhine	58013600	Degrading
Crooked Creek	Tamarack	58002400	Improving

Table 8: Trends in stream transparency in the Kettle River and Upper St. Croix River Watersheds.
Note: Green values indicate an improving trend while red values indicate a degrading trend

HUC-10 Subwatershed	Stream Name	Reach Description	AUID	Trend
Sand Creek	Partridge Creek	Headwaters to Unnamed cr	07030001-552	Degrading*
Sand Creek	Sand Creek	Headwaters to T44 R18W S27, south line	07030001-538	Improving
Bear Creek	Bear Creek	Headwaters to St Croix R	07030001-518	Improving
Upper Kettle River	Kettle River	Carlton/Pine County line to Birch Cr	07030003-552	Improving

*A monitoring station with a citizen Secchi tube dataset located further upstream in this same reach (AUID) has Secchi tube data that is too clear to run a test on, which may suggest localized issues between the two stations. See Figure 3.

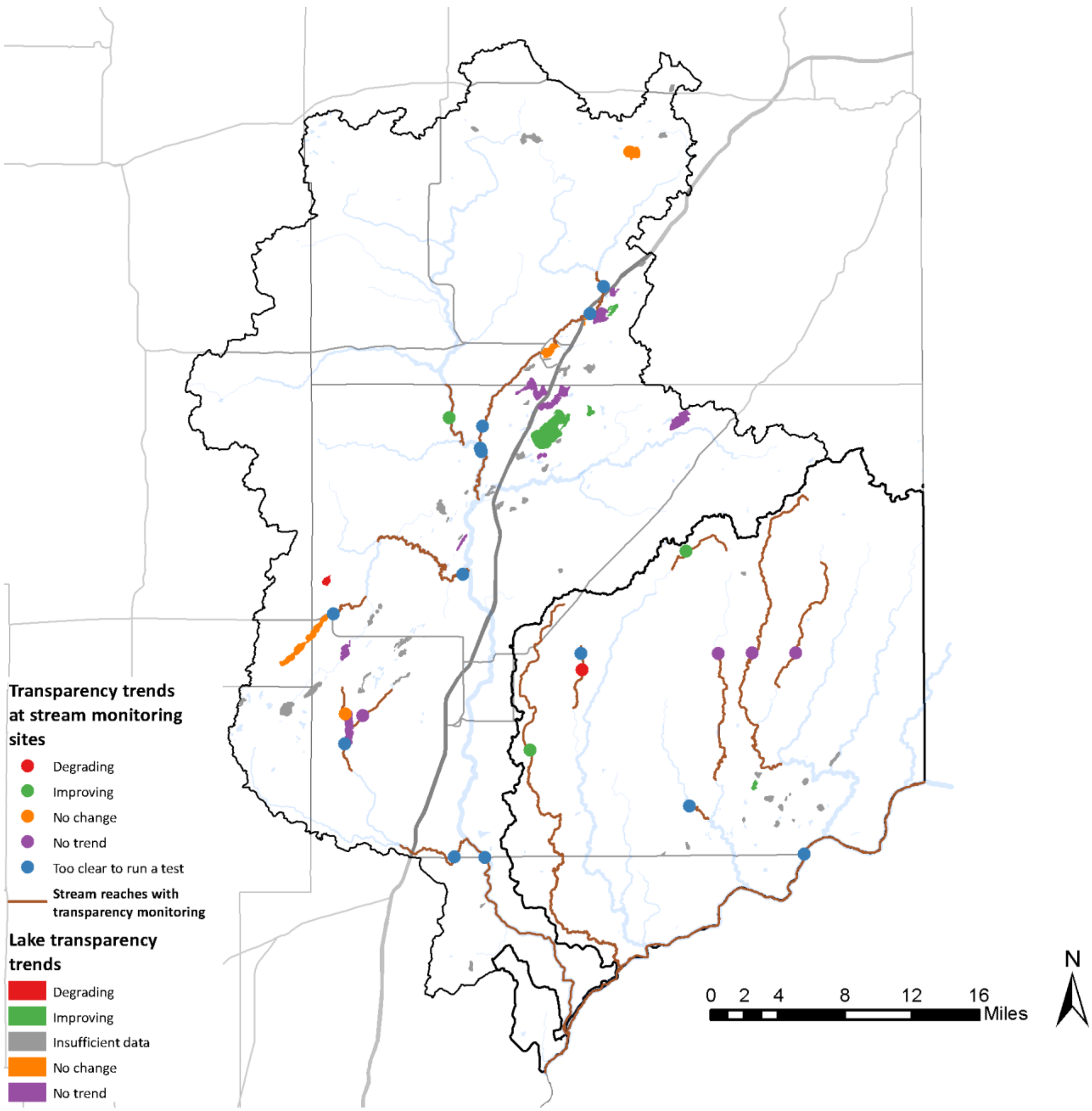


Figure 3: Transparency trends in the Kettle River and Upper St. Croix River watersheds. Stream monitoring sites (stations) are shown as points on monitored stream reaches. Lake monitoring sites are not shown, but the lake trend data is displayed through lake polygons. Appendix A provides this information in tabular form.

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. Biological SID is conducted for stream/river reaches with either fish or macroinvertebrate biota impairments, and encompasses the evaluation of both pollutant and nonpollutant-related (e.g., altered hydrology, fish passage, habitat) factors as potential stressors. Pollutant source assessments are done where a biological SID process identifies a pollutant as a stressor, as well as for the typical pollutant impairment listings. Section 3 provides further detail on stressors and pollutant sources.

Pollutants and stressors are identified in different ways: pollutants are compared to the water quality standards directly, while stressors are identified based on the characteristics of the aquatic community in tandem with water quality information and other observations. Often times, pollutants and stressors can be complex and interconnected. Furthermore, an identified stressor can be more of an effect than a cause, and will therefore have additional stressors and/or sources driving the problem. The difference between a pollutant and a stressor and a brief summary of how pollutants and stressors are identified are illustrated in Figure 4.

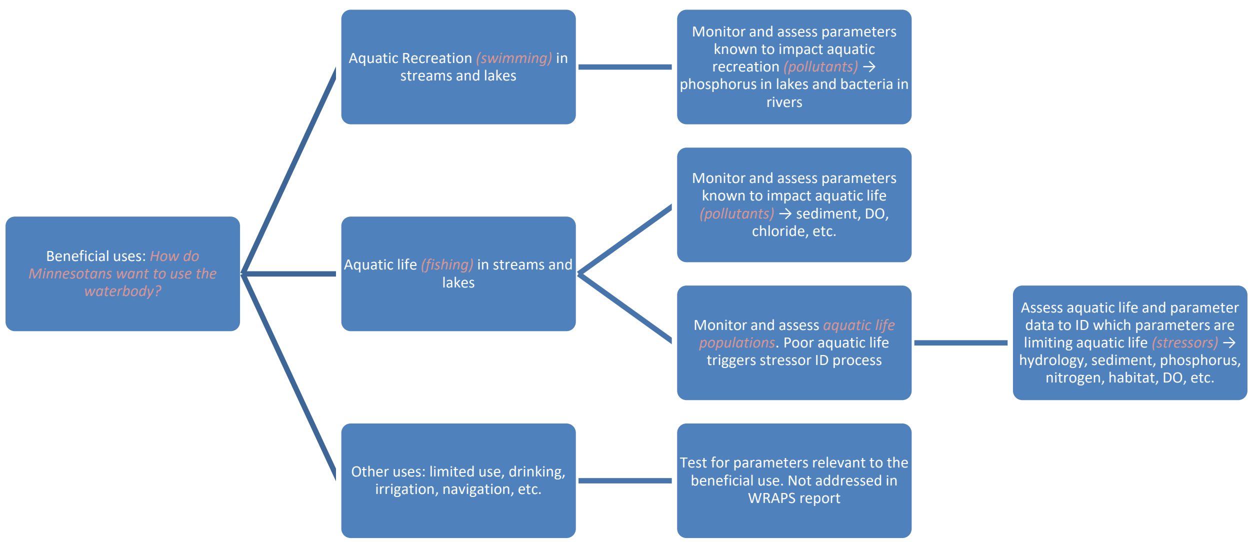


Figure 4: Pollutants and stressors are identified through different processes. Pollutants are parameters that are tested for directly, and the level of the parameter can be compared directly to a pre-developed numeric water quality standard. Stressors are parameters that are assessed only when aquatic life populations are monitored and assessed and found to be low or imbalanced (using the IBI score). Then, the SID process is triggered to determine which parameters are impacting the aquatic life populations. Both pollutants and stressors must be addressed to restore and protect water quality beneficial uses like swimming and fishing.

Stressors of biologically-impaired stream and river reaches

SID studies were completed in 2020 to identify the factors (i.e., stressors) that are causing the fish and macroinvertebrate community impairments in the Kettle River and Upper St. Croix River watersheds (MPCA 2020a and MPCA 2020b). Nine stream sections, referred to as Assessment Units (AUIDs), that were not meeting biological life use standards were included in the Kettle River Watershed SID work.

Four other AUIDs without impairment designations were investigated in the Kettle River Watershed SID process; these reaches had recently changed warm/cold water designations, were determined by an assessment committee to be due to natural background conditions, or were labeled as inconclusive due to an abnormally-large rainfall event's potential effects on sampling. Three AUID reaches from three different streams were included in the Upper St. Croix River Watershed SID Report. Table 9 summarizes the primary stressors identified for each impaired reach covered in the SID studies.

The identified stressors were nonpoint source pollution, connectivity, or naturally-occurring circumstances. No pollution originating from permitted point sources, such as wastewater treatment plants (WWTPs) was associated with the biological impairments. Infrastructure stressors included culverts that were installed such that fish passage is difficult or not possible (various reaches). The Grindstone Dam (Figure 5)—a complete barrier to fish migration—is also a contributing stressor to the impairment of the fish community of South Branch Grindstone River; however, at the time of this report's publication, the DNR had proposed a project to remove the Grindstone Dam, which would greatly increase connectivity in the Grindstone River if completed. Also included in the infrastructure category are several legacy ditching projects, which in the early 1900s attempted to drain bog areas throughout much of the Kettle River Watershed. Although these ditch systems are not as long or extensive as those in adjacent watersheds to the north or west (e.g. around the cities of Cromwell, McGregor, Aitkin, Palisade, Hill City, and Floodwood), these ditches alter the hydrology downstream, and appear to have caused channel damage in some locations, leading to habitat loss. The ditches also likely contribute to low DO levels in streams due to the wetland-sourced water they convey to the streams. The natural stressors are low DO, due to the extensive wetlands, stagnant pools downstream of road crossings, and beaver dams, which have the potential to block fish passage and prevent fish movement in spring from downstream overwintering habitat.

Figure 5: The Grindstone Dam, an example of a stressor impacting connectivity in the Kettle River Watershed

There is one reach—Skunk Creek (AUID 618), impaired by FIBI—that warrants additional discussion. This reach is located within the city of Sandstone and has historic releases of creosote from the Former Kettle River Company Creosote Plant Site. The Minnesota Department of Agriculture (MDA) is currently overseeing clean-up for this site/reach, which involves collection of sediment, surface water, groundwater, soil vapor, and air samples for the analysis of polycyclic aromatic hydrocarbons (PAHs) and/or volatile organic compounds (VOCs). In the spring of 2019, PAH and VOC data were used to complete a Preliminary Ecological Risk Assessment for Skunk Creek. The conclusion from the Preliminary Ecological Risk Assessment made a recommendation to conduct an advanced ecological assessment, which was ongoing as of summer 2020. More information about this investigation and clean-up can be found on the MDA website.

Table 9: Primary stressors to aquatic life in biologically impaired reaches in the Kettle River and Upper St. Croix River watersheds.

HUC-10 Subwatershed	AUID (Last 3 digits)	River or Stream	Biological impairment	Primary stressor								
				Dissolved oxygen	Phosphorus	TSS	Connectivity	Altered Hydrology	Channel Alteration	Habitat	Water Temp.	Toxic chemicals
Upper Kettle River	511	Kettle River	Fish	•					•	•		
Willow River	619	Hay Creek	Fish					♦	•	•		
Pine River	633	Pine River	MI	•								
	634	Pine River	MI	•								
Grindstone River	516	S. Branch Grindstone River	Fish	•			•					
	550	Spring Creek	Fish				•					
Lower Kettle River	525	Cane Creek	Fish, MI				•	◊		•		
	617	Friesland Ditch	Fish					♦	•	?		
	618	Skunk Creek	Fish				•					?
Sand Creek	501	Hay Creek	Fish, MI	•	?	?	•	•			?	
	503	Sand Creek	Fish	•	?	?		•				
Crooked Creek	502	Wolf Creek	MI	•	?	?		•				

MI = Macroinvertebrate

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

◊ Possible contributing root cause.

• Determined to be a direct stressor.

? Inconclusive

Pollutant sources

This section summarizes the sources of pollutants (such as phosphorus, bacteria or sediment) to lakes and streams in the Kettle River and Upper St. Croix River watersheds, including point sources (such as WWTPs) or nonpoint sources (such as runoff from the land). HSPF model results were used to evaluate the relative magnitude of nonpoint versus point sources in both major watersheds as demonstrated in Table 10. In general, nonpoint source pollution represents the dominant pathway for nutrient export to the majority of streams and lakes throughout each major watershed. More information about the HSPF model is provided in Section 3.1 of this report.

Table 10: HSPF estimated source contributions (percent of total) of total phosphorus for each major HUC-10 subwatershed in the Kettle River and Upper St. Croix River watersheds

HUC-10 Subwatershed	Nonpoint Sources					Point Sources
	Forest and Wetland	Pasture and Grassland	Cropland	Developed	Stream Bed/ Bank	
Upper Kettle River	29%	48%	12%	7%	1%	2%
Moose River	18%	33%	10%	13%	2%	24%
Willow River	27%	35%	9%	12%	17%	0%
Pine River	20%	31%	21%	6%	2%	21%
Grindstone River	10%	31%	29%	7%	6%	18%
Lower Kettle River	20%	37%	30%	11%	2%	0%
Kettle River Watershed Total	**21%**	**37%**	**19%**	**9%**	**4%**	**10%**
Bear Creek	22%	45%	19%	7%	1%	7%
Sand Creek	24%	32%	38%	6%	1%	0%
Crooked Creek	27%	31%	37%	4%	1%	0%
Lower Tamarack River	64%	24%	2%	7%	3%	0%
Upper Tamarack River	52%	33%	5%	8%	2%	0%
Chases Brook	40%	34%	8%	13%	4%	0%
Upper St. Croix River Watershed Total	**34%**	**32%**	**24%**	**7%**	**2%**	**1%**

Note: due to rounding, sums may not equal 100%.

The Kettle River and Upper St. Croix River watersheds TMDL Study (MPCA 2020c) identified the relative contribution of point and nonpoint phosphorus sources to the watershed's impaired lakes. The TMDL study also identified point and nonpoint bacteria and sediment sources to the watershed's impaired streams. Below is a brief discussion of the major point and nonpoint sources that have been identified in these watersheds.

Point Sources

Point sources are defined as facilities that discharge stormwater or wastewater to a lake or stream and have a National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit (Permit). There are nine permitted municipal wastewater treatment facilities (WWTF) and one industrial WWTF in the Kettle River and Upper St. Croix River watersheds (Table 11 and Figure 7). Figure 6 shows the annual phosphorus loading by municipal WWTF in the Kettle River and Upper St. Croix River watersheds.

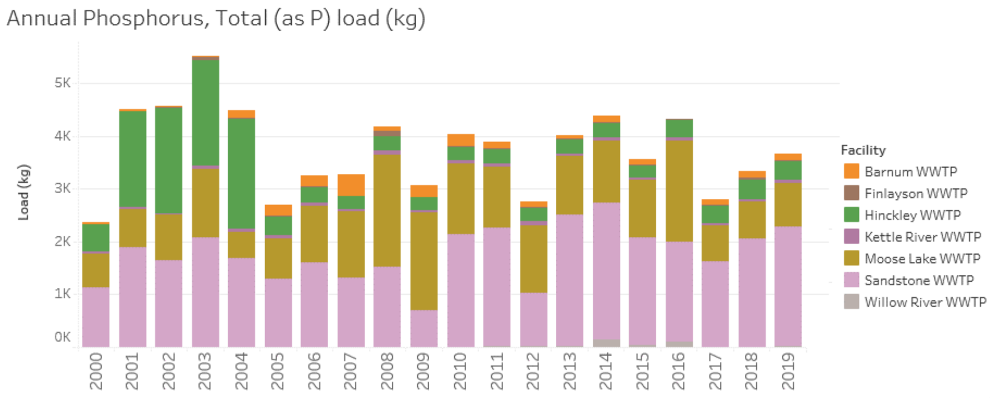


Figure 6: Annual phosphorus loading in kilograms (kg) by municipal WWTFs.

Additionally, 19 nonmetallic mining operations, permitted under the General Permit for Nonmetallic Mining Operations and Associated Activities have active operations that have the potential to discharge stormwater and/or wastewater within the watersheds (Table 12 and Figure 7). There is only one NPDES/SDS permitted facility, Hinckley WWTP, whose surface discharge stations fall within an *E. coli* impaired stream subwatershed (Grindstone River Reach 501). An individual WLA was provided for this facility in the TMDL study, although it does not require any changes to the facility's discharge permit limits.

Table 11: Point Sources in the Kettle River and Upper St. Croix River watersheds.

HUC-10 Subwatershed	Name	Permit #	Facility Type	Permit Type	Pollutant Reduction Required
Upper Kettle River	Kettle River WWTP	MNG580183	Domestic (municipal wastewater)	NPDES/SDS	No
	Barnum WWTP	MNG580142	Domestic (municipal wastewater)	NPDES/SDS	No
	Aitkin Agri-Peat Inc	MN0055662	Industrial (individual permit)	NPDES/SDS	No
Moose River	Sturgeon Lake WWTP	MN0067270	Domestic (municipal wastewater)	SDS*	No
	Moose Lake WWTP	MN0020699	Domestic (municipal wastewater)	NPDES/SDS	No
Pine River	Finlayson WWTP	MNG580203	Domestic (municipal wastewater)	NPDES/SDS	No
Grindstone River	Hinckley WWTP	MN0023701	Domestic (municipal wastewater)	NPDES/SDS	No
Lower Kettle River	Sandstone WWTP	MNG580213	Domestic (municipal wastewater)	NPDES/SDS	No
Sand Creek	Askov WWTP	MNG580229	Domestic (municipal wastewater)	NPDES/SDS	No

*Sturgeon Lake WWTP is a subsurface discharge facility that uses a rapid infiltration basin, so while it is a permitted wastewater facility, it is not authorized to discharge to a surface water.

Table 12: Industrial (Nonmetallic Mining/Associated Activities General Permit) Point Sources in the Kettle River and Upper St. Croix River watersheds.

<table>
<tr><th>HUC-10 Subwatershed</th><th>Name</th><th>Permit #</th><th>Site description</th><th>Permit Type</th><th>Pollutant Reduction Required</th></tr>
<tr><td>Sand Creek</td><td>North Pine Aggregate Inc.</td><td>MNG490210</td><td>Fogt Pit (J1-1442, J2-1411)</td><td rowspan="16">Industrial (Nonmetallic Mining/Associated Activities General Permit)</td><td rowspan="16">No</td></tr>
<tr><td rowspan="3">Upper Kettle River</td><td>Anderson Brothers Construction Co.</td><td>MNG490001</td><td>Lammi (J1-1442, D1-2951)</td></tr>
<tr><td rowspan="2">Carlton County Transportation Department</td><td rowspan="2">MNG490138</td><td>Kettle River Pit (J1-1442)</td></tr>
<tr><td>CSAH 22 Pit (J1-1442)</td></tr>
<tr><td rowspan="9">Moose River</td><td rowspan="7">Carlton County Transportation Department</td><td rowspan="7">MNG490138</td><td>Moose Lake Airport Pit (J1-1442)</td></tr>
<tr><td>Soo Line Pit (J1-1442)</td></tr>
<tr><td>Hatchery Pit (J1-1442)</td></tr>
<tr><td>Nordstroms Pit (J1-1442)</td></tr>
<tr><td>CR138 Pit (J1-1442)</td></tr>
<tr><td>Thomson Pit (J1-1442)</td></tr>
<tr><td>Atkinson Pit (J1-1442)</td></tr>
<tr><td>KGM Contractors Inc.</td><td>MNG490090</td><td>Barnum (J1-1442, D1-2951)</td></tr>
<tr><td>Omar's Sand & Gravel</td><td>MNG490530</td><td>Skelton (J1-1442)</td></tr>
<tr><td rowspan="3">Lower Kettle River</td><td>Hammerlund Construction</td><td>MNG490279</td><td>Bonks Borrow, Willow River (J1-1442)</td></tr>
<tr><td>Knife River Central Minnesota</td><td>MNG490003</td><td>Betty Davidson (J1-1442)</td></tr>
<tr><td>Sheryl's Construction Inc.</td><td>MNG490199</td><td>Isle 2/3 (J1-1442 or 1446, J2 1441 or 1423, D1 2951 Activities)</td></tr>
</table>

HUC-10 Subwatershed	Name	Permit #	Site description	Permit Type	Pollutant Reduction Required
			Peterson Pit - Pine County (J1-1442 or 1446)		
	Stafne Excavating LLC	MNG490162	Stafne Pit-City of Sandstone (J1-1442 or 1446)		
Grindstone River	Stafne Excavating LLC	MNG490162	Hinckley/Stafne Pit-Pine County (J1-1442 or 1446)		

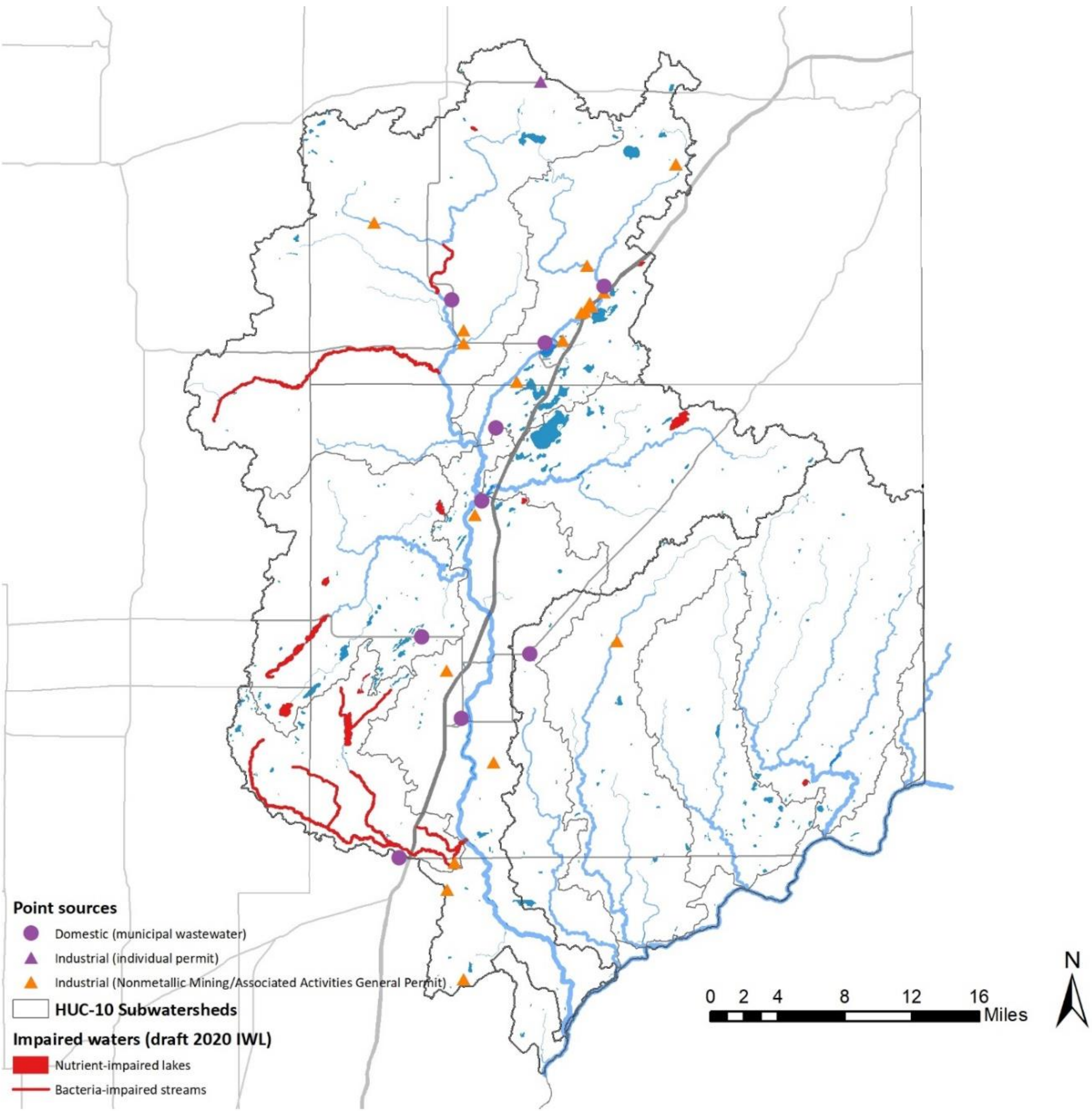


Figure 7: Point sources and selected impairments (nutrients for lakes and bacteria for streams) in the Kettle River and Upper St. Croix River watersheds

Nonpoint Sources

Nonpoint sources of pollution, unlike pollution from industrial and municipal sewage treatment plants, come from many diffuse sources. Nonpoint source pollution is accumulated by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries natural and human-made pollutants, finally depositing them into lakes and streams. Common nonpoint pollutant sources in the Kettle River and Upper St. Croix River watersheds include:

- **Watershed runoff**: Erosion from agricultural fields and forests can deliver sediment to waterbodies that contains nutrients when soil is disturbed or exposed to wind and rain. Runoff from roads, parking lots and other impervious surfaces can also carry pollutants to lakes and streams. The HSPF model was used to estimate watershed runoff volumes and pollutant loads for all subwatersheds in the Kettle River and Upper St. Croix River watersheds. The HSPF model is based on land cover and soil type, and was calibrated using meteorological data from 1996 through 2009.
- **Wetlands**: Phosphorus export from wetlands is a well-known phenomenon in northern Minnesota wetlands (O'Brien et al. 2013; Fristedt 2004; Dillon and Molot 1997; Banaszuk et al. 2005). Several of the impaired lakes in the watershed are located in watersheds with wetland-dominated tributaries. At this time, it is not known if these wetlands are major contributors to downstream impairments. Monitoring of these wetland tributaries would help determine if they are exporting elevated levels of phosphorus and/or other pollutants.
- **Upstream lakes and streams**: A few of the impaired lakes receive a significant amount of their phosphorus load from upstream lakes and major stream reaches. For these lakes, restoration and protection efforts should focus on improving the water quality of the upstream lakes and streams.
- **Runoff from feedlots**: Fertilizer and manure contain high concentrations of phosphorus, nitrogen, and bacteria that can run off into lakes and streams when not properly managed.
- **Failing septic systems**: Septic systems that are not maintained or are failing near a lake or stream can contribute excess phosphorus, nitrogen, and bacteria.
- **Atmospheric deposition**: Atmospheric deposition represents the phosphorus that is bound to particulates in the atmosphere and is deposited directly onto surface waters.
- **Lake internal loading**: Lake sediments and macrophytes contain large amounts of phosphorus that can be released into the lake water through physical mixing or under certain chemical conditions or during the senescence of macrophytes. Internal loading of phosphorus can also occur through sediment resuspension by rough fish such as common carp and black bullheads.
- **Artificial drainage and stream morphometry**: An increase in artificial drainage combined with stream channelization can lead to streambank instability, reduced base flow, and longer periods of intermittent flow.
- **Timber harvesting**: Forest harvest has been and currently is a major activity within the Kettle River and Upper St. Croix River watersheds. Historical large-scale forest removal occurred in the

watershed, which may have created legacy effects still being experienced by streams and lakes today.

2.4 TMDL summary

A TMDL is a calculation of how much of a pollutant a lake or stream can receive before it does not meet state water quality standards. These standards define pollutant concentrations in terms of beneficial uses that a given water can support, which include aquatic recreation and aquatic life. TMDL studies are required by the Clean Water Act for all impaired lakes and streams. The Kettle River and Upper St. Croix River watersheds TMDL Report was drafted in 2019 and 2020 in conjunction with this WRAPS document, and addresses 12 impaired lakes and 10 impaired streams throughout the Kettle River and Upper St. Croix River watersheds (Table 13). A majority of the impairments addressed in the TMDL study are located in the Pine River and Grindstone River HUC-10 subwatersheds. For more details, refer to the TMDL document. See Appendix B for the existing pollutant loading, load/wasteload allocations, and the load reduction goals needed to meet water quality standards.

Impairments not caused by pollutants, for example aquatic life use impairment for macroinvertebrate IBI caused by degraded physical habitat, were not addressed through the TMDL process. Loading computations (TMDLs) are not required or appropriate for such impairments. The strategies in Section 3 of this report also cover streams and lakes with non-TMDL related impairments.

Sand Creek (07030001-538) in the Upper St. Croix River Watershed is impaired by TSS and was deferred from inclusion in the TMDL report due to a lack of monitoring data. The impairment listing for Sand Creek was based on Secchi Tube data—with no TSS data collected for the reach—, which made it impossible to estimate a monitored TSS load reduction target at the time of the TMDL report's development. The MPCA will reevaluate Sand Creek in the next impairment assessment for this watershed.

Table 13: Summary of impaired lakes and streams with completed TMDLs in the Kettle River and Upper St. Croix River watersheds.

HUC-10 Subwatershed	Stream or Lake Name	Reach AUID or Lake ID	Pollutant(s)
Upper Kettle River	Kettle River	07030003-529	*E. coli*
	Split Rock River	07030003-513	*E. coli*
	Merwin Lake	09005800	Excess Nutrients
Moose River	Twentynine Lake	09002200	Excess Nutrients
Willow River	Oak Lake	58004800	Excess Nutrients
Pine River	Pine River	07030003-631	*E. coli*
	Pine Lake	01000100	Excess Nutrients
	Big Pine Lake	58013800	Excess Nutrients
	Eleven Lake	33000100	Excess Nutrients
	Fox Lake	58010200	Excess Nutrients
	Rhine Lake	58013600	Excess Nutrients
Grindstone River	N. Branch Grindstone River	07030003-541	*E. coli*
	Unnamed Creek	07030003-546	*E. coli*
	S. Branch Grindstone River	07030003-516	*E. coli*

HUC-10 Subwatershed	Stream or Lake Name	Reach AUID or Lake ID	Pollutant(s)
	Judicial Ditch 1	07030003-526	*E. coli*
	N. Branch Grindstone River	07030003-544	*E. coli*
	Spring Creek	07030003-550	*E. coli*
	Grindstone River	07030003-501	*E. coli*
	Elbow Lake	58012600	Excess Nutrients
	Grindstone Lake	58012300	Excess Nutrients
Lower Kettle River	McCormick Lake	58005800	Excess Nutrients
Lower Tamarack River	Grace Lake	58002900	Excess Nutrients

2.5 Protection considerations

Many of the lakes and streams in the Kettle River and Upper St. Croix River watersheds already meet or exceed water quality goals. Protecting water quality from degrading is typically more cost effective than trying to restore degraded waters. This section provides a brief discussion of some of the tools, reports, and information that is available to guide protection efforts in the Kettle River and Upper St. Croix River watersheds. All of the items highlighted below are based on input and work done by state agencies and local partners and were used to guide the identification and prioritization of strategies in Section 3.3.

Stream Protection

The Kettle River is designated as a Minnesota State Wild and Scenic River. This program was established in 1973 to protect rivers which have outstanding natural, scenic, geographic, historic, cultural, and recreational values. As such, preservation and restoration of continuous natural vegetation within the Kettle River riparian corridor and preservation of floodplains is critical to protecting and preserving wildlife, water quality, flood abatement and the scenic nature of the river.

The Kettle River Watershed Landscape Stewardship Plan (KRWLSP) was developed to help private parties and public agencies to protect and enhance forest and water resources in the watershed. The key finding of the plan includes a focus on seven subwatersheds in the Kettle River Watershed for future strategic landscape planning and project implementation that opportunities for improved water quality. The KRWLSP is described in more detail later in this document.

Through the IWM process, 34 stream segments were assessed for aquatic life and/or aquatic recreation. Generally, it was found that the streams of the Upper St. Croix are among the most biologically intact, healthy and resilient of any watershed in Minnesota with aquatic life use (AQL) standards being met on 93% of streams that were assessed for fish and macroinvertebrates.

Further, the 2019 Kettle River Watershed Monitoring and Assessment Report states that water quality conditions throughout the Kettle River Watershed were generally categorized as good to great, with aquatic life (AQL) use standards met on 78% of the assessed stream reaches; however, aquatic recreation (AQR) use standards were met on only 46% of stream reaches sampled for *E. coli* bacteria.

Recently, the MPCA, DNR, and other state agencies worked together to develop a Stream Protection and Prioritization Tool that can be used to generate a prioritized list of streams. This tool, and its application in the Kettle River and Upper St. Croix River watersheds, is discussed in more detail in Section 3.1.

Lake Protection

As stated above, in 2016 the MPCA began the two-year IWM project in the Upper St. Croix River Watershed. The project was designed to assess the quality of the streams and lakes in the watershed through both biological and water chemistry monitoring. Overall, four lakes were assessed for aquatic life and/or aquatic recreation. Generally, it was found that the lakes within the Upper St. Croix River Watershed are among the most biologically intact, healthy and resilient of any watershed in Minnesota. Fish tissue from two lakes (Tamarack and Rock) was tested for mercury, with only Tamarack Lake being listed as impaired by high mercury, which is covered by the Minnesota Statewide Mercury TMDL (see Table 1).

Further, the 2019 Kettle River Watershed Monitoring and Assessment Report states that water quality conditions throughout the Kettle River Watershed as generally categorized as good to great. Aquatic life (AQL) use standards are met on 61% of the lakes sampled for fish. However, mercury in fish tissue remains a concern, with 13 of the 16 tested lakes listed as impaired by high mercury. Of the 13 lakes, 9 are covered by the Minnesota Statewide Mercury TMDL (see Table 1).

Below is a list of studies, data, modeling tools, designations, local knowledge, and criteria that is available and should be considered when prioritizing lakes for protection in the Kettle River and Upper St. Croix River watersheds. Refer to Section 3 for information and details regarding the specific lakes that meet the protection criteria and categories listed below:

- Lakes with high recreational value/use identified by local stakeholders (12 lakes in Kettle)
- Lakes barely meeting water quality standards and therefore have been identified as "vulnerable" by MPCA (6 lakes in Kettle);
- Lakes demonstrating decreasing trends in water clarity (2 lakes in Kettle);
- Lakes currently not meeting State standards for Lake FIBI (1 lake in Kettle);
- DNR Lakes of Biological Significance (16 lakes in Kettle; 7 lakes in Upper St. Croix);
- DNR Lake Benefit: Cost Assessment Score (See Section 3.1 for more details) (5 lakes in Kettle scored in the "Higher" or "Highest" categories in terms of cost benefit);
- DNR Level 8 Subwatershed Habitat Strategy (33 lakes assessed in Kettle; 11 lakes assessed in Upper St. Croix);
- DNR designated Wild Rice Lakes – see discussion below (15 lakes in Kettle; 2 lakes in Upper St. Croix);
- DNR designated Cisco Refuge Lakes (2 lakes in Kettle);
- DNR designated Stream Trout Lakes (1 lake in Kettle);
- DNR designated Muskie Lake (1 lake in Kettle);
- MPCA-DNR Lake Phosphorus Sensitivity Analysis (See Section 3.1 for more details) (25 lakes in Kettle scored in the "Higher" or "Highest" categories for sensitivity; 2 lakes in Upper St. Croix scored in the "Higher" or "Highest" categories); and

- MPCA-DNR Lake Protection and Prioritization Tool (See Section 3.1 for more details) (10 high priority lakes identified in Kettle; 1 high priority lake in Upper St. Croix identified).

Watershed Protection Framework for Minnesota Lakes

Lake water quality depends largely on watershed land use. Agricultural and urban runoff contains significantly more nutrients such as phosphorus and nitrogen than undisturbed forests, grasslands, and wetlands. These nutrients increase algal growth, which is a primary driver for water quality in lakes. Catchments with undisturbed lands lie primarily in the forested ecoregions and generally provide good water quality.

In an effort to prioritize protection and restoration efforts of fishery lakes, the DNR has developed a ranking system by separating lakes into two categories, those needing protection and those needing restoration. Modeling by the DNR Fisheries Research Unit suggests that TP concentrations increase significantly over natural concentrations in lakes that have watershed with disturbance greater than 25%. Therefore, lakes with watersheds that have less than 25% disturbance need protection and lakes with more than 25% disturbance need restoration (Table 14). Watershed disturbance was defined as having urban, agricultural and mining land uses. Watershed protection in this ranking system is defined as publicly owned land, public water, wetlands, or conservation easement. In the larger context of this report, the concept of protection is expanded to include additional management strategies on private land such as forest stewardship planning.

Table 14: Suggested approaches for watershed protection and restoration (source: DNR).

Watershed Disturbance (%)	Watershed Protection (%)	Management Strategy	Comments
< 25%	> 75%	Vigilance	Sufficiently protected -- Water quality supports healthy and diverse native fish communities. Keep public lands protected.
	< 75%	Protection	Excellent candidates for protection -- Water quality can be maintained in a range that supports healthy and diverse native fish communities. Disturbed lands should be limited to less than 25%.
25% - 60%	n/a	Full Restoration	Realistic chance for full restoration of water quality and improve quality of fish communities. Disturbed land percentage should be reduced and BMPs implemented.
> 60%	n/a	Partial Restoration	Restoration will be very expensive and probably will not achieve water quality conditions necessary to sustain healthy fish communities. Restoration opportunities must be critically evaluated to assure feasible positive outcomes.

The next step was to prioritize lakes within each of these management categories. DNR Fisheries identified high value fishery lakes, such as cisco refuge lakes. Ciscos (*Coregonus artedi*) can be an early indicator of eutrophication in a lake because they require cold hypolimnetic temperatures and high DO levels. These watersheds with low disturbance and high value fishery lakes are excellent candidates for priority protection measures, especially those that are related to forestry and minimizing the effects of landscape disturbance. Forest stewardship planning, harvest coordination to reduce hydrology impacts and forest conservation easements are some potential tools that can protect these high value resources for the long term.

Figure 8 and Appendix C show the general management strategy for each HUC-12 subwatershed in the Kettle River and Upper St. Croix River watersheds using the DNR approach described above. A majority of the HUC-12 subwatersheds in the Kettle and Upper St. Croix fall into the “protection” management category. This suggests that primary strategies for both watersheds should focus on limiting human disturbance and enhancing and protecting un-disturbed land through forest stewardship plans, conservation easements, public land acquisition, and other tools discussed in Section 3.3.

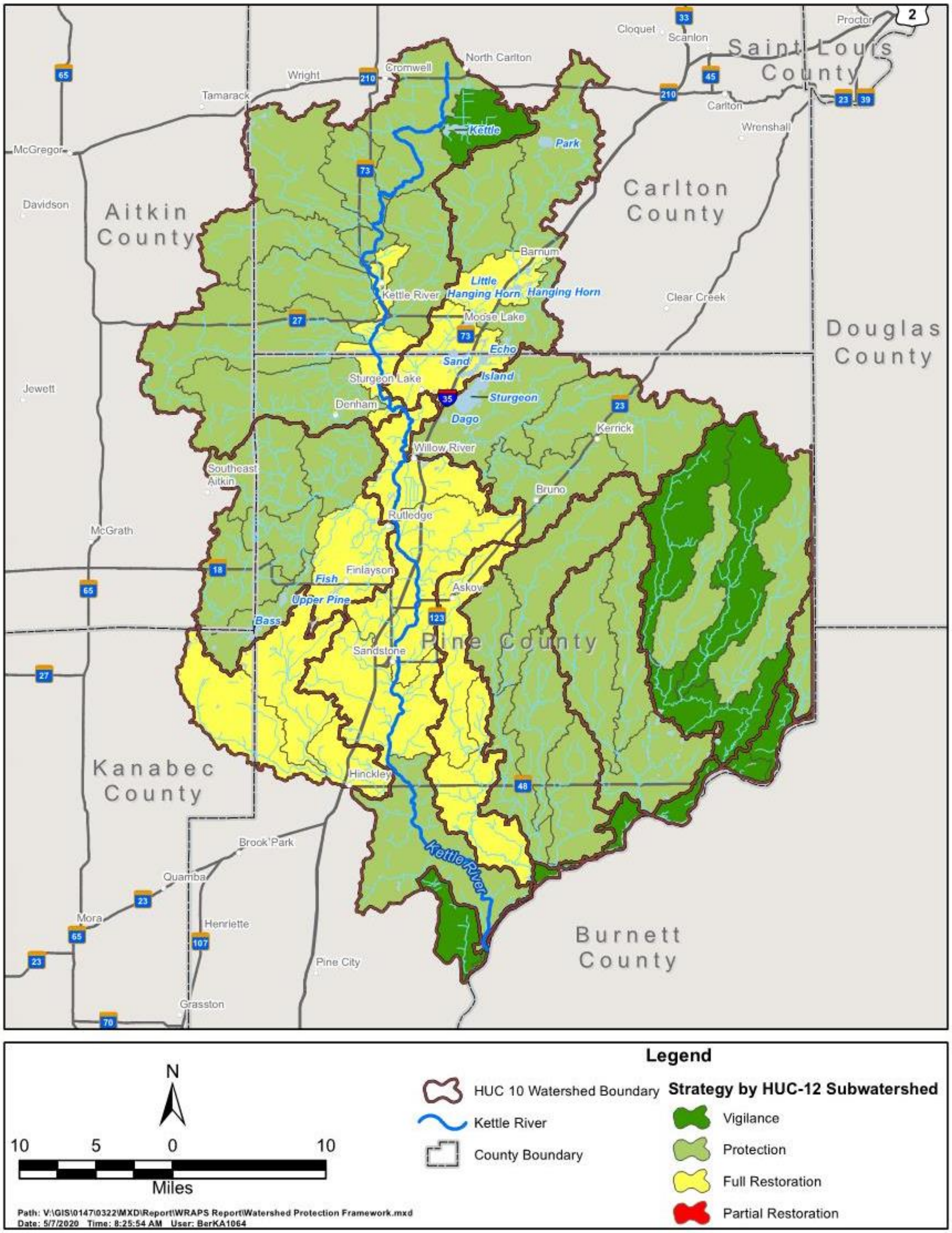


Figure 8: Subwatershed restoration and protection strategies for the Kettle River and Upper St. Croix River watersheds. See Appendix C for this data in tabular form.

Wild Rice and Tribal Lands

A relatively small portion of the Kettle River Watershed falls within the reservation lands of the Fond du Lac Band of Lake Superior Chippewa (Figure 10). This portion includes the northernmost extent of the Moose River HUC-10 Subwatershed and a very small part (approximately 280 acres; Figure 22), of the northeastern Upper Kettle River Subwatershed (Figure 21).

The Fond du Lac Band of Lake Superior Chippewa has federal Clean Water Act jurisdiction for Sections 106, 319, 303(c) and 401 for waters of the Reservation, and is active in watershed management and water quality restoration on the Reservation and in the 1854 Ceded Territory. The Fond du Lac Band has established water quality standards for its waters and implements a water quality monitoring, assessment, protection, and restoration program on the Reservation. Waterbodies under jurisdiction of the Fond du Lac Band addressed in this WRAPS report include Manoomini-zaaga'iganing/Wild Rice Lake (AUID 09-0023-00) and the uppermost reach of the Moose Horn River (AUID 07030003-535).

Manoomini-zaaga'iganing/Wild Rice Lake is the headwaters of the Moose Horn River and listed as an Outstanding Reservation Resource Water by the Fond du Lac Band. The importance of the lake to the Fond du Lac Band is further codified through its wild rice cultural use designation. This cultural use designation is defined as “A stream, reach, lake or impoundment, or portion thereof, presently, historically or with the potential to be vegetated with wild rice” (Fond du Lac Band of Lake Superior Chippewa, Ordinance #12/98, as amended, 2001).

Wild rice, known as *manoomin* in Anishinaabemowin, is a significant and sacred spiritual and cultural resource to the Chippewa (also known as Ojibwe) people. Wild rice is part of the Ojibwe migration story, and Ojibwe and others have gathered wild rice for generations. Tribal rights to harvest wild rice are enshrined in treaties. Harvesting, preparing, sharing, and selling wild rice are important cultural, spiritual, and social activities to the Ojibwe people and other Native American groups in Minnesota. In addition to its immense importance to humans, wild rice is also an important food source for wildlife (Vennum 2004).

In addition to the Fond du Lac Band’s Reservation lands, multiple Mille Lacs Band of Ojibwe trust lands are located throughout the Kettle River and Upper St. Croix River watersheds (Figure 10). The Mille Lacs Band uses these lands for multiple purposes and they are important to tribal natural resource, economic, and environmental programs. Beyond lands directly affiliated with Tribal Nations, the entirety of both watersheds is ceded territory under two treaties between the United States government and signatory Ojibwe Bands—the Treaty of 1837 and the Treaty of 1854. These treaties secured the rights of Ojibwe people to hunt, fish, and gather within these ceded territories. The 1854 Treaty Authority is a tribal natural resources agency that manages off-reservation hunting, fishing and gathering in the 1854 Ceded Territory on behalf of the Bois Forte and the Grand Portage Band of Lake Superior Chippewa.

Wild rice grows in many waterbodies throughout the Kettle River and Upper St. Croix River watersheds (Figure 10). Given wild rice’s significance to Native Americans, tribal organizations conduct research and monitoring on wild rice and are actively involved in wild rice management and restoration. Additional information on some of these efforts within the Kettle River and Upper St. Croix River watersheds can be found on the 1854 Treaty Authority’s website: http://www.1854treatyauthority.org/wild-rice/wild-rice.html.

During the development of this WRAPS report, staff from the Fond du Lac Band's Office of Water Protection collaborated with the MPCA staff to share data and develop strategies to protect and improve the water quality and associated designated uses of Manoomini-zaaga'iganing/Wild Rice Lake (Figure 9). Based on the Fond du Lac Band's 2018 assessment, Manoomini-zaaga'iganing/Wild Rice Lake fully supports the Band's wild rice cultural use designation from a water quality standpoint. The lake is listed as impaired by mercury under the Band's Wildlife Designated Use. At the time of this report's writing, the Fond du Lac Band was updating its Nonpoint Source Assessment Report and Management Plan, and Tribal staff indicated that Manoomini-zaaga'iganing/Wild Rice Lake will be classified as severely impaired from a nonpoint source standpoint in the updated report. Tribal staff have indicated that the wild rice population in Manoomini-zaaga'iganing/Wild Rice Lake has significantly declined over the past 20 years, and they attribute this decline in wild rice to high water levels in the lake.

Figure 9: Looking north/northeast from the outlet of Manoomini-zaaga'iganing/Wild Rice Lake (Moose Horn River) at Minnesota State Highway 210

Wild rice grows in shallow water from one to three feet deep and is sensitive to changing water levels (1854 Treaty Authority 2020). A likely contributing factor to high water levels in Manoomini-zaaga'iganing/Wild Rice Lake is beaver activity in the low-gradient reach of the Moose Horn River downstream of the lake's outlet. In 2019, the Minnesota Department of Transportation (MnDOT) assessed the culvert under State Highway 210 that is directly downstream of Manoomini-zaaga'iganing/Wild Rice Lake and concluded that it is functioning properly. Using historic aerial photos, hydrologic models, state records on culvert maintenance at this location, and in-person observations, MNDOT and Fond du Lac Resource Management jointly concluded that the main reason for sustained high water in the lake is due to tailwater effects from a series of beaver dams downstream of the lake (personal communication; Fond du Lac Reservation 2004). Increased precipitation due to climate change is another potential contributing factor. Strategies to address the decline of wild rice in Manoomini-zaaga'iganing/Wild Rice Lake identified in discussion with tribal staff include improving hydrologic connectivity and potential water level management and are described in further detail strategy table for Moose River Subwatershed (Table 18).

For more information, please see the following websites:

- Fond du Lac Band of Lake Superior Chippewa Resource Management, Water Quality: http://www.fdlrez.com/RM/waterquality.htm
- Water Quality Standards Regulations, EPA: https://www.epa.gov/wqs-tech/water-quality-standards-regulations-fond-du-lac-band-minnesota-chippewa-tribe
- The Fond du Lac Band of the Minnesota Chippewa Tribe Water Quality Standards: https://www.epa.gov/sites/production/files/2014-12/documents/chippewa-tribe.pdf

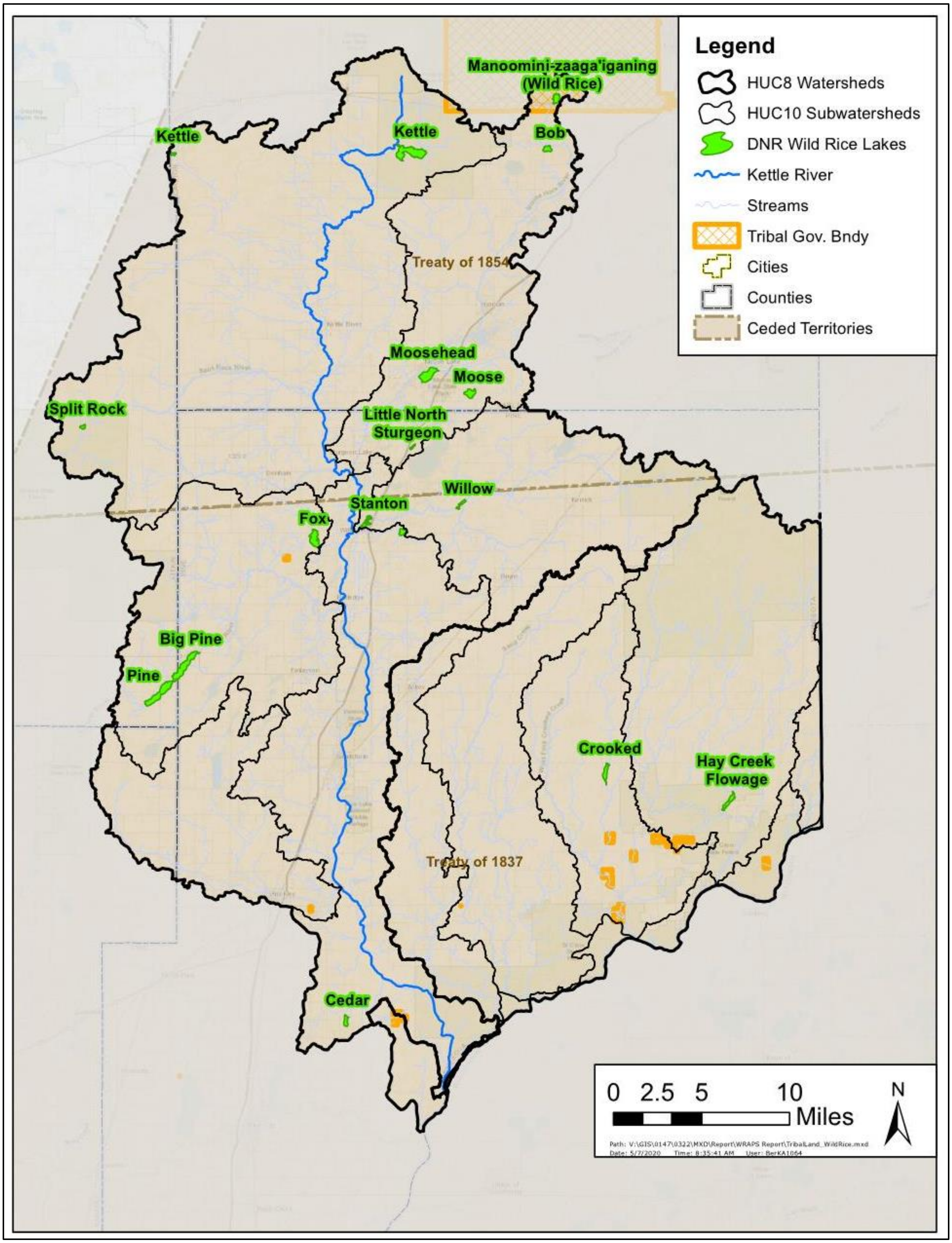


Figure 10: Tribal land and wild rice lakes in the Kettle River and Upper St. Croix River watersheds

Groundwater and Drinking Water

Portions of the Kettle River and Upper St. Croix River watersheds are important for recharge of regional aquifers, including those serving the towns and small communities throughout the watershed. It is important to keep water on the land in these areas, and certain areas sensitive to groundwater pollution should not host pollutant-generating facilities without appropriate BMPs and mitigation strategies in place.

The Environmental Health Division of the MDH administers numerous programs of interest to local water management planning, including drinking water protection and wellhead protection, among others.

The following table illustrates the number and size of Well Head Protection Areas (WHPAs) and Drinking Water Supply Management Areas (DWSMAs) within the 12 HUC-10 subwatersheds. The table also includes the area in acres that are vulnerable to groundwater contamination and identified karst areas in acres by subwatershed.

Table 15: Summary of groundwater and drinking water features in the Kettle River and Upper St. Croix River watersheds

HUC-10 Subwatershed	WHPAs / DWSMAs (count)	WHPA (acres)	DWSMA (acres)	Vulnerable Groundwater Areas (acres)	Karst Areas (acres)
Upper Kettle River	1/1	34	120	20,621	0
Moose River	6/6	1,848	3,197	34,470	0
Willow River	1/1	8	33	37,297	23,313
Pine River	1/1	160	501	27,933	12,967
Grindstone River	2/1	445	855	28,520	13,437
Lower Kettle River	2/2	146	254	67,508	53,843
Bear Creek	1/1	297	589	12,161	11,522
Sand Creek	1/1	148	266	23,012	21,165
Crooked Creek	0/0	--	--	0	0
Lower Tamarack River	0/0	--	--	0	0
Upper Tamarack River	0/0	--	--	0	0
Chases Brook	0/0	--	--	0	0

Further, Figure 11 below depicts the geographic location and extent of the WHPAs, DWSMAs, vulnerable groundwater areas, and areas prone to development of karst features. Karst is a landscape characterized by porous rock, which is generally Hinckley Sandstone bedrock in the Kettle River and Upper St. Croix River watersheds (Alexander and Tipping 2002; Morey et al. 1981). Weathering of these porous rocks over time form underground drainage systems that are often expressed as topographic features on the surface (MPCA 2020d). These karst features illustrate the intricate connection between the surface land use and surface water/groundwater quality in the area.

Karst features like sinkholes are present within the watershed. Sinkholes are closed depressions in the landscape that act as direct conduits for surface waters to enter subsurface geological units. A Sinkhole Distribution study was conducted by the Department of Geology and Geophysics at the University of Minnesota in 2001. Approximately 245 sinkholes were mapped in north-central Pine County. The project began as a survey of sinkholes in Partridge Township but expanded northeast into Bruno Township and southwest into Sandstone Township. Protection strategies that should be considered for karst areas and vulnerable groundwater areas within these watersheds include:

- Further identifying karst features by expanding the existing inventory;
- Increasing monitoring or targeting existing local monitoring in karst areas;
- Increasing vegetative buffers around sinkholes, stream-sinks, karst outcroppings;
- Promoting subsurface sewage treatment systems (SSTS) compliance through education, maintenance, and inspection; and
- Education and outreach to farmers and feedlot operators regarding nutrient management in karst areas and areas with vulnerable groundwater; Minnesota Rules chapter 7020 contains requirements for manure and process wastewater application near karst features (Minn. R. 7020.2225 - Land Application of Manure).

The MDA has developed the Groundwater Protection rule to minimize potential sources of nitrate pollution to the state's groundwater and protect drinking water. "The rule restricts fall application of nitrogen fertilizer in areas vulnerable to contamination, and it outlines steps to reduce the severity of the problem in areas where nitrate in public water supply wells is already elevated" (MDA 2020). More information can be found on the MDA website. For land application of manure, restrictions of fall application in areas vulnerable to contamination apply to feedlots with NPDES permits (large operations with greater than or equal to 1,000 animal units [AUs}).

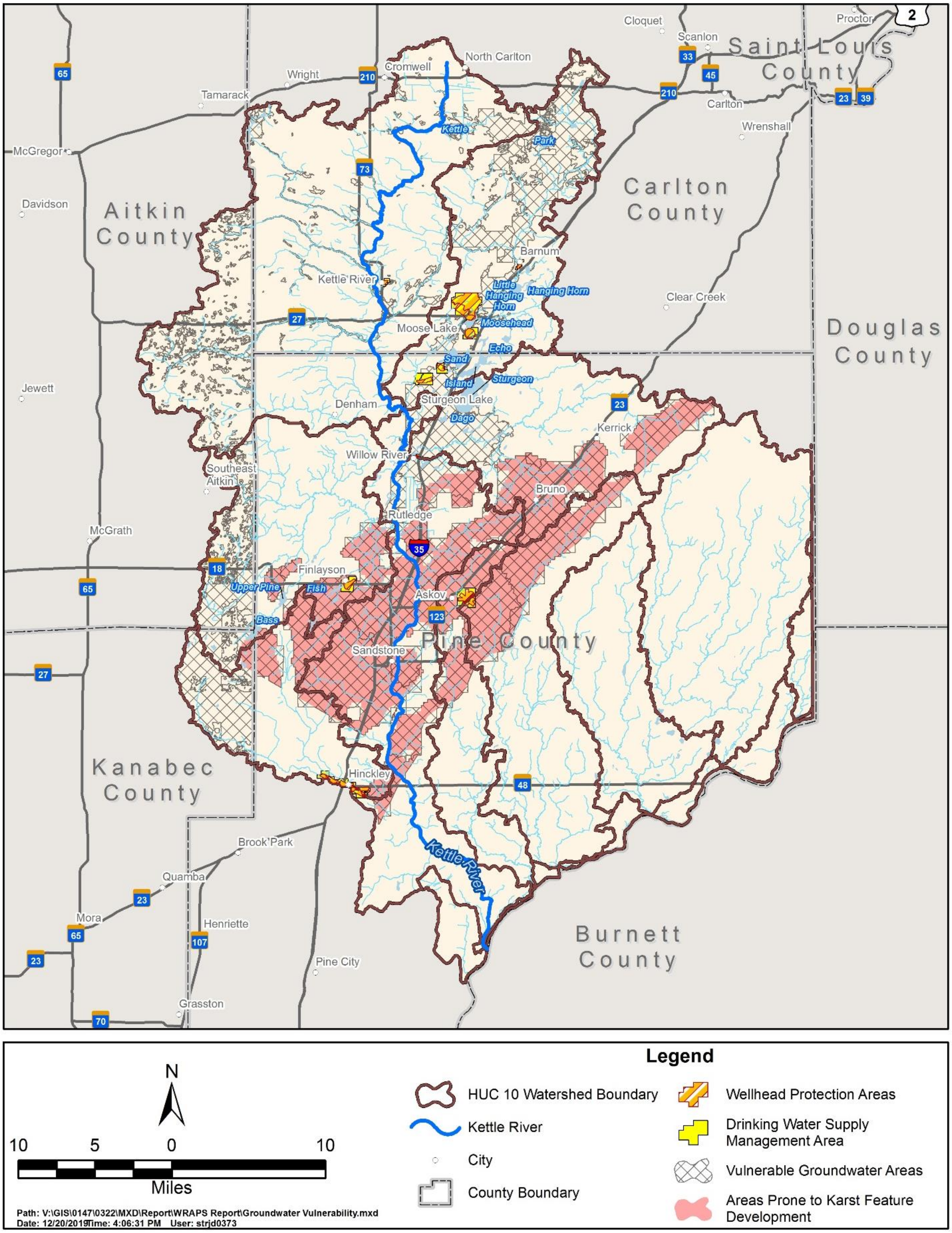


Figure 11: Kettle and Upper St. Croix River WHPAs, DWSMAs, vulnerable groundwater areas and areas prone to karst

Kettle River Watershed Landscape Stewardship Plan

The KRWLSP was developed in 2014 to help private parties and public agencies to protect and enhance forest and water resources in the watershed. Key themes of the KRWLSP focused on partners and partnerships, implementation program s and priorities, training and funding and engagement of communities and landowners within the watershed. A team of resource professionals was assembled to guide the development of the KRWLSP. The team included a comprehensive array of professionals including: The Nature Conservancy, the Minnesota Forest Resources Council, Natural Resource Conservation Service, United States Forest Service, WIDNR, MNDNR, county and SWCD staff, members of the St. Croix Tribe and the St. Croix River Association among others.

The primary focus of landscape stewardships plans is forest resources. However, the framework of this Plan recognized the critical connection of management of forest resources with the management of water resources and recreational resources. The KRWLSP outlines desired future conditions that include the protection and improvement of water quality the protection and improvement of forest resources, and attractive and engaging recreational resources across the watershed.


Kettle River Watershed
Landscape Stewardship Expanded Plan

Prepared for the Kettle River Watershed Partnership

April 2014

The KRWLSP included a detailed subwatershed assessment for seven subwatersheds: the Lower Kettle River, Grindstone River, Pine River, Willow River, Moose River, Upper Kettle River, and the Headwaters Kettle River. All of these subwatersheds are aligned with the HUC-10 subwatersheds used in this report, except for the “Upper Kettle River” and the “Headwaters Kettle River”, which consist of two aggregated HUC-12 subwatersheds of what is only the Upper Kettle River subwatershed in this report. The subwatershed assessments included physical descriptions, key findings, and an overall subwatershed risk assessment ranking. The assessments were further summarized to help draw conclusions for management priorities.

The following goals and objectives pertaining to water and forest resources were borne from the process.

Water Resources:

- Protect healthy water systems and features,
- protect forested riparian corridors,
- protect undeveloped shorelands,
- advocate and support the implementation of protection BMPs,

- improve impaired water resources,
- implement projects to restore and improve native vegetation,
- work with partners and stakeholders to implement shoreland restoration projects,
- build coordination and share knowledge to advance water and forest resource management,
- work with counties and other partners to develop and implement forest management practices into County Water Plans, and
- work with counties and other partners to develop and implement lake management plans to include forest management practices, and monitor water quality.

Forest Resources:

- Protect healthy forest ecosystems,
- support the protection and maintenance of public forestlands using assessment criteria established in the subwatershed analyses,
- implement projects that protect and maintain private forestlands using priorities established in the subwatershed analyses,
- support and participate in programs and projects that promote proactive forest health practices,
- increase and restore native forest land cover,
- support the implementation of forest restoration projects on priority sites within each subwatershed,
- support efforts to prevent and manage invasive species,
- design and implement forest and other land-based restoration projects to maximize utilization of removed undesirable woody plant material,
- build coordination and share knowledge related to forest resources and management to protect and restore water quality and quantity,
- actively educate partners in the watershed about the watershed/forest land cover connection and its role in promoting water quality and quantity,
- support the expansion and effectiveness of local conservation groups, and
- advocate for sound land use planning and recognition of forest resources in local planning and regulatory processes.

3. Tools and information for prioritizing and implementing restoration and protection

The Clean Water Legacy Act (CWLA) requires that WRAPS reports:

- summarize TMDLs, watershed modeling outputs, and resulting pollution load allocations and identify areas with high pollutant-loading rates;
- contain strategies that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources, including identifying water quality goals, strategies, and targets by parameter of concern; and
- contain an example of the scale of adoptions with a timeline to meet the water quality restoration or protection goals.

This section of the WRAPS report provides the results of such 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 (BMPs). Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed modeling efforts 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 Targeting of geographic areas

The following section describes the information and tools gathered throughout the Kettle and Upper St. Croix River WRAPS project to develop restoration and protection strategies for the lakes and streams throughout each watershed. Follow-up field reconnaissance will be the next part of the process to validate the identified areas potentially needing work.

It is understood that management needs for the Kettle River and Upper St. Croix River watersheds exceed available resources, and therefore prioritization and focus is necessary to achieve goals in high priority areas. The following subsections provide several methods of prioritizing geographic areas. Later in the report, tables of management strategies were drafted to include those management approaches deemed most important. While this information provides substantial direction, it is expected that local water management authorities will further define the highest priority projects and geographic areas based on scientific, social, political, and financial considerations.

Hydrologic Simulation Program-FORTRAN (HSPF)

HSPF is a large-basin, watershed model that simulates nonpoint source runoff and water quality in urban and rural landscapes. The Kettle and Upper St. Croix River HSPF model incorporates real-world meteorological data and is calibrated to real-world stream flow data. HSPF model development includes the addition of point source data in the watershed, including both domestic and industrial WWTFs.

HSPF was used to predict the relative magnitude of runoff, TSS, TP, and Total Nitrogen (TN) pollution generated in each subwatershed of both watersheds. The HSPF model was also used to evaluate the extent of contributions from point, nonpoint, and atmospheric sources where necessary. Development of the HSPF model helps to better understand existing water quality conditions and predict how water quality might change under different land management practices and/or climatic changes at the subwatershed scale. HSPF also provides a means to evaluate the impacts of alternative management strategies to reduce these loads and improve water quality conditions. Runoff, TSS, TP, and TN yields predicted from the HSPF model in the Kettle River and Upper St. Croix River watersheds are mapped in Figure 12.

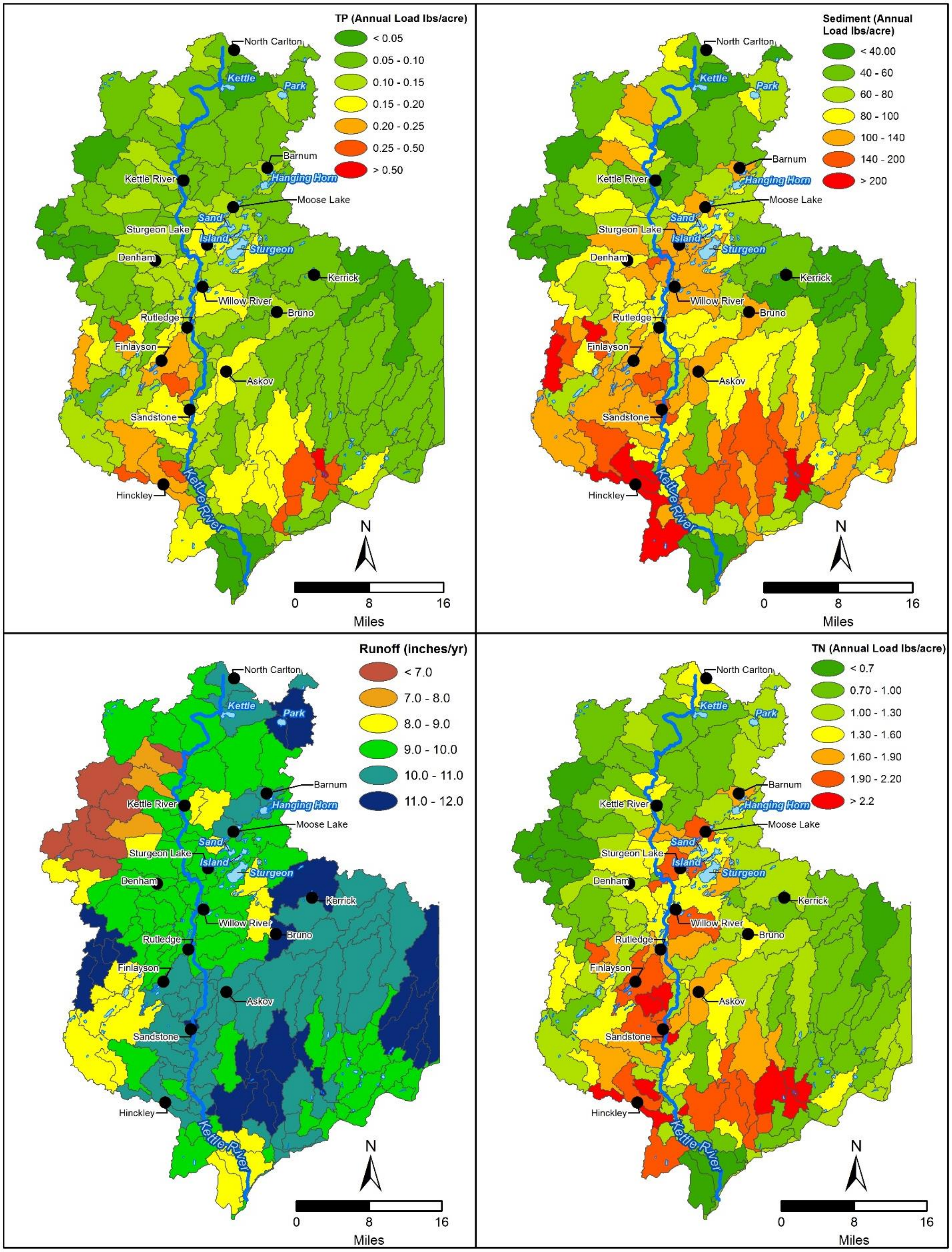


Figure 12: Kettle River and Upper St. Croix River watersheds HSPF-predicted runoff and pollutant loading by HUC-12 subwatershed

Stream Protection and Prioritization Tool

The MPCA, DNR, and other state agencies worked together to develop a Stream Protection and Prioritization Tool that can be used to generate a prioritized list of streams. The list is based on the results of water quality assessments, the level of risk posed from near shore areas, the level of risk posed from the contributing watershed, and the level of protection already in place in the watershed. The tool utilizes state-wide coverages; therefore, additional local information must be weighed including factors such as forest management practices, potential development trends, and mining impacts.

The process is limited to streams that have water quality assessments that include fish and/or macroinvertebrates (bugs) and the streams must be meeting water quality standards – i.e., they are considered to be fully supporting of aquatic life. The first step considers how close these communities are to being impaired or degraded.

The second step looks at near shore (riparian) risks to healthy stream communities. In developing the tool, the following parameters were considered: the presence of steep slopes, percent altered streams, percent wetland loss, road density, population density, population change, feedlots, septic system density, and a variety of land use categories (percent agriculture, percent row crop, percent impervious surface, percent undeveloped). This analysis indicates that road density and disturbed land use (cultivated and urban uses) can best predict impacts or changes in stream biological health. These same risks are then also evaluated for the larger, upstream watershed.

The third step looks at how well protected the near shore areas and upstream watershed already are. To complete this step, analysis of lands in public ownership or with public easements is conducted.

A prioritized list of streams is then generated for the entire watershed. The list may then be further prioritized by splitting out, or separately considering, modified streams (ditches), general use streams (good biology and habitat), and exceptional streams (best biological communities and habitat).

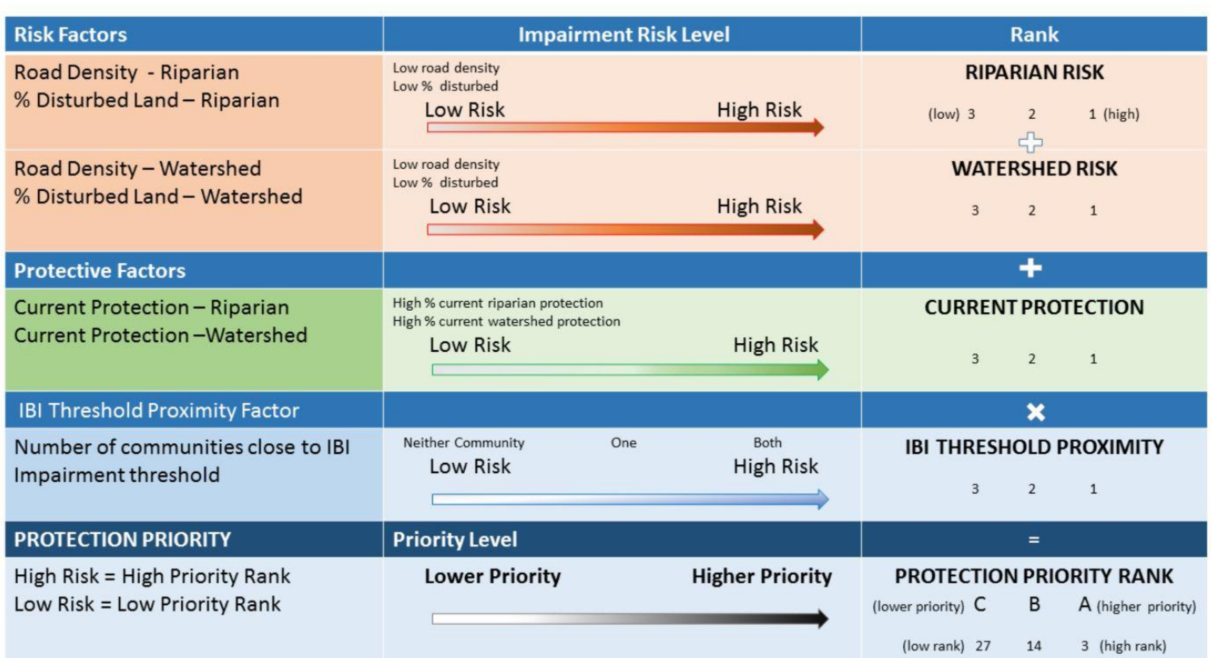


Figure 13: Stream protection and prioritization tool matrix

The Stream Protection and Prioritization Tool was applied (where applicable) to nonimpaired stream reaches throughout the Kettle River and Upper St. Croix River watersheds. Once all of the nonimpaired stream reaches in each watershed were ranked and prioritized, they were grouped into priority categories by splitting the list into thirds; the top third are high (A) priority, the next third medium (B) priority, and the final third are low (C) priority. Thirty-two stream reaches in the Kettle River Watershed had the required data and information for assessment using the tool (Figure 15). Of these stream reaches, seven were identified as Priority A (highest priority for protection) since they are near the tipping point towards one or more impairments. The Priority A streams include four Exceptional Use streams: Little Pine Creek (560), the west branch of the Moose Horn River (628), Pine River (624) and Kettle River (505). Additionally, three General Use streams, the Grindstone River (501), the Moose Horn River (521), and Larson's Creek (548), also scored as high priority for protection efforts. The tool also identified 19 Priority B and six Priority C stream reaches.

Twenty-five stream reaches in the Upper St. Croix River Watershed had the required data and information for assessment using the tool. Of these reaches, two were identified as Priority A, nine as Priority B, and 14 as Priority C. The higher priority stream reaches include five Exceptional Use streams: Little Sand Creek, Bangs Brook, Sand Creek, Crooked Creek, and the Upper Tamarack River. In addition, one General Use stream, Kenney Brook, scored as high priority for protection efforts. While these streams currently meet standards, work done to maintain current condition is important to prevent future impairment. A detailed list of protection streams can be found in Appendix A.

Lake Protection and Prioritization Tool

The MPCA and other state agencies have also developed a Lake Protection and Prioritization Tool to generate a prioritized list of protection lakes in each major watershed throughout the State. The analysis is based on water quality assessment results, the amount of clarity lost if phosphorus is added, the amount of land use disturbance, lake size, as well as what is known about current trends in water quality.

The prioritization process is limited to lakes that have completed water quality assessments and that are currently meeting water quality standards – i.e., they are considered fully supporting for aquatic recreation. The first step considers how much lake clarity would be lost with an increase of 100 pounds of phosphorus to the lake. This is also known as the lake's phosphorus sensitivity.

Figure 14: Lake Protection and Prioritization Tool Framework

The second step considers the significance of this sensitivity – i.e., the likelihood that this increase in phosphorus would occur. Factors considered include the percentage of disturbed land use (cultivated and urban uses), the amount of surface area of the lake, the current phosphorus concentration and loading to the lake, and the proximity of the lake to the impairment threshold. Any information on declining trends in water quality are also considered.

The third step for lakes results in a prioritized list of lakes, each with a load reduction goal. The goal is calculated as a 5% reduction in predicted phosphorus loading (pounds/year) for any given lake. The goal is not regulatory; it is intended to give local groups a value to aim for, in lieu of just maintaining current phosphorus levels. This provides a way to measure progress over time for a given lake; estimated load reductions in phosphorus can be tracked as new practices are implemented.

Once all of the nonimpaired lakes in the watershed have been ranked and prioritized, they are grouped into priority categories. The top 25th percentile is the high (A) priority, 50 to 75th percentile is medium (B) priority, and the bottom half of the lakes are the lower (C) priority. Forty-three lakes in the Kettle River Watershed had the required data and information for assessment using the Lake Protection and Prioritization Tool (Figure 15). Priority A lakes in the Kettle River Watershed include: Bear, Little Hanging Horn, Eddy, Island, Sturgeon, Dago, Sand, and Bass Lakes.

Thirteen lakes in the Upper St. Croix River Watershed had the required data and information for assessment using the tool (Figure 15). Of these lakes, Lena Lake was the only lake identified as Priority A. A detailed list of the priority protection lakes can be found in Appendix A.

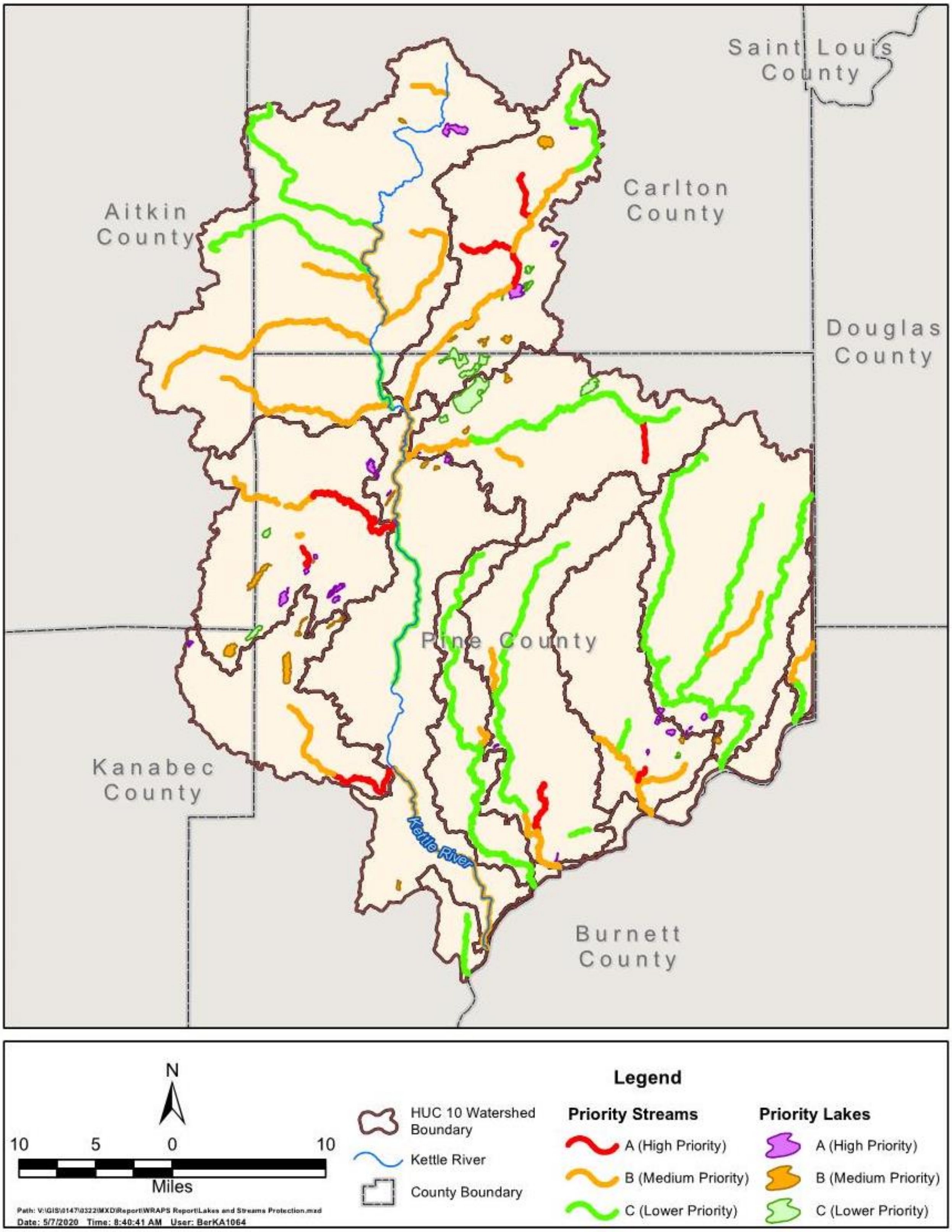
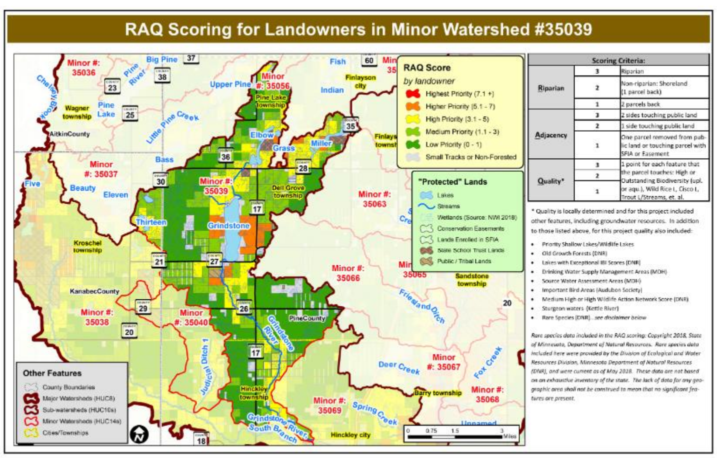


Figure 15: Priority streams and lakes in the Kettle River and Upper St. Croix River watersheds identified using the MPCA Stream and Lake Protection and Prioritization Tools.

Riparian Adjacency Quality (RAQ) Tool

The Riparian Adjacency Quality (RAQ) tool is a GIS tool developed by BWSR Technical Services Area 8 (i.e. north-central Minnesota) that local planners can use for targeting specific large tracts of forested land for protection strategies. This conservation-based analysis and subsequent scoring model places an emphasis on the forest-water interface. This forest-water interface, and the protection strategies that can be implemented to protect it, are critical for influencing water quality, habitat and other public benefits. The RAQ tool scores each private forested parcel on a 0-3 scale for each of three common characteristics: “Riparian”--the parcels proximity to water; “Adjacency”--the parcels location in relation to contiguous tracts of protected/managed land in preference to parcels scattered across the landscape, knowing that a forest community is healthier and more diverse with less fragmentation; and “Quality”--the most subjective of the three characteristics. Quality is defined by the local technical team within their realm of expertise, such as the presence of wild rice, cisco, or other outstanding or unique biological resources, either terrestrial or aquatic. The greatest risk for development and fragmentation is riparian private forest lands. The three individual Riparian, Adjacency and Quality scores are added together to make a composite RAQ score.

Scoring Criteria:		
Riparian	**3**	Riparian
	2	Non-riparian: Shoreland (1 parcel back)
	1	2 parcels back
Adjacency	**3**	2 sides touching public land
	2	1 side touching public land
	1	One parcel removed from public land or touching parcel with SFIA or Easement
Quality*	**3**	1 point for each feature that the parcel touches: High or Outstanding Biodiversity (upl. or aqu.), Wild Rice L, Cisco L, Trout L/Streams, et. al.
	2	
	1	



The higher the total RAQ score, the higher priority the parcel should have to implement protection strategies.

The RAQ tool has been developed for the entire Kettle River Watershed and includes a series of RAQ maps for each major HUC-10 subwatershed: Upper Kettle River, Lower Kettle River, Moose River, Willow River and Grindstone River. The tool prioritizes private parcels adjacent to state or federal lands (protected lands in the model). The RAQ tool will be a helpful tool for local SWCDs, county staff, DNR forestry, and other land and water managers in the Kettle River Watershed to aid in future planning efforts to target areas where public investments will have the most benefit. To date, the RAQ tool has not been developed for the Upper St. Croix River Watershed. Development of the RAQ tool for the Upper St. Croix River Watershed to advance the ongoing work of local partners in the watershed has been identified as a strategy in this report.

Watershed Health Assessment Framework (WHAF)

The DNR developed the Watershed Health Assessment Framework (WHAF), which provides a comprehensive overview of the ecological health of Minnesota's watersheds. The WHAF is based on a "whole-system" approach that explores how all parts of the system work together to provide a healthy watershed. The WHAF divides the watershed's ecological processes into five components: biology, connectivity, geomorphology, and hydrology and water quality. A suite of watershed health index scores have been calculated that represent many of the ecological relationships within and between the five components. These scores have been built into a statewide GIS database that is compared across Minnesota to provide a baseline health condition report for each of the 80 major watersheds in the state. The DNR has applied the condition report to larger (HUC-8) watersheds, as well as smaller (HUC-12) subwatersheds. Thus, the WHAF is a helpful resource and targeting tool for future restoration and protection planning and implementation in the Kettle River and Upper St. Croix River watersheds (see Figure 16 for example).

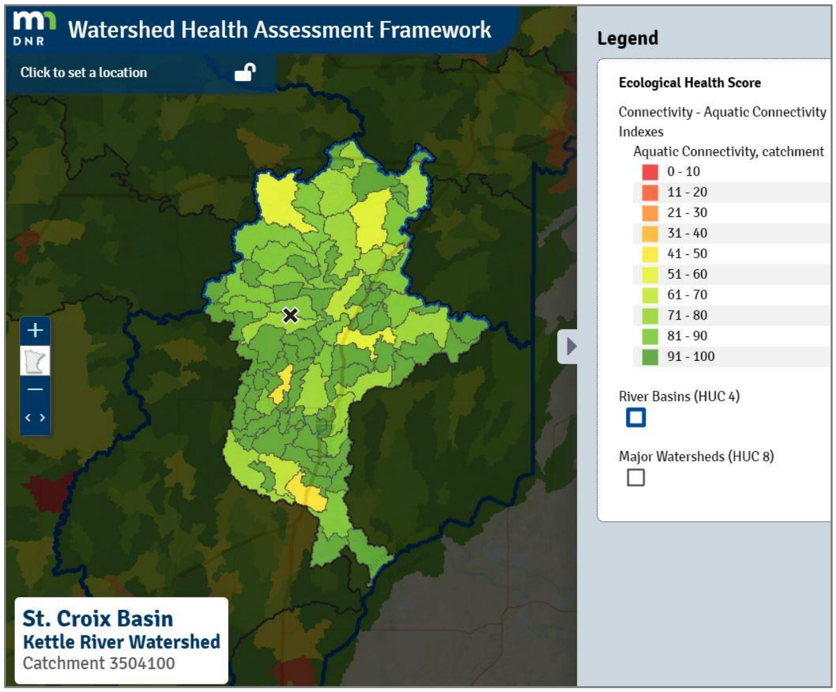


Figure 16: Aquatic connectivity analysis by individual catchment for the Kettle River Watershed using the DNR's online WHAF tool

Other Available Tools and Models

Table 16 below summarizes several other state-wide databases, analyses, tools and models that can be used to help prioritize and target waterbodies and/or upland areas for restoration and protection in the Kettle River and Upper St. Croix River watersheds.

Table 16: State-wide databases, analyses, tools, and models

Tools	Description	Link to information and data
Lake Phosphorus Sensitivity Significance Index	Index tool developed by MPCA to predict how much water clarity would be reduced with additional phosphorus loading to a given lake. The index is a function of phosphorus sensitivity, lake size, lake TP concentration, proximity to MPCA's phosphorus impairment thresholds, and watershed disturbance. Results are used to help prioritize lakes as they relate to MPCA's policy objective of focusing on high quality, unimpaired lakes at greatest risk of becoming impaired. This index tool was also used as one of the key metrics in the Lake Protection and Prioritization Tool described above	MN Geospatial Commons
Lake Benefit: Cost Assessment	Analysis performed by DNR to rank lakes as they relate to the state's priority of focusing on high-quality, high-value lakes that likely provide the greatest return on investment. For each lake, a benefit: cost assessment priority score was calculated. This score is a function of phosphorus sensitivity, lake size, and catchment disturbance. Lakes were then grouped based on this score and assigned a priority rating.	MN Geospatial Commons
Ecological ranking tool (Environmental Benefit Index - EBI)	This dataset consists of three Geographic Information System (GIS) raster data layers including soil erosion risk, water quality risk, and habitat quality. The 30-meter grid cells in each layer contain scores from 0-100. The sum of all three scores is the EBI score (max of 300). A higher score indicates a higher priority for restoration or protection.	MPCA Web Map MPCA download
Restorable wetland inventory	A GIS data layer that shows potential wetland restoration sites across Minnesota. Created using a compound topographic index (CTI) (10-meter resolution) to identify areas of ponding, and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) soils with a soil drainage class of poorly drained or very poorly drained.	Restorable Wetlands
National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD)	The NHD is a vector GIS layer that contains features such as lakes, ponds, streams, rivers, canals, dams, and stream gages, including flow paths. The WBD is a companion vector GIS layer that contains watershed delineations.	USGS
Light Detection and Ranging (LiDAR)	Elevation data in a digital elevation model (DEM) GIS layer. Created from remote sensing technology that uses laser light to detect and measure surface features on the earth.	MGIO

3.2 Public Participation

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic participation.

Accomplishments and future plans

The MPCA partnered with two local governmental units in the Kettle River and Upper St. Croix River watersheds (Carlton Soil and Water Conservation District and Pine County Soil and Water Conservation District) to directly advance public participation throughout the watersheds for much of the duration of this project. Through the partnership, the MPCA provided grant funds for the local partners to engage directly with watershed residents and landowners on a variety of water quality topics. These projects were successful in helping local watershed partners connect with watershed residents to build relationships that will be integral in implementing the strategies described in this report. Specific examples of the work completed through these partnerships include the following:

- Recruitment for the MPCA's Citizen Stream and Lake Monitoring Program resulted in 13 new citizen monitor volunteers;
- Water quality factsheets prepared by SWCD staff;
- Kettle River Watershed Lakes Summary Report for Carlton and Pine Counties, Upper St. Croix River Watershed Lakes Summary Report for Pine County, and 15 reports on individual lakes across both watersheds;
- An educational bus tour of the Kettle River Watershed;
- Watershed articles shared in local press and county newsletters;
- Meetings with stakeholders across both watersheds, including lake associations, farmer organizations, conservation groups;
- Outreach events with students and community members;
- Targeted mailings to feedlot and forest landowners promoting conservation practices and SFIA; and
- An ArcGIS Story Map for the Kettle River Watershed (https://carltonswcd.org/kettle-river-watershed) sharing key water quality messages.

The work that began under these civic engagement partnerships will continue to be advanced by local partners as implementation continues throughout both watersheds.

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 January 11, 2021 through February 10, 2021. There were no comment letters received and responded to as a result of the public comment period. Staff from both engaged SWCD offices were contacted and both indicated no further comment was needed.

3.3 Restoration and protection strategies

Watershed-Wide Strategies

The following watershed-wide strategies were identified by the local partners as priority strategies during this WRAPS process and/or during the development of the KRWLSP.

Shoreland Protection

Minnesota's buffer law requires perennial vegetative buffers along public ditches, and DNR designated shoreland of lakes, rivers, and streams. Buffers along lakes, rivers, and streams must be at least 50 feet in width on each bank, and buffers along public ditches must be at least 16.5 feet wide on each bank as well. Vegetative buffers help filter out phosphorus and sediment. Buffers are critical to protecting and restoring water quality and healthy aquatic life, natural stream functions and aquatic habitat due to their immediate proximity to the water. Further, maintained vegetative buffers provide needed filter strips that can limit runoff into streams during manure application in fields.

The buffer law provides some flexibility for landowners to install alternative practices if they provide equal or better water quality benefits. An example of an alternative practice could be a narrower buffer if the land slopes away from the water body. This is not uncommon with some ditches, rivers, and streams. Alternative practices must be approved by the local governmental unit that implements the buffer law. It should be noted that this law defines a buffer as any type of perennial cover, including turf grass. However, buffers that are most effective at protecting water quality and habitat are characterized by native, deep-rooted vegetation.

Within the Kettle River and Upper St. Croix River watersheds, most of the private lands are well vegetated with forests, grasslands, and wetlands. Most of the privately owned lands are managed for wildlife habitat, forest management, or recreational purposes. These lands are almost always covered by permanent vegetation. The buffer requirement is sometimes not met on agricultural lands, depending on the current crop or tillage methods. The majority of lands where buffers are not in place are being used for agricultural purposes—either livestock or crop production. As it pertains to karst features, there is consensus to increase vegetative buffers around identified sinkholes, stream-sinks and karst outcroppings.

Buffer compliance is referenced as a priority in all the County Local Water Plans. The KRWLSP identifies the action item of protecting forested riparian corridors in the Plan, which is also applicable to the Upper St. Croix Watershed. The KRWLSP lists a few specific priority buffer-related management strategies and general locations by subwatershed in the Kettle River Watershed:

- Upper Kettle River Subwatershed – riparian buffers strips along drainage ditches in Birch Creek and Split Rock River minor watersheds.
- Moose River Subwatershed – protect riparian areas along designated trout streams.
- Willow River Subwatershed – riparian buffers along Sturgeon Lake and along the streams upstream from Big Slough Lake.
- Pine River Subwatershed – protect and restore riparian buffers along Pine River downstream of Big Pine Lake and around Bass Lake.

- Lower Kettle River Subwatershed – restore and protect riparian forests along tributaries of concern.
- Grindstone River Subwatershed – protect and restore riparian buffers along lakes and tributaries of concern.

Note that the KRWLSP was completed in 2014 and therefore may not account for vegetative buffer improvements since publication. Also note that in general, most of the suggested management strategies discussed in the KRWLSP are highly applicable to the Upper St. Croix River Watershed. Per a BWSR 2020 buffer evaluation report, both watersheds rank high in the minimum buffer compliance requirements.

Forest Protection

Water quality in these watersheds is overall good, with its quality derived from well-managed forestlands, grasslands, and agricultural lands. Forestland ranks among the best land cover in providing clean water by absorbing rainfall and snow melt, slowing storm runoff, recharging aquifers, sustaining stream flows, filtering pollutants from the air and runoff before they enter the waterways, and providing critical habitat for fish and wildlife. In addition, forested watersheds provide abundant recreational opportunities, help support local economies, provide an inexpensive source of drinking water, and improve the quality of our lives.

As stated previously, the KRWLSP was developed to help private parties and public agencies to protect and enhance forest and water resources in the watershed. Key themes of the Plan are focused on partners and partnerships, implementation programs and priorities, training and funding and engagement of communities and landowners within the watershed. Specific forest management protection strategies and general locations outlined in the Plan include:

- Upper Kettle River Subwatershed – protect forests that extend outward from Solana State Forest and the State owned/County administered lands.
- Moose River Subwatershed – protect forests upstream from Hanging Horn and Little Hanging Horn Lakes as they are high quality Tullibee (Cisco) lakes.
- Willow River Subwatershed – restore forests east of Sturgeon Lake. Extend protected forest land to the east of General C.C. Andrews State Forest.
- Pine River Subwatershed – Restore forests in the Big Pine Lake and Medicine Creek – Pine River minor watersheds. Extend protected areas south of Solana State Forest in the Big Pine Lake minor subwatershed.
- Lower Kettle River Subwatershed – restore and protect riparian forests along tributaries of concern.
- Grindstone River Subwatershed – protect an additional 1,860 acres of upland forest (to maintain stable spring snow melts); start with areas near state forest lands in the headwaters that are located in Kroschel Township.

Further, the Kanabec County Water Plan identifies the Grindstone River Subwatershed as high priority for protection and restoration, particularly regarding forest management.

The KRWLSP stresses the importance of private forest management. When outlining coordination and implementation strategies for forest resource management plans, it is important to consider the entire range of options available to resource managers. The following is a range of options in the implementation toolbox as outlined in the Plan that could be applied to forest management in both the Kettle and the Upper St. Croix River watersheds. As one moves down the list, the costs and benefits generally increase in cost, permanence and social benefit.

- Technical Advice and Assistance – information, site visits, tree sales, equipment
- Forest Stewardship Plans – individual, cluster, common
- Cost Share Programs – Federal, State, local
- Property Tax Programs – credit, deferral
- Forest Economic Development – coops, forest banks
- Conservation Easements – donated, purchased
- Land Trades and Exchanges – public, industrial
- Fee Title Acquisition – Federal, State, local.

The DNR Forest Stewardship webpage provides an excellent resource for private forest management including education, management plan development, cost-share programs, and other grant and program opportunities: https://www.dnr.state.mn.us/foreststewardship/index.html

Subsurface Sewage Treatment Systems (SSTS) Improvements

Failing SSTS (also referred to as septic systems) can export high levels of bacteria, nutrients, and other pollutants to both surface and groundwater. Straight pipe systems and cesspools pose a greater pollution threat and are considered imminent threats to public health (ITPH) because they can cause significant harm to both people and the environment. Failing SSTS were identified in the lake (nutrients) and stream (bacteria) TMDLs for the watersheds as potential sources of bacteria and phosphorus to surface waters. However, at this time the exact location, condition, and number of potentially failing SSTS is largely unknown. In order to properly assess the level of influence failing SSTS have on the impairments of the Kettle River and Upper St. Croix River watersheds, further planning will be required.

There are a number of administrative and programmatic approaches local units of government that administer SSTS programs can pursue. Typical approaches include inventories of SSTS file materials, education and outreach, ordinance amendments requiring SSTS compliance inspection upon property sale or transfer, compliance inspection triggers as a condition of building permits, and systematic and prioritized site inspections based on local need. Three of the four counties within the Kettle River and Upper St. Croix watersheds require SSTS compliance inspections at time of property transfer. Those three counties are Aitkin, Kanabec and Pine. In Carlton County, SSTS compliance inspections are required at the time of property transfer or permit application for SSTS located in shoreland zoning areas. In Pine County, administration of county SSTS ordinances occurs at either the township level or the county level, varying by township. This can result in inconsistency in ordinance administration throughout the county as a whole.

Figure 17 shows a high-level overview of how wastewater is treated in the Kettle River and Upper St. Croix River watersheds. The largest cities in the watersheds operate municipal WWTPs, which collect wastewater through sanitary sewer systems and pump it to a central location for treatment before eventual discharge. Homes and businesses in smaller cities, townships, unincorporated communities (which include many homes and seasonal cabins along the shoreline of lakes), and unorganized territories throughout the watersheds primarily have individual or shared/community SSTS that treat wastewater onsite through soil-based treatment. Effective maintenance and management of SSTS is necessary to ensure that systems are functioning correctly, which in turn protects public health and quality of both surface and groundwater.

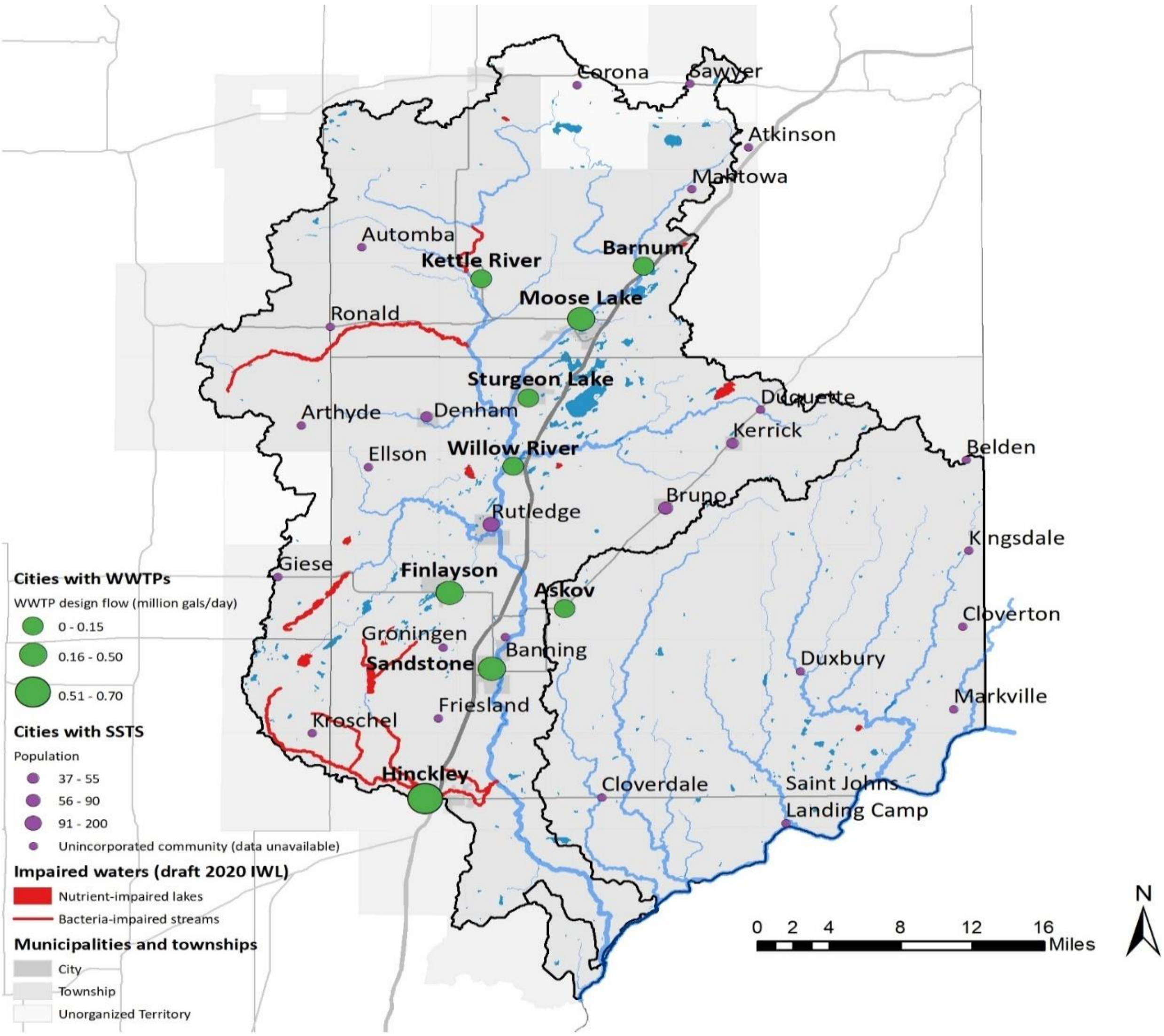


Figure 17: Wastewater treatment methods of the cities, townships, and unorganized territories within the Kettle River and Upper St. Croix River watersheds. The largest cities in the watersheds use wastewater treatment plants while smaller cities, unincorporated communities, and populated places use subsurface sewage treatment systems (SSTS). Note that this map does not show communities/developed areas around lakes, which generally use SSTS for wastewater treatment, and can negatively impact lake water quality if SSTS are not properly maintained.

Compliance with state and county regulations of SSTS along with maintenance and management practices are key to ensuring that groundwater and nearby surface water quality is protected. While these practices are important throughout the watershed, they are of additional concern in the areas of the watershed where the risk of groundwater contamination is highest. As mentioned in the Groundwater and Drinking Water discussion of Section 2.5, karst areas exist within the Kettle River and Upper St. Croix River Watershed; karst features such as sinkholes can serve as direct conduits between groundwater and the surface. Groundwater and surface water in these areas are particularly at risk of contamination from failing SSTS due to this unique interaction between the surface/near-surface and the geology below. SSTS program managers should take this knowledge into consideration in administration of their programs.

The following includes some funding sources local units of government have access to pertaining to administering a SSTS program.

Natural Resource Block Grant funds

Each Minnesota County receives Natural Resource Block Grant (NRBG) funds from the Board of Water and Soil Resources (BWSR) to help administer certain county programs that influence water quality. Those NRBG funds cover the following programs: a shoreland program, an SSTS program, a feedlot program, a Wetland Conservation Act (WCA) program, and a local water planning program. NRBG funds associated with SSTS are limited, and often help support the cost of staffing an employee to manage an SSTS program. However, some jurisdictions use the funds to supplement existing SSTS administrative functions funded through the County. The BWSR webpage provides details regarding county grants including the NRBG program: https://bwsr.state.mn.us/nrbg.

SSTS Assessments

There are state-sponsored funding programs available for community-wide septic system assessments. The Public Facilities Authority (PFA) administers the Small Community Wastewater Treatment Program, which provides grants of up to $60,000 to local government units to "conduct preliminary site evaluations and prepare feasibility reports, provide advice on possible SSTS alternatives, and help develop the technical, managerial, and financial capacity to build, operate, and maintain SSTS systems" (PFA website). These studies assess current SSTS compliance status as well as potential future individual and/or community SSTS solutions.

The PFA Small Community Wastewater Program offers grant and loan packages of up to $2,000,000 for the construction of publicly-owned community SSTS. The PFA webpage provides an excellent resource in providing financial and technical resources for a variety of wastewater projects: https://mn.gov/deed/pfa/.

BWSR and the MPCA have also provided grant opportunities in the past to local governments for large-scale SSTS compliance inspection projects. These projects typically involve riparian communities on impaired waterbodies.

SSTS Upgrades/Replacement process

When a straight pipe system or other Imminent Threat to Public Health (ITPH) location is confirmed, the local SSTS Local Government Unit (LGU) will send a Notice of Noncompliance to the owner that includes a replacement or repair timeline. State rules mandate a 10-month deadline for the system to be brought into compliance, but an LGU can choose to set a more restrictive timeline.

An SSTS does not need to be a straight pipe or other ITPHS to be a threat to surface water quality. Leaking tanks or a drainfield without adequate separation from groundwater can result in the transport of pathogens or excess nutrients to nearby surface waters through the groundwater. This is of particular concern for properties in shoreland or karst areas.

Low Income Fix-up Grants

Since 2013, the MPCA wastewater program has been providing grant funds to counties to fix noncompliant SSTS for low-income individuals. From 2013 through 2019, a combined total of $526,358 has been awarded to Aitkin, Carlton, Kanabec, and Pine Counties. Since these funds are awarded on a county-wide basis, they are not specific to any given watershed.

Additionally, some Counties and SWCDs offer their own low-interest loan programs for SSTS upgrades or replacement. Zero-interest loans available from the MPCA's Clean Water Partnership program can support local governments' efforts to provide these programs to individuals in their jurisdiction.

SSTS Maintenance and Education

The most cost-effective BMP for managing loads from SSTS is regular maintenance. EPA recommends that septic tanks be pumped every three to five years depending on the tank size and number of residents in the household (EPA 2002). When not maintained properly, SSTS can cause the release of pathogens and excess nutrients into surface water. Annual inspections, in addition to regular maintenance, ensure that systems function properly. Compliance with state and county code is essential to reducing *E. coli* and phosphorus loading from SSTS. SSTS are regulated under Minn. Stat §§ 115.55 and 115.56. Counties must enforce ordinances in Minn. R. ch. 7080 to 7083.

Education is another crucial component of reducing pollutant loading from SSTS. Education can occur through public meetings, routine SSTS service provider home visits, mass mailings, and radio and television advertisements. An inspection program can also help with public education because inspectors can educate owners about proper operation and maintenance during inspections.

The University of Minnesota Onsite Sewage Treatment Program website offers workshops, training, and licensure for SSTS professionals and property owner maintenance and education materials: https://septic.umn.edu/

Feedlots

Animal feedlots are defined in Minnesota Rules as "a lot or building or combination of lots and buildings intended for the confined feeding, breeding, raising, or holding of animals and specifically designed as a confinement area in which manure may accumulate, or where the concentration of animals is such that a vegetative cover cannot be maintained within the enclosure" (Minn. R. ch. 7020.0300, subp. 3). Pasturelands are generally excluded from this formal definition of feedlots.

As of January 2020, there are approximately 77 feedlots requiring MPCA registration (defined as greater than or equal to 50 AUs, or greater than or equal to 10 AUs in shoreland) located in the Kettle River and Upper St. Croix River watersheds. These operations house approximately 26,500 AUs—AUs refer to a standardized system to account for differences between manure production among different animals. In addition to the feedlots that require MPCA registration, an unknown number of smaller operations operate throughout the watershed. While these operations are small and produce less manure than those required to register, they are prevalent throughout both watersheds and present an opportunity for education and outreach to ensure that appropriate BMPs are being utilized to both conserve landowners' resources and protect water quality.

Discussions with the Local Work Group that guided the development of this report and MPCA Feedlots Program staff identified several priorities for feedlot and manure management in the watershed. Given the lack of information in the majority of the watersheds about smaller feedlot operations, one of the preliminary steps discussed that will be foundational for further implementation is to conduct a feedlot inventory throughout watershed to inform prioritization of projects. This effort would likely happen through a combination of desktop and field visits to better document the current status of small feedlot operations within the watersheds. This data would expand upon and supplement existing county, SWCD, and state datasets and will be invaluable for implementing BMPs at feedlot operations of all sizes across the watersheds. An additional benefit of a feedlot analysis is that it can help to better understand operations that may not be currently active, which helps to prioritize limited resources and to update infrequently-updated datasets. Carlton SWCD has already completed a feedlot inventory for Carlton County and their work can serve as a model for other LGUs as they begin working on their inventories.

Another feedlots focus area identified in the Kettle River and Upper St. Croix River watersheds is manure management, particularly at smaller feedlot operations (i.e., less than 300 AUs). A key component of manure management at these sites includes updates and improvements to manure management plans and improvements to storage facilities, including more stacking slabs, longer storage times, and larger pits for manure storage. This longer storage time is particularly of relevance for feedlot operations located within karst areas of the watersheds. (Land application of manure near karst features is regulated under Minn. R. ch. 7020.2225, subp. 8.) Education and outreach about land application requirements can be valuable tools to ensure rule compliance. To ensure success in these feedlot strategies, it will be invaluable to leverage existing partnerships and create new partnerships across the watersheds. Partnerships should include (but not be limited to) feedlot owners/operators, local producer organizations, SWCDs, counties, BWSR, NRCS, and MPCA Feedlots Program.

Peatland Altered Hydrology

A large part of the northwestern area of the Kettle River Watershed is flat and contains various wetland/peatland, low-gradient streams with soft bottoms, and darkly stained tannins. Altering the hydrology in these large wetland/peatland systems was common in the early 1900s throughout this part of the watershed, as well as other locations in the Kettle River Watershed, in order to drain many of these bog areas (Figure 18). The channelized wetlands/peatlands are likely a major contributor to low DO levels in downstream streams due to the wetland-sourced water they convey to the streams. It is also believed that these altered systems are impacting downstream hydrology, however, the extent of these impacts are unclear and are still being studied (Holden et al. 2004). Some of the biotic impaired reaches in the Kettle River Watershed that are located downstream of the altered peatlands appear to have channel damage in some locations, which has led to habitat loss.

In order to better understand the hydrologic impacts of these systems, paired flow monitoring stations could be established both upstream (i.e. in the peatland) and downstream of the altered wetland/peatlands. Such a study would improve knowledge of how hydrology is quantitatively altered in these systems, and how that alteration has affected water quality in and downstream of these peatlands. Restoring hydrology in these systems is a complex task, and a standard template of peatland restoration does not exist (Price et al. 2003). Efforts to restore natural hydrology to stream channels by restoring upstream peatland hydrology should be done in consultation with experienced hydrologists, and it should be realized that attempts at the current time are not guaranteed to succeed since peatland hydrology is still being researched.

Figure 18: Example of altered peatland system in the Upper Kettle River Subwatershed located just west of Kettle Lake

Culvert Replacement and other Barriers

As discussed in Section 2.3, infrastructure stressors, which include dams and perched and undersized culverts, can make fish passage difficult or impossible and lead to negative impacts and impairments to biological communities. Problem culverts and dams were identified as primary stressors for several of the biotic impaired reaches in the Kettle and Upper St. Croix Watershed SID reports. In 2019, the DNR completed Stream Crossing Inventory and Prioritization Reports for the Kettle River and Upper St. Croix River watersheds. For these reports, a total of 398 stream crossings (245 in Kettle; 153 in Upper St. Croix) were identified and assessed for fish passage. The DNR uses a set of criteria to determine complete (Level 1) and significant (Level 2) barriers such as water/culvert slopes, headloss, degree of perching and the sizing ratio. These barriers were then prioritized using upstream drainage area, natural stream miles, rare features, and professional judgement points. Results of the assessments indicate there are 72 total barriers (45 in Kettle; 27 in Upper St. Croix) throughout both watersheds, which includes: 8 dams, 2 Level 1 (complete) barriers, and 62 Level 2 (significant) barriers.

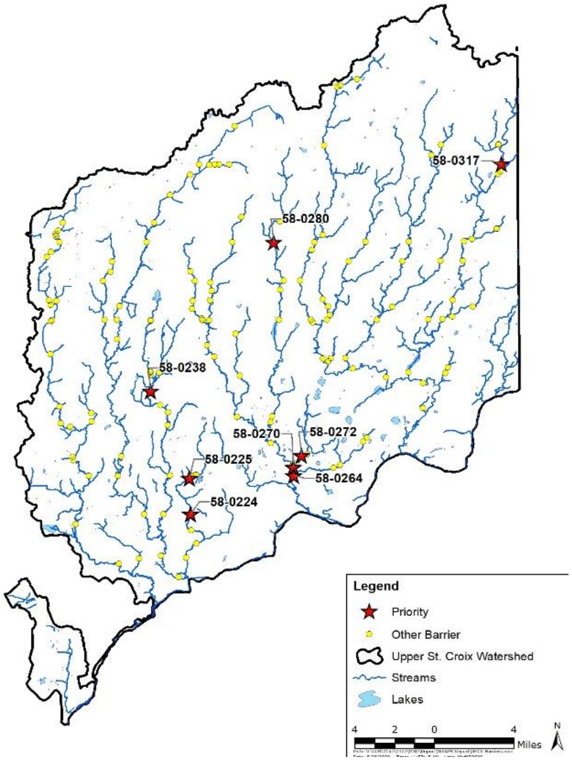


Figure 20: Priority barriers for the Upper St. Croix River Watershed

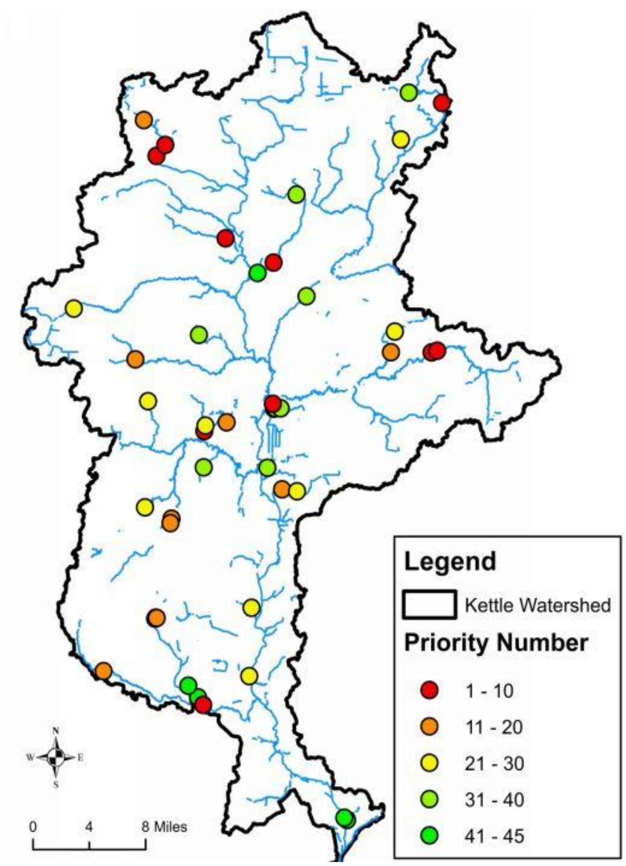


Figure 19: Priority barriers for the Kettle River Watershed

Figure 19 shows the locations of the priority barriers for the Kettle River Watershed. In this figure, priority scores of 1-10 are the highest priority sites based on the prioritization criteria described above. High priority sites will need a full site assessment to determine if restoration is necessary and/or possible. Figure 20 shows the locations of barriers identified for the Upper St. Croix River Watershed, with priority barriers specified. Note that a different prioritization methodology was used for barriers in the Upper St. Croix River Watershed, so while the results are generally comparable, full site assessments prior to restoration activities should be completed in both watersheds to ensure that the highest priority sites are being effectively addressed.

The priority barrier locations for both watersheds are also shown in the HUC-10 subwatershed maps (Figures 21 through 32) that proceed the individual restoration and protection tables later in this section.

Beaver activity was also identified as a likely stressor for a number of the biotic impaired reaches in the Kettle River and Upper St. Croix River watersheds. Beaver dams can act as partial, or in some cases complete, barriers by blocking fish passage and preventing repopulation of streams in spring from downstream overwintering habitat. Beaver dams also have the potential to impound and slow streamflow which leads to longer residences times, increased temperatures, and decreases in DO. The biotic impaired reaches with known beaver activity are noted in the SID Reports and the individual strategies tables below.

Funding Sources

There are a variety of funding sources to help cover some of the cost to implement practices that reduce pollutants from entering surface waters and groundwater. Below are several web links to the programs and contacts for each entity. The contacts for each grant program can assist in the determination of eligibility for each program, as well as funding requirements and amounts available.

- Agriculture BMP Loan Program (MDA)
- Agricultural Water Quality Certification Program (MDA)
- Clean Water Fund Grants (BWSR)
- Clean Water Partnership Loans (MPCA)
- Environment and Natural Resources Trust Fund (Legislative-Citizen Commission on Minnesota Resources)
- Environmental Assistance Grants Program (MPCA)
- Phosphorus Reduction Grant Program (Minnesota Public Facilities Authority)
- Clean Water Act Section 319 Grant Program (MPCA)
- Small Community Wastewater Treatment Construction Loans & Grants (Minnesota Public Facilities Authority)
- Source Water Protection Grant Program (MDH)
- Surface Water Assessment Grants (MPCA)
- Wastewater and storm water financial assistance (MPCA)

- Conservation Partners Legacy Grant Program (DNR)
- Environmental Quality Incentives Program (Natural Resources Conservation Service)
- Conservation Reserve Program (USDA)
- Clean Water State Revolving Fund (EPA)

Climate protection co-benefit of strategies

Many agricultural BMPs that reduce the load of nutrients and sediment to receiving waters also act to decrease emissions of greenhouse gases (GHGs) to the air. Agriculture is the third-largest emitting sector of GHGs in Minnesota. Important sources of GHGs from crop production include the application of manure and nitrogen fertilizer to cropland, soil organic carbon oxidation resulting from cropland tillage, and carbon dioxide (CO_2) emissions from fossil fuel used to power agricultural machinery or in the production of agricultural chemicals. Reduction in the application of nitrogen to cropland through optimized fertilizer application rates, timing, and placement is a source reduction strategy; while conservation cover, riparian buffers, vegetative filter strips, field borders, and cover crops reduce GHG emissions as compared to cropland with conventional tillage.

The USDA NRCS has developed a ranking tool for cropland BMPs that can be used by local units of government to consider ancillary GHG effects when selecting BMPs for nutrient and sediment control. Practices with a high potential for GHG avoidance include: conservation cover, forage and biomass planting, no-till and strip-till tillage, multi-story cropping, nutrient management, silvopasture establishment, other tree and shrub establishment, and shelterbelt establishment. Practices with a medium-high potential to mitigate GHG emissions include: contour buffer strips, riparian forest buffers, vegetative buffers and shelterbelt renovation. A longer, more detailed assessment of cropland BMP effects on GHG emission can be found at NRCS, *et al*., "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRDC Conservation Practice Planning http://comet-planner.nrel.colostate.edu/COMET-Planner_Report_Final.pdf.

Watershed Priorities

The tools, models, KRWLSP, and county water plans have been integral in identifying and organizing information around watershed priorities that are taking place throughout the watershed. In lieu of completing a formal ranked prioritization exercise during the development of this report, efforts were concentrated on comparing tool and model output with existing priorities outlined in county water plans, the KRWLSP, and local professional judgement. Discussions with a Local Work Group consisting of partners from a variety of different groups and affiliations helped to refine the scope of what priorities will look like during the implementation period of this WRAPS report. Partners participating in the Kettle River Upper St. Croix River watersheds Local Work Group included staff from tribal governments, county environmental services/planning and zoning departments, SWCDs, MPCA, DNR, BWSR, MDA, MDH, lake associations, and other interested and affected citizens, LGUs, and agencies. Implementation of restoration and protection projects at the project level are very likely to directly involve these partners, so the local knowledge and expertise of the Local Work Group weighed heavily in the creation of implementation tables in this report.

Water-based recreation on the lakes and streams of the Kettle River and Upper St. Croix River watersheds is important to many, both residents and visitors. The lake associations that participated in the Local Work Group have a vested interest in the lake(s) that their organizations oversee. Based on stakeholder/interest group input, modeling and tool outputs, and discussions with local resource professionals, the following lakes stood out as having relatively high recreational use: Bear, Big Pine, Dago, Echo, Grindstone, Hanging Horn, Island, Little Hanging Horn, Moose, Pine, Sand, and Sturgeon. Of these lakes, Pine, Big Pine, and Grindstone have impaired aquatic recreation due to excess nutrients. Additionally, Hanging Horn and Island were both flagged as vulnerable to future aquatic recreation impairment based on available data. Restoration efforts in the impaired lakes' drainage areas and protection efforts throughout the drainage areas of all of these lakes will be important to ensure that these lakes can become or remain suitable for aquatic recreation going forward. While these lakes are located throughout the watershed, a slight majority of them are located in the Moose River HUC-10 Subwatershed, which helps to underscore the importance of connecting lakeshed-specific projects to the larger subwatershed scale to allow for regional water quality benefits. Conversations with local professionals also identified that development pressure around Moose Lake (the city) has been increasing, so maximizing existing protected lands and working to expand protection on private land through programs such as SFIA and conservation easements, and integrating stormwater BMPs whenever possible will be important tools to protect both lakes and streams in the subwatershed against degrading water quality.

Another HUC-10 subwatershed that was identified as a priority for protection and restoration is the Grindstone River Subwatershed. None of the six assessed streams meet water quality standards for aquatic recreation and two lakes (Grindstone and Elbow) are also impaired by aquatic recreation use. Additionally, compared to other subwatersheds in the Kettle River Watershed, the Grindstone River has the largest percentage of rangeland land use and the lowest percentage of wetland land use. Forest and wetland land uses are still dominant, so projects in this subwatershed should concentrate on protecting these resources and minimizing additional losses, as well as conserving and restoring rangeland through BMP implementation. The feedlot strategies identified earlier in this report will be of particular relevance in this watershed due to the prevalence of range and pasturelands. Beyond improvements in livestock and manure management, tillage and residue management will also be of high importance to reduce nutrient and bacteria loading into lakes and streams in the Grindstone River Subwatershed.

Across both watersheds, rare/sensitive species and areas of high biological integrity also stood out as important factors to inform watershed priorities. As previously discussed, cisco (*Coregonus artedi*) can be an early indicator of eutrophication in a lake because of their requirements for cold hypolimnetic temperatures and high DO levels. Two cisco lakes—Hanging Horn and Little Hanging Horn—are found in the watersheds. Hanging Horn, which has a relatively large watershed area due to the Moose Horn River flowing through the lake, is particularly sensitive to changes in land use upstream. Protection measures will be key to ensuring that sensitive and indicator species such as cisco are able to thrive into the future. Another sensitive fish species found in the Kettle River and Upper St. Croix River watersheds are lake sturgeon (*Acipenser fulvescens*). Sturgeon migrate widely through the stream and lake systems they are found in, so connectivity issues can directly impact their ability to spawn and feed (DNR 2020). Strategically addressing the fish passage barriers present in critical habitat areas throughout the watersheds can improve sturgeon habitat and help this fish species of special concern thrive.

The MPCA has adopted a Tiered Aquatic Life Use (TALU) framework, which designates several exceptional use (highest quality habitat) streams within both watersheds and holds these streams to higher IBI standards to prevent degradation of these high-quality communities. “Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition” (MPCA 2019a and MPCA 2019b). These stream reaches, which are listed in Appendix A of this report, should be given special consideration for protection efforts to ensure that these high quality aquatic communities are protected against degradation. There is much land already protected in both watersheds, so in many instances, vigilance of existing protections may be more appropriate. Beyond TALU-designated exceptional use streams, there are many streams in the watersheds that support coldwater fish and macroinvertebrate species, including multiple species of trout (brook, brown, and rainbow). These coldwater taxa are often particularly vulnerable to watershed and in-channel disturbances, so reaches that support coldwater taxa are of particular concern for protection considerations. Many of these reaches are also designated by DNR as trout streams and are managed for trout angling, which is an important recreational resource available to watershed residents and visitors alike that depends on high water quality.

Beyond fish and macroinvertebrate communities, the Kettle River and Upper St. Croix River watersheds are home to multiple lakes and impoundments that support wild rice. As discussed in Section 2.5, wild rice is sacred to the Ojibwe people and provides a valuable food source to both humans and wildlife alike. Wild rice lakes and lakes of biological significance were both identified as priorities for protection and restoration in this report due to the benefits they provide for both humans and ecosystems. Lakes of biological significance were “identified and classified by DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, birds)” (https://gisdata.mn.gov/dataset/env-lakes-of-biological-signific). These lakes, which often include wild rice lakes, and their classification in an objective manner can provide a helpful frame of reference of the status of biological communities in and around lakes. Protection and restoration activities should be prioritized to ensure that wild rice and lakes of biological significance are adequately guarded from degradation.

HUC-10 Subwatershed Strategies

This section provides detailed tables identifying restoration and protection strategies for individual lakes and streams in each HUC-10 subwatershed. The subwatershed-based implementation strategy tables outline the strategies and actions that are capable of cumulatively achieving the needed pollution load reductions for point and nonpoint sources, as well as watershed and in-stream improvements to decrease stressors on biological communities throughout the watershed. The tables were developed by reviewing results of the TMDL studies, SID reports, the KRWLSP, HSPF and other modeling tools, specific conditions affecting each subwatershed, and input and feedback from the Kettle River Watershed technical group and local citizen groups.

Upper Kettle River HUC-10

Subwatershed Characteristics

- Size: 224,693 acres
- HUC-12 subwatersheds: Headwaters Kettle River, Kettle Lake, Heikkila Creek-Kettle River, West Branch River, Dead Moose River, Silver Creek, Gillespie Brook, City of Kettle River-Kettle River, Split Rock River, Birch Creek
- Towns/Cities: Cromwell (pop. 231) (partially in the Mississippi River-Grand Rapids major watershed), Kettle River (pop. 180) and Denham (pop. 35)
- Point Source Dischargers: Kettle River WWTP and Barnum WWTP
- Land cover: wetlands (45%), forest/shrubland (38%), hay/pasture (12%), developed (2%), cropland (1%), open water (1%), and barren/mining (<1%)
- Forested Land Protection: 36% (30,816 acres) public ownership, 64% (54,903 acres) privately owned
- WHPAs: Kettle River (34 acres) (see Figure 11)
- DWSMAs: Kettle River (120 acres) (see Figure 11)

Streams

- Streams: 378 miles
- Stream Types
  - Natural: 195 miles
  - Altered: 133 miles
  - Impounded: <1 mile
  - No definable channel: 49 miles
- Impaired Streams (45.42 miles, three AUIDs):
  - Kettle River: Headwaters to W Br Kettle R (-511), FishesBio
  - Split Rock River: Headwaters to Kettle R (-513), *E. coli*
  - Kettle River: W Br Kettle R to Dead Moose R (-529), *E. coli*
- Public Watercourses: 158 miles
- TALU Classes
  - Exceptional use: 0 miles
  - General use: 107 miles
  - Modified use 0 miles
- DNR Designated Trout Streams: None

- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 0 reaches
    - Priority B: 7 reaches (69 miles)
    - Priority C: 3 reaches (37 miles)
- Stream Crossing Inventory and Prioritization
    - Top 10: 4 barriers
    - Rank 11-19: 1 barrier
    - Rank 20-29: 2 barriers
    - Rank 30-39: 1 barrier
    - Rank 40-45: 2 barriers

Lakes

- Lakes >10 acres: Kettle (2), Little Kettle, Mattlia, Merwin, School, Section One, Split Rock, Walli
- Lakes >100 acres: Kettle
- Impaired Lakes: Merwin
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: Kettle, Little Kettle
    - High: none
    - Moderate: Mattlia
- DNR Priority Shallow Lakes: Kettle
- DNR Wild Rice Lakes: Kettle and Split Rock
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: none
    - Priority B: none
    - Priority C: Kettle
- Lake Benefit: Cost Assessment Tool:

- Highest: none
- Higher: none
- High: Kettle and Merwin

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: Low
- Minor Subwatershed Priorities: West Branch River, Birch Creek, Split Rock River,
- Lakes and Tributaries of Concern: West Branch River
- Priority Management Strategies:
    - Protect areas along West Branch River between State Owned/County Administered lands and around Fond Du Lac State Forest
    - Riparian buffer strips along drainage ditches in Birch Creek and Split Rock River minor watersheds
    - Protect forests that extend outward from Solana State Forest and the State Owned/County Administered lands
- 10-year Demonstration Projects:
    - Birch Creek to Moose Horn River Reach: Funding applied for 3 small projects focused on riparian areas (Carlton SWCD)
    - Northwest State/County Forest Block: Protect these blocks from fragmentation and parcelization (DNR Forestry and Carlton County Land Department)
    - West Branch Kettle River: Protect riparian areas. Consists of mostly 40-acre parcels owned by a variety of private nonindustrial landowners (Carlton SWCD)
    - Fond Du Lac State Forest: Re-meandering of drainage ditches (DNR Forestry)

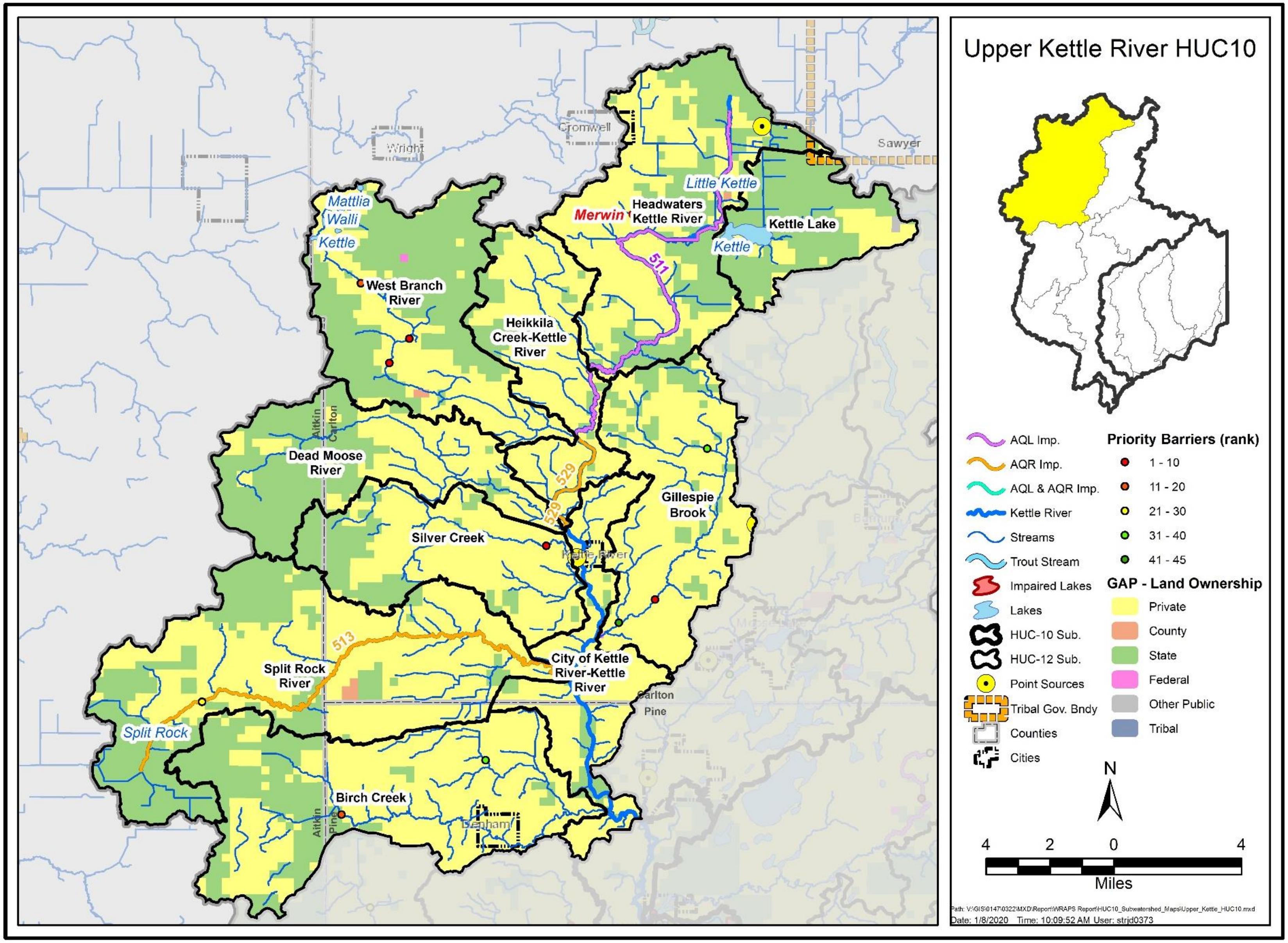


Figure 21: Upper Kettle River HUC-10 Subwatershed

Table 17: Strategies and actions proposed for the Upper Kettle River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.	Estimated Adoption Rate				Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Aitkin County	Pine County	Cities	Lake Assoc.	Landowners	
Upper Kettle River	All	Carlton, Aitkin, Pine	All	N/A	N/A	Monitoring, Assessments, & Inventories	Conduct inventory/assessment of streambank and riparian conditions along the Kettle River to ID & prioritize bank stabilization, stream restorations, and other riparian improvement projects	N/A	Complete inventory/ assessment	Use completed inventory/assessment to ID & prioritize projects	completed inventory/ assessment					x	x	x	x				2040
						Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations.	57%	75%	>75%	% land in subwatershed protected			x		x	x	x	x			x	
						Restore natural hydrology	Abandon ditches of little or no benefit within peatlands throughout subwatershed to restore natural hydrology	35% of streams in subwatershed altered	ID & prioritize projects/locations, complete feasibility studies	Complete 3 projects	completed projects			x	x	x	x					x	
						Modify/replace dams culverts & fish passage barriers	10 potential barriers identified by DNR throughout subwatershed (see Figure 21). Modify/replace	N/A	Modify/replace 3 barriers	Modify/replace 10 barriers	completed projects			x		x	x	x	x				

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Aitkin County	Pine County	Cities	Lake Assoc.	Landowners	
							barriers as opportunities arise.																
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale (only in shoreland zoning areas in Carlton Co.)	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems						x	x	x	x		x	
	Kettle River (07030003-511)	Carlton	Fish IBI	Fish IBI = 30, 40; stressors = DO, channel alteration, habitat	Fish IBI >42	Restore floodplains and reconnect with channel	Re-connect flow into original meandering channels to improve habitat and hydrology (e.g. downstream of Kettle Lake)	N/A	Complete feasibility study, complete 1 project	Complete 3 projects	completed projects			x		x	x					x	2040
						Restore natural hydrology	Ditch abandonment to restore natural hydrology within peatland/wetland east of Kettle Lake in WMA	N/A	Complete feasibility study	Complete restoration	completed restoration			x		x	x					x	
	Kettle River (07030003-529)	Carlton	E. coli	118 - 529 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 76% reduction	See strategies below for E. coli impairments																	2040
	Split Rock River (07030003-513)	Carlton, Aitkin	E. coli	90 - 329 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 62% reduction																		
	Strategies for E. coli impairments noted above					Monitoring	Conduct longitudinal (upstream to downstream) E. coli monitoring surveys to determine potential locations of bacteria loading	N/A	Conduct 1-3 surveys on each impaired reach	Use surveys to inform & prioritize project implementation	completed monitoring				x	x							

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Specific Implementation Strategy	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	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Aitkin County	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							If results of longitudinal surveys are inconclusive, consider performing microbial source tracking to identify sources of bacteria to streams	N/A	Conduct source tracking as necessary depending on results of longitudinal surveys	Use source tracking to inform & prioritize project implementation	completed monitoring				x	x							
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 3 projects with landowners	Complete 8 projects with landowners	completed projects				x	x	x	x				x	
						Improve livestock and manure management Improve riparian vegetation	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas Bank revegetation where appropriate, protect and enhance existing riparian buffers, protect forested buffers on private land through SFIA and other programs	N/A N/A	Complete 3 projects with landowners ID & prioritize sensitive shorelands & poorly buffered areas, complete 2 projects	Complete 8 projects with landowners Increase riparian buffers by at least 50% in identified areas	completed projects completed projects, sensitive shorelands, poorly buffered areas				x	x x	x	x				x x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale (only in shoreland zoning areas in Carlton Co.)	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x	x	x	x		x	
						Monitor water quality in wetland and major tributary entering lake from northwest,			4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring								x	x			

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Aitkin County	Pine County	Cities	Lake Assoc.	Landowners	
						compare to TMDL modeling																	
	Merwin Lake (09005800)	Carlton	Phosphorus (TP)	167 lb TP/yr; 39 ppb TP summer avg. 29 ppb TP summer avg.	120 lb TP/yr; <30 ppb TP summer avg. Maintain or improve existing water quality	Monitoring Improve riparian vegetation	Collect sediment cores to evaluate phosphorus release from sediment and potential impacts of historic paper mill, compare to TMDL	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	completed coring					x					x		
							Conduct fish survey according to DNR methods and protocols	N/A	Complete survey	Use survey results to evaluate if fisheries mgt. is needed	completed survey			x							x		
							Conduct shoreline inventory to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach/	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x							
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects					x	x				x		
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale in shoreland zoning areas	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x	x				x	
						Monitoring	Conduct WQ monitoring to further assess conditions and track changes/trends as upstream projects are completed	N/A	Monitor annually as projects are completed	Assess changes/trends	completed monitoring				x	x			x	x		x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Aitkin County	Pine County	Cities	Lake Assoc.	Landowners	
	Kettle Lake (09004900)	Carlton Carlton	Phosphorus (TP) Fish IBI, Invert. IBI, Dissolved Oxygen	29 ppb TP summer avg. Fish and Invert. IBI insufficient information to determine impairment, DO could be stressor	Maintain or improve existing water quality Improve existing conditions	Restore natural hydrology	Ditch abandonment to restore natural hydrology within peatland/wetland east of Kettle Lake in WMA	N/A	Complete feasibility study	Complete restoration	completed restoration			x		x	x						N/A
						Monitoring	Collect additional DO data and Fish and Invert. IBI data to determine impairment and potential stressors	N/A	Complete 1 season of monitoring	Use monitoring results to determine impairment and inform management	completed monitoring				x	x						x	
	Heikkila Creek (07030003-616)	Carlton	Fish IBI, Invert. IBI, Dissolved Oxygen	Fish and Invert. IBI insufficient information to determine impairment, DO could be stressor	Improve existing conditions	Restore floodplains and reconnect with channel	Re-connect flow into original meandering channels to improve DO and hydrology	N/A	Complete feasibility study, complete project	Complete project if feasible	completed projects			x		x	x						
																						x	

Color Key:

- Restoration
- Protection
- Subwatershed-wide strategies

Moose River HUC-10

Subwatershed Characteristics

- Size: 90,326 acres
- HUC-12 subwatersheds: Hanging Horn Lake-Moose Horn River, Moose Horn River, Moose River, Portage River, Portage River
- Towns/Cities: Sturgeon Lake (pop. 2,447), Moose Lake (pop. 2,001), Barnum (pop. 646)
- Point Source Dischargers: Moose Lake WWTP and Sturgeon Lake WWTP
- Land cover: wetlands (40%), forest/shrubland (35%), hay/pasture (13%), developed (6%), open water (5%), cropland (1%), and barren/mining (<1%)
- Forested Land Protection: 13% (4,042 acres) public ownership, 87% (27,306 acres) privately owned
- WHPAs: Barnum (41 acres), Moose Lake (1,370 acres), Minnesota Correctional Facility - Moose Lake (216 acres), Sturgeon Lake (133 acres), and Sun Bay Mobile Home Park and Campground (89 acres) (see Figure 7)
- DWSMAs: Minnesota Correctional Facility - Moose Lake (436 acres), Sturgeon Lake (208 acres), Moose Lake (1,870 acres), Barnum (92 acres), and Sun Bay Mobile Home Park and Campground (243 acres) (see Figure 7)

Streams

- Streams: 160 miles
- Stream Types
    - Natural: 119 miles
    - Altered: 12 miles
    - Impounded: 2 miles
    - No definable channel: 27 miles
- No impaired streams
- Public Watercourses: 75 miles
- TALU Classes
    - Exceptional use: 7 miles
    - General use: 38 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 15 miles
- Cold Water Streams: 2 streams (15 miles)
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)

- Priority A: 3 reaches (12 miles)
- Priority B: 3 reaches (22 miles)
- Priority C: 1 reach (11 miles)

- Stream Crossing Inventory and Prioritization
  - Top 10: 1 barrier
  - Rank 11-19: No barriers
  - Rank 20-29: 1 barrier
  - Rank 30-39: 2 barriers
  - Rank 40-45: No barriers

Lakes

- Lakes >10 acres: 16 lakes
- Lakes >100 acres: Echo, Little Hanging Horn, Moose, Moosehead, Park, Hanging Horn, Sand, and Island
- Impaired Lakes: Twentynine
- Nearly/Barely Impaired Lakes: Bear, Eddy, Moosehead, Hanging Horn, and Island
- Lakes of Biological Significance
  - Outstanding: Manoomini-zaaga'iganing (Wild Rice), Moosehead, and Hanging Horn
  - High: Lords
  - Moderate: None
- DNR Priority Shallow Lakes: Spring and Wild Rice
- DNR Wild Rice Lakes: Little North Sturgeon, Manoomini-zaaga'iganing (Wild Rice), Bob, Moose, and Moosehead
- DNR Cisco Refuge Lakes: Hanging Horn and Little Hanging Horn
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: Island
- FIBI scores
  - Exceptional: Echo and Hanging Horn
  - At or Above Impairment: Bear and Island
  - Below Impairment Threshold: Sand
- Lake Protection & Prioritization Tool (see Figure 14)
  - Priority A: Eddy, Bear, Little Hanging Horn, Sand, and Island
  - Priority B: Coffee, Echo, Moose, Moosehead, and Park

- Priority C: Twentynine, Bob, and Hanging Horn

- Lake Benefit: Cost Assessment Tool:
  - Highest: none
  - Higher: Sand and Island
  - High: Eddy, Bear, Little Hanging Horn, Coffee, Echo, Moose, Moosehead, Park, Twentynine, Bob, and Hanging Horn

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: High
- Minor Subwatershed Priorities: Moose River
- Lakes and Tributaries of Concern: Moosehead Lake, Sand Lake, Island Lake, Hanging Horn Lake, Little Hanging Horn Lake
- Priority Management Strategies:
  - Shoreland restoration with lakeshore owners around lakes of concern in Moose River HUC-12.
  - Urban Forestry in the City of Moose Lake.
  - Protect Riparian areas along designated trout streams
  - Protect forests upstream from Hanging Horn and Little Hanging Horn Lakes (high quality Tullibee (Cisco) Lakes).
- 10-year Demonstration Projects:
  - City of Sturgeon Lake: Urban and community forestry, parkland, important areas for stormwater runoff, Moose Horn River run through, meets Kettle river on southwest corner.
  - Hanging Horn Drainage: Part of the Clean Water Legacy Tullibee Lakeshed Stewardship Project, which gives possibility of multiple benefits for projects.
  - King Creek: Designed trout stream, meanders past several agricultural fields, possible areas for some buffer expansion.
  - Moose Horn River Headwaters: Designed trout stream, meanders past several agricultural fields, possible areas for some buffer expansion, but judging from aerial imagery mostly flows through a mix of floodplain shrubs and forests.
  - City of Moose Lake: Urban and community forestry, parkland, important areas for stormwater runoff, next to Moosehead Lake, which is part of the Moose Horn River.

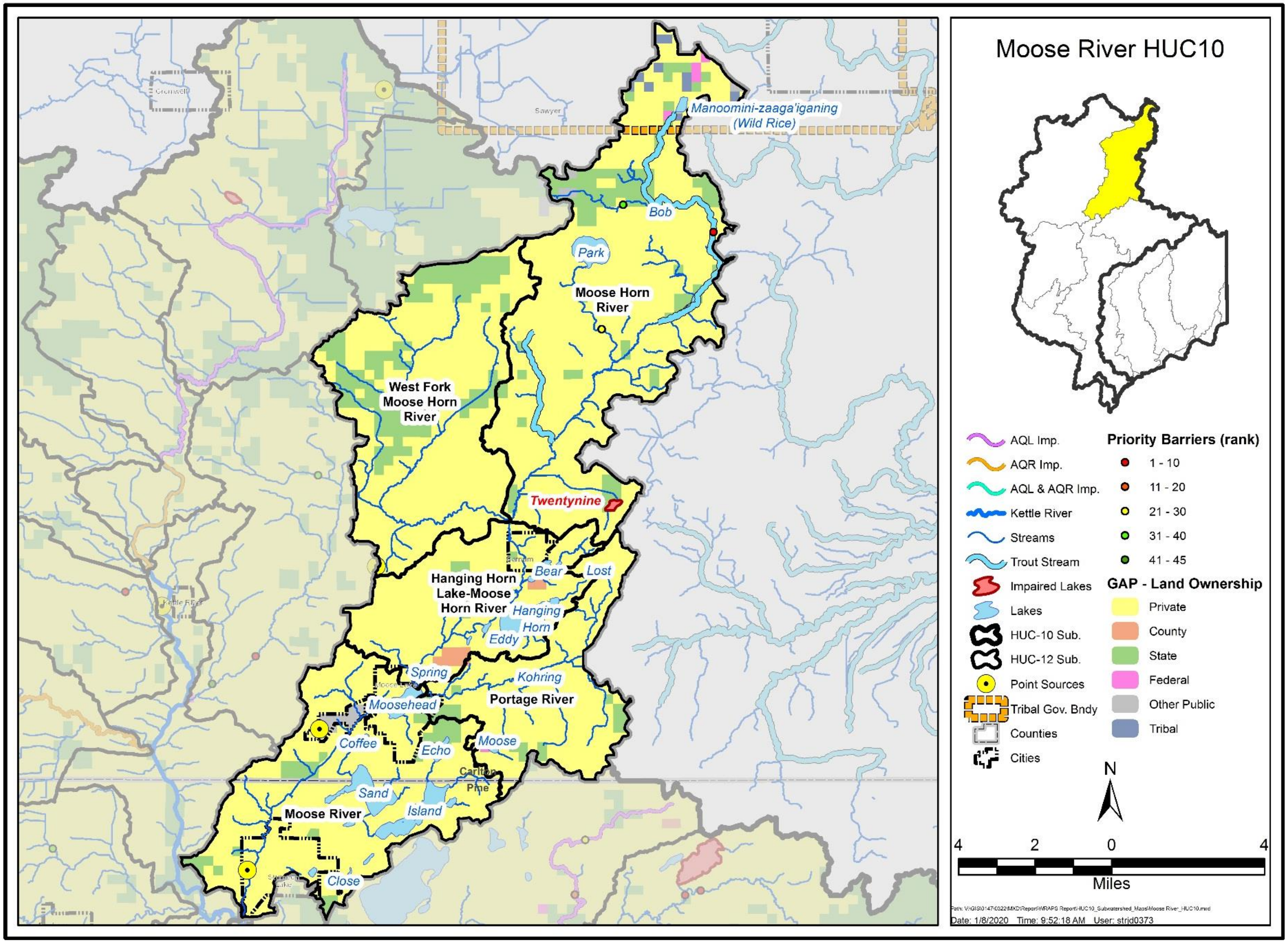


Figure 22: Moose River HUC-10 Subwatershed

Table 18: Strategies and actions proposed for the Moose River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
Moose River	All	Carlton, Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations	42%	60%	>75%	% land in subwatershed protected		x	x		x	x	x				x	2040
						Modify/replace dams culverts & fish passage barriers	4 potential barriers identified by DNR throughout subwatershed (see Figure 22). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 2 barriers	Modify/replace 4 barriers	completed projects			x		x	x	x					
	Twentynine Lake (09002200)	Carlton	Phosphorus (TP)	249 lb TP/yr; 53 ppb TP summer avg.	116 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality in wetland tributary entering lake from south, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x					x		2040
							Collect sediment cores to evaluate phosphorus release from sediment and potential sources of internal load, compare to TMDL	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	completed coring					x					x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
							Monitor water quality after ice-out to determine spring chloride concentrations and the potential influence of winter maintenance of nearby impervious surfaces (I-35) on lake chloride concentrations	N/A	3-5 monitoring events	Use monitoring results to inform & prioritize projects	completed monitoring				x	x					x		
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale in shoreland zoning area	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x				x	x	
	All non-impaired lakes	Carlton, Pine	Phosphorus (TP)	See below	See Below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x	x	x			x		N/A
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x	x	x			x		
							Protect shorelines for wild rice rivers and lakes throughout watershed through RIM easements and other programs (e.g. Moose Horn River south of Moose Lake)	N/A	Obtain 3 easements	Obtain 10 easements	easements					x	x	x					

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale (only in shoreland zoning areas in Carlton Co.)	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems						x	x		x	x	x	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas upstream of non-impaired lakes	N/A	Complete 1 project with landowner	Complete >1 project with landowners	completed projects					x	x	x				x	
	Manoomini-zaaga'iganing (Wild Rice) Lake (09002300)	Carlton, Fond Du Lac Reservation	Phosphorus (TP)	18 ppb TP summer avg.	Maintain or improve existing water quality	Water level management	Manage beaver dams and other woody debris obstructing culverts downstream of lake outlet to maintain water levels favorable to wild rice production. Investigate and implement non-lethal beaver management techniques as feasible.	Intermittent culvert monitoring/clean-out efforts	Increased culvert clean-out and downstream beaver management techniques	Lake water levels are maintained at levels favorable to wild rice production	Lake water levels			x		x	x		x				
	Bear Lake (09003400)	Carlton	Phosphorus (TP)	26 ppb TP summer avg.	Maintain or improve existing water quality	Stormwater management	Identify and implement stormwater BMPs to treat runoff from I-35 and the City of Barnum prior to entering lake	N/A	Complete feasibility study	Implement 1 project	completed projects					x	x			x			
						Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified at least one lakeshore parcel with high	52%	75%	>75%	% land in immediate subwatershed protected					x	x				x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
							conservation potential (private land >20 acres and <50% developed/impacted).																
	Eddy Lake (09003900)	Carlton	Phosphorus (TP)	22 ppb TP summer avg. (vulnerable and declining Secchi trend)	Improve existing water quality	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	42%	60%	>75%	% land in immediate subwatershed protected					x	x				x	x	
	Hanging Horn Lake (09003800)	Carlton	Phosphorus (TP)	26 ppb TP summer avg. (vulnerable)	Improve existing water quality; cisco habitat protection	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	51%	75%	>75%	% land in immediate subwatershed protected					x	x				x	x	
						Monitoring	Regularly monitor water quality in Moose Horn River upstream of lake to prioritize projects, evaluate trends, and track progress as	N/A	Establish and implement monitoring plan	Regular monitoring	completed monitoring				x	x					x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
							BMPs are implemented																
							Conduct regular in-lake water quality monitoring (Secchi, TP, Chl-a) to evaluate trends and track progress as BMPs are implemented	N/A	Establish and implement monitoring plan	Regular monitoring	completed monitoring				x	x					x		
	Island Lake (58006200)	Pine, Carlton	Phosphorus (TP)	31 ppb TP summer avg. (vulnerable)	Improve existing water quality	BMP assessment	Subwatershed assessment to identify specific BMPs and locations to reduce watershed runoff and nutrient loads	N/A	Complete subwatershed assessment	Implement BMPs identified in assessment	completed assessments					x		x			x		
						Monitoring	Update and conduct periodic lake-wide vegetation surveys to track changes in vegetation community as BMPs and AIS treatments are completed	N/A	Complete 2 surveys	Semi-regular surveys	completed surveys			x		x		x			x		
						AIS management	AIS prevention (e.g. education and inspections) and treatments (e.g. Eurasian watermilfoil)	AIS inspections at public water access	Adaptive management	Adaptive management	N/A					x		x			x		
						Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50%	47%	60%	>75%	% land in immediate subwatershed protected					x	x	x			x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
							developed/impacted).																
	Little Hanging Horn Lake (09003500)	Carlton	Phosphorus (TP)	17 ppb TP summer avg.	Maintain or improve existing water quality; cisco habitat protection	Monitoring	Conduct regular in-lake water quality monitoring (Secchi, TP, Chl-a) to evaluate trends and track progress as BMPs are implemented	N/A	Establish and implement monitoring plan	Regular monitoring	completed monitoring				x	x					x		
						Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified five parcels on upstream river tributary with high conservation potential (private land >20 acres and <50% developed/impacted).	33%	50%	>75%	% land in immediate subwatershed protected					x	x				x	x	
	Moosehead (09004100)	Carlton	Phosphorus (TP)	36 ppb TP summer avg. (vulnerable and declining Secchi trend)	Improve existing water quality	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	48%	60%	>75%	% land in immediate subwatershed protected					x	x				x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
						Stormwater management	Identify and implement stormwater BMPs to address localized flooding issues and reduce pollutant loading from City of Moose Lake	N/A	Complete subwatershed assessment, implement 1 project	Implement 3 projects	completed projects					x	x			x			
	Park Lake (09002900)	Carlton	Phosphorus (TP)	16 ppb TP summer avg.	Maintain or improve existing water quality	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	68%	75%	>75%	% land in immediate subwatershed protected					x	x				x	x	
	Sand Lake (58008100)	Carlton, Pine	Phosphorus (TP)	18 ppb TP summer avg.	Maintain or improve existing water quality	BMP assessment	Subwatershed assessment to identify specific BMPs and locations to reduce watershed runoff and nutrient loads	N/A	Complete subwatershed assessment	Implement BMPs identified in assessment	completed assessments					x		x			x		
						Monitoring	Update and conduct periodic lake-wide vegetation surveys to track changes in vegetation community as BMPs and AIS treatments are completed	N/A	Complete 2 surveys	Semi-regular surveys	completed surveys			x		x		x			x		
						AIS management	AIS prevention (e.g. education and inspections) and treatments (e.g. Eurasian watermilfoil)	AIS inspections at public water access and herbicide treatment of	Adaptive management	Adaptive management	N/A					x		x			x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Carlton County	Pine County	Fond du Lac Tribe	Cities	Lake Assoc.	Landowners	
								Eurasian watermilfoil															
	King Creek (07030003-547)		Fish IBI	Fish IBI = 36 (vulnerable, trout stream)	Fish IBI threshold >35; improve existing biotic communities	Improve riparian vegetation	Expand and enhance buffers in riparian areas, particularly agricultural fields near creek	N/A	Complete 1 project	Complete 3 projects	completed projects					x	x					x	
	Portage River	Carlton	N/A	N/A	N/A	Restore floodplains and reconnect with channel	Restore and re-meander ditched segments throughout subwatershed to improve habitat and hydrology	N/A	Complete feasibility study, complete 1 project	Complete 3 projects	completed projects			x		x	x					x	

Color Key:

- Restoration
- Protection
- Subwatershed-wide strategies

Willow River HUC-10

Subwatershed Characteristics

- Size: 85,750 acres
- HUC-12 subwatersheds: Little Willow River, Oak Lake-Willow River, Sturgeon Lake-Willow River
- Towns/Cities: Willow River (pop. 1,229), Kerrick (pop. 641), Bruno (pop. 639)
- Point Source Dischargers: None
- Land cover: wetlands (40%), forest/shrubland (40%), hay/pasture (10%), developed (4%), open water (4%), cropland (1%), and barren/mining (<1%)
- Forested Land Protection: 26% (9,020 acres) public ownership, 74% (25,610 acres) privately owned
- WHPAs: Willow River (8 acres) (see Figure 11)
- DWSMAs: Willow River (33 acres) (see Figure 7)

Streams

- Streams: 114 miles
- Stream Types
    - Natural: 83 miles
    - Altered: 16 miles
    - Impounded: <1 mile
    - No definable channel: 14 miles
- Impaired Streams (9.7 miles, one AUID):
    - Hay Creek: Headwaters to Willow R (-619), FishesBio
- Public Watercourses: 63 miles
- TALU Classes
    - Exceptional use: 8 miles
    - General use: 29 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 3 miles
- Cold Water Streams: 1 stream (3 miles)
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 1 reach (3 miles)
    - Priority B: 2 reaches (10 miles)

- Priority C: 1 reach (24 miles)

- Stream Crossing Inventory and Prioritization
  - Top 10: 3 barriers
  - Rank 11-19: 1 barrier
  - Rank 20-29: 1 barrier
  - Rank 30-39: No barriers
  - Rank 40-45: No barriers

Lakes

- Lakes >10 acres: 14 lakes
- Lakes >100 acres: Eleven, Dago, Oak, and Sturgeon
- Impaired Lakes: Oak
- Nearly/Barely Impaired Lakes: Eleven
- Lakes of Biological Significance
  - Outstanding: none
  - High: Turtle
  - Moderate: Big Slough
- DNR Priority Shallow Lakes: Stanton
- DNR Wild Rice Lakes: Willow and Stanton
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
  - Exceptional: none
  - At or Above Impairment: Sturgeon
  - Below Impairment Threshold: Oak
- Lake Protection & Prioritization Tool (see Figure 14)
  - Priority A: Dago, Oak, Sturgeon
  - Priority B: Passenger and Eleven
  - Priority C: Stanton
- Lake Benefit: Cost Assessment Tool:
  - Highest: Sturgeon

- Higher: Dago
- High: Oak, Passenger, Eleven, and Stanton

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: Moderate
- Minor Subwatershed Priorities: Sturgeon Lake – Willow River
- Lakes and Tributaries of Concern: Sturgeon Lake
- Priority Management Strategies:
    - Riparian Buffers around Sturgeon Lake and along streams upstream from Big Slough Lake.
    - Restore upland forests east of Sturgeon Lake.
    - Extend protected forest lands to the east of General C.C Andrews State Forest.
- 10-year Demonstration Projects:
    - Larson's Creek: Designed trout stream, larger block of contiguous forest, surrounded by the Nemadji State Forest, DNR Forestry land, Trust land, and Misc. County land. In the northeast corner of the junction of Kerrick Road and Larson Creek, a landowner has several tree plantings - possible private partner.

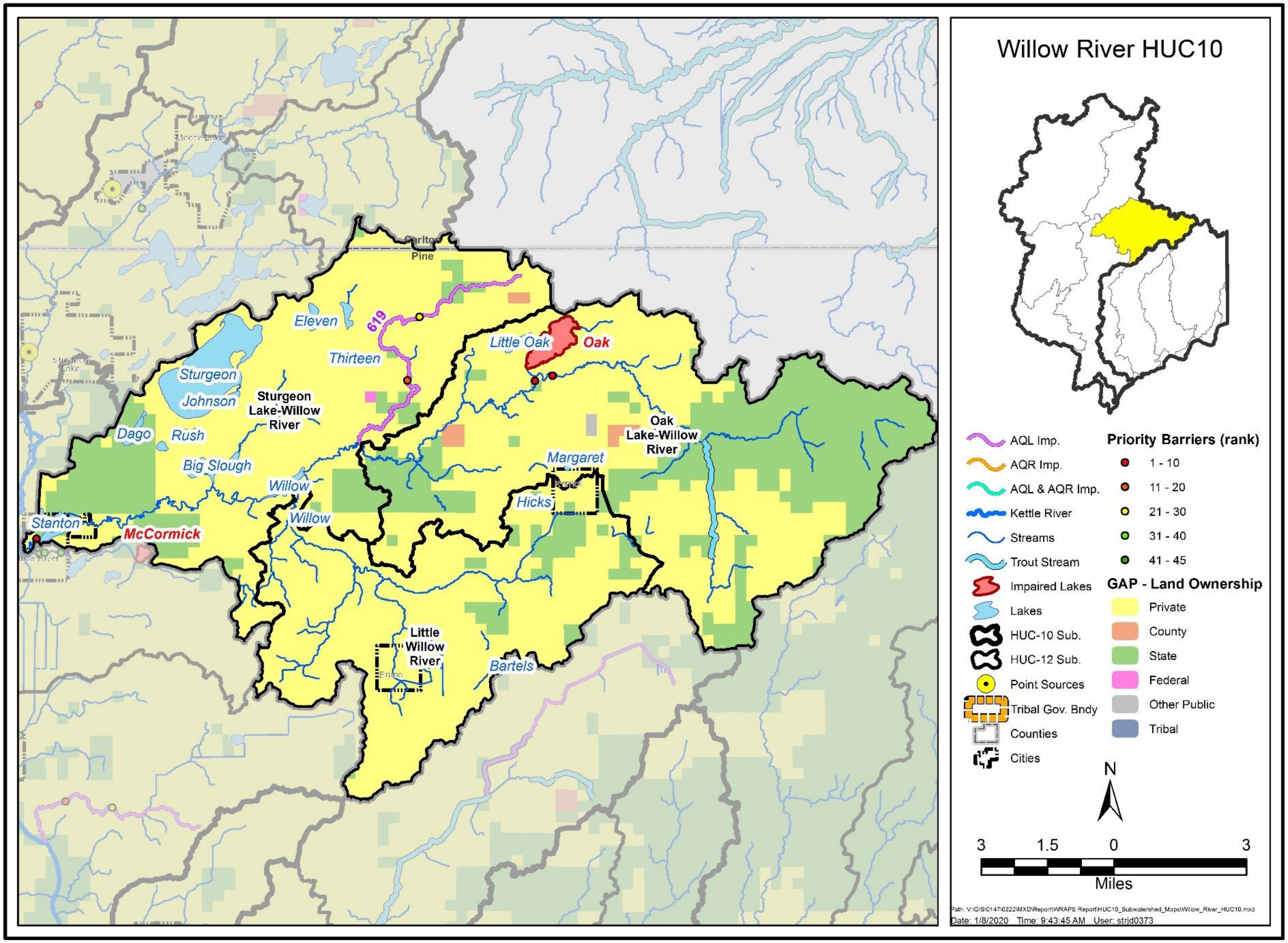


Figure 23: Willow River HUC-10 Subwatershed

Table 19: Strategies and actions proposed for the Willow River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
Willow River	All	Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations	46%	75%	>75%	% land in subwatershed protected		x	x		x	x			x	2040
						Modify/replace dams culverts & fish passage barriers	5 potential barriers identified by DNR throughout subwatershed (see Figure 23). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 2 barriers	Modify/replace 4 barriers	completed projects			x		x	x				
	Hay Creek (07030003-619)	Pine	Fish IBI	Fish IBI = 0, 50	Fish IBI >42	Modify/replace dams culverts & fish passage barriers	2 culverts identified as potential barriers. Also, significant beaver activity noted throughout reach. Manage beaver activity and modify/replace problem culverts as opportunities arise.	N/A	Modify/replace 1 barrier	Modify/replace 2 barriers	completed projects			x		x	x				2040
						Stream channel stabilization	Channel stability issues manifested by incision and bank erosion have created a lack of stable channel substrate, impacting fish habitat. In-stream restoration projects to increase channel stability should be investigated and implemented.	N/A	Complete investigation/feasibility study	Implement 1 project	completed projects			x		x	x			x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
						Restore floodplains and reconnect with channel	In-stream restoration projects to address channel stability issues should also consider floodplain connectivity and restore stream connection to the floodplain	N/A	Complete investigation/feasibility study (aligned with stream channel stabilization)	Implement 1 project (aligned with stream channel stabilization)	completed projects			x		x	x			x	
	Oak Lake (58004800)	Pine	Phosphorus (TP)	684 lb TP/yr; 33 ppb TP summer avg.	609 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality in tributary entering lake from east and wetland west of lake, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x			x		
						Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2018) identified 6 lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	60%	75%	>75%	% land in immediate subwatershed protected					x	x			x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x		x	x	
	All Non-impaired Lakes	Pine	Phosphorus (TP)	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x			x		N/A
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x			x		
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x		x	x	

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Specific Implementation Strategy	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	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							inventory/assessment of SSTS. Upgrade failing SSTS														
	Sturgeon Lake (58006700)	Pine	Phosphorus (TP)	14 ppb TP summer avg.	Maintain or improve existing water quality	BMP assessment	Subwatershed assessment to identify specific BMPs and locations to reduce watershed runoff and nutrient loads	N/A	Complete subwatershed assessment	Implement BMPs identified in assessment	completed assessments					x	x		x		
						Water level assessment	Complete study/investigation into high water levels and identify projects and solutions	N/A	Complete study/investigation	Implement solutions	completed study/investigation					x	x		x	x	
						Monitoring	Update and conduct periodic lake-wide vegetation surveys to track changes in vegetation community as BMPs and AIS treatments are completed	N/A	Complete 2 surveys	Semi-regular surveys	completed surveys			x		x	x		x		
						AIS management	AIS prevention (e.g. education and inspections) and treatments (e.g. Eurasian watermilfoil)	AIS inspections at public water access and herbicide treatment of Eurasian watermilfoil	Adaptive management	Adaptive management	N/A						x		x		
						Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified two lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	64%	75%	>75%	% land in immediate subwatershed protected					x	x			x	
	Dago Lake (58007300)	Pine	Phosphorus (TP)	16 ppb TP summer avg.	Maintain or improve existing	See strategies above for all non-impaired lakes															

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
					water quality																
	Eleven Lake (58006800)	Pine	Phosphorus (TP)	25 ppb TP summer avg. (vulnerable)	Improve existing water quality																
	Passenger Lake (58007600)	Pine	Phosphorus (TP)	12 ppb TP summer avg.	Maintain or improve existing water quality																
	Stanton Lake (58011100)	Pine	Phosphorus (TP)	41 ppb TP summer avg.	Improve existing water quality																

Color Key:

(pink)	Restoration
(green)	Protection
(white)	Subwatershed-wide strategies

Pine River HUC-10

Subwatershed Characteristics

- Size: 92,127 acres
- HUC-12 subwatersheds: Big Pine Lake, Bremen Creek, Fox Lake-Pine River, Little Pine Creek, Medicine Creek-Pine River, Rhine Lake-Pine River
- Towns/Cities: Rutledge (pop. 1,933) Finlayson (pop. 1,870)
- Point Source Dischargers: Finlayson WWTP
- Land cover: forest/shrubland (40%), wetlands (35%), hay/pasture (15%), developed (4%), open water (4%), cropland (2%), and barren/mining (<1%)
- Forested Land Protection: 20% (7,425 acres) public ownership, 80% (29,496 acres) privately owned
- WHPAs: Finlayson (160 acres) (see Figure 11)
- DWSMAs: Finlayson (501 acres) (see Figure 7)

Streams

- Streams: 170 miles
- Stream Types
    - Natural: 126 miles
    - Altered: 15 miles
    - Impounded: 5 miles
    - No definable channel: 23 miles
- Impaired Streams (11.04 miles, three AUIDs):
    - Pine River: Headwaters to Pine Lk (-631), *E. coli*
    - Pine River: Big Pine Lk to Little Pine Cr (-633), InvertBio
    - Pine River: Little Pine Cr to Bremen Cr (-634), InvertBio
- Public Watercourses: 81 miles
- TALU Classes
    - Exceptional use: 15 miles
    - General use: 8 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: None
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 2 reaches (15 miles)
    - Priority B: 3 reaches (69 miles)
    - Priority C: 0 reaches
- Stream Crossing Inventory and Prioritization
    - Top 10: 1 barrier
    - Rank 11-19: 3 barriers
    - Rank 20-29: 3 barriers
    - Rank 30-39: 1 barrier
    - Rank 40-45: No barriers

Lakes

- Lakes >10 acres: Clear, Little, Little Bass, Mud, Cemetery, Bass (58012800), Loon, Beauty, Indian, Little Pine, and Grass
- Lakes >100 acres: Rhine, Fish, Fox, Bass (58013700), Upper Pine, Eleven, Pine, Big Pine
- Impaired Lakes: Bass, Rhine, Fox, Eleven, Pine, and Big Pine
- Nearly/Barely Impaired Lakes: Pine and Big Pine
- Lakes of Biological Significance
    - Outstanding: none
    - High: Eleven
    - Moderate: Bass (58013700)
- DNR Priority Shallow Lakes: Grass, Fox, Upper Pine, and Eleven
- DNR Wild Rice Lakes: Fox, Pine, and Big Pine
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: Fox, Upper Pine, Eleven, and Big Pine
    - Below Impairment Threshold: Pine and Bass (58013700)
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: Rhine
    - Priority B: Little Bass and Eleven
    - Priority C: Upper Pine, Fox, Fish, Little Pine, and Indian
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: Bass
    - High: Pine, Upper Pine, Fox, Fish, Little Pine, Indian, Big Pine, Eleven, Little Bass, Bass (58013700), and Rhine

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: High
- Minor Subwatershed Priorities: Big Pine Lake, Rhine Lake - Pine River, Medicine Creek – Pine River
- Lakes and Tributaries of Concern: Pine Lake and Big Pine Lake, Pine River downstream of Big Pine Lake, Bass Lake.
- Priority Management Strategies:
    - Protect and restore riparian buffers along Pine River Downstream from Big Pine Lake and Around Bass Lake.
    - Restore upland forests in the Big Pine Lake and Medicine Creek – Pine River minor watersheds.
    - Extend protected areas south of Solana State Forest in the Big Pine Lake Minor watershed.
- 10-year Demonstration Projects:
    - Hinckley-Finlayson School Forest. The school has two 80-acre parcels connected diagonally, one of which has been used for many years for outdoor environmental

education. Little Pine Creek bisects one of the parcels and connects Upper Pine Lake and Little Pine Lake. Prior to 2003, some trail improvements were made to the forest with help from the Pine County Ruffed Grouse Society and the Finlayson-Giese Sportsmen's Club. Need to include a Forestry Stewardship Plan, interpretive signs, invasive species identification, or seedlings. Pine County SWCD.

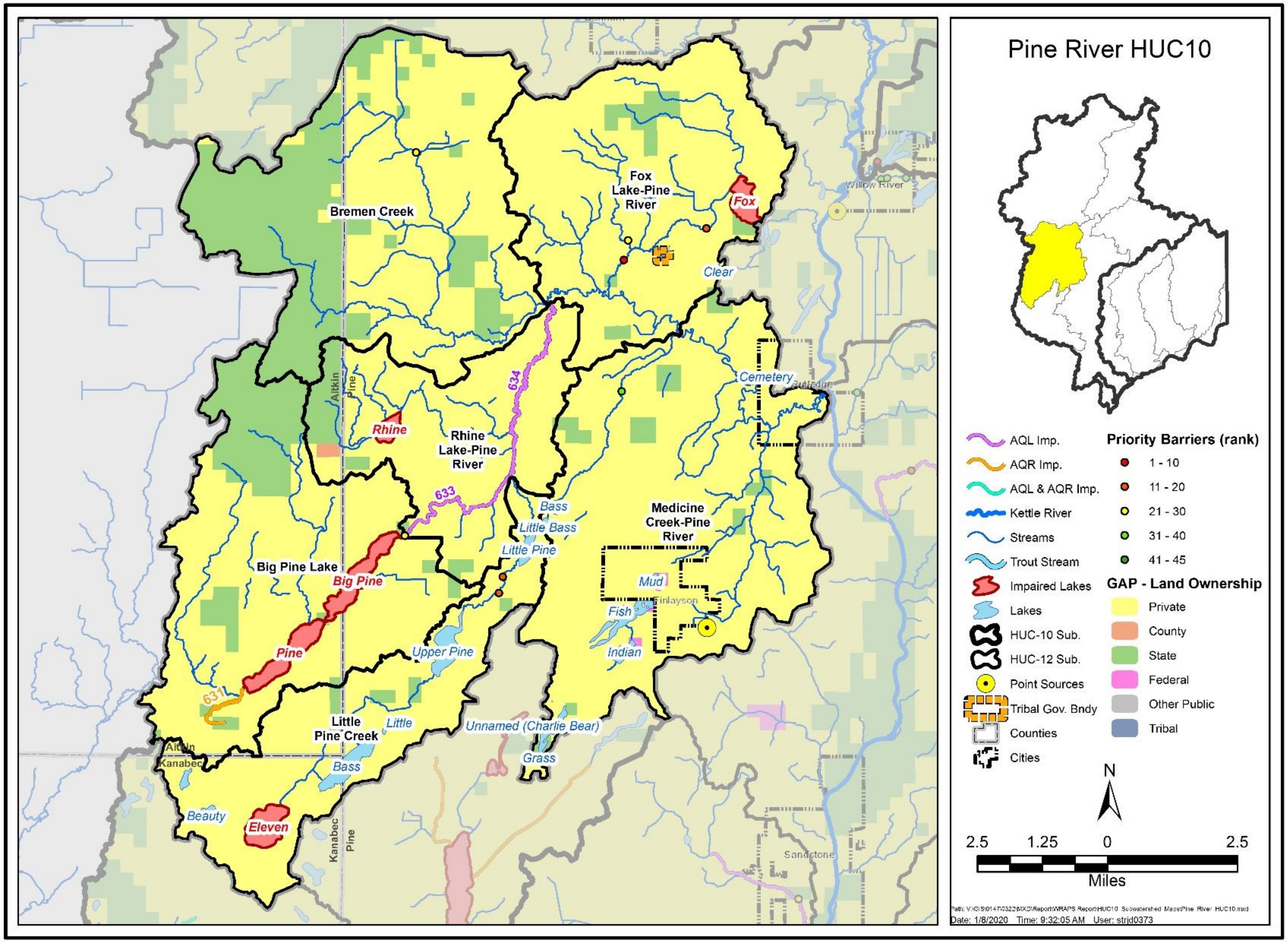


Figure 24: Pine River HUC-10 Subwatershed

Table 20: Strategies and actions proposed for the Pine River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.	Estimated Adoption Rate				Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
Pine River	All	Aitkin, Pine, Kanabec	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations	39%	50%	>75%	% land in subwatershed protected		x			x	x	x	x			x	2040
						Modify/replace dams culverts & fish passage barriers	8 potential barriers identified by DNR throughout subwatershed (see Figure 24). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 3 barriers	Modify/replace 8 barriers	completed projects			x		x	x	x	x				
	Pine River (07030003-633)	Pine	Invert. IBI	Invert. IBI = 45, 47	Invert. IBI >53	Upstream improvements	Improve nutrient conditions in upstream lakes (Pine and Big Pine Lakes) that contribute to these reaches	N/A	See strategies below	See strategies below	See strategies below				x	x	x	x			x	x	2040
	Pine River (07030003-634)	Pine	Invert. IBI	Invert. IBI = 28	Invert. IBI >53																		
	Pine River (07030003-631)	Aitkin	*E. coli*	3 - 194 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 35% reduction	Monitoring	Conduct longitudinal (upstream to downstream) *E. coli* monitoring surveys to determine potential locations of bacteria loading	N/A	Conduct 1-3 surveys on each impaired reach	Use surveys to inform & prioritize project implementation	completed monitoring				x	x							
							If results of longitudinal surveys are inconclusive, consider performing microbial source tracking to	N/A	Conduct source tracking as necessary depending on results of longitudinal surveys	Use source tracking to inform & prioritize	completed monitoring				x	x							

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							identify sources of bacteria to streams			project implementation													
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 3 projects with landowners	Complete 8 projects with landowners	completed projects				x	x	x					x	
						Improve riparian vegetation	Bank revegetation where appropriate, protect and enhance existing riparian buffers, protect forested buffers on private land through SFIA and other programs	N/A	ID & prioritize sensitive shorelands & poorly buffered areas, complete 2 projects	Increase riparian buffers by at least 50% in identified areas	completed projects, sensitive shorelands, poorly buffered areas					x						x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x					x	
	Pine Lake (01000100)	Aitkin	Phosphorus (TP)	4,815 lb TP/yr; 38 ppb TP summer avg. (barely impaired)	3,388 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Collect in-lake sediment cores to evaluate phosphorus release from sediment and compare to TMDL modeling. Use results to evaluate sediment inactivation (e.g. alum treatment) feasibility and cost.	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	Completed analyses					x					x		
							Collect sediment cores and/or paired WQ samples upstream and downstream of historic commercial trout ponds at the south end of Pine Lake to evaluate potential legacy effects	N/A	Complete monitoring & analyses	Use results to inform & prioritize projects	Completed analyses					x					x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
							and projects (if necessary)																
							Update and conduct periodic lake-wide vegetation surveys to evaluate curly-leaf pondweed abundance and track changes in vegetation community as BMPs are completed	N/A	Complete 2 surveys	Semi-regular surveys	completed surveys			x		x	x				x		
						Forest protection	Protect private forest and undeveloped land through protection programs described above.	38%	50%	>75%	% land in subwatershed protected					x	x					x	
						Tillage/residue management	Education and outreach to landowners to implement cover crops, conservation tillage, no-till and other residue management BMPs in cropland areas	N/A	??	??	??	x				x						x	
						Improve riparian vegetation	Continue implementing buffer improvements to protect shoreline areas	70%	90%	100%	% of shoreline protected with adequate buffers					x	x				x		
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	
						Stormwater management	Identify and implement stormwater BMPs to treat runoff from developed and high-sloped areas surrounding lake	N/A	Complete feasibility study	Implement 2 projects	completed projects					x						x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate				NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
								Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units												
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 75%	Upgrade 100%	% of failing systems				x		x				x	x	
						AIS Management	Evaluate zebra mussel abatement/risk reduction options; evaluate adding AIS decontamination equipment at access point	N/A	Develop plan	Implement plan	zebra mussel management plan						x				x		
	Big Pine Lake (58013800)	Aitkin, Pine	Phosphorus (TP)	3,046 lb TP/yr; 32 ppb TP summer avg. (barely impaired)	2,676 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Update and conduct periodic lake-wide vegetation surveys to evaluate curly-leaf pondweed abundance and track changes in vegetation community as BMPs are completed	N/A	Complete 2 surveys	Semi-regular surveys	completed surveys			x		x		x			x		
						Upstream improvements	Improve nutrient conditions in Pine Lake	N/A	See strategies above	See strategies above	See strategies above				x	x	x	x			x	x	
						Forest protection	Protect private forest and undeveloped land through protection programs described above	53%	75%	>75%	% land in immediate subwatershed protected					x	x	x				x	
						Tillage/residue management	Education and outreach to landowners to implement cover crops, conservation tillage, no-till and other residue management BMPs in cropland areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects	x				x						x	
						Improve riparian vegetation	Continue implementing buffer improvements to protect shoreline areas	70%	90%	100%	% of shoreline protected with adequate buffers					x	x	x			x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	
						Stormwater management	Identify and implement stormwater BMPs to treat runoff from developed and high-sloped areas surrounding lake	N/A	Complete feasibility study	Implement 2 projects	completed projects					x						x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 75%	Upgrade 100%	% of failing systems				x		x	x			x	x	
						AIS Management	Evaluate zebra mussel abatement/risk reduction options; evaluate adding AIS decontamination equipment at access point	N/A	Develop plan	Implement plan	zebra mussel management plan						x	x			x		
	Eleven Lake (33000100)	Kanabec	Phosphorus (TP)	444 lb TP/yr; 39 ppb TP summer avg.	310 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality in wetland tributaries that drain to lake, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x					x		
						Improve riparian vegetation	Conduct shoreline inventory to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach/	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x			x		x		
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
							management in identified areas																
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x				x		x	x	
	Fox Lake (58010200)	Pine	Phosphorus (TP)	1,371lb TP/yr; 52 ppb TP summer avg.	708 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality in major tributary entering lake from north, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x					x		
							Collect sediment cores to evaluate phosphorus release from sediment and potential impacts of historic paper mill, compare to TMDL	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	completed coring					x					x		
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x			x			x	x	
	Rhine Lake (58013600)	Aitkin, Pine	Phosphorus (TP)	753 lb TP/yr; 62 ppb TP summer avg.	328 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality in major tributaries entering lake from west, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x					x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
							Collect sediment cores to evaluate phosphorus release from sediment and potential impacts of historic paper mill, compare to TMDL	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	completed coring					x					x		
							Update fish vegetation surveys according to DNR methods and protocols. Use survey results to evaluate if fisheries and/or vegetation management is needed	N/A	Complete surveys	Manage as necessary	Completed surveys			x		x					x		
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x			x			x	x	
	All Non-impaired Lakes	Aitkin, Kanabec, Pine	Phosphorus (TP)	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x					x		N/A
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x					x		
						SSTS education, maintenance,	Provide education and maintenance materials for SSTS parcels. Conduct	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x	x	x		x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
						inventory, upgrade	inventory/assessment of SSTS. Upgrade failing SSTS																
	Bass Lake (58013700)	Aitkin, Kanabec, Pine	Phosphorus (TP)	17 ppb TP summer avg.	Maintain or improve existing water quality	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above	71%	75%	>75%	% land in immediate subwatershed protected					x	x	x	x		x	x	
	Upper Pine Lake (58013000)	Pine	Phosphorus (TP)	24 ppb TP summer avg.	Maintain or improve existing water quality	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified five lakeshore parcels with high conservation potential (private land >20 acres and <50% developed/impacted).	45%	60%	>75%	% land in immediate subwatershed protected					x		x			x	x	
	Fish Lake (58013100)	Pine	Phosphorus (TP)	69 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes																	
	Indian Lake (58013200)	Pine	Phosphorus (TP)	27 ppb TP summer avg.	Maintain or improve existing water quality	See strategies above for all non-impaired lakes																	
	Little Bass Lake (58012700)	Pine	Phosphorus (TP)	35 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes																	
	Little Pine Lake (58012900)	Pine	Phosphorus (TP)	65 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes																	
	Bremen Creek (07030003-620)	Aitkin, Pine	Invert. IBI	Invert IBI = 47 (vulnerable)	Improve existing biotic communities	Forest and shoreline protection	Protect private forest and undeveloped land through protection programs described above.	N/A	additional 15%	>75%	% land in immediate subwatershed protected					x	x	x				x	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure	N/A	Complete 1 project with landowner	Complete 1 project with landowner	completed projects				x	x						x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility											Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate															
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Aitkin County	Pine County	Kanabec County	Cities	Lake Assoc.	Landowners	
							management in identified areas																

Color Key:

	Restoration
	Protection
	Subwatershed-wide strategies

Grindstone River HUC-10

Subwatershed Characteristics

- Size: 55,558 acres
- HUC-12 subwatersheds: Grindstone River, North Branch Grindstone River, South Branch Grindstone River
- Towns/Cities: Hinckley (pop. 1,868)
- Point Source Dischargers: Hinckley WWTP
- Land cover: forest/shrubland (34%), wetlands (29%), hay/pasture (25%), developed (5%), cropland (4%), open water (3%), and barren/mining (<1%)
- Forested Land Protection: 9% (1,774 acres) public ownership, 91% (17,329 acres) privately owned
- WHPAs: Hinckley (445 acres) (see Figure 11)
- DWSMAs: Hinckley (855 acres) (see Figure 11)

Streams

- Streams: 77 miles
- Stream Types
    - Natural: 42 miles
    - Altered: 20 miles
    - Impounded: 6 miles
    - No definable channel: 9 miles
- Impaired Streams (46.05 miles, seven AUIDs):
    - Grindstone River: Grindstone Reservoir to Kettle R (-501), *E. coli*
    - Grindstone River, South Branch: Headwaters to Grindstone R (-516), *E. coli* and FishesBio
    - Judicial Ditch 1: Headwaters to S Br Grindstone R (-526), *E. coli*
    - Grindstone River, North Branch: Headwaters to Grindstone Lk (-541), *E. coli*
    - Grindstone River, North Branch: T42 R21W S33, north line to Grindstone R (-544), *E. coli*
    - Unnamed creek: Miller Lk to Grindstone Lk (-546), *E. coli*
    - Spring Creek: Headwaters to Grindstone R (-550), *E. coli* and FishesBio
- Public Watercourses: 42 miles
- TALU Classes
    - Exceptional use: 0 miles

    - General use: 14 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 6 miles
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 1 reach (7 miles)
    - Priority B: 1 reach (7 miles)
    - Priority C: 0 reaches
- Stream Crossing Inventory and Prioritization
    - Top 10: 1 barrier
    - Rank 11-19: 3 barriers
    - Rank 20-29: 1 barrier
    - Rank 30-39: 1 barrier
    - Rank 40-45: 2 barriers

Lakes

- Lakes >10 acres: McMuller, Charlie Bear, Featherbed, Twelve, White Lily, Long, Five, Thirteen, Miller, and Elbow
- Lakes >100 acres: Grindstone
- Impaired Lakes: Elbow and Grindstone
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: Grindstone
    - High: Thirteen
    - Moderate: none
- DNR Priority Shallow Lakes: Miller
- DNR Wild Rice Lakes: none
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: Grindstone
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: Grindstone

- At or Above Impairment: none
- Below Impairment Threshold: none

- Lake Protection & Prioritization Tool (see Figure 14)
  - Priority A: none
  - Priority B: Elbow, Grindstone, and Miller
  - Priority C: Five
- Lake Benefit: Cost Assessment Tool:
  - Highest: none
  - Higher: none
  - High: Five, Elbow, Grindstone, and Miller

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: Very High
- Minor Subwatershed Priorities: Grindstone, South Branch, North Branch (all minors)
- Lakes and Tributaries of Concern: Grindstone Lake, tributaries to Grindstone Lake, South Branch of the Grindstone River – west of Hinckley to Kroschel Township.
- Priority Management Strategies:
  - Protect and restore riparian buffers along lakes and tributaries of concern.
  - Protect an additional 1,860 acres of upland forest (to maintain stable spring snow melts); start with areas near state forest lands in the headwaters area located in Kroschel Township.
  - Urban forestry in the City of Hinckley.
- 10-year Demonstration Projects:
  - Spring Creek: Designed trout stream that runs through several agriculture and grassland cover types but is surrounded by a good sized forest buffer.
  - City of Hinckley: Urban and community forestry, parkland, important areas for stormwater runoff; Grindstone River runs through.
  - Grindstone Lake: Audubon Center, potential interested landowner w/ 300 acres, designed trout stream. Water quality monitoring, particularly temperature/ DO profiles monthly through open water season, compare with charge in land use upstream (which has 2—60% disturbance).

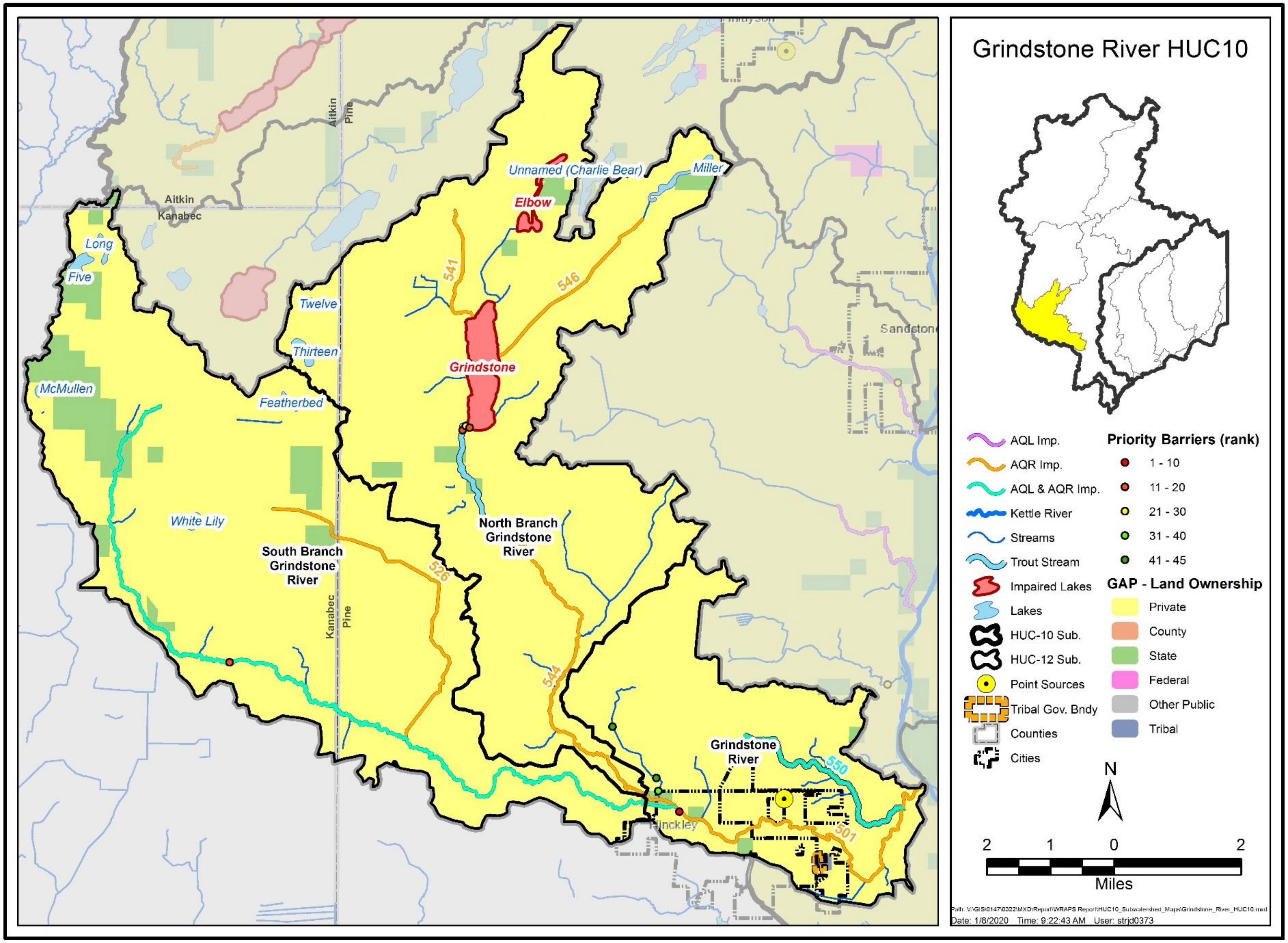


Figure 25: Grindstone River HUC-10 Subwatershed

Table 21: Strategies and actions proposed for the Grindstone River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate														
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	
Grindstone River	All	Kanabec, Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations	35%	50%	>75%	% land in subwatershed protected		x			x	x	x	x		x	2040
						Modify/replace dams culverts & fish passage barriers	8 potential barriers identified by DNR throughout subwatershed (see Figure 25). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 3 barriers	Modify/replace 8 barriers	completed projects			x		x	x	x	x			
	South Branch Grindstone River (07030003-516)	Kanabec, Pine	Fish IBI	Fish IBI = 25, 28	Fish IBI >42	Modify/replace dams culverts & fish passage barriers	Remove/replace dams (e.g. Hinckley), impoundments, private road crossings, and improperly sized culverts identified in Stressor ID report that could be potential barriers to fish passage and negatively impacting DO and temperature	N/A	Remove/replace 2 structures	Remove/replace all identified structures	completed projects			x		x	x	x	x			2040
						Improve livestock management	Implement fencing and other practices to exclude cattle from streams at various locations identified in Stressor ID report	N/A	Complete 2 projects with landowners	Complete 5 projects with landowners	completed projects				x	x	x	x			x	
						Stream Restoration	Narrow channels where poor culverts or cattle trampling have created wide pools	N/A	Complete 1 project	Complete 4 projects	completed projects			x		x	x	x				

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate														
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	
						Improve riparian vegetation	Plant and establish woody vegetation along riparian areas where natural vegetation has been removed	N/A	Complete 2 projects with landowners	Complete 5 projects with landowners	completed projects					x	x	x			x	2040
	Spring Creek (07030003-550)	Pine	Fish IBI	Fish IBI = 21, 20	Fish IBI >35	Modify/replace dams culverts & fish passage barriers	Remove/replace fish barriers identified in Stressor ID report (e.g. culverts at Old Government road, beaver dams, private field crossings)	N/A	Remove/replace 2 structures	Remove/replace all identified structures	completed projects			x		x	x	x	x			
						Stormwater management	Monitor runoff from airport area to determine temperature impacts. Implement BMPs to promote infiltration if it is determined runoff occurs during sizable rain events	N/A	Complete monitoring and ID projects	Implement projects	completed monitoring and projects					x			x			
	North Branch Grindstone River (07030003-541)	Pine	*E. coli*	32 - 210 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 40% reduction	See strategies below for *E. coli* impairments																
	Unnamed Creek (07030003-546)	Pine	*E. coli*	11 - 389 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 76% reduction																	
	South Branch Grindstone River (07030003-516)	Kanabec, Pine	*E. coli*	13 - 217 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 42% reduction																	
	Judicial Ditch 1 (07030003-526)	Kanabec, Pine	*E. coli*	27 - 624 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100																	

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
					mL; 80% reduction																	
	North Branch Grindstone River (07030003-544)	Pine	*E. coli*	9 - 279 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 55% reduction																	
	Spring Creek (07030003-550)	Pine	*E. coli*	20 - 603 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 79% reduction																	
	Grindstone River (07030003-501)	Pine	*E. coli*	12 - 606 cfu/100 mL monthly geomeans	Maximum monthly geomean <126 cfu/100 mL; 79% reduction																	
	Strategies for *E. coli* impairments noted above					Monitoring	Conduct longitudinal (upstream to downstream) *E. coli* monitoring surveys to determine potential locations of bacteria loading	N/A	Conduct 1-3 surveys on each impaired reach	Use surveys to inform & prioritize project implementation	completed monitoring				x	x						
						Monitoring	If results of longitudinal surveys are inconclusive, consider performing microbial source tracking to identify sources of bacteria to streams	N/A	Conduct source tracking as necessary depending on results of longitudinal surveys	Use source tracking to inform & prioritize project implementation	completed monitoring				x	x					x	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 6 projects with landowners	Complete 12 projects with landowners	completed projects				x	x	x	x			x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	
						Improve riparian vegetation	Bank revegetation where appropriate, protect and enhance existing riparian buffers, protect forested buffers on private land through SFIA and other programs	N/A	ID & prioritize sensitive shorelands & poorly buffered areas, complete 6 projects	Increase riparian buffers by at least 50% in identified areas	completed projects, sensitive shorelands, poorly buffered areas					x					x	
						Urban stormwater management	Identify and implement stormwater BMPs to treat runoff and bacteria loading from City of Hinckley to Grindstone River	N/A	Complete feasibility study	Implement 3 projects	completed study & projects					x			x			
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x	x			x	
	Elbow Lake (58012600)	Pine	Phosphorus (TP)	445 lb TP/yr; 41 ppb TP summer avg.	303 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality entering lake from north, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x				x		2040
						Monitoring	Update fish vegetation & surveys according to DNR methods and protocols. Use survey results to evaluate if fisheries and/or vegetation management is needed	N/A	Complete surveys	Manage as necessary	Completed surveys			x		x		x		x		
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete >1 projects with landowners	completed projects				x	x		x			x	
						Tillage/residue management	Education and outreach to landowners to implement cover crops, conservation tillage, no-till and other residue management BMPs in cropland areas	N/A	Complete 1 project with landowner	Complete >1 projects with landowners	completed projects	x				x					x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x			x		x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	
							inventory/assessment of SSTS. Upgrade failing SSTS															
	Grindstone Lake (58012300)	Pine	Phosphorus (TP)	2,321 lb TP/yr; 13 ppb TP summer avg.	2,042 lb TP/yr; <12 ppb TP summer avg.	Monitoring	Continue water quality monitoring in tributaries entering lake to prioritize projects, evaluate trends, and track progress as BMPs are implemented	N/A	Establish and implement monitoring plan	Semi regular monitoring	completed monitoring				x	x				x		
						Monitoring	Conduct regular in-lake water quality monitoring (Secchi, TP, Chl-a) to evaluate trends and track progress as BMPs are implemented	N/A	Establish and implement monitoring plan	Regular monitoring	completed monitoring				x	x				x		
						Upstream improvements	Improve nutrient conditions in Elbow Lake	N/A	See strategies above	See strategies above	See strategies above					x		x		x	x	
						Forest protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified 5 parcels along lakeshore with high conservation potential (private land >20 acres and <50% developed/impacted).	42%	60%	>75%	% land in immediate subwatershed protected					x		x			x	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 3 projects with landowners	Complete >5 projects with landowners	completed projects				x	x		x			x	
						Tillage/residue management	Education and outreach to landowners to implement cover crops, conservation tillage, no-till and other residue management BMPs in cropland areas	N/A	Complete 3 projects with landowners	Complete >5 projects with landowners	completed projects	x				x					x	
						Improve riparian vegetation	Conduct shoreline inventory to ID buffer/vegetation improvements	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x				x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	
							(combination of desktop and field visits), implement projects															
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x			x		x	x	
						Lake management planning	Develop lake management plan that identifies goals and prioritizes restoration/protection efforts	N/A	Plan developed for Grindstone Lake	Plans are developed for Grindstone and all upstream lakes	# of upstream lakes with lake management plans				x	x		x		x	x	
	All Non-impaired Lakes	Kanabec, Pine	Phosphorus (TP)	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x				x		N/A
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x				x	x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x	x		x	x	
	Five Lake (33000300)	Kanabec	Phosphorus (TP)	24 ppb TP summer avg.	Maintain or improve existing water quality	See strategies above for all non-impaired lakes																
	Miller Lake (58013500)	Pine	Phosphorus (TP)	36 ppb TP summer avg.	Improve existing water quality																	

Color Key:

Restoration

Protection

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate														
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Kanabec County	Pine County	Cities	Lake Assoc.	Landowners	

	Subwatershed-wide strategies

Lower Kettle River HUC-10

Subwatershed Characteristics

- Size: 124,403 acres
- HUC-12 subwatersheds: City of Sandstone-Kettle River, City of Willow River-Kettle River, Friesland Ditch-Kettle River, Kettle River
- Towns/Cities: Sandstone (pop. 3,466), Sturgeon Lake (pop. 2,447), Rutledge (pop. 1,933), Hinckley (pop. 1,868), Willow River (pop. 1,229)
- Point Source Dischargers: Sandstone WWTP and Willow River WWTP
- Land cover: forest/shrubland (42%), wetlands (30%), hay/pasture (16%), developed (5%), cropland (4%), open water (2%), and barren/mining (<1%)
- Forested Land Protection: 31% (16,203 acres) public ownership, 69% (36,326 acres) privately owned
- WHPAs: Willow River (6 acres), and Hinckley (141 acres) (see Figure 11)
- DWSMAs: Willow River (11 acres) and Hinckley (8242 acres) (see Figure 11)

Streams

- Streams: 235 miles
- Stream Types
  - Natural: 143 miles
  - Altered: 61 miles
  - Impounded: 1 mile
  - No definable channel: 29 miles
- Impaired Streams (12.3 miles, three AUIDs):
  - Cane Creek: Headwaters to Kettle R (-525), FishesBio & InvertBio
  - Friesland Ditch: RR tracks to Kettle River (-617), FishesBio & InvertBio
  - Skunk Creek: Unnamed creek to Kettle R (-618), FishesBio
- Public Watercourses: 102 miles
- TALU Classes
  - Exceptional use: 10 miles
  - General use: 30 miles
  - Modified use 0 miles
- DNR Designated Trout Streams: 3 miles
- Cold Water Streams: None

- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 2 reaches (<1 mile)
    - Priority B: 5 reaches (27 miles)
    - Priority C: 1 reaches (12 miles)
- Stream Crossing Inventory and Prioritization
    - Top 10: No barriers
    - Rank 11-19: 1 barrier
    - Rank 20-29: 2 barriers
    - Rank 30-39: 5 barriers
    - Rank 40-45: 2 barriers

Lakes

- Lakes >10 acres: Skunk, Mud (58009000), Shoemaker, Little Mud, Mud (58010300), Clear, Stevens, Second, McCormick, Long, Cedar, and First
- Lakes >100 acres: none
- Impaired Lakes: McCormick
- Nearly/Barely Impaired Lakes: Long
- Lakes of Biological Significance
    - Outstanding: none
    - High: none
    - Moderate: Clear, Long, and Second
- DNR Priority Shallow Lakes: none
- DNR Wild Rice Lakes: McCormick and Cedar
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: Rhine

- Priority B: Cedar, First, Long, and Second
- Priority C: Little Mud, McCormick, and Mud (58010300)

- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: Cedar, First, Long, Second, Little Mud, McCormick, and Mud (58010300)

Subwatershed Priorities Identified in KRWLSP

- Overall Subwatershed Risk Assessment: Moderate
- Minor Subwatershed Priorities: None identified
- Lakes and Tributaries of Concern: Pelkey Creek and Cane creek.
- Priority Management Strategies:
    - Protect and restore riparian forests along tributaries of concern.
    - Extend protection around state park lands.
    - Urban forestry in the City of Sandstone.
- 10-year Demonstration Projects:
    - Pelkey Creek: Designed trout stream, large block of continuous forest stretching northwest from public lands including School Trust lands, misc. County land, Chengwatana State Forest, and St. Croix State Park.
    - City of Sandstone: Urban and community forestry, parkland, important areas for stormwater runoff; Kettle River runs through it.
    - Kettle River Streambank Erosion – Banning State Park. Approximately 500 feet of streambank erosion located downstream of Highway 23 bridge within Banning State Park.
    - East Central High School Property. The East Central High School is built on an 80-acre parcel. There is a large wetland and forest on the back part of the property. I know they talked in the past about using area for classes.
    - Cane Creek: larger block of contiguous forest, edged by Banning State Park, County miscellaneous land, Rutledge WMA, and School Trust land. Appears to have highly varied land cover.

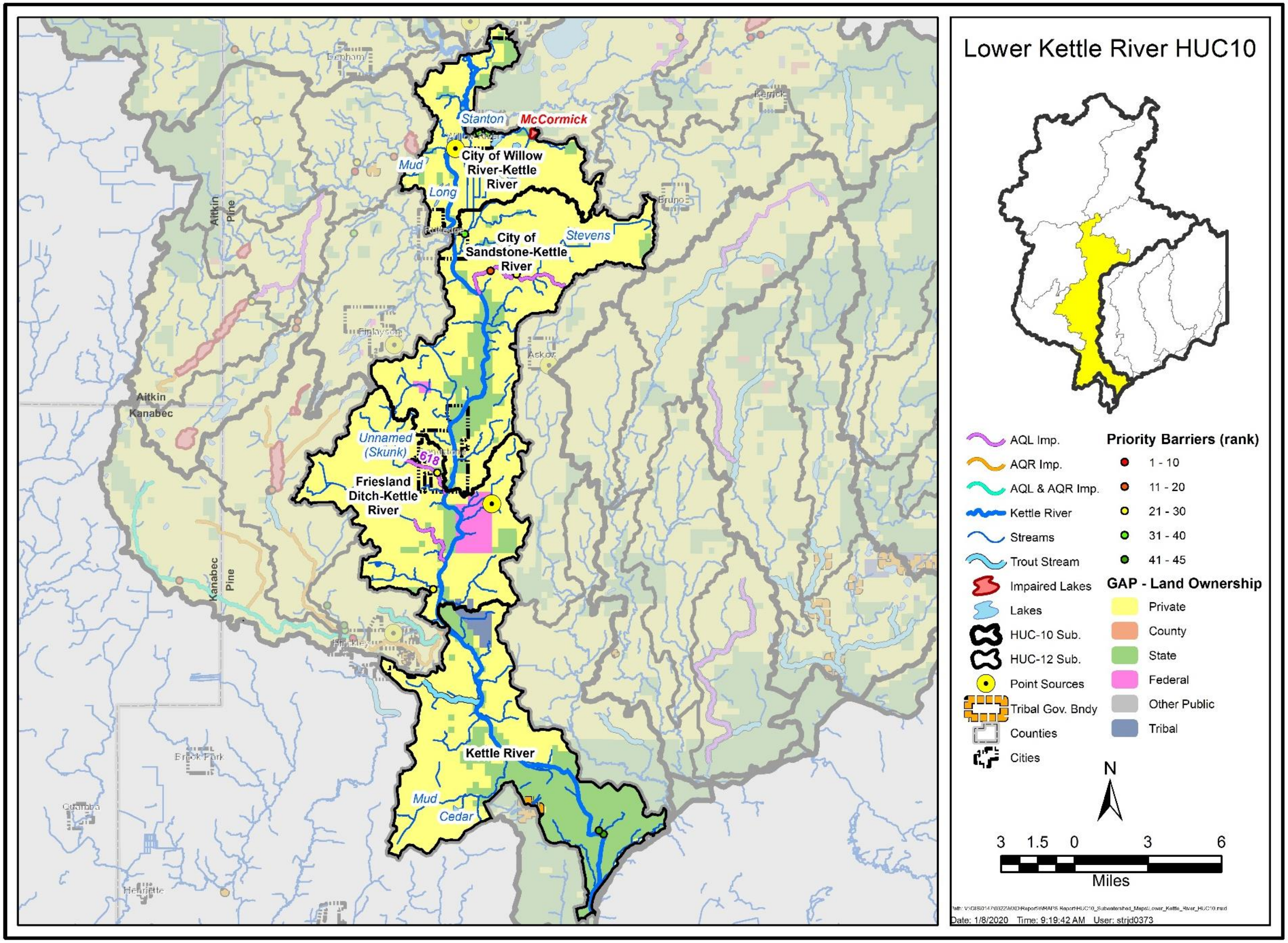


Figure 26: Lower Kettle River HUC-10 Subwatershed

Table 22: Strategies and actions proposed for the Lower Kettle River HUC-10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets. Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	MDA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
Lower Kettle River	All	Pine	All	N/A	N/A	Monitoring, Assessments, & Inventories	Conduct inventory/assessment of streambank and riparian conditions along the Kettle River to ID & prioritize bank stabilization, stream restorations, and other riparian improvement projects	N/A	Complete inventory/assessment	Use completed inventory/assessment to ID & prioritize projects	completed inventory/assessment						x	x				2040
						Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Use completed RAQ analysis to ID, prioritize, & target specific locations	42%	60%	>75%	% land in subwatershed protected		x				x	x			x	
						Modify/replace dams culverts & fish passage barriers	10 potential barriers identified by DNR throughout subwatershed (see Figure 26). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 3 barriers	Modify/replace 10 barriers	completed projects			x			x	x	x			
	Cane Creek (07030003-525)	Pine	Invert. IBI	Invert. IBI = 44	Invert. IBI >53	Modify/replace dams culverts & fish passage barriers	Review I-35 cement drop structure downstream of monitoring site and evaluate feasibility for	N/A	Complete review and feasibility	Implement results of review and feasibility	completed review and feasibility			x			x	x				2040

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate														
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	MDA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
							removal and potential benefits															
	Friesland Ditch (07030003-617)	Pine	Fish IBI	Fish IBI = 27	Fish IBI >42	Modify/replace culverts & fish passage barriers	Replace undersized culverts at Old Government Road that were identified in Stressor ID report as potential barriers to fish passage	N/A	Replace culverts	Replace culverts	culvert replacement			x			x	x				
						Beaver management	Manage beaver activity near Kettle River to allow fish passage and recolonization	N/A	Develop management plan	Implement plan	management plan and implementation			x			x					
						Restore natural hydrology	Decrease peak flow volumes by implementing BMPs to store water and restore natural hydrology in ditched areas of subwatershed	N/A	Identify and implement 1 project	Implement >1 project	completed projects						x	x			x	
	Skunk Creek (07030003-618)	Pine	Fish IBI	Fish IBI = 0, 22	Fish IBI >42	Modify/replace culverts & fish passage barriers	Re-install 2 improperly sized culverts with correct elevations that were identified in Stressor ID report as significant barriers to fish passage	N/A	Replace 2 culverts	Replace 2 culverts	culvert replacement			x			x	x				
						Stream habitat improvement and management	Continue to investigate and remediate historical contamination in Skunk Creek from the Kettle River Company Creosote Plant	N/A	Implement 2 projects informed by advanced ecological risk assessment	Implement all projects necessary to reduce ecological risk to acceptable levels	completed projects					x					x	
	McCormick Lake (58005800)	Pine	Phosphorus (TP)	678 lb TP/yr; 35 ppb TP summer avg.	567 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality entering lake from major tributary inflows, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x		x			x		

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility										Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate														
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	MDA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
						Improve livestock and manure management	Implement exclusion fencing, grazing rotations, and responsible manure management in identified areas	N/A	Complete 1 project with landowner	Complete >1 projects with landowners	completed projects				x		x	x			x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x			x		x	x	
						Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x		x			x		
	All Non-impaired Lakes	Pine	Phosphorus (TP)	See below	See below	Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline						x	x		x		N/A
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x			x		x	x	
	Long Lake (58010700)	Pine	Phosphorus (TP)	30 ppb TP summer avg. (vulnerable)	Improve existing water quality	Forest protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified 4 parcels along lakeshore with high	42%	60%	>75%	% land in immediate subwatershed protected						x	x			x	

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	MDA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							conservation potential (private land >20 acres and <50% developed/impacted).															
	Cedar Lake (58008900)	Pine	Phosphorus (TP)	38 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes																
	First Lake (58009900)	Pine	Phosphorus (TP)	39 ppb TP summer avg.	Improve existing water quality																	
	Little Mud Lake (58010600)	Pine	Phosphorus (TP)	55 ppb TP summer avg.	Improve existing water quality																	
	Second Lake (58008300)	Pine	Phosphorus (TP)	28 ppb TP summer avg.	Maintain or improve existing water quality																	

Color Key:

(pink)	Restoration
(green)	Protection
(white)	Subwatershed-wide strategies

Bear Creek HUC-10

Subwatershed Characteristics

- Size: 42,898 acres
- HUC-12 subwatersheds: Lower Bear Creek, Upper Bear Creek
- Towns/Cities: Askov (pop. 816)
- Point Source Dischargers: Askov WWTP
- Land cover: forest/shrubland (43%), wetlands (30%), hay/pasture (20%), cropland (4%), developed (3%), open water (<1%), and barren/mining (<1%)
- Forested Land Protection: 26% (4,769 acres) public ownership, 74% (13,790 acres) privately owned
- WHPAs: Askov (297 acres) (see Figure 11)
- DWSMAs: Askov (589 acres) (see Figure 11)

Streams

- Streams: 74 miles
- Stream Types
    - Natural: 40 miles
    - Altered: 28 miles
    - Impounded: <1 mile
    - No definable channel: 7 miles
- No impaired streams
- Public Watercourses: 49 miles
- TALU Classes
    - Exceptional use: 0 miles
    - General use: 41 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 2 miles
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 0 reaches
    - Priority B: 1 reach (2 miles)
    - Priority C: 1 reach (40 miles)

- Stream Crossing Inventory and Prioritization
    - No priority barriers

Lakes

- Lakes >10 acres: none
- Lakes >100 acres: none
- Impaired Lakes: none
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: none
    - High: none
    - Moderate: none
- DNR Priority Shallow Lakes: none
- DNR Wild Rice Lakes: none
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: none
    - Priority B: none
    - Priority C: none
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: none

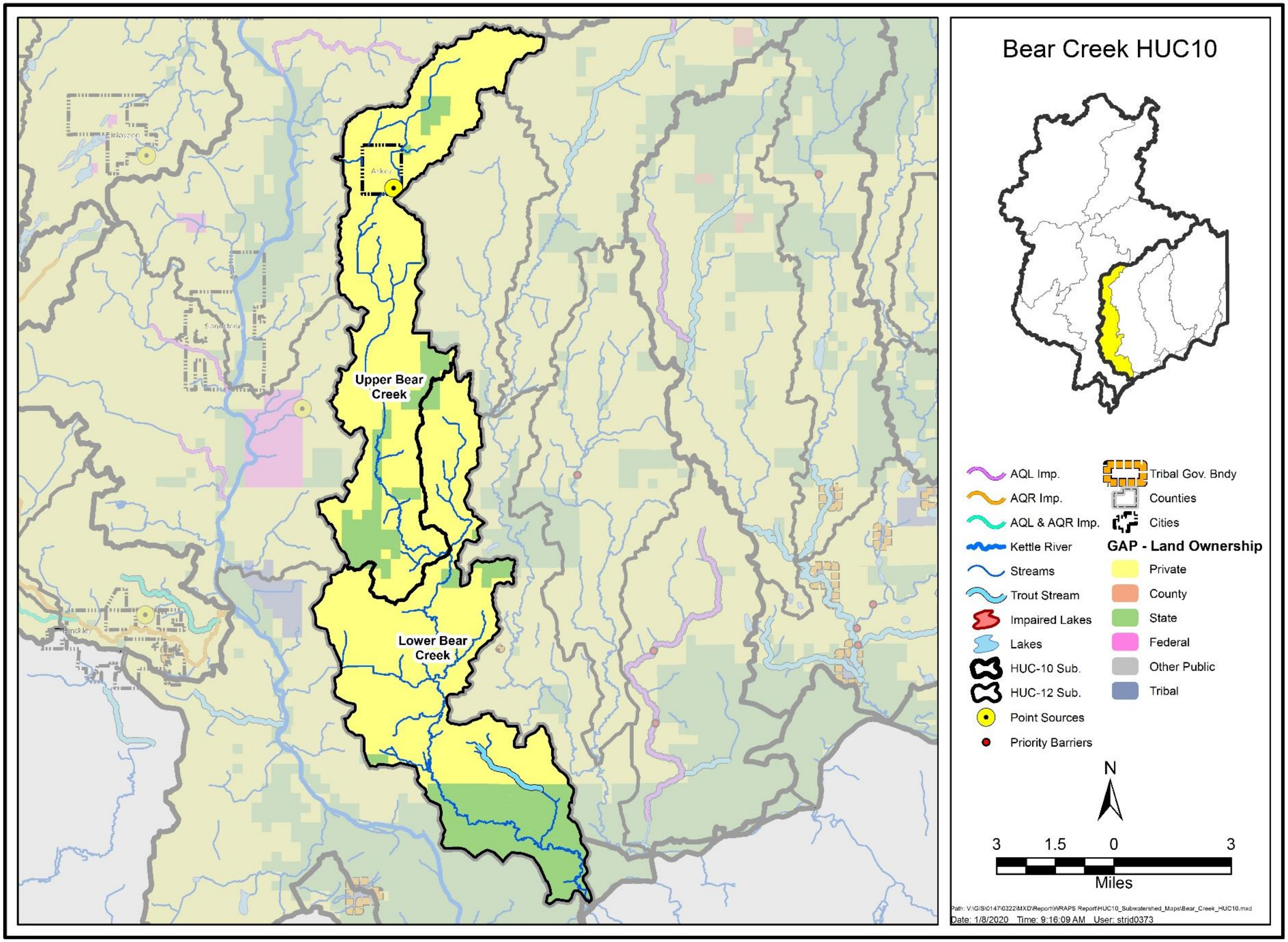


Figure 27: Bear Creek HUC-10 Subwatershed

Table 23: Strategies and actions proposed for the Bear Creek HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
Bear Creek	All	Pine	All	See below	See below	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	41%	60%	>75%	% land in subwatershed protected		x			x	x			x	N/A
	Bear Creek (07030001-518)	Pine	Fish IBI	Fish IBI = 72	Fish IBI threshold >47; maintain or improve existing biotic communities	See strategies above for all non-impaired streams															N/A
			Invert. IBI	Invert. IBI = 32, 81, 72, 77	Invert. IBI threshold >53; maintain or improve existing biotic communities																
	Little Bear Creek (07030001-581)	Pine	Fish IBI	Fish IBI = 68	Fish IBI threshold >42; maintain or improve existing biotic communities																
			Invert. IBI	Invert. IBI = 62	Invert. IBI threshold >51; maintain or improve existing biotic communities																

Color Key:

- Restoration
- Protection
- Subwatershed-wide strategies

Sand Creek HUC-10

Subwatershed Characteristics

- Size: 89,860 acres
- HUC-12 subwatersheds: Hay Creek-Sand Creek, Little Sand Creek, Lower Sand Creek, Partridge Creek, Upper Sand Creek
- Towns/Cities: None
- Point Source Dischargers: None
- Land cover: forest/shrubland (48%), wetlands (32%), hay/pasture (12%), cropland (4%), developed (3%), open water (1%), and barren/mining (<1%)
- Forested Land Protection: 28% (12,210 acres) public ownership, 72% (31,092 acres) privately owned
- WHPAs: Askov (148 acres) (see Figure 11)
- DWSMAs: Askov (266 acres) (see Figure 11)

Streams

- Streams: 143 miles
- Stream Types
  - Natural: 98 miles
  - Altered: 29 miles
  - Impounded: 2 miles
  - No definable channel: 15 miles
- Impaired Streams (19.82 miles, three AUIDs):
  - Sand Creek: Headwaters to T44 R18W S27, south line (-538), TSS
  - Hay Creek: Headwaters to Lk Clayton (-546), FishesBio & InvertBio
  - Sand Creek: T44 R18W S34, north line to Unnamed cr (-604), FishesBio
- Public Watercourses: 92 miles
- TALU Classes
  - Exceptional use: 14 miles
  - General use: 34 miles
  - Modified use 0 miles
- DNR Designated Trout Streams: 24 miles
- Cold Water Streams: 3 reaches (7 miles)
- Stream Protection & Prioritization Tool (see Figure 9 and Appendix A)

- Priority A: 1 reach (6 miles)
- Priority B: 2 reaches (12 miles)
- Priority C: 4 reaches (30 miles)

- Stream Crossing Inventory and Prioritization
  - 3 priority barriers
  - T106 culvert
  - Private Culvert
  - T777 Culvert

Lakes

- Lakes >10 acres: Bartels, Clayton, Wallace, Wilbur
- Lakes >100 acres: none
- Impaired Lakes: none
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
  - Outstanding: none
  - High: none
  - Moderate: none
- DNR Priority Shallow Lakes: none
- DNR Wild Rice Lakes: none
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
  - Exceptional: none
  - At or Above Impairment: none
  - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
  - Priority A: none
  - Priority B: none
  - Priority C: Clayton and Wallace
- Lake Benefit: Cost Assessment Tool:

- Highest: none
- Higher: none
- High: Clayton and Wallace

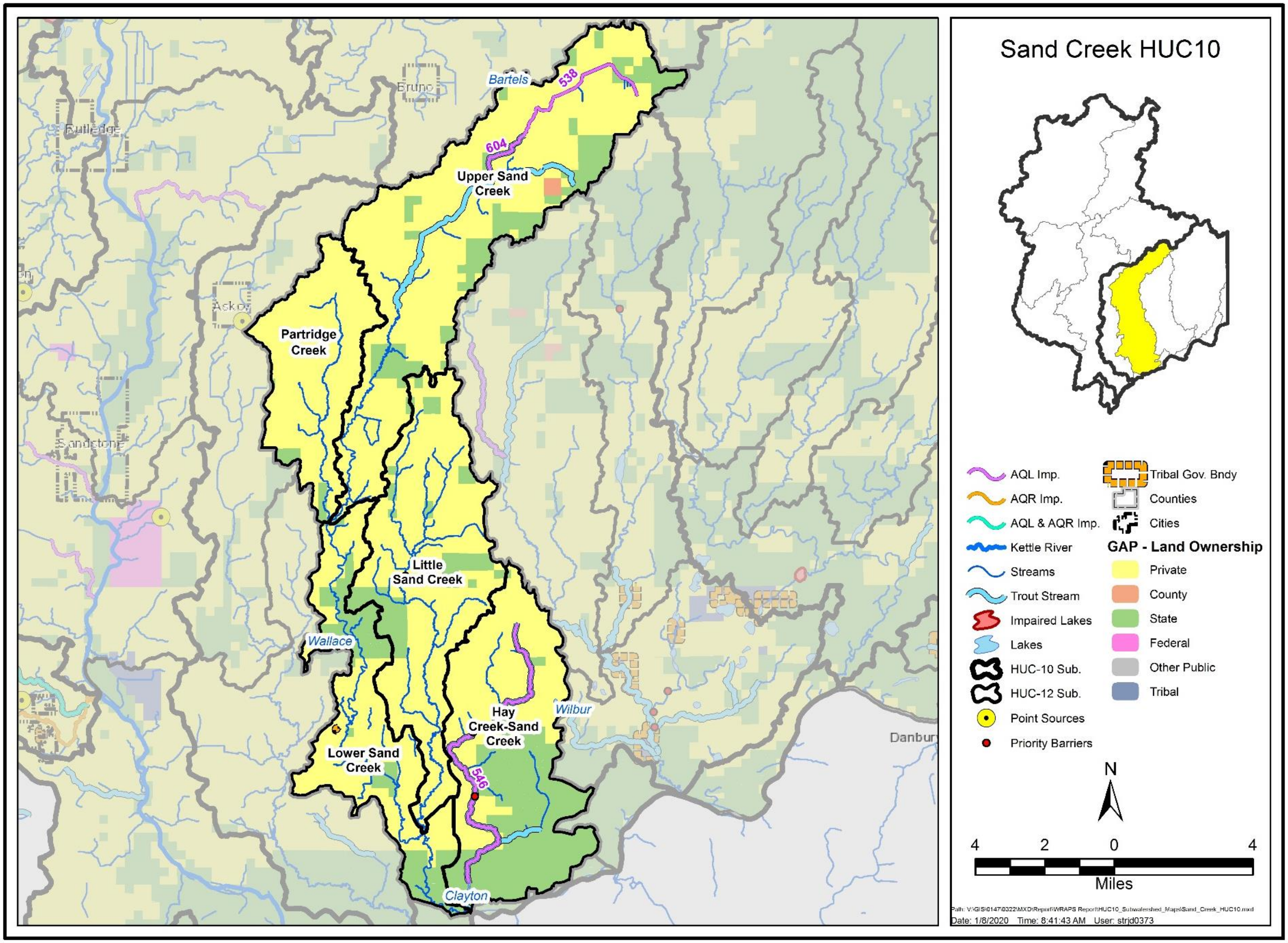


Figure 28: Sand Creek HUC-10 Subwatershed

Table 24: Strategies and actions proposed for the Sand Creek HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
Sand Creek	All	Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	47%	60%	>75%	% land in subwatershed protected		x			x	x			x	2040
						Modify/replace dams culverts & fish passage barriers	3 potential barriers identified by DNR throughout subwatershed (see Figure 28). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 1 barriers	Modify/replace 3 barriers	completed projects			x		x	x				
	Hay Creek (07030001-546)	Pine	Fish IBI & Invert. IBI	Fish IBI = 33, 47, 38, 34; 'Invert. IBI = 26, 28, 18	Fish IBI >35; Invert. IBI > 32	Modify/replace dams culverts & fish passage barriers	Remove/replace barriers identified in Upper St. Croix Stressor ID report and DNR assessment (e.g. Sand River Road, private crossing downstream of Hwy 48) that	N/A	Remove/replace 1 structure	Remove/replace all identified structures	completed projects			x		x	x			x	2040

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							could be potential barriers to fish passage														
						Beaver Management	Continue managing beaver activity to prevent dams that result in potential fish barriers and impoundments that cause low DO	N/A	Continue current management	Continue current management	management			x							
						Assess culverts	Assess all culverts to evaluate which may contribute to backing up water and affect DO and/or temperature	N/A	Complete assessment	Replace all identified problem culverts	completed projects			x		x	x				
	Sand Creek (07030001-604)	Pine	Fish IBI	Fish IBI = 23, 27	Fish IBI >35	Restore floodplains and reconnect with channel	Re-connect flow into original meandering channels to improve habitat and hydrology (e.g. downstream of Kettle Lake)	N/A	Complete feasibility study	Complete project	completed projects			x		x	x				
						Assess culverts	Assess all culverts to evaluate which may contribute to backing up water and affect DO and/or temperature	N/A	Complete assessment	Replace all identified problem culverts	completed projects			x		x	x				
	Sand Creek (07030001-538)	Pine	TSS	18% of samples <40 cm transparency	<10% of samples <40 cm transparency	Monitoring	Monitor TSS concentrations to further evaluate impairment and potential sources	N/A	Develop & implement monitoring plan	Monitoring	monitor water quality				x	x					
	All Non-impaired Lakes and Streams	Pine	All	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x			x		N/A

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
							support future assessments														
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x			x	x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x		x	x	
	Clayton Lake (58004000)	Pine	Phosphorus (TP)	55 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes and streams															
	Wallace Lake (58005400)	Pine	Phosphorus (TP)	32 ppb TP summer avg.	Improve existing water quality																
	Little Sand Creek (07030001-554)	Pine	Fish IBI	Fish IBI = 66 (vulnerable)	Fish IBI threshold >68; improve existing biotic communities																
			Invert. IBI	Invert. IBI = 88	Invert. IBI threshold >76; maintain or improve																

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
					existing biotic communities																

Color Key:

(pink)	Restoration
(green)	Protection
(white)	Subwatershed-wide strategies

Crooked Creek HUC-10

Subwatershed Characteristics

- Size: 64,158 acres
- HUC-12 subwatersheds: Crooked Creek, East Fork Crooked Creek, West Fork Crooked Creek
- Towns/Cities: None
- Point Source Dischargers: None
- Land cover: forest/shrubland (57%), wetlands (28%), hay/pasture (9%), cropland (3%), developed (2%), open water (2%), and barren/mining (<1%)
- Forested Land Protection: 42% (15,265 acres) public ownership, 58% (21,287 acres) privately owned
- WHPAs: None (see Figure 11)
- DWSMAs: None (see Figure 11)

Streams

- Streams: 97 miles
- Stream Types
    - Natural: 90 miles
    - Altered: 3 miles
    - Impounded: 1 mile
    - No definable channel: 4 miles
- Impaired Streams (4.14 miles, one AUID):
    - Wolf Creek: T43 R18W S32, north line to Crooked Cr (-548), InvertBio
- Public Watercourses: 81 miles
- TALU Classes
    - Exceptional use: 7 miles
    - General use: 13 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 34 miles
- Cold Water Streams: 4 reaches (16 miles)
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 1 reach
    - Priority B: 4 reaches (16 miles)
    - Priority C: 1 reach (3 miles)

- Stream Crossing Inventory and Prioritization
    - 4 Priority barriers
    - MN48 bridge
    - T1348 culvert
    - T381 culvert
    - CSAH32 culvert

Lakes

- Lakes >10 acres: 15 lakes
- Lakes >100 acres: none
- Impaired Lakes: none
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: Crooked
    - High: Razor
    - Moderate: Alma, Tamarack and Greigs
- DNR Priority Shallow Lakes: Crooked
- DNR Wild Rice Lakes: Crooked
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: Lena
    - Priority B: Greigs
    - Priority C: McGowan, Tamarack, and Razor
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: Lena, Greigs, McGowan, Tamarack, and Razor

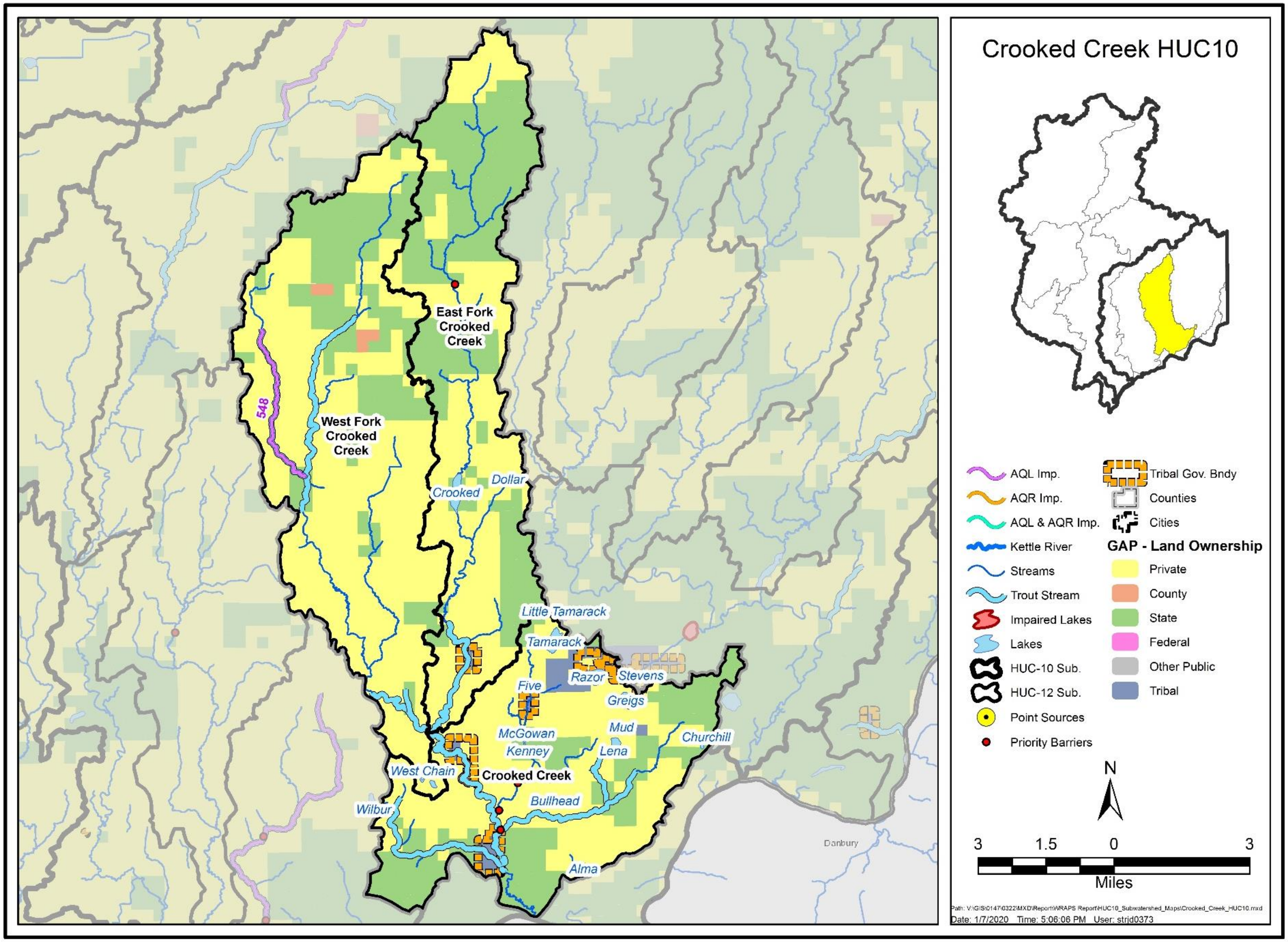


Figure 29: Crooked Creek HUC-10 Subwatershed

Table 25: Strategies and actions proposed for the Crooked Creek HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
Crooked Creek	All	Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	53%	75%	>75%	% land in subwatershed protected		x			x	x			x	2040
						Modify/replace dams culverts & fish passage barriers	4 potential barriers identified by DNR throughout subwatershed (see Figure 29). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 2 barriers	Modify/replace 4 barriers	completed projects			x		x	x				
	Wolf Creek (07030001-548)	Pine	Invert. IBI	Invert. IBI = 23, 15	Invert. IBI >32	Monitoring	Collect additional DO data (continuous and longitudinal) under various flow conditions to further evaluate stressors	N/A	Develop & implement monitoring plan	Monitoring	monitor water quality				x	x					2040
						Assess culverts	Assess all culverts to evaluate which may contribute to backing up water and affect DO, temperature, and/or fine sediment accumulation; the presence of upstream pools or sediment deposition should inform the assessment	N/A	Complete assessment	Replace all identified problem culverts	completed projects			x		x	x				
						Beaver Management	Evaluate beaver dams to determine if impoundments are causing low DO, increased temperature, and/or fine sediment accumulation	N/A	Assess and develop management plan	Implement management plan	management			x							
	All Non-impaired Lakes and Streams	Pine	All	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x			x		N/A

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Estimated Adoption Rate: Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation improvements (combination of desktop and field visits), implement projects	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x			x	x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x		x	x	
	Tamarack (58002400)	Pine	Phosphorus (TP)	20 ppb TP summer avg.	Maintain or improve existing water quality	Forest protection	Protect private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified 5 parcels along lakeshore with high conservation potential (private land >20 acres and <50% developed/impacted).	50%	60%	>75%	% land in immediate subwatershed protected		x			x	x			x	
	Crooked Lake (58002600) (wild rice lake)	Pine	Phosphorus (TP)	Unknown	Maintain or improve existing water quality	See strategies above for all non-impaired lakes and streams															
	Greigs Lake (58001300)	Pine	Phosphorus (TP)	27 ppb TP summer avg.	Maintain or improve existing water quality																
	Lena Lake (58001800)	Pine	Phosphorus (TP)	32 ppb TP summer avg.	Improve existing water quality																
	McGowan Lake (58001200	Pine	Phosphorus (TP)	41 ppb TP summer avg.	Improve existing water quality																
	Razor (58001000)	Pine	Phosphorus (TP)	15 ppb TP summer avg.	Maintain or improve existing water quality																
	Kenney Brook (07030001-562)	Pine	Fish IBI	Fish IBI = 48	Fish IBI threshold >42; maintain or improve																

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
					existing biotic communities																
			Invert. IBI	Invert. IBI = 53	Invert. IBI threshold >53; improve existing biotic communities																

Color Key:

(pink)	Restoration
(green)	Protection
(white)	Subwatershed-wide strategies

Lower Tamarack River HUC-10

Subwatershed Characteristics

- Size: 118,453 acres
- HUC-12 subwatersheds: Hay Creek-Lower Tamarack River, Headwaters Lower Tamarack River, Keene Creek, Lower Tamarack River, McDermott Creek
- Towns/Cities: None
- Point Source Dischargers: None
- Land cover: forest/shrubland (55%), wetlands (41%), hay/pasture (2%), developed (1%), open water (1%), cropland (<1%), and barren/mining (<1%)
- Forested Land Protection: 61% (39,552 acres) public ownership, 39% (25,153 acres) privately owned
- WHPAs: None (see Figure 11)
- DWSMAs: None (see Figure 11)

Streams

- Streams: 178 miles
- Stream Types
    - Natural: 170 miles
    - Altered: 2 miles
    - Impounded: 1 mile
    - No definable channel: 4 miles
- No impaired streams
- Public Watercourses: 125 miles
- TALU Classes
    - Exceptional use: 0 miles
    - General use: 87 miles
    - Modified use 0 miles
- DNR Designated Trout Streams: 5 miles
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
    - Priority A: 0 reaches
    - Priority B: 1 reach (6 miles)
    - Priority C: 6 reaches (81 miles)

- Stream Crossing Inventory and Prioritization
    - 1 Priority barrier
    - T918 culvert

Lakes

- Lakes >10 acres: Grace, Hay Creek Flowage, Little Tamarack, Rock, and Stevens
- Lakes >100 acres: none
- Impaired Lakes: Grace
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: Grace and Hay Creek Flowage
    - High: none
    - Moderate: none
- DNR Priority Shallow Lakes: Rock, Grace, and Hay Creek Flowage
- DNR Wild Rice Lakes: Hay Creek Flowage
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: none
    - Priority B: Rock
    - Priority C: Grace, Hay Creek Flowage, Little Tamarack, and Stevens
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: Grace, Hay Creek Flowage, Little Tamarack, Rock, and Stevens

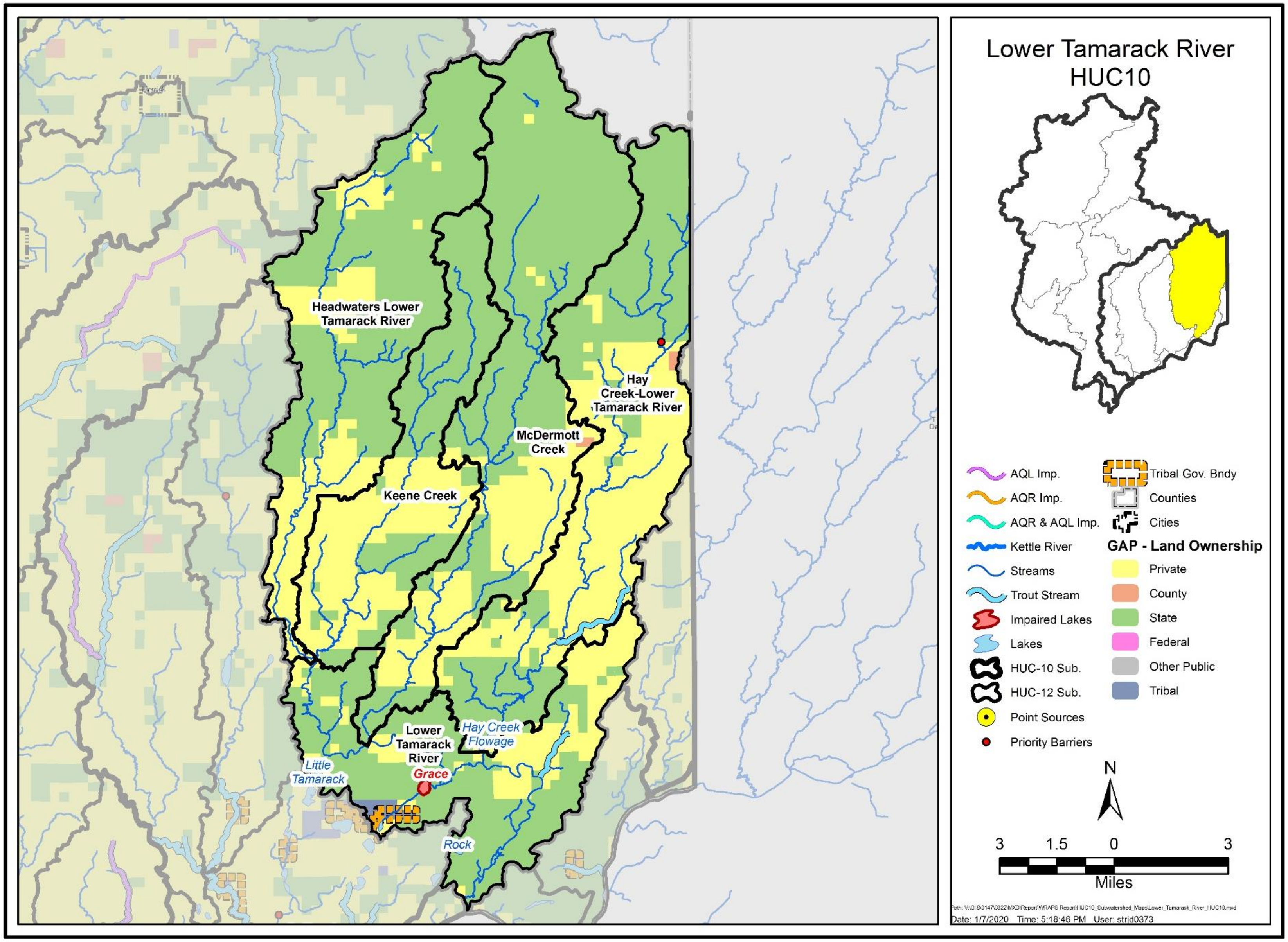


Figure 30: Lower Tamarack River HUC-10 Subwatershed

Table 26: Strategies and actions proposed for the Lower Tamarack River HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
Lower Tamarack River	All	Pine	All	N/A	N/A	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	75%	>75%	>75%	% land in subwatershed protected		x			x	x			x	2040
						Modify/replace dams culverts & fish passage barriers	1 potential barriers identified by DNR throughout subwatershed (see Figure 30). Modify/replace barriers as opportunities arise.	N/A	Modify/replace 1 barrier	Modify/replace 1 barrier	completed projects			x		x	x				
	Grace Lake (58002900)	Pine	Phosphorus (TP)	732 lb TP/yr; 70 ppb TP summer avg.	269 lb TP/yr; <30 ppb TP summer avg.	Monitoring	Monitor water quality entering lake from major tributary inflow, compare to TMDL modeling	N/A	4-5 monitoring events prior to implementing projects	Use monitoring results to update model & inform & prioritize projects	completed monitoring				x	x			x		2040
							Collect sediment cores to evaluate phosphorus release from sediment and potential impacts of recent logging and	N/A	Complete sediment core analysis	Use coring results to update model & inform & prioritize projects	completed coring					x			x		

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
							timber harvesting, compare to TMDL														
							Update fish & vegetation surveys according to DNR methods and protocols. Use survey results to evaluate if fisheries and/or vegetation management is needed	N/A	Complete surveys	Manage as necessary	Completed surveys			x		x	x		x		
						Forest protection	Continue to protect and maintain private forest and undeveloped land through protection programs described above. Lake Management Report (RMB 2019) identified two parcels along lakeshore with high conservation potential.	88%	>88%	>88%	% land in immediate subwatershed protected		x			x	x			x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Identify & upgrade 50%	Upgrade 100%	% of failing systems				x		x		x	x	
	All Non-impaired Lakes	Pine	Phosphorus (TP)	See below	See below	Monitoring	Expand water quality monitoring program to track trends, fill data gaps, and support future assessments	N/A	Develop & implement monitoring plan	Routine monitoring	monitor water quality				x	x			x		N/A
						Improve riparian vegetation	Conduct shoreline inventory on priority lakes to ID buffer/vegetation	N/A	Complete inventory and outreach	100% of shoreline with sufficient buffers	completed inventory, % of shoreline					x			x	x	

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
							improvements (combination of desktop and field visits), implement projects														
							Protect shorelines for wild rice rivers and lakes throughout watershed through RIM easements and other programs (e.g. Moose Horn River south of Moose Lake)	N/A	Obtain 3 easements	Obtain 10 easements	easements			x		x			x	x	
						SSTS education, maintenance, inventory, upgrade	Provide education and maintenance materials for SSTS parcels. Conduct inventory/assessment of SSTS. Upgrade failing SSTS	SSTS inspections at point of sale	Complete inventory/assessment	Upgrade failing SSTS	% of failing systems				x		x		x	x	
	Hay Creek Flowage (5800500) (wild rice lake, DNR priority shallow lake)	Pine	Phosphorus (TP)	75 ppb TP summer avg.	Improve existing water quality	See strategies above for all non-impaired lakes															
	Rock Lake (58000700) (wild rice lake, DNR priority shallow lake)	Pine	Phosphorus (TP)	35 ppb TP summer avg.	Maintain or improve existing water quality																
	Little Tamarack Lake (58002800)	Pine	Phosphorus (TP)	26 ppb TP summer avg.	Maintain or improve existing water quality																
	Stevens Lake (58000900)	Pine	Phosphorus (TP)	63 ppb TP summer avg.	Improve existing water quality																

Color Key:

- Restoration
- Protection

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	

	Subwatershed-wide strategies

Upper Tamarack River HUC-10

Subwatershed Characteristics

- Size: 6,879 acres
- HUC-12 subwatersheds: Spruce River, Upper Tamarack River
- Towns/Cities: None
- Point Source Dischargers: None
- Land cover: forest/shrubland (64%), wetlands (26%), hay/pasture (5%), developed (3%), cropland (2%), open water (<1%), and barren/mining (<1%)
- Forested Land Protection: 15% (646 acres) public ownership, 85% (3,759 acres) privately owned
- WHPAs: None (see Figure 11)
- DWSMAs: None (see Figure 11)

Streams

- Streams: 16 miles
- Stream Types
  - Natural: 11 miles
  - Altered: <1 miles
  - Impounded: 0 miles
  - No definable channel: 4 miles
- No impaired streams
- Public Watercourses: 8 miles
- TALU Classes
  - Exceptional use: 4 miles
  - General use: 4 miles
  - Modified use 0 miles
- DNR Designated Trout Streams: None
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)
  - Priority A: 0 reaches
  - Priority B: 1 reach (4 miles)
  - Priority C: 1 reach (4 miles)
- Stream Crossing Inventory and Prioritization

    - No priority barriers

Lakes

- Lakes >10 acres: none
- Lakes >100 acres: none
- Impaired Lakes: none
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: none
    - High: none
    - Moderate: none
- DNR Priority Shallow Lakes: none
- DNR Wild Rice Lakes: none
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection & Prioritization Tool (see Figure 14)
    - Priority A: none
    - Priority B: none
    - Priority C: none
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: none

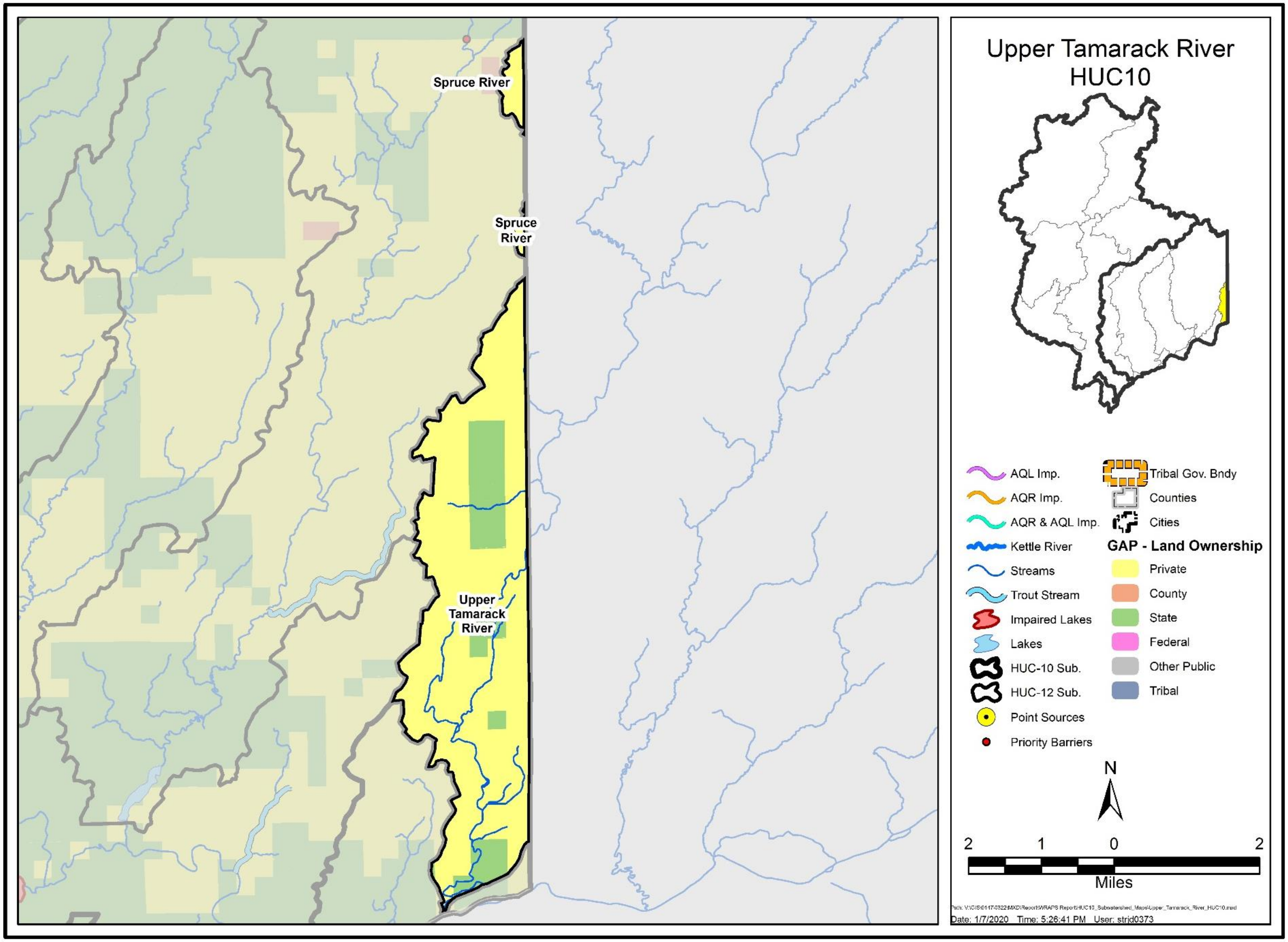


Figure 31: Upper Tamarack River HUC-10 Subwatershed

Table 27: Strategies and actions proposed for the Upper Tamarack River HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions (load or concentration)	Water Quality: Goals / Targets and Estimated % Reduction	Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.: Specific Implementation Strategy	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	Government Units with Primary Responsibility: NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	Estimated Year to Achieve Water Quality Target
Upper Tamarack River	All	Pine	All	See below	See below	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	36%	50%	>75%	% land in subwatershed protected		x			x	x			x	N/A
	Upper Tamarack River (07030001-613)	Pine	Fish IBI	Fish IBI = 97, 97	Fish IBI threshold >61; maintain or improve existing biotic communities	See strategies above for all non-impaired streams															N/A
			Invert. IBI	Invert. IBI = 56, 80 (vulnerable)	Invert. IBI threshold >82; improve existing biotic communities																

Color Key:

- Restoration
- Protection
- Subwatershed-wide strategies

Chases Brook-St. Croix River HUC-10

Subwatershed Characteristics

- Size: 25,405 acres
- HUC-12 subwatersheds: Redhorse Creek, Hay Creek-Saint Croix River*, City of Danbury-Saint Croix River*, Barrett Creek-Saint Croix River*
- Towns/Cities: None
- Point Source Dischargers: None
- Land cover: forest/shrubland (57%), wetlands (37.2%), hay/pasture (1.1%), developed (1.4%), cropland (<1%), open water (2.4%), and barren/mining (<1%)
- Forested Land Protection: 85% (21,594 acres) public ownership, 15% (3,811 acres) privately owned
- WHPAs: None (see Figure 11)
- DWSMAs: None (see Figure 11)

*Note that the majority of these HUC-12 subwatersheds (and the Chases Brook-St. Croix River HUC-10 subwatershed overall) are located in Wisconsin. This report only covers the portion of the Upper St. Croix River HUC-8 watershed that is located in Minnesota.

Streams

- Streams: 62.7 miles
- Stream Types
  - Natural: 55.9 miles (this number includes the mainstem St. Croix River, which was assessed separately from this effort)
  - Altered: <1 miles
  - Impounded: 0 miles
  - No definable channel: 6.4 miles
- No impaired streams
- Public Watercourses: 48.4 miles (this number includes the mainstem St. Croix River, which was assessed separately from this effort)
- TALU Classes
  - Exceptional use: 10.3 miles
  - General use: 4.8 miles
  - Modified use 0 miles
- DNR Designated Trout Streams: 1.3 miles
- Cold Water Streams: None
- Stream Protection & Prioritization Tool (see Figure 13 and Appendix A)

    - Priority A: 0 reaches
    - Priority B: 2 reaches (10.3 miles)
    - Priority C: 1 reach (4.8 miles)
- Stream Crossing Inventory and Prioritization
    - No priority barriers

Lakes *(Note: there are no lakes in the portion of this HUC-10 subwatershed located in Minnesota)*

- Lakes >10 acres: none
- Lakes >100 acres: none
- Impaired Lakes: none
- Nearly/Barely Impaired Lakes: none
- Lakes of Biological Significance
    - Outstanding: none
    - High: none
    - Moderate: none
- DNR Priority Shallow Lakes: none
- DNR Wild Rice Lakes: none
- DNR Cisco Refuge Lakes: none
- DNR Stream Trout Lakes: none
- DNR Muskie Lakes: none
- FIBI scores
    - Exceptional: none
    - At or Above Impairment: none
    - Below Impairment Threshold: none
- Lake Protection and Prioritization Tool (see Figure 14)
    - Priority A: none
    - Priority B: none
    - Priority C: none
- Lake Benefit: Cost Assessment Tool:
    - Highest: none
    - Higher: none
    - High: none

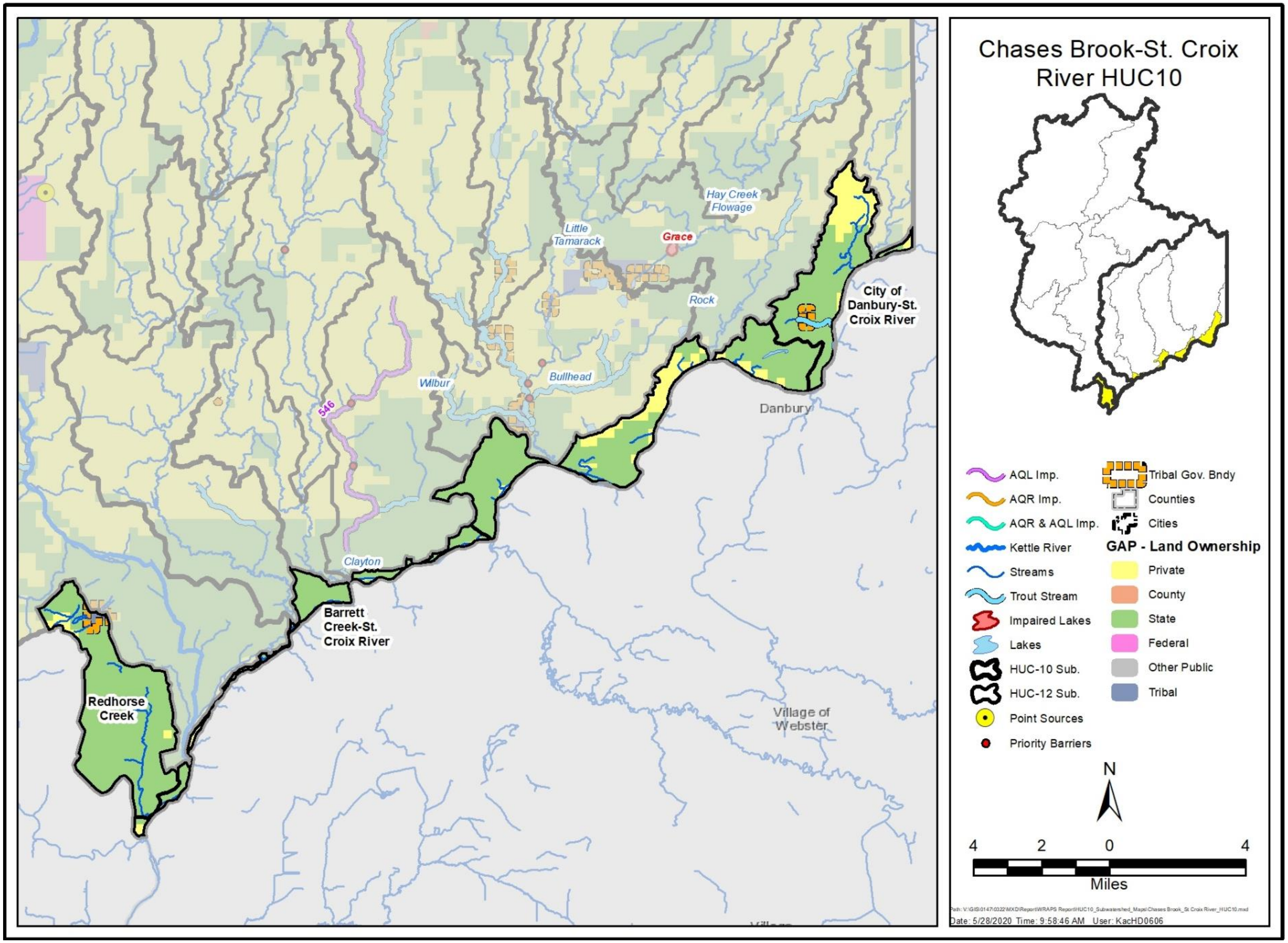


Figure 32: Chases Brook-St. Croix River HUC-10 Subwatershed

Table 28: Strategies and actions proposed for the Chases Brook-St. Croix River HUC-10 Subwatershed

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategy type (see key below)	Strategy scenario showing estimated scale of adoption to meet 10 yr. milestone and final water quality targets.					Government Units with Primary Responsibility									Estimated Year to Achieve Water Quality Target
								Estimated Adoption Rate													
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions (load or concentration)	Goals / Targets and Estimated % Reduction		Specific Implementation Strategy	Current strategy adoption level, if known	Interim 10-year Milestone	Suggested Goal	Units	NRCS	BWSR	DNR	MPCA	SWCDs	Pine County	Cities	Lake Assoc.	Landowners	
Upper Tamarack River	All	Pine	All	See below	See below	Maintain existing forest cover - prevent new losses	Protect and maintain private forest land through forest stewardship planning, 3rd party certification, Sustainable Forest Incentive Act (SFIA), local woodland cooperatives, fee title, conservation easements, aquatic management areas (AMAs) and other programs. Work with BWSR, DNR Forestry, and SWCD Technical Service Area 3 to complete RAQ analysis to ID, prioritize, & target specific locations	86%	Continued vigilance	>75%	% land in subwatershed protected		x			x	x			x	N/A
Upper Tamarack River	Redhorse Creek (07030001-519)	Pine	Fish IBI	Fish IBI = 47.60	Fish IBI threshold >42; maintain or improve existing biotic communities	See strategy above for all waterbodies															N/A
Upper Tamarack River	Redhorse Creek (07030001-519)	Pine	Invert. IBI	Invert. IBI = 61.43	Invert. IBI threshold >53; maintain or improve existing biotic communities	See strategy above for all waterbodies															N/A

Color Key:

- Restoration
- Protection
- Subwatershed-wide strategies

4. Monitoring plan

The collection of current land and water data is an important component to both assess progress and inform management and decision-making. For improved watershed management to work in the Kettle River and Upper St. Croix River watersheds, there needs to be reliable data collected and analyzed. Monitoring of both land management and water resources is needed to inform and calibrate watershed models, evaluate progress towards defined goals, and adjust strategies as time goes on to reach desired outcomes. Section 7 of the Kettle and Upper St. Croix River TMDL Report includes more information on monitoring.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction. The response of the lakes and streams will be monitored and subsequently evaluated as management practices are implemented. The management approach to achieving the goals should be adapted as new monitoring data is collected and evaluated (i.e. adaptive management approach, Figure 29). Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in these watersheds. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired water bodies.

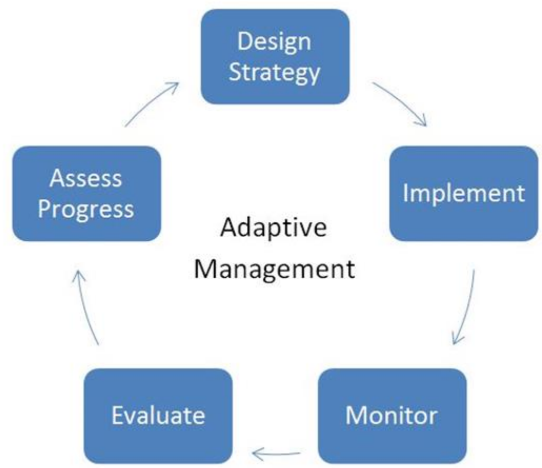


Figure 33: Adaptive management framework

The overall schedule for implementation of this TMDL and WRAPS project is 2021 through 2040. During this time period, it is expected that on average, water quality pollutant concentrations will decline each year equivalent to approximately 3% of the starting (i.e., long-term) pollutant load reduction for the *E. coli* impairments and 2% for the lake TP impairments. This progress benchmark will generally result in meeting water quality standards by 2040 for the majority of the waterbodies.

Again, this is a general guideline. Factors that may mean slower progress include limits in funding or landowner acceptance, challenging fixes (e.g., restoring large peatlands, invasive species, lake internal load management) and unfavorable climatic factors. Conversely, there may be faster progress for some impaired waters, especially where high-impact fixes are slated to occur.

Data from numerous monitoring programs will continue to be collected and analyzed throughout the Kettle River and Upper St. Croix River watersheds. Monitoring is conducted by local, state and federal entities, and also special projects as described below.

Intensive Watershed Monitoring

Through the State of Minnesota's Watershed Approach, the MPCA collects water quality and biological data for two years every 10 years at established stream and lake monitoring stations within every major watershed in the state. The first round of IWM for the Kettle River and Upper St. Croix River watersheds was completed in 2016 and 2017. These efforts are summarized in the monitoring and assessment reports (MPCA 2019a and MPCA 2019b). The MPCA, with assistance from LGUs, will re-visit and reassess a key subset of these monitoring stations, as well as have some capacity to visit new sites in areas with BMP implementation activity, scheduled to begin in 2027. It is expected that funding for monitoring and analysis will be available through the MPCA.

Watershed Pollutant Load Monitoring Network

The WPLMN, which includes state and federal agencies, Metropolitan Council Environmental Services, state universities, and local partners, collects data on water quality and flow in Minnesota to calculate pollutant loads in rivers and streams. Data is collected at 199 sites around the state. Each year, approximately 25 to 35 water quality samples are collected at each monitoring site, either year-round or seasonally depending on the site. Water quality samples are collected near gaging stations, at or near the center of the channel. Samples are collected more frequently when water flow is moderate and high, when pollutant levels are typically elevated and most changeable. Pollutant concentrations are generally more stable when water flows are low, and fewer samples are taken in those conditions. This staggered approach generally results in samples collected over the entire range of flows.

Data collected through WPLMN is used to assist in watershed modeling, determine pollutant source contributions, evaluate trends, develop reports, and measure water quality restoration efforts. There are two WPLMN sites within the Kettle River Watershed (see discussion in Section 2.2).

Citizen Stream and Lake Monitoring Program

The MPCA's Citizen Stream and Lake Monitoring Program relies on a network of private citizen volunteers who take stream and lake measurements regularly, reported annually. Data collected through these efforts can provide a continuous record of waterbody transparency throughout much of the basin. There is currently a limited number of citizens doing monitoring within the Kettle River and Upper St. Croix River watersheds. The MPCA and local units of government have sought and will continue to seek more citizen monitors to track trends of water quality transparency for impaired waters within the basin. Civic engagement work completed during the duration of this project (see Section 3.2) resulted in an additional 13 citizen monitor volunteers across both watersheds.

County and Lake Association Monitoring

Soil and Water Conservation Districts and county governments within the Kettle River and Upper St. Croix River watersheds played a key role in conducting the IWM in 2016 and 2017 that informed this report and others. Due to resource limitations, ongoing water quality monitoring is generally not conducted by these LGUs. However, as previously mentioned, LGUs have promoted and encouraged citizen participation in the MPCA Citizen Monitoring Program, which produces valuable data for condition assessments and long term trend analysis.

Lake associations are another type of organization that often have capacity to conduct monitoring, either directly or through member participation in the MPCA's Citizen Monitoring Program. There are many active lake associations in the Kettle River and Upper St. Croix River watersheds, and lake associations in Pine County also network through the Pine County Coalition of Lake Associations (COLA). The Big Pine Lakes Association, Grindstone Lake Association, and the Windemere Township Lakes Association were active on the Local Work Group that helped to develop this report.

The Big Pine Lakes Association regularly monitors six sites within Big Pine and Pine Lakes and adjacent tributaries for TP and monitors for chl-*a*, nitrogen, and Secchi depth at three of these sites. Their dataset extends back to 2013 or 2014 (depending on the parameter). Members of the Grindstone Lake Association are involved in both lake (Secchi disc depth) and stream (Secchi tube) citizen monitoring on Grindstone Lake and its tributaries. These datasets are extensive, dating back to 1993 (although not continuous) in some instances. The Windemere Township Lakes Association encompasses 13 lakes in Pine County's Windemere Township; several of its members monitor the lakes they live on through MPCA's lake citizen monitoring program, contributing to increased monitoring capacity in that area of the watersheds. Conversations during the development of this report encouraged one longtime citizen monitor on Island Lake to apply for the MPCA's Advanced Citizen Lake Monitoring Program (CLMP+, https://www.pca.state.mn.us/water/advanced-citizen-lake-monitoring-program-clmp), which will help to fill in data gaps and allow for future water quality assessments to happen.

Diagnostic and Targeted Monitoring

The Kettle River and Upper St. Croix River watersheds SID reports, TMDL allocations, and source assessment exercises were developed using available monitoring data, surveys, assessments, and models. For many of the impairments, it is recommended that additional targeted data and information be collected prior to investing significant money and resources into restoring these waterbodies. Collecting additional diagnostic and targeted monitoring data will help calibrate and/or validate modeling results, refine the TMDL source assessments, pinpoint geographic locations of problem areas, and provide baseline data prior to project implementation. Several targeted monitoring activities were identified in the Kettle River and Upper St. Croix River watersheds SID and TMDL reports. Many of these activities have been incorporated into the individual strategy tables in this WRAPS and include the following:

- Longitudinal (upstream to downstream) *E. coli* monitoring surveys in all bacteria impaired streams to evaluate potential locations of elevated bacteria loading
- Microbial source tracking in some bacteria-impaired streams to identify sources of fecal contamination. Microbial source tracking should be considered for reaches where the results of the longitudinal surveys and other source assessment analyses are inconclusive.
- Additional DO and flow monitoring within peatlands where hydrology has been altered (channelized/drained)
- Inventory/assessment of streambank and riparian conditions along the main-stem Kettle River to identify and prioritize bank stabilization, stream restorations, and other riparian improvement projects
- Collect flow and water quality (e.g. TP) in major tributaries and wetlands flowing to impaired lakes. Compare monitoring results to HSPF and lake response models for validation and/or re-calibration
- Collect sediment cores and evaluate phosphorus release from sediment within selected impaired lakes and compare to TMDL model predictions
- Collect targeted water quality measurements and sediment data within lakes and streams that have been identified as having potential legacy loading impacts (e.g. historic paper mills, logging, trout farms, etc.)

- Conduct/update fish and/or vegetation surveys according to DNR methodology for lakes that have never been surveyed or have limited or outdated survey data.

Implementation Tracking

Implementation tracking is conducted by both BWSR (i.e., eLink) and NRCS. Both agencies track the locations of BMP installations. Tillage transects and crop residue data are collected periodically and reported through the Tillage Transect Survey Data Center. In addition, the MPCA documents (integrating data from eLink and NRCS, among other sources) actions taken in Minnesota's watersheds to meet water quality goals and outcomes on its Healthier Watersheds webpage. This report includes the status of WRAPS/TMDLs, wastewater loading, BMP, and spending for implementation projects.

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Appendix A: Lake and Stream Protection and Prioritization Results and Transparency Trends

Lakes with priority scores

HUC-10 Subwatershed	Lake ID	Lake Name	Mean TP (ug/L)	Secchi Trend (2019)	% Disturbed Land Use	Load Reduction Goal (TP lbs/year)	Priority
Grindstone River	58-0123-00	Grindstone	19.5	No trend	12%	83	B*
	58-0135-00	Miller	35.5	Insufficient data	11%	7	B
	33-0003-00	Five	24.3	Insufficient data	5%	2	C
Lower Kettle River	58-0083-00	Second	28.0	Insufficient data	12%	2	B
	58-0089-00	Cedar	38.0	Insufficient data	8%	11	B
	58-0099-00	First	39.0	Insufficient data	27%	30	B
	58-0107-00	Long	29.6	No trend	13%	10	B
	58-0103-00	Mud	80.0	Insufficient data	3%	15	C
	58-0106-00	Little Mud	54.5	Insufficient data	3%	8	C
Moose River	09-0034-00	Bear	25.6	No trend	44%	7	A
	09-0035-00	Little Hanging Horn	17.2	Improving	15%	5	A
	09-0039-00	Eddy	22.3	No change	10%	121	A
	58-0062-00	Island	31.5	No trend	22%	39	A
	58-0081-00	Sand	17.9	No trend	20%	35	A
	09-0029-00	Park	16.5	No change	4%	8	B
	09-0041-00	Moosehead	35.9	No change	61%	378	B
	09-0043-00	Moose	24.0	Insufficient data	7%	8	B
	09-0044-00	Echo	16.0	Insufficient data	13%	5	B
	09-0045-00	Coffee	19.9	Insufficient data	28%	30	B
	09-0026-00	Bob	17.6	Insufficient data	4%	9	C
	09-0038-00	Hanging Horn	25.5	No trend	10%	276	C
Pine River	58-0137-00	Bass	16.7	Insufficient data	16%	4	A

HUC-10 Subwatershed	Lake ID	Lake Name	Mean TP (ug/L)	Secchi Trend (2019)	% Disturbed Land Use	Load Reduction Goal (TP lbs/year)	Priority
	58-0127-00	Little Bass	35.1	Insufficient data	15%	1	B
	58-0128-00	Bass	23.5	Insufficient data	7%	1	C
	58-0129-00	Little Pine	67.0	Insufficient data	11%	118	C
	58-0130-00	Upper Pine	24.2	No trend	7%	43	C
	58-0131-00	Fish	69.0	Insufficient data	18%	23	C
	58-0132-00	Indian	27.0	Insufficient data	9%	14	C
Upper Kettle River	09-0049-00	Kettle	28.9	Insufficient data	1%	53	C
Willow River	58-0067-00	Sturgeon	14.0	Improving	17%	27	A
	58-0073-00	Dago	16.1	Insufficient data	21%	3	A
	58-0068-00	Eleven	24.6	Improving	8%	3	B
	58-0076-00	Passenger	12.3	Insufficient data	11%	1	B
	58-0111-00	Stanton	41.0	Insufficient data	27%	394	C
Crooked Creek	58-0018-00	Lena	32.0	Insufficient data	15%	2	A
	58-0013-00	Greigs	27.0	Insufficient data	16%	2	B
	58-0010-00	Razor	15.0	Insufficient data	3%	3	C
	58-0024-00	Tamarack	20.4	Improving	3%	2	C
	58-0012-00	McGowan	41.0	Insufficient data	0%	24	C
Lower Tamarack River	58-0007-00	Rock	35.1	Insufficient data	3%	3	B
	58-0028-00	Little Tamarack	26.0	Insufficient data	5%	4	C
	58-0009-00	Stevens	63.0	Insufficient data	7%	4	C
	58-0005-00	Hay Creek Flowage	75.3	Insufficient data	3%	340	C
Sand Creek	58-0054-00	Wallace	32.0	No data	5%	4	C
	58-0040-00	Clayton	55.0	No data	3%	106	C

*Grindstone Lake is the only lake assessed as impaired by aquatic recreation to be assigned a priority score. Grindstone Lake is classified as a Class 2A (Lake Trout) water, a use classification with stringent water quality standards to protect coldwater aquatic life. Protection and restoration efforts are needed to both prevent further decline and restore the lake to meet water quality standards.

Lakes without priority scores (see note, below)

HUC-10 Subwatershed	Lake ID	Lake Name	Mean TP (ug/L)	Secchi Trend (2019)	% Disturbed Land Use	Load Reduction Goal (TP lbs/year)	Priority	Nutrient Impairment?	DNR Aquatic Life Assessment Results
Grindstone River	58-0126-00	Elbow	40.9	Insufficient data	13%	23	NA*	Yes	No data
Lower Kettle River	58-0058-00	McCormick	34.5	Insufficient data	9%	21			Insufficient information
Moose River	09-0022-00	Twentynine	53.4	Insufficient data	11%	8			Insufficient information
Pine River	01-0001-00	Pine	36.8	No change	7%	109			Insufficient information; **vulnerable**
	58-0138-00	Big Pine	35.9	No change	12%	129			Insufficient information; **vulnerable**
	33-0001-00	Eleven	38.9	Insufficient data	10%	22			Fully supporting
	58-0102-00	Fox	52.1	Insufficient data	7%	52			Fully supporting
	58-0136-00	Rhine	62.0	**Degrading**	6%	31			No data
Upper Kettle	09-0058-00	Merwin	39.3	Insufficient data	9%	7			Insufficient information
Willow River	58-0048-00	Oak	32.8	No trend	12%	24			**Not supporting**
Lower Tamarack River	58-0029-00	Grace	70.3	Insufficient data	3%	31			Insufficient information

*These lakes are not assigned a priority score because they are all impaired by aquatic recreation due to excess nutrients. Management efforts on these lakes should focus on restoration efforts to improve water quality in these lakes, which should also protect the lakes from further degradation.

Additional lakes evaluated for Secchi (transparency) trends that did not meet the Lake Protection and Prioritization Tool's criteria (see Section 3.1)

HUC-10 Subwatershed	Lake Name	AUID	Secchi Trend (2019)
Moose River	Manoomini-zaaga'iganing/Wild Rice	09-0023-00	Insufficient Data
	Lords	58-0063-00	Insufficient Data
Willow River	Johnson	58-0074-00	Insufficient Data
	Rush	58-0078-00	No Trend
Lower Kettle River	Stevens	58-0059-00	Insufficient Data
	Unnamed	58-0088-00	Insufficient Data
	Unnamed	58-0100-00	Insufficient Data
Crooked Creek	Keene	58-0015-00	Insufficient Data
	Unnamed	58-0205-00	Insufficient Data
Sand Creek	Olive	58-0044-00	Insufficient Data
	Wilbur	58-0045-00	Insufficient Data
Lower Tamarack River	Unnamed	58-0190-00	Insufficient Data

Stream Protection and Prioritization Tool Results

HUC-10 Subwatershed	WID	Stream Name	TALU	Cold/ Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
Grindstone River	07030003-501	Grindstone River	General	warm	one	high	med/high	med/low	A
	07030003-544	Grindstone River, North Branch	General	warm	neither	medium	medium	med/low	B
Lower Kettle River	07030003-501	Grindstone River	General	warm	one	high	med/high	med/low	A
	07030003-502	Kettle River	General	warm	one	low	medium	medium	B
	07030003-503	Kettle River	Exceptional	warm	neither	med/high	medium	med/low	B
	07030003-505	Kettle River	Exceptional	warm	one	medium	medium	medium	B
	07030003-528	Kettle River	General	warm	neither	medium	medium	med/high	C
Moose River	07030003-521	Moose Horn River	General	warm	one	high	med/high	med/low	A
	07030003-547	King Creek	General	cold	one	med/low	medium	low	A
	07030003-628	Moose Horn River, West Branch	Exceptional	warm	one	med/high	medium	med/low	A
	07030003-531	Moose Horn River	General	warm	neither	medium	med/high	medium	B
	07030003-629	Moose Horn River	Exceptional	warm	neither	med/high	med/high	medium	B
	07030003-630	Moose Horn River	General	warm	neither	medium	med/high	medium	B
	07030003-535	Moose Horn River	General	cold	neither	med/low	medium	medium	C
Pine River	07030003-560	Little Pine Creek	Exceptional	warm	both	high	med/high	low	A
	07030003-624	Pine River	Exceptional	warm	one	medium	medium	med/low	A
	07030003-568	Bremen Creek	General	warm	neither	med/high	med/low	medium	B
	07030003-609	Rhine Creek	General	warm	neither	high	medium	med/low	B
	07030003-620	Bremen Creek	General	warm	one	med/low	low	med/high	B
Upper Kettle River	07030003-509	Gillespie Brook	General	warm	neither	med/low	medium	med/low	B
	07030003-510	Kettle River	General	warm	neither	medium	medium	medium	B
	07030003-513	Split Rock River	General	warm	neither	medium	medium	medium	B
	07030003-514	Birch Creek	General	warm	neither	medium	medium	medium	B
	07030003-529	Kettle River	General	warm	neither	med/high	medium	med/low	B
	07030003-592	Silver Creek	General	warm	neither	med/low	medium	med/low	B
	07030003-615	Unnamed ditch	General	warm	one	med/low	medium	medium	B

HUC-10 Subwatershed	WID	Stream Name	TALU	Cold/ Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
	07030003-512	Kettle River, West Branch	General	warm	neither	medium	med/low	medium	C
	07030003-537	Dead Moose River	General	warm	neither	med/low	medium	medium	C
	07030003-552	Kettle River	General	warm	neither	med/low	medium	medium	C
Willow River	07030003-548	Larsons Creek	General	cold	both	low	low	medium	A
	07030003-575	Little Willow River	General	warm	neither	med/low	medium	low	B
	07030003-622	Willow River	Exceptional	warm	neither	med/high	medium	medium	B
	07030003-621	Willow River	General	warm	neither	low	medium	medium	C
Bear Creek	07030001-581	Little Bear Creek	General	warm	neither	med/high	medium	low	B
	07030001-518	Bear Creek	General	warm	neither	med/low	medium	medium	C
Chases Brook-St. Croix River	07030001-541	Crooked Creek	Exceptional	warm	one	low	med/low	med/high	B
	07030001-618	Sand Creek	Exceptional	warm	one	medium	medium	medium	B
	07030001-519	Redhorse Creek	General	warm	neither	medium	med/low	high	C
Crooked Creek	07030001-562	Kenney Brook	General	warm	one	med/high	medium	med/low	A
	07030001-522	Crooked Creek	General	cold	one	medium	med/low	medium	B
	07030001-537	Crooked Creek, West Fork	General	cold	neither	med/high	med/low	medium	B
	07030001-541	Crooked Creek	Exceptional	warm	one	low	med/low	med/high	B
	07030001-545	Bangs Brook	Exceptional	cold	one	medium	medium	medium	B
	07030001-533	Crooked Creek, East Fork	General	cold	neither	medium	med/low	medium	C
Lower Tamarack River	07030001-528	Squib Creek	General	warm	one	med/low	med/low	medium	B
	07030001-510	Lower Tamarack River	General	warm	neither	med/low	low	med/high	C
	07030001-511	Hay Creek	General	warm	neither	med/low	low	medium	C
	07030001-512	Lower Tamarack River	General	warm	neither	low	low	high	C
	07030001-513	McDermott Creek	General	warm	neither	low	low	high	C
	07030001-514	Lower Tamarack River	General	warm	neither	med/low	low	med/high	C

HUC-10 Subwatershed	WID	Stream Name	TALU	Cold/ Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
	07030001-532	Keene Creek	General	warm	neither	med/high	low	medium	C
Sand Creek	07030001-554	Little Sand Creek	Exceptional	warm	one	medium	med/low	low	A
	07030001-553	Partridge Creek	General	warm	neither	med/low	medium	med/low	B
	07030001-618	Sand Creek	Exceptional	warm	one	medium	medium	medium	B
	07030001-605	Sand Creek	General	cold	neither	med/low	med/low	medium	C
	07030001-606	Sand Creek	General	cold	neither	medium	med/low	med/high	C
	07030001-617	Sand Creek	General	warm	neither	med/low	medium	medium	C
	07030001-902	Little Hay Creek	General	cold	neither	med/low	medium	med/high	C
Upper Tamarack River	07030001-613	Upper Tamarack River	Exceptional	warm	one	med/low	low	low	B
	07030001-614	Upper Tamarack River	General	warm	neither	low	low	med/low	C

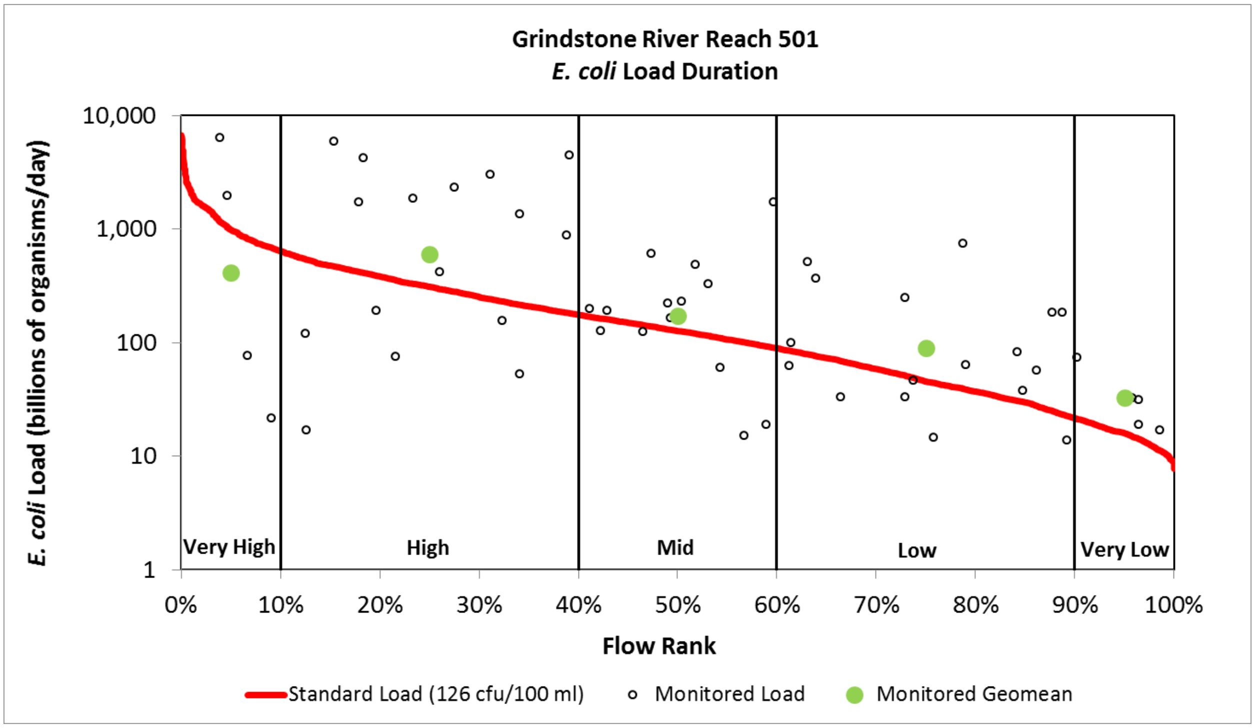
Streams evaluated for Secchi (transparency) trends (see Section 2.2)

HUC-10 Subwatershed	WID*	Stream reach (WID) description*	Monitoring station ID	Secchi trend (2019)
Bear Creek	07030001-518	Bear Creek: Headwaters to St Croix R	S005-443	Improving
Chases Brook-Saint Croix River	07030001-619	St Croix River: MN/WI border to Snake R	S000-056	Too clear to run a test
Crooked Creek	07030001-537	Crooked Creek, West Fork: T41 R18W S11, north line to Crooked Cr	S001-645	Too clear to run a test
	07030001-616	Crooked Creek, East Fork: CSAH 32 to T42 R18W S36, east line	S005-533	No trend
Grindstone River	07030003-501	Grindstone River: Grindstone Reservoir to Kettle R	S001-270	Too clear to run a test
	07030003-541	Grindstone River, North Branch: Headwaters to Grindstone Lk	S004-891	No change
	07030003-543	Grindstone River, North Branch: Grindstone Lk to T42 R21W S28, south line	S004-379	Too clear to run a test
	07030003-546	Unnamed creek: Miller Lk to Grindstone Lk	S005-325	No trend
	07030003-502	Kettle River: Grindstone R to St Croix R	S000-121	Too clear to run a test

HUC-10 Subwatershed	WID*	Stream reach (WID) description*	Monitoring station ID	Secchi trend (2019)
Lower Kettle River	07030003-505	Kettle River: Moose Horn R to Willow R	S003-786	Too clear to run a test
	07030003-505	Kettle River: Moose Horn R to Willow R	S001-642	Too clear to run a test
Lower Tamarack River	07030001-514	Lower Tamarack River: Headwaters to McDermott Cr	S005-534	No trend
	07030001-529	Keene Creek: Headwaters to Unnamed cr	S005-535	No trend
Moose River	07030003-521	Moose Horn River: W Br Moose Horn R to Hanging Horn Lk	S005-297	Too clear to run a test
	07030003-531	Moose Horn River: Hanging Horn Lk to Kettle R	S001-328	Too clear to run a test
	07030003-531	Moose Horn River: Hanging Horn Lk to Kettle R	S001-674	Too clear to run a test
Pine River	07030003-624	Pine River: Bremen Cr to Kettle R	S006-553	Too clear to run a test
	07030003-633	Pine River: Big Pine Lk to Little Pine Cr	S005-435	Too clear to run a test
Sand Creek	07030001-538	Sand Creek: Headwaters to T44 R18W S27, south line	S003-374	Improving
	07030001-552	Partridge Creek: Headwaters to Unnamed cr	S005-266	Too clear to run a test
	07030001-552	Partridge Creek: Headwaters to Unnamed cr	S005-267	**Degrading**
Upper Kettle River	07030003-552	Kettle River: Carlton/Pine County line to Birch Cr	S005-393	Improving

*WIDs with multiple monitoring stations are listed in order from upstream to downstream by monitoring station.

Appendix B: Stream and Lake TMDL Summaries



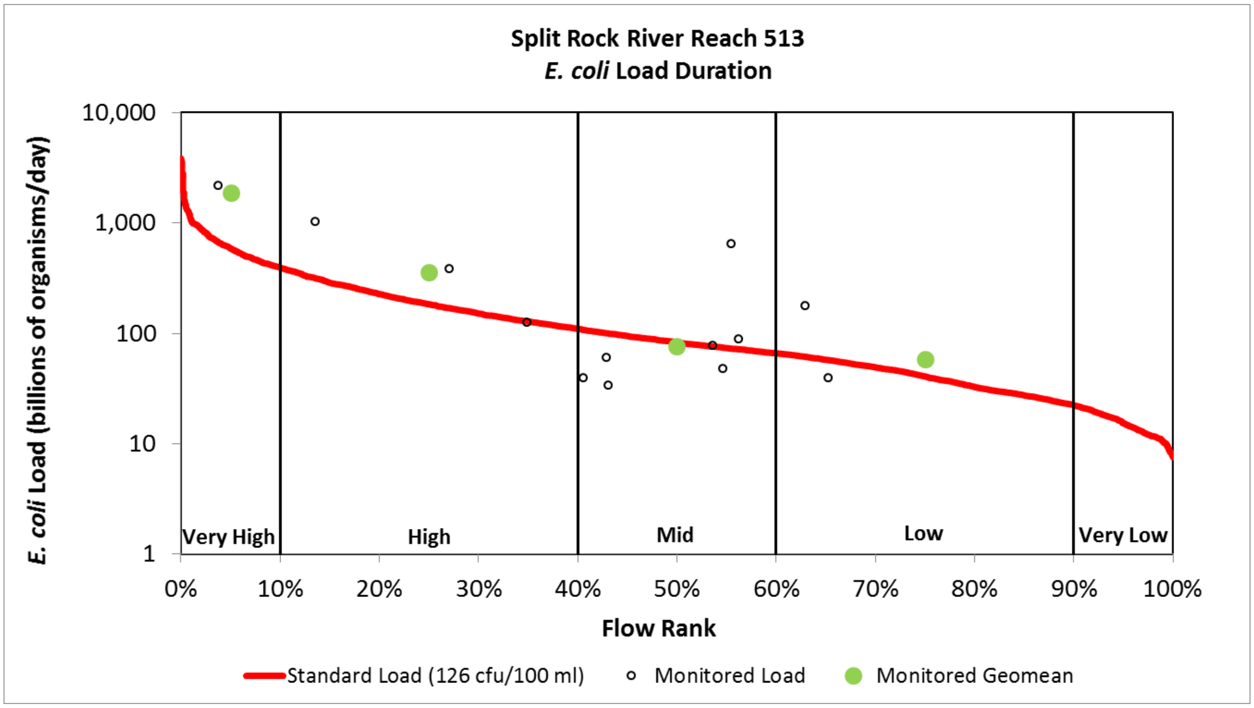
Grindstone River Reach 501 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Grindstone River Reach 501.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Hinckley WWTP (MN0023701)	3	3	3	3	3
	Total WLA	3	3	3	3	3
Load	Total LA	880	277	111	38	11
	MOS	98	31	13	5	2
	Total load	981	311	127	46	16
	Existing Concentration Apr-Oct (org/100 mL)**	202				
	Maximum Monthly Geometric Mean (org/100mL)**	606				
	Overall Estimated Percent Reduction***	79%				

* Model simulated flow for HSPF reach 627 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S001-270 (years 2007-2009, 2016 and 2017)



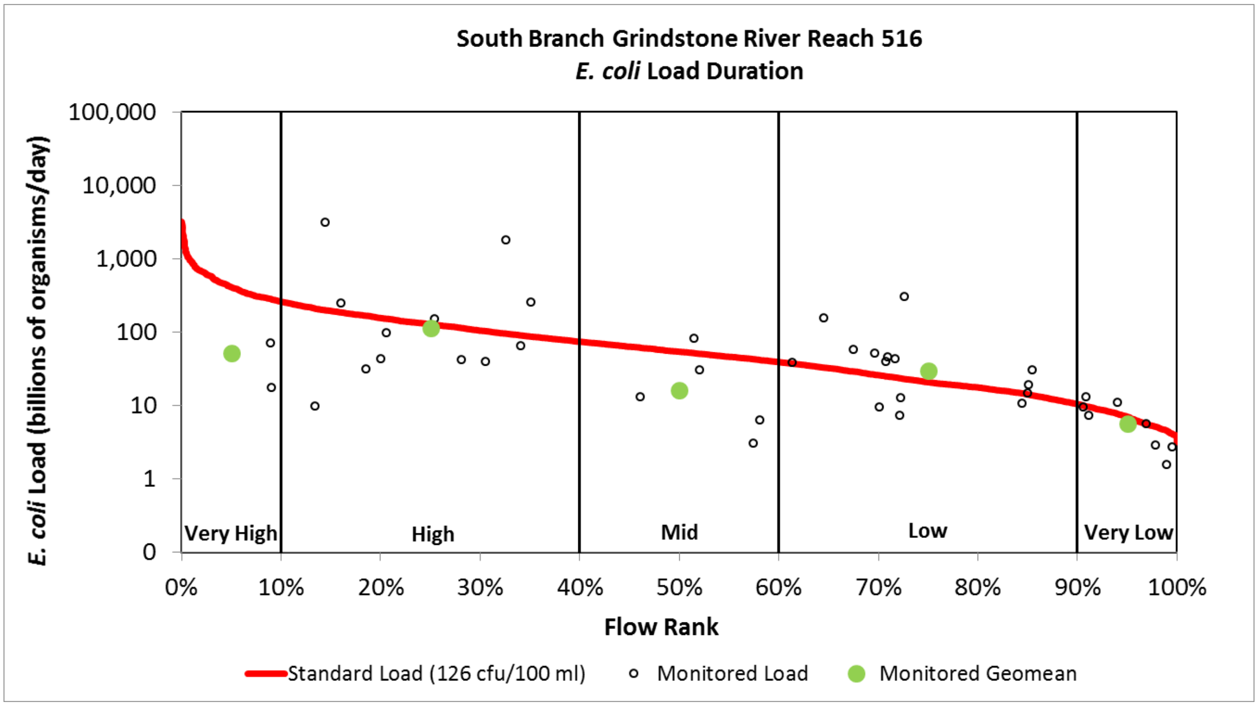
Split Rock River Reach 513 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Split Rock River Reach 513.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	526	165	74	37	14
	MOS	58	18	8	4	2
	Total load	584	183	82	41	16
	Existing Concentration Apr-Oct (org/100 mL)**	172				
	Maximum Monthly Geometric Mean (org/100mL)**	329				
	Overall Estimated Percent Reduction**	62%				

* Model simulated flow for HSPF reach 467 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S008-823 (years 2016 & 2017)



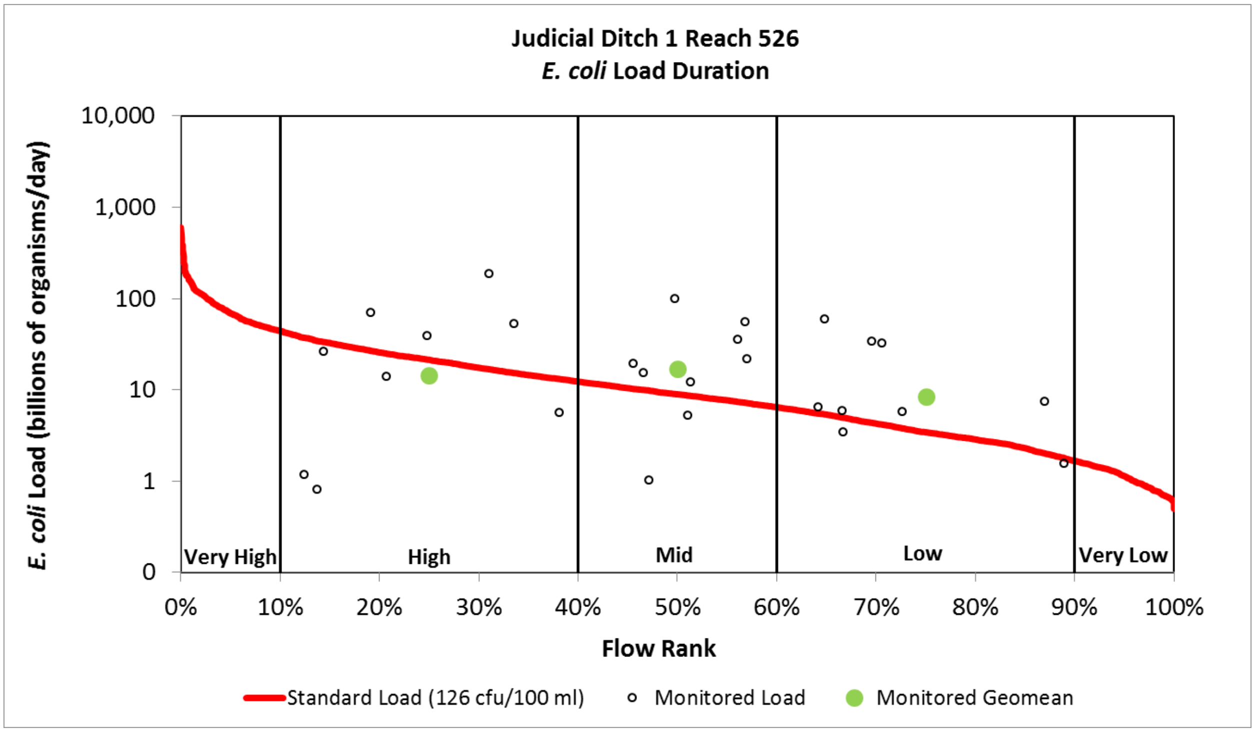
South Branch Grindstone River Reach 516 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for South Branch Grindstone River Reach 516.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	367	115	49	19	6
	MOS	41	13	5	2	0.7
	Total load	408	128	54	21	7
	Existing Concentration Apr-Oct (org/100 mL)**	104				
	Maximum Monthly Geometric Mean (org/100mL)**	217				
	Overall Estimated Percent Reduction**	42%				

* Model simulated flow for HSPF reach 624 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S001-263 (years 2007 through 2009)



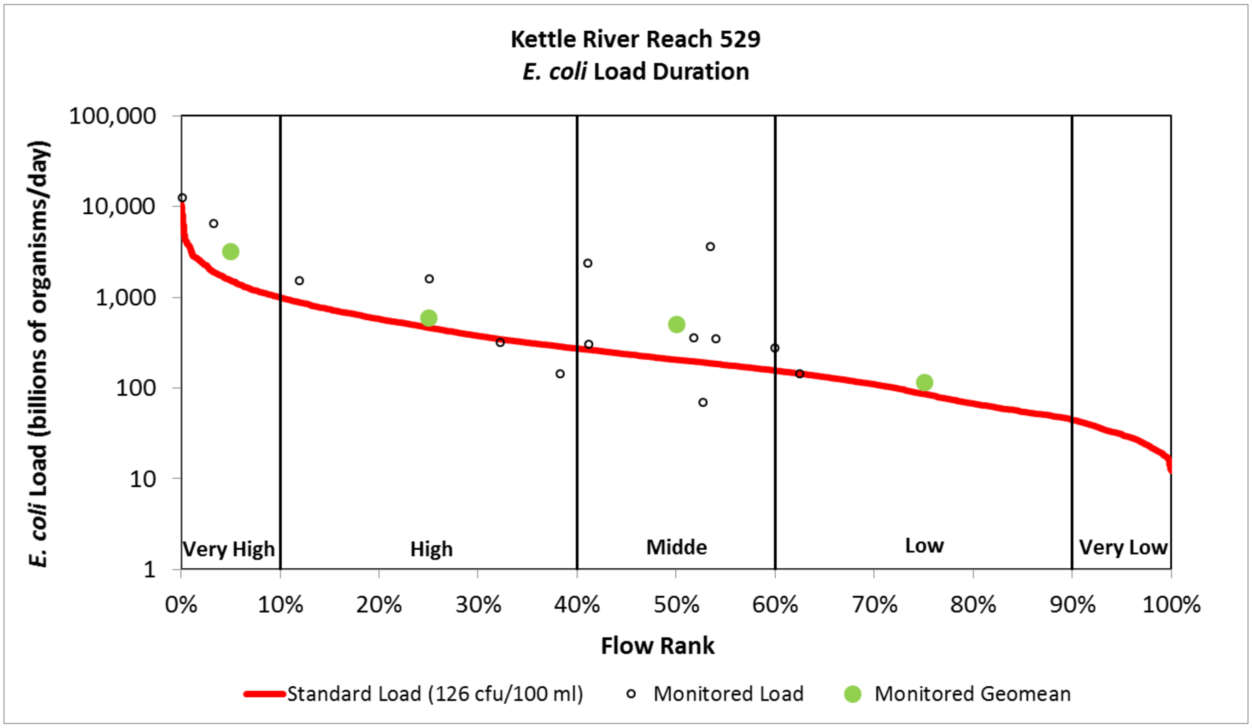
Judicial Ditch #1 Reach 526 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Judicial Ditch #1 Reach 526.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	62	19	8	3	1
	MOS	7	2	0.9	0.3	0.1
	Total load	69	21	9	3	1
	Existing Concentration Apr-Oct (org/100 mL)**	185				
	Maximum Monthly Geometric Mean (org/100mL)**	624				
	Overall Estimated Percent Reduction**	80%				

* Model simulated flow for HSPF reach 622 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S004-894 (years 2008 through 2010)



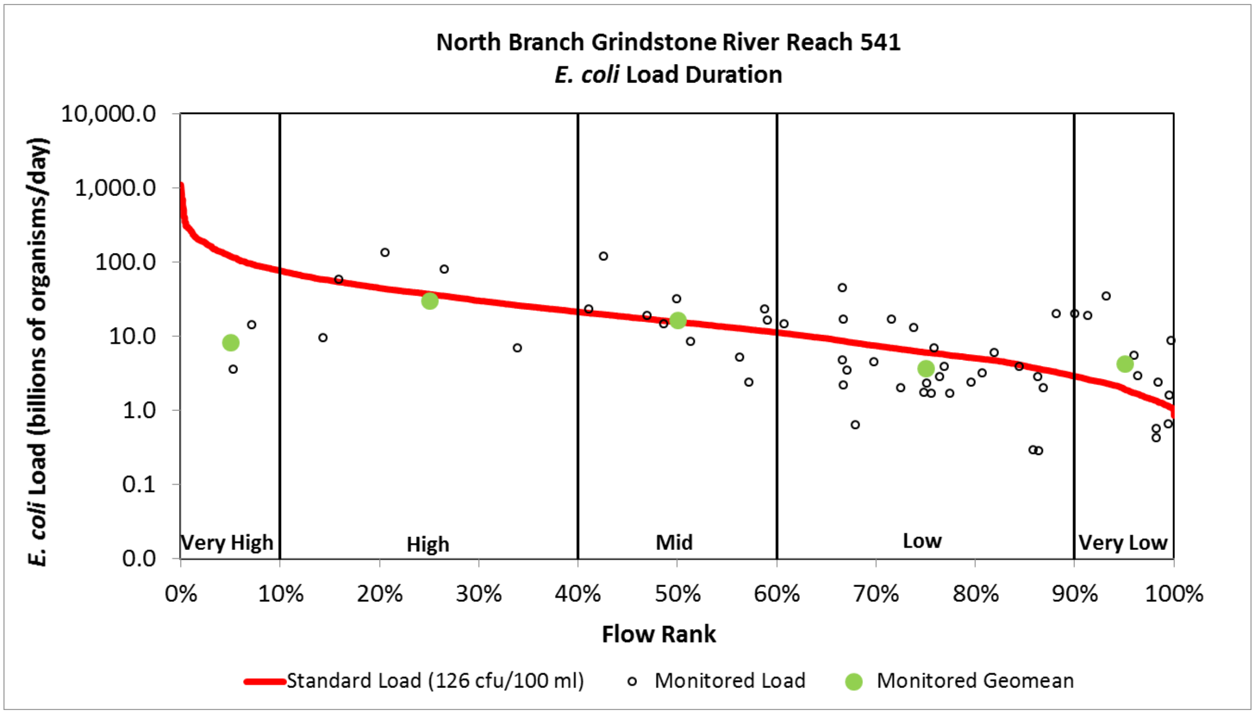
Kettle River Reach 529 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Kettle River Reach 529.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	1,377	416	184	78	27
MOS		153	46	20	9	3
Total load		1,530	462	204	87	30
Existing Concentration Apr-Oct (org/100 mL)**		232				
Maximum Monthly Geometric Mean (org/100mL)**		529				
Overall Estimated Percent Reduction**		76%				

* Model simulated flow for HSPF reach 430 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S008-822 (years 2016 & 2017)



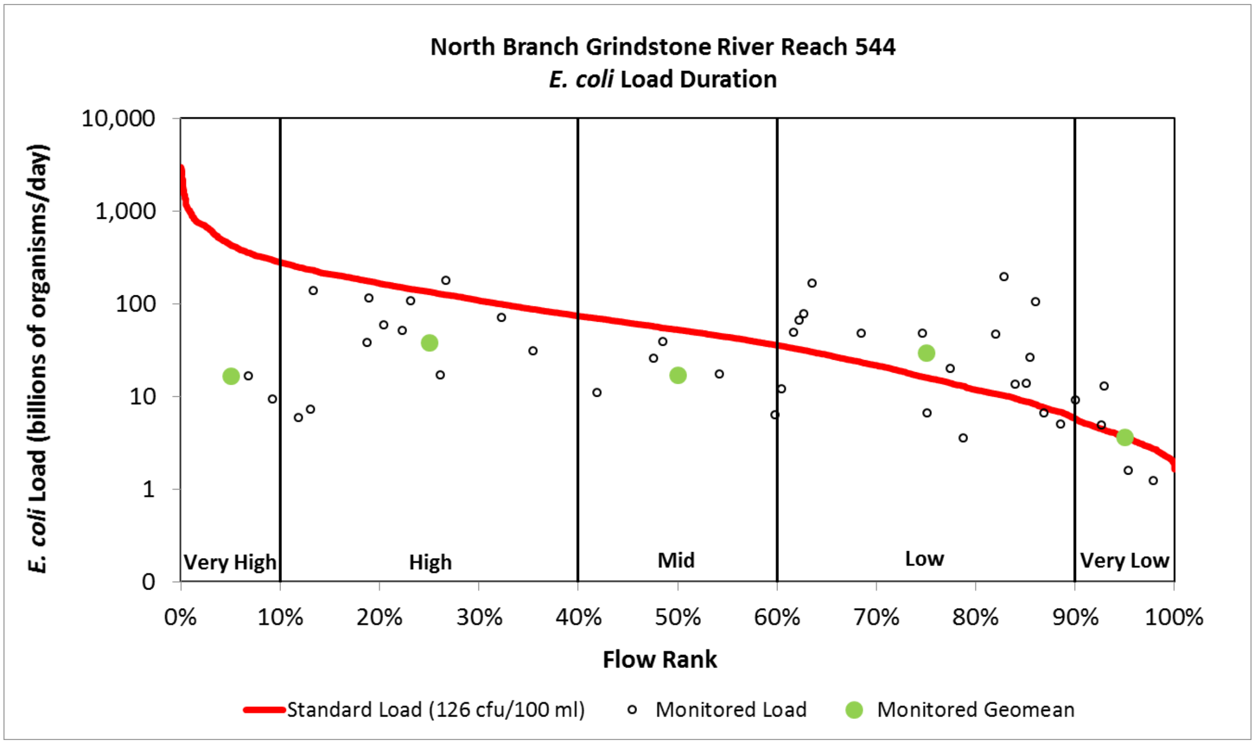
North Branch Grindstone River Reach 541 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for North Branch Grindstone River Reach 541.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	107	33	14	5	2
	MOS	12	4	2	0.6	0.2
	Total load	119	37	16	6	2
	Existing Concentration Apr-Oct (org/100 mL)**	105				
	Maximum Monthly Geometric Mean (org/100mL)**	210				
	Overall Estimated Percent Reduction**	40%				

* Model simulated flow for HSPF reach 625 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S004-891 (years 2006-2009, 2016 and 2017)



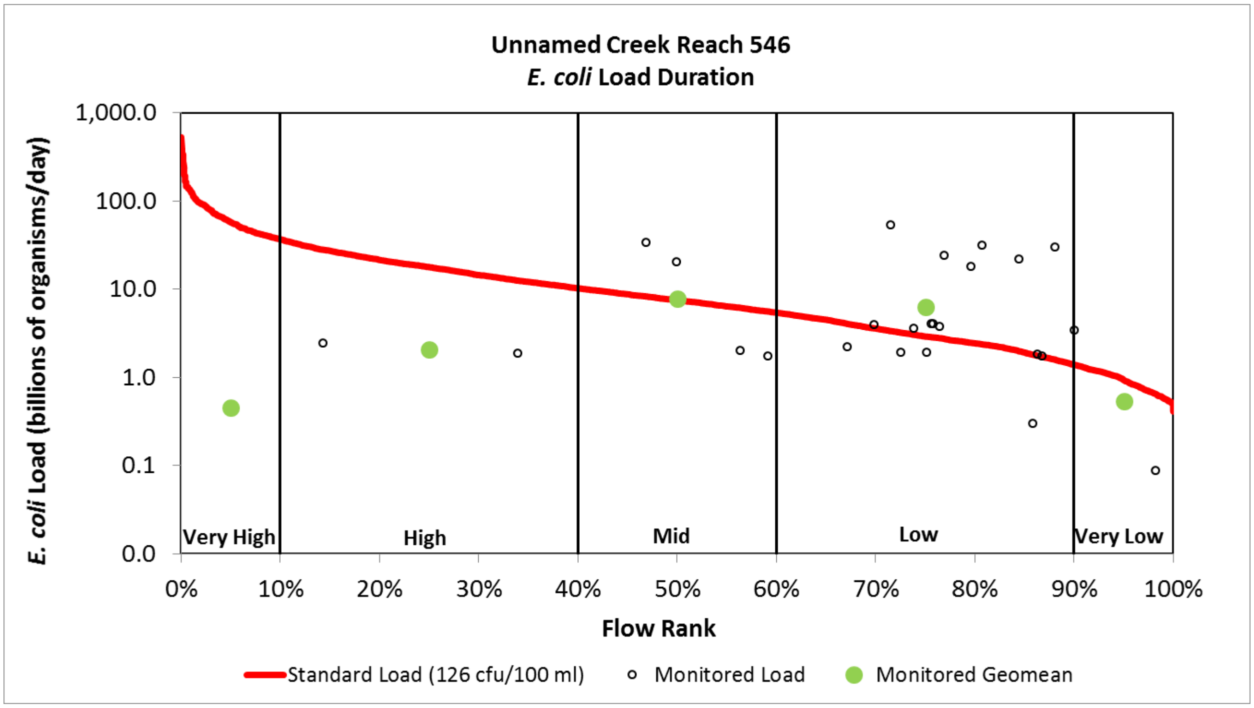
North Branch Grindstone River Reach 544 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for North Branch Grindstone River Reach 544.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	386	121	47	14	3
	MOS	43	13	5	2	0.4
	Total load	429	134	52	16	3
	Existing Concentration Apr-Oct (org/100 mL)**	86				
	Maximum Monthly Geometric Mean (org/100mL)**	279				
	Overall Estimated Percent Reduction**	55%				

* Model simulated flow for HSPF reach 626 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S001-262 (years 2007 through 2009)



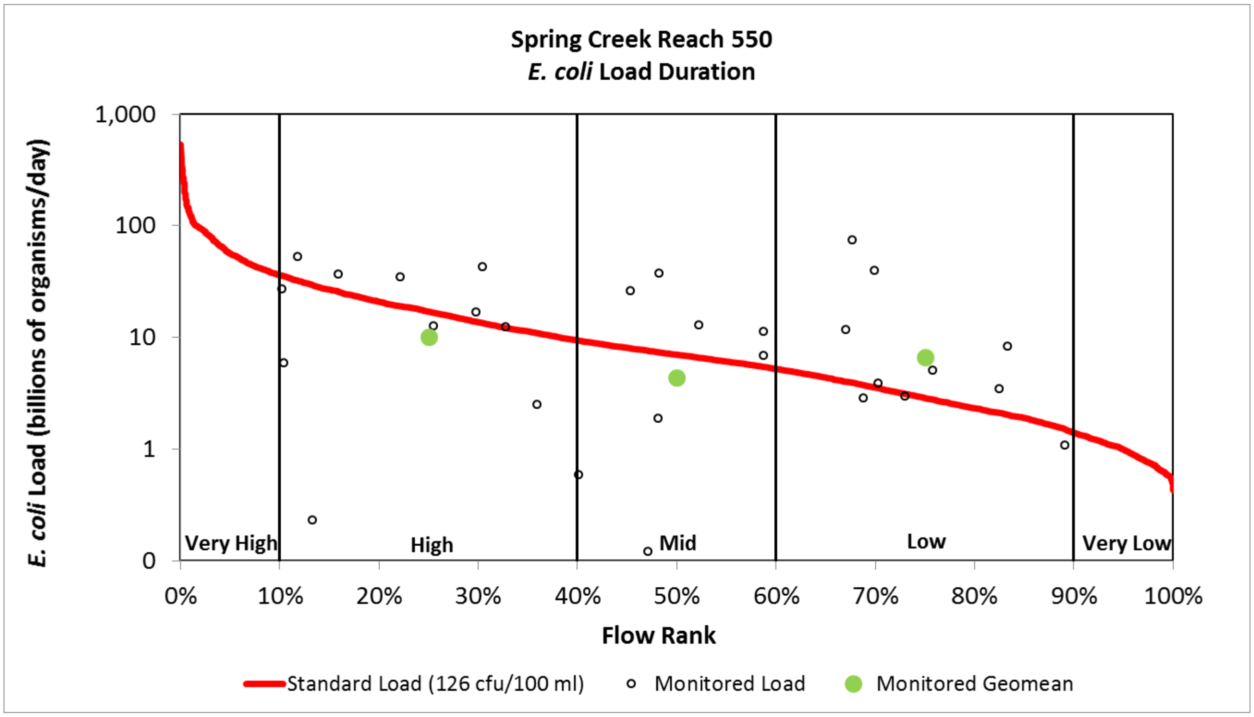
Unnamed Creek Reach 546 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Unnamed Creek Reach 546.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	52	16	7	3	0.8
MOS		6	2	0.8	0.3	0.09
Total load		58	18	8	3	0.9
Existing Concentration Apr-Oct (org/100 mL)**		140				
Maximum Monthly Geometric Mean (org/100mL)**		530				
Overall Estimated Percent Reduction**		76%				

* Model simulated flow for HSPF reach 624 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

** Water quality monitoring station(s) used to estimate reductions: S002-245 (years 2008 and 2009)

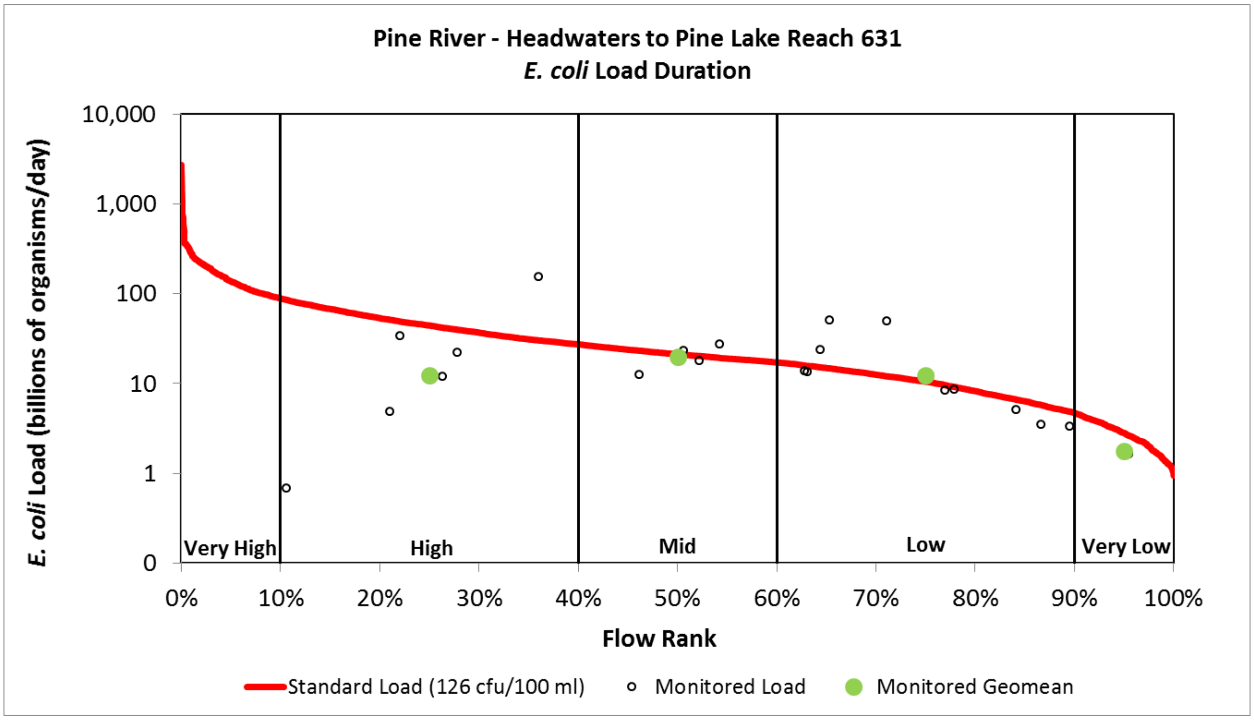


Spring Creek Reach 550 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Spring Creek Reach 550.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	50	15	6	3	0.9
	MOS	6	2	0.7	0.3	0.1
	Total load	56	17	7	3	1
	Existing Concentration Apr-Oct (org/100 mL)**	121				
	Maximum Monthly Geometric Mean (org/100mL)**	603				
	Overall Estimated Percent Reduction**	79%				

* Model simulated flow for HSPF reach 628 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach
** Water quality monitoring station(s) used to estimate reductions: S004-895 (years 2008 through 2010)



Pine River Reach 631 *E. coli* LDC and monitored loads.

***E. coli* TMDL summary for Pine River Reach 631.**

E. coli		Flow zones*				
		Very high	High	Mid-range	Low	Very low
Sources		*E. coli* load (billions of org/day)				
Wasteload	Total WLA	--	--	--	--	--
Load	Total LA	124	40	19	9	3
MOS		14	4	2	1	0.3
Total load		138	44	21	10	3
Existing Concentration Apr-Oct (org/100 mL)**		90				
Maximum Monthly Geometric Mean (org/100mL)**		194				
Overall Estimated Percent Reduction**		35%				

* Model simulated flow for HSPF reach 521 from April-October (2000-2017) was used to develop the flow zones and LCs for this reach

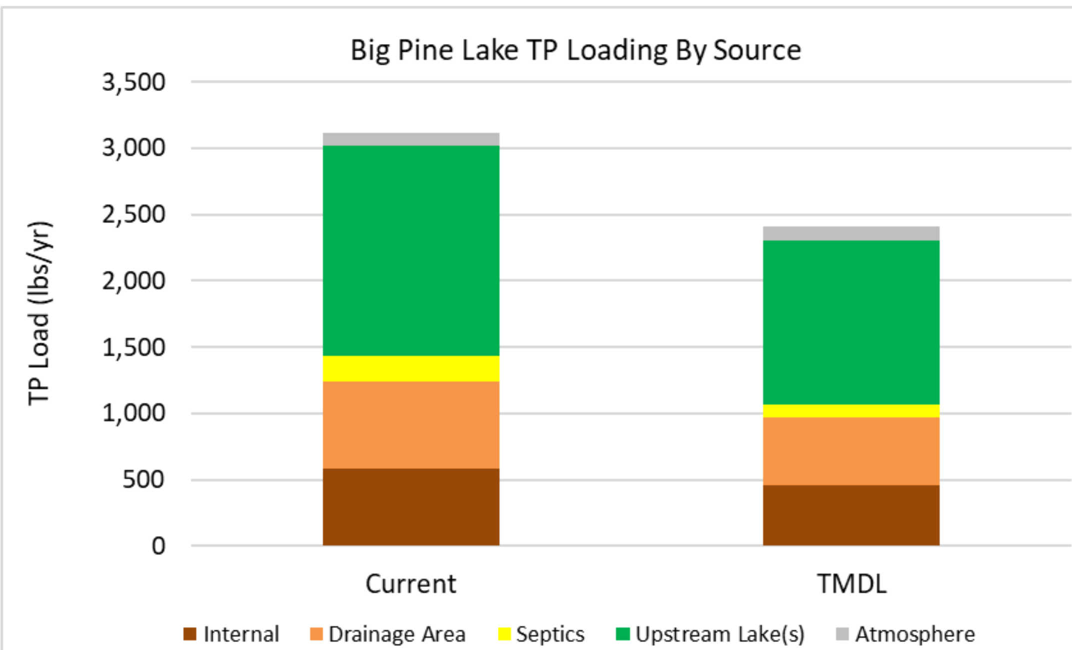
** Water quality monitoring station(s) used to estimate reductions: S004-889 (years 2008-2010)

Big Pine Lake (58-0138-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.8**	**0.002**	**0.8**	**0.002**	**0**	**0%**
	Construction/Industrial SW	0.8	0.002	0.8	0.002	0	0%
Load	**Total LA**	**3,119**	**8.5**	**2,407**	**6.7**	**712**	**23%**
	Atmosphere	103	0.3	103	0.3	0	0%
	Drainage Area	653	1.8	512	1.4	141	22%
	Upstream Lakes (Pine)	1,584	4.3	1,239	3.4	345	22%
	Septic Systems	193	0.5	94	0.3	99	51%
	Internal Load	586	1.6	459	1.3	127	22%
	MOS			**268**	**0.7**		
	Total load	**3,120**	**8.5**	**2,676**	**7.4**	**712****	**21%**

* Model calibration year(s): 2008, 2009, 2014, 2015, 2016, 2017

** Net reduction from current load to TMDL is 370 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 444 + 268 = 712 lbs/yr.

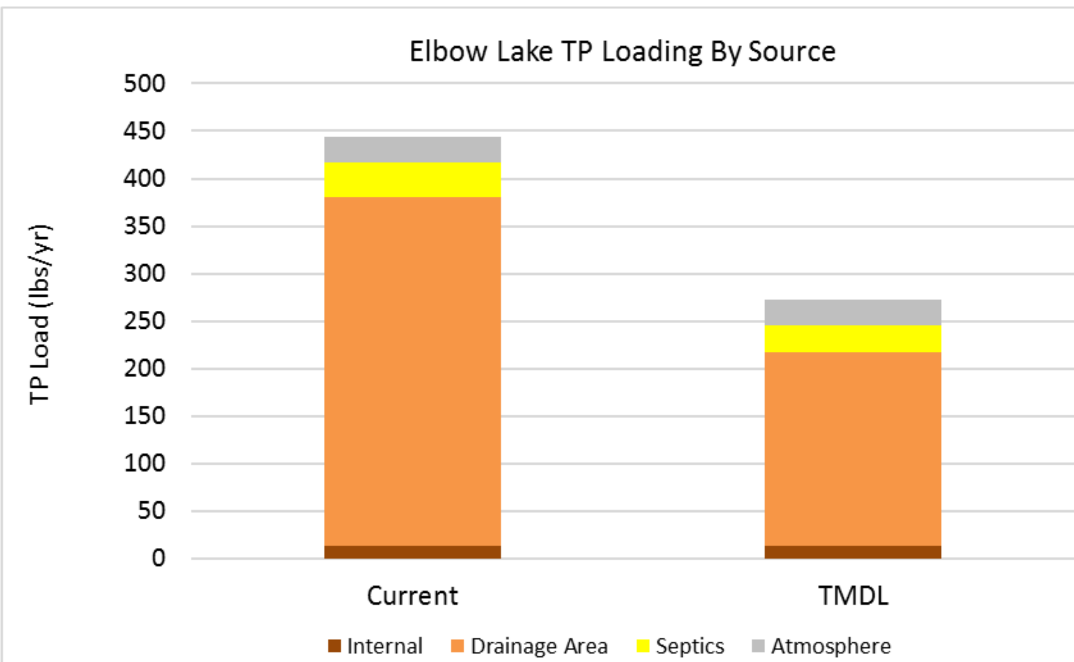


Big Pine Lake phosphorus source reductions to meet TMDL.

Elbow Lake (58-0126-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.5**	**0.001**	**0.5**	**0.001**	**0**	**0%**
	Construction/Industrial SW	0.5	0.001	0.5	0.001	0	0%
Load	**Total LA**	**444**	**1.2**	**272**	**0.8**	**172**	**42%**
	Atmosphere	27	0.1	27	0.1	0	0%
	Drainage Area	367	1.0	203	0.6	164	45%
	Septic Systems	36	0.1	28	0.1	8	22%
	Internal Load	14	0.04	14	0.04	0	0%
MOS				**30**	**0.1**		
Total load		**445**	**1.2**	**303**	**0.9**	**172****	**39%**

* Model calibration year(s): 2011, 2012
** Net reduction from current load to TMDL is 142 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 142 + 30 = 172 lbs/yr.



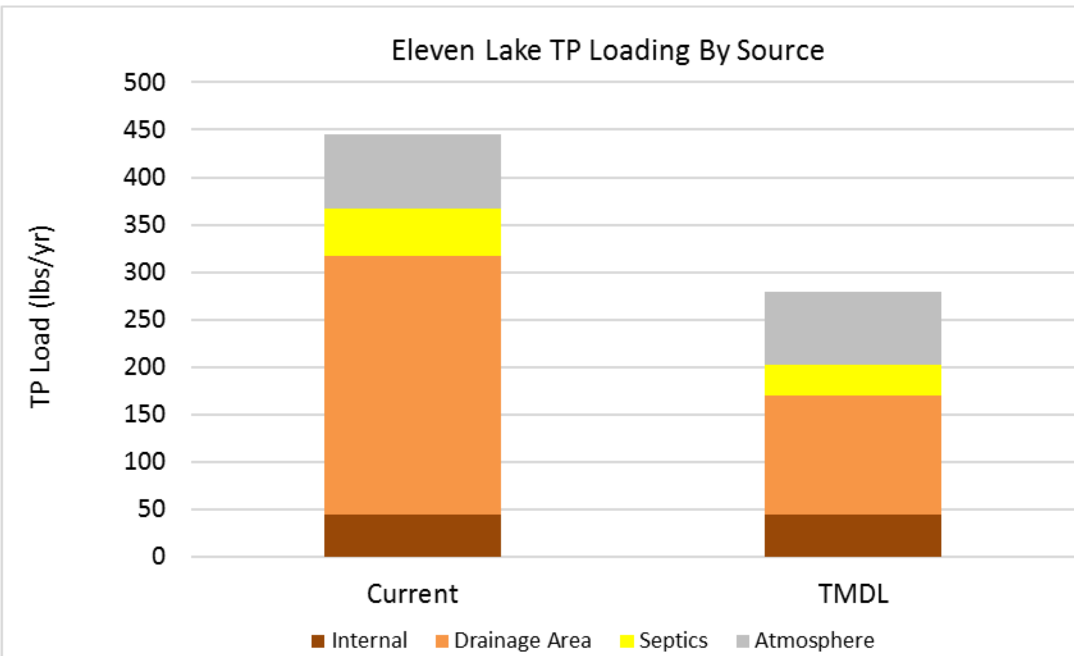
Elbow Lake phosphorus source reductions to meet TMDL.

Eleven Lake (33-0001-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.3**	**0.0009**	**0.3**	**0.0009**	**0**	**0%**
	Construction/Industrial SW	0.3	0.0009	0.3	0.0009	0	0%
Load	**Total LA**	**444**	**1.2**	**279**	**0.7**	**165**	**37%**
	Atmosphere	78	0.2	78	0.2	0	0%
	Drainage Area	273	0.8	125	0.3	148	54%
	Septic Systems	49	0.1	32	0.1	17	35%
	Internal Load	44	0.1	44	0.1	0	0%
MOS				**31**	**0.1**		
Total load		**444**	**1.2**	**310**	**0.8**	**165****	**37%**

* Model calibration year(s): 2008, 2010, 2015, 2016

** Net reduction from current load to TMDL is 134 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 134 + 31 = 165 lbs/yr.

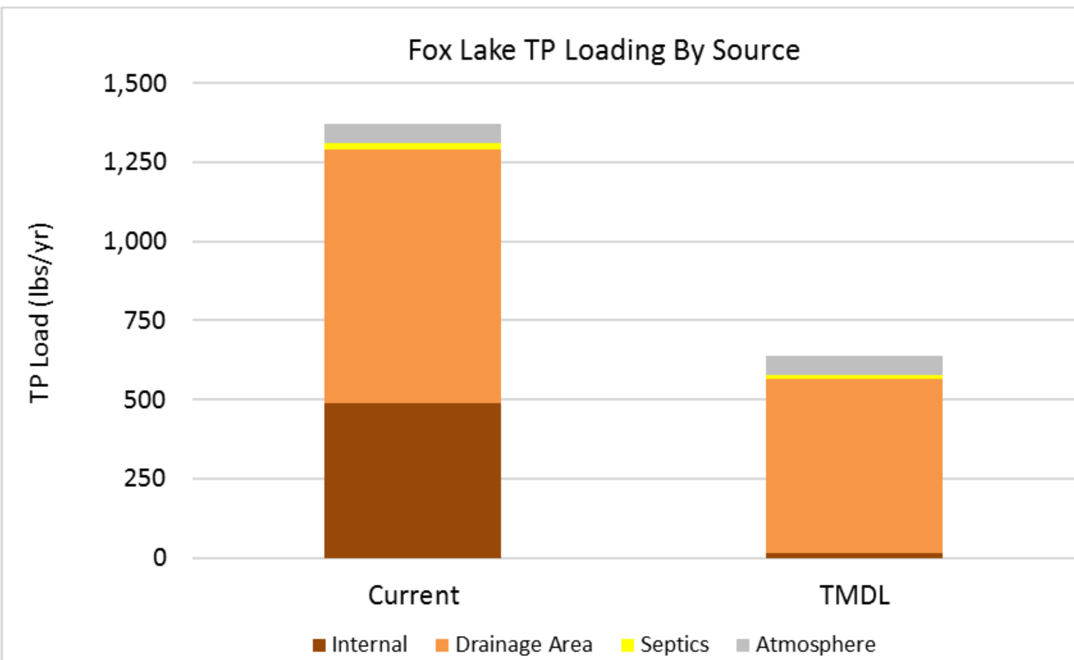


Eleven Lake phosphorus source reduction to meet TMDL.

Fox Lake (58-0102-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**1**	**0.003**	**1**	**0.003**	**0**	**0%**
	Construction/Industrial SW	1	0.003	1	0.003	0	0%
Load	**Total LA**	**1,370**	**3.8**	**636**	**1.8**	**734**	**54%**
	Atmosphere	59	0.2	59	0.2	0	0%
	Drainage Area	801	2.2	547	1.5	254	32%
	Septic Systems	20	0.1	14	0.04	6	28%
	Internal Load	490	1.3	16	0.04	474	97%
MOS				**71**	**0.2**		
Total load		**1,371**	**3.8**	**708**	**2.0**	**734****	**54%**

* Model calibration year(s): 2016, 2017
** Net reduction from current load to TMDL is 663 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 661 +71 = 734 lbs/yr.



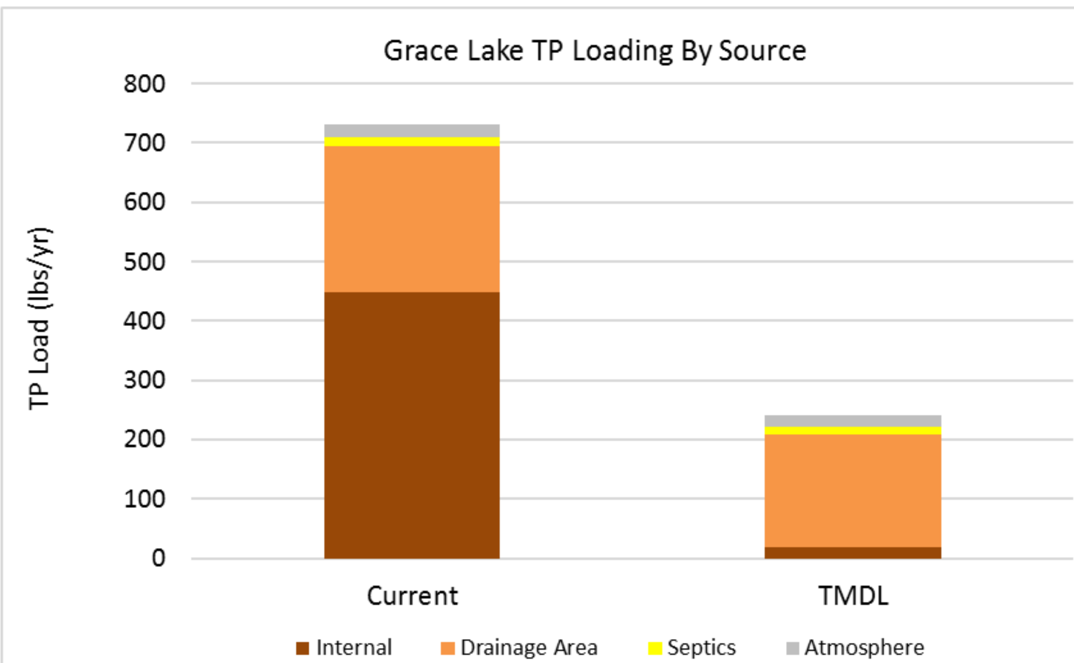
Fox Lake phosphorus source reductions to meet TMDL.

Grace Lake (58-0029-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.2**	**0.0004**	**0.2**	**0.0004**	**0**	**0%**
	Construction/Industrial SW	0.2	0.0004	0.2	0.0004	0	0%
Load	**Total LA**	**732**	**2.0**	**242**	**0.6**	**490**	**67%**
	Atmosphere	21	0.06	21	0.06	0	0%
	Drainage Area	245	0.7	191	0.5	54	22%
	Septic Systems	17	0.05	12	0.03	5	29%
	Internal Load	449	1.2	18	0.05	431	96%
MOS				**27**	**0.1**		
Total Load		**732**	**2.0**	**269**	**0.7**	**490****	**66%**

* Model calibration year(s): 2016, 2017

** Net reduction from current load to TMDL is 463 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 463 + 27 = 490 lbs/yr.



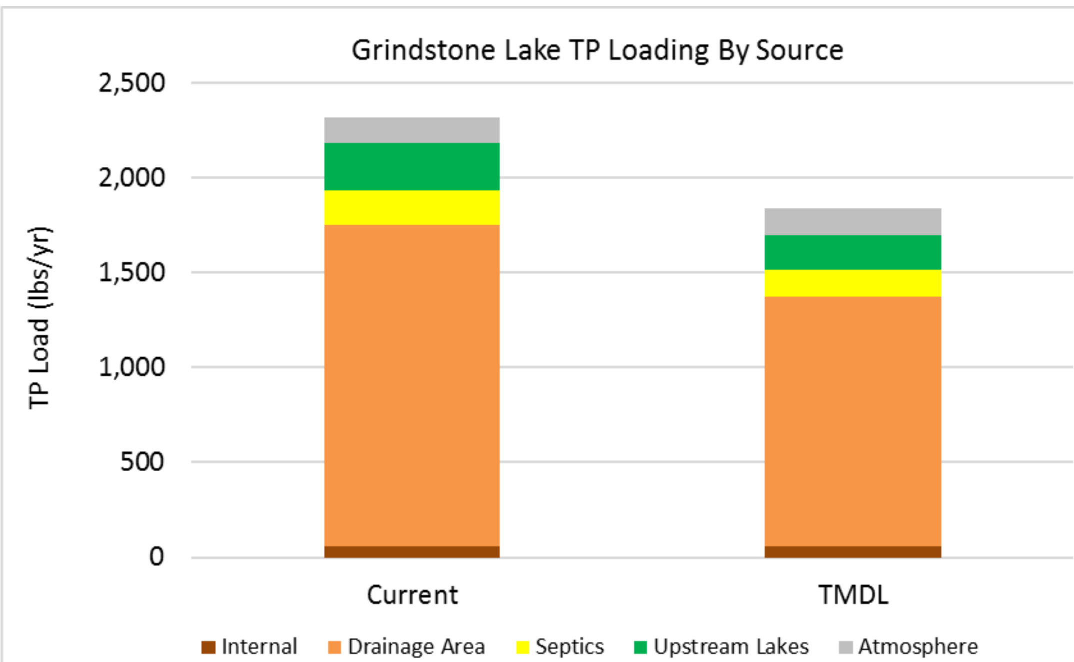
Grace Lake phosphorus source reductions to meet TMDL.

Grindstone Lake (58-0123-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**2**	**0.006**	**2**	**0.006**	**0**	**0%**
	Construction/Industrial SW	2	0.006	2	0.006	0	0%
Load	**Total LA**	**2,319**	**6.4**	**1,836**	**5.1**	**483**	**21%**
	Atmosphere	137	0.4	137	0.4	0	0%
	Drainage Area	1,695	4.6	1,315	3.6	380	22%
	Upstream Lakes (Elbow)	250	0.7	184	0.5	66	27%
	Septic Systems	180	0.5	143	0.4	37	20%
	Internal Load	57	0.2	57	0.2	0	0%
MOS				**204**	**0.6**		
Total Load		**2,321**	**6.4**	**2,042**	**5.7**	**483****	**21%**

* Model calibration year(s): 2008, 2016, 2017

** Net reduction from current load to TMDL is 279 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 279 + 204 = 483 lbs/yr.

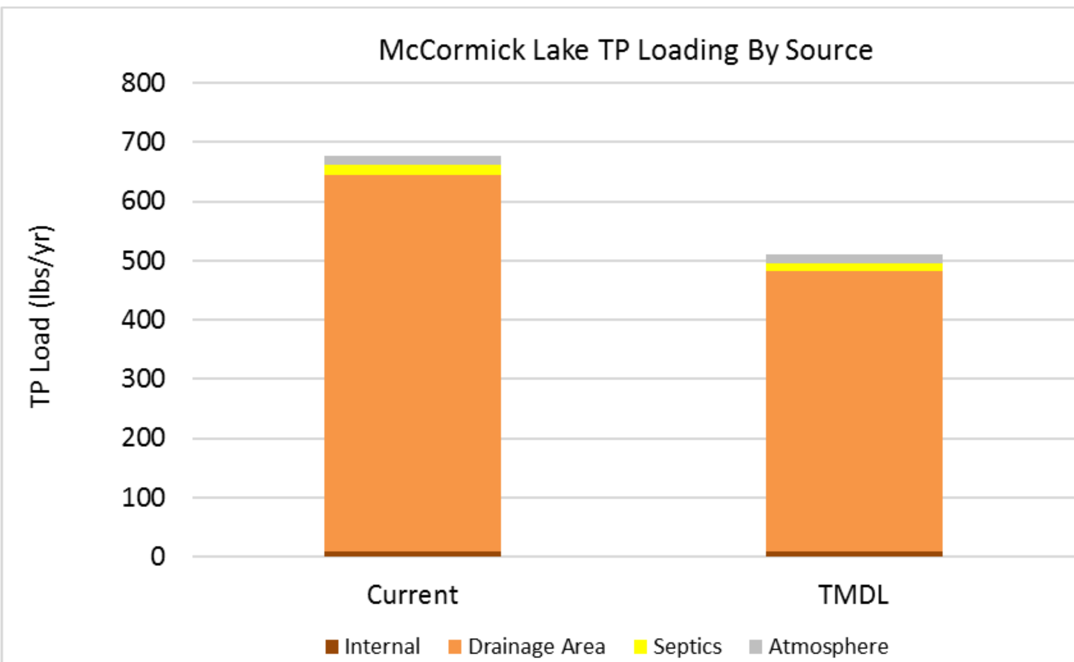


Grindstone Lake phosphorus source reductions to meet TMDL.

McCormick Lake (58-0058-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.8**	**0.002**	**0.8**	**0.002**	**0**	**0%**
	Construction/Industrial SW	0.8	0.002	0.8	0.002	0	0%
Load	**Total LA**	**677**	**1.8**	**509**	**1.4**	**168**	**25%**
	Atmosphere	16	0.04	16	0.04	0	0%
	Drainage Area	633	1.7	471	1.3	162	26%
	Septic Systems	18	0.05	12	0.03	6	29%
	Internal Load	10	0.03	10	0.03	0	0%
MOS				**57**	**0.2**		
Total load		**678**	**1.8**	**567**	**1.6**	**168****	**25%**

* Model calibration year(s): 2016, 2017
** Net reduction from current load to TMDL is 111 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 111 + 57 = 168 lbs/yr.

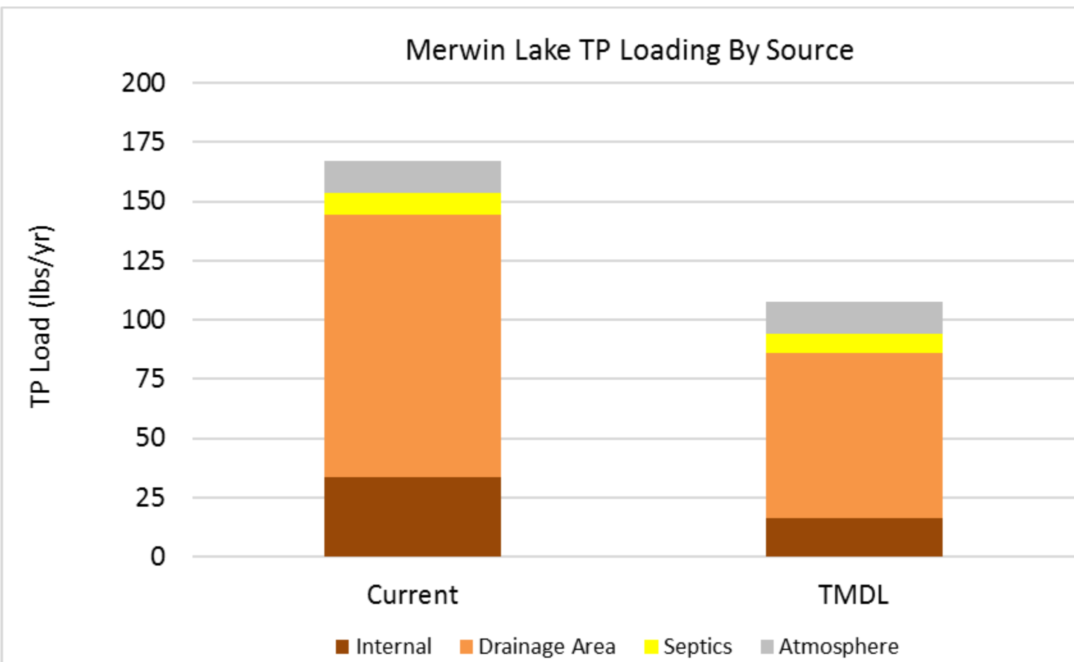


McCormick Lake phosphorus source reductions to meet TMDL.

Merwin Lake (09-0058-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.1**	**0.0004**	**0.1**	**0.0004**	**0**	**0%**
	Construction/Industrial SW	0.1	0.0004	0.1	0.0004	0	0%
Load	**Total LA**	**167**	**0.5**	**108**	**0.3**	**59**	**36%**
	Atmosphere	14	0.04	14	0.04	0	0%
	Drainage Area	110	0.3	70	0.2	40	37%
	Septic Systems	9	0.03	8	0.02	1	16%
	Internal Load	34	0.1	16	0.04	18	52%
MOS				**12**	**0.03**		
Total load		**167**	**0.5**	**120**	**0.3**	**59****	**35%**

* Model calibration year(s): 2016, 2017
** Net reduction from current load to TMDL is 47 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 47 + 12 = 59 lbs/yr.

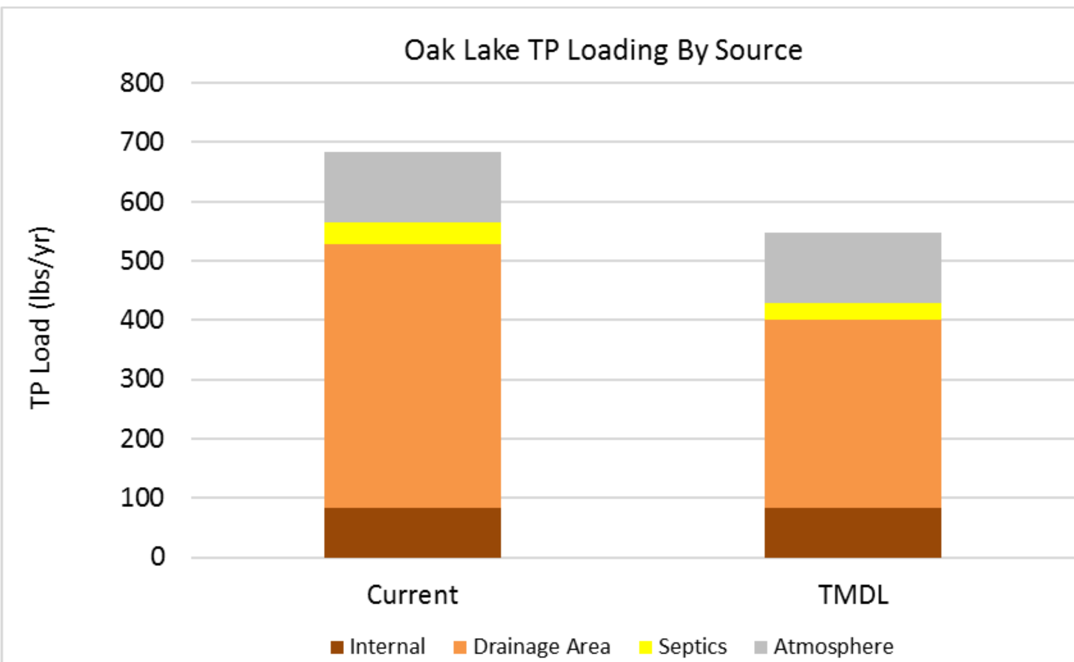


Merwin Lake phosphorus source reductions to meet TMDL.

Oak Lake (58-0048-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.6**	**0.002**	**0.6**	**0.002**	**0**	**0%**
	Construction/Industrial SW	0.6	0.002	0.6	0.002	0	0%
Load	**Total LA**	**683**	**1.8**	**547**	**1.5**	**136**	**20%**
	Atmosphere	118	0.3	118	0.3	0	0%
	Drainage Area	444	1.2	316	0.9	128	29%
	Septic Systems	37	0.1	29	0.1	8	21%
	Internal Load	84	0.2	84	0.2	0	0%
MOS				**61**	**0.2**		
Total load		**684**	**1.8**	**609**	**1.7**	**136****	**20%**

* Model calibration year(s): 2011, 2012, 2016
** Net reduction from current load to TMDL is 75 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 75 + 61 = 136 lbs/yr.



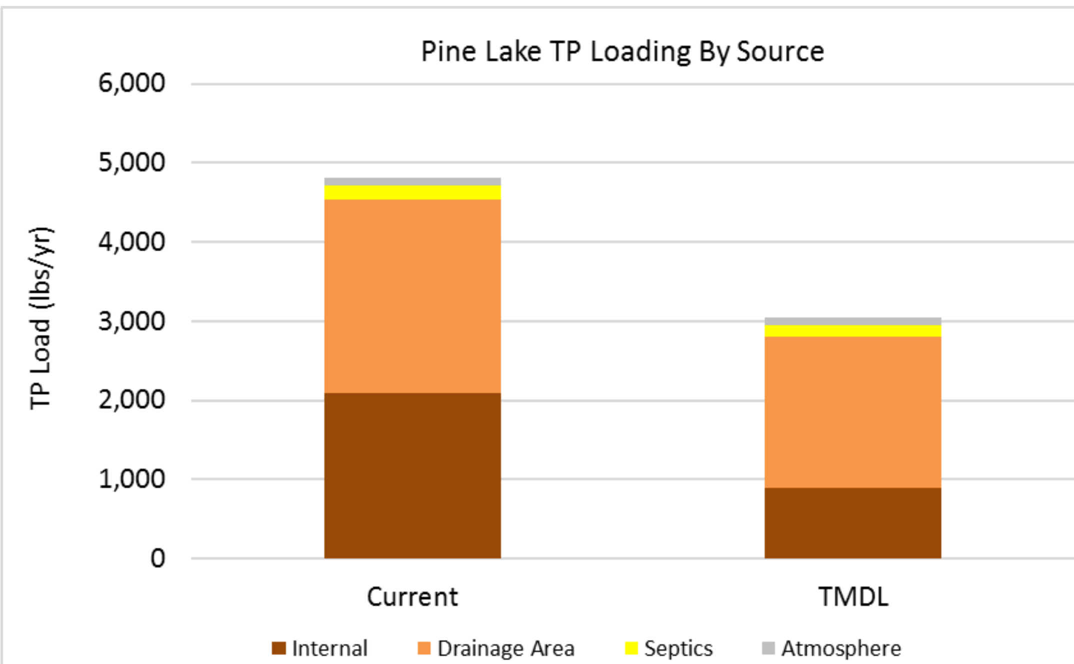
Oak Lake phosphorus source reductions to meet TMDL.

Pine Lake (01-0001-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**3**	**0.008**	**3**	**0.008**	**0**	**0%**
	Construction/Industrial SW	3	0.008	3	0.008	0	0%
Load	**Total LA**	**4,812**	**13.2**	**3,046**	**8.3**	**1,766**	**37%**
	Atmosphere	98	0.3	98	0.3	0	0%
	Drainage Area	2,442	6.7	1,917	5.2	525	22%
	Septic Systems	175	0.5	143	0.4	32	18%
	Internal Load	2,097	5.7	888	2.4	1,209	58%
MOS				**339**	**0.9**		
Total load		**4,815**	**13.2**	**3,388**	**9.2**	**1,766****	**37%**

* Model calibration year(s): 2008, 2009, 2014, 2015, 2016, 2017

** Net reduction from current load to TMDL is 1,427 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 1,427 + 339 = 1,766 lbs/yr.



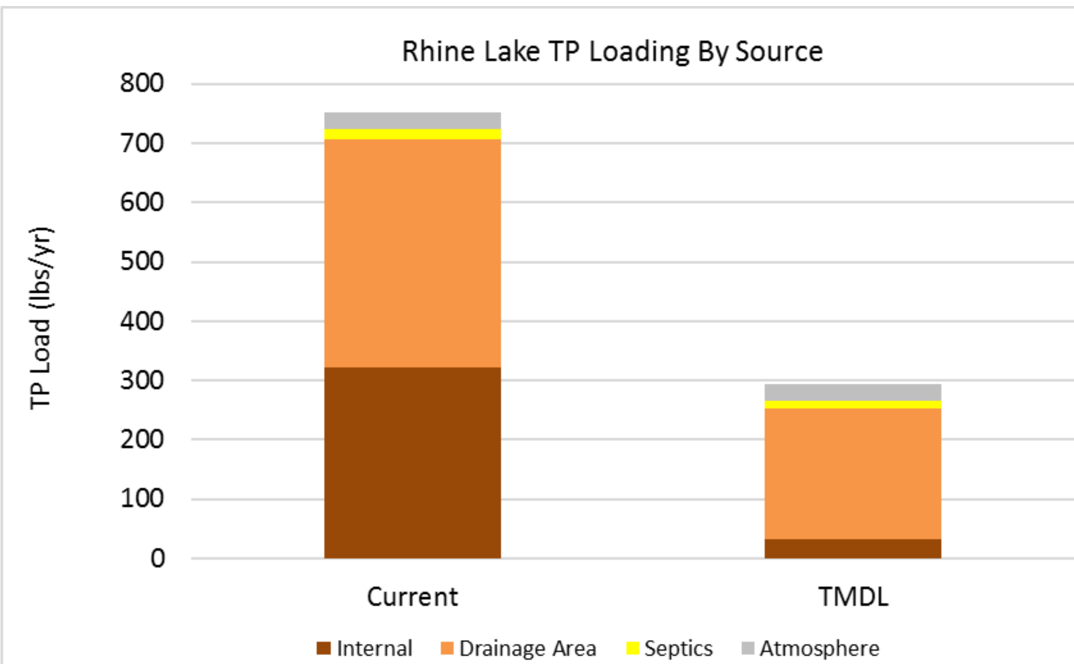
Pine Lake phosphorus source reductions to meet TMDL.

Rhine Lake (58-0136-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.5**	**0.001**	**0.5**	**0.001**	**0**	**0%**
	Construction/Industrial SW	0.5	0.001	0.5	0.001	0	0%
Load	**Total LA**	**752**	**2.1**	**294**	**0.8**	**458**	**61%**
	Atmosphere	29	0.1	29	0.1	0	0%
	Drainage Area	385	1.1	220	0.6	165	43%
	Septic Systems	16	0.04	13	0.04	3	20%
	Internal Load	322	0.9	32	0.1	290	90%
MOS				**33**	**0.1**		
Total load		**753**	**2.1**	**328**	**0.9**	**458****	**61%**

* Model calibration year(s): 2011, 2012

** Net reduction from current load to TMDL is 425 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 425 + 33 = 458 lbs/yr.

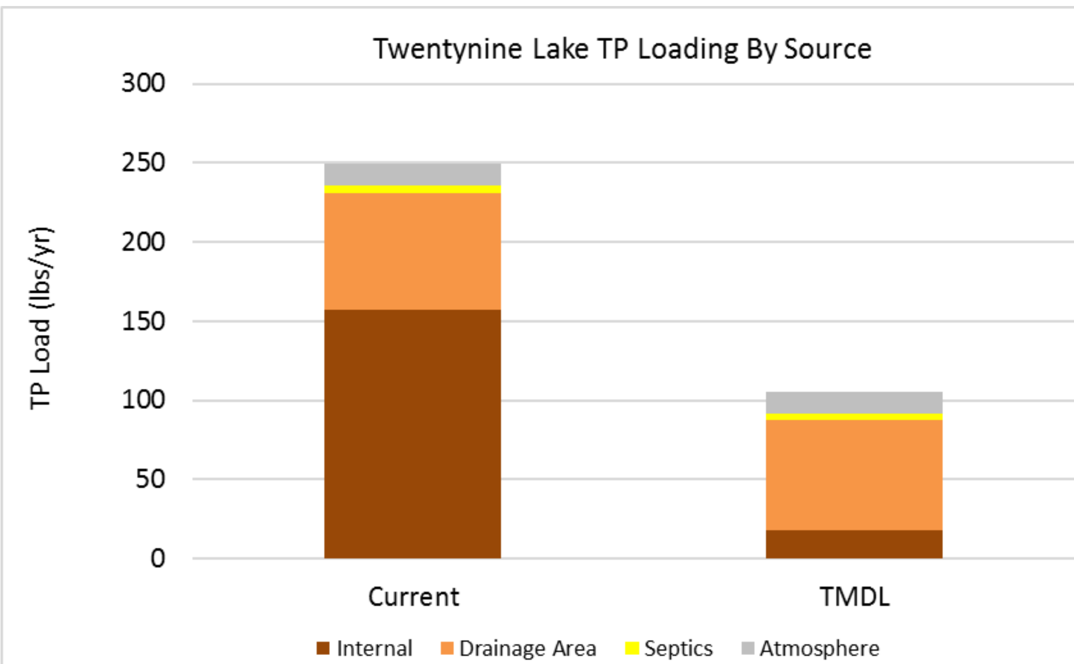


Rhine Lake phosphorus source reductions to meet TMDL.

Twentynine (09-0022-00) phosphorus TMDL.

Phosphorus Sources		Existing TP load*		Allowable TP load		Estimated load reduction	
		lbs/yr	lbs/day	lbs/yr	lbs/day	lbs/yr	%
Wasteload	**Total WLA**	**0.09**	**0.0003**	**0.09**	**0.0003**	**0**	**0%**
	Construction/Industrial SW	0.09	0.0003	0.09	0.0003	0	0%
Load	**Total LA**	**249**	**0.7**	**104**	**0.3**	**145**	**58%**
	Atmosphere	13	0.04	13	0.04	0	0%
	Drainage Area	74	0.2	70	0.2	4	5%
	Septic Systems	5	0.01	4	0.01	1	20%
	Internal Load	157	0.4	17	0.05	140	89%
MOS				**12**	**0.03**		
Total load		**249**	**0.7**	**116**	**0.3**	**145****	**58%**

* Model calibration year(s): 2016, 2017
** Net reduction from current load to TMDL is 133 lbs/yr, but the gross load reduction from all sources must also accommodate the MOS and is therefore 132 + 12 = 145 lbs/yr.



Twentynine Lake phosphorus source reductions to meet TMDL.

Appendix C: Restoration and protection approaches for the Kettle River and Upper St. Croix River Watersheds by HUC-12 subwatershed

Suggested approaches for watershed protection and restoration (see Section 2.5)

HUC-10 Name	HUC-10	HUC-12	HUC-12 Name	Approach	Approximate Area (acres)
Bear Creek	0703000111	070300011101	Upper Bear Creek	Full restoration	20120.27
	0703000111	070300011102	Lower Bear Creek	Full restoration	22778.04
Chases Brook-Saint Croix River	0703000112	070300011205	Redhorse Creek	Vigilance	8363.37
	0703000112	070300011203	City of Danbury-Saint Croix River	Vigilance	8844.18
	0703000112	070300011204	Barrett Creek-Saint Croix River	Vigilance	2828.64
	0703000112	070300011202	Hay Creek-Saint Croix River	Vigilance	5550.7
Crooked Creek	0703000107	070300010703	Crooked Creek	Protection	19140.44
	0703000107	070300010701	East Fork Crooked Creek	Protection	19498.15
	0703000107	070300010702	West Fork Crooked Creek	Protection	25519.24
Grindstone River	0703000305	070300030503	Grindstone River	Full restoration	9738.55
	0703000305	070300030502	South Branch Grindstone River	Full restoration	22690.05
	0703000305	070300030501	North Branch Grindstone River	Full restoration	23129.2
Lower Kettle River	0703000306	070300030601	City of Willow River-Kettle River	Full restoration	19190.79
	0703000306	070300030603	Friesland Ditch-Kettle River	Full restoration	30824.54
	0703000306	070300030604	Kettle River	Protection	37126.04
	0703000306	070300030602	City of Sandstone-Kettle River	Full restoration	37261.74
Lower Tamarack River	0703000106	070300010602	Keene Creek	Protection	16899.39
	0703000106	070300010605	Lower Tamarack River	Vigilance	19284.93
	0703000106	070300010601	Headwaters Lower Tamarack River	Vigilance	25515.39
	0703000106	070300010603	McDermott Creek	Vigilance	29851.61
	0703000106	070300010604	Hay Creek-Lower Tamarack River	Protection	26904.43
Moose River	0703000302	070300030204	Portage River	Protection	10275.99
	0703000302	070300030203	Hanging Horn Lake-Moose Horn River	Full restoration	11386.39
	0703000302	070300030202	West Fork Moose Horn River	Protection	19502.4
	0703000302	070300030205	Moose River	Full restoration	19810.27
	0703000302	070300030201	Moose Horn River	Protection	29351.43
Pine River	0703000304	070300030403	Rhine Lake-Pine River	Protection	10034.42
	0703000304	070300030402	Little Pine Creek	Protection	10387.54
	0703000304	070300030405	Fox Lake-Pine River	Protection	14680.31

HUC-10 Name	HUC-10	HUC-12	HUC-12 Name	Approach	Approximate Area (acres)
	0703000304	070300030401	Big Pine Lake	Protection	16814.15
	0703000304	070300030404	Bremen Creek	Protection	19377.16
	0703000304	070300030406	Medicine Creek-Pine River	Full restoration	20903.65
Sand Creek	0703000110	070300011002	Partridge Creek	Protection	10734.44
	0703000110	070300011005	Lower Sand Creek	Protection	13041.33
	0703000110	070300011003	Little Sand Creek	Protection	18538.02
	0703000110	070300011004	Hay Creek-Sand Creek	Protection	18548.74
	0703000110	070300011001	Upper Sand Creek	Protection	28997.59
Upper Kettle River	0703000301	070300030104	Heikkila Creek-Kettle River	Protection	15212.83
	0703000301	070300030105	Dead Moose River	Protection	18892.59
	0703000301	070300030103	West Branch River	Protection	25083.96
	0703000301	070300030102	Headwaters Kettle River	Protection	28896.47
	0703000301	070300030108	Split Rock River	Protection	39460.6
	0703000301	070300030101	Kettle Lake	Vigilance	11689.07
	0703000301	070300030110	City of Kettle River-Kettle River	Full restoration	14325.98
	0703000301	070300030106	Silver Creek	Protection	17644.82
	0703000301	070300030107	Gillespie Brook	Protection	21463.05
	0703000301	070300030109	Birch Creek	Protection	32023.42
Upper Tamarack River	0703000103	070300010303	Upper Tamarack River	Protection	6657.63
	0703000103	070300010301	Spruce River	Protection	273.98
Willow River	0703000303	070300030302	Little Willow River	Protection	21593.11
	0703000303	070300030303	Sturgeon Lake-Willow River	Protection	29711.28
	0703000303	070300030301	Oak Lake-Willow River	Protection	34445.19