Rainy River - Headwaters

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Rainy River - Headwaters Watershed Restoration and Protection Strategy Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Contents

List of Figures

List of Tables

Key terms

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 due to 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 due to impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired due to 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 Rainy River Basin and Lake of the Woods is assigned a HUC-4 of 0903 and the Rainy River - Headwaters Watershed is assigned a HUC-8 of 09030001.

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.

Acronyms and Abbreviations

1W1P	One Watershed One Plan
AIS	aquatic invasive species
BMP	best management practice
BWCAW	Boundary Waters Canoe Area Wilderness
BWSR	Board of Water and Soil Resources
Chl-*a*	chlorophyll-*a*
CLMP	Citizen Lake Monitoring Program
CSWCD	Cook County Soil and Water Conservation District
CWLA	Clean Water Legacy Act
DNR	Minnesota Department of Natural Resources
DO	Dissolved oxygen
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
EQB	Minnesota Environmental Quality Board
FWMC	flow-weighted mean concentration
GHG	greenhouse gas
GWUDI	groundwater under the direct influence of surface water
HSPF	Hydrological Simulation Program-FORTRAN
HSPF-SAM	Hydrological Simulation Program-FORTRAN Scenario Application Manager
HUC	hydrologic unit code
IBI	index of biotic integrity (M-IBI for macroinvertebrate IBI; F-IBI for fish IBI)
IWM	Intensive Watershed Monitoring
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
LBCA	Lake Benefit Cost Assessment
LPSS	Lakes of Phosphorus Sensitivity Significance
LSWCD	Lake County Soil and Water Conservation District
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
NLCD	National Land Cover Database

NLF	Northern Lakes and Forests
NMW	Northern Minnesota Wetlands
NO_3+NO_2-N	nitrate plus nitrite nitrogen
NSLSWCD	North Saint Louis Soil and Water Conservation District
NRCS	Natural Resources Conservation Service
NPDES	National Pollutant Discharge Elimination System
ORVW	outstanding resource value waters
RRHW	Rainy River - Headwaters Watershed
SDS	State Disposal System
SID	Stressor Identification
SNF	Superior National Forest
SSTS	Subsurface sewage treatment system
SWCD	Soil and Water Conservation District
TALU	Tiered Aquatic Life Uses
TMDL	Total Maximum Daily Load
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
VNP	Voyageurs National Park
WHAF	Watershed Health Assessment Framework
WID	waterbody identifier
WRAPS	Watershed Restoration and Protection Strategy
WWTP	wastewater treatment plant

Executive summary

The Minnesota Pollution Control Agency (MPCA) employs a watershed approach to restore and protect Minnesota's rivers, lakes, and wetlands. To characterize watershed health, intensive water quality monitoring and assessments are conducted in each of the state's 80 major watersheds every 10 years. This is followed by the identification of stressors to aquatic life and investigation of problems identified by the watershed characterization. This Watershed Restoration and Protection Strategy (WRAPS) Report builds on the work completed during intensive water quality assessment and stressor identification (SID) summarized in the Rainy River - Headwaters Watershed Monitoring and Assessment Report (MPCA 2017), the Rainy River - Headwaters SID Report (MPCA 2019), and the supplemental report, *The status of Coldwater fish in Dunka River, a protection-priority stream in northern Minnesota* (MPCA 2020b). It also guides future restoration and protection strategies in the watershed.

The Rainy River - Headwaters Watershed (RRHW; hydrologic unit code (HUC) ID 09030001) is located in Northeastern Minnesota and the southern part of the Canadian province of Ontario. This report focuses on the Minnesota portion of the RRHW. The Minnesota portion of the watershed is 2,954 mi^2 (1,890,689 acres) in size, and is home to 1,273 lakes that are larger than 10 acres. There are 408 stream reaches, many of which are small reaches that drain to area lakes. Much of the watershed is forested and under public ownership, contributing the excellent water quality found throughout the watershed. The wilderness nature of the RRHW also makes it a popular outdoor recreation destination for camping, hiking, boating, and fishing. A large portion of the watershed is part of the Boundary Waters Canoe Area Wilderness (BWCAW) and is managed by the United States Forest Service (USFS). The western edge of the RRHW falls within Voyageurs National Park (VNP). Watersheds within the BWCAW and VNP are highly protected from disturbance. Other public lands in the watershed include Bear Head Lake State Park, 6 state forests, and 14 scientific and natural areas. Most of the watershed lies within the 1854 Ceded Territory.

The watershed covers portions of four Minnesota counties: Lake (46% of the watershed), St. Louis (43%), Cook (11%), and Koochiching (<1%). The largest population center in the RRHW is Ely, with a population of roughly 3,408. The total population within the watershed is nearly 8,000.

The largest land use pressures on the watershed come from the timber industry and outdoor recreation. The RRHW also holds metallic rock resources and there are areas of past metallic mining activity and interest in additional metallic mining development. Small scale gravel mining also takes place within the watershed. Additional localized water quality influences include channelization and pasture operation.

Overall, the water quality in the RRHW is excellent. Utilizing available data collected within the last 10 years and during intensive watershed monitoring (IWM), the MPCA assessed 64 stream reaches and 245 lakes greater than 10 acres in size (MPCA 2017). Of these, seven stream reaches were identified to harbor exceptional fish and macroinvertebrate communities, reflecting the wilderness nature of the watershed. Two impaired stream reaches were identified that require a Total Maximum Daily Load (TMDL), the Blackduck River, and the Ash River. The Blackduck River is impaired by excess suspended sediment (TSS) and *Escherichia coli* (*E. coli*); and a TMDL was developed. The RRHW TMDL Report (MPCA 2021) establishes restoration strategies and best management practices (BMP) for the Blackduck River. The Lower Ash River was also found to exceed the cold water (class 2A) TSS standard, however it is in the process of a potential use-class change to warm water (class 2B), so a TMDL analysis was deferred.

A few waterbodies were found that naturally exceed water quality standards. This includes Blueberry Lake, impaired due to eutrophication, and four stream segments exceeding the aluminum water quality standard - one of which also exceeds the copper water quality standard. These impairments were reviewed by the MPCA Assessment Consistency and Technical Team's Natural Background Review Committee. The committee concluded the impairments were due to natural conditions. TMDLs are not required for waters impaired due to natural background conditions.

With minimal aquatic life and aquatic recreation use impairments in the watershed, the Rainy River - Headwaters WRAPS focuses on protection strategies that will help maintain high water quality and protect water bodies near impairment from becoming impaired.

A Core Team of representatives from local, state, federal, and tribal agencies met throughout the watershed approach process to guide assessment, problem investigation, and strategy development. Several protection-focused management strategy themes were developed to address key issues identified by Core Team members. Each of these strategy themes has implementation actions associated with them in the protection strategy table in Section 3.3.3. They include:

- drinking water protection;
- forestland management;
- habitat and aquatic connectivity management;
- lake management;
- recreational management;
- septic system improvement;
- stormwater runoff control; and
- streambank and gully protection

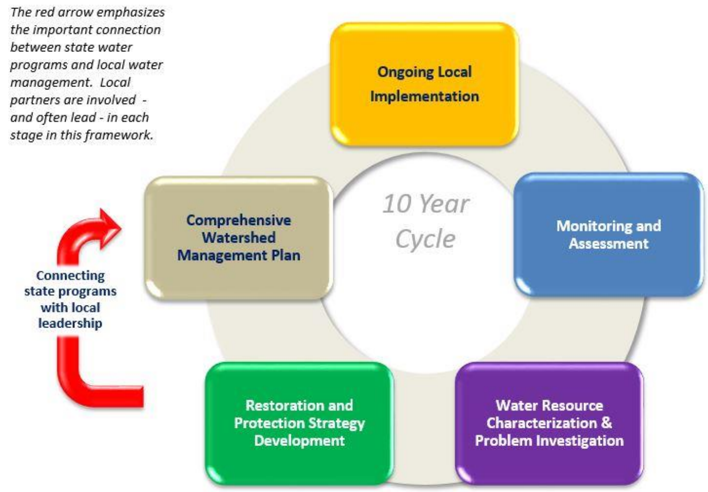
The Core Team associated various "risks" and "qualities" with each of the strategy types and attributed them to the waterbodies within the watershed. This formed the basis for the protection prioritization and targeting process.

Additionally, the Hydrological Simulation Program-FORTRAN (HSPF) model was used to determine potential future changes in runoff, sediment, and nutrient loading under increased development, climate change, and increased forest disturbance scenarios. This process was guided by the Core Team. Although all models make assumptions and are unable to predict future outcomes with certainty, they are a powerful tool that help inform management by filling data gaps and forecasting potential future conditions. Results help prioritize and target areas in need of additional protection and support management actions that foster resiliency for possible future changes to the watershed. These results are incorporated into prioritization and targeting in this report.

Finally, each protection strategy theme is associated with various BMPs, some of which apply at the major watershed scale (i.e., all waterbodies in the RRHW) and others that apply at minor watershed or lakeshed scale.

What is the WRAPS report?

Minnesota has adopted a watershed approach to address 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 Watershed Restoration and Protection Strategy (WRAPS) development. The WRAPS reports have two components: 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 waterbodies 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. The WRAPS report also serves as the basis for addressing the U.S. Environmental Protection Agency's (EPA) Nine Minimum Elements of watershed plans, to help qualify applicants for eligibility for Clean Water Act (CWA) Section 319 implementation funds.

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: • *Rainy River Headwaters Watershed Monitoring and Assessment* • *Rainy River Headwaters Watershed Biotic Stressor Identification* • *The status of Coldwater fish in Dunka River, a protection-priority stream in northern Minnesota* • *Rainy River Headwaters 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, Federal, and Tribal agencies (MPCA, DNR, BWSR, USFS, 1854 Treaty Authority, etc.)

This report focuses on conventional pollutants and stressors, including aquatic macroinvertebrate assessments, fish bioassessments, fecal bacteria, nutrients and eutrophication indicators, dissolved oxygen (DO), pH, temperature, and TSS. Minnesota's TMDL Priorities for 2016 through 2022 document focuses on TMDL completion for conventional pollutants and states: “For the other nonconventional pollutants, Minnesota is using (or is in the process of developing) other strategies. The MPCA will continue to develop TMDLs for nonconventional pollutants, such as mercury and chloride, during this time period, but those impairments are not included in Minnesota TMDL Completion Priority List.” Also, when appropriate, other processes (e.g., permitting) are used to address nonconventional pollutants.

1. Watershed background and description

The RRHW (HUC ID 09030001) is located in Northeast Minnesota and the southern part of the Canadian province of Ontario. This WRAPS document only provides data and statistics for the portion of the watershed that is in Minnesota. This remote watershed hosts an abundance of high quality surface water and largely undeveloped lands contributing to its popularity as an outdoor recreation destination for which it is most widely known. The watershed covers 2,954 mi^2 (1,890,689 acres) and is home to 408 stream reaches, and 1,273 lakes that are larger than 10 acres. The majority of the Boundary Water Canoe Area Wilderness (BWCAW) lies within the RRHW and is one of the largest and most visited wilderness areas in the United States. Other recreational highlights include VNP and the Superior National Forest (SNF). Watersheds within the BWCAW are highly protected from disturbance.

In 2008, the International Joint Commission's Transboundary Hydrographic Data Harmonization Task Force was convened to improve the alignment of geospatial hydrographic datasets along the United States–Canada border. The results of the data harmonization shifted the HUC-8 Major watershed boundary in the Northeast, incorporating a portion of the Rainy River–Rainy Lake Watershed (09030003). The MPCA uses the Natural Resources Conservation Service's (NRCS) Watershed Boundary Set, which reflects the data harmonization results. However, note that the HUC-8 boundary dataset used by the Minnesota Department of Natural Resources (DNR) does not reflect the data harmonization results, and therefore the DNR considers some portions of the northwestern part of this watershed, including the impaired Blackduck River Watershed, to be part of the Rainy River–Rainy Lake Watershed (09030003).

Although there are no Native American reservations within the watershed, most of the RRHW falls within the 1854 Treaty Area, where the Bois Forte, Grand Portage and Fond du Lac bands of the Lake Superior Chippewa have retained treaty rights to hunt, fish and gather. Wild rice is found in waters throughout the watershed, and these waters have high cultural significance to the Lake Superior Chippewa tribes.

The majority of the watershed (99.8%) resides within the Northern Lakes and Forests (NLF) EPA Level III Ecoregion. The remaining .2% is within the Northern Minnesota Wetlands (NMW) ecoregion. Bedrock geology is primarily comprised of the Canadian Shield, a broad plain of eroded ancient rock that covers much of central Canada and sections of northern Minnesota. Rock of the Canadian Shield is extremely hard, but some areas of weaker rock were excavated by moving glaciers, leaving behind the current topographic relief within the watershed. Sedimentary deposits are present in the watershed resulting primarily from three distinct glacial lobes (Des Moines, Rainy, and Superior) that were present during the most recent glacial period. As a result, soils in the watershed are often shallow and very sandy, increasing in percent sand and decreasing in percent silt from the west to the east. The Des Moines lobe covered much of the western side of the watershed where the present-day Ash River is located. Soils within the area of the Des Moines lobe are mostly calcareous, silty-clay soils which are considered highly erodible.

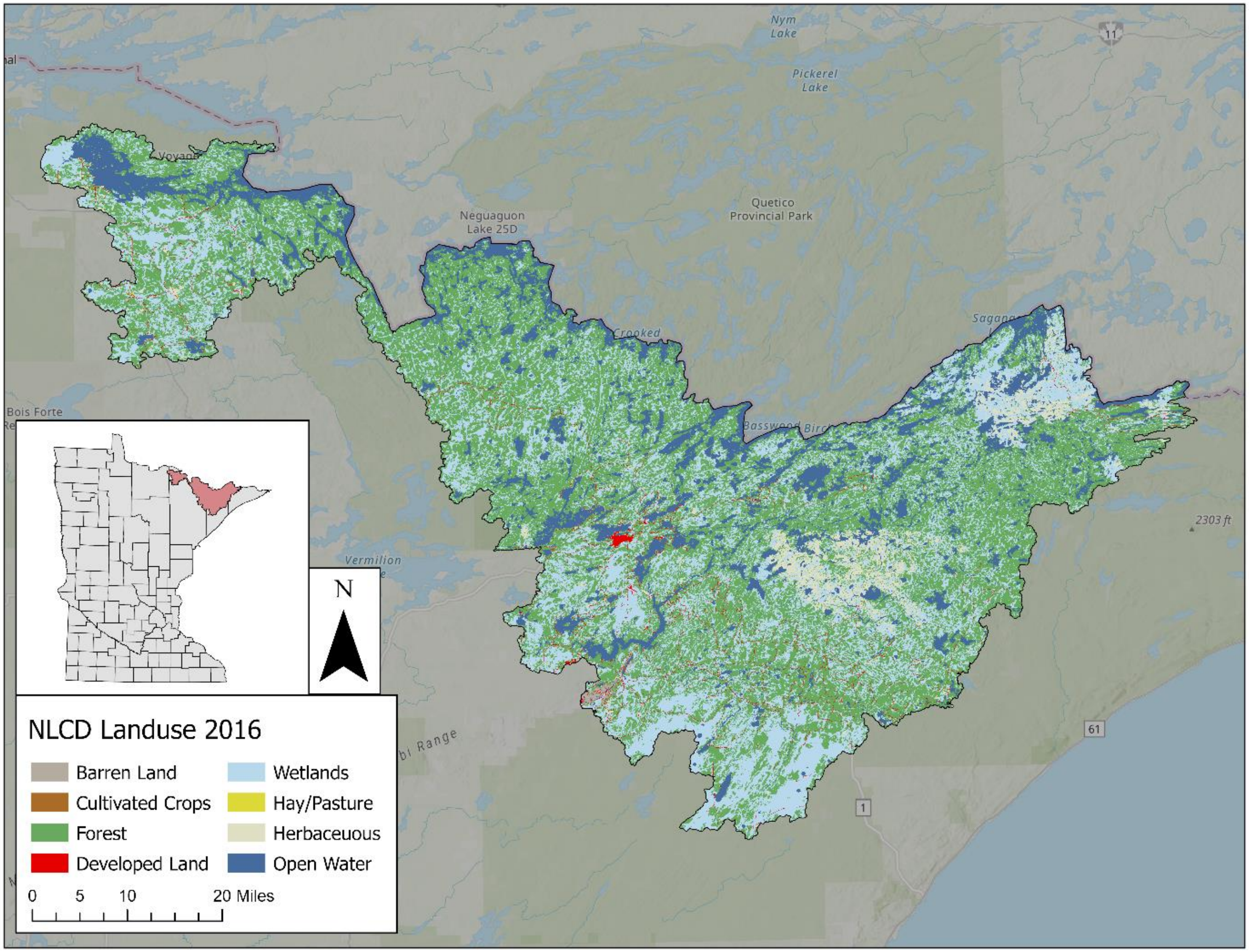
Table 1. Rainy River - Headwaters Watershed - 2016 land use NLCD

Land Use	%
Forest	48%
Wetlands	29%
Open water	14%
Herbaceous/Shrub	7%
Developed	1%
Hay/Pasture	<1%
Cultivated Crop	<1%
Barren Land	<1%

Four counties make up the watershed: Lake (46%), St. Louis (43%), Cook (11%), Koochiching (<1%). The total RRHW population is approximately 8,000 people. The largest population center is Ely, Minnesota, with a population of 3,408 in 2010; however, there are many smaller towns within the watershed, including Winton and Isabella. A five year summary of American Community Survey data indicates that much of the western half of the watershed lies within a census tract with at least 40% of people with reported income less than 185% of the federal poverty level. Based on this data, the MPCA considers this an area of concern for environmental justice.

Before European-settlement began in the late 1600s, the landscape was dominated by forest, bogs, and wetlands. Today, much of the watershed remains undeveloped. A breakdown of current land use (2016) is shown in Table 1 and Figure 1.

Figure 1. Rainy River - Headwaters land use map (NLCD 2016)



Pressure to develop land in the watershed dates back to when fur trading began in the mid to late 1600s. Much of the landscape that was altered before the 1600s by Native Americans, was done to create easier movement and portage routes between waterbodies. These portages within the region were used by the Native Americans and the early fur trading companies to move goods until shorter and less grueling routes were discovered (MPCA 2017). Leading up to World War I, much of the BWCAW and surrounding area had been logged or burned. Today the RRHW and BWCAW are largely comprised of red and white pine and white spruce trees. Recent discoveries have shown that there is evidence of significant historical fires within the region. Such fires were described in journal entries from early European travelers moving through the area (USDA USFS 2020b).

By the end of World War I, the watershed area had become increasingly popular for canoeing and wilderness enjoyment. By 1930, the Shipstead-Newton-Nolan Act had been passed, preventing the alteration of existing water levels and logging along shoreland within what is now the BWCAW. Other legislation followed, setting aside additional land within the watershed for preservation, including the Superior Roadless Primitive Area, which established one million acres of the SNF. Following World War II, the land continued to be developed in the region; most notably "fly-in" resorts. In 1949, President Harry S. Truman issued an executive order prohibiting recreational use of aircraft in the area by 1951 (MPCA 2017). In 1978, the area was officially designated as the Boundary Waters Area Canoe Wilderness (US Public Law 95-495) with some additions of acreage and restrictions as they are in the present.

The creation of VNP was initially debated back in the 1960s and came to be in 1975, designating over 160,000 acres of land to National Park status. Today, the landscape remains one of the most revered outdoor wildernesses in the country; however, the pressure to develop the area continues (USDA USFS 2020b). Currently, 75% of the land within the watershed is owned by the federal government, 13% is owned by the state of Minnesota, less than 1% is owned by the county, and 11% is privately owned (NRCS). Almost half of the entire drainage area of the RRHW is within the BWCAW.

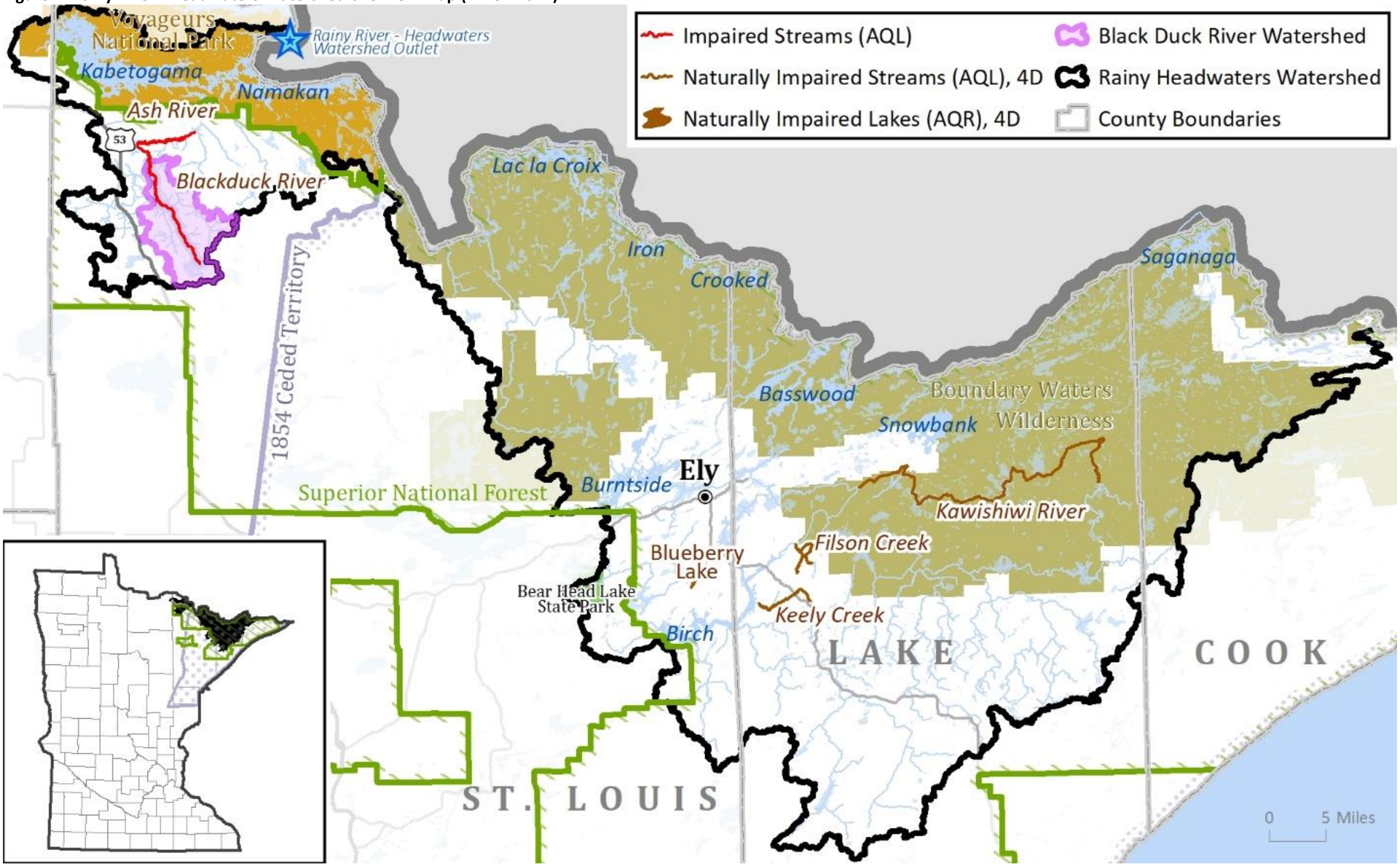
Mining, logging, and motorized recreational use areas are all points of discussion for land use and development (MPCA 2019). Currently, timber production occurs on both private and public lands throughout the watershed at varying degrees of intensity. The RRHW also holds metallic rock resources and there are areas of past metallic mining activity and interest in additional metallic mining development. Small scale gravel mining also takes place within the watershed.

Additional pressures on forests from insect damage threaten to change forest hydrology in the RRHW. Trees such as ash, balsam, and tamarack are susceptible to damage from invasive species such as the emerald ash borer and increased activity from native insects such as the spruce budworm and the larch beetle. The loss of these common tree species could alter the hydrologic regime within riparian areas in the watershed.

Thirty-year precipitation averages (1981 through 2010) within the watershed range from roughly 24 to 30 inches per year, with higher precipitation totals in the eastern portion of the watershed. The watershed-wide 30-year average is 29.1 inches of precipitation. Over the last 20 years, there has been no statistically significant increase in precipitation on an annual basis for the northeast region of Minnesota. However, over the last 100 years, the northeastern section of Minnesota has seen significant increases in annual precipitation, matching similar trends throughout the state. Average annual temperatures within the watershed (1981 through 2010) range between 37°F to 40°F, with an average 30-year temperature across the watershed of 37.8°F (DNR 2018).

Some of the major waterbodies of the RRHW are shown in Figure 2. The largest assessed lake in the watershed entirely within Minnesota is Kabetogama at 22,325 acres, located on the western side of the watershed within VNP. However, three larger lakes which share waters with Canada are located on the border of Minnesota and Canada: Basswood Lake (25,953 acres total, 14,051 in MN), Lac la Croix (25,597 acres total, 13,707 in MN), and Namakan (24,066 acres total, 11,755 in MN). These, along with other large border lakes including Gunflint, Saganaga, and Crooked lakes, are all near-pristine remnants of the "North Woods." The RRHW has many river systems that generally flow northward toward border waters. The largest of these is the Kawishiwi River. Originating in Kawishiwi Lake in the BWCAW, the river flows westward through a series of lakes. After flowing 47 miles, the river splits, and leaves the BWCAW. The South Kawishiwi heads southwest towards Birch Lake and the Kawishiwi River heads westward. From there both rivers join the White Iron Chain of Lakes and the Kawishiwi flows northward back into the BWCAW through a series of lakes to Basswood Lake, a border water. Kawishiwi Falls, between Garden and Fall Lake, is a 60-foot waterfall that attracts numerous tourists each year.

Figure 2. Rainy River - Headwaters Watershed overview map (MPCA 2017)



The watershed has 12 active dams within it: four within St. Louis County and eight within Lake County. Six dams are owned by the USFS, one by the DNR, two by the city of Ely, and three are owned by power companies. The dams were constructed between 1900 and 1975, and are used for hydroelectric power generation and water level controls between lakes (MNGeo 2017). The watershed has 54% of its streams in a natural state, 7% of streams are impounded, less than 1% are considered altered (DNR 2018). The remaining 39% of watercourses within the watershed have no definable channel, which is defined by the MPCA as a channel that does not exist or does not represent flowing waters such as a wetland (MnGeo 2013).

2. Watershed conditions

Utilizing water quality data collected within the past 10 years and during the 2014 and 2015 IWM monitoring effort, the MPCA assessed 64 of 408 stream reaches and 245 of 1,273 lakes greater than 10 acres in size against aquatic life and recreational standards (Figure 3). Several groups helped the MPCA perform lake sampling, including Lake County Soil and Water Conservation District (LCSWCD), North Saint Louis SWCD (NSLSWCD), Cook SWCD (CSWCD), the USFS, University of Minnesota Duluth's Natural Resources Research Institute (NRRI), and Vermilion Community College. In addition, many citizens engaged in the Citizen Lake Monitoring Program (CLMP) provided monitoring assistance including the White Iron Chain of Lakes Association (WICOLA), the Cook County Coalition of Lake Associations, and the Boy Scouts of America.

Overall, waters within the RRHW are considered to be in excellent health. Several stream reaches were identified as exceptional waters under the Tiered Aquatic Life Use standards (TALU), having exceptional fish and macroinvertebrate (aquatic insect) communities. These include Bezhik Creek (-975), Cross River (-966), Denley Creek (-627), Jack Pine Creek (-564), Little Isabella River (-530), Mitawan Creek (-568), and Snake River (-542). These high quality waters now fall under the exceptional use class IBI standard set to protect the existing high quality of these communities.

All assessed streams were evaluated for aquatic life use (fish and macroinvertebrate community IBIs, DO, suspended sediment, chloride, pH, phosphorus, Chlorophyll-*a* (Chl-*a*), biochemical oxygen demand and un-ionized ammonia data), and 12 of those were also assessed for aquatic recreation (fecal bacteria). Of the 64 streams assessed for aquatic life, 62 met water quality standards. Eleven of the 12 streams assessed for aquatic recreation also met water quality standards. The MPCA identified two stream reach impairments during the intensive monitoring study. The Blackduck River (-820) is impaired due to excess suspended sediment and fecal bacteria impacting both aquatic life and aquatic recreation. The lower Ash River reach (-818), downstream from the Blackduck River, is also impaired due to excess suspended sediment. Problem investigation during 2017 and 2018 indicated impacts from channelization, road crossings, forest conversion, and cattle are contributing to the impairment. The impaired Ash River reach is relatively unimpacted and located at the lower reaches of the watershed where pollutants and stressors can accumulate (MPCA 2017).

Additionally, 4 stream reaches sampled as part of a separate United States Geological Survey (USGS) study on baseline conditions in wilderness streams were found to be naturally impaired by aluminum, and one of these reaches was also impaired by copper. These aquatic life impairments are caused by surface water contact with mineralized bedrock in undeveloped areas and do not require a TMDL due to their natural causes.

All assessed lakes were assessed for aquatic recreation (phosphorus, Chl-*a*, and Secchi) and 61 lakes were assessed for aquatic life (chloride). The only lake that showed any definitive impairment was Blueberry Lake (69-0054-00) near Ely (MPCA 2017). Blueberry Lake does not support aquatic recreation based on the Class 2B eutrophication standard, but it was determined that this impairment was due to natural background because of the large catchment to lake ratio and relatively unimpacted drainage area.

Of the 245 assessed lakes, 129 had insufficient data to make a determination about aquatic recreation impairments. Similarly, all 61 lakes that were monitored for aquatic life had insufficient information to make a conclusion about impairment. Despite the lack of data to make many determinations, water quality in the watershed is considered to be excellent, which is attributed to the dominating forest landscape and limited shoreland development.

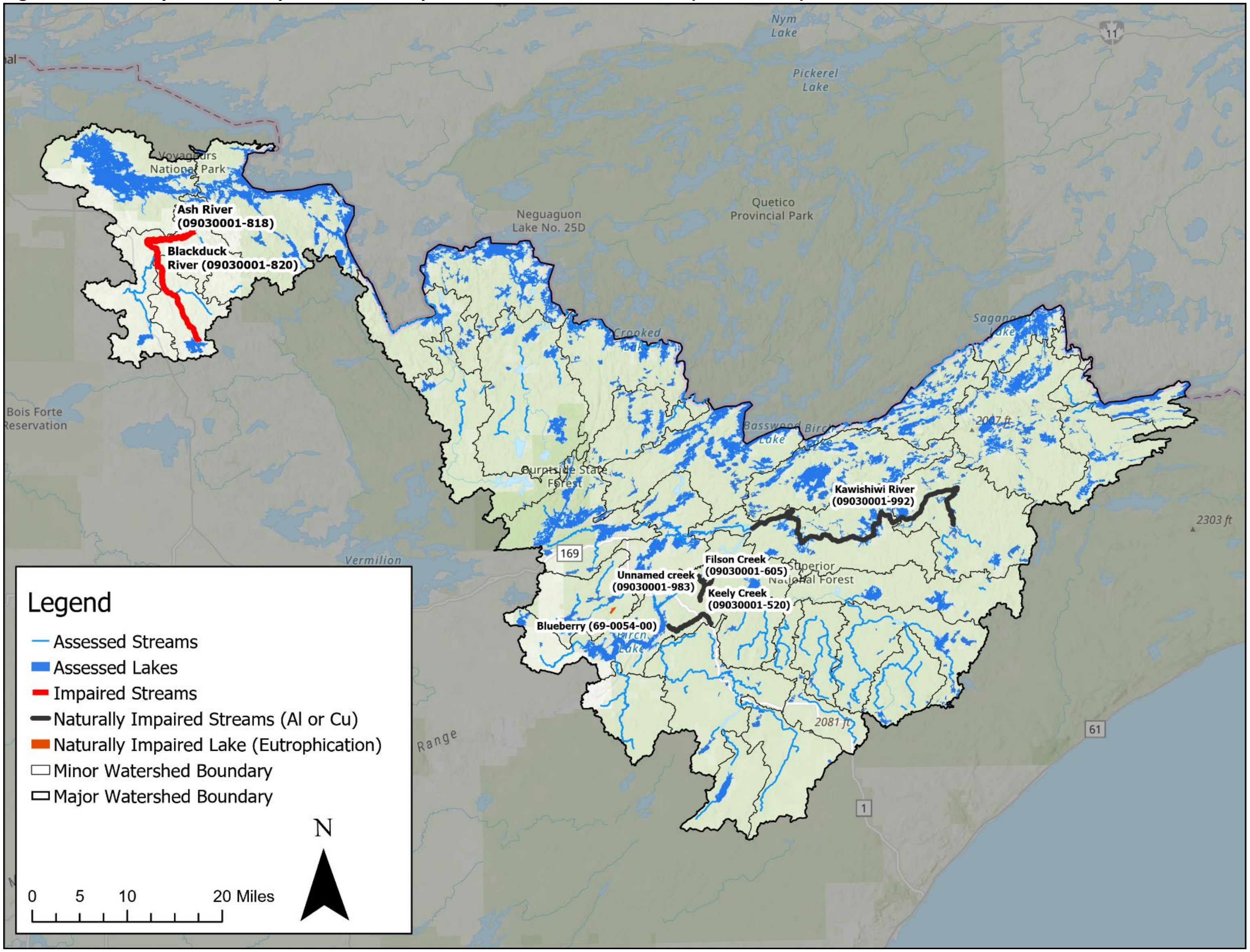
There are 212 lakes that have aquatic consumption impairments due to high levels of mercury in fish tissue; however, toxicity pollutants are not discussed in this report. Of these, 117 mercury TMDLs were approved as part of the Statewide 2018 Mercury TMDL, and the remaining TMDLs are expected to be completed between 2021 and 2033. Consumption advisories have been issued by the Minnesota Department of Health (MDH) for the affected lakes.

As of January 2020, there are no MS4 permits active within the watershed boundary based on the MPCA's 'What's In My Neighborhood' (WIMN) database. There are 15 active National Pollution Discharge Elimination System (NPDES) and/or State Disposal System (SDS) permits within the watershed, of which three are wastewater treatment plants (WWTP) and several are permitted under general permits. Other permits include mining operations and industry or sanitation discharge not related to a WWTP.

A more detailed analysis of water quality within the RRHW can be found in the RRHW Watershed Monitoring and Assessment Report and SID Report (MPCA 2017 and MPCA 2019).

A summary of the watershed assessment information for the RRHW is shown in Figure 3. This map does not include mercury or polychlorinated biphenyls (PCBs) in fish tissue impairments.

Figure 3. Summary of RRHW aquatic life and aquatic recreation assessments (MPCA 2017)



2.1 Condition status

The condition of the streams and lakes within the RRHW were assessed as part of the MPCA IWM between 2012 and 2016. Condition status primarily comes from these efforts and additional investigation documented in the RRHW SID Report (MPCA 2019). The waters within the RRHW are considered to be in excellent condition. Of the assessed lakes and streams as part of IWM, there were a total of three stream impairments within two stream reaches and one lake impairment (MPCA 2017). One of these impairments is considered to be due to natural background conditions as determined by a review from the MPCA Assessment Consistency and Technical Team's Natural Background Review Committee. Impairments that are not found to be naturally occurring require restoration efforts, while waterbodies that currently meet requirements for aquatic life and recreation are subject to protection efforts to prevent them from becoming impaired.

In addition, five aquatic life impairments on four stream reaches due to elevated aluminum and/or copper were identified by assessment of data collected as part of USGS research through an MPCA toxic pollutant review process that occurs every two years outside of IWM assessments. These impairments were reviewed by the MPCA Assessment Consistency and Technical Team's Natural Background Review Committee. In September 2017, the committee concluded that the impairments are due to naturally occurring elevated concentrations present in bedrock and TMDLs do not need to be developed. USGS research demonstrated the influence of natural copper and nickel-bearing bedrock on water quality (Elliott et al. 2020). These watersheds were targeted for this research given their location in wilderness areas and surface exposure of metal-bearing mineralized bedrock. For a listing of these waters see the Rainy River – Headwaters Total Maximum Daily Load (MPCA 2021). For more information on the USGS research see the report '*Assessing the influence of natural copper-nickel-bearing bedrocks of the Duluth Complex on water quality in Minnesota'* at https://pubs.er.usgs.gov/publication/sir20205039.

A significant portion of the watershed area is forested. As such, protection strategies specific to forestland management are important to maintaining and protecting water bodies in the watershed. Forest loss can impact the local environment by reducing stream shading and increasing erosion. In the late 1800s and early 1900s, there was large-scale timber harvesting of mature forest within the watershed. Since then, the region's forests have reestablished and many continue to be managed for forest harvest at varying levels of intensity. In addition to harvest, forest loss can occur from insect damage, disease, large scale blowdowns, and wildfires. Current forestland management activities in the RRHW, especially on public lands, have successfully protected waterbodies and should be maintained. Additional BMPs should highlight past successes.

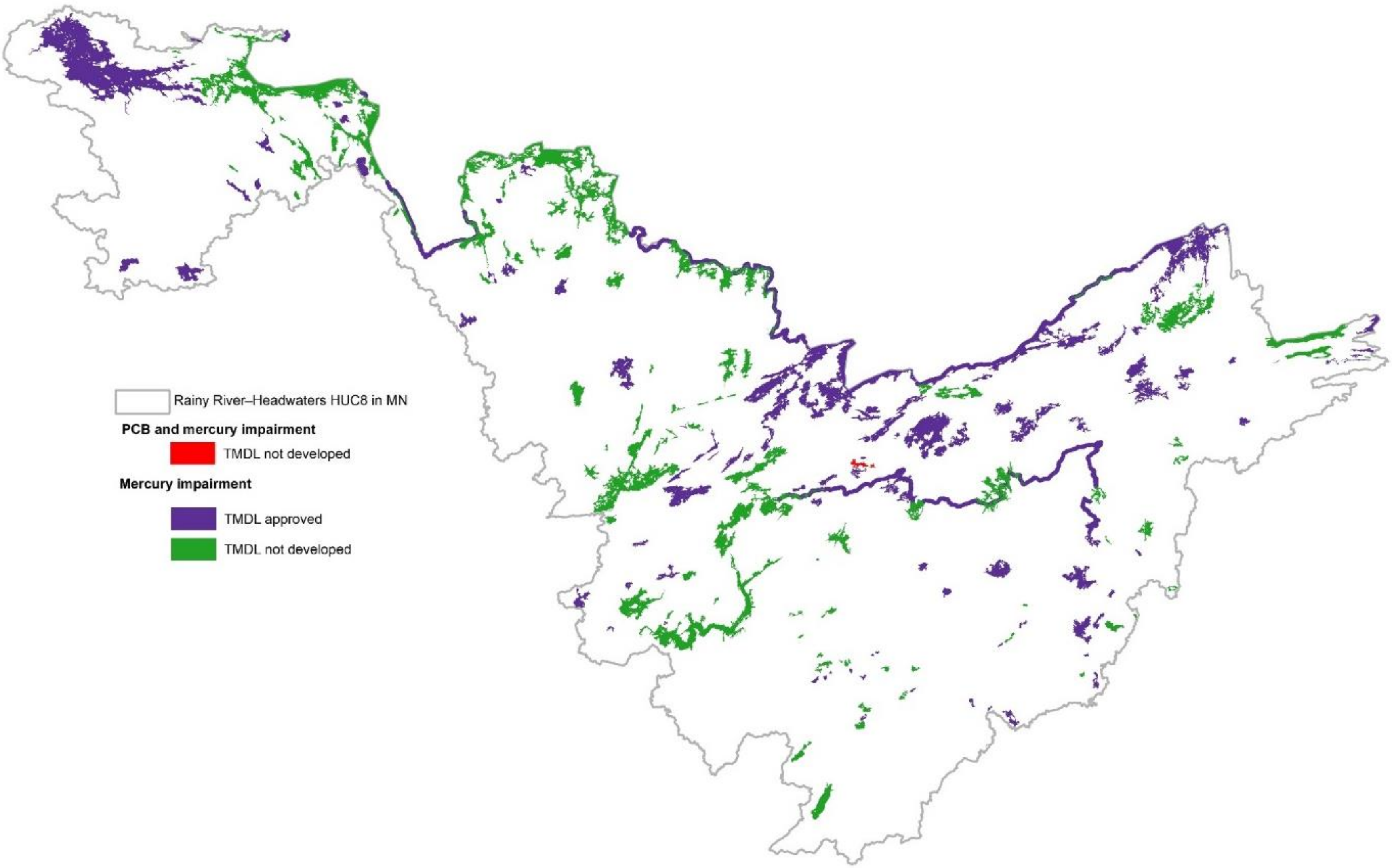
Some streams and lakes within the RRHW are either currently impaired or in need of protection so they do not become impaired in the future. Impairment classification is based on determining if a waterbody can meet aquatic life and/or aquatic recreation standards. Factors used to determine whether a waterbody is capable of supporting and harboring aquatic life (aquatic life standards) include the fish and macroinvertebrate index of biotic integrity (IBI) (F-IBI and M-IBI, respectively), DO concentration, suspended sediment concentration (expressed as total suspended solids [TSS]), along with other physical descriptions and characteristics of the stream or lake. The factors used to assess the suitability of a waterbody for aquatic recreation (aquatic recreation standard) is the concentration of *E. coli* bacteria in streams, and eutrophication indicators such as phosphorus and Chl-*a* in lakes. Streams and lakes with aquatic life aquatic recreation impairments will be targeted with restoration practices, while the waterbodies that currently meet aquatic life and aquatic recreation criteria will be the focus of protection efforts.

2.1.1 Aquatic Consumption Impairments

In addition to the aquatic life and aquatic recreation impairments, there are water bodies on Minnesota's 2018 list of impaired water bodies with aquatic consumption impairments based on mercury in fish tissue (212), mercury in the water column (1), or PCBs in fish tissue (1). Of these impairments, 117 mercury TMDLs were approved as part of the 2018 Mercury TMDL Appendix A (Figure 4).

Revisions to Appendix A of the Minnesota Statewide Mercury TMDL (MPCA 2007) are submitted to the EPA every two years with the impaired waters list. Water resources with mercury concentrations greater than 0.572 mg/kg are not part of Appendix A. These will undergo a separate process, which could include TMDL development, to meet the specific needs for greater reductions. This includes assessing the need to address sulfate and other pollutants and watershed processes in relation to their impact on mercury methylation. TMDLs for these 96 water bodies in the Rainy River–Headwaters Watershed are expected to be completed by 2033, where appropriate (according to Minnesota's draft 2020 list of impaired water bodies). A TMDL for the PCB impairment is also expected to be completed by 2033. For more information on mercury impairments, see the statewide mercury TMDL: https://www.pca.state.mn.us/water/statewide-mercury-reduction-plan. A list of mercury impairments in the RRHW can also be found in Appendix B of this report.

Figure 4. Aquatic consumption impairments in the Rainy River–Headwaters Watershed



2.1.2 Streams

The IWM conducted by the MPCA looked at many parameters to determine if the assessed stream reaches met aquatic life and aquatic recreation standards. These parameters and associated results can be found in Appendix C. The factors used to determine aquatic life indicators are F-IBI, M-IBI, DO, turbidity/TSS, Secchi tube depth, chloride, pH, Ammonia-NH_3, pesticides, and eutrophication. Two reaches were identified as impaired by TSS, one of which was also impaired by *E. coli*. There were additional minor pH exceedances; however, these were determined to be from natural conditions seen in many wetland influenced streams (MPCA 2017).

Two coldwater stream reaches in the Ash River Watershed, the Blackduck River (-820) and the Ash River (-818) from Blackduck River to Ash River Falls, are both impaired by excess suspended sediment, which can negatively impact aquatic life. The Blackduck River is the largest tributary to the Ash and is more developed than the Ash River. Located in glacial lake deposits, these streams flow through the most erodible soils in the RRHW (MPCA 2019). Investigation of coldwater habitat and coldwater fish communities indicates the Blackduck River contains more suitable coldwater habitat than Ash River reach -818. Both reaches narrowly meet the fish-IBI threshold for Northern Coldwater streams (MPCA 2019). A TMDL was deferred on Ash River reach -818 pending a decision on recategorizing the reach as warmwater based on habitat and fish assemblage characteristics. A TMDL has been developed for the Blackduck River.

Forestry is an active industry in the Ash River Watershed. A forest change study conducted by the U.S. Park Service (Kirschbaum 2017) reviewed forest change in 11 RRHW subwatersheds that drain to VNP during years 1995 to 2013, including the ARW. The report found that the ARW had experienced the highest forest disturbance (23% of watershed area) and that harvest was the dominant disturbance agent.

Three large sections of land were disturbed in the watershed of these reaches starting in the early 2000s. Considerable logging and forest conversion to pastureland has occurred adjacent to the Blackduck River. Additionally, a 400-acre section of forest upstream from the impaired Ash River reach was cleared due to insect/disease management in 2001. Between 2005 and 2009 an adjacent section of forest land totaling 300 acres was also logged. This forest reduction resulted in a decrease in mature forest cover within the Ash River Watershed, potentially impacting surface runoff, streamflow dynamics, and erosion (MPCA 2019).

Additionally, about a three-quarter mile section of the Blackduck River was channelized prior to 1939 to construct a road that is still in use today. This reduced the length of that section of river by 34%, and increased the slope on that section by approximately 60% (MPCA 2019). The stream is moderately incised in this section and does not connect to the floodplain during bankfull flow. The area draining to this reach also includes land used for logging, grazing, and cattle farming, adding to the degradation of the stream banks. This is likely causing stream instability and contributing to the suspended sediment impairment.

The Blackduck River also has an aquatic recreation impairment. *E. coli* bacteria concentrations exceed the maximum standard of 1,260 organisms/100mL and the geometric mean standard (126 MPN/100mL). A major source of the bacteria is pastureland within the subwatershed. This source was identified through stream sampling which took place both upstream and downstream of the pastureland. Six locations in the Blackduck River Subwatershed were sampled weekly (12 to 15 times) during June through mid-September in 2017. Samples from all stations were collected within a two-hour timeframe of one another on each sample date. The Blackduck River immediately upstream of the ranch had zero exceedances of the individual standard and much lower seasonal means. Bacteria levels at sites within the ranch were elevated with respect to others for the majority of stations (MPCA 2019). A TMDL has been developed for this impairment.

2.1.3 Lakes

Lakes are assessed for impairment using Northern Lakes and Forest ecoregion standards developed by the MPCA. To assess aquatic recreation use, a minimum of 8 TP, Chl-*a*, and Secchi depth observations are required within a 10-year period per current evaluation criteria. These parameters and associated results can be found in Appendix C. Lakes were not assessed for fish community health in the watershed as the DNR is currently developing biological health metrics for the Canadian Shield lakes within the drainage basin.

The RRHW had 245 of its 1,273 lakes (19%) assessed during the IWM. Of the 245 lakes, one showed signs of impairment by eutrophication. Blueberry Lake (69-0054-00) in the Bear Island River subwatershed HUC-12 has an aquatic recreational use impairment, but it was determined to be due to natural causes. Blueberry Lake is a very small, shallow lake with a maximum lake depth of six feet. It has a large drainage area with many wetlands draining to it, and due to the high catchment to lake ratio, it receives nutrients that naturally exceed the current Class 2B eutrophication standards.

2.2 Water quality trends

The MPCA recently published a report on the Rainy River. This report concluded that the Rainy River is in excellent condition. Once marred by industrial and municipal pollution, this river has made a remarkable recovery—thanks to regulations and hard work by local business, industry, and citizens—and now needs protection (MPCA 2020a). The RRHW drains into the Rainy River, and therefore is a very high priority for protection.

Dedicated volunteers, with the support of the North St. Louis, Lake, and Cook SWCDs, have collected water quality data on lakes in the RRHW for over 10 years. Table 2 shows trends for total phosphorus (TP) concentration, Chl-*a* concentration, and Secchi disk depth from lakes within the watershed (RMBEL 2020).

The MPCA completes a trend analysis for transparency on all lakes with sufficient data annually. The trend is calculated using the Mann-Kendall Statistic and a minimum of eight years of data are required to determine the trend. Much of this transparency data is collected by volunteers through the MPCA's CLMP. A total of 43 lakes in the RRHW have enough data for a trend analysis on transparency (Table 3). The data show that 8 lakes have degrading trends, 4 lakes have improving trends. The rest of the lakes show no trend.

Table 2. Trends for lake water quality parameters in the RRHW

Lake Lake ID	County	TP	Chl-*a*	Secchi Disk Depth	Time Period	Data Source
Seagull 16-0629-00	Cook	↑	**NT**	**NT**	2008-2017	RMBEL
Farm 38-0779-00	Lake	**NT**	**NT**	↓	2006-2020	RMBEL
Garden 38-0782-00	Lake	**NT**	**NT**	↓	2005-2020	RMBEL
White Iron 69-0004-00	St. Louis	**NT**	↑	**NT**	2006-2020	RMBEL
Birch 69-0003-00	St. Louis	**NT**	**NT**	↓	2011-2020	RMBEL

↑ Improving trend ↓ Degrading trend **NT** No trend

Table 3. Secchi Depth Trends for Lakes in the RRHW. Trend data is from 1972-2019

County	Lake ID	Lake Name	Trend Description
	16-0356-00	Gunflint	↑
	16-0448-00	Loon	**NT**
	16-0337-00	Mayhew	**NT**
	16-0619-00	Onagon	**NT**
	16-0633-00	Saganaga	**NT**
Cook	16-0629-00	Sea gull	**NT**
	38-0330-00	Alice	↓
	38-0502-00	Ashigan	**NT**
	38-0645-00	Basswood	↓
	38-0187-00	Eddy	**NT**
	38-0498-00	Ensign	**NT**
	38-0811-00	Fall	**NT**
	38-0779-00	Farm	↓
	38-0372-00	Fraser	↓
	38-0782-00	Garden	↓
	38-0557-00	Grouse	**NT**
	38-0792-00	Horse	**NT**
	38-0400-00	Ima	**NT**
	38-0511-00	Jordan	**NT**
	38-0226-00	Kekekabic	**NT**
	38-0404-00	Knife	**NT**
	38-0644-00	Moose	**NT**
	38-0619-00	Newfound	**NT**
	38-0180-00	Ogishkemuncie	↓
	38-0640-00	Ojibway	**NT**
	38-0529-00	Snowbank	**NT**
	38-0778-00	South farm	**NT**
	38-0531-00	Splash	**NT**
	38-0530-00	Sucker	**NT**
	38-0351-00	Thomas	**NT**
	38-0724-00	Tofte	**NT**
Lake	38-0642-00	Wind	**NT**
	69-0864-00	Ash	**NT**
	69-0003-00	Birch	↓
	69-0842-00	Blackduck	**NT**
	69-0118-00	Burntside	↓
St. Louis	69-0120-00	Everett	↑

County	Lake ID	Lake Name	Trend Description
	69-0085-00	Fenske	↑
	69-0845-00	Kabetogama	**NT**
	69-0116-00	Mitchell	**NT**
	69-0693-00	Namakan	**NT**
	69-0617-00	Sand point	**NT**
	69-0069-00	Shagawa	↑
	69-0004-00	White iron	**NT**
	69-0161-00	Wolf	**NT**

↑ Improving trend ↓ Degrading trend **NT** No trend

2.3 Stressors and sources

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 river reaches with either fish or macroinvertebrate biota impairments. It also encompasses the evaluation of both pollutant and nonpollutant-related (e.g., altered hydrology, fish passage, habitat) factors as potential stressors. The IBI is used to determine how impacted a waterbody is based on the fish and macroinvertebrate communities present. 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.

2.3.1 Stressors to aquatic life in impaired and priority river reaches

Because there are no biological impairments present within the 64 stream reaches that were monitored, SID focused on problem investigation including identification of pollutant sources contributing to existing impairments, as well as filling data gaps in a stream system identified as a local protection priority. The results provide supportive information for restoration and protection. Table 4 identifies the priority watersheds that were additionally monitored by the MPCA during SID. The Ash River Watershed was selected based on the chemistry impairments of the Ash River reach (-818) and Blackduck River (-820), and Dunka River was selected to further evaluate brook trout habitat suitability due to interest from local and regional stakeholders.

Problem investigation in the Ash River Watershed suggests sediment is contributed from the higher gradient upper portions of the watershed and is remaining suspended in the downstream impaired low gradient Ash River reach (-818). This was determined through longitudinal water chemistry sampling that showed flashier changes in TSS that corresponded with rain events in the upper portions of the watershed and more consistent levels of TSS in the lower reach.

To supplement sampling results and delineate major sources of sediment, a Bank Assessment for Nonpoint source Consequences of Sediment (BANCS) survey was completed to determine areas of stream bank erosion. This combined with the chemistry data identified sediment sources that could be targeted for restoration. The top 10 isolated contributing banks were identified. The 10 isolated banks identified were found in areas with beaver dams and spots where the stream abuts a valley wall. A three-mile stretch of stream contributing 30% of total bank erosion in only 11% of the survey length was also identified (Figure 23). This stretch occurs alongside and downstream from the channelized portion of the Blackduck River. Channelization is likely contributing to stream instability along this portion of stream and is a major contributor to the TSS impairment. For more information see the *Rainy River-Headwaters Stressor Identification Report*.

The Dunka River watershed was also investigated to further evaluate brook trout habitat suitability and determine if a change in aquatic life use classification is needed. Fish and macroinvertebrate communities as well as habitat surveys suggest the lower reach of the Dunka River supports coldwater aquatic life use. A wide range of brook trout age classes were sampled in the lower reach of the Dunka River (-987) suggesting natural reproduction of brook trout is occurring within the Lower Dunka River reach. The Dunka Watershed has mining activity but is otherwise forested, and the lower reach contains high-quality coldwater habitat, vulnerable to future land use and hydrological changes. A use class change to 2A coldwater is recommended to protect the coldwater assemblages found in Dunka River reach -987. For more information, see the MPCA report *The status of Coldwater fish in Dunka River, a protection-priority stream in northern Minnesota*.

Table 4. Additional problem investigation performed in reaches within the RRHW

HUC-12 Subwatershed	WID (Last 3 digits)	River	Reach description	Biological impairment (Fish IBI)	Water Quality Impairment	Further Investigation For		
						Trout suitability	TSS	*E.coli* (bacteria)
	818	Ash River Lower	Blackduck R to Ash River Falls	None	TSS	●	●	
Ash River	819	Ash River Upper	Headwaters (Ash Lk 69-0964-00) to Blackduck R	None	None	●	●	
Blackduck River	820	Blackduck River	Headwaters (Blackduck Lk 69-0842-00) to Ash R	None	TSS, *E.coli*	●	●	●
	986	Dunka River	Headwaters to Unnamed Ditch	None	None	●		
Dunka River	987	Dunka River	Unnamed Ditch to Birch Lk	None	None	●		

2.3.2 Pollutant sources

Pollutant sources vary by subwatershed and ecoregion depending on upstream loading conditions, NPDES permitted discharges, and nonpoint sources within the watershed. Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification, while point source pollution comes from a single identifiable source of pollution such as a WWTP or discharge pipe (EPA 2020).

Nonpoint sources

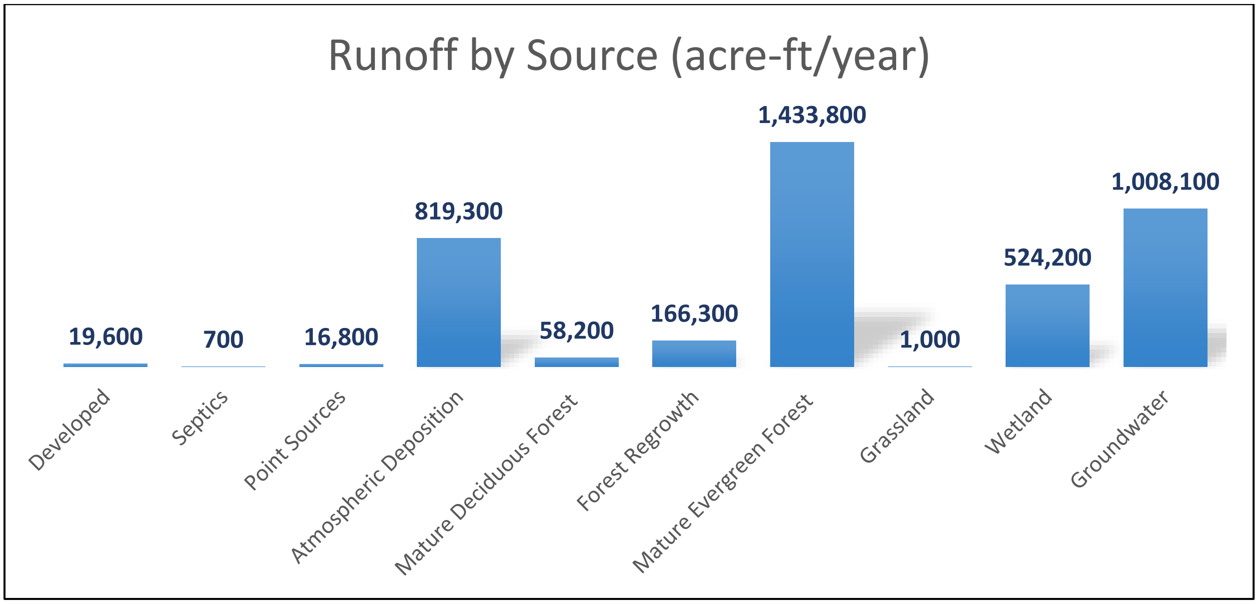
Due to the generally low population density, there are no Municipal Separate Storm Sewer System (MS4) permits within the watershed. Areas of high population density, in general, can cause water quality stressors. However, due to the limited population within the watershed, it is expected that these urban stressors are very localized. Less dense development poses potential water quality risks due to the lack of localized or regional sanitation infrastructure. Rural areas often have subsurface sewage treatment systems (SSTS) that can create localized pollution issues if not properly maintained. Old septic systems that are not up to current design standards or septic systems that are failing can create localized pollution issues. HSPF was used to estimate nonpoint source loads to the watershed. It is important to note that these estimates are result of modeling in which there is some inherent uncertainty in the breakdown between sources. These results are a tool to assist with management decisions in combination with sample data, local knowledge, and professional judgement. Models can be used to estimate conditions where there may not be watershed data. A representative dataset that contains a robust range of conditions (flows, chemistry and field measurements) supports model calibration that can mimic measured conditions. Once the model is calibrated to existing conditions using existing data, the model can then be used to estimate conditions throughout the watershed.

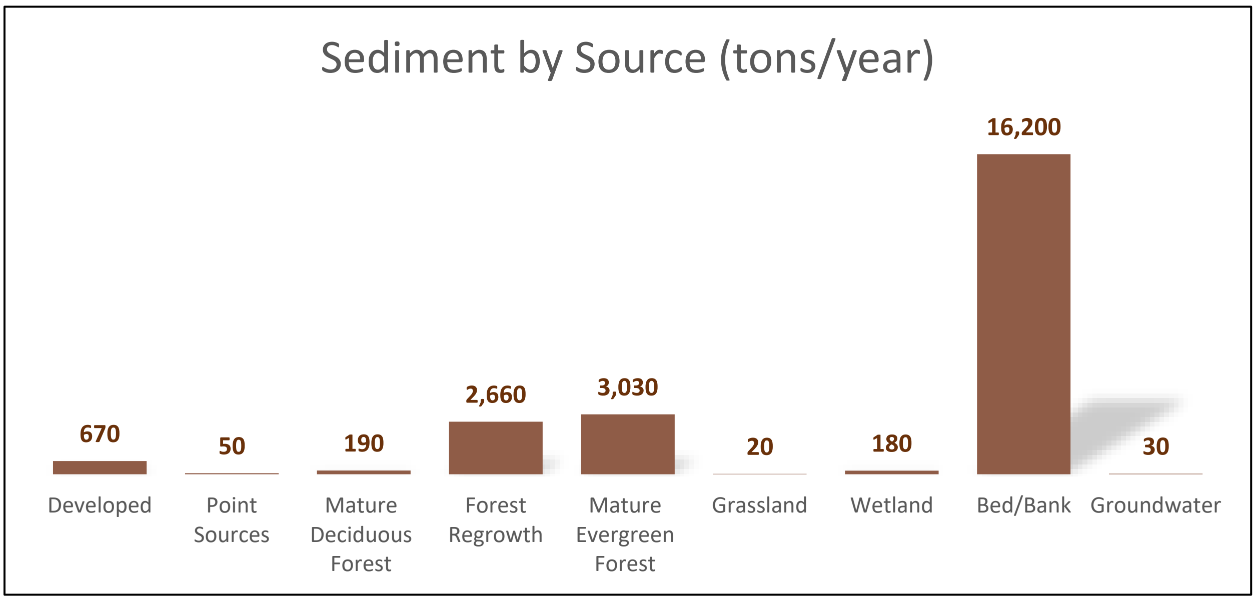
Nonpoint sources of TSS, TP, and/or TN as well as runoff were modeled for the RRHW using HSPF (Figure 5). The resulting values represent the source load, which is the constituent load contributed from each different source for the entire watershed. Results indicate that nonpoint sources account for > 99% of runoff, sediment, and total nitrogen (TN) and nearly 98% of TP delivered to streams and lakes in the RRHW. Additionally, the Hydrologic Simulation Program-FORTRAN Scenario Application Manager (HSPF-SAM) was used to evaluate TSS, TP, and TN yields by subwatershed within the RRHW (Figure 7, Figure 8, and Figure 9). When compared to other watersheds throughout the state, the RRHW has some of the lowest nitrate plus nitrite nitrogen (NO_3+NO_2-N), TSS, and TP, annual flow weighted mean concentrations (FWMCs) (Figure 6).

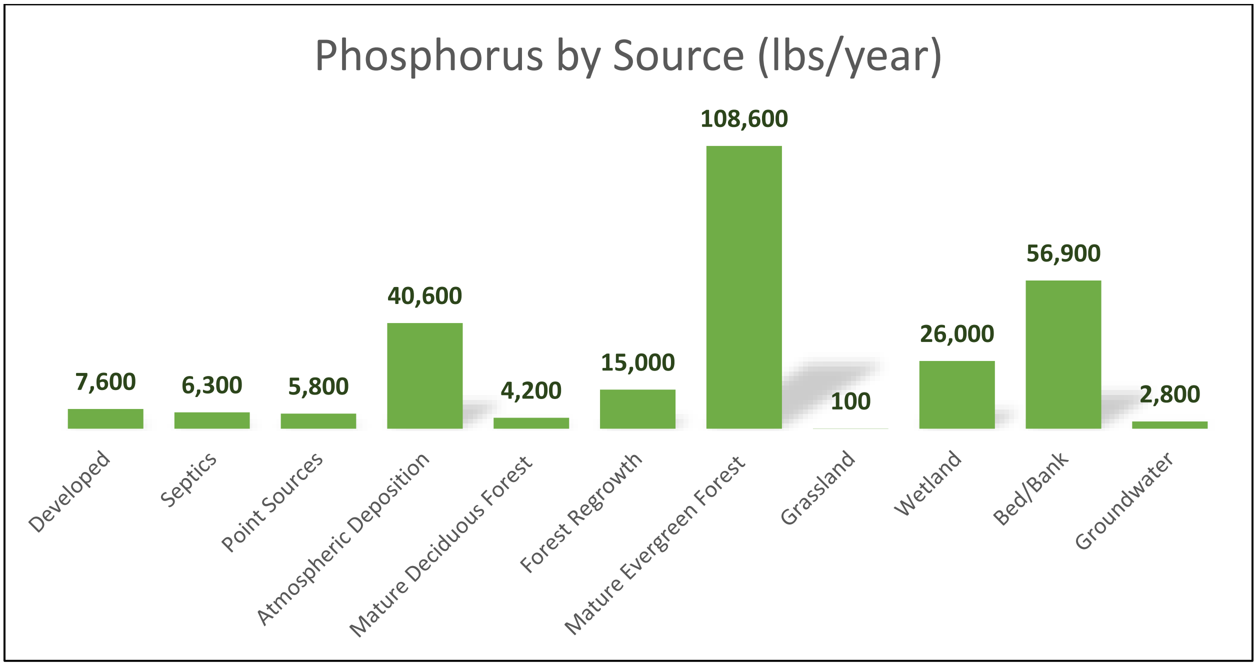
Although the HSPF subwatersheds are presented at a finer spatial scale and do not perfectly overlap the aggregated HUC-12 subwatersheds, general spatial trends can be inferred from the figures. In general, the western and southern portions of the watershed showed higher TSS, TP, and TN yields than the northeastern portion. This reflects the higher level of development and other land use pressures in the southern and western parts of the watershed. It should be noted that the HSPF results represent data from two separate models, the Rainy Headwaters model and the Rainy Lake model (Appendix E).

Additionally, nonpoint sources to the Blackduck River were identified as part of TMDL development. As no point sources are known to contribute to the impairment, nonpoint sources of sediment and bacteria are the focus of implementation efforts. Bank erosion, channelization, forest conversion, road crossings, old rail crossings, and pastureland are contributing to the suspended sediment impairment on the Blackduck River. A further discussion of these sources are discussed in Section 2.4 and in the RRHW TMDL Report (MPCA 2021).

Figure 5. Breakdown of runoff, sediment, and nutrient sources in the RRHW
Results are estimates from the HSPF model.






Phosphorus by Source (lbs/year)
7,600
6,300
5,800
40,600
4,200
15,000
108,600
100
26,000
56,900
2,800
Developed
Septics
Point Sources
Atmospheric Deposition
Mature Deciduous Forest
Forest Regrowth
Mature Evergreen Forest
Grassland
Wetland
Bed/Bank
Groundwater

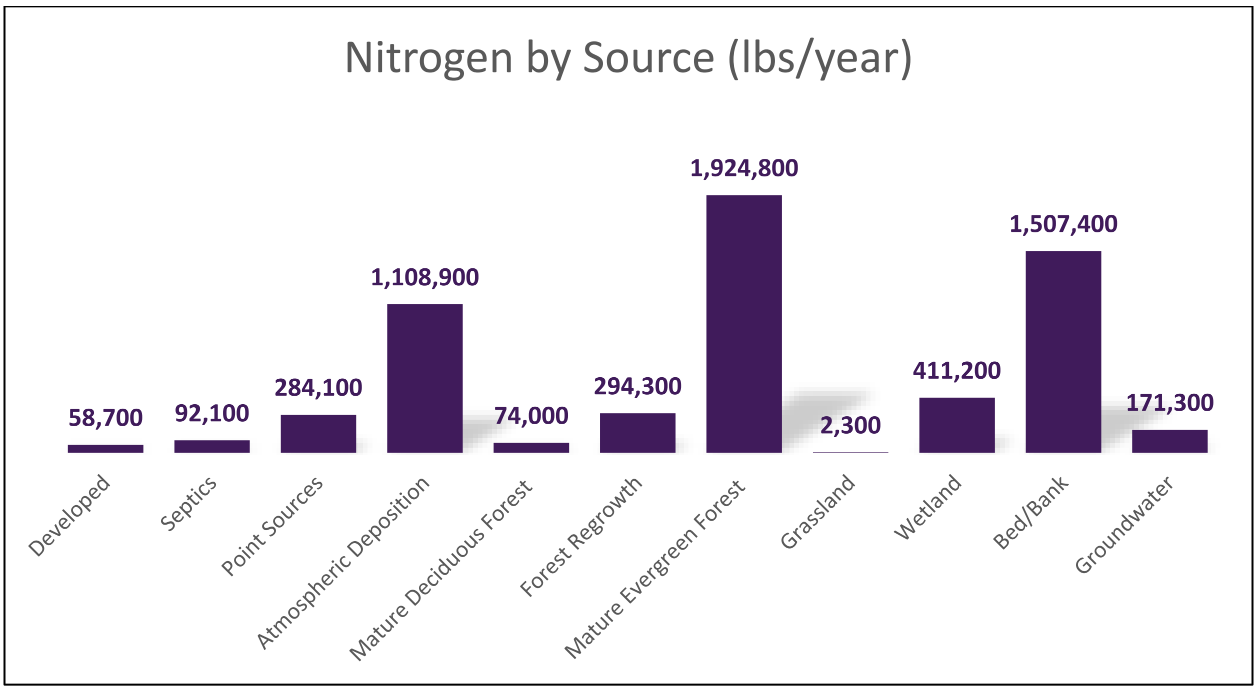

Nitrogen by Source (lbs/year)
58,700
92,100
284,100
1,108,900
74,000
294,300
1,924,800
2,300
411,200
1,507,400
171,300
Developed
Septics
Point Sources
Atmospheric Deposition
Mature Deciduous Forest
Forest Regrowth
Mature Evergreen Forest
Grassland
Wetland
Bed/Bank
Groundwater

Figure 6. 2007-2014 average annual NO3+NO2-N, TSS, TP, FWMCs, and runoff by major watershed (MPCA 2017)

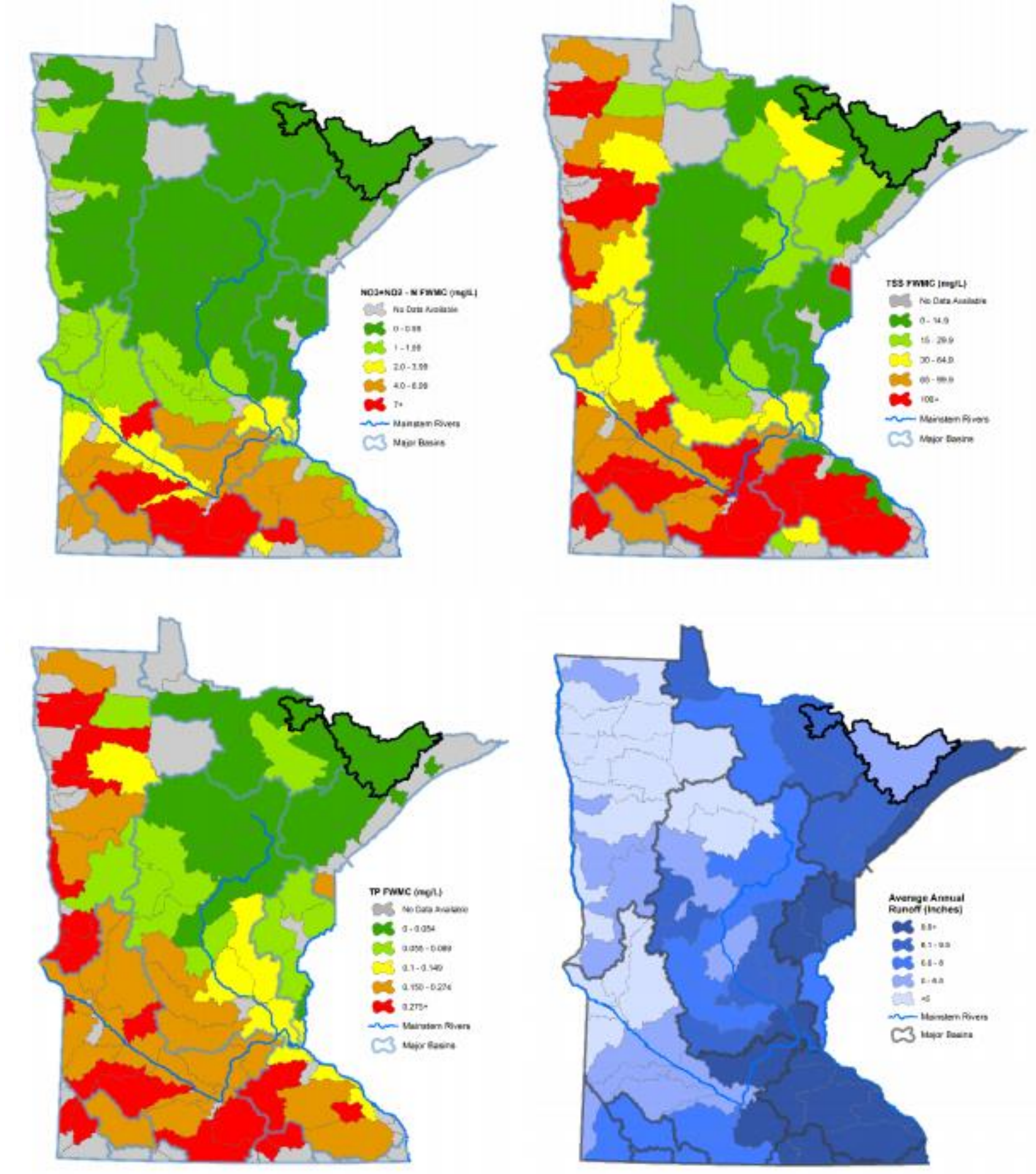


Figure 7. Modeled TSS yield by subwatershed within the RRHW (HSPF-SAM)

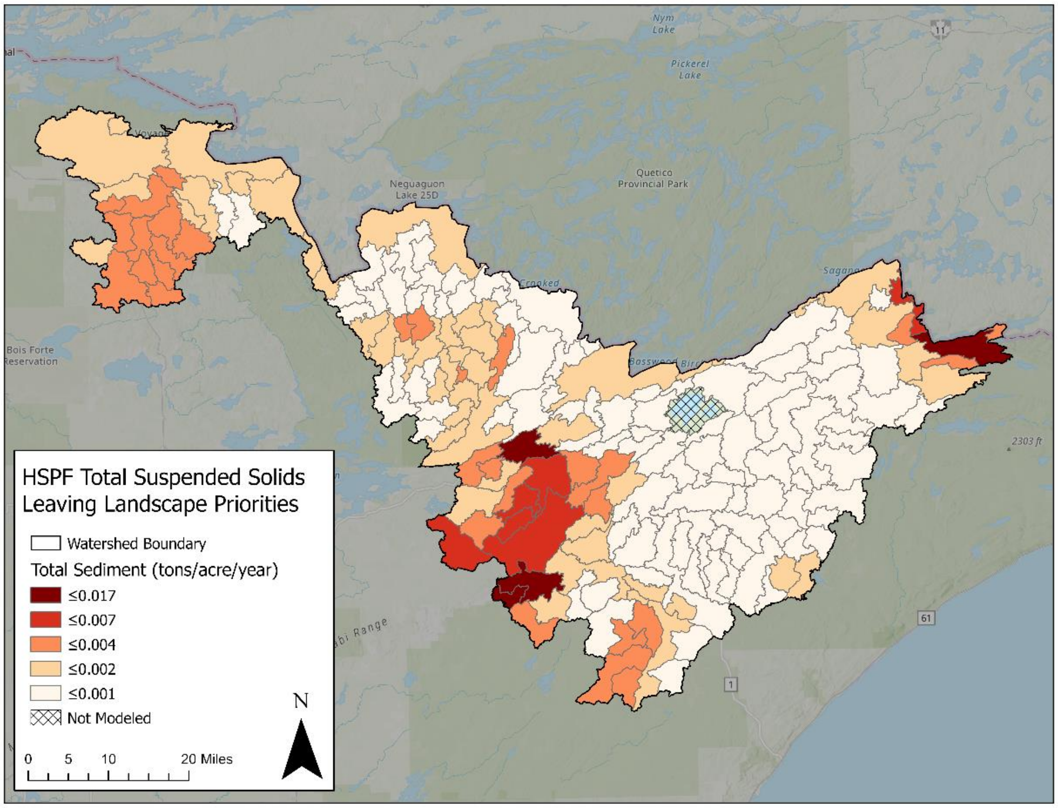


Figure 8. Modeled TP yield by subwatershed within the RRHW (HSPF-SAM)

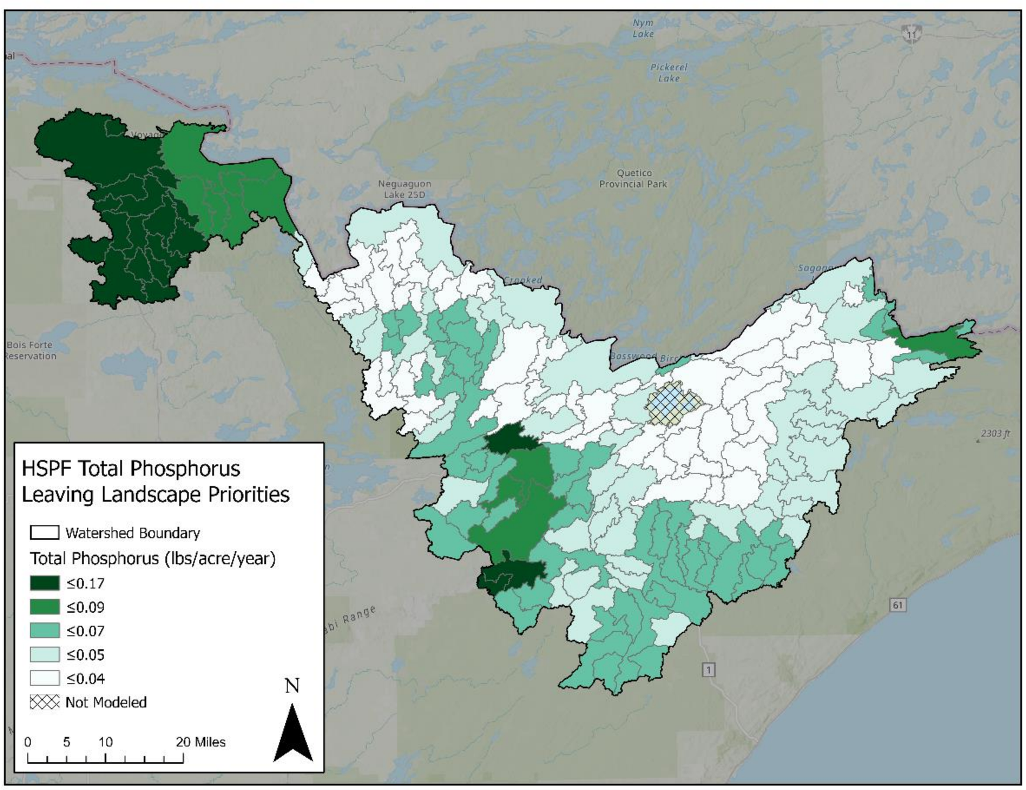
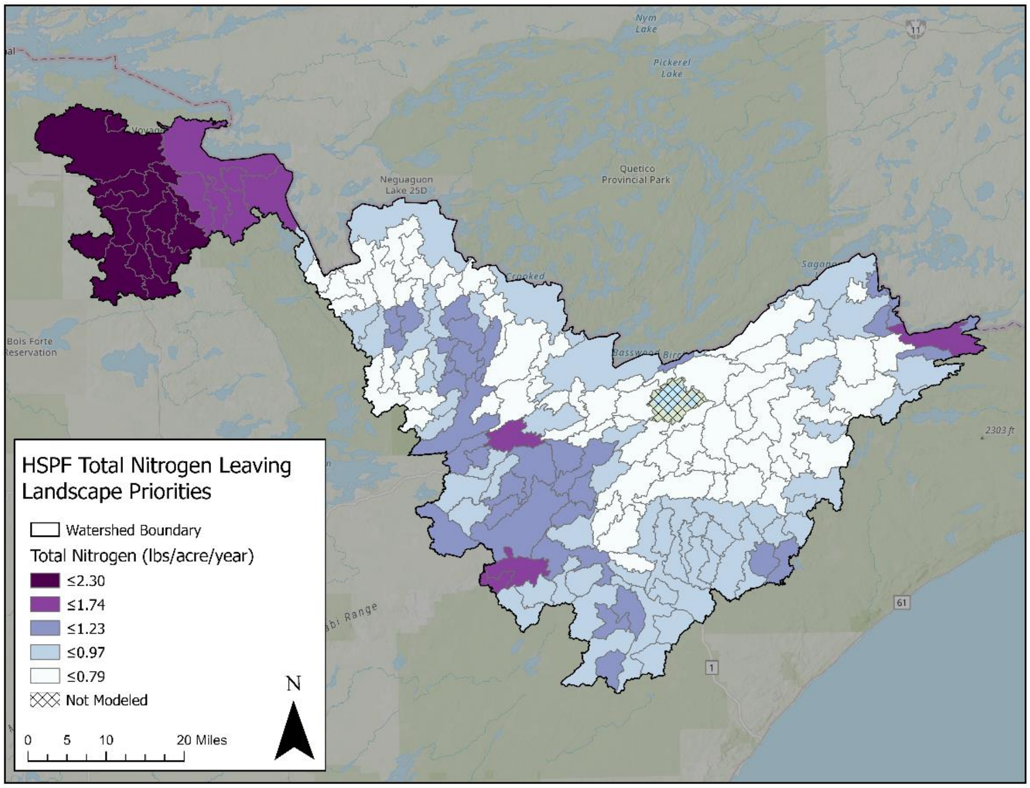


Figure 9. Modeled TN yield by subwatershed within the RRHW (HSPF-SAM)



Point Sources

For the RRHW WRAPS, point sources refer to entities that are permitted under the NPDES and/or the SDS permit programs. Point sources in the RRHW are summarized in Table 5, as of January 2020, from the MPCA's 'What's in My Neighborhood' (WIMN) dataset. No point sources are thought to be contributing to existing impairments. Because there are no TMDLs or associated pollutant load reductions to the waters these point sources discharge to, the point source permits are subject only to their current permit conditions or limits.

Table 5. Point sources in the Rainy River - Headwaters Watershed

Aggregated HUC-12	Name	Permit	Activity
Moose Lake (0903000105-06)	Charles L Sommers Wilderness Canoe Base	MN0050199	Municipal wastewater
Dunka River (0903000108-02)	Cliffs - Dunka Mining Area	MN0042579	Industrial wastewater
	Northshore Mining Co - Peter Mitchell	MN0046981	Industrial wastewater
Birch Lake (0903000108-03)	Cliffs - Dunka Mining Area	MN0042579	Industrial wastewater
Shagawa Lake (0903000110-02)	Ely WWTP	MN0020508	Municipal wastewater
	Ely WTP	MNG640109	Industrial wastewater
	Winton WWTP	MNG580187	Municipal wastewater
Kabetogama (0903000124-00)	Pucks Point Sanitary Sewer District	MN0070530	Municipal wastewater

Aggregated HUC-12	Name	Permit	Activity
Various	Various	MNG490000	Nonmetallic mining and associated activities
Various	Various	MNR100001	Construction Stormwater
Rainy Lake (0903000319-07)	Kettle Falls Hotel & Guest Villas*	MN0057410	Municipal wastewater

*Kettle Falls Hotel and Guest Villas is located on the border of the Rainy River Headwaters watershed.

2.3.3 Mining and water quality

There is little industrial activity within the RRHW. Some gravel pits and mining features exist within the watershed. The RRHW includes portions of the ore-bearing Mesabi and Vermilion formations. Mining these two formations dates back to the late 1800s. Extraction began with open pits, but operations later moved underground to reach larger deposits. Ore from the mines was shipped by rail to the ports in Duluth and loaded into lake freighters bound for steel mills in the eastern United States. Today only the Mesabi Range is actively mined for iron ore and taconite (DNR 2020b). In addition to the active mines, many inactive mining pits and waste rock piles remain. Many pits, such as Miner's Lake near Ely, have since filled with water and become recreational fishing destinations.

The DNR's Watershed Health Assessment Framework (WHAF) identifies areas most impacted by metallic mining activities (Figure 10). Potential impacts to natural resources during and following mining activity include altered hydrology, soil disturbance, runoff from tailings management areas, and existing waste rock seepage, which can lead to changes in flow and water quality. Water quality impacts may include but are not limited to changes in TSS, temperature, sulfate, and conductivity.

The lower reach of the Dunka River has high-quality habitat, supports naturally reproducing brook trout population, and is vulnerable to future land use and hydrological changes due to forest harvest, new mining activities, and mine closures. The Peter Mitchel Mine is an actively working pit with 1722 acres located within the Dunka River Subwatershed. Expected changes based on a mine closure plan for this taconite ore facility, projected for some time around 2070, could change the hydrology of the Lower Dunka River (-987), an unnamed tributary to the Lower Dunka, and Langley Creek (-603) from current conditions due to changes in drainage areas and mine pit outflow upon pit closure (MPCA 2019 and MPCA 2020b). A 2008 study by Barr Engineering estimated current flows will increase under the closure plan in the unnamed tributary to the Lower Dunka by a factor of six (>500% increase) (MPCA 2019). Other hydrological changes include a flow increase in the Dunka River by 32% and decrease in Langley Creek flows by 60% from current conditions. Mineral exploration continues within the Dunka River Watershed including exploration and testing of copper-nickel containing ore.

The presence of copper-nickel deposits was confirmed along the Kawishiwi River in the 1950s. This area, near Birch Lake, is currently being considered for future mining of copper and nickel. Elevated concentrations of trace metals such as copper and nickel can adversely impact fish, aquatic invertebrates, plants, and amphibians. There is concern that this mining could adversely affect the unique and sensitive water resources in the BWCAW, which is downstream of the proposed mining site (Elliot et al. 2020).

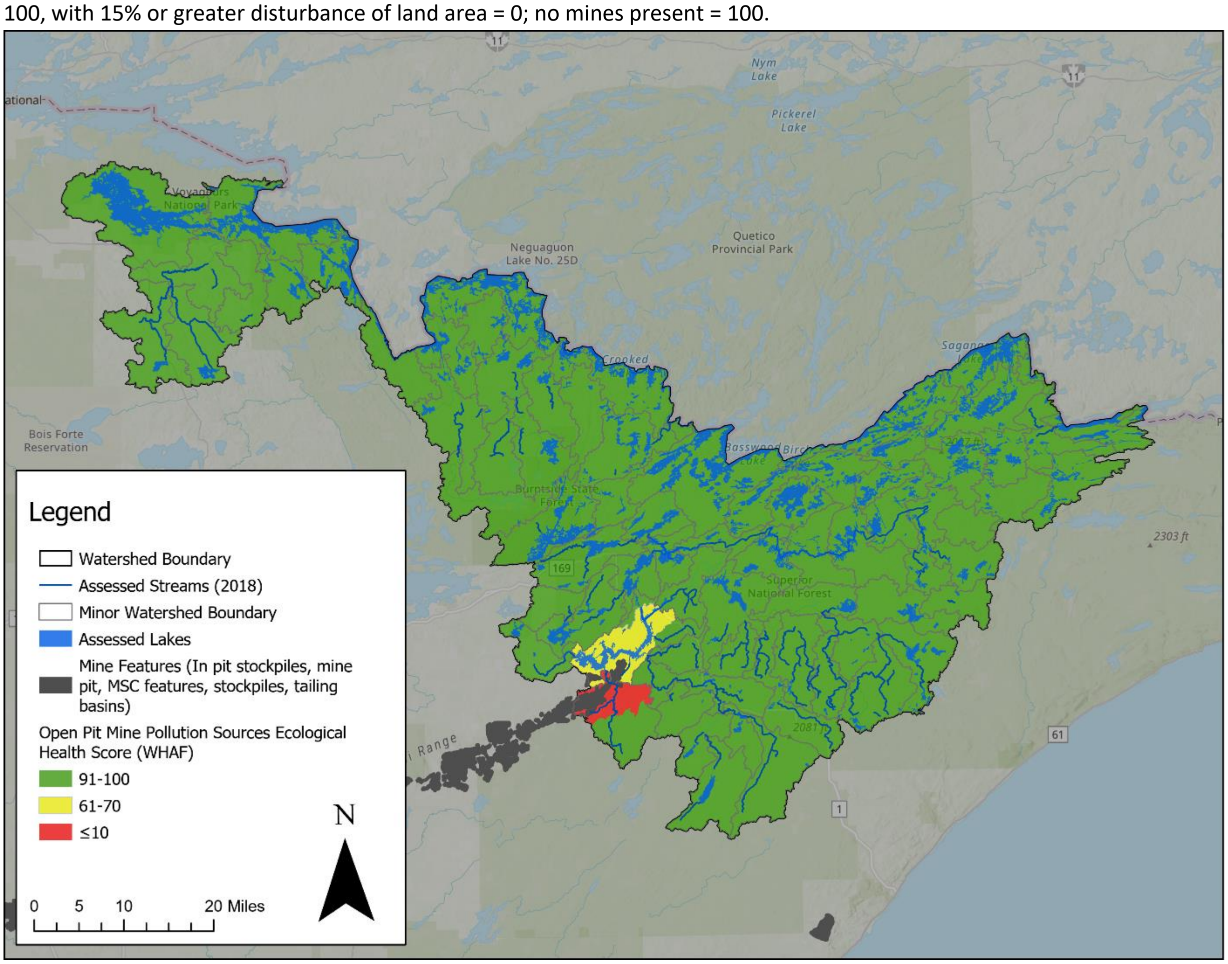
A USGS study was completed to update water quality conditions ahead of possible development, and this work produced water quality data later assessed by the MPCA as naturally occurring aluminum and copper impairments in the watershed where water runs over exposed mineralized bedrock in wilderness areas (Elliott et al. 2020).

Factors such as changes to flow, temperature, and water quality should be considered as part of mine expansion and closure. Other programs such as Environmental Review and the NPDES/SDS permits program consider these impacts and set discharge limits protective of water quality standards. Permits include enforceable requirements about how the facilities are constructed, operated and eventually closed. Permits also include effluent limits and extensive requirements for monitoring and reporting to the MPCA during operations to ensure that facilities operate in compliance with permit requirements. NPDES/SDS permit conditions are consistent with attainment of water quality standards. Any future mining will be subject to applicable environmental review and permitting as the protection mechanisms for these high-quality waters.

Additionally, potential impacts from gravel pits in the RRHW include contributions of sediment to nearby waters. BMPs such as maintaining buffers and restoring gravel pits upon closure provide protection from these impacts.

Figure 10. Mining features and the water quality health index score from the WHAF

The index score is based on the amount of land area within a catchment disturbed by mining activity. Scores range from 0 to 100, with 15% or greater disturbance of land area = 0; no mines present = 100.



Conductivity:

Biological effects of conductivity are often difficult to quantify. Increased specific conductivity can cause community shifts favoring ion tolerant taxa and an increase in ion tolerant life stages, but it is difficult to separate the role of specific conductivity in this shift from influence of confounding stressors. A study of Minnesota biological data and stressor linkages found that sites with specific conductivity exceeding 1,000 µS/cm rarely meet the biological integrity impairment thresholds for general use streams (MBI 2012).

There was not an aquatic life water quality standard that specifically considered conductivity in place at the time of assessments in this watershed. However, the MPCA is currently in the process of implementing the Aquatic Life Narrative Standard to protect aquatic life. The standard (Minn. R. 7050.0150, Subp. 3) states: "For all class 2 waters…the normal aquatic biota and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of aquatic biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste, or other wastes to the waters."

To implement the narrative standard, a framework using biological indicators to identify Class 2 waters potentially impacted by specific conductance, followed by a case-specific determination of permit conditions necessary to ensure that the Class 2 aquatic life narrative standard has been developed. MPCA is preparing to implement this framework, and plans to continue doing so until numeric Class 2 water quality standards for ions are adopted. The approach is in Exhibit S-5 in the SONAR for the Class 3 and Class 4 use class revisions. Currently this new framework has not identified any RRHW waters as impacted waters. The next assessment will fully consider all aquatic life standards. For more information on implementing this standard see the MPCA document 'Implementing the Aquatic Life Narrative Standard'.

At this time there are no identified aquatic life impairments attributed to high conductivity in the RRHW. However, continued condition monitoring by the MPCA staff ahead of water quality assessments in waters receiving wastewater from mining facilities is recommended.

2.3.4 Culverts and connectivity

Limiting stream connectivity can negatively impact aquatic life by limiting fish access to upstream and downstream reaches. Longitudinal connectivity is particularly important for cold and cool water species that need to be able to access cold water refugia in warm summer months. Restriction of fish passage in streams is often caused by improperly aligned or undersized culverts. These can also contribute to channel instability, restricted flow resulting in low DO, and increased erosion impacting water quality.

Local partners with the help of DNR and MPCA surveyed 66 culverts in the Ash River Subwatershed. The survey found that 74% of culverts were potential fish barriers, 65% were undersized (<0.8 bankfull width), 26% had visible erosion, 18% were improperly aligned, and 18% were perched (MPCA 2019). In addition to this work, LCSWCD has worked to survey culverts throughout Lake County. The DNR's Ecology and Water Resources staff and Finland Area Fisheries staff utilized the culvert survey data in Lake County to prioritize culverts in greatest need of replacement based on stream stability impacts, culvert sizing, and the distance of habitat that would be connected by replacing a given crossing. Scoring criteria were further refined to prioritize culvert replacements to enhance stream trout access, address connectivity in coldwater streams, and consider the probability of continued brook trout suitability mid to late century given anticipated changes in climate. The top 10 culvert priorities identified in this work are identified in Table 6. This was a desktop analysis and needs field verification ahead of any replacement projects.

Table 6. DNR top 10 scoring culverts in the Lake County portion of the RRHW for connectivity prioritization for brook trout resiliency

River	Road name	Score	Northing	Easting
Hill Creek	Forest Road	34.5	5281030	618387
Arrowhead Creek	Forest Road 367	33.3	5281610	625765
West Camp Creek	Northwest Rd	31.8	5285270	622832
Arrowhead Creek	Sawbill Landing	31.2	5280560	624980
Camp Creek	Northwest Rd	30.3	5284500	624672
Inga Creek	Bomber Rd	29.9	5286550	617110
Scott Creek	Wanless Rd	29.5	5277440	634196
Arrowhead Creek	Dumbbell Rd	29.1	5284660	625742
Camp E Creek	Deep Lake Rd	28.2	5283460	607853
Unnamed Creek	Cramer Rd	27.9	5286150	641925

2.4 TMDL summary

Blackduck River (-820) is located in the far western portion of the RRHW does not meet aquatic life or aquatic recreation use standards (Table 7), and is classified as impaired (Table 8). The causes of impairment are high levels of TSS and *E. coli*, affecting aquatic life and aquatic recreation designated uses, respectively. Reductions in TSS and *E. coli* delivered to the Blackduck River will be necessary to achieve the numeric water quality standards and meet the water quality goal.

Table 7. Water quality criteria for class 2A water bodies

Parameter	Water Quality Standard	Numeric Criteria
TSS	10 mg/L (milligrams per liter); TSS standards for class 2A may be exceeded for no more than 10% of the time. This standard applies April 1 through September 30.	≤ 10 mg/L
E. coli	Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 org/100 mL. The standard applies only between April 1 and October 31.	≤ 126 org/100 mL (monthly geometric mean) ≤ 1,260 org/100 mL (individual sample)

The loading capacities for TSS and *E. coli* were developed using load duration curves for the Blackduck River. The load duration curves provide loading capacities along all flows observed in the stream along with observed loads calculated from monitoring data and simulated flow. An explicit Margin of Safety (MOS) of 10% was included in the Blackduck River TSS and *E. coli* TMDLs to account for uncertainties in water quality monitoring, calibration and validation of the HSPF watershed model, and environmental variability in flow and sediment loading. This MOS is considered to be sufficient given the robust dataset and the calibration results of the HSPF model.

The TSS standard was exceeded primarily under middle to very high flows (Figure 11). To meet the standard, the TSS concentrations in the Blackduck River need to be reduced by approximately 64% (Table 9).

E. coli concentrations are high across all flow regimes that were monitored (Figure 12). To meet the standard, the *E. coli* concentrations in the Blackduck River need to be reduced by approximately 71% (Table 10). All reductions need to be made by nonpermitted sources as there are no known permitted sources of *E. coli* within the watershed.

Table 8.TMDLs completed or not necessary (greyed out) within the Rainy River - Headwaters Watershed

Waterbody Name	WID [a]	Year Added to 303(d) List	Designated Use Class	Affected Designated Use	Pollutant or Stressor	EPA Category [b]	TMDL Developed
Blackduck River	09030001-820	2018	1B, 2Ag, 3B	Aquatic Life	Total suspended solids	4A (proposed)	Yes
Blackduck River	09030001-820	2018	1B, 2Ag, 3B	Aquatic Recreation	*E. coli*	4A (proposed)	Yes
Ash River	09030001-818	2018	1B, 2Ag, 3B	Aquatic Life	s	5	No
Blueberry Lake	69-0054-00	2018	2B, 3C	Aquatic Recreation	Nutrient/ eutrophication biological indicators	4D	No
Keely Creek	09030001-520	2018	2Bg, 3C	Aquatic Life	Aluminum	4D	No
Unnamed creek	09030001-983	2018	2Bg, 3C	Aquatic Life	Aluminum	4D	No
Filson Creek	09030001-605	2018	2Bg, 3C	Aquatic Life	Aluminum	4D	No
Filson Creek	09030001-605	2018	2Bg, 3C	Aquatic Life	Copper	4D	N
Kawishiwi River	09030001-992	2018	1B, 2Bdg, 3C	Aquatic Life	Aluminum	4D	N

[a] WID = waterbody identification

[b] 4A: Impaired or threatened but a TMDL study has been approved by EPA. 4A categories are proposed upon approval of the TMDL report. 4D: Impaired or threatened but doesn't require a TMDL because the impairment is due to natural conditions with only insignificant anthropogenic influence. 5: Use assessment indicates an impaired status and a TMDL plan has not been completed.

Table 9. TSS TMDL summary, Blackduck River (09030001-820)

		TSS load (tons/day)				
TMDL parameter		**Very High (62-1,008 cfs)**	**High (15-62 cfs)**	**Mid (7.5-15 cfs)**	**Low (1.9-7.5 cfs)**	**Very Low (0.4-1.9 cfs)**
WLA	Construction stormwater	0.00048	0.00013	0.000050	0.000019	0.0000058
	Industrial stormwater	0.00048	0.00013	0.000050	0.000019	0.0000058
	Total WLA	0.00096	0.00026	0.00010	0.000038	0.000012
LA	**Total LA**	2.4	0.67	0.25	0.099	0.030
MOS		0.27	0.074	0.028	0.011	0.0033
Total load		2.7	0.74	0.28	0.11	0.033
Existing 90th percentile concentration (mg/L)		28				
Overall estimated percent reduction		64%				

Loads are rounded to two significant digits.

Figure 11. TSS load duration curve, Blackduck River (09030001-820)

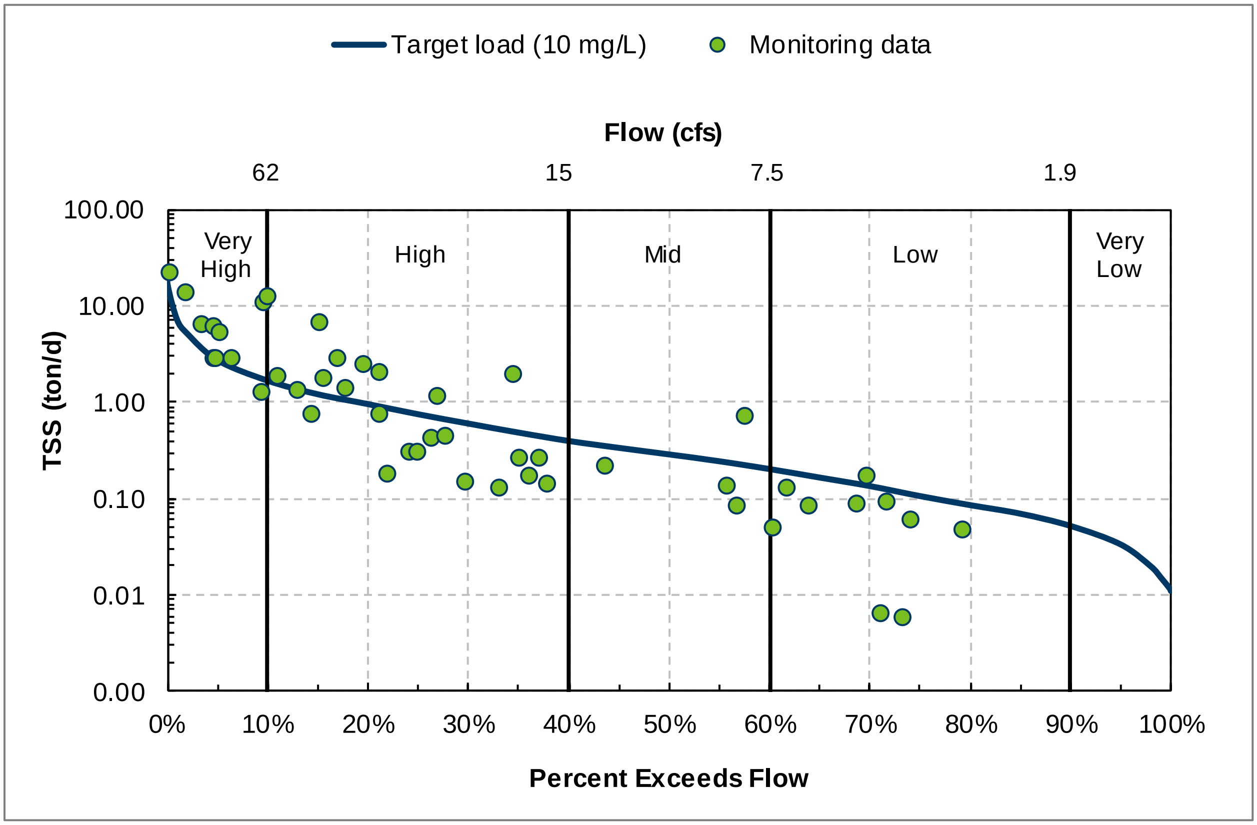


Table 10. *E. coli* TMDL summary, Blackduck River (09030001-820)

	***E. coli* load (B org/day [a])**				
TMDL parameter	**Very High (62-1,008 cfs)**	**High (15-62 cfs)**	**Mid (7.5-15 cfs)**	**Low (1.9-7.5 cfs)**	**Very Low (0.4-1.9 cfs)**
Total LA	279	76	30	11	3.4
MOS	31	8.5	3.3	1.2	0.38
Total load	310	85	33	12	3.8
Maximum observed monthly geometric mean (org / 100 mL)	440				
Overall estimated percent reduction	71%				

[a] B org/day = billion organisms per day

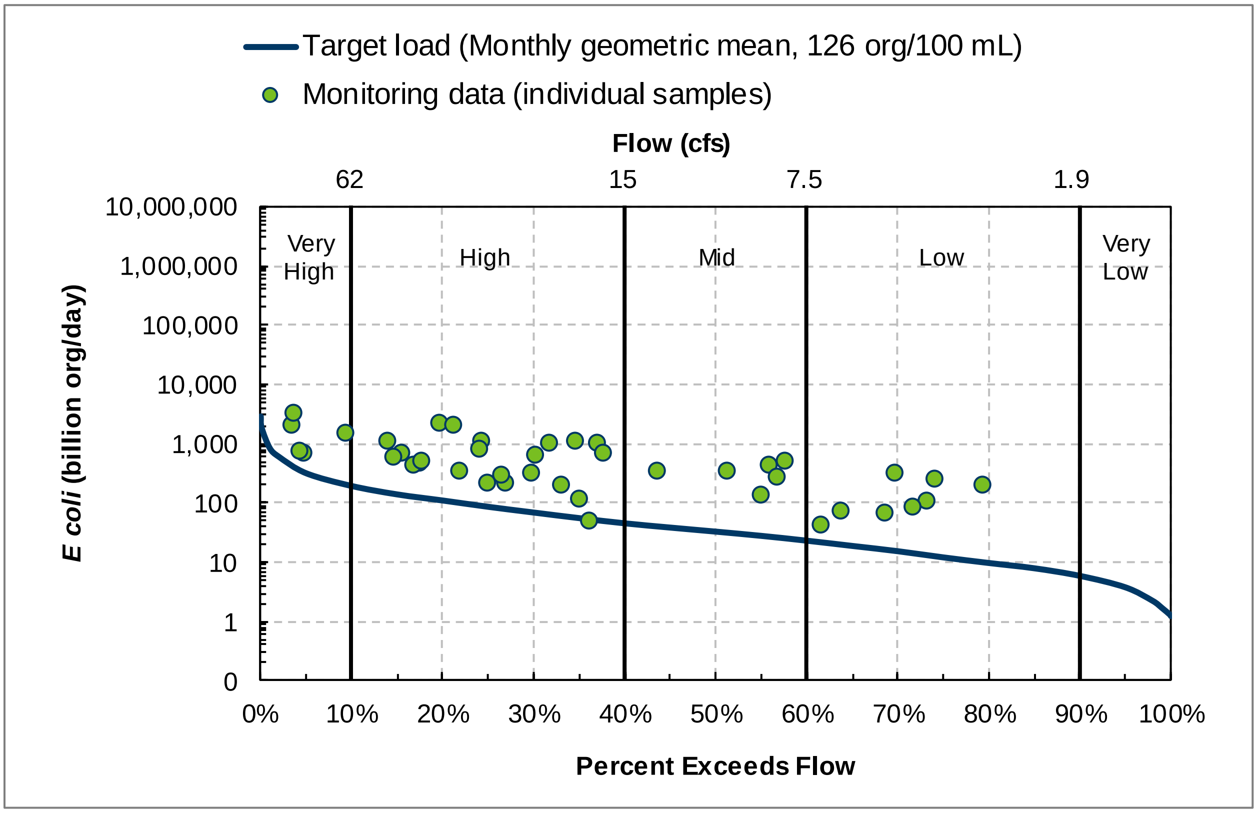
Loads are rounded to two significant digits, except in the case of values greater than 100, which are rounded to the nearest whole number.

Listing year: 2018

Baseline year(s): 2015

Numeric standard used to calculate TMDL: 126 org *E. coli*/100 mL

Figure 12. *E. coli* load duration curve, Blackduck River (09030001-820)



Additionally, a TMDL for the impaired reach of the Ash River (-818) has been deferred pending consideration of a Use Class change from 2A (coldwater) to 2B (warm/cool water). Knowing this classification is critical because TSS standards and associated target load reductions are dependent on whether the stream is classified as a coldwater or warm water stream. After the use class decision is finalized, a TMDL will be completed if the water body is still considered impaired (MPCA 2021).

Several other waterbodies also failed to meet water quality standards, but did not receive TMDLs because anthropogenic influences were insignificant and impairments were due primarily to natural conditions within the waterbody or direct drainage area, as shown in Table 8.

Excessive nutrients are causing the aquatic recreation impairment on Blueberry Lake (69-0054-00). The MPCA Assessment Consistency and Technical Team's Natural Background Review Committee concluded that the impairment is a result of natural conditions, and a TMDL does not need to be developed. Blueberry Lake is shallow with a maximum depth of six feet and a watershed to lake ratio of 44:1. There is little development, and wetlands dominate the watershed, contributing nutrients that support Blueberry Lake's high productivity.

Five aquatic life impairments due to elevated aluminum and/or copper were identified from USGS research on baseline water quality conditions in wilderness areas. These impairments were reviewed by the MPCA Assessment Consistency and Technical Team's Natural Background Review Committee. In September 2017, the committee concluded that the impairments are due to naturally occurring elevated concentrations present in bedrock, and TMDLs do not need to be developed. USGS research demonstrated the influence of natural copper and nickel-bearing bedrock on water quality. These watersheds were targeted for this research given their location in wilderness areas and surface exposure of metal-bearing mineralized bedrock. More information on this study can be found in the USGS report: *Assessing the influence of natural copper-nickel-bearing bedrocks of the Duluth Complex on water quality in Minnesota* (Elliott et al. 2020).

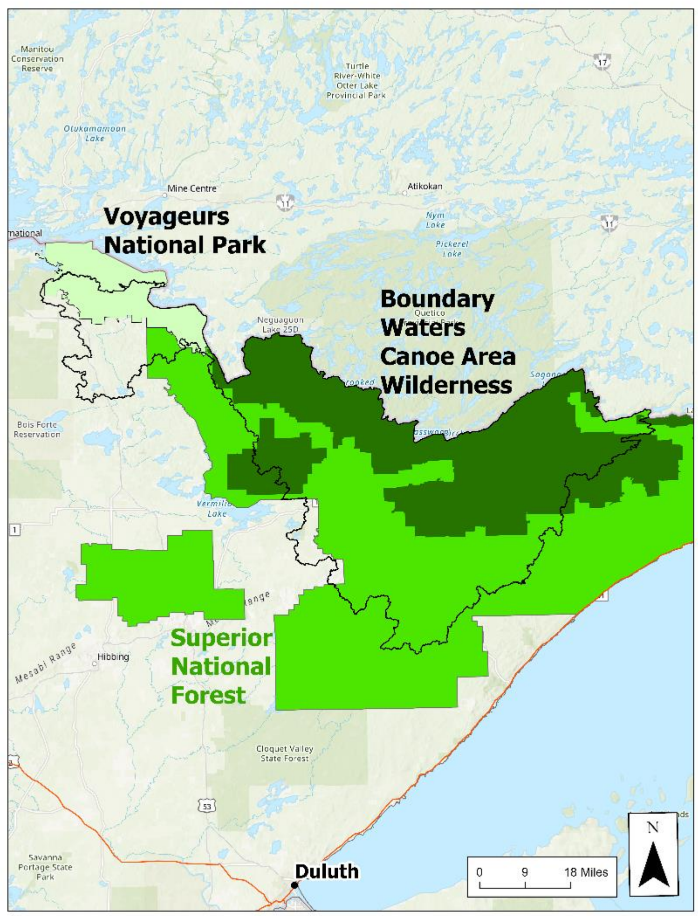
2.5 Protection considerations

The definition of protection can vary in different regions based on the water quality, land cover, and local values. Protection can mean limiting further degradation of current water quality, preserving a specific resource such as wild rice, active land management such as forest harvesting, or permanent protection. The RRHW is a relatively pristine landscape, encompassing a wide variety and breadth of protections, which are described in this section. Also, waterbodies were prioritized for protection based on existing data and criteria.

2.5.1 Protected Areas

The majority of the RRHW (>90%) is afforded protections by being managed as public lands. These areas have various restrictions on human activity, which help preserve the outstanding natural resources. Federally owned land includes the SNF, BWCA, and VNP. The SNF was championed by General Christopher C. Andrews, the First Chief Fire Warden of Minnesota, and later its Forestry Commissioner. It started with 500,000 acres of forest in Lake and Cook Counties in 1902, and then over a series of additions grew to 1,018,638 acres by 1909. Today, the SNF covers three million acres of land in northeast Minnesota's Arrowhead region, and comprises 84% of the RRHW. The SNF is managed for multiple uses including recreation and timber harvest. The USFS uses principles of ecosystem management to maintain the forest and the ecosystem services it provides.

Figure 13. Federal land in the RRHW



The BWCAW lies within the boundaries of the SNF, as shown in Figure 13. The BWCAW was established in 1949, but officially designated a wilderness area in 1978. It consists of 1,029,000 acres of lakes, streams, forests, and exposed bedrock and covers 19% of the RRHW. This area has more strict protections than the SNF and is some of the most protected land in the nation. It is protected from mining, and forest harvest, and mechanized equipment is forbidden except boat motors of limited horsepower on 15 specific lakes. A permit is required year-round for entry to control human access (USDA USFS 2020b).

VNP was established in 1975 and its name commemorates the Voyageurs – the French-Canadian fur traders who were the first European settlers to frequently travel through the area. The park covers 7% of the RRHW and includes Lake Kabetogama. The park allows numerous recreational activities.

2.5.2 Prioritizing streams for protection

Designation of streams as candidates for protection is important for identifying resource management needs and aligning with the Nonpoint Priority Funding Plan for Clean Water Funding Implementation (BWSR 2020) and Minnesota's Clean Water Roadmap (MPCA 2014). All streams should have a certain level of protection; however, some waters require special consideration because they show a statistically higher risk of degradation. Knowledge of current habitat and biological characteristics, or where watershed risk has been rated as highly susceptible to disturbance can help prioritize streams in need of additional protection.

The MPCA collaborated with the DNR, Board of Water and Soil Resources (BWSR), MDH, and the Minnesota Department of Agriculture (MDA) to develop guidance for incorporating protection strategies into WRAPS reports, local water plans, and/or One Watershed One Plan (1W1P) documents.

The stream protection and prioritization tool (MPCA 2018) is designed to generate a prioritized list of streams based on the results of water quality assessments, the level of risk posed from nearshore areas (riparian), the level of risk posed from the contributing watershed, as well as the level of protection already in place in the watershed. It is important to note that this prioritization tool is considered a starting point. Additional factors should be considered when evaluating the provided lists and ultimately more decisions will be made at the local water management planning levels. The data is split into thirds; the top third is high (A) priority, the next third medium (B) priority, and the final third are low (C) priority. These classifications are shown in Table 11. These streams represent those that are most at risk for future impairment. These categories include:

- 'Community Nearly Impaired' means that the IBI scores for macroinvertebrate and/or fish are on average within five points of the assigned threshold.
- 'Riparian risk' is based on road density and disturbed land use within the riparian area.
- The current level of protection is based on the percentage of public and easement protected land in the watershed area.

This list should be used in conjunction with local knowledge to help further prioritize these streams for protection efforts.

Table 11. Stream protection and prioritization results

WID	Stream Name	TALU	Cold/Warm	Fish or Macroinvertebrate Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09030001-550	Arrowhead Creek	General	cold	neither	low	low	high	C
09030001-674	August Creek	General	warm	neither	low	low	high	C
09030001-608	Bear Island River	General	warm	neither	med/low	low	medium	C
09030001-665	Bear Island River	General	warm	neither	low	low	high	C
09030001-663	Beaver River	General	warm	one	low	low	high	B
09030001-975	Bezhik Creek	Exceptional	warm	one	low	low	high	B
09030001-519	Birch River	General	warm	one	med/low	med/low	high	B
09030001-808	Burntside River	General	warm	one	low	low	medium	B
09030001-868	Camp Ninety Creek	General	warm	one	low	low	medium	B
09030001-976	Crab Creek	General	warm	neither	low	low	high	C
09030001-966	Cross River	Exceptional	warm	both	med/high	low	high	A
09030001-627	Denley Creek	Exceptional	warm	neither	low	med/low	high	C
09030001-744	Duck Creek	General	warm	neither	low	low	high	C
09030001-632	Dumbbell River	General	cold	neither	low	low	high	C
09030001-634	Dumbbell River	General	warm	neither	low	low	high	C
09030001-987	Dunka River	General	cold	one	medium	med/low	med/high	B
09030001-986	Dunka River	General	warm	neither	low	med/low	high	C
09030001-605	Filson Creek	General	warm	neither	medium	low	high	C
09030001-773	Folly Creek	General	cold	neither	low	low	high	C
09030001-602	Greenwood River	General	warm	neither	low	low	medium	C
09030001-979	Harriet Creek	General	cold	neither	medium	med/low	high	C
09030001-555	Harris Creek (Harris Lake Creek)	General	cold	neither	low	medium	high	C
09030001-556	Hill Creek	General	cold	neither	low	low	high	C
09030001-676	Hog Creek	General	cold	neither	medium	low	high	C
09030001-719	Horse River	General	warm	neither	low	low	high	C
09030001-558	Inga Creek	General	cold	one	med/low	medium	high	B
09030001-560	Inga Creek	General	cold	neither	med/low	med/low	high	C
09030001-529	Island River	General	warm	neither	low	low	high	C
09030001-563	Island River	General	warm	neither	low	low	high	C
09030001-564	Jack Pine Creek	Exceptional	cold	one	med/high	med/low	high	B
09030001-708	Johnson Creek	General	warm	one	med/low	med/low	medium	B

WID	Stream Name	TALU	Cold/Warm	Fish or Macroinvertebrate Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09030001-990	Kawishiwi River	General	warm	neither	low	low	high	C
09030001-520	Keely Creek	General	warm	neither	low	low	high	C
09030001-974	Larch Creek	General	cold	neither	med/high	low	high	C
09030001-557	Little Indian Sioux River	General	warm	one	low	low	high	B
09030001-530	Little Isabella River	Exceptional	cold	one	medium	med/low	high	B
09030001-561	Little Isabella River	General	cold	neither	low	med/low	high	C
09030001-565	Longstorff Creek	General	cold	neither	med/low	low	medium	C
09030001-568	Mitawan Creek	Exceptional	cold	neither	med/low	low	high	C
09030001-521	Moose River	General	warm	neither	low	low	high	C
09030001-650	Nina Moose River	General	warm	neither	low	low	high	C
09030001-804	Nip Creek	General	cold	one	med/high	low	med/high	B
09030001-982	Phoebe Creek	General	warm	neither	low	low	high	C
09030001-601	Portage River	General	warm	neither	low	low	high	C
09030001-788	Portage River	General	warm	neither	medium	low	high	C
09030001-574	Scott Creek	General	cold	neither	low	med/low	high	C
09030001-535	Shagawa River	General	warm	one	med/high	med/low	medium	B
09030001-531	Snake River	General	cold	neither	low	med/low	high	C
09030001-542	Snake River	Exceptional	cold	neither	low	low	high	C
09030001-577	Sphagnum Creek	General	cold	neither	medium	med/low	high	C
09030001-984	Stony River	General	warm	neither	low	low	high	C
09030001-985	Stony River	General	warm	neither	med/low	low	high	C
09030001-733	Stuart River	General	warm	neither	low	low	high	C
09030001-578	Tomlinson Creek	General	cold	neither	low	low	high	C
09030001-801	Trappers Creek	General	cold	neither	low	low	high	C
09030001-978	Unnamed creek	General	warm	neither	low	med/low	high	C
09030001-586	West Camp Creek	General	cold	neither	low	low	high	C
09030001-693	Wilbar Creek	General	warm	one	medium	low	high	B

2.5.3 Prioritizing lakes for protection

Many Minnesota lakes have water quality that is substantially better than their applicable standards, especially throughout the NLF ecoregion in the north-central and northeastern parts of the state. The RRHW is no different, with all but one of the 116 lakes with enough data for assessment meeting water quality standards for eutrophication. Additionally, waters fully within the BWCAW and VNP are afforded some of the highest protection in the nation.

With a focus on the susceptibility of a lake to phosphorus pollution, the DNR - Ecological and Water Resources (EWR) Division created a database of Lakes of Phosphorus Sensitivity Significance (LPSS) and Lake Benefit Cost Assessment (LBCA) with the intent to support planning, natural resource management, research, and other resource protection-related activities. The sensitivity of a lake to phosphorus inputs was assessed for the lakes of the RRHW by estimating the change in water clarity that would result with increased phosphorus loading to the lake. The LBCA index was formulated 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". Lakes were assigned a protection priority class based on estimated phosphorus sensitivity, lake size, lake TP concentration, proximity to MPCA's phosphorus impairment thresholds, and watershed disturbance (MPCA 2018). This prioritization aligns with the MPCA's policy of focusing protection efforts on high quality, unimpaired lakes that have the greatest risk of becoming impaired. For lakes, 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.

In 2019, the lakes identified as the highest priority for additional protection based on LPSS (Priority Class A) and LBCA Priority Class 'Highest' are identified in Table 12. Burntside, Big, Little Long, and Cedar lakes score both LPSS Priority Class A and 'Highest' LBCA Priority Class. Additionally, Burntside Lake shows a degrading trend in transparency, a eutrophication indicator making it a possible candidate for high protection priority.

These tables should be used alongside additional local knowledge of the watershed to further prioritize protection efforts. For example, the list does not account for cultural or local values or the ability to implement a project though existing resources.

The MPCA has established a basic method to identify monitored lakes close to their regional TP standards. These lakes, identified as "nearly or barely" impaired due to eutrophication are within 10% above or below the standard, and are thus identified as vulnerable ("nearly" impaired) or suitable candidates for restoration ("barely" impaired) (Anderson 2018). Johnson Lake (69-0117-00) and Sand Lake (38-0735-00), were both identified as nearly impaired as part of this process using data collected between 2007 and 2019.

Table 12. Rainy River - Headwaters Watershed Lake Prioritization Summary

WID	Lake Name	Mean TP (ug/L)	Target TP (ug/L)	Predicted Load (lb/year)	Load Target (lb/year)	5% Load Reduction Goal (lb/year)	LPSS Priority Class	LBCA Priority Class
38-0153-00	Adams	8	7	236	200	12	C	High
69-0830-00	Agnes	23	20	122	100	6	C	High
38-0336-00	Amber	20	17	147	122	7	C	High
69-0096-00	Angleworm	21	18	141	117	7	C	High

WID	Lake Name	Mean TP (ug/L)	Target TP (ug/L)	Predicted Load (lb/year)	Load Target (lb/year)	5% Load Reduction Goal (lb/year)	LPSS Priority Class	LBCA Priority Class
69-0864-00	Ash	25	21	1600	1354	80	C	High
38-0691-00	August	12	10	120	100	6	B	High
69-0063-00	Bass	19	16	315	264	16	C	High
69-0254-00	Bear Head	10	8	141	119	7	B	Higher
69-0115-00	Bear Island	18	15	2038	1744	102	B	Higher
69-0480-00	Beartrack	6	5	15	13	1	C	High
69-0837-00	Beast	12	10	44	37	2	C	High
38-0223-00	Beaver	19	16	612	515	31	C	High
16-0659-00	Beth	9	8	60	50	3	C	High
69-0190-00	**Big**	7	6	257	218	13	**A**	**Highest**
69-0003-00	**Birch**	24	20	39069	33561	1953	**A**	High
69-0842-00	Black Duck	19	16	687	584	34	B	Higher
69-0054-00	Blueberry	47	39	564	465	28	NA	High
69-0452-00	Bootleg	14	12	199	167	10	C	High
38-0780-00	Browns	17	14	63	52	3	B	High
69-0118-00	**Burntside**	10	8	2527	2191	126	**A**	**Highest**
38-0057-02	Canal	12	10	20	17	1	C	High
38-0510-00	Cattyman	10	8	27	22	1	C	High
38-0810-00	**Cedar**	9	8	102	86	5	**A**	**Highest**
38-0064-00	Coffee	16	13	77	64	4	C	High
69-0155-00	Cold	11	9	14	11	1	C	High
38-0290-00	Comfort	25	21	12	9	1	C	High
38-0004-00	Cook	24	20	55	45	3	C	High
69-0220-00	Crab	9	8	207	175	10	C	High
69-0832-00	Cruiser	5	4	15	13	1	C	High
69-0325-00	Cummings	9	8	716	609	36	C	High
38-0393-00	**Dumbbell**	15	13	117	98	6	**A**	Higher
38-0664-00	Dunnigan	9	8	10	8	1	B	High
38-0674-00	East Chub	13	11	27	23	1	B	High
69-0163-01	East Twin	8	7	48	40	2	C	High
69-0199-00	Ed Shave	63	53	107	89	5	C	High
38-0432-00	Eighteen	11	9	40	33	2	B	High
69-0843-00	Ek	16	14	57	48	3	C	High
38-0498-00	Ensign	8	7	1698	1443	85	C	High
69-0120-00	Everett	51	43	244	202	12	C	High
38-0811-00	Fall	22	18	44262	37722	2213	C	High
38-0779-00	**Farm**	16	14	30231	25731	1512	**A**	High
69-0481-00	Fat	12	10	17	14	1	C	High
69-0085-00	Fenske	5	4	21	17	1	B	High

WID	Lake Name	Mean TP (ug/L)	Target TP (ug/L)	Predicted Load (lb/year)	Load Target (lb/year)	5% Load Reduction Goal (lb/year)	LPSS Priority Class	LBCA Priority Class
69-0119-00	First	8	7	5	4	0	C	High
38-0813-00	Fourtown	17	14	1700	1440	85	C	High
69-0754-00	Franklin	17	14	47	39	2	C	High
38-0701-00	Gabbro	35	29	24439	20786	1222	C	High
38-0782-00	**Garden**	19	16	29387	24845	1469	**A**	High
38-0573-00	Gegoka	13	11	235	194	12	B	High
38-0656-00	Greenwood	17	14	1379	1161	69	C	High
38-0557-00	Grouse	17	14	839	695	42	C	High
16-0632-01	Gull	6	5	1317	1104	66	C	High
69-0487-00	Gun	13	10	89	75	4	C	High
16-0356-00	**Gunflint***	4	5	3,046	2,776	152	**A**	**Highest**
69-0189-00	Hanson	6	5	2	2	0	C	High
38-0048-00	Harriet	18	15	276	231	14	B	High
69-0299-00	Hassel	14	12	19	16	1	C	High
38-0553-00	Hide	16	13	5	4	0	C	High
69-0071-00	High	8	7	62	52	3	B	High
38-0673-00	Highlife	13	11	6	5	0	C	High
38-0057-01	Hogback	12	10	23	19	1	C	High
38-0269-00	Homestead	17	14	25	20	1	C	High
69-0182-00	Hook	18	15	46	38	2	C	High
38-0792-00	Horse	15	13	1576	1331	79	C	High
38-0580-00	Horseshoe	11	9	181	152	9	C	High
69-0343-00	Hustler	14	12	168	142	8	C	High
16-0328-00	Iron	19	16	169	141	8	C	High
38-0396-00	Isabella	22	18	3279	2774	164	C	High
69-0456-00	Jeanette	12	10	209	176	10	B	Higher
69-0117-00	Johnson	29	24	665	556	33	C	High
69-0691-00	Johnson	15	13	1118	955	56	C	High
69-0845-00	Kabetogama	26	22	25560	22264	1278	C	High
38-0272-00	Katydid	14	12	5	4	0	C	High
38-0080-00	Kawishiwi	17	14	190	159	9	C	High
69-0296-00	Little Crab	16	13	240	199	12	C	High
38-0703-00	Little Gabbro	23	19	11155	9313	558	C	High
16-0355-00	Little Iron	18	15	206	170	10	C	High
69-0760-00	**Little Johnson**	26	22	1902	1600	95	**A**	High
69-0066-00	**Little Long**	8	7	47	40	2	**A**	**Highest**
69-0180-00	Little Rice	8	7	10	8	0	C	High
69-0086-00	Little Sletten	47	39	40	33	2	C	High
69-0682-00	Little Trout	10	8	46	39	2	C	High

WID	Lake Name	Mean TP (ug/L)	Target TP (ug/L)	Predicted Load (lb/year)	Load Target (lb/year)	5% Load Reduction Goal (lb/year)	LPSS Priority Class	LBCA Priority Class
69-0608-00	Little Vermilion*	11	16	7,679	7,085	384	C	High
16-0448-00	**Loon**	6	5	392	336	20	**A**	Higher
38-0616-00	Manomin	39	33	332	278	17	B	High
16-0337-00	**Mayhew**	6	5	38	32	2	**A**	Higher
69-0329-00	Meander	9	8	17	15	1	B	High
69-0305-00	Meat	9	8	8	7	0	C	High
69-0065-00	Minister	61	51	172	142	9	C	High
38-0644-00	Moose	17	14	1226	1047	61	B	High
69-0684-00	Mukooda	8	7	130	111	7	C	Higher
38-0788-00	Muskeg	22	18	201	166	10	C	High
69-0693-00	Namakan*	12	6	262,766	152,475	13,138	C	High
69-0080-00	Nels	13	10	245	205	12	C	High
69-0757-00	Net	27	23	125	104	6	C	High
38-0619-00	Newfound	6	5	452	383	23	C	High
38-0445-00	Nine A.M.	21	18	15	12	1	C	High
38-0738-00	North Branch Kawishiwi	12	10	6037	5115	302	C	High
38-0686-00	North McDougal	23	19	2630	2196	132	C	High
38-0688-00	Norway	10	8	3	2	0	C	High
38-0640-00	**Ojibway**	6	5	110	93	5	**A**	Higher
69-0685-00	O'Leary	9	7	40	33	2	C	High
69-0061-00	One Pine	8	7	711	594	36	B	High
38-0067-00	Organ	19	16	20	17	1	C	High
38-0420-00	Osier	29	24	21	17	1	C	High
69-0058-00	Perch	25	21	98	81	5	C	High
38-0220-00	Perent	12	10	1340	1136	67	C	High
38-0676-00	Pitcha	25	21	67	54	3	C	High
38-0104-00	Polly	9	8	914	769	46	C	High
16-0327-00	Portage	10	9	60	50	3	B	High
16-0633-00	Saganaga*	3	10	17,693	15,438	885	C	High
38-0735-00	Sand	31	26	857	717	43	B	High
69-0617-00	Sand Point*	11	13	52,641	49,346	2,632	C	High
38-0786-00	Sandpit	8	7	23	19	1	C	High
38-0058-00	Scarp	29	24	28	23	1	C	High
16-0629-00	Sea Gull	8	7	4442	3844	222	C	High
38-0292-00	Section 29	14	12	82	68	4	B	High
69-0069-00	Shagawa	24	20	6019	5144	301	B	High
38-0219-00	Silver Island	23	19	1746	1474	87	C	High
38-0666-00	Slate	22	18	592	494	30	C	High

WID	Lake Name	Mean TP (ug/L)	Target TP (ug/L)	Predicted Load (lb/year)	Load Target (lb/year)	5% Load Reduction Goal (lb/year)	LPSS Priority Class	LBCA Priority Class
69-0084-00	Sletten	25	21	14	11	1	C	High
69-0181-00	Slim	7	6	73	61	4	C	High
38-0529-00	**Snowbank**	11	9	1279	1106	64	B	**Highest**
38-0778-00	South Farm	16	13	431	364	22	C	High
69-0761-00	Spring	8	6	54	46	3	C	High
38-0066-00	T	11	9	275	230	14	C	High
38-0724-00	**Tofte**	8	6	15	13	1	**A**	Higher
69-0756-00	Tooth	10	8	26	21	1	C	High
16-0417-00	Tucker	14	12	101	85	5	B	High
38-0704-00	Turtle	24	20	101	84	5	C	High
38-0671-00	Two Deer	10	8	33	27	2	B	High
69-0869-00	Unnamed (Quarter Line)	19	16	17	14	1	C	High
38-0681-00	Wadop	12	10	40	33	2	C	High
38-0685-00	Wampus	28	23	44	37	2	B	High
38-0079-00	Watonwan	16	13	78	65	4	C	High
69-0831-00	Weir	22	18	183	150	9	C	High
69-0163-02	West Twin	5	4	32	27	2	C	High
69-0004-00	White Iron	19	16	32988	28259	1649	C	High
38-0068-00	Windy	11	9	243	205	12	C	High
69-0161-00	Wolf	16	13	312	262	16	B	High

2.5.4 Drinking Water Protection

Drinking water is important in any watershed in Minnesota. The majority of Minnesotans (75%) rely on groundwater for their drinking water source, and whether the source is a public or private well, that groundwater quality can be highly impacted by nearby surface water features. The remaining 25% of Minnesotans rely on surface water, primarily from the 23 city-owned and operated community public water suppliers active throughout the state. These surface water-using communities are highly dependent on the health of the watersheds in which they are located. Therefore, the protection of drinking water should be a high priority for all watersheds in Minnesota.

The RRHW contributes to two community public water supplies and 29 noncommunity public water supplies that use surface water or groundwater under the direct influence (GWUDI) of surface water as a source for drinking water. The City of International Falls, while not in the watershed, relies on the Rainy River for its drinking water, and likewise benefits from restoration and protection of surface water in the watershed. The RRHW is a major tributary to the Rainy River.

Many of the implementation activities conducted by the MPCA, SWCDs, logging and mining industries, private landowners, and local entities can help address surface water quality. The main issues for the public water suppliers in this watershed include:

- Naturally-generated elevated organic carbon concentrations in many waterbodies. These elevated concentrations, when combined with drinking water disinfection via chlorination, lead to disinfection byproduct formation.
- Elevated nutrient concentrations in some waterbodies.

Algal blooms have impacted Lake Kabetogama. These blooms can contain harmful cyanobacteria species that create cyanotoxins that can lead to illness in humans and animals when water containing those toxins is consumed. Blooms generally occur when higher nutrient concentrations are available in a clear and stagnant or slow-moving water column.

Non-community Public Water Supplies

The noncommunity public water supplies in the watershed rely on surface water from the many lakes and rivers present in the watershed for drinking water. Noncommunity public water supplies include bars, restaurants, camps, and resorts that serve customers for shorter periods. The following waterbodies either serve as drinking water sources or appear to contribute flow to nearby drinking water wells.

- Big Lake
- Burntside Lake
- Farm Lake
- Fenske Lake
- Gunflint Lake
- Johnson Lake
- Kawishiwi River
- Lake Kabetogama
- Mitchell Lake
- Moose Lake
- Sea Gull Lake
- Sea Gull River
- Shagawa Lake
- Snowbank Lake
- White Iron Lake

Community Public Water Supplies

The city of Ely relies on water from Burntside Lake for its drinking water, and is therefore dependent on the ongoing restoration and protection of the watershed to supply clean and drinkable water to their citizens. The City of International Falls, while not in the watershed, relies on the Rainy River for its drinking water and likewise benefits from restoration and protection of surface water in the Rainy Headwaters watershed.

The Source Water Assessment areas for Ely and International Falls are shown in Figure 14 and Figure 15, respectively. The areas were delineated using the following criteria.

- The Inner Emergency Response Area is defined as the area in which the public water supply utility would have little or no time to respond to a direct discharge of contamination, other than to close the intake. The area closest to the intake was designed to help the public water supplier address contaminant releases, which present an immediate (acute) health concern to water users. The geographic area is defined by the amount of notification time the PWS would need to close the surface intake and a "buffer time" to accommodate unanticipated delays in notification and shut down. Three different sets of criteria were developed and used to delineate an ERA for different types of surface waterbodies, including 1) rivers and streams, 2) lakes, and 3) mine pits. Information about the intake, water supply treatment system, water storage capacity, and treatment methods were also considered.

- The Outer Source Water Management Area is defined as the area where the impacts to drinking water from point and nonpoint sources of contamination can be minimized by preventive management. This area was delineated to protect water users from long-term (chronic) health effects related to low levels of chemical contamination or the periodic presence of contaminants at low levels in the surface water used by the PWS.

Figure 14 shows the city of Ely and the surface runoff and watershed area that contributes to the city's drinking water intake. Each of the streams and lakes inside the two Source Water Assessment areas are important places to focus on when planning implementation and restoration activities. Figure 15 shows the city of International Falls and the surface runoff and watershed area that contributes to the city's drinking water intake. Each of the streams and lakes inside the two Source Water Assessment areas are important places to focus on when planning implementation and restoration activities.

Both Source Water Assessments will be updated using new guidance and definitions by 2025. The current documents, which will be replaced by amended Assessments as they are completed, are available at the MDH Source Water Assessment webpage:
https://www.health.state.mn.us/communities/environment/water/swp/swa.html.

Figure 14. Source Water Assessment areas for the city of Ely

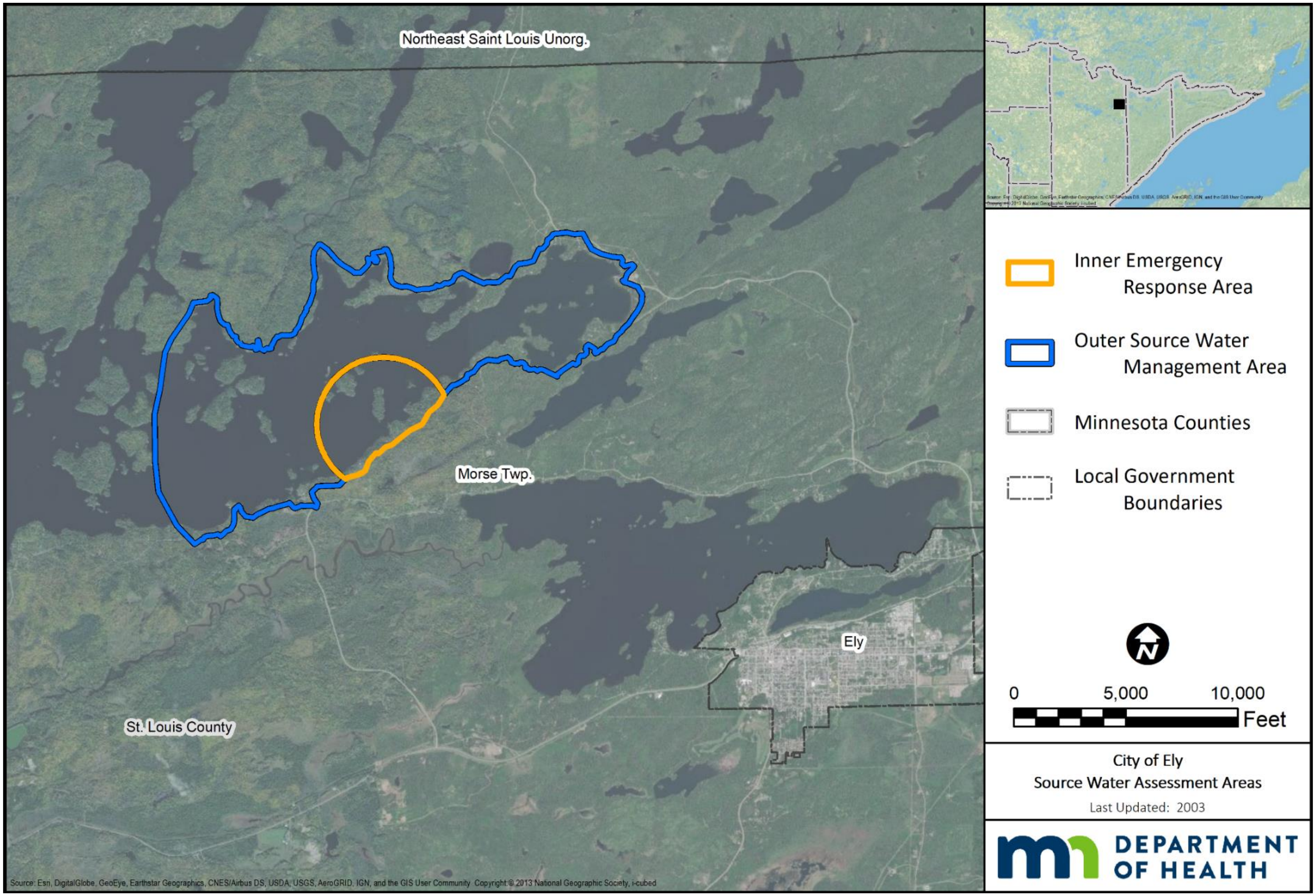
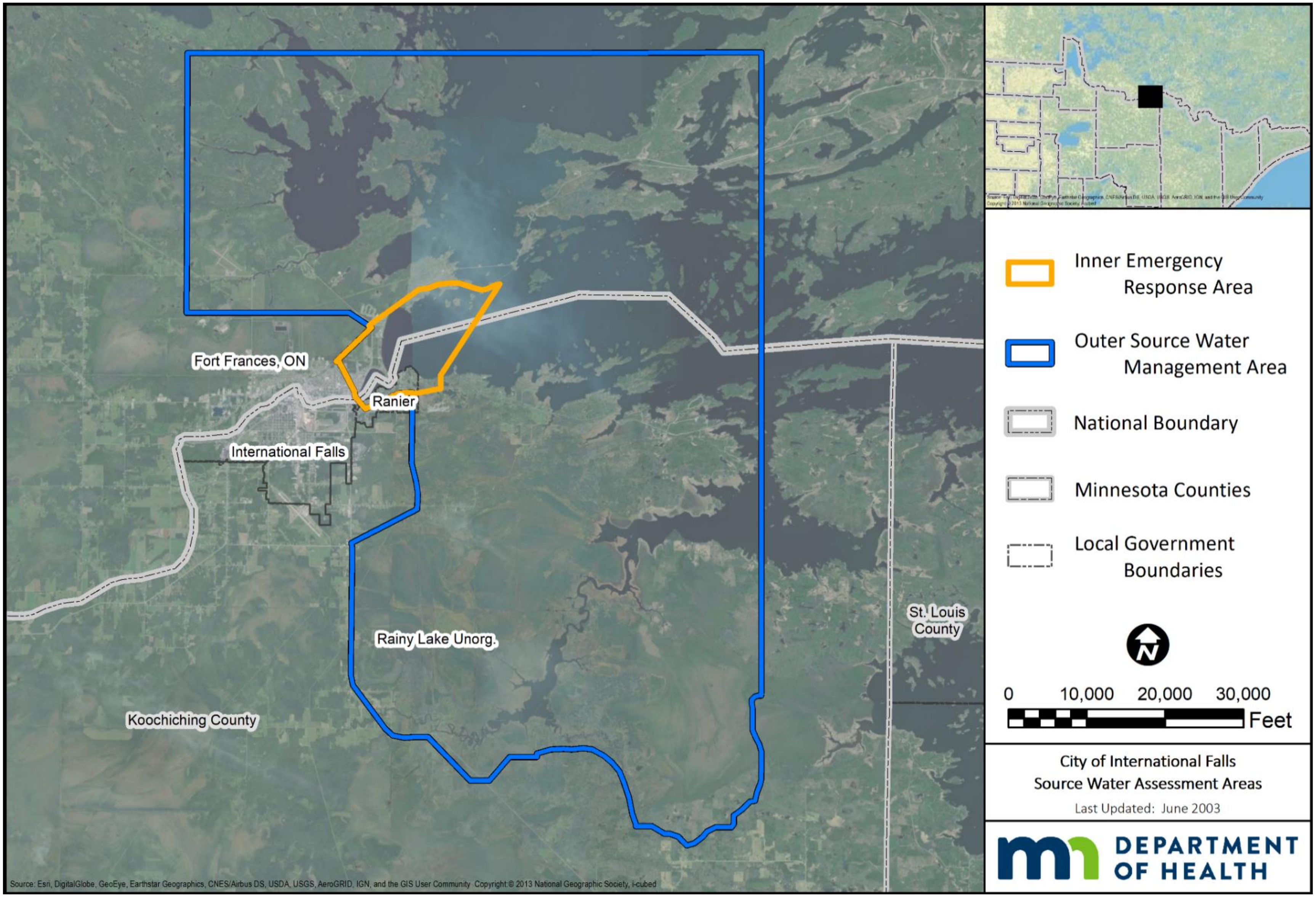


Figure 15. Source Water Assessment areas for the city of International Falls



Class 1 Drinking Water

Waterbodies in Minnesota are classified for specific beneficial uses in statute as required by the Clean Water Act. Class 1 waters are designated for human consumption, which means they are clean enough to drink. Class 1A waters are water sources that can be consumed without treatment and are generally limited to groundwater. Class 1B waters are surface or groundwater that can be consumed with approved disinfection such as chlorination. Class 1C waters are generally surface waters that can be consumed with treatment consisting of coagulation, sedimentation, filtration, storage, and chlorination, or other equivalent treatment processes.

There are 599 Class 1 lakes in the RRHW as illustrated in Figure 19 in Section 3.1 and identified individually in the *Protection and Restoration Strategies and Prioritization Technical Memorandum* included in Appendix D. The majority of these lakes are in the BWCAW, sit above bedrock, and have minimal human impact. These lakes are still susceptible to localized bacteria issues from campsites, wildlife, and waste disposal. Waters outside of the BWCA are also susceptible to localized fecal bacteria issues from septic systems.

2.5.5 Outstanding resources

The RRHW has many outstanding natural resources that can be targeted for specific protections. These include wild rice, coldwater fisheries, and outstanding resource value waters (ORVW).

Wild Rice

Wild rice, a native grain with both ecological and cultural importance, has been identified in waters in the RRHW in surveys from the DNR, 1854 Treaty Authority, and the MPCA. It is an important food source for waterfowl and wildlife and several Native American cultures consider wild rice to be a sacred component of their culture. It grows in shallow water in small lakes and slow-flowing streams. Wild Rice is protected, and a harvesting license is needed for non-Native American people.

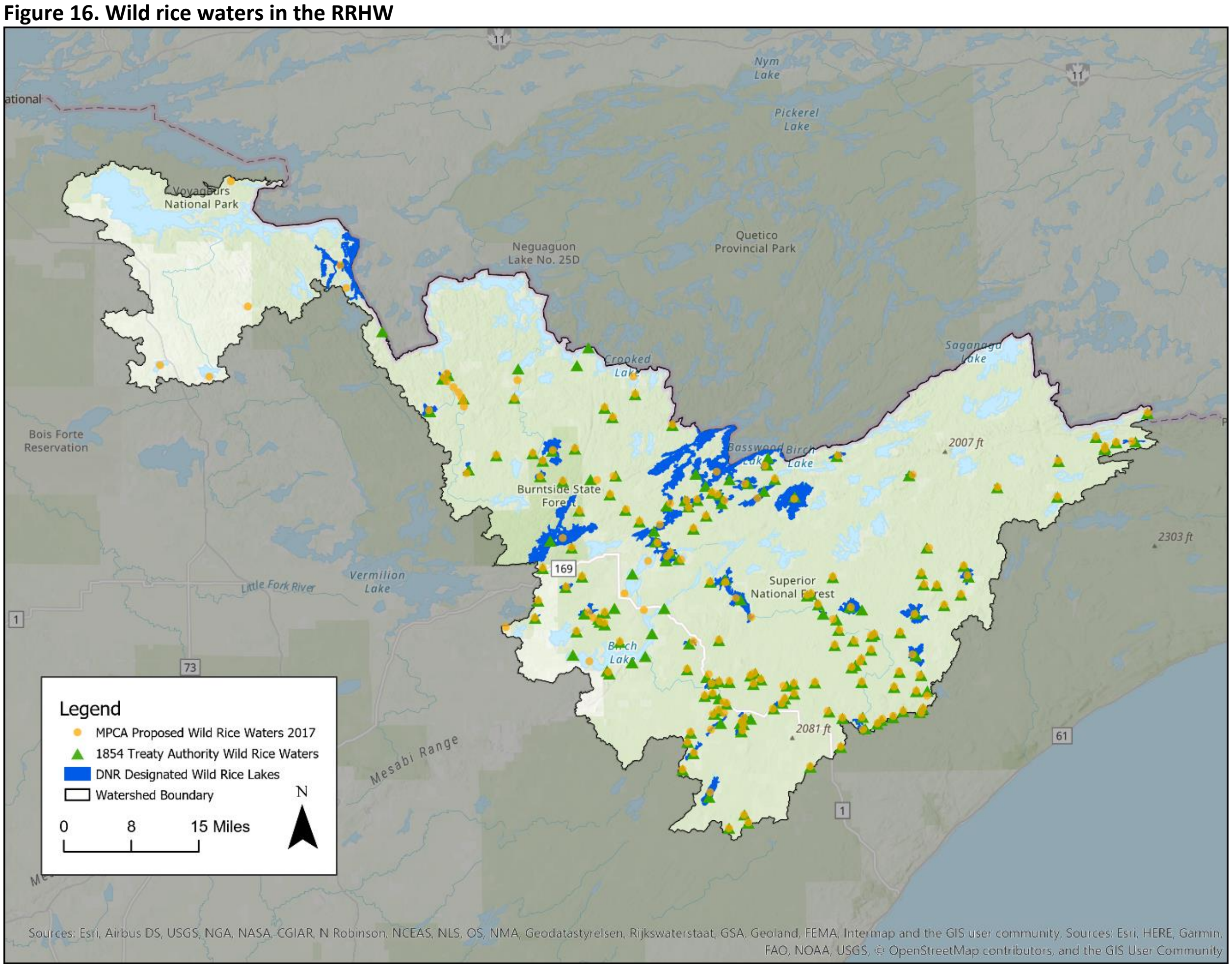
Wild rice is vulnerable to changes in water levels and the addition of sulfate which can negatively impact wild rice stands. Sulfate is typically found in low concentrations in natural streams but can become elevated due to mining activities in sulfide bearing rocks. According to Pastor et al., 2017, sulfate in the oxygenated water column becomes toxic to wild rice once converted to sulfide in the anoxic sediment.

Although there is a Class 4A sulfate water quality standard that applies to waters used for the production of wild rice (Minn. R. 7050.0224), waters in the RRHW were not assessed against this standard. Current Minnesota state law precludes the MPCA from assessing any waters against the standard at this time (Laws of Minnesota 2017, ch. 93, article 2, section 149).

Minnesota has had a sulfate standard for waters used for the production of wild rice since 1973, but implementation has been a source of contention. In 2021, the EPA added several waters in the state to Minnesota's 2020 Impaired Waters List as impaired by sulfate. These waterbodies exceed the sulfate standard of 10 mg/L applicable to waters used for production of wild rice (Minn. R. 7050.0224). No waters in the RRHW were identified as impaired by sulfate during this process. The other listings represent an important first step toward resolving the long-standing issue of implementing the existing standard after a state law prohibited the agency from enforcing the current standard (Laws of Minnesota 2017, ch. 93, article 2, section 149) and an administrative law judge rejected a 2018 proposal to revise the standard. The MPCA is currently working to determine the next steps to address sulfate impairments throughout the state and is committed to implementing the existing wild rice water quality standard to ensure these waters are restored.

Multiple surveys have identified waters within the RRHW that harbor wild rice (Figure 16 and Appendix D). The DNR maintains a data set of waters containing wild rice in the state of Minnesota, and the 1854 Treaty Authority conducts ongoing wild rice surveys within the 1854 Ceded Territory. In 2017, the MPCA undertook a survey of wild rice waters as part of proposed changes to sulfate water quality standard, which has been withdrawn, but still provides a resource list to aid in targeting areas for protection. These datasets identify numerous lakes in the RRHW that contain wild rice.

Figure 16. Wild rice waters in the RRHW



Coldwater Fisheries

Northern Minnesota has cold, deep lakes left behind after the glaciers retreated. These lakes can support fish that can only survive in cold, well-oxygenated water, such as cisco, lake trout, and lake whitefish. These fish can also be considered the "canary in the coal mine" because they are indicators of changing lake conditions. These fish are threatened by two main causes: climate change and reduced DO caused by eutrophication (Jacobsen et al 2010). Climate change can warm the waters and reduce the size of cool, well-oxygenated areas of the lake, which reduce suitable habitat for these fish. Eutrophication is caused by the addition of nutrients such as phosphorus from surrounding lands impacted by humans, enhancing algae growth. The decay of the additional plant material utilizes oxygen and lowers DO. Protecting lakes with cold water fisheries by maintaining or increasing forest cover in the watershed and limiting runoff from developed areas will help these fish continue to survive in these lakes.

Fisheries research from the DNR indicates that keeping at least 75% of a lakeshed forested is crucial to maintaining habitat for cold water fish species such as lake trout, cisco, and lake whitefish (Jacobson et al. 2016). The deepest and clearest lakes are expected to be most resilient to the warming climate and provide coldwater habitat decades into the future. These are designated as Cisco Refuge Lakes by the DNR. In addition, there are coldwater lakes and streams categorized as Use Class 2A in Minn. R. 7050. These waters are held to a water quality standard "as to permit the propagation and maintenance of a healthy community of cold water aquatic biota, and their habitats" (Table 13).

Table 13. Northern Lakes and Forest ecoregion lake eutrophication standards

Use Class	TP (ppb)	Chl-*a* (ppb)	Secchi (meters)
NLF-Lake trout (Class 2A)	<12	<3	>4.8
NLF-Stream trout (Class 2A)	<20	<6	>2.5
NLF-Aquatic recreation use (Class 2B)	<30	<9	>2.0

There are 54 Cisco Refuge Lakes identified in the RRHW, along with 123 lakes and 226 streams reaches designated as 2A waters. These lakes are shown in Figure 24 in Section 3.1 as High-Quality Lakes and identified individually in the *Watershed Protection Prioritization Criteria* included in Appendix D.

In addition, there are a number of lakes within the RRHW known to harbor lake trout, lake whitefish, and cisco. Recent collaboration between the DNR and the MPCA has resulted in a draft list of these lakes (Figure 21). This work is preliminary only and is included here solely to assist in identifying lakes in need of additional protections.

Outstanding Resource Value Waters

Minnesota rules (Minn R. 7050.0335) designate very outstanding, sensitive, and unique resources as "ORVWs". ORVWs must be maintained and protected. Both the BWCA and VNP are listed as ORVWs, and new or expanded discharges are banned in these areas.

2.5.6 Climate Change

Minnesota's climate is changing, and these changes can impact the natural resources in the RRHW. Long-term trend data show an increase in temperature and precipitation in Northeast Minnesota, shown in Figure 17 and Figure 18. In addition, a shorter term decreasing trend in precipitation has been seen in the last 25 years. The reasons for this recent precipitation decline are still unclear. Snowfall totals have appeared to remain relatively stable or increase, with lake effect zones seeing increases over the last several decades (GLISA 2017). Along with increased precipitation, increases in temperature are expected to increase evapotranspiration which could create dry spells between rain events.

Figure 17. Annual average temperature trends in the RRHW alongside the 30-year running average (DNR 2015)

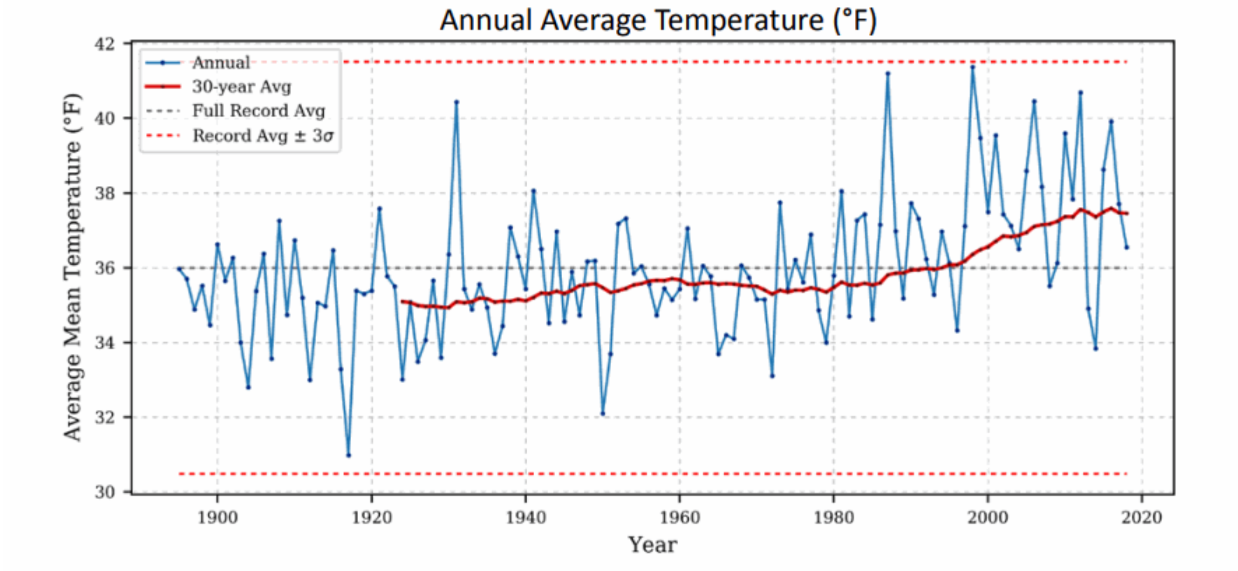
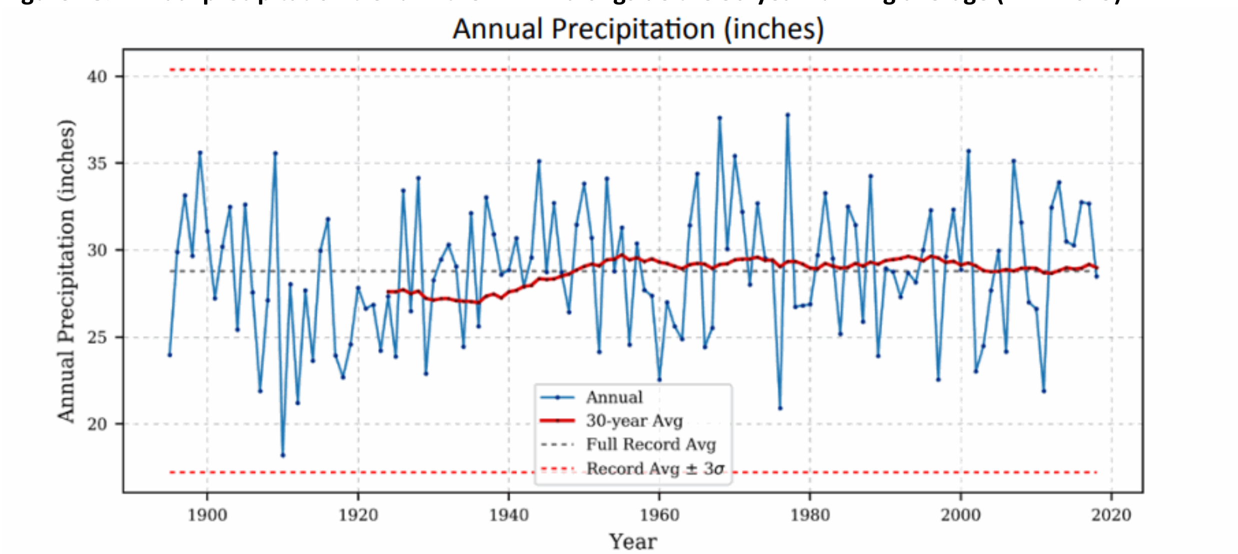


Figure 18. Annual precipitation trend in the RRHW alongside the 30-year running average (DNR 2015)



The impacts of climate change to this region can include the loss of coldwater fish habitat (Jacobson et al. 2010), decreased lake ice cover (Magnuson et al. 2000), increased frequency of algal blooms (Paerl et al. 2016), change in tree species composition, increased risk of forest fire, and increased risk of new aquatic and terrestrial invasive species invasions. Warming surface waters can alter thermal stratification in lakes. Shallow lakes, which are usually unstratified, may see increased temporary stratification events which release nutrients from the lake sediment leading to higher internal nutrient loading and increases in algae production. Forest species composition changes potentially include a decrease in balsam fir, black ash, black spruce, jack pine, northern white cedar, paper birch, quaking aspen, and white spruce, and an increase in red maple and eastern white pine (Handler et al. 2017).

As part of this project, the impact of climate change to water quality was modeled in the RRHW. The HSPF-SAM includes multiple default climate change scenarios. These scenarios were used to show the impacts of climate change in the watershed. The three climate change options available include:

- **Mild**: 1°F increase in average air temperature and a 4% increase in extreme precipitation;
- **Moderate**: 2°F increase in average air temperature and 8% increase in extreme precipitation; and
- **Severe**: 4°F increase in average air temperature and a 12% increase in extreme precipitation.

The climate change options adjust the existing climate record for the HSPF model. For air temperature increases, the change is applied across the whole record. For the change in extreme precipitation, the percent increase is applied to the extreme precipitation events to represent storm intensification due to climate change.

It is important to note that these estimates are result of modeling that does not include any changes that might occur to the overall forest community, which in turn could also impact forest hydrology. Since we can only collect data in the present, we can use models to predict conditions under different environmental conditions and scenarios. These results are a tool to assist with management decisions in combination with sample data, local knowledge, and professional judgement.

All three climate change options were modeled to estimate the amount of change under the existing climate change projections. HSPF-SAM incorporates change in precipitation along a gradient rather than just an overall increase. Overall, the model increases the total amount of precipitation and surface water runoff in all three scenarios. Additionally, the highest precipitation events increase while the lowest precipitation events are reduced. No change is made to median storm events. Sediment transport is highly influenced by larger storms, which scour and increase sediment wash-off occurring during large events. The increase in surface water runoff and extreme precipitation events in all three scenarios resulted in increased sediment loading.

Additionally, the model incorporates increases in temperatures in all three scenarios. This increases evapotranspiration and decreases 'total runoff', which is a combination of surface runoff and groundwater flow. Although groundwater flow may be small relative to surface runoff from a storm event on a daily timescale, it occurs throughout the year and can be a significant contributor to flow and nutrient loading in a watershed. And although nutrients bound to sediment will increase with increased sediment loading, this decrease in groundwater flow has a stronger influence on the resulting modeled nutrient loading. Overall, with less 'total runoff', nutrient loading decreased.

The 'severe' option showed decreases in runoff from <1% in Ely to 4% in VNP. To see the detailed results for the full watershed, see the *Rainy Headwaters HSPF Model – Scenario Modeling Technical Memorandum* in Appendix E.

2.5.7 Land Cover Change

Compared to other watersheds in Minnesota, the RRHW is relatively unimpacted by human changes to land cover. Historically, land cover in the RRHW was largely forest with a mixture of brushland, wetlands, and open water. The forest was dependent on infrequent low-lying fires that cleared out thick brush and alders to regenerate saplings (MPCA 2017). Stream corridors were heavily forested and provided ample shade to tributary streams. The corridors consisted of small patches of thick alder, marsh, and sedge meadows in the river's meanders and abandoned oxbows (MPCA 2017).

The present-day land cover within the Minnesota portion of the RRHW is indicated in Table 1 and Figure 1 (NRCS 2011). Over 99% of the Rainy River-Headwaters Watershed is undeveloped and utilized for timber production, hunting, fishing, hiking, and other recreational opportunities (MPCA 2017). Due to the vast protections in the watershed, land cover changes and impacts are localized and focused around some lakes outside the BWCAW and existing towns.

The Core Team identified two primary future impacts to the watershed: an increase in development and an increase in forest disturbance. These impacts were modeled using HSPF-SAM to estimate how these changes in land use might impact water quality in the watershed. To see more detail of how the model was set up and the resulting maps, see the *Rainy Headwaters HSPF Model – Scenario Modeling Technical Memorandum* in Appendix E. As stated earlier, these are modeled values with inherent uncertainty, and they are meant to be used in combination of local knowledge, and professional judgement to assist the development of management decisions.

Development

With less than three people per square mile, the watershed is currently sparsely developed. Limited road access throughout the watershed combined with the desired types of development (i.e., recreational and/or residential) indicates future development is likely to be largely focused in predictable areas (e.g., lakes, rivers, road access, etc.).

The Core Team provided input of specific lakes and rivers that are likely to see future development. Additionally, the Core Team provided input on which land use types should or should not be considered for potential future development. A key concern for this watershed is shoreland development. This includes development such as residential (e.g., houses and cabins) and commercial (e.g., resorts and camping).

The development scenario included: an overall 10% increase in development in the watershed (excluding federal and state lands), conversion of municipalities to entirely developed, an increase of septic system loading at a rate consistent with the population density loading from the existing model, and development of privately-owned lands within 500 feet of lakes and rivers identified by the Core Team. Overall, the changes in loading from the septic systems is relatively small compared to the changes in land types. Although it is unlikely that all the lands within the modeled scenario will become developed, the results can help us better understand how increased development can impact runoff and pollutant loading.

The scenario results show that the most change in runoff and sediment, and nutrient loading occurred in the areas that already have some disturbance from development, including the Ash River, and the lakes around Ely (White Iron Chain, Shagawa, and Burntside). This is likely the result of the relative amount of area within the watershed converted to ‘Developed’ in the model as the scenario converted all privately-owned lands within 500 feet of lakes and streams. Increased phosphorus runoff to these lakes with additional development in the future range from 26% to 33%. Table 14 and Table 15 show the modeled average yields for land types in the RRHW and the HSPF portion of the Rainy River – Rainy Lake model that is part of the RRHW in the NRCS watershed boundary dataset. The differences in these values illustrate the impact development can have on runoff, sediment, and nutrient loading. To see more detail of how the model was set up and the resulting maps, see the *Rainy Headwaters HSPF Model – Scenario Modeling Technical Memorandum* in Appendix E.

Table 14. Average yields for land types in the RRHW, based on HSPF model result

Land Type	Discharge	Sediment	Nitrogen	Phosphorus
	(acre-ft/acre/year)	(tons/acre/year)	(lbs/acre/year)	(lbs/acre/year)
Wetland	0.688	0.00024	0.385	0.029
Forest mature deciduous	0.775	0.0026	0.785	0.040
Forest regrowth	0.802	0.0132	1.187	0.049
Forest mature evergreen	0.618	0.0013	0.663	0.033
Grassland	0.994	0.0194	1.936	0.066
Cropland high till	0.0	0.0	0.0	0.0
Feedlot	0.0	0.0	0.0	0.0
Developed-all	1.722	0.042	3.279	0.581
Developed-pervious	1.198	0.0397	3.116	0.555
Developed-impervious	23.461	0.1187	10.052	1.640

Table 15. Average yields for land types in the Rainy River - Rainy Lake Watershed, based on HSPF model result

Land type	Discharge	Sediment	Nitrogen	Phosphorus
	(acre-ft/acre/year)	(tons/acre/year)	(lbs/acre/year)	(lbs/acre/year)
Wetland	0.275	0.00001	0.408	0.009
Forest mature deciduous	0.552	0.0027	1.289	0.038
Forest regrowth	0.506	0.0068	1.323	0.061
Forest mature evergreen	0.365	0.0015	0.855	0.025
Grassland	0.659	0.0105	2.072	0.117
Cropland high till	0.544	0.1427	3.659	0.399
Feedlot	1.102	0.0565	8.758	1.263
Developed-all	2.081	0.021	3.288	0.272
Developed-pervious	0.880	0.0174	2.866	0.179
Developed-impervious	17.320	0.0722	8.643	1.453

Forests

Approximately 80% of the watershed is forested. This substantial percentage indicates that forest disturbances could have significant impacts on water quality within the watershed and its resources. Forest disturbance could include forest loss due to disease, insect damage, harvest, wildfire, and blowdowns. Forested land is protective of water quality, reducing runoff and holding sediment and nutrients on the landscape.

Largescale blowdowns have occurred in this watershed over the past two decades resulting in large areas of mature forest conversion to young forest. Some of these areas have experienced forest fires, while others have not. Both are regenerating to forestland. For example, the Fernberg Corridor/Gunflint Corridor has experienced recent blowdown events and the area was salvage logged to prevent potential uncontrolled wildfire and to protect private property. The resulting forest is a young forest with infrequent old growth pines that were not affected by the windstorms.

Additionally, the Ely area is severely affected by spruce budworm. While this is a native pest, persistent warmer winters have allowed the budworm to flourish, causing massive die off of balsam fir, a common species the watershed. And other forest pests such as the emerald ash borer and the larch beetle may threaten ash and tamarack stands in the future, important species present in riparian areas of the RRHW.

The HSPF model was used to explore the possible impact of increased forest disturbance on the RRHW. The Core Team provided input on how to set up the scenario. The resulting increased forest disturbance scenario changed mature forest (excluding BWCAW) to young forest at a rate of 10%, 20%, and 30% to show different degrees of change. These disturbance rates are not anticipated, but were chosen to better understand the cause-effect relationship between forested lands and pollutant runoff/loading to lakes and streams.

Variations in runoff and loading results between subwatersheds are largely a result of differences in amount of existing mature forest. For example, subwatersheds with more mature forest experiencing a 10% change to forest regrowth experience greater change than a watershed that has less mature forest as there is less land converted in the scenario.

Overall, with a 10% increase in forest disturbance, runoff increased from 0% to 8% and the sediment load increased by 0% to 32%, except for the reach that contains Big Lake. Big Lake showed the most change with a 54% increase in sediment loading and a 35% increase in TP loading. The runoff, sediment and nutrient loading only increased slightly in the 20% and 30% increase in forest disturbance scenarios.

Furthermore, changes in runoff, sediment, and nutrients are all relative to the average yield of different land types. The overall change in a subwatershed is dependent of the yields from its contained land types. Small changes in loading could be buffered or exaggerated depending on the composition of the subwatershed. Another way to judge the impact of disturbing different land types in the watershed is to look at how the modeled conversion of different land types to Forest Regrowth changed on an acre-by-acre basis. Table 16 and Table 17 show the overall yields and relative changes of Mature Forest to Forest Regrowth in the RRHW and the HSPF portion of the Rainy River – Rainy Lake model that is part of the RRHW in the NRCS watershed boundary dataset. These values are averaged across the whole watershed. Small differences between climate zones may exist but the averaged values show the potential differences in loading between the Mature Forest land types and the Forest Regrowth land type. These modeled results show a greater change in runoff, sediment, and nutrients from disturbed mature evergreen forest than from mature deciduous. To see more detail of how the model was set up and the resulting maps, see the *Rainy Headwaters HSPF Model – Scenario Modeling Technical Memorandum* in Appendix E.

Table 16. Average yields from forest areas in the RRHW, based on HSPF results

Land type	Discharge (acre-ft/acre/year)	Sediment (tons/acre/year)	Nitrogen (lbs/acre/year)	Phosphorus (lbs/acre/year)
Forest mature evergreen	0.618	0.0013	0.663	0.033
Forest mature deciduous	0.775	0.0026	0.785	0.040
Forest regrowth	0.802	0.0132	1.187	0.049
Forest disturbance impact				
Mature evergreen to regrowth change	0.184	0.01189	0.523	0.0160
Percent change from mature evergreen	29.8%	910.9%	78.9%	48.2%
Mature deciduous to regrowth change	0.027	0.01062	0.4020	0.0097
Percent change from mature deciduous	3.4%	411.5%	51.2%	24.5%

Table 17. Average yields from forest areas in the Rainy River - Rainy Lake Watershed, based on HSPF results

Land type	Discharge (acre-ft/acre/year)	Sediment (tons/acre/year)	Nitrogen (lbs/acre/year)	Phosphorus (lbs/acre/year)
Forest mature evergreen	0.365	0.0015	0.855	0.025
Forest mature deciduous	0.552	0.0027	1.289	0.038
Forest regrowth	0.506	0.0068	1.323	0.061
Forest disturbance impact				
Mature evergreen to regrowth change	0.141	0.00526	0.468	0.0360
Percent change from mature evergreen	38.6%	341.7%	54.8%	144.3%
Mature deciduous to regrowth change	-0.046	0.00413	0.0341	0.0232
Percent change from mature deciduous	-8.4%	154.5%	2.6%	61.4%

Forest harvest occurs at varying intensities across the RRHW including private lands and multiple-use management on state and federal lands. Current forestland management activities in the RRHW, especially on public lands, have successfully protected waterbodies and should be maintained. Additional BMPs should emulate past successes. Identification of priority waters for protection in areas planned for increased harvest can help guide the selection of environmentally sound management principles for all lands managed for economic return.

State School Trust Lands are mandated to be managed for maximum long-term economic return with sound natural resource conservation and management principles, providing funding for Minnesota schools. The State of Minnesota, Superior National Forest and The Conservation Fund have collaborated to develop a proposed land swap that could increase the amount of school trust land outside the BWCA in these watersheds. This would allow the consolidation of land ownership within the BWCAW to the Forest Service to better protect the wilderness resource while increasing revenue generation activities on lands outside the BWCAW to support public education. There is a potential increase in State School Trust land in the Dunka River watershed, a proposed Class 2A coldwater stream. Currently this stream reach is afforded protections from the surrounding forestland. Management of this area should consider the possible impacts to the hydrology and biological suitability for coldwater communities in the Dunka River.

3. Strategies for restoration and protection

The Clean Water Legacy Act (CWLA) requires that WRAPS contain strategies that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources, including water quality goals, strategies, and targets by parameter of concern, and an example of the scales and timeline of adoption to meet water quality protection and restoration goals.

This section of the WRAPS report provides the results of watershed 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 BMPs. Thus, effective ongoing public participation is f3ully a part of the overall plan for moving forward.

The restoration and protection strategies and geographical prioritization were developed by the Core Team over a series of meetings in 2020. The Core Team is comprised of members from the MPCA, DNR, BWSR, MDA, MDH, USFS, VNP, 1854 Treaty Authority, North St. Louis SWCD, Lake County SWCD, and Cook County SWCD.

The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed modeling efforts (HSPF SAM) 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.

Section 3 is organized by the following strategy themes identified throughout this process.

- Restoration Strategies:
  - Managing sediment sources to the Blackduck River
  - Managing cattle access to the Blackduck River
- Protection Strategies:
  - Drinking water protection
  - Forestland management
  - Habitat and stream connectivity management
  - Lake management
  - Recreational management
  - Septic system improvement
  - Stormwater runoff control
  - Streambank and gully protection

Targeted geographic areas for each strategy type are provided in Section 3.1, additional information on the Core Team meetings and public participation is provided in Section 3.2, and strategy types are expanded upon to include BMP actions in Section 3.3.

3.1 Targeting of geographic areas

Because of its remote and relatively undisturbed nature, the RRHW has very few impairments and water quality concerns. The Blackduck River, where aquatic recreation and aquatic life uses are impaired by bacteria and sediment, is a restoration target. The majority of the watershed is meeting existing water quality standards and has a protection focus.

To prioritize areas for protection, criteria were developed by the Core Team. Prioritization for protection lies at the intersection of quality and risk. Therefore some of the criteria identify risks, such as declining water quality trends, and some of the criteria identify qualities, such as the presence of wild rice or the quality of a coldwater stream. Lakes and streams with many risks and qualities can be targeted with protection strategies.

The prioritization criteria were matched with applicable strategy types. These strategy types are explained further in Table 18. The criteria are also illustrated on individual summary maps, per strategy type. These maps are shown in Figure 19 through Figure 27. The intent is that the risks and qualities associated with the priority waterbodies drive the protection or restoration strategies that should be implemented to protect or restore water quality. For example, to target the septic system and waste management strategies, developed shoreline around lakes is highlighted in Figure 25. This targeting helps in the decision of where to implement improvements in the future. Criteria scores per waterbody can be found in Appendix D. Additional options for prioritization are shown in Figure 19.

The WHAF was used in the figures of this section to show geographical changes throughout the watershed. The WHAF provides health scores, which include an index of 0-100 that combine many available data sources. For example, the Aquatic Connectivity WHAF score is based on statewide data for dams, bridges, and culverts and scored on a state-wide scale. A score of 100 is the best score and 0 is the poorest score. Additional information about how WHAF scores can be interpreted can be found on the DNR website: https://www.dnr.state.mn.us/whaf/about/scores/using-scores.html.

Table 18. Strategy themes and the descriptions for prioritizing resources and geographic areas

Figure	Strategy Type	Description
Figure 19	Drinking Water Protection	Drinking water protection incorporates both the risk of near surface pollution sensitivity of groundwater and the quality of Class 1 Drinking Water Lakes.
Figure 20, Figure 21	Forestland Management	Forestland management is targeted around Class 2A coldwater lakes and streams and Class 1 Drinking Water lakes. Forestland risks include the percentage of young forest in a catchment, which can identify areas of disturbance including forest harvest, forest fires, and tree loss from insect damage and disease. Forest practices may include promotion of forest species and age class diversity as well as choosing tree species resilient to climate change. Recent collaboration between the DNR and MPCA has also generated a proposed list of lake trout, whitefish, and cisco lakes.
Figure 22, Figure 23, Figure 16	Habitat and aquatic connectivity management	Designated Coldwater Streams (2A) and aquatic connectivity scores from the WHAF can be used to prioritize stream reaches. Stream reaches with the highest densities of culverts, bridges, and dams potentially limiting the free flow of water produce a lower the aquatic connectivity score. In collaboration with the DNR, Lake County SWCD performed a culvert survey, and a desktop analysis was performed to identify priority culverts for replacement to enhance connectivity for coldwater reaches, targeting the longest stream lengths that would be gained. These should be verified in the field ahead of implementation. In addition, culvert surveys were performed in the Ash River Watershed to identify culverts that could be contributing to impairments.

Figure	Strategy Type	Description
		Protecting high value wild rice waters should be considered in planning efforts. Coldwater habitat is considered in the forestland and lake management strategies.
Figure 24, Figure 16	Lake Management	Lake Management is prioritized for water quality restoration and protection by risk criteria and quality criteria. This includes managing lakes for aquatic recreation use, drinking water, and coldwater habitat (cisco, whitefish and trout). 'High Risk' lakes are defined here as having scored 'Highest' in the LPSS or LBCA protection prioritization described in Section 2.5.3. In addition, protecting high value wild rice waters should also be considered in planning efforts.
Figure 2	Recreational Management	The RRHW includes the BWCAW, VNP, and the SNF. In addition, the watershed is a popular recreation destination including fishing, boating, canoeing, hiking, hunting, camping, and OHV trail use. Recreational management strategies can be targeted to areas with high recreational use such lakes and rivers, ATV trails, and campsites. Encouraging mindful recreation to reduce potential environmental impacts to land and water resources is recommended.
Figure 25	Septic system improvement	Septic system improvement is targeted around waterbodies that are at risk of contamination from fecal bacteria (Class 1 Drinking Water lakes) and additional nutrient inputs that could boost algal productivity. Also, Gunflint, Kabetogama, and the Ash River were identified as priority areas by the Core Team.
Figure 26	Stormwater runoff control	The RRHW does not have large urban areas, but there are developed areas including Ely and focused around lakes and streams. Because of this localized stormwater focus, the criteria used to target these practices include identifying waterbodies at risk to additional nutrient inputs and that have high disturbance or development density in their catchment. The HSPF modeling scenario for increased development can be used to target locations where improvements will best enhance water quality (Appendix E).
Figure 27	Streambank and gully protection	Streambank and gully protection is targeted around waterbodies that are impaired, altered, designated as coldwater, and a high priority for protection based on high quality biologic communities. Local priorities provided by the Core Team include riparian buffers for the Ash and Blackduck Rivers.

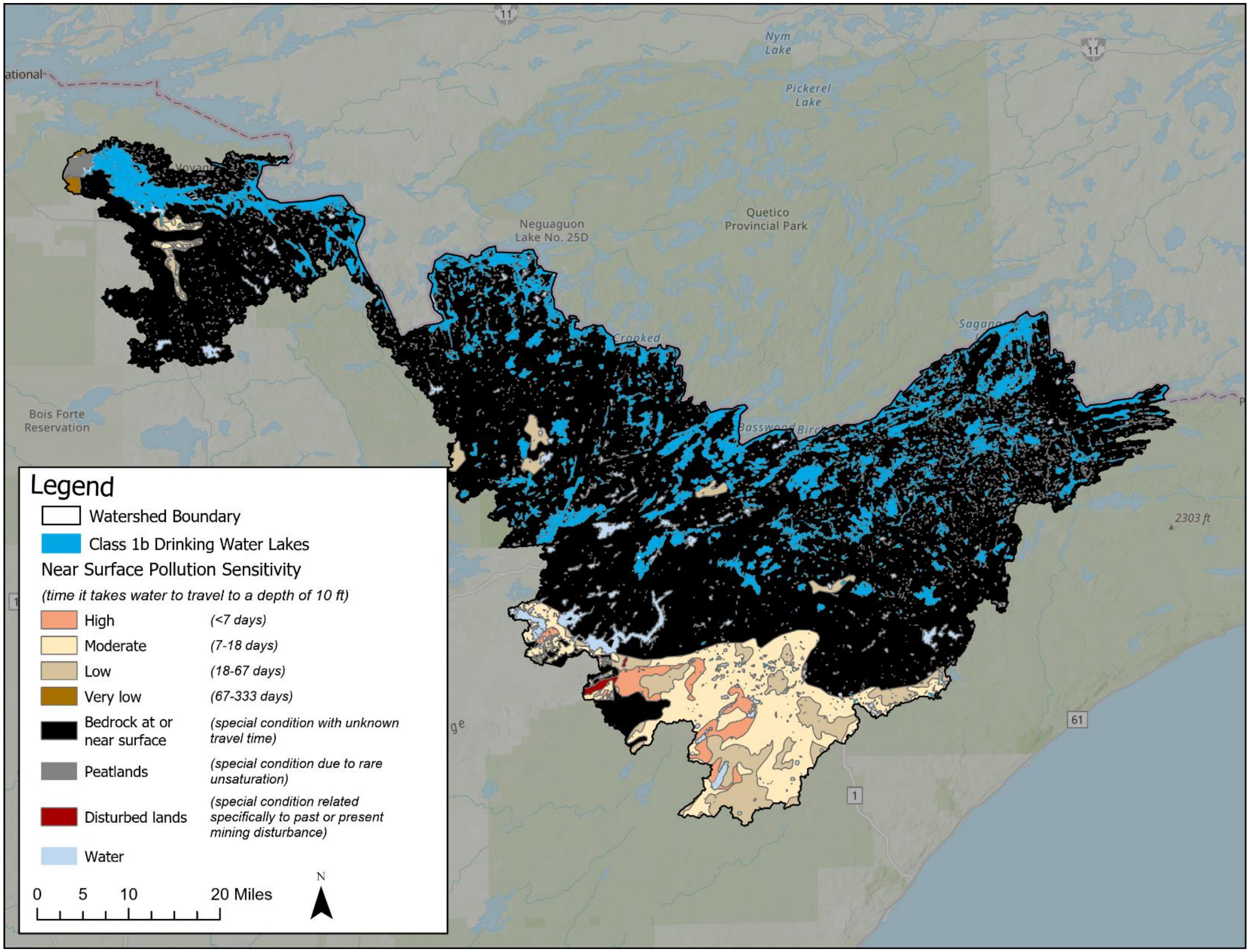


Figure 19. Geographical targeting for drinking water protection strategies

Septic Systems are also a drinking water risk and more detail about them can be viewed in Figure 25.

Figure 20. Geographical targeting for forestland management protection strategies

Maintaining forested watersheds at 75% or more healthy forest is protective of coldwater lakes and provides additional protections to all waters. Young forest (a result of harvest and tree loss through disease or fire) is not as effective at this protection. Watersheds close to 25% young forest with coldwater habitat should be evaluated for additional protection.

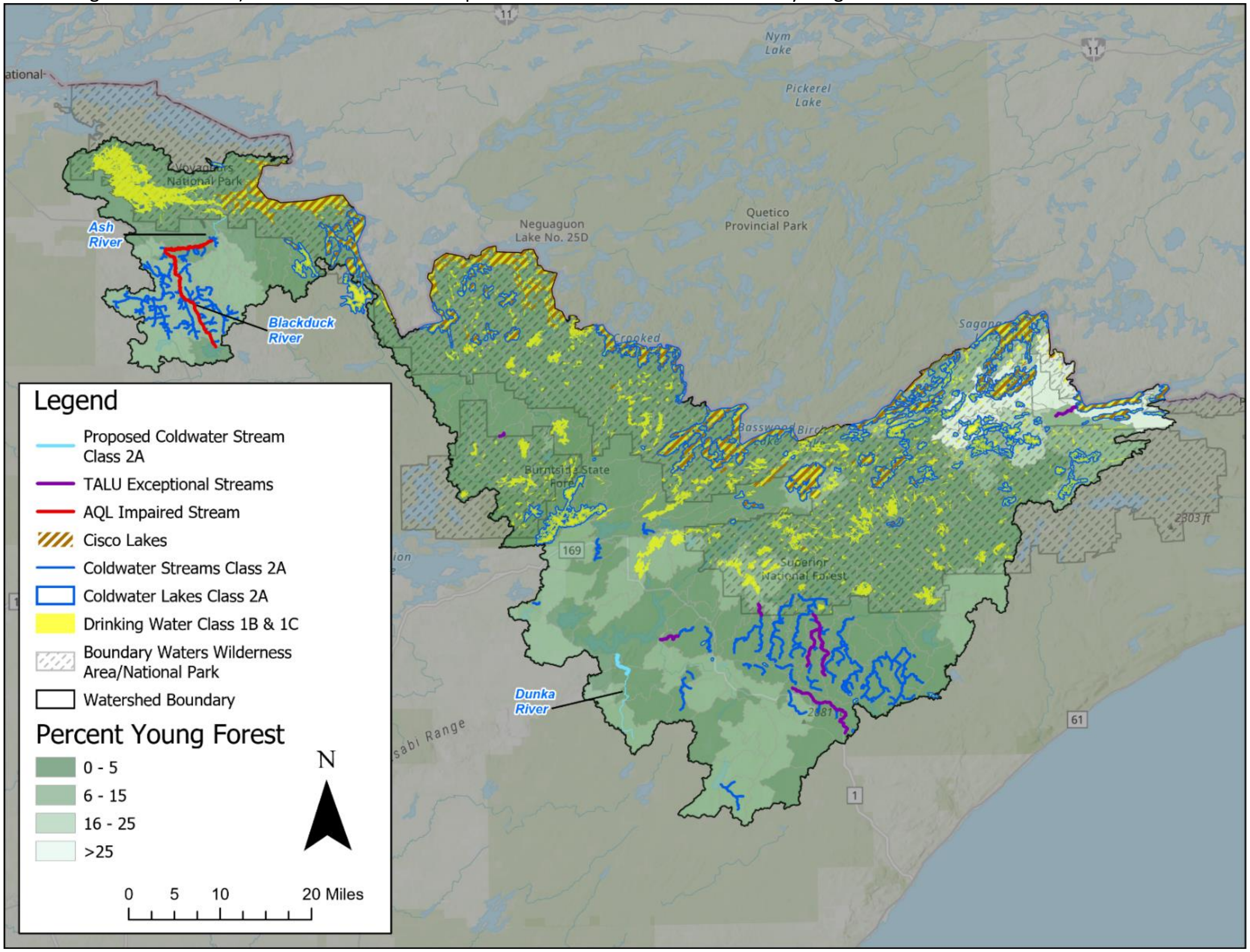


Figure 21. Proposed Coldwater Lake Designations

A recent collaboration between the MCPA and DNR has identified lakes that support coldwater species (lake trout, lake whitefish, and cisco). Although this proposal is in draft form, this data can help identify coldwater fish habitat in need of protection (data provided by Will Bouchard, MPCA and Derek Bahr, DNR).

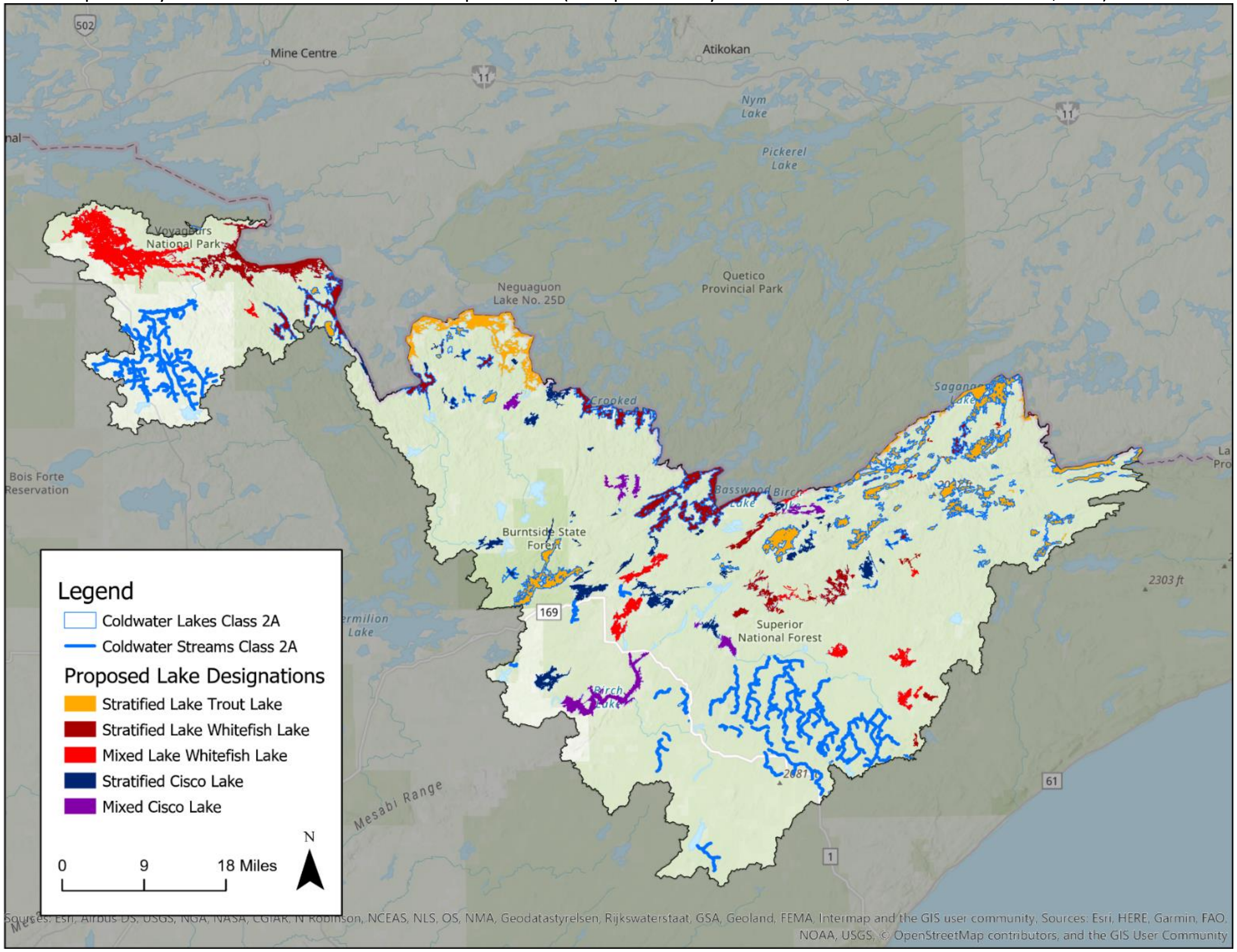


Figure 22. Geographical targeting for habitat and stream connectivity management protection strategies

The aquatic connectivity ecological heath score from the WHAF is based on the density of culverts, bridges and dams in each watershed. The higher the density of structures limiting the free flow of water, the lower the aquatic connectivity score. Priority culverts in Lake County were identified through desktop analysis by DNR Finland Fisheries and need to be ground-truthed ahead of replacement.

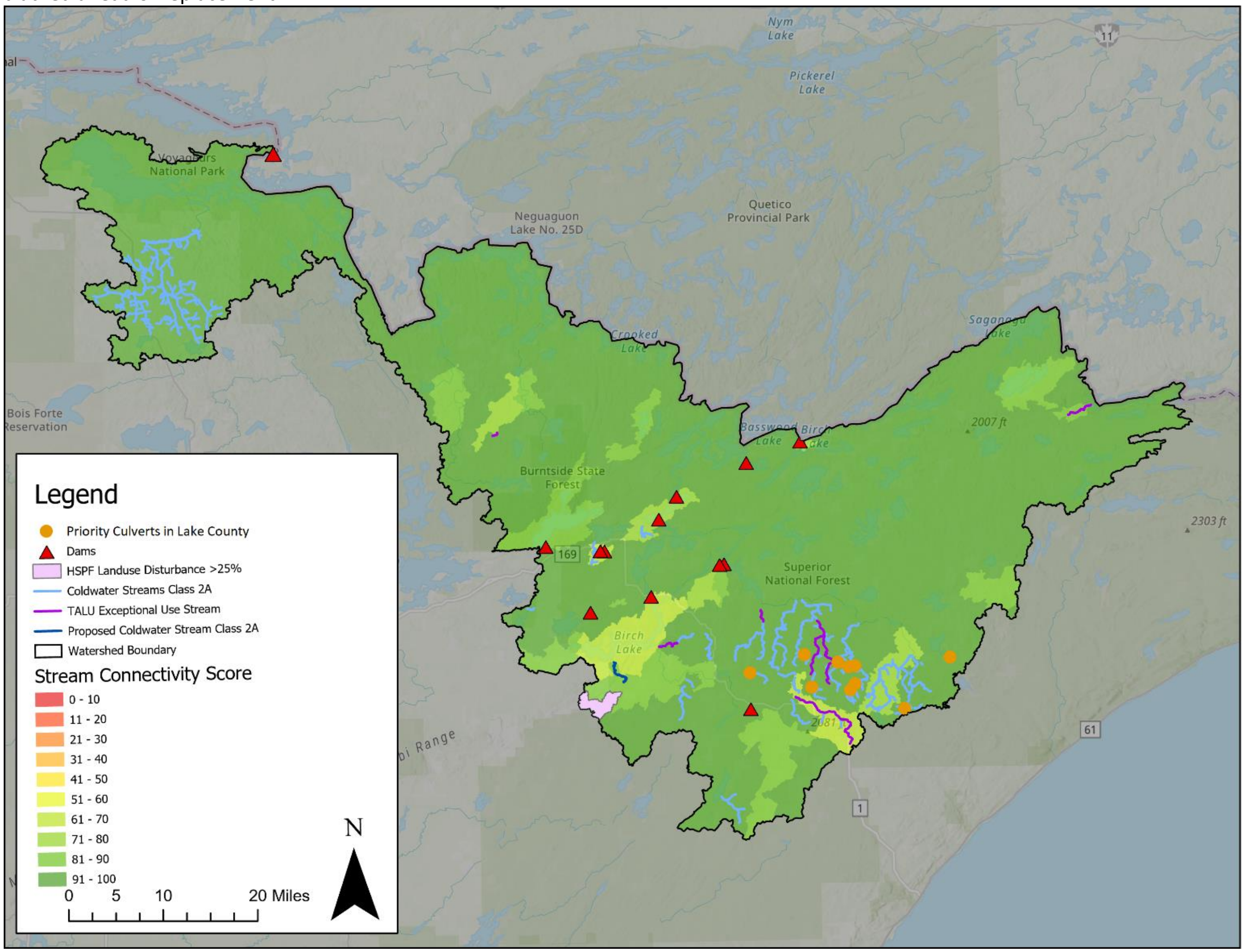


Figure 23. Culvert inventory results for the Ash River Watershed (MPCA 2019)

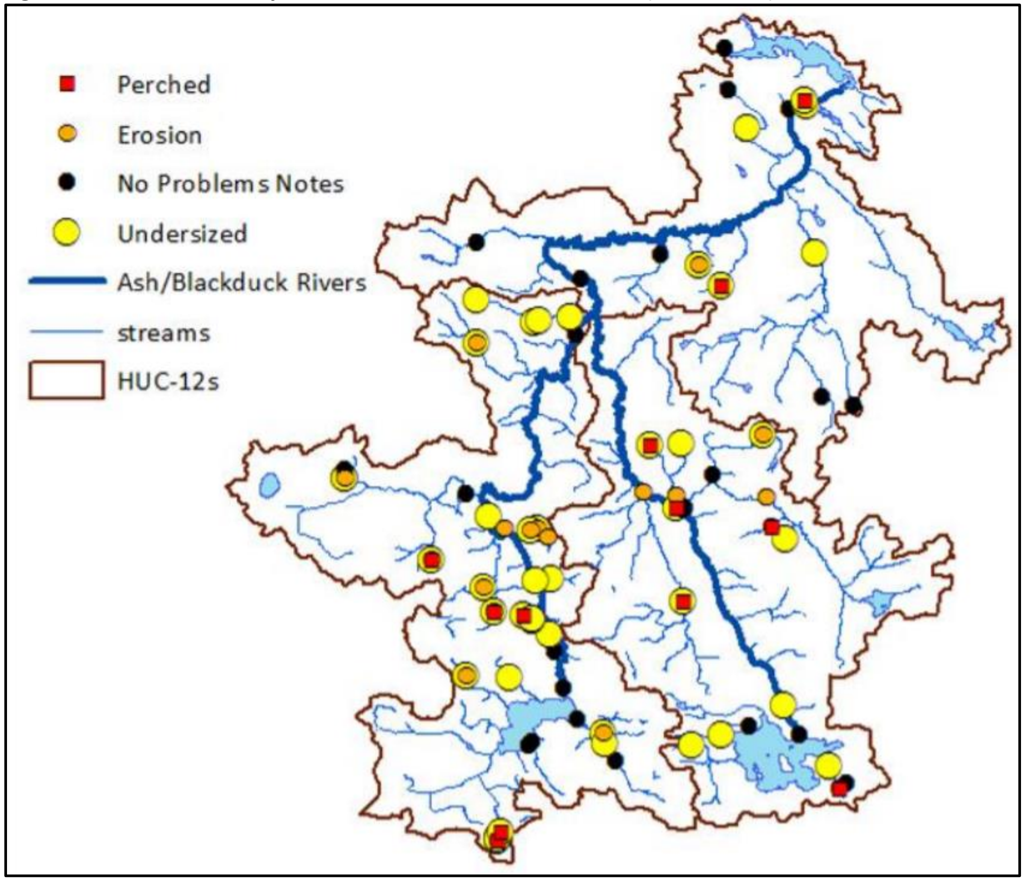


Figure 24. Geographical targeting for lake management protection strategies

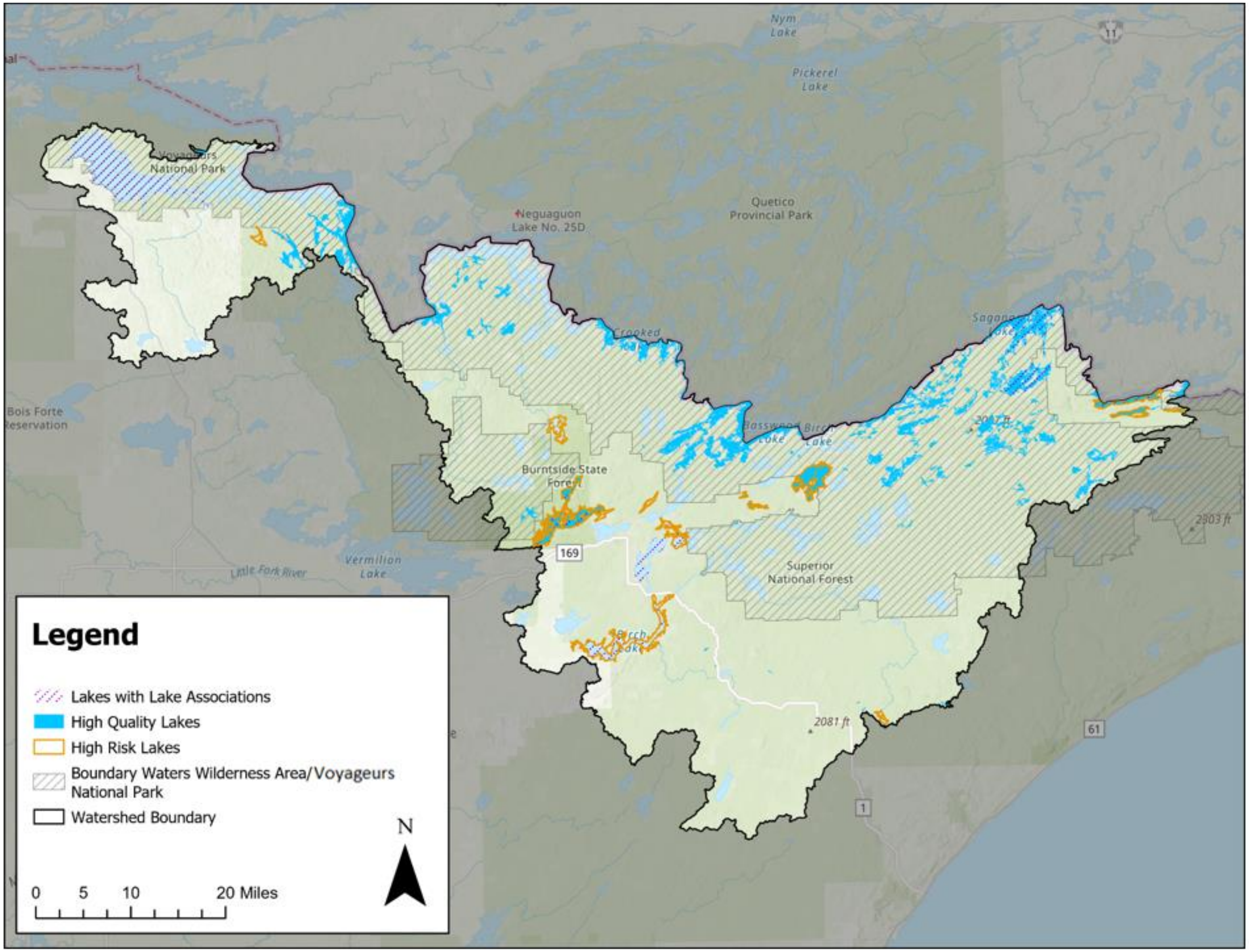


Figure 25. Geographical targeting for septic and wastewater management protection strategies

The septic systems health score from the WHAF provides a conservative estimate of actual septic system density. The metric score is based on well density per square km of land area in a catchment. Scores range from 0 to 100, with a density of 15.587 wells/km2 or greater = 0; no wells present = 100.

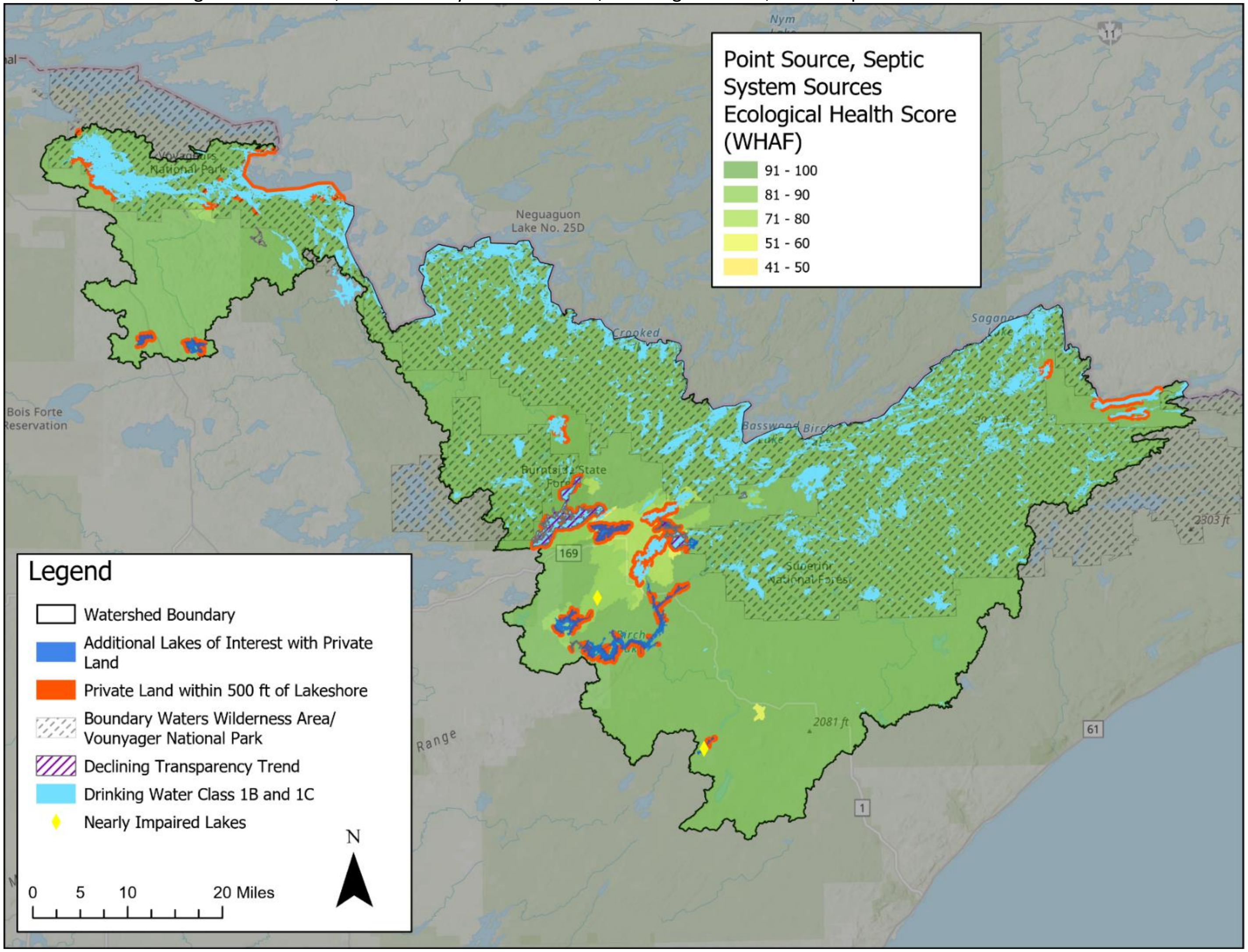
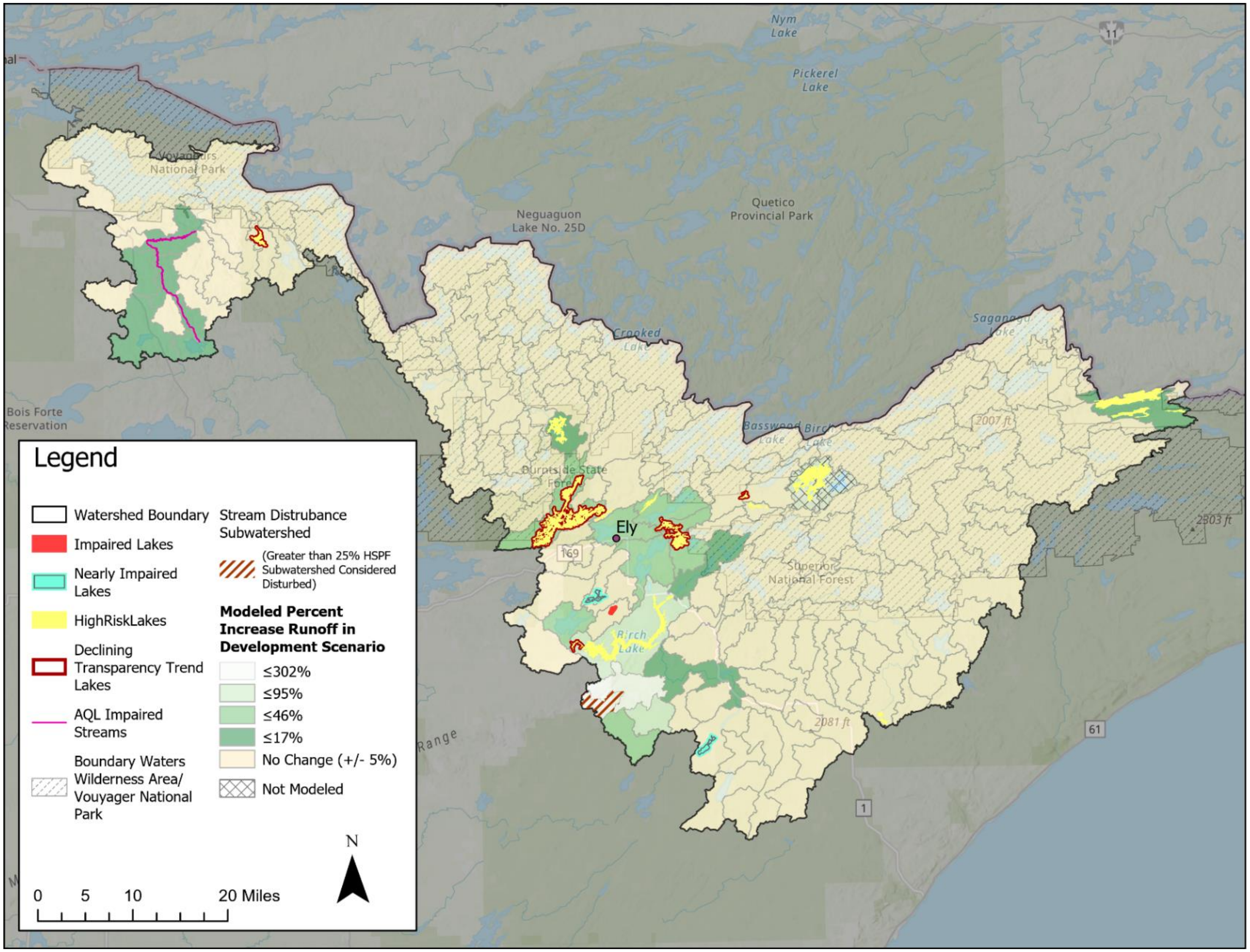


Figure 26. Geographical targeting for stormwater runoff control protection strategies



High risk lakes have been classified as 'Highest' phosphorus sensitivity and/or 'Highest' benefit to cost assessment.

Figure 27. Geographical targeting for streambank and gully protection and restoration strategies

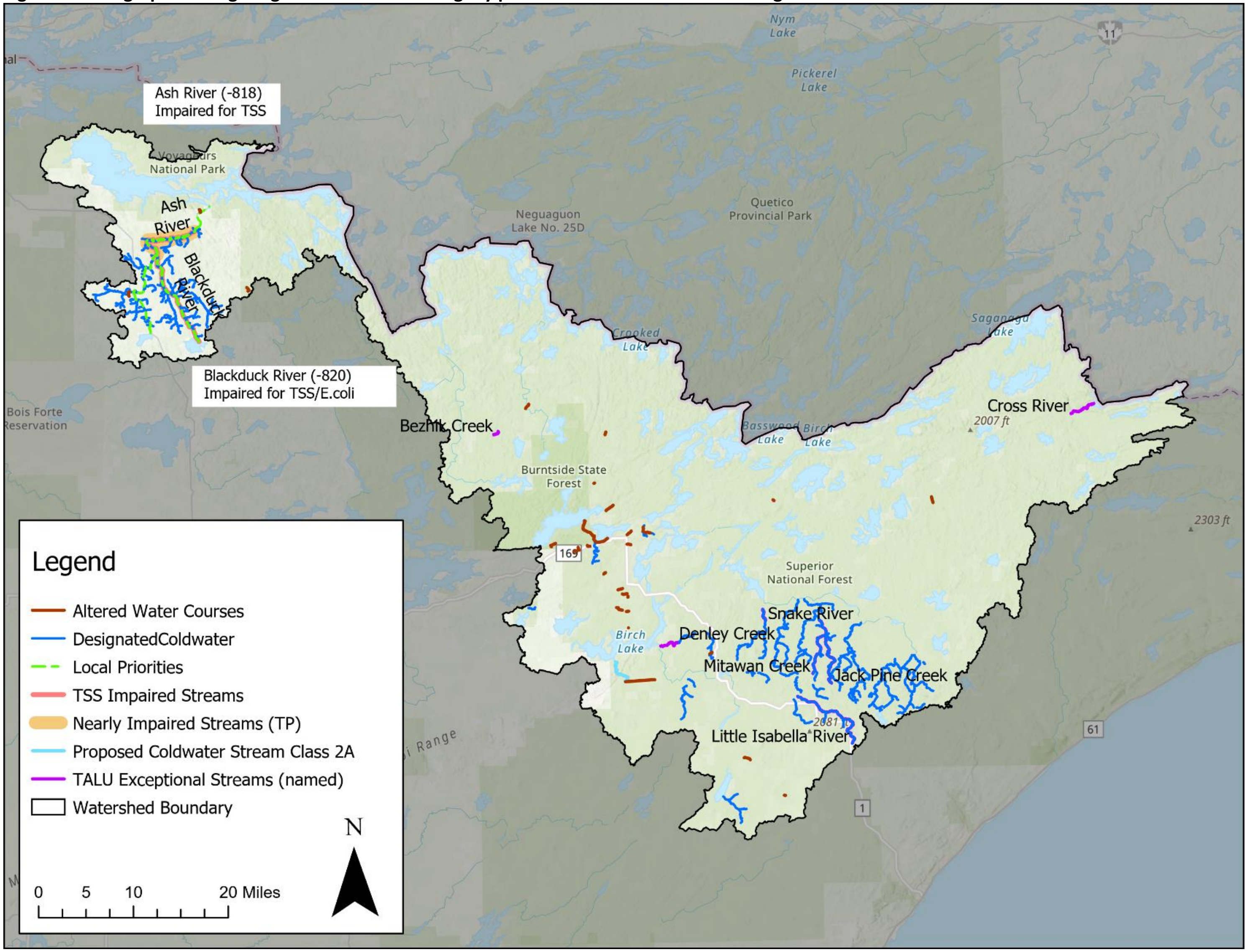


Figure 28. BANCS survey results in the Ash River Watershed

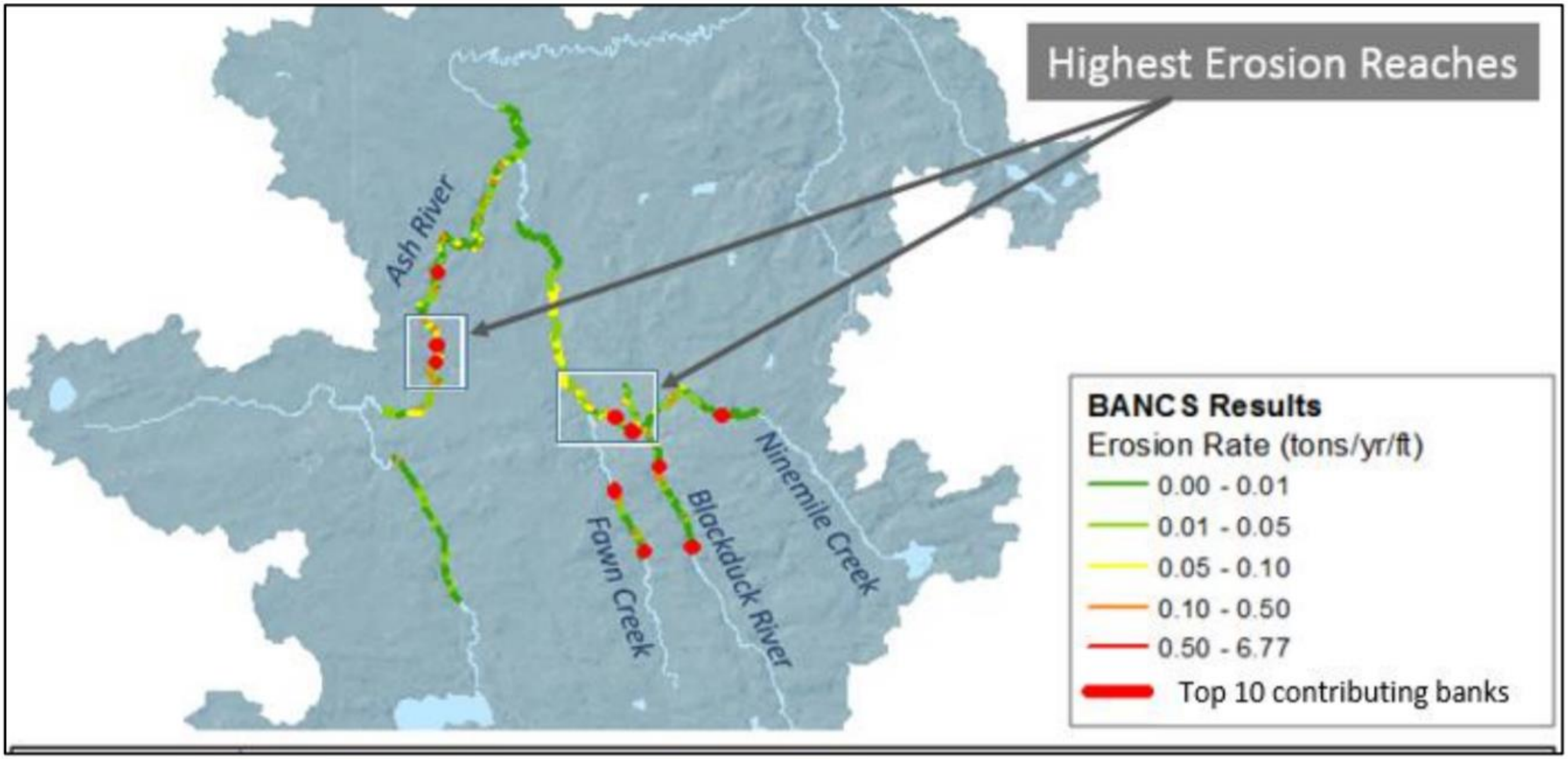


Table 19. Additional tools that can be used for prioritization in the watershed

Tools	Description	How can the tool be used?	Notes	Link to information and data
Board of Water and Soil Resources (BWSR) Landscape Resiliency Strategies	These webpages describe strategies for integrated water resources management to address soil and water resource issues at the watershed scale and to increase landscape and hydrological resiliency in agricultural areas.	In addition to providing key strategies, the webpages provide links to planning programs and tools such as Stream Power Index, PTMApp, Nonpoint Priority Funding Plan, and local water management plans.	These data layers are available on BWSR website. The MPCA download link offers spatial data that can be used with GIS software to make maps or perform other geography-based functions.	Landscape Resiliency - Water Planning Landscape Resiliency - Agricultural Landscapes MPCA download
Zonation	This tool serves as a framework and software for large-scale spatial conservation prioritization, and a decision support tool for conservation planning. The tool incorporates values-based priorities to help identify areas important for protection and restoration.	Zonation produces a hierarchical prioritization of the landscape based on the occurrence levels of features in sites (grid cells). It iteratively removes the least valuable remaining cell, accounting for connectivity and generalized complementarity, in the process. The output of Zonation can be imported into GIS software for further analysis. Zonation can be run on very large data sets (with up to ~50 million grid cells).	The software allows balancing of alternative land uses, landscape condition and retention, and feature-specific connectivity responses. (Paul Radomski, DNR, has expertise with this tool.)	Software
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) NRCS Soil Survey Geographic Database (SSURGO) soils with a soil drainage class of poorly drained or very poorly drained.	Identifies potential wetland restoration sites with an emphasis on wildlife habitat, surface and groundwater quality, and reducing flood damage risk.	The GIS data layer is available for viewing and download on the Minnesota 'Restorable Wetland Prioritization Tool' website.	Restorable Wetlands

Tools	Description	How can the tool be used?	Notes	Link to information and data
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.	General mapping and analysis of surface-water systems. These data have been used for fisheries management, hydrologic modeling, environmental protection, and resource management. A specific application of this data set is to identify riparian buffers around rivers.	The layers are available on the USGS website.	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.	General mapping and analysis of elevation/terrain. These data have been used for erosion analysis, water storage and flow analysis, siting and design of BMPs, wetland mapping, and flood control mapping. A specific application of the data set is to delineate small catchments.	The layers are available on the Minnesota Geospatial Information Office (MGIO) website.	MGIO
Hydrological Simulation Program – FORTRAN (HSPF) Model	Simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land. Typically used in large watersheds (greater than 100 square miles).	Incorporates watershed-scale and nonpoint source models into a basin-scale analysis framework. Addresses runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/ transformation of chemical constituents in stream reaches.	Local or other partners can work with MPCA HSPF modelers to evaluate at the watershed scale: 1) the efficacy of different kinds or adoption rates of BMPs, and 2) the effects of proposed or hypothetical land use changes.	EPA Models USGS

3.2 Public Participation

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful public participation. Public participation refers to education, outreach, marketing, training, technical assistance, and other methods of working with stakeholders to achieve water resource management goals.

Public Meetings and Outreach

Two public stakeholder meetings were held as part of the Rainy River Headwaters WRAPS process. The meetings were offered in two different locations, Orr and Ely, in 2017 to provide access to the communities nearest to the impaired waters and to the largest population center in the Rainy River Headwaters watershed. The meeting provided an overview of the MPCA's watershed approach, details on exceptional use waters and impairments within the watershed, and an introduction to WRAPS. After a presentation, participants asked questions about the process and shared concerns about protecting the RRHW. The Blackduck River impairment was discussed at these meetings, along with the water quality in the rest of the watershed. Concern was expressed by some anglers on the impact of elevated suspended sediment to trout within the Blackduck River and its tributaries, with a focus on Fawn Creek, which is stocked with trout.

In addition to the public meetings, a presentation on the Blackduck and Ash River system impairments and problem investigation was made to Rainy Basin resource professionals at the 2018 International Rainy–Lake of the Woods Watershed Forum in International Falls.

Cook, North Saint Louis, and Lake SWCDs all conducted additional public outreach activities, including water quality workshops, citizen monitoring outreach, development of nonpersonal nonelectronic public participation tools, and youth development activities related to water quality. Public meetings and events are summarized in Table 20.

Table 20. Summary of RRHW public meetings and outreach during the WRAPS process

Date	Location	Topic	Style	Target
2/28/2016	International Falls	Watershed Approach Introduction	Presentation/Q&A	White Iron Chain of Lakes Association
11/9/2017	Remote meeting	Impaired Waters Listing Public Notice	Presentation/Q&A	Public
11/16/2017	Ely	Watershed Approach Update	Presentation/Q&A/Open House	Public
10/2018	Ely	Forestry Workshop in October of 2018 in coordination with the Minnesota Department of Natural Resources, Vermilion Community College, USDA NRCS, and Firewise	Workshop	Public
2018	Ely	Numerous youth development activities related to water quality with Ely Community Resources	Activities	Youth

Date	Location	Topic	Style	Target
3/14/2019	International Falls	Ash/Blackduck SID and Problem investigation (LOW Forum)	Presentation	Bi-national Rainy Basin Resource Professionals
7/2019	Ely	Storm drain stencil workshop in coordination with the City of Ely, Ely Community Resources, and Keep Ely Clean	Workshop	Public
12/9/2019	Remote meeting	Ash/Blackduck Sediment Impairment and Problem Investigation	Presentation/Discussion	Arrowhead Landscape Pilot Project Resource Professionals
3/11/2020	International Falls	Rainy Basin WRAPS progress (LOW Forum)	Presentation	Bi-national Rainy Basin Resource Professionals

North Saint Louis SWCD also created numerous outreach tools, strengthened partnerships, and enhanced their online presence in support of this effort. Examples of these are listed below.

- Completed a watershed section on the North Saint Louis SWCD Web site that includes a story map of the watershed
- Created a communications network in RRHW
- Completed a public participation plan for RRHW
- Developed several public participation tools including:
  - Display at the Ely Public Library on the watershed
  - Storm drain stencils used to stencil near the Ely Public School
  - Door hanger distributed in coordination with the storm drain stenciling
  - Ely Echo Article on Private Forests & Water Quality Field Day
  - Backyard Conservation Booklet
  - Shagawa Lake Factsheet
  - Who is your Local SWCD? Booklet
- Built partnerships between North Saint Louis SWCD and the WICOLA and the Burntside Lake Association
- Prepared a crowd-sourced hydrology site for engaging the public in data collection and water quality issues on the Burntside River
- Promoted MPCA Citizen Lake and Stream Monitoring Program with community groups
  - Ely Field Naturalists
  - Ely City Planning
  - WICOLA Board
  - Ely Community Resources

- Ely Farmer's Market
- Ely Blueberry Festival

Cook County SWCD focused water quality outreach in support of WRAPS goals on the following areas.

- Citizen lake and stream monitoring outreach
- Lake Management Planning
- Outreach workshops about the watershed, wetlands, aquatic vegetation, and aquatic macro-invertebrate species
- Development of public participation tools

Lake County SWCD also provided support including the work listed below.

- Working with the WICOLA to conduct water monitoring
- Recruiting a volunteers for the water CLMP program
- Designed one-page water quality protection handouts to distribute at workshops and online
- Engaging with local citizen groups on water quality concerns and values
- Providing native planting and septic systems workshops

Core Team Meetings

A Core Team of regional resource professionals met 10 times throughout the process to provide their professional judgment on water quality issues within the watershed and provide guidance to WRAPS and TMDL development. This core team included representatives from various entities listed below:

- North Saint Louis SWCD
- Lake County SWCD
- Cook County SWCD
- DNR
- 1854 Treaty Authority
- MPCA
- BWSR
- MDH
- USFS
- National Park Service (NPS)

A strategy development kickoff meeting was held in February 2020 at the MPCA office in Duluth. In March 2020, the COVID-19 pandemic began, and meetings were held remotely throughout the rest of the project. The Core Team meetings are summarized in the list below.

1. June 6, 2016, Ely
    - Discussion of the Professional Judgement Group (PJG) assessments

2. January 23, 2017, Duluth
    - DNR discussion of DNR deliverables for the process
3. May 30, 2017, Ely
    - Presentation and discussion of impairments, exceptional use assessments, and 2017 field planning
4. November 30, 2017, Duluth
    - Presentation and discussion of field planning with the focus on the Ash and Blackduck rivers, impaired waters list public notice, culvert inventory, and natural background metals impairments
5. May 21, 2019, Duluth
    - Presentation and discussion on the draft SID report, impairments, Dunka River, and protection priority results
6. February 3, 2020, Duluth
    - Kickoff with Houston Engineering (HEI) and RRHW WRAPS Overview
    - RRHW WMAR and SID Report Overview
    - Agency and local government lightning round of activities in the watershed
    - Protection discussion in small groups about protection priorities in the watershed and data analyses needed
    - Restoration discussion in small groups about protection priorities in the watershed and data analyses needed
7. April 16, 2020, remote
    - Reviewed summarized priorities from the February meeting
    - Reviewed and discussed prioritization metrics for prioritizing waterbodies
8. May 5, 2020, remote
    - HSPF model introduction
    - Discussed scenario options based on priorities identified at the earlier meetings and introduced an online survey to gather input on modeling scenarios and priority areas
9. August 8, 2020, remote
    - Reviewed TMDL results
    - Reviewed strategy types and waterbody prioritization (Appendix D)
10. October 8, 2020
    - Reviewed draft strategies table
    - Reviewed draft WRAPS

3.2.1 Accomplishments and future plans

Many organizations in the RRHW are involved in public participation and outreach, including SWCDs, Counties, Lake Associations, and civic organizations.

In addition to the public participation activities listed in the sections above, the North Saint Louis SWCD also completed a survey of the local community values. Seven community capacity interviews were conducted through a collaborative project with the MPCA, Koochiching SWCD, and Lake of the Woods Sustainability Foundation across the Rainy Basin in both Ontario, Canada, and Minnesota. The goals of the project were to:

- Determine the drivers and constraints for taking part in water protection/restoration among those who live in the watershed.
- Better understand how involvement or interest in water protection/restoration initiatives varies across the binational watershed.
- Inform strategies for policy-makers, resource professionals, and other local actors to best design and promote water resource programs that are ecologically, hydrologically, and socially relevant and responsive to changing conditions.

Due to COVID-19 restrictions, the interviews were recorded by phone. The interviews have been delivered to MPCA for transcription and analysis. At the local level, the district has gained insight into the local communities and concerns of residents and professionals in the watershed. Study findings will inform conservation program development, outreach, and planning into the future.

Active Lake Associations in the watershed include WICOLA (White Iron, Farm, Garden, and Birch Lakes), Burntside Lake Association, Seagull Lake/Saganaga Homeowners Association, Gunflint Lake Homeowners Association, and Kabetogema Lake Association. These lake associations are heavily involved in water quality monitoring, aquatic plant surveys, aquatic invasive species (AIS) monitoring and prevention, and education and outreach. They are an effective partner to the local government agencies for implementing BMPs.

Since 2005, volunteers from WICOLA has been partnering with Lake County SWCD and the MPCA to monitor four of the lakes in the Kawishiwi River system using the protocols of the Clean Lakes Monitoring Program Plus. In 2010, WICOLA applied for a CWLA grant with Lake County serving as the fiscal agent. They were awarded a $225,000 grant and another Clean Water Partnership grant for $174,500 in early 2011. These grants have expanded water quality monitoring through more of the watershed. This research and monitoring for water quality, invasive species, failing septic systems, and sensitive areas, has provided information for outreach to partners and citizens, and ultimately produced a watershed management plan for the Kawishiwi portion of the Rainy River - Headwaters.

Currently, implementation in the watershed is led by local county water plans. Existing plans in the watershed include:

- St Louis County Comprehensive Water Management Plan, 2010-2020;
- Cook County Compressive Local Water Management Plan, 2014-2024; and
- Lake County Compressive Local Water Management Plan, 2010-2022.

In the future, the local entities in the RRHW will embark on a 1W1P effort to unify implementation using the watershed boundary. This WRAPS will provide the data and analyses needed to prioritize and plan for future implementation. Also, watershed partners will continue to build upon the relationships nurtured throughout the WRAPS process and use the tools and educational information developed during this process to continue their successful outreach program.

3.2.2 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 August 30, 2021 through October 29, 2021. There were three comments received and responded to as a result of the public comment period. Each comment was responded to individually. Responses to comments identified changes made to the Report, based on that comment. Comments focused on non-ferrous metallic mining issues that are under the authority of regulatory mechanisms in place to protect water quality in relation to industrial activity. This was explained in the responses and language was included in the Report to provide this additional context. Comments also included discussion of conductivity impacts to aquatic life and mercury methylation by sulfate. Additional language was added to the Report to provide more context on how the MPCA is approaching these issues. Recommendations to continue monitoring waters receiving mine wastewater, and to include data collection to support a greater understanding of the effects of conductivity to aquatic life in these waters, were also added to the Report.

3.3 Restoration and protection strategies

This section summarizes the implementation strategies for both restoration and protection in the RRHW. The RRHW is a relatively natural watershed and has very few impaired waterbodies in need of restoration, as indicated in Table 8. As a result, protecting the tremendous natural resources will be extremely important in the RRHW.

3.3.1 Existing BMPS

Watershed partners have completed many projects to protect and improve the water quality in the RRHW (Figure 29). A list of existing BMPs that have been implemented or installed within the RRHW is available on the MPCA Healthier Watersheds webpage and is shown in Table 21. All BMPs were implemented trying to reduce nonpoint source pollution within the watershed.

Figure 29. BMPs implemented in the watershed from 2004-2019 (MPCA Healthier Watersheds)

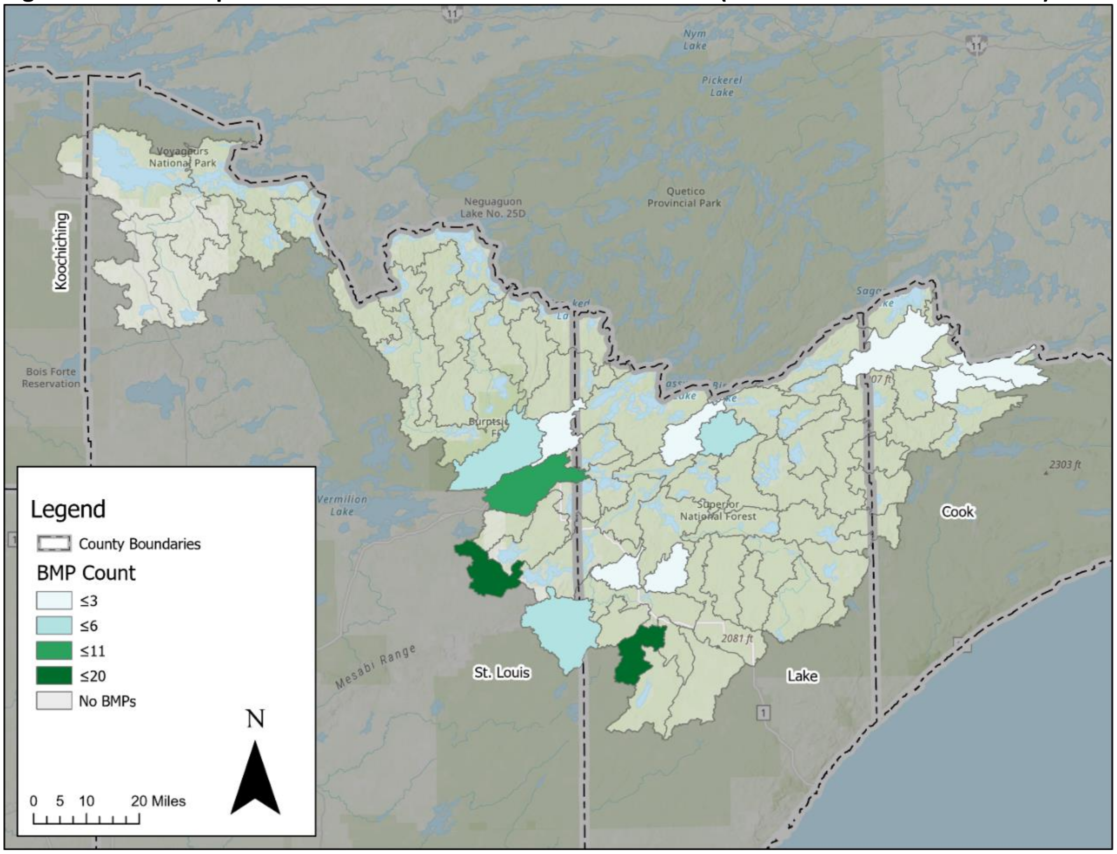


Table 21. BMPs installed in the Rainy River - Headwaters Watershed between 2009 and 2019
Source: MPCA Healthier Watersheds, 10/2/2020

Strategy type	BMP	NRCS BMP code	Number of BMPs installed	Installed Amount (by unit)	Units
Other	Forest Stand Improvement	666	21	42	Acres
Other	Woody Residue Treatment	384	20	135	Acres
Habitat & stream connectivity	Tree/Shrub Establishment	612	17	139	Acres
Other	Forest Management Plan - Written	106	10	10	Count
Other	Tree/Shrub Site Preparation	490	6	12	Acres
Septic System Improvements	Septic System Improvement	126M	5	5	Count
Other	Seasonal High Tunnel System for Crops	798	4	7756	Feet
Habitat & stream connectivity	Upland Wildlife Habitat Management	645	1	0	Acres
Living cover to crops in fall/spring	Cover Crop	340	1	1	Count
Designed erosion control	Grassed Waterway	412	1	0	Acres
Other	High Tunnel System	325	1	2,178	Feet

3.3.2 Restoration Strategies

Two rivers in the watershed, Ash River (-818) and Blackduck River (-820), have elevated TSS concentrations, which indicate conditions that do not support aquatic life. These conditions are likely a combination of natural and anthropogenic causes. Within the impaired Ash River reach, upstream contributions likely contribute to the high TSS. Stream channelization and forest disturbance from conversion to pastureland on the Blackduck River, a tributary to the Ash, are potential targets for reducing the sediment load in the Blackduck River and its downstream receiving water, the Ash River reach -818.

The Blackduck River also experiences elevated *E. coli* concentrations. Significant evidence suggests that numerous locations where cattle have stream access are greatly increasing sediment and *E. coli* concentrations in the Blackduck River.

Achieving water quality goals in the Blackduck and Ash rivers will require reductions in nonpermitted sources. The implementation strategies presented below address these priority sources.

- **Streambank stabilization and channel restoration (TSS strategy)**

  Implement restoration activities to address stream bank erosion and stream instability. Consider re-meandering the stream channel and reconnecting it to the floodplain in the unstable channelized reach. Ensure restoration activities take a comprehensive approach to addressing stream function and form, are protective of existing infrastructure, produce minimal disturbance to existing vegetation, and are designed by a licensed engineer.

- **Pasture and grazing management guidance (TSS and *E. coli* strategy)**

  Work with the landowner of the ranch to promote and develop a pasture and grazing management plan that benefits the pasture environment and stream ecosystem, and reduces pollutant sources to the Blackduck River and its tributaries. Encourage the use of barriers that limit or exclude the animals from entering surface water bodies, and enhance vegetative buffers along waterways that include un-grazed native grasses, forbs, trees, and shrubs. Connect the landowner of the ranch with NRCS programs such as EQIP to provide funding for BMP implementation including installation of an alternative water source for livestock. Coordinate with other state and local experts such as the Sustainable Farming Association of Minnesota to maximize environmental and landowner benefits.

- **Forest management guidance (TSS strategy)**

  Encourage adherence to State Forest Management Guidelines and forestry practices that are protective of the stream riparian and water quality. Work with private land owners to develop Forest Stewardship Plans. Emphasize long-lived conifers in critical riparian locations of the watershed and climate change resiliency in species selection. Encourage private and public (intra-agency) communications and collaboration to reduce, or at a minimum prevent an increase in, open lands in the watershed.

- **Culvert guidance (TSS strategy)**

  A culvert inventory was completed for the watershed through a multi-agency effort administered by the DNR. These data have been imported into the DNR's culvert inventory database. Several culverts were identified as being barriers for fish passage and/or contributing to stream bank and channel erosion. Review the inventory data and work with road management entities, both public and private, to prioritize and upgrade culverts with consideration of climate change resiliency in infrastructure design.

- **Roadway, motorized trail, and ditch maintenance guidance (TSS strategy)**

  Assess and prioritize roadways and motorized trails within the watershed for gullying, erosion, and pollutant runoff. Assess the state of existing roadside ditches and identify priority locations for ditch management (e.g., re-vegetation, armoring). Encourage roadway and motorized trail design and management practices that are protective of water quality, including low maintenance roads. Develop and implement guidance for public and private road ditch maintenance to minimize un-vegetated channels and associated erosion.

- **Remnant railroad piling removal and rail grade/bank stabilization (TSS strategy)**

  Inventory in-stream railroad pilings and sections of the old railroad grade that abut the stream channel. Prioritize areas for restoration that negatively impact aquatic life and/or water quality and/or show signs of streambank erosion, sedimentation, and channel instability. Research piling removal methods and removal process impacts on stream stability. Develop recommendations and communicate findings to public and private landowners. Upon future approval of all-terrain vehicle use proposed for sections of the David Dill/Arrowhead Trail, former railroad-stream crossings within the state trail section should be designed to meet permit standards and be protective of stream health and stability.

- **Septic system inventory and upgrades (*E. coli* strategy)**

  Conduct an inventory of SSTS in the Blackduck River Watershed for systems with unknown status, identifying total number of systems and compliance status. Prioritize SSTS according to compliance status; identify all ITPHS systems as high priority for maintenance and replacement. Work with private landowners to achieve compliance.

- **Education and outreach (TSS and *E. coli* strategy)**

  Provide education and outreach for pollutant-reduction activities. Assist private landowners in forest management, pasture management, and grazing planning. Provide information or hands-on workshops to landowners on forest and pasture management activities as well as stream crossing, road, ditch, beaver dam, and stream habitat management.

With high quality waters identified throughout the watershed, most of the RRHW's waters are not currently impaired and should be protected from potential degradation and future impairment. See Protection Strategies in Section 3.3.3.

Table 22. Restoration strategies and actions proposed for the Rainy River - Headwaters Watershed

Waterbody and location			Water quality			Strategies to achieve final water quality goal				
							EXAMPLE Best Management Practice (BMP) Scenario			
HUC-10 Sub-watershed	**Waterbody (ID)**	**Location and upstream influence counties**	**Pollutant/ Stressor**	**Current WQ conditions** (conc. & load as related to impairment)	**Final WQ Goal** (% and load to reduce)	**Strategy type**	**BMP**	**Amount**	**Unit**	**Estimated reduction (lbs/yr)** *as applicable*
Blackduck River (0903000123-03)	Blackduck River (820)	St. Louis County	Sediment /TSS	28 mg/L (90th percentile concentration)	< 10 mg/L > 90% of the time, April – Sept Overall, a 64% reduction will be required to meet the TSS water quality standard	Buffers, field edge	Riparian buffers, 50+ ft wide (replacing pasture) [390, 391, 327]		Acres	
						Forestry management	Maintain existing forest cover - prevent new losses			
							Forestry management and improvement [147M, 490, 666]			
							Reforestation on nonforested land and after cutting		Number of	
						Stream banks, bluffs and ravines protected/restored	Re-meander channelized stream reaches [584]	1	Number of	
							Streambanks/shoreline - stabilized or restored [580]		Feet	
							Riparian bluffs stabilized or restored [580]		Feet	
							Critical area planting [342]		Acres	
							Culvert replacement: Accurately size and position culverts	4	Number of	
						Pasture management	Livestock access control [472]		Acres	
							Watering facility to reduce livestock in stream [614]		Number of	
						sum of above (= to final WQ goal)				
			Bacteria /E. coli	440 org/100 mL (maximum monthly geometric mean)	≤ 126 org/100 mL (monthly geometric mean) ≤ 1,260 org/100 mL (individual sample) Overall, a 71% reduction will be required to meet the *E.coli* water quality standard	Pasture management	Livestock access control [472]		Acres	
						Pasture management	Watering facility to reduce livestock in stream [614]		Number of	
						Pasture management	Conventional pasture to prescribed rotational grazing [528, 808M]		Acres	
						sum of above (= to final WQ goal)				

3.3.3 Protection Strategies

Protection strategies for the RRHW were developed from data on existing BMPs (Section 3.3.1), existing reports, Core Team input, and the analyses conducted during the WRAPS process. Many protection strategies apply to all waterbodies in the RRHW; these are identified in Table 23 (labeled “All” under HUC-12 Aggregated Watersheds and Waterbody ID). The water quality goal for unimpaired lakes could range from maintaining current water quality in high-quality protection lakes to reducing phosphorus loading by 5% in at-risk lakes as indicated in the LPSS/LBCA dataset. Current phosphorus concentrations, target concentrations, and phosphorus reduction goals are provided per lake in Table 12. Current assessment status for streams is provided in Table 27, and stream data related to TALU, biological impairments, riparian risk, watershed risk, and current protection level are provided in Table 11.

Priority lakes identified by the Core Team are further analyzed in Appendix F with individual lake source assessments. These source assessments quantify phosphorus loading from different land uses within the lakes’ direct drainage area using HSPF-SAM, and target parcels for BMPs such as rain gardens and permanent protection strategies such as conservation easements. It is important to note that these are modeled results that should be used in combination with best professional judgement.

The strategies in Table 23 are organized per strategy type:

- Drinking water protection;
- Forestland management;
- Habitat and stream connectivity management;
- Lake management;
- Recreational management;
- Septic system and waste management;
- Stormwater runoff control; and
- Streambank and gully protection and restoration.

The strategies table only contains strategies that directly affect the quality of the waterbody, but there are many other strategies, such as education and outreach, that lay the groundwork for water quality improvement. Those items are summarized below.

Lake Management Outreach Strategies

- Develop lake management plans for individual lakes;
- Encourage formation and organization and lake associations;
- Conduct outreach to lakeshore landowners about BMPs; and
- Coordinate education and outreach messages and delivery methods with and between federal and state agencies, tribal governments and agencies, county and local governments, lake associations, and other groups.

Climate protection co-benefit of strategies and adaptation BMPs

Although agricultural use is minimal in this watershed there are locations where agriculture related BMPs such as riparian buffers and conversion of open lands to forest can reduce GHG emissions in addition to providing water quality benefits. Many agricultural BMPs, which 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 United States Department of Agriculture (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.com/.

A study on Wisconsin lakes offers some adaptation strategies for northern lakes facing climate change that can also apply in the RRHW (Magee et al. 2019). These include the strategies listed below.

- Water Levels: perform Lake level monitoring and education to adjust user expectations from static to fluctuating water levels. Also enact policies that protect the land near lakes, which could minimize property damage during high water.
- Water Quality: Traditional strategies such as BMPs may not be enough to reduce nutrients and runoff in the watershed. Adaptive strategies such as increased restrictions on watershed land use and increased protection may be necessary.
- Invasive Species: Controlling AIS vectors and pathways through policy changes and pathway-specific prevention approaches could help reduce the new invasive species entering the area.
- Fisheries: Protecting forest cover around coldwater fisheries can minimize the impact of climate change (Jacobson et al. 2010).

Subsequent local planning steps (i.e., 1W1P) will describe more specific planning elements such as intended projects and efforts, goals, resource needs for each project, who will be involved, and project timeframes.

Table 23. Protection strategies table for the RRHW

Waterbody and location		Water quality			Strategies to achieve final water quality goal			
						EXAMPLE Best Management Practice (BMP) Scenario		
HUC-12 Aggregated Watersheds	**Waterbody (ID)**	**Pollutant/ Stressor**	**Current WQ conditions**	**WQ Goal** (% and load to reduce)	**Strategy type**	**BMP** [NRCS BMP code included if available]	**Amount**	**Estimated reduction** *as applicable*
All	All	Sediment, nutrients (phosphorus and nitrogen), invasive species, forest loss, climate change	Appendix C, Table 11 Table 12	5% phosphorus reduction in at-risk lakes (Table 12)	Forestland management	Maintain existing forest cover - prevent new losses and maintain at least 75% forested watersheds surrounding coldwater lakes and streams	-	-
						Riparian zone forestland management – maintain forested riparian zones and convert short lived species to conifers and other long lived species to promote diverse mature forests, as applicable	-	-
						Terrestrial invasive species prevention and mitigation	-	-
						Prescribed burning	-	-
						Forestland management and improvement [147M, 490, 666]	-	-
						Roads and trails improvement [655]	-	-
						Implement DNR's Private Managed Forest Program and encourage enrollment of private land in 2c Managed Forest Lands or SFIA	-	-
						Forest erosion control on harvested lands	-	-
						Encourage easements and practices that reduce parcelization		
						Prepare and adjust for pests, invasive species, and other effects of climate change by considering underplanting and replacement species	-	-
		Fish passage, invasive species, sediment, temperature			Habitat and stream connectivity management	Protection of vulnerable ecosystems & habitats. Includes protection of cold water streams and lakes and wild rice waters through easements, forestland management, education, and water level management	-	-
						Build upon current culvert surveys	-	-
						Protect the existing connections stream channels have to their floodplains	-	-
						Modify/replace culverts & fish passage barriers	-	-
						Riparian tree planting to improve shading [390, 612]	-	-
		Sediment, phosphorus, altered hydrology			Streambank and gully protection	Restore riffle substrate	-	-
						Stream channel stabilization	-	-
						Maintain riparian herbaceous cover and improve quality of existing cover [390]	-	-
		Trash, invasive species, sediment/TSS			Recreational Management	Develop long-term solution to littering and trash collection near and in recreational areas	-	-
						Manage ATV trail impacts	-	-
						Promote care and stewardship of trails and wilderness areas	-	-
		Sediment/TSS phosphorus, chloride			Stormwater Runoff Controls	Outreach to promote smart salting practices, encourage rain barrels, and increase awareness of stormwater impacts to water quality		
						Enhanced road salt management	-	-

Waterbody and location		Water quality			Strategies to achieve final water quality goal			
						EXAMPLE Best Management Practice (BMP) Scenario		
HUC-12 Aggregated Watersheds	**Waterbody (ID)**	**Pollutant/ Stressor**	**Current WQ conditions**	**WQ Goal** (% and load to reduce)	**Strategy type**	**BMP** [NRCS BMP code included if available]	**Amount**	**Estimated reduction** *as applicable*
						Implement stormwater BMPs to reduce runoff from built structures	-	-
						Bioretention/biofiltration/rain garden (urban) [567M, 712M]	-	-
						Permeable surfaces and pavements	-	-
		Nutrients (phosphorus and nitrogen), bacteria/*E. coli*			Septic system improvements	Septic system maintenance and improvement [126M]	-	-
						Continue to enforce septic system ordinances	-	-
						Increase inspections and conduct inventory to support prioritization	-	-
		Phosphorus, sediment, temperature, invasive species			Lake Management	Enforce shoreland management regulations as property develops and redevelops, and discourage variances that increase shoreland run-off/reduce riparian vegetation. Encourage voluntary actions to mitigate the impacts of past development	-	-
						Implement DNR Fisheries Management Plans	-	-
						Proactively protect beneficial uses by taking positive actions to halt or minimize the spread of aquatic invasive species	-	-
						Continue to monitor water quality and evaluate water quality trends	-	-
						Encourage formation of organization and lake associations	-	-
						Aquatic Invasive Species management	-	-
						Maintenance of adequate water levels during low flow periods	-	-
						Protect and restore wild rice waters through ordinances, easements, water level management, and education	-	-
		Sediment/TSS Invasive species, bacteria/*E. coli*	Appendix C, Table 11, Table 12	5% phosphorus reduction in at-risk lakes (Table 12)	Recreational Management	Develop long-term solution to littering and trash collection near and in recreational areas	-	-
						Campsite stabilizations	-	-
						Promote care and stewardship of trails and wilderness	-	-
						Improve signage and education about aquatic hitchhikers on watercraft entering and exiting the BWCA and VNP	-	-
						Stabilization of portage trails	-	-
						Update and modernize the required video before entering the BWCA	-	-
Dunka River 0903000108-02	Dunka River (-986, -987)	Flow, temperature, TSS, conductivity, ions	Appendix C, Table 11 Table 12		Habitat and stream connectivity management	Continue to monitor Dunka River water quality parameters including conductivity and fish and macroinvertebrate communities.	-	-
					Habitat and stream connectivity management	Collaborate with stakeholders on the Dunka River and its tributaries to investigate impacts to stream temperature from the existing mine closure plan to prevent material increases in temperature that could lead to a stream impairment.	-	-

Waterbody and location		Water quality			Strategies to achieve final water quality goal			
						EXAMPLE Best Management Practice (BMP) Scenario		
HUC-12 Aggregated Watersheds	**Waterbody (ID)**	**Pollutant/ Stressor**	**Current WQ conditions**	**WQ Goal** (% and load to reduce)	**Strategy type**	**BMP** [NRCS BMP code included if available]	**Amount**	**Estimated reduction** *as applicable*
					Habitat and stream connectivity management	Collaborate with stakeholders on the Dunka River and its tributaries to examine potential hydrologic impacts of changes in flows estimated for post-mine pit closure.	-	-
					Forestland management	Collaborate with stakeholders on the Dunka River to maintain forest cover, especially in riparian zones and promote diverse mature forests.	-	-
Birch Lake (0903000108-06)	Unnamed Creek-Headwaters to Bob's Bay Birch Lk (-604)	Conductivity, ions	Additional data needed. See 'Section 4. Monitoring Plan'.	-	Habitat and stream connectivity management	Further evaluate, and better understand the impacts of conductivity to aquatic life in unnamed tributary to Bob's Bay of Birch Lake.	-	-

4. Monitoring plan

Continued monitoring is critical for determining if progress has been made in restoration and protection and for determining the effects of future impacts on water quality. This section describes existing and recommended future monitoring activities in the watershed.

As part of the state's watershed approach, the MPCA conducts IWM at the HUC-8 watershed scale approximately every 10 years. This two-year intensive monitoring program of lakes and streams informs assessments of water quality throughout the watershed and identifies impaired waters. The next round of IWM for the RRWH will start in 2025.

In addition, the MPCA coordinates two programs aimed at encouraging long term citizen surface water monitoring: the CLMP and the Citizen Stream Monitoring Program (CSMP). Blackduck Lake is currently monitored through the CLMP, and the CSMP has identified a site on the Blackduck River as a high priority site in need of a citizen monitor. Having citizen volunteers monitor a given lake or stream station monthly and from year to year can provide long-term data needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years.

Monitoring in the RRHW has been conducted by many different entities, including state agencies such as the MPCA, DNR, and MDH, along with counties, SWCDs, Lake Associations, USFS, and VNP. DNR Fisheries staff also regularly collect data in support of fishery management. Some Lake Associations, such as the WICOLA, have been collecting water quality condition data for over 10 years.

Some specialized monitoring has been conducted in the RRHW including:

- Metals monitoring in the Kawishiwi Watershed;
- Sentinel Lakes monitoring in Bear Head and White Iron Lakes (DNR);
- Phytoplankton and algal toxicity monitoring in Lake Kabetogama;
- Nutrient and biology monitoring in Lake Kabetogama in response to water level manipulation;
- Paleolimnologic reconstructions for the White Iron Chain of Lakes;
- AIS surveys and monitoring; and
- Aquatic plant surveys in Burntside Lake.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction and protection. Watershed partners already have good momentum in the past implementing BMPs, shown in Figure 29 and Table 21, and there are many existing programs for protection such as the Sustainable Forest Incentive Act. Barriers that could slow future progress include the degree of landowner willingness to implement practices, limitations of face-to-face contact with landowners due to the lingering COVID-19 Pandemic, and challenging projects (e.g., stream restoration, culvert and dam replacement, invasive species, mining expansion). Conversely, there may be faster progress for some impaired waters, especially where high-impact projects are slated to occur.

As implementation occurs in the watershed, monitoring can track the response in waterbodies. In addition to the continuing monitoring occurring by the MPCA, DNR, and local organizations such as SWCDs and Lake Associations, possible monitoring and research recommendations include:

- Expanded culvert inventories to identify priority areas limiting fish passage and exacerbating water quality degradation
- Conduct thorough roadway and ditch assessments in prioritized areas throughout the Ash River Watershed
- *E.coli* and TSS effectiveness monitoring following implementation of protection projects monitoring in Ash and Blackduck rivers
- Stormwater monitoring and analysis near towns to better understand stormwater impacts within the watershed
- Continued transparency monitoring of lakes experiencing a declining transparency trend or near impairment
- Water quality monitoring in Lake Kabetogama to better understand internal loading rates
- Continue biological sampling in the Lower Dunka River to identify areas in need of protection, including areas that are critical to spawning and supportive of different age classes of brook trout and protective of other cool/warmwater species
- Characterize the contributions of tributaries to healthy trout habitat in the Dunka River. This includes continued temperature and flow monitoring of the Dunka River and its tributaries
- Monitoring the potential impact of climate change including
    - Streamflow and stream temperature
    - DO and temperature profiles in coldwater lakes
- Monitoring for the prevention of AIS movement into BWCAW
- Updated LiDAR data to better support desktop analysis
- Continue to monitor waters receiving wastewater from mining facilities to better understand conditions of conductivity, sulfate, temperature, and TSS as they relate to aquatic life standards.
- Monitor, evaluate, and better understand the impacts of conductivity to aquatic life in unnamed tributary to Bob's Bay of Birch Lake. Collect enough data for evaluation against aquatic life standards, both narrative and numeric.
- Work with Northshore Mining Company to evaluate anticipated changes in flow and other impacts to water quality under the existing mine closure plan.
- Continue to monitor Dunka River water quality parameters including conductivity and fish and macroinvertebrate communities.

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Additional Rainy River - Headwaters Watershed Resources

During the WRAPS process, a bibliography of studies and data within the watershed was collected from the Core Team and is included in **Appendix A**.

6. Appendices

Appendix A. Rainy River Headwaters Watershed Bibliography

The purpose of this table is to provide a comprehensive bibliography of all watershed and water quality related studies and projects previously completed in the Rainy River Headwaters Watershed.

Table 24. RRHW Literature

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
DNR	2017	Water Appropriation Permits Summary	DNR	Supplied to MPCA Core Team								X
Anderson, J. et al.	2010	Sentinel Lake Assessment Report White Iron Lake (69-0004)	MPCA/DNR	https://www.pca.state.mn.us/sites/default/files/wq-2slice69-0004.pdf			X					X
Anderson, P.; et. al.	2000	Minnesota State and Regional Government Review of Internal Phosphorus Load Control: An important option in the lake management toolbox	MPCA, DNR, BWSR, Metropolitan Council	https://www.pca.state.mn.us/sites/default/files/wq-s1-98.pdf			X					

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Anderson, J.; Valley, R.; Klick, D.	2012	Sentinel Lake Assessment Report Bear Head Lake (69-0254)	MPCA/DNR	https://www.pca.state.mn.us/sites/default/files/wq-2slice69-0254.pdf			X					X
Anderson. P. et al.	2017	Incorporating Lake Protection Strategies into WRAPS Reports	MPCA	https://www.pca.state.mn.us/sites/default/files/wq-ws4-03c.pdf	X	X	X	X	X			
Barr Engineering	2008	Long-Range Hydrology Study Northshore Mining Company Final Report	Barr Engineering		X		X	X				
Bartosiewicz.M, et. al.	2019	Hot tops, cold bottoms: Synergistic climate warming and shielding effects increase carbon burial in lakes	University of Basel, University of Montreal	*Limnology and Oceanography,* 4: 132– 144 https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lol2.10117	X		X					

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Brigham, E.; et.al.	2014	Lacustrine Responses to Decreasing Wet Mercury Deposition Rates - Results from a Case Study in Northern Minnesota	USGS, University of Wisconsin, University of Illinois, NPS	*Environ. Sci. Technol.*, 48: 6115–6123 https://pubs.acs.org/doi/10.1021/es500301a	X		X	X				X
Christensen, V.G.; Maki, R.P.; Stelzer. E.A.; Norland J.E.; Khan E.	2019	Phytoplankton community and algal toxicity at a recurring bloom in Sullivan Bay, Kabetogama Lake, MN	USGS, North Dakota State University, VNP, University of Nevada	*Scientific Reports*, 9: 16129 https://doi.org/10.1038/s41598-019-52639-y	X	X	X					X
Christensen, V.G.; Maki, R.P.; Kiesling, R.L.	2011	Relation of Nutrient Concentrations, Nutrient Loading, and Algal Production to Changes in Water Levels in Kabetogama Lake, Voyageurs National Park, Northern Minnesota, 2008-09	USGS/USDI	*Scientific Investigations Report,* 2011-5096 https://doi.org/10.3133/sir20115096	X	X	X	X				X

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Christensen, V.G.; Payne, G.A.; Kallemeyn, L.W.	2004	Effects of Changes in Reservoir Operations on Water Quality and Trophic State Indicators in Voyageurs National Park, Northern Minnesota, 2001-03	USGS/USDI	*Scientific Investigations Report*, 2004-5044 https://doi.org/10.3133/sir20045044	X		X					
Christensen, V.G.; Maki, R.P.; Kiesling, R.L.	2013	Evaluation of internal loading and water level changes: implications for phosphorus, algal production, and nuisance blooms in Kabetogama Lake, Voyageurs National Park, MN	USGS/USDI	*Lake and Reservoir Management,* 29: 202-215 https://doi.org/10.1080/10402381.2013.831148	X	X	X	X				X
Christensen, V.G.; Maki,R.P.	2015	Trophic State in Voyageurs National Park Lakes Before and After Implementation of Revised Water Level Management Plan	USGS/USDI	*Journal of the American Water Resources Association*, 51: 99-111	X		X	X				X

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
				https://doi.org/10.1111/jawr.12234								
Corman, J.R.; et al.	2018	Nitrogen and Phosphorus Loads to Temperate Seepage Lakes Associated with Allochthonous Dissolved Organic Carbon Loads	University of Wisconsin-Madison	*AGU Geophysical Research Letters, 45*, 5481–5490. https://doi.org/10.1029/2018GL077219	X		X					
Heiskary, S; Egge, L.	2016	A review of Secchi transparency trends in Minnesota lakes	MPCA	https://www.pca.state.mn.us/sites/default/files/wq-s2-08.pdf	X		X					
Jacobson, P.C.; Stefan, H.G.; Pereira, D.L	2002	Coldwater fish oxythermal habitat in Minnesota lakes: influence of total phosphorus, July air temperature, and relative depth	DNR and U of M, Saint Anthony Falls Hydraulic Laboratory	*Journal of Fish and Aquatic Science, 67*, 2002–2013			X	X				

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Jasperson, J.	2019	Rainy River - Headwaters Stressor Identification Report	MPCA	https://www.pca.state.mn.us/sites/default/files/wq-ws5-09030001a.pdf	X	X	X					X
Johnson-Bice, S.M.; et. al.	2018	A Review of Beaver-Salmonid Relationships and History of Management Actions in the Western Great Lakes Region	NRRI, Bemidji State University	*American Fisheries Society,* 38:1203–1225	X		X					X
Kallemeyn, L.W.; Holmberg, K.L.; Perry, J. A.; Odde, B.Y.	2003	Aquatic Synthesis for Voyageurs National Park	USGS/USDI	*USGS Information and Technology Report 2003-0001* https://www.cerc.usgs.gov/pubs/center/pdfdocs/ITR2003-0001.pdf	X		X	X	X			X
Kirschbaum, A.A.; Gafvert, U.B.	2017	Landsat-based Monitoring of Landscape Dynamics at Voyageurs National Park	NPS/NRSS/USDI	*Natural Resource Data Series NPS/GLKN/NRDS—2017/1089*	X	X	X					X

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Kolka, R.K.; et al.	2017	Emissions of forest floor and mineral soil carbon, nitrogen and mercury pools and relationships with fire severity for the Pagami Creek Fire in the Boreal Forest of northern Minnesota	USFS, Michigan State University, University of Wisconsin Madison, Iowa State University, University of Maine, North Dakota State University	*International Journal of Wildland Fire*, 26, 296–305	X	X	X	X				
Magee, M.R.; et. al.	2019	Scientific advances and adaption strategies for Wisconsin lakes facing climate change	University of Wisconsin-Madison, WIDNR	*Lake and Reservoir Management, 35*, 364–381 https://doi.org/10.1080/10402381.2019.1622612	X		X					
Mielke, N.	2017	Rainy River Headwaters Watershed Monitoring and Assessment Report	MPCA	https://www.pca.state.mn.us/sites/default/files/wq-ws3-09030001b.pdf			X					X
DNR	2019	Watershed Health Assessment Framework (WHAF): Climate	DNR	http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/								X

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
		Summary for Watersheds RRHW		climate_summary_major_72.pdf								
DNR	2017	Watershed Health Assessment Framework (WHAF): Watershed Context Report RRHW	DNR	http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_72.pdf								X
DNR	2015	Watershed Health Assessment Framework (WHAF): Watershed Report Card RRHW	DNR	http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_72.pdf								X
Minnesota Environmental Quality Board (EQB)	1979	Minnesota Environmental Quality Board. The Minnesota Regional Copper-Nickel Study, 1976-1979	EQB	https://www.lrl.mn.gov/edocs/edocs?oclcnumber=05579755	X		X					
MPCA, DNR, BSWR	2018	Protection and Prioritization: Tools available to help	MPCA, DNR, BSWR	https://www.pca.state.mn.us/sites/default/files/wq-ws1-29.pdf	X	X	X					

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
		prioritize waters for protection efforts										
Payne, G.A.	1991	Water Quality of Lakes and Streams in Voyageurs National Park, Northern Minnesota, 1977-84	USGS/USDI	*Water-Resources Investigations Report 88-4016* https://doi.org/10.3133/wri884016			X					
Payne, G.A.	2000	Water Quality of Lakes in Voyageurs National Park, Northern Minnesota, 1999	USGS/USDI	https://doi.org/10.3133/wri20004281								
Radomski, P; Carlson, K.	2018	Prioritizing lakes for conservation in lake-rich areas	DNR	*Lake and Reservoir Management, 34*, 401–416			X	X				
Reavie, E.	2013	Paleolimnological Reconstructions for the White Iron Chain of Lakes	UMD NRRI	https://hdl.handle.net/11299/187336	X		X					X

Authors	Year	Title	Agency/ Organization	Link or Journal (if available)	Hydrology/Altered Hydrology	Sediment	Water Quality	Watershed Modeling	In Stream Hydraulic Modeling	Flooding	Aquatic Invasive Species	Watershed Information
Vogt, D. J.	2021	Wild Rice Monitoring and Abundance in the 1854 Ceded Territory (1998-2020)	1854 Treaty Authority	https://www.1854treatyauthority.org/management/biological-resources/fisheries/reports.html?id=228&task=document.viewdoc								X
Wiener, J. G.; et al.	2006	Mercury in Soils, Lakes, and Fish in Voyageurs National Park: Importance of Atmospheric Deposition and Ecosystem Factors	University of Wisconsin- La Crosse, USGS, Gustavus Adolphus College, St. Croix Watershed Research Station, Metropolitan Council Environmental Services	*Environmental Science & Technology*, 40: 6261-6268 https://pubs.acs.org/doi/abs/10.1021/es060822h	X		X					X

Table 25. Other RRHW data types

Data Name	Source	Date (if applicable)	Type of Data	Information contained
1854 Treaty Authority Wild Rice Water Shapefile	1854 Treaty Authority		Shapefile	Location of wild rice stands
Arrowhead Pilot Project Brief	Arrowhead Pilot Project	2019	Word Document	Description of sustainable forest initiative
DNR Finland Area Fisheries Connectivity Prioritization	DNR	2019	Powerpoint	Description of crossing prioritization method to enhance brook trout suitability
Rainy Headwater Lake County Culvert Prioritization	DNR Finland Fisheries	2020	Spreadsheet	List of prioritized crossings to enhance brook trout suitability
RRHW Historical Precipitation Summary	DNR	2018	Word Document	Historical precipitation 1900-present
RRHW Outlet Structure Shapefile	DNR	2018	Shapefile	Outlet structure locations for the RRHW
Statewide List of Nearly/Barely Impaired lakes	MPCA	2020	Spreadsheet	Proximity of lakes to the aquatic recreation standards
Stream & Lake Protection Prioritization RRHW	DNR, MPCA	2020	Spreadsheet	Breakdown of lakes, stream prioritization and ranking criteria
Stream & Lake Protection Prioritization RRRL (includes lakes in RRHW harmonized boundary)	DNR, MPCA	2020	Spreadsheet	Breakdown of lakes, stream prioritization and ranking criteria
Rainy River Headwaters Outlet Structures	DNR	2017	Shapefile	Location of river outlet structures

Appendix B. Aquatic Consumption Impairment Table

There are numerous waterbodies in the Rainy River Headwaters Watershed that have aquatic consumption impairments based on mercury in fish tissue (212), mercury in the water column (1, Hustler Lake), or PCBs in fish tissue (1, Ojibwe Lake). Of these impairments, 117 mercury TMDLs were approved as part of the 2018 Mercury TMDL Appendix A (Table 1). Revisions to Appendix A of the Minnesota Statewide Mercury TMDL (MPCA 2007) are submitted to the EPA every two years with the impaired waters list. Water resources with mercury concentrations greater than 0.572 mg/kg are not part of Appendix A, and TMDLs for these 96 water bodies in the Rainy River–Headwaters Watershed are expected to be completed between 2021 and 2033 (according to Minnesota's draft 2020 list of impaired water bodies). A TMDL for the PCB impairment is expected to be copleted by 2033.

For more information on mercury impairments, see the statewide mercury TMDL: https://www.pca.state.mn.us/water/statewide-mercury-reduction-plan.

Table 26. Summary of mercury fish tissue impairments in the Rainy River Headwaters Watershed (Draft Minnesota 2020 303(d) list).

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
Adams	Lake	1998	38-0153-00	Y
Agnes	Lake	1998	69-0830-00	
Alpine	Lake	1998	16-0759-00	
Amoeber	Lake	2020	38-0227-00	
Ash	Lake	1998	69-0864-00	Y
August	Lake	1998	38-0691-00	
Bass	Lake	2002	69-0063-00	Y
Basswood	Lake	1998	38-0645-00	Y
Basswood River	Stream	1998	09030001-505	Y
Bear Island	Lake	1998	69-0115-00	
Bearhead (main lake)	Lake	1998	69-0254-01	Y
Bearhead (northerly-most northwest bay)	Lake	1998	69-0254-02	Y
Beast	Lake	2004	69-0837-00	
Beaver Hut	Lake	1998	38-0737-00	
Big	Lake	1998	69-0190-00	Y
Big Moose	Lake	1998	69-0316-00	
Birch	Lake	1998	38-0532-00	Y
Birch	Lake	1998	69-0003-00	
Black Duck	Lake	2002	69-0842-00	Y
Bog	Lake	2012	38-0443-00	Y
Border waters	Stream	1998	09030001-503	Y
Border waters	Stream	1998	09030001-812	Y
Bottle River and Iron Lake	Stream	1998	09030001-507	Y
Browns	Lake	1998	38-0780-00	Y
Bunny	Lake	2002	38-0293-00	
Burntside	Lake	1998	69-0118-00	

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
Cedar	Lake	1998	38-0810-00	Y
Cherry	Lake	2020	38-0166-00	
Clear	Lake	2002	38-0722-00	Y
Coffee	Lake	1998	38-0064-00	Y
Comfort	Lake	2018	38-0290-00	
Cook	Lake	2018	38-0004-00	Y
Crab	Lake	2004	69-0220-00	
Crooked	Lake	1998	16-0723-00	Y
Crooked	Lake	1998	38-0817-00	Y
Cruiser	Lake	1998	69-0832-00	Y
Deep	Lake	1998	38-0668-00	
Disappointment	Lake	1998	38-0488-00	Y
Dovre	Lake	1998	69-0604-00	
Dumbbell	Lake	1998	38-0393-00	Y
Dunnigan	Lake	1998	38-0664-00	
East Chub	Lake	1998	38-0674-00	Y
East Pope	Lake	2010	16-0342-00	
East Twin	Lake	1998	69-0163-01	Y
East Twin	Lake	2002	69-0174-00	
Ed Shave	Lake	1998	69-0199-00	
Eighteen	Lake	1998	38-0432-00	Y
Ek	Lake	1998	69-0843-00	Y
Ensign	Lake	2006	38-0498-00	
Ester	Lake	2020	38-0207-00	
Eugene	Lake	2004	69-0473-00	
Everett	Lake	1998	69-0120-00	
Extortion	Lake	2002	16-0450-00	Y
Fall	Lake	1998	38-0811-00	
Farm	Lake	2008	38-0779-00	
Fat	Lake	1998	69-0481-00	Y
Fenske	Lake	2002	69-0085-00	
Flash	Lake	1998	38-0630-00	Y
Flat Horn	Lake	1998	38-0568-00	Y
Four	Lake	2020	38-0528-00	
Fourtown	Lake	1998	38-0813-00	
Franklin	Lake	1998	69-0754-00	
Fraser	Lake	1998	38-0372-00	Y
Frost	Lake	1998	16-0571-00	Y
Gabbro	Lake	2018	38-0701-00	
Gabimichigami	Lake	1998	16-0811-00	Y
Gander	Lake	1998	38-0554-00	
Gannon	Lake	2010	69-0819-00	

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
Garden	Lake	1998	38-0782-00	
Ge-Be-On-Equat	Lake	1998	69-0350-00	
Gegoka	Lake	2010	38-0573-00	
Gillis	Lake	1998	16-0753-00	Y
Grass	Lake	1998	38-0635-00	Y
Grassy	Lake	2002	69-0082-00	
Greenstone	Lake	1998	38-0718-00	Y
Greenwood	Lake	1998	38-0656-00	
Grouse	Lake	1998	38-0557-00	
GULL (MAIN BASIN)	Lake	2002	16-0632-01	
Gun	Lake	1998	69-0487-00	
Gunflint	Lake	1998	16-0356-00	
Hanson	Lake	2020	38-0206-00	
Harriet	Lake	1998	38-0048-00	Y
Harris	Lake	1998	38-0736-00	
Heritage	Lake	2006	69-0469-00	
Highlife	Lake	1998	38-0673-00	Y
Hobo	Lake	2004	69-0062-00	Y
Hog	Lake	1998	16-0653-00	
Horse	Lake	1998	38-0792-00	
Hustler	Lake	1998	69-0343-00	
Ima	Lake	2002	38-0400-00	Y
Insula	Lake	2004	38-0397-00	
Iron	Lake	2002	16-0328-00	Y
Iron	Lake	2020	69-0121-00	
Isabella	Lake	1998	38-0396-00	Y
Jack	Lake	2002	38-0441-00	Y
Jasper	Lake	1998	16-0768-00	Y
Jeanette	Lake	1998	69-0456-00	Y
Johnson	Lake	1998	69-0117-00	Y
Johnson	Lake	1998	69-0691-00	
Jorgens	Lake	2002	69-0867-00	
Joseph	Lake	2014	69-0157-00	Y
Jouppi	Lake	2010	38-0909-00	Y
Kabetogama	Lake	1998	69-0845-00	Y
Kawishiwi	Lake	1998	38-0080-00	Y
Kawishiwi River	Stream	2002	09030001-512	Y
Kawishiwi River	Stream	2002	09030001-988	Y
Kawishiwi River	Stream	2002	09030001-990	Y
Kawishiwi River	Stream	2002	09030001-992	Y
Kekekabic	Lake	2020	38-0226-00	
Knife	Lake	1998	38-0404-00	Y

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
Lac la Croix	Lake	1998	69-0224-00	
Little	Lake	1998	69-0056-00	
Little Iron	Lake	2002	16-0355-00	Y
Little Johnson	Lake	1998	69-0760-00	Y
Little Knife	Lake	1998	38-0229-00	Y
Little Long	Lake	1998	69-0066-00	Y
Little Loon	Lake	2012	69-0484-00	
Little Saganaga	Lake	1998	16-0809-00	Y
Little Trout	Lake	1998	69-0682-00	Y
Little Vermilion	Lake	1998	69-0608-00	
Long	Lake	2002	69-0765-00	Y
Loon	Lake	1998	16-0448-00	
Loon	Lake	1998	69-0470-00	
Loon River and Little Vermilion Lk	Stream	1998	09030001-509	Y
Low	Lake	1998	69-0070-00	Y
Lower Pauness	Lake	2008	69-0464-00	Y
Lynx	Lake	2006	69-0383-00	
Mayhew	Lake	1998	16-0337-00	Y
Meditation	Lake	2002	16-0583-00	Y
Mesaba	Lake	1998	16-0673-00	
Middle McDougal	Lake	2002	38-0658-00	Y
Minister	Lake	1998	69-0065-00	
Moose	Lake	1998	38-0644-00	Y
Moose	Lake	1998	69-0750-00	Y
Muckwa	Lake	1998	69-0159-00	Y
Mudro	Lake	2016	69-0078-00	
Mukooda	Lake	1998	69-0684-00	Y
Namakan	Lake	1998	69-0693-00	
Namakan Narrows	Stream	1998	09030001-813	Y
Nels	Lake	1998	69-0080-00	
Net	Lake	2002	69-0757-00	
Newfound	Lake	1998	38-0619-00	Y
Newton	Lake	1998	38-0784-00	Y
Nickel	Lake	2002	38-0705-00	
North	Lake	1998	16-0331-00	Y
North Branch Kawishiwi	Lake	2008	38-0738-00	
North McDougal	Lake	2002	38-0686-00	
Ogishkemuncie	Lake	2004	38-0180-00	Y
Ojibway	Lake	1998	38-0640-00	
Ole	Lake	2004	69-0175-00	
O'Leary	Lake	1998	69-0685-00	Y

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
One	Lake	1998	38-0605-00	Y
One Pine	Lake	1998	69-0061-00	
Organ	Lake	2002	38-0067-00	
Ottertrack	Lake	2002	38-0211-00	
Oyster	Lake	1998	69-0330-00	
Parent	Lake	1998	38-0526-00	Y
Perch	Lake	1998	69-0058-00	
Perent	Lake	1998	38-0220-00	Y
Phoebe	Lake	2002	16-0808-00	
Pickerel	Lake	2002	38-0741-00	Y
Picket	Lake	2002	69-0079-00	
Pike	Lake	1998	38-0670-00	Y
Polly	Lake	2006	38-0104-00	
Quadga	Lake	1998	38-0596-00	Y
Ramshead	Lake	1998	69-0339-00	Y
Red Rock	Lake	1998	16-0793-00	Y
Redskin	Lake	2010	38-0440-00	Y
Round	Lake	1998	16-0606-00	Y
Saganaga	Lake	1998	16-0633-00	Y
Sand	Lake	1998	38-0735-00	
Sand Point	Lake	1998	69-0617-00	
Sandpit	Lake	1998	38-0786-00	
Sea Gull	Lake	1998	16-0629-00	
Section 29	Lake	1998	38-0292-00	Y
Section Twelve	Lake	2002	38-0714-00	Y
Shagawa	Lake	1998	69-0069-00	Y
Shell	Lake	2018	69-0461-00	Y
Silver Island	Lake	1998	38-0219-00	Y
Slate	Lake	1998	38-0666-00	
Slim	Lake	1998	69-0181-00	
Snowbank	Lake	1998	38-0529-00	Y
South Farm	Lake	2008	38-0778-00	
South McDougal	Lake	2002	38-0659-00	
Spring	Lake	1998	69-0761-00	
Square	Lake	1998	38-0074-00	Y
Stuart	Lake	1998	69-0205-00	
Sucker	Lake	1998	38-0530-00	
Surprise	Lake	2002	38-0550-00	Y
Sylvania	Lake	2002	38-0395-00	
T	Lake	1998	38-0066-00	Y
Takucmich	Lake	2002	69-0369-00	Y
Tee	Lake	2002	69-0083-00	Y

Water body name	Water body type	Year added to 303(d) list	WID	TMDL Approved (Y)
Thomas	Lake	1998	38-0351-00	Y
Three	Lake	1998	38-0600-00	
Tooth	Lake	1998	69-0756-00	
Triangle	Lake	1998	38-0715-00	Y
Two	Lake	1998	38-0608-00	Y
Two Deer	Lake	2014	38-0671-00	Y
Unnamed	Lake	2002	69-0869-00	
Upper Pauness	Lake	2008	69-0465-00	
Vera	Lake	1998	38-0491-00	Y
Wanless	Lake	1998	38-0049-00	
Watonwan	Lake	1998	38-0079-00	
West Chub	Lake	1998	38-0675-00	Y
West Pope	Lake	2002	16-0341-00	Y
West Twin	Lake	1998	69-0163-02	Y
Whisper	Lake	1998	69-0059-00	Y
White Iron	Lake	1998	69-0004-00	
Wind	Lake	2014	38-0642-00	Y
Windy	Lake	1998	38-0068-00	
Wine	Lake	1998	16-0686-00	
Wolf	Lake	1998	69-0161-00	
Wye	Lake	2012	38-0042-00	Y

Appendix C: Assessment status of lakes and rivers in the RRHW

Table 27. Assessment status of river reaches in the RRHW

Aggregated HUC-12	WID (09030001-)	Reach Name	Reach Description	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
Granite River 0903000103-01	974	Larch Creek	Headwaters to Boundary Waters Canoe Area Wilderness Boundary	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
Cross River 0903000103-02	966	Cross River	Ham Lk Outlet to Gunflint Lk	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	IF	SUP	SUP
Lower Stony River 0903000106-01	978	Unnamed Creek	Wadop Lk to Stony R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	804	Nip Creek	Jackpot Cr to T60 R11W S22, North Line	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	555	Harris Creek (Harris Lake Creek)	Headwaters to T61 R10W S19, west line	MTS	- -	- -	- -	- -	- -	- -	- -	- -	SUP	- -
	573	Nira Creek	Harris Lk to Denley Cr	MTS	MTS	- -	- -	- -	- -	- -	- -	- -	SUP	- -
	627	Denley Creek	Nira Cr to Stony R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	985	Stony River	Unnamed Creek (Stony Lk Outlet) to Birch Lk	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	MTS	SUP	SUP
Upper Stony River 0903000106-02	693	Wilbar Creek	Osier Cr to Stony R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	984	Stony River	Headwaters (Source Lk 38-0654-00) to Unnamed Creek (Stony Lake Outlet)	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	IF	SUP	IF
Greenwood River 0903000106-03	602	Greenwood River	Stockade Cr to Stony Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -

Aggregated HUC-12	WID (09030001-)	Reach Name	Reach Description	Aquatic Life Indicators									Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH3	Eutrophication		
Isabella River 0903000107-01	676	Hog Creek	Unnamed Cr to Unnamed Cr	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
Little Isabella River 0903000107-02	577	Sphagnum Creek	Headwaters to Little Isabella R	MTS	- -	- -	- -	- -	- -	- -	- -	- -	SUP	- -
	530	Little Isabella River	Headwaters to Flat Horn Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	561	Little Isabella River	Dragon Lk to Boundary Waters Canoe Area Wilderness Boundary	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	IF	SUP	SUP
Mitawan Creek 0903000107-03	556	Hill Creek	Headwaters to Mitawan Lk	MTS	- -	- -	- -	- -	- -	- -	- -	- -	SUP	- -
	564	Jack Pine Creek	T60 R8W S18, east line to Mitawan Cr	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	558	Inga Creek	Majava Lk to T 60 R10W S 14, north line	MTS	MTS	IF	IF	MTS	- -	MTS	IF	IF	SUP	- -
	560	Inga Creek	T60 R10W S14, south line to Mitawan Cr	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	568	Mitawan Creek	Kitigan Lk to T61 R9W S13, north line	MTS	MTS	IF	IF	MTS	- -	MTS	IF	IF	SUP	- -
Island River 0903000107-04	979	Harriet Creek	Harriet Lk to Silver Island Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	529	Island River	Headwaters (Silver Island Lk 38-0219-00) to Island Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	586	West Camp Creek	Headwaters to Camp Cr	MTS	- -	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	801	Trappers Creek	Trappers Lk to T60 R8W S28, north line	MTS	- -	- -	- -	- -	- -	- -	- -	- -	SUP	- -
	550	Arrowhead Creek	Spear Lk to Island R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	563	Island River	Island Lk to Isabella R	MTS	- -	IF	IF	MTS	MTS	EXS	MTS	IF	SUP	SUP
Dumbbell River	578	Tomlinson Creek	Headwaters to Dumbbell R	MTS	- -	- -	- -	- -	- -	- -	- -	- -	SUP	- -

Aggregated HUC-12	WID (09030001-)	Reach Name	Reach Description	Aquatic Life Indicators									Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH3	Eutrophication		
0903000107-05	574	Scott Creek	Headwaters (Scott Lk 38-0271-00) to Dumbbell R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	773	Folly Creek	Folly Lk outlet to Green Wing Cr	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	632	Dumbbell River	Tomlinson Cr to Scott Cr	MTS	- -	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	634	Dumbbell River	Unnamed Cr to Island R	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	IF	SUP	SUP
South Kawishiwi 0903000108-01	531	Snake River	Headwaters to T 61 R9W S18, north line	MTS	MTS	NA	- -	MTS	- -	EXS	- -	- -	SUP	- -
	542	Snake River	T61 R9W S7, south line to T61 R10W S12, north line	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	674	August Creek	August Lk to Boundary Waters Canoe Area Wilderness Boundary	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	605	Filson Creek	Omaday Lk to South Kawishiwi R	- -	MTS	IF	IF	MTS	- -	EXS	IF	IF	SUP	- -
	684	Keely Creek	Headwaters (Heart Lk 38-0692-00) to Birch Lk	MTS	MTS	IF	IF	MTS	- -	IF	IF	IF	SUP	- -
	519	Birch River	Isaac Lk to Birch Lk	MTS	- -	IF	IF	MTS	- -	IF	IF	IF	SUP	- -
	537	South Kawishiwi River	Boundary Waters Canoe Area Wilderness Boundary to Birch Lk	- -	- -	IF	IF	MTS	IF	MTS	IF	MTS	SUP	- -
	536	South Kawishiwi River	NE tip of Birch Lk to dam	- -	- -	IF	MTS	MTS	MTS	MTS	MTS	MTS	NA	SUP
Dunka River 0903000108-02	986	Dunka River	Headwaters to Unnamed Ditch	MTS	MTS	NA	IF	MTS	- -	IF	IF	IF	SUP	- -
	987	Dunka River	Unnamed Ditch to Birch Lk	MTS	MTS	NA	IF	MTS	MTS	MTS	MTS	MTS	SUP	SUP
	982	Phoebe Creek	Hazel Lk to Lk Polly	MTS	MTS	IF	- -	- -	- -	IF	- -	- -	SUP	- -

Aggregated HUC-12	WID (09030001-)	Reach Name	Reach Description	Aquatic Life Indicators									Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH3	Eutrophication		
Upper Kawaishiwi River 0903000109-02	990	Kawishiwi River	Kawasachong Lk to Lk Polly	MTS	MTS	IF	- -	- -	- -	IF	- -	- -	SUP	- -
Shagawa River 0903000110-01	976	Crab Creek	Boundary Waters Canoe Area Wilderness Boundary to Burntside Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	808	Burntside River	Burntside Lk to Shagawa Lk	MTS	- -	- -	IF	IF	- -	- -	- -	IF	SUP	- -
	565	Longstorff Creek	Mitchell Lk to Shagawa Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	535	Shagawa River	Shagawa Lk to Fall Lk	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	MTS	SUP	SUP
Bear Island River 0903000111-02	708	Johnson Creek	Headwaters (Mud Lk 69-0060-00) to Johnson Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	663	Beaver River	Unnamed Cr to Bear Island Lk	MTS	- -	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	665	Bear Island River	Bear Island Lk to One Pine Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	608	Bear Island River	One Pine Lk to White Iron Lk	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	MTS	SUP	SUP
Horse River 0903000113-02	719	Horse River	Headwaters (Horse Lk 38-0792-00) to Rainy R	MTS	MTS	IF	- -	IF	- -	IF	- -	- -	SUP	- -
Boulder River 0903000118-01	744	Duck Creek	Boundary Waters Canoe Area Wilderness Boundary to Portage R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	788	Portage River	T65 R14W S24, east line to T65 R13W S19, north line	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	601	Portage River	T65 R14W S12, east line to Nina Moose Lk	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -

Aggregated HUC-12	WID (09030001-)	Reach Name	Reach Description	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
	975	Bezhik Creek	Boundary Waters Canoe Area Wilderness Boundary to Moose R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	521	Moose River	T65 R14W S34, south line to T65 R14W S11, 0.09 mi above south	MTS	- -	IF	IF	IF	- -	IF	MTS	IF	SUP	- -
	650	Nina Moose River	Nina Moose Lk to Ramshead Cr	MTS	MTS	IF	- -	IF	- -	IF	- -	- -	SUP	- -
	733	Stuart River	Jerry Cr to Mule Cr	- -	MTS	IF	- -	IF	- -	IF	- -	- -	SUP	- -
Little Indian Sioux River 0903000120-02	557	Little Indian Sioux River	T65 R15W S35, south line to T65 R15W S1, north line	MTS	MTS	IF	MTS	MTS	MTS	EXS	MTS	MTS	SUP	SUP
Ash River 0903000123-01	868	Camp Ninety Creek	Unnamed Cr to T68 R19W S20, north line	MTS	MTS	- -	IF	IF	- -	- -	- -	IF	SUP	- -
	823	Kinmount Creek	Unnamed Cr to Ash R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	819	Ash River	Headwaters (Ash Lk 69-0964-00) to Blackduck R	MTS	MTS	IF	IF	IF	- -	IF	- -	IF	SUP	-
	818	Ash River	Blackduck R to Ash River Falls	MTS	- -	EXS	EXS	EXS	MTS	MTS	MTS	IF	IMP	SUP
Blackduck River 0903000123-03	827	Ninemile Creek	Chub Lk to Blackduck R	MTS	MTS	IF	IF	IF	- -	IF	IF	IF	SUP	- -
	820	Blackduck River	Headwaters (Blackduck Lk 69-0842-00) to Ash R	MTS	MTS	EXS	EXS	EXS	MTS	IF	MTS	IF	IMP	IMP

Abbreviations for Indicator Evaluation: MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information

Abbreviations for Use Support Determinations: -- = No Data; NA = Not Assessed, IF = Insufficient Information; SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)

Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information

Table 28. Assessment status of lakes in the RRHW

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
16-0617-00	Gneiss	61.1	70	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0580-00	Granite	38.1	45	Deep Lake	- -	- -	- -	IF	- -	IF
16-0357-00	Crab	78	17	- -	IF	- -	- -	- -	IF	IF
16-0331-00	North	530	125	Deep Lake	- -	- -	- -	MTS	- -	IF
16-0356-00	Gunflint	2165.5	200	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
16-0448-00	Loon	1099.9	202	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
16-0328-00	Iron	107	15	Shallow Lake	- -	MTS	MTS	IF	- -	SUP
16-0337-00	Mayhew	218.4	80	Deep Lake	- -	MTS	MTS	MTS	- -	SUP
16-0355-00	Little Iron	108.7	18	Shallow Lake	- -	MTS	MTS	IF	- -	SUP
16-0463-00	Magnetic	177	93	Deep Lake	- -	- -	- -	IF	- -	IF
16-0581-00	Clove	129.2	25	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0610-00	Marabaeuf	389.5	55	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0546-00	Lower George	18.7	10	Shallow Lake	- -	- -	- -	IF	- -	IF
16-0605-00	Ron	10	20	Deep Lake	- -	- -	- -	IF	- -	IF
16-0458-00	Town	86.2	60	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0548-00	Doe	12.9	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0414-00	Vesper	11.7	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0423-00	Sebeka	33.3	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0427-00	Muskeg	33.4	15	Shallow Lake	- -	- -	- -	IF	- -	IF
16-0513-00	Sitka	30.7	50	Deep Lake	- -	- -	- -	IF	- -	IF
16-0526-00	Cross Bay	82.7	10	Shallow Lake	- -	- -	- -	IF	- -	IF
16-0544-00	Rib	84.3	10	Shallow Lake	- -	- -	- -	IF	- -	IF
16-0425-00	Cave	24.9	- -	- -	- -	- -	- -	IF	- -	IF
16-0424-00	Ross	32.4	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0529-00	Missing Link	36.1	25	Deep Lake	- -	- -	- -	IF	- -	IF
16-0460-00	Long Island	895.7	69	Deep Lake	- -	- -	- -	IF	- -	IF
16-0524-00	Cherokee	852	142	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0417-00	Tucker	145.7	42	Deep Lake	- -	MTS	MTS	IF	- -	SUP
16-0428-00	Kiskadinna	116.8	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0461-00	Karl	124.4	75	Deep Lake	- -	- -	- -	IF	- -	IF
16-0527-00	Snipe	113.2	80	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0569-00	Gordon	143.5	93	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0606-00	Round	155.3	45	Deep Lake	IF	- -	- -	IF	IF	IF
16-0608-00	Ham	120.2	40	Deep Lake	- -	- -	- -	IF	- -	IF

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
16-0613-00	Tenor	21.3	11	Shallow Lake	- -	- -	- -	IF	- -	IF
16-0795-00	Lone	87.2	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0012-00	Swamp	135.3	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0633-00	Saganaga	4949	--	Deep Lake	--	--	IF	IF	- -	IF
16-0793-00	Red Rock	449.3	64	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0813-00	Zephyr	143.5	47	Deep Lake	- -	- -	- -	IF	- -	IF
38-0189-00	Spice	25.8	27	Deep Lake	- -	- -	- -	IF	- -	IF
16-0628-00	Green	37.3	70	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0720-00	Rattle	41.1	30	Deep Lake	- -	- -	- -	IF	- -	IF
16-0752-00	Bat	83.8	100	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0812-00	Kingfisher	39.4	38	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0602-00	Flying	37.8	- -	Deep Lake	- -	- -	- -	IF	- -	IF
38-0191-00	Skindance	50.8	51	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0193-00	Mueller	23.5	36	Deep Lake	- -	- -	- -	MTS	- -	IF
16-0619-00	Onagon	20.3	- -	Deep Lake	- -	MTS	EXS	IF	- -	SUP
16-0719-00	Virgin	57	40	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0739-00	Whipped	54.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0741-00	Fente	33.7	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0781-00	Glossy Squat	25.7	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0786-00	Seahorse	26.1	21	Deep Lake	- -	- -	- -	IF	- -	IF
16-0674-00	Hug	27.7	35	Deep Lake	- -	- -	- -	IF	- -	IF
16-0689-00	Zenith	20.3	20	Deep Lake	- -	- -	- -	IF	- -	IF
16-0718-00	West Fern	82.9	60	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0765-00	Rog	53.1	40	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0783-00	Fay	69.7	65	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0143-00	Hoe	46.1	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0007-00	Vierge	23.8	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0756-00	Powell	51	75	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0716-00	Fern	72.3	70	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0782-00	Glee	46.1	8	- -	- -	- -	- -	IF	- -	IF
38-0011-00	Agamok	107.1	29	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0126-00	Elton	125.7	53	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0147-00	Makwa	133.5	76	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0623-00	Tuscarora	788.3	130	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0629-00	Sea Gull	3982.9	130	Deep Lake	IF	MTS	IF	EXS	IF	SUP
16-0753-00	Gillis	615.2	180	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0759-00	Alpine	885.3	65	Deep Lake	- -	- -	- -	MTS	- -	SUP
16-0809-00	Little Saganaga	1648	150	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0811-00	Gabimichigami	1197	209	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0180-00	Ogishkemuncie	769.3	70	Deep Lake	- -	- -	- -	IF	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
16-0600-00	Brandt	106.4	80	Deep Lake	- -	- -	- -	IF	- -	IF
16-0626-00	Paulson	123.5	60	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0632-01	Gull (Main Basin)	169.6	40	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
16-0673-00	Mesaba	206.9	65	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0721-00	Elm	108.4	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0723-00	Crooked	240.3	75	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0732-00	Mora	213.9	40	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0748-00	Hub	117.3	- -	Deep Lake	- -	- -	- -	IF	- -	IF
16-0755-00	French	119.6	135	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0757-00	Peter	277.5	120	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0768-00	Jasper	256.4	125	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0161-00	Fish	98.3	30	Deep Lake	- -	- -	- -	IF	- -	IF
38-0162-00	Gift	39.4	35	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0163-00	Link	39.9	30	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0168-00	Lunar	63.8	50	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0169-00	Lake of the Clouds	29.9	110	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0173-00	Canoe	19.6	30	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0175-00	Clam	20.6	9.5	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0184-00	Toe	45.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0188-02	Kekekabic Pond 2	25.1	25	- -	- -	- -	- -	MTS	- -	SUP
38-0188-03	Kekekabic Pond 3	24	17	Deep Lake	- -	- -	- -	IF	- -	IF
38-0196-00	Calico	11	20	- -	- -	- -	- -	IF	- -	IF
38-0216-00	Totem	15.5	10	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0228-00	Kek	55	130	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0194-01	Jenny (West Bay)	67.5	93	- -	- -	- -	- -	MTS	- -	SUP
38-0360-00	Strup	70.6	105	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0520-00	Frog	50	38	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0386-00	Sema	73	70	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0165-00	Bullfrog	66.1	20	Deep Lake	- -	- -	- -	IF	- -	IF
38-0195-00	Annie	19.5	16	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0166-00	Cherry	155	80	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0172-00	Topaz	146.2	70	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0187-00	Eddy	120.2	95	Deep Lake	- -	- -	- -	MTS	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0206-00	Hanson	292.6	100	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0207-00	Ester	371.9	110	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0209-00	Gijikiki	112.1	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0210-00	Ashdick	108.9	- -	Deep Lake	- -	- -	- -	IF	- -	IF
38-0211-00	Ottertrack	291.8	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0214-00	Rabbit	117.1	90	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0227-00	Amoeber	405.4	110	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0229-00	Little Knife	427	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0361-00	Wisini	109.3	137	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0381-00	Skoota	127.4	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0388-00	Spoon	253	85	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0389-00	Pickle	105	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0390-00	Bonnie	101.8	10	Shallow Lake	- -	- -	- -	MTS	- -	IF
38-0391-00	Dix	102.6	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0521-00	Carp	114.1	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0226-00	Kekekabic	1692.1	195	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0530-00	Sucker	376.9	30	Deep Lake	IF	- -	- -	MTS	IF	SUP
38-0532-00	Birch	353.2	35	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0404-00	Knife	3691.7	179	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0632-00	Unnamed	14.2	14	- -	- -	- -	- -	IF	- -	IF
38-0490-00	Trader	51.7	10	Shallow Lake	- -	- -	- -	MTS	- -	IF
38-0505-00	Haven	15.1	5	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0398-00	Missionary	96.3	71	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0366-00	Gerund	89.5	85	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0373-00	Shepo	48.9	17	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0624-00	Skull	27.8	38	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0629-00	Griddle	26.1	- -	Deep Lake	- -	- -	- -	IF	- -	IF
38-0134-00	Ledge	14.9	- -	Deep Lake	- -	- -	- -	IF	- -	IF
38-0137-00	Cap	40	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0139-00	Roe	66.7	7	Shallow Lake	- -	- -	- -	IF	- -	SUP
38-0472-00	Becoosin	56.6	17	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0492-00	Neglige	30.5	58	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0500-00	Solitude	59.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0506-00	Swing	10.5	13	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0507-00	Abinodji	34.1	33	Deep Lake	- -	- -	- -	IF	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0509-00	Jitterbug	26.2	5	Shallow Lake	- -	- -	- -	IF	- -	SUP
38-0510-00	Cattyman	17.3	9	Shallow Lake	IF	IF	IF	IF	IF	IF
38-0512-00	Adventure	47	9	Shallow Lake	- -	- -	- -	IF	- -	SUP
38-0516-00	Ahsub	59.2	78	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0531-00	Splash	92.6	18	Shallow Lake	- -	- -	- -	MTS	- -	IF
38-0623-00	Spree	28.1	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0630-00	Flash	78.6	24	Deep Lake	- -	- -	- -	IF	- -	IF
38-0365-00	Ahmakose	40.5	68	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0376-00	Muskrat	25.9	18	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0508-00	Gibson	33.8	24	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0113-00	Raven	174.8	56	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0225-00	Sagus	157.6	37	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0369-00	Hatchet	139.4	40	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0491-00	Vera	242.9	55	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0502-00	Ashigan	150.6	59	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0503-00	Boot	185.7	83	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0511-00	Jordan	149.4	66	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0526-00	Parent	450	50	Deep Lake	IF	- -	- -	IF	IF	SUP
38-0640-00	Ojibway	354.6	110	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0641-00	Jasper	168.1	25	Deep Lake	- -	- -	- -	IF	- -	IF
38-0715-00	Triangle	293.4	43	Deep Lake	- -	- -	- -	IF	- -	IF
38-0351-00	Thomas	1445.5	110	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0372-00	Fraser	690	104	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0400-00	Ima	748.1	116	Deep Lake	- -	- -	- -	IF	- -	IF
38-0488-00	Disappointment	902	50	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0498-00	Ensign	1407.2	30	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0529-00	Snowbank	4603.4	150	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0619-00	Newfound	612.4	45	Deep Lake	IF	IF	IF	MTS	IF	SUP
38-0644-00	Moose	1291.6	65	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0670-00	Pike	75	8	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0671-00	Two Deer	43.1	11	- -	IF	IF	IF	IF	IF	IF
38-0676-00	Pitcha	28	2	Shallow Lake	- -	IF	- -	- -	- -	IF
38-0679-00	Campers	48.2	3	Shallow Lake	- -	- -	- -	IF	- -	IF

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0664-00	Dunnigan	83.2	14	Shallow Lake	IF	MTS	MTS	IF	IF	SUP
38-0665-00	Gypsy	15.2	18	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0674-00	East Chub	63.4	8	Shallow Lake	IF	- -	- -	IF	IF	IF
38-0666-00	Slate	321.3	12	Shallow Lake	IF	IF	IF	IF	IF	IF
38-0735-00	Sand	480.8	10	Shallow Lake	IF	IF	MTS	IF	IF	IF
38-0420-00	Osier	70.6	- -	Shallow Lake	- -	IF	IF	IF	- -	IF
38-0658-00	Middle McDougal	101.3	5	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0659-00	South McDougal	273.2	5	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0686-00	North McDougal	259.1	10	Shallow Lake	IF	MTS	MTS	IF	IF	SUP
38-0656-00	Greenwood	1318.3	5	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
38-0064-00	Coffee	130.3	11	Shallow Lake	IF	- -	- -	- -	IF	IF
38-0220-00	Perent	1603.7	38	Deep Lake	- -	- -	- -	IF	- -	IF
38-0396-00	Isabella	1077.5	18	Shallow Lake	- -	MTS	MTS	MTS	- -	SUP
38-0568-00	Flat Horn	51.1	10	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0557-00	Grouse	121.3	10	Shallow Lake	- -	MTS	MTS	MTS	- -	SUP
38-0573-00	Gegoka	140.5	7	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
38-0559-00	Kitigan	68.5	8	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0561-00	Mitawan	186.4	27	Deep Lake	- -	- -	- -	IF	- -	IF
38-0218-00	Elixir	15.5	8	Shallow Lake	- -	- -	- -	IF	-	IF
38-0058-00	Scarp	40.8	15	Shallow Lake	- -	- -	- -	IF	-	IF
38-0445-00	Nine A.M.	15.1	14	Shallow Lake	- -	- -	- -	IF	-	IF
38-0056-00	Fulton	38.8	17.5	- -	- -	- -	- -	IF	-	IF
38-0395-00	Sylvania	77	4.5	- -	- -	- -	- -	IF	-	IF

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0431-00	Trappers	19	13	Shallow Lake	- -	- -	- -	IF	-	IF
38-0042-00	Wye	52.6	10	Shallow Lake	- -	- -	- -	IF	-	IF
38-0048-00	Harriet	259.6	35	- -	MTS	MTS	MTS	MTS	IF	SUP
38-0050-00	Sister	124.2	15	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0066-00	T	291.4	11	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
38-0068-00	Windy	459.7	39	Deep Lake	MTS	MTS	MTS	IF	IF	SUP
38-0292-00	Section 29	100.5	20	Deep Lake	MTS	MTS	MTS	IF	IF	SUP
38-0432-00	Eighteen	103.9	8	Shallow Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0219-00	Silver Island	1231.2	15	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
38-0255-00	Tanner	56.5	5	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0269-00	Homestead	44.5	7	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0440-00	Redskin	43.8	30	- -	- -	- -	- -	IF	- -	IF
38-0393-00	Dumbbell	413.7	40	- -	MTS	MTS	MTS	MTS	IF	SUP
69-0154-00	Arthur	71	19	Deep Lake	- -	- -	- -	IF	- -	IF
69-0056-00	Little	66.3	24	Deep Lake	IF	- -	- -	- -	IF	IF
38-0691-00	August	223.5	19	Shallow Lake	IF	- -	- -	IF	IF	IF
38-0703-00	Little Gabbro	188.7	26	Deep Lake	- -	MTS	MTS	MTS	- -	SUP
38-0704-00	Turtle	343.5	9	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0637-00	Bald Eagle	1251.6	36	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0701-00	Gabbro	1044.3	50	Deep Lake	- -	- -	- -	IF	- -	IF
69-0003-00	Birch	7314.5	25	Deep Lake	MTS	MTS	MTS	IF	IF	SUP
69-0254-00	Bear Head	648.6	46	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0720-00	Conchu	48.3	67	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0610-00	Rifle	39.2	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0527-00	Delta	25.6	7	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0334-00	Kiana	207.5	56	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0340-00	Carol	101.6	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0483-00	Fire	107.9	30	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0484-00	Hudson	408.8	35	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0580-00	Horseshoe	202.7	40	Deep Lake	- -	- -	- -	IF	- -	IF
38-0718-00	Greenstone	329.1	72	Deep Lake	IF	- -	- -	- -	IF	IF

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0397-00	Insula	3024.9	63	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0528-00	Four	677.7	25	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0600-00	Three	921.5	37	Deep Lake	- -	- -	- -	MTS	- -	IF
38-0605-00	One	890.8	57	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0608-00	Two	542.9	35	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0638-00	Clearwater	637.3	46	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0738-00	North Branch Kawishiwi	546.9	55	Deep Lake	- -	MTS	MTS	IF	- -	SUP
38-0222-00	Bugo	30.4	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0150-00	Panhandle	10.7	22	Deep Lake	- -	- -	- -	IF	- -	IF
38-0151-00	Pan	93.8	59	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0157-00	Anit	18.3	19	Deep Lake	- -	- -	- -	IF	- -	IF
16-0658-00	Ella	51.5	6	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0108-00	Kivaniva	45.5	49	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0132-00	Fee	29.3	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0131-00	Vee	34.8	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0321-00	Unnamed	22.3	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0329-00	Cacabic	26.8	30	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0069-00	Hazel	96.3	7	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0073-00	Baskatong	68.6	6	Shallow Lake	- -	- -	- -	IF	- -	SUP
38-0070-00	Kawasachong	161.3	11	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0074-00	Square	126.5	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0080-00	Kawishiwi	388.7	12	Shallow Lake	- -	- -	- -	MTS	- -	IF
38-0090-00	Malberg	414.8	33	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0098-00	Koma	252.6	14	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0104-00	Polly	485.3	21	Deep Lake	- -	- -	- -	IF	- -	IF
38-0140-00	Boulder	262.7	54	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0153-00	Adams	489.3	84	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0223-00	Beaver	217.7	76	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0338-00	River	109.4	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0343-00	Fishdance	160	50	Deep Lake	- -	- -	- -	IF	- -	SUP
16-0808-00	Phoebe	611.2	25	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0330-00	Alice	1485.1	53	Deep Lake	- -	- -	- -	MTS	- -	SUP
16-0657-00	Grace	441.5	16	Deep Lake	- -	- -	- -	IF	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
16-0659-00	Beth	171.3	22	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0085-00	Fenske	104.3	43	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
69-0116-00	Mitchell	245	38	Deep Lake	- -	- -	- -	MTS	- -	IF
69-0120-00	Everett	109.4	15	Shallow Lake	IF	- -	- -	MTS	IF	IF
69-0161-00	Wolf	267.9	28	Deep Lake	- -	MTS	MTS	MTS	- -	SUP
69-0163-01	East Twin	219.2	51	Shallow Lake	- -	MTS	MTS	MTS	- -	SUP
69-0163-02	West Twin	219.2	18	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
69-0174-00	East Twin	120.7	22	Deep Lake	IF	- -	- -	- -	IF	IF
69-0180-00	Little Rice	122.9	5	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0181-00	Slim	309.6	49	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0810-00	Cedar	459.8	42	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0778-00	South Farm	562.2	30	Deep Lake	- -	MTS	MTS	IF	- -	SUP
38-0779-00	Farm	1282.6	56	Deep Lake	- -	MTS	MTS	MTS	- -	SUP
38-0782-00	Garden	636	55	Deep Lake	- -	MTS	MTS	IF	- -	SUP
38-0811-00	Fall	2234.5	32	Deep Lake	MTS	MTS	MTS	IF	IF	SUP
69-0004-00	White Iron	3150.8	47	Deep Lake	MTS	MTS	MTS	IF	IF	SUP
69-0054-00	Blueberry	124	6	Shallow Lake	- -	EXS	EXS	IF	- -	IMP
69-0061-00	One Pine	352.4	13	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
69-0117-00	Johnson	446.7	18	Shallow Lake	- -	MTS	MTS	IF	- -	SUP
69-0115-00	Bear Island	2319.7	70	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0786-00	Sandpit	59.1	53	Deep Lake	- -	- -	- -	MTS	- -	SUP
69-0005-00	Alruss	26.6	45	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0620-00	Found	58.7	38	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0626-00	Washte	77.9	8	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0083-00	Tee	37.9	25	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0724-00	Tofte	131.2	70	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
38-0725-00	Indiana	138.3	31	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0726-00	Good	178.7	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0728-00	Hula	130.1	6	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0066-00	Little Long	318.8	45	Deep Lake	- -	MTS	MTS	MTS	- -	SUP
69-0070-00	Low	288.2	40	Deep Lake	IF	- -	- -	- -	IF	IF
69-0082-00	Grassy	244.8	15	Shallow Lake	IF	- -	- -	- -	IF	IF

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0642-00	Wind	918.3	32	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0645-00	Basswood	14050.8	111	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0729-00	Wood	604.2	21	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0796-00	Maingan	21.7	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0806-00	Wabosons	34.1	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0814-00	Niki	53	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0818-00	Papoose	39.8	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0204-00	Fox	28.6	7	Shallow Lake	- -	- -	- -	IF	- -	SUP
38-0797-00	Pakwene	23.3	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0809-00	Chippewa	82.5	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0088-00	Wagosh	45.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0202-00	Dark	32.7	10	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0794-00	Jackfish	206.7	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0089-00	Bear Trap	119.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0090-00	Sinneeg	157.5	32	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0104-00	Sunday	115.7	- -	Deep Lake	- -	- -	- -	MTS	- -	SUP
69-0203-00	Rush	110.1	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0206-00	Sterling	154.4	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
38-0817-00	Crooked	5191.3	160	Deep Lake	- -	- -	- -	MTS	- -	SUP
69-0121-00	Iron	1462.1	65	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0815-00	Bullet	42.1	10	Shallow Lake	- -	- -	- -	IF	- -	SUP
69-0081-00	Regenbogen	11.3	34	Deep Lake	- -	- -	- -	IF	- -	IF
69-0119-00	First	15.6	40	Deep Lake	- -	- -	- -	IF	- -	IF
69-0078-00	Mudro	90.3	76	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0091-00	Mudhole	10.4	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
38-0785-00	Tin Can Mike	141.2	29	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0816-00	Moosecamp	163.4	16	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0075-02	South Hegman	184.6	55	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0080-00	Nels	177.6	30	Deep Lake	- -	MTS	MTS	IF	- -	SUP
69-0092-00	Gull	168.2	13	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0093-00	Gun	335.8	57	Deep Lake	- -	- -	- -	MTS	- -	SUP
69-0094-00	Fairy	102.9	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0100-00	Boot	313.6	27	Deep Lake	- -	- -	- -	IF	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
38-0792-00	Horse	698.5	25	Deep Lake	- -	- -	- -	MTS	- -	SUP
38-0813-00	Fourtown	1164.5	25	Deep Lake	- -	- -	- -	IF	- -	IF
69-0208-00	Nibin	38.1	- -	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0329-00	Meander	97.4	25	Deep Lake	IF	IF	IF	IF	IF	IF
69-0182-00	Hook	87.1	13	Shallow Lake	- -	- -	- -	IF	- -	SUP
69-0207-00	Bibon	26.2	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0335-00	Emerald	72.4	34	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0341-00	Lamb	98.2	20	Deep Lake	- -	- -	- -	IF	- -	IF
69-0340-00	Nina Moose	411.1	6	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0342-00	Rocky	118.7	40	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0190-00	Big	1873.5	22	Deep Lake	MTS	MTS	MTS	MTS	IF	SUP
69-0205-00	Stuart	770.3	40	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0223-00	Agnes	1044.4	30	Deep Lake	- -	- -	- -	MTS	- -	IF
69-0330-00	Oyster	766.4	130	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0479-00	Little Beartrack	46.6	35	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0332-00	Little Hustler	66.8	70	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0474-00	South	34.4	10	Shallow Lake	- -	- -	- -	IF	- -	SUP
69-0343-00	Hustler	270.6	60	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0358-00	Green	151.3	23	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0369-00	Takucmich	339.9	150	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0473-00	Eugene	182.2	60	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0475-00	Steep	99.8	40	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0478-00	Slim	138.3	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0480-00	Beartrack	158.6	55	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0488-00	North	166.2	10	Shallow Lake	- -	- -	- -	IF	- -	SUP
69-0224-00	Lac la Croix	13706.6	169	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0350-00	Ge-Be-On-Equat	656	55	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0384-00	Little Shell	90.1	- -	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0383-00	Lynx	283.8	85	Deep Lake	- -	- -	- -	MTS	- -	SUP
69-0461-00	Shell	486.4	15	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0469-00	Heritage	211.1	40	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0608-00	Little Vermilion	430.8	52	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
69-0470-00	Loon	1935.9	75	Deep Lake	- -	- -	- -	IF	- -	SUP

WID	Lake Name	Area (acres)	Max Depth (ft)	Assessment Method	Aquatic Life Indicators:	Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
					Chloride	Total Phosphorus	Chlorophyll-a	Secchi		
69-0296-00	Little Crab	58.5	15	Shallow Lake	IF	IF	IF	IF	IF	SUP
69-0464-00	Lower Pauness	115.3	35	Deep Lake	- -	- -	- -	IF	- -	SUP
69-0465-00	Upper Pauness	189	10	Shallow Lake	- -	- -	- -	IF	- -	IF
69-0456-00	Jeanette	592.3	15	Shallow Lake	MTS	MTS	MTS	IF	IF	SUP
69-0864-00	Ash	689	29	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
69-0842-00	Blackduck	1240.7	30	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
69-0845-00	Kabetogama	22325	50	Deep Lake	IF	MTS	MTS	MTS	IF	SUP
69-0761-00	Spring	218.1	60	Deep Lake	- -	MTS	MTS	MTS	IF	SUP
69-0691-00	Johnson	1664.2	88	Deep Lake	- -	MTS	MTS	MTS	IF	SUP
69-0693-00	Namakan	11919.9	150	Deep Lake	- -	MTS	MTS	MTS	IF	SUP
69-0760-00	Little Johnson	560.6	28	Deep Lake	- -	MTS	MTS	MTS	IF	SUP
69-0617-00	Sand Point	4716	184	Deep Lake	- -	MTS	MTS	MTS	IF	SUP

Abbreviations for Ecoregion **NLF** = Northern Lakes and Forests
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information

Appendix D: Rainy River - Headwaters Watershed Protection Prioritization Criteria

Several protection-focused management strategy themes were developed to address key issues identified by Core Team members. To geographically target where the different strategy types should be implemented, prioritization criteria were developed to best describe each strategy type. Prioritization lies at the intersection of quality and risk, therefore some of the criteria identify risks, such as declining water quality trends, and some of the criteria identify qualities, such as the presence of wild rice or the quality of a coldwater fishery (cisco and trout). Lakes and streams with many risks and qualities can be targeted for protection and restoration.

The Core Team developed the prioritization criteria during a meeting in April of 2020. When choosing criteria, it is important to choose factors that vary across the watershed so that local geographic areas can be targeted. In addition, it is helpful to choose just a few criteria per strategy type to keep geographical targeting as simple as possible. The prioritization criteria are further described in Table 1.

The prioritization criteria were matched with applicable strategy types, shown in Table 2. The intent is that when strategies are developed, under each strategy type, their implementation can be prioritized and targeted. In other words, the risks and qualities associated with the priority waterbodies drive the protection or restoration strategies that should be implemented to protect or restore water quality. For example, lakes with developed shorelines are priorities for septic system improvements. The criteria results for each specific lake and stream are provided in Table 3 and Table 4, respectively. The overall total risks and qualities are also shown, indicating which lakes and streams have the most risks and qualities.

Table 29. Prioritization criteria descriptions.

Risk or Quality	Name	Description
Risk	Altered Watercourses	Altered Rivers and Streams were identified from the MnGEO shapefile, which was developed by the MPCA and MnGEO.
	Stream Connectivity (WHAF)	Stream Connectivity (WHAF) comes from the DNR Watershed Assessment Health Score Stream Connectivity shapefile. The Aquatic Connectivity Index is based on the density of culverts, bridges and dams in each watershed. The higher the density of structures limiting the free flow of water, the lower the Aquatic Connectivity score.
	Declining Trend	The lake has a declining trend in transparency as documented in the 2019 MPCA trend results by county.
	Development Density (Lakeshore)	Current development area (determined as the perimeter of development raster cells from HSPF PERLAND data) divided by the developable area (private land) around the lakeshore within 500 ft of the lake.
	Disturbance (HSPF subwatershed)	The percent disturbance in the HSPF reach was determined based on the HSPF land use raster. If a subwatershed had greater than 25% of the land use in agriculture, mining or developed land it was considered disturbed. In the case of this watershed, the disturbance was mining.
	HSPF Scenario Model Results: Development Scenario	Increases in sediment, total phosphorus, and total nitrogen loading as a result of estimated increased development in the modeling scenario.
	Impaired	Waterbody is on the 2020 Draft Impaired Waters List for anything except mercury.
	Local Priorities – Lakes	Lakes identified by the Core Group as potentially being developed. Outlined areas where private land exists on the lakeshore.
	Local Priorities – Streams	The Blackduck and Ash Rivers were identified during a Core Team meeting as priorities for riparian vegetation enhancement and stream restoration.
	Mine Features	Mine Features includes in pit stockpiles, mine pits, MSC features, stockpiles, and tailing basins from DNR Mineral Unit.
	"Nearly" Impaired	Lakes identified by the MPCA as “nearly or barely” impaired for recreational use are within a set percentage above or below the standard and are thus identified as vulnerable (“nearly” impaired) or suitable candidates for restoration (“barely” impaired).
	Near Surface Pollution Sensitivity (WHAF)	The Pollution Sensitivity of Near-Surface Materials delineates different rates at which contaminants may travel through the top 10 feet of the soil profile. The different rates across the state show the range in risk level for contamination to infiltrate toward groundwater resources. In some areas, the surface is so hard that it limits infiltration of water but increases the risk that contaminants may run over the surface directly into lakes and streams.
	Open Pit Mines (WHAF)	Open Pit Mines (WHAF) come from DNR Watershed Health Assessment Framework.
	Phosphorus Sensitivity	Phosphorus sensitivity was estimated for each lake by the DNR by predicting how much water clarity would be reduced with additional phosphorus loading to the lake. The lake is identified on the Lakes of Phosphorus Sensitivity Significance (DNR) study as the “Highest” level of sensitivity.
	Septic Systems (WHAF)	Septic Systems (WHAF) comes from the DNR Watershed Assessment Health Score Septic Systems shapefile. This metric provides a conservative estimate of actual septic system density. The metric score is based on well density per

Risk or Quality	Name	Description
		square km of land area in a catchment. Scores range from 0 to 100, with a density of 15.587 wells/km2 or greater = 0; no wells present = 100.
	Stream Barriers	Information gathered from the Stressor Identification Report and Local information.
	% Young Forest	Shows forest disturbance from logging and forest fires based on PERLAND HSPF model data.
Quality	BWCAW	BWCAW is valued for its outstanding interconnected water resources and provides both recreational opportunities and protection from development.
	Class 1B & 1C Drinking Water	The lake is designated Class 1 Drinking Water, which means that it is suitable for drinking with minimal treatment.
	Coldwater Habitat	Lakes known to harbor coldwater species including lake trout, lake whitefish, and cisco
	Exceptional Waters (TALU)	Streams that meet the Exceptional Standard for Tiered Aquatic Life Uses (TALU)
	Locally Defined Recreational Concern Areas	Items that were priorities from the Core Team.
	Outstanding Biological Significance	DNR Lakes of Biological Significance – Outstanding, means that they have high aquatic plant richness, wild rice, exceptional fishery, endangered or threatened lake bird species.
	Voyageurs National Park	Voyageurs National Park is valued for its outstanding interconnected water resources and provides both recreational opportunities and protection from development.
	Wild Rice	Waters identified in multiple datasets by DNR, 1854 Treaty Authority, and the MPCA. The MPCA list was generated in 2017 as a proposed list of wild rice waters. These lists are combined here to assist local partners with protection planning.

Table 30. Strategy Types matched with the criteria used to prioritize waterbodies and geographic areas for protection and restoration.

Strategy Type	Risks																Qualities								
	Aquatic life and aquatic recreation impairment	"Nearly" Impaired for aquatic recreation	Declining Water Quality Trend	Highest Phosphorus Sensitivity	Disturbance (HSPF stream reach)	Development Density (Lakeshore)	HSPF Scenario Model Results: Development Scenario	Near surface pollution sensitivity (WHAF)	Altered Watercourses	Local Priorities	Aquatic Connectivity (WHAF)	Stream Barriers (SID, local information)	Open Pit Mines (WHAF)	Mine Features (Mine pits, stock piles, tailing basins)	Septic Systems (WHAF)	% Young Forest	Exceptional Waters (TALU)	Outstanding Biological Significance	Class 1 Drinking Water Lakes	Coldwater lakes and streams	Wild Rice (DNR, 1854 Treaty Authority, MPCA Proposed)	Designated trout stream	Boundary Waters Canoe Area	Voyageurs National Park	Locally Defined Recreational Concern Areas
Drinking Water Protection			●	●				●							●				●						
Forestland Management			●	●	●											●	●		●	●		●			
Habitat and stream connectivity management											●	●									●	●			
Lake Management	●	●	●	●			●								●	●		●	●	●	●				
Recreational Management																							●	●	●
Septic system and waste management improvement	●	●	●	●		●				●					●			●	●	●					
Stormwater runoff control	●	●	●	●	●	●	●																		
Streambank, bluff, and ravine protection and restoration	●	●							●	●							●								

Lakes are in alphabetical order in the prititization criteria table below. Lakes in the watershed that did not fit any of these criteria were not included in the table, and some lakes were not included in on all datasets. As such this table does not replace use class listings found in Minn. R. ch 7050, ‘Waters of the State’; however it can be a useful initial resource to compare lakes within the watershed. The risks and qualities are summed in the “Total” column. Each column represents ‘1’ characteristic as some risks and qualities incorporate more than one data source. For example, there are multiple wild rice datasets maintained by partner agencies. Presence on one or more of these lists is counted as 1 quality. Additionally, coldwater habitats are indicated by a 2A use class designation, while an additional list of lakes supporting coldwater fish species generated by the DNR and MPCA has been proposed. These were also combined under one column to illustrate a coldwater quality. Cisco refuge lakes, however, appear in a separate column and are counted separately as these are considered lakes most resilient to climate change. Lakes shaded in grey are within or on the boundary of the BWCAW.

Table 31. Individual lakes and prioritization criteria.

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Abinodji	38-0507-00												1B		1
Achundo	69-0486-00												1B		1
Acorn	16-0776-00												1B		1
Adams	38-0153-00							2A, LKW					1B		2
Adventure	38-0512-00												1B		1
Agamok	38-0011-00							2A					1B		2
Agawato	69-0334-00												1B		1
Agnes	69-0830-00							TLC					1B		2
Ahmakose	38-0365-00							2A, LAT			X		1B		3
Ahsub	38-0516-00							2A					1B		2
Alice	38-0330-00			X				TLC					1B	1	3
Alpha	16-0311-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	Total Risk	Total Qualities
Alpine	16-0759-00				1%			2A, LKW, TLC	X				1B	1	3
Alruss	69-0005-00							2A					1B		2
Alworth	38-0401-00												1B		1
Amber	38-0336-00							TLC					1B		2
Amimi	38-0130-00												1B		1
Amoeber	38-0227-00							2A, LAT, TLC	X		X		1B		4
Andek	38-0305-00												1B		1
Angleworm	69-0096-00												1B		1
Anit	38-0157-00												1B		1
Annie	38-0195-00												1B		1
Arc	16-0584-00												1B		1
Arkose	38-0382-00							2A					1B		2
Arrow - 3	38-0310-00												1B		1
Ash	69-0864-00				15%	X				MPCA				2	1
Ashdick	38-0210-00							2A, TLC	X		X		1B		4
Ashigan	38-0502-00							TLC	X		X		1B		4
Assawan	38-0344-00												1B		1
Astray	38-0723-00												1B		1
August	38-0691-00									1854, MPCA					1
Bakekana	38-0224-00												1B		1
Bald Eagle	38-0637-00							TLC		DNR, 1854, MPCA			1B		3

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation		
Barto	16-0701-00												1B		1
Baskatong	38-0073-00												1B		1
Bass	69-0063-00				4%									1	
Basswood	38-0645-00			X				2A, LKW, TLC	X	DNR, 1854, MPCA	X		1B	1	5
Bat	16-0752-00							2A, LAT			X		1B		3
Batista	69-0201-00												1B		1
Battle	69-0300-00												1B		1
Beam	38-0470-00												1B		1
Bear Island	69-0115-00				4%	X		TLC		1854, MPCA				2	2
Bear Trap	69-0089-00							TLC	X	DNR, 1854, MPCA			1B		4
Beartrack	69-0480-00							2A	X				1B		3
Beast	69-0837-00									MPCA					1
Beaver	38-0223-00							2A, TLC	X		X		1B		4
Beaver Hut	38-0737-00							2A					1B		2
Becoosin	38-0472-00												1B		1
Bedford	38-0357-00												1B		1
Beetle	38-0551-00							2A					1B		2
Benezie	38-0473-00												1B		1
Beth	16-0659-00												1B		1
Bibon	69-0207-00												1B		1
Big	69-0190-00					X	X			DNR, 1854, MPCA		X	1C	2	2

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Big Moose	69-0316-00												1B		1
Big Rice	69-0178-00									DNR, 1854, MPCA	X		1B		3
Big Ruby	69-0333-00							2A					1B		2
Bill Lake	38-0085-00									1854, MPCA					1
Bingshick	16-0627-00							2A					1B		2
Birch	38-0532-00							LKW, TLC					1B		2
Birch	69-0003-00			X	1%	X	X	TLC		DNR, 1854, MPCA	X			4	3
Birl	38-0144-00												1B		1
Black Duck	69-0842-00				27%	X				MPCA				2	1
Blue Snow	16-0532-00							LAT					1B		2
Blueberry	69-0054-00	X			9%					DNR, 1854, MPCA				2	1
Bog	38-0443-00												1B		1
Boga	38-0315-00									1854			1B		2
Bonga	38-0762-00									DNR, 1854, MPCA	X				2
Bonnie	38-0390-00												1B		1
Boot	38-0503-00							TLC	X		X		1B		4
Boot	69-0100-00							TLC					1B		2
Bootleg	69-0452-00									DNR, 1854, MPCA			1B		2
Bottle	69-1064-00												1B		1
Boulder	38-0140-00												1B		1
Bourassa	69-0471-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
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Bowstring	38-0097-00												1B		1
Boze	38-0095-00												1B		1
Brandt	16-0600-00							2A					1B		2
Brewis	38-0587-00												1B		1
Briar	38-0071-00												1B		1
Briddle	38-0451-00												1B		1
Brieand	69-0387-00												1B		1
Browns	38-0780-00				2%									1	
Bruin	38-0702-00												1B		1
Brush	38-0444-00												1B		1
Bugo	38-0222-00												1B		1
Bullet	38-0815-00												1B		1
Bullfrog	38-0165-00												1B		1
Bunggee	69-0107-00												1B		1
Bunny	38-0293-00									1854, MPCA					1
Burntside	69-0118-00			X	2%	X	X	2A, LAT, LKW, TLC		DNR, 1854, MPCA	X	X	1B	4	5
Burt	16-0565-00												1B		1
Cacabic	38-0329-00												1B		1
Cache	38-0477-00												1B		1
Calamity	38-0309-00												1B		1
Calico	38-0196-00												1B		1

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
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Camp	38-0789-00												1B		1
Campers	38-0679-00									DNR, 1854, MPCA	X				2
Canal	38-0057-02							2A					1B		2
Canary	69-0055-00									DNR, 1854, MPCA					1
Canoe	38-0173-00												1B		1
Canthook	69-0318-00												1B		1
Cap	38-0137-00												1B		1
Caper	16-0751-00												1B		1
Capote	38-0112-00												1B		1
Cargo	38-0594-00												1B		1
Carol	38-0340-00												1B		1
Carp	38-0521-00												1B		1
Cash	16-0438-00							LAT			X		1B		3
Cattyman	38-0510-00												1B		1
Cave	16-0425-00												1B		1
Caveman	38-0093-00												1B		1
Cavity	16-0772-00												1B		1
Cedar	38-0810-00						X	TLC		1854, MPCA		X	1C	1	4
Chaco	38-0213-00												1B		1
Chad	69-0450-00												1B		1
Charity	38-0055-00									DNR, 1854, MPCA					1

General Info		Risks						Qualities							
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Charm	69-0351-00												1B		1
Cherokee	16-0524-00							2A, LAT			X		1B		3
Cherry	38-0166-00							2A, LAT, TLC	X		X		1B		4
Chickadee	38-0221-00												1B		1
Chippewa	38-0809-00												1B		1
Circle	38-0793-00												1B		1
Clam	38-0175-00												1B		1
Clark	69-0307-00												1B		1
Clear	38-0722-00												1B		1
Clearwater	38-0638-00							LKW					1B		2
Clevise	38-0302-00												1B		1
Clove	16-0581-00												1B		1
Comfort	38-0290-00									DNR, 1854, MPCA					1
Conchu	38-0720-00							2A					1B		2
Conic	38-0170-00												1B		1
Contest	16-0531-00												1B		1
Contest	69-0209-00												1B		1
Cook	38-0004-00									1854, MPCA					1
Cook County	38-0010-00				6%								1B	1	1
Coot	38-0876-00												1B		1
Cortes	38-0700-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
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Cougar	38-0767-00									DNR, 1854, MPCA					1
Coxey Pond	69-0186-00												1B		1
Crab	16-0357-00							2A, TLC					1B		2
Crab	69-0220-00							2A, TLC					1B		2
Crag	16-0625-00												1B		1
Crane	69-0616-00							2A, LKW, TLC		DNR	X		1B		4
Crooked	16-0723-00							2A, LAT	X		X		1B		4
Crooked	38-0817-00							2A, LKW, TLC		DNR, 1854, MPCA	X		1B		4
Cross Bay	16-0526-00												1B		1
Cruiser	69-0832-00				8%			2A, LAT			X		1B	1	3
Cummings	69-0221-00												1B		1
Cummings	69-0325-00							TLC					1B		2
Dark	69-0202-00												1B		1
Darlet	38-0133-00												1B		1
Dawkins	16-0459-00												1B		1
Delta	38-0527-00												1B		1
Denley	38-0773-00									1854, MPCA					1
Dent	16-0677-00												1B		1
Devils Elbow	16-0616-00							LKW, TLC					1B		2
Diamond	16-0802-00												1B		1
Diana	38-0459-00									1854, MPCA			1B		2

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Dipper	38-0387-00												1B		1		
Disappointment	38-0488-00							TLC					1B		2		
Dix	38-0391-00												1B		1		
Doe	16-0548-00												1B		1		
Dogfish	69-0338-00												1B		1		
Douse	38-0379-00												1B		1		
Dovre	69-0604-00												1B		1		
Drag	38-0485-00												1B		1		
Dragon	38-0552-00									1854, MPCA					1		
Dry	69-0064-00							TLC							1		
Duck	69-0191-00									DNR, 1854, MPCA					1		
Dumbbell	38-0270-00									DNR					1		
Dumbbell	38-0393-00				2%		X			DNR, 1854, MPCA	X			2	2		
Dunnigan	38-0664-00									1854, MPCA					1		
Dutton	38-0171-00												1B		1		
East Chub	38-0674-00				8%					1854, MPCA				1	1		
East Dawkins	16-0418-00												1B		1		
East Kerfoot	16-0586-00												1B		1		
Ed Shave	69-0199-00				5%					DNR, 1854, MPCA				1	1		
Eddy	38-0187-00							2A, LKW					1B		2		
Eighteen	38-0432-00									1854, MPCA					1		

General Info		Risks						Qualities							
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Elixir	38-0218-00				34%									1	
Elk	38-0362-00												1B		1
Ell	16-0564-00												1B		1
Ella	16-0658-00												1B		1
Ella Hall	38-0727-00									DNR, 1854, MPCA			1B		2
Ellquist	16-0787-00												1B		1
Elm	16-0721-00				10%								1B	1	1
Elton	38-0126-00												1B		1
Elusion	16-0780-00												1B		1
Emerald	69-0335-00												1B		1
Ensign	38-0498-00							TLC					1B		2
Eskwagama	38-0707-00												1B		1
Ester	38-0207-00							2A, LAT, LKW, TLC			X		1B		3
Eugene	69-0473-00							2A, LKW	X				1B		3
Everett	69-0120-00				2%									1	
Explorer	38-0399-00							2A, LAT			X		1B		3
Extortion	16-0450-00							2A					1B		2
Fairy	69-0094-00												1B		1
Faith	38-0160-00												1B		1
Fall	38-0811-00				3%	X		LKW, TLC		DNR, 1854, MPCA			1B	2	3
Fallen Arch	38-0461-00												1B		1

General Info		Risks						Qualities							
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Fantail	38-0100-00												1B		1
Farm	38-0779-00			X	4%	X	X	TLC		DNR, 1854, MPCA	X		1C	4	4
Fast	38-0476-00												1B		1
Fat	69-0349-00												1B		1
Fat	69-0481-00							2A, LAT			X		1B		3
Fay	16-0783-00							2A, LAT			X		1B		3
Fee	38-0132-00												1B		1
Fenske	69-0085-00				1%			TLC					1C	1	2
Fente	16-0741-00									DNR, 1854, MPCA			1B		2
Ferello	69-0346-00												1B		1
Fern	16-0716-00							2A, LAT			X		1B		3
Finger	69-0348-00							2A, TLC	X		X		1B		4
Fire	38-0483-00												1B		1
Fish	38-0161-00												1B		1
Fishdance	38-0343-00							2A, LKW, TLC	X		X		1B		4
Fisher	38-0322-00												1B		1
Flat Horn	38-0568-00									DNR, 1854, MPCA	X				2
Flint	16-0762-00				25%								1B	1	1
Flying	16-0602-00												1B		1
Folly	38-0265-00									1854, MPCA					1
Fools	38-0761-00									DNR, 1854, MPCA					1

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Found	38-0620-00							2A					1B		2
Four	38-0528-00							LKW					1B		2
Fourth McDougal	38-0657-00									1854, MPCA					1
Fourtown	38-0813-00							TLC					1B		2
Fox	69-0204-00												1B		1
Fraser	38-0372-00			X				2A, LAT, TLC	X		X		1B	1	4
Frederick	16-0692-00												1B		1
French	16-0755-00							2A, LAT			X		1B		3
Frog	38-0520-00												1B		1
Frond	38-0094-00												1B		1
Frost	16-0571-00							2A, LAT			X		1B		3
Fungus	16-0556-00												1B		1
Gabbro	38-0701-00							TLC		DNR, 1854, MPCA			1B		3
Gabimichigami	16-0811-00							2A, LAT			X		1B		3
Garden	38-0782-00			X	3%	X	X	TLC		DNR, 1854, MPCA	X			4	3
Ge-Be-On-Equat	69-0350-00							2A, LKW, TLC	X				1B		3
Gegoka	38-0573-00									DNR, 1854, MPCA	X				2
George	16-0420-00												1B		1
Geraldine	69-0169-00												1B		1
Gerund	38-0366-00												1B		1
Gibson	38-0508-00							TLC					1B		2

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Gift	38-0162-00							LKW					1B		2
Gijikiki	38-0209-00							2A, LAT			X		1B		3
Gillis	16-0753-00							2A, LAT			X		1B		3
Glee	16-0782-00												1B		1
Glossy Squat	16-0781-00												1B		1
Gneiss	16-0617-00							LAT, LKW, TLC			X		1B		3
Good	38-0726-00							TLC	X	1854, MPCA	X		1B		5
Gordon	16-0569-00							2A		1854, MPCA			1B		3
Grace	16-0657-00												1B		1
Grandpa	16-0798-00												1B		1
Granite	38-0937-00							LKW, TLC					1B		2
Grass	38-0635-00									1854, MPCA					1
Grassy	69-0082-00									DNR, 1854, MPCA					1
Grassy (Beaver)	69-0216-00									DNR, 1854, MPCA					1
Green	16-0628-00												1B		1
Green	69-0358-00												1B		1
Green Wing	38-0264-00									1854, MPCA					1
Greenwood	38-0656-00									DNR, 1854, MPCA	X				2
Griddle	38-0629-00														
Grouse	38-0557-00				4%					1854, MPCA				1	1
Grub	38-0504-00												1B		1

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Guard	16-0498-00												1B		1
Gull	16-0632-00				1%			LKW, TLC	X				1C	1	3
Gull	38-0590-00												1B		1
Gull	69-0092-00									DNR, 1854, MPCA			1B		2
Gun	69-0093-00												1B		1
Gun	69-0487-00							2A, LAT, TLC	X		X		1B		4
Gunflint	16-0356-00					X	X	2A, LAT, TLC	X		X	X	1B	2	5
Gypo	38-0798-00												1B		1
Gypsy	38-0665-00							2A					1B		2
Hack	38-0145-00												1B		1
Hag	69-0366-00												1B		1
Ham	38-0339-00												1B		1
Hanson	38-0206-00							2A, LAT, LKW, TLC			X		1B		3
Harbor	38-0525-00												1B		1
Hardtack	69-0074-00												1B		1
Harica	38-0316-00												1B		1
Harmony	38-0377-00												1B		1
Harriet	38-0048-00							LKW		1854, MPCA					2
Harris	38-0736-00									DNR, 1854, MPCA					1
Hassel	69-0299-00												1B		1
Hatchet	38-0369-00												1B		1

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Haunted	69-0347-00												1B		1
Haven	38-0505-00												1B		1
Hazel	38-0069-00												1B		1
Heritage	69-0469-00							TLC	X				1B		3
Hide (Bearskin)	38-0553-00									1854, MPCA					1
Hivernant	16-0799-00												1B		1
Hoe	38-0143-00												1B		1
Hogback	38-0057-00				4%			2A					1B	1	2
Holiday	38-0582-00												1B		1
Holt	38-0178-00							2A, LAT			X		1B		3
Holy	69-0087-00												1B		1
Homestead	38-0269-00									1854, MPCA					1
Honker	16-0601-00												1B		1
Hood	38-0480-00												1B		1
Hook	69-0182-00												1B		1
Hop	16-0810-00												1B		1
Hopkins	69-0101-00												1B		1
Horse	38-0792-00							M-TLC					1B		2
Horsefish	38-0121-00												1B		1
Horseshoe	38-0580-00							LKW, TLC	X				1B		3
Horseshoe	69-0255-00									1854, MPCA					1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	**Lake ID**	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Hotfoot	38-0149-00												1B		1
Howard	16-0789-00							2A, LAT			X		1B		3
Howl	16-0535-00												1B		1
Hub	16-0748-00												1B		1
Hube	38-0803-00												1B		1
Hudson	38-0484-00							LKW, TLC					1B		2
Hug	16-0674-00												1B		1
Hula	38-0728-00									DNR, 1854, MPCA	X		1B		3
Hump	38-0456-00												1B		1
Humpback	38-0156-00												1B		1
Hush	38-0454-00												1B		1
Hustler	69-0343-00							2A, TLC	X		X		1B		4
Ima	38-0400-00							2A, LAT, TLC	X		X		1B		4
Image	38-0122-00												1B		1
Incus	38-0127-00												1B		1
Indiana	38-0725-00												1B		1
Insula	38-0397-00							LKW, TLC					1B		2
Intersection	16-0624-00												1B		1
Iris	16-0572-00												1B		1
Iron	16-0328-00									DNR, 1854, MPCA					1
Iron	69-0121-00							TLC					1B		2

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	**Lake ID**	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Isabella	38-0396-00							LKW		DNR, 1854, MPCA			1B		3
Island River	38-0289-00									1854, MPCA	X				2
Island River	38-0842-00									1854, MPCA	X				2
Jack	38-0441-00									1854, MPCA					1
Jackfish	38-0794-00												1B		1
Jacob	69-0077-00												1B		1
Jasper	16-0768-00							2A, LAT, LKW			X		1B		3
Jasper	38-0641-00												1C		1
Jeanette	69-0456-00				3%					DNR, 1854, MPCA				1	1
Jenny (East Bay)	38-0194-02							LKW					1B		2
Jenny (West Bay)	38-0194-01							LKW					1B		2
Jerry	16-0725-00												1B		1
Jig	16-0734-00												1B		1
Jitterbug	38-0509-00												1B		1
John	38-0574-00												1B		1
John Ek	38-0008-00												1B		1
Johnson	69-0117-00		X		1%					DNR, 1854, MPCA				2	1
Johnson	69-0691-00							2A, LKW, TLC					1B		2
Jonathan	69-0317-00												1B		1
Jordan	38-0511-00							TLC	X				1B		3
Jouppi	38-0909-00							2A		1854, MPCA			1B		3

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Jump	38-0887-00												1B		1
Jut	38-0475-00												1B		1
Kaapoo	38-0327-00												1B		1
Kabetogama	69-0845-00				21%	X		LKW, TLC			X		1B	2	3
Kangas	69-0057-00									1854, MPCA					1
Karl	16-0461-00							2A					1B		2
Kawasachong	38-0070-00												1B		1
Kawishiwi	38-0080-00									DNR, 1854, MPCA			1B		2
Kayoskh	38-0585-00												1B		1
Kek	38-0228-00							2A, LAT			X		1B		3
Kekekabic	38-0226-00				1%			2A, LAT			X		1B	1	3
Kekekabic Pond 1	38-0188-01												1B		1
Kekekabic Pond 2	38-0188-02												1B		1
Kekekabic Pond 3	38-0188-03												1B		1
Kettle	38-0392-00												1B		1
Kiana	38-0334-00												1B		1
Kickshaw	38-0106-00												1B		1
Kingfisher	16-0812-00							LKW					1B		2
Kiskadinna	16-0428-00												1B		1
Kitigan	38-0559-00				4%					1854, MPCA				1	1
Kivandeba	38-0158-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
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Kivaniva	38-0108-00												1B		1
Knife	38-0404-00							2A, LAT, LKW, TLC	X		X		1B		4
Knight	16-0807-00									1854, MPCA					1
Kobe	38-0515-00												1B		1
Koma	38-0098-00							LKW					1B		2
Korb	69-0315-00												1B		1
La Pond	69-0177-00										X		1B		2
Lac la Croix	69-0224-00							LAT, LKW, TLC	X		X		1B		4
Lake of the Clouds	38-0169-00							2A, LAT			X		1B		3
Lamb	69-0341-00												1B		1
Lapond	69-0177-00									DNR, 1854, MPCA					1
Leak	16-0672-00												1B		1
Ledge	38-0134-00												1B		1
Leg	38-0123-00												1B		1
Legend	69-0222-00												1B		1
Lethe	38-0348-00												1B		1
Link	38-0163-00							LKW					1B		2
Little Beartrack	69-0386-00												1B		1
Little Beartrack	69-0479-00												1B		1
Little Copper	16-0540-00												1B		1
Little Crab	69-0296-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
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Little Dry	69-1040-00							TLC							1
Little Gabbro	38-0703-00							TLC		1854, MPCA			1B		3
Little Hustler	69-0332-00												1B		1
Little Iron	16-0355-00				2%					1854, MPCA				1	1
Little Johnson	69-0760-00			X			X	LKW						2	1
Little Knife	38-0229-00							LAT, LKW, TLC	X		X		1B		4
Little Long	69-0066-00				13%		X	TLC				X	1C	2	3
Little Loon	69-0484-00							TLC					1B		2
Little Saganaga	16-0809-00							2A, LAT			X		1B		3
Little Shell	69-0384-00							TLC					1B		2
Little Trout	69-0682-00				16%			2A, LAT, TLC	X		X		1B	1	4
Little Vermilion	69-0608-00							STLC		DNR, 1854			1B		3
Little Wampus	38-0684-00									DNR, 1854, MPCA					1
Loki	38-0201-00												1B		1
Lone	16-0795-00												1B		1
Long	69-0765-00									MPCA					1
Long Island	16-0460-00							2A, LAT					1B		2
Loon	16-0448-00				1%	X	X	2A, LAT, TLC	X	1854, MPCA	X		1B	3	5
Loon	69-0470-00							2A, LKW, TLC		DNR	X		1B		4
Low	69-0070-00				2%					DNR, 1854, MPCA	X			1	2
Lower George	16-0546-00												1B		1

General Info		Risks						Qualities						Total Risk	Total Qualities
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Lower Pauness	69-0464-00									DNR, 1854, MPCA			1B		2
Lucky Finn	69-0354-00												1B		1
Lunar	38-0168-00							2A, LAT			X		1B		3
Lunetta	69-0295-00												1B		1
Lynx	69-0383-00							2A, TLC	X		X		1B		4
Magnet	38-0514-00												1B		1
Magnetic	16-0463-00							S-LAT, TLC			X		1B		3
Maingan	38-0796-00												1B		1
Makwa	38-0147-00							2A, LAT			X		1B		3
Malberg	38-0090-00							S-LKW					1B		2
Maniwaki	38-0300-00												1B		1
Manomin	38-0616-00									DNR, 1854, MPCA					1
Marabaeuf	16-0610-00							LAT, LKW, TLC	X				1B		3
Marathon	38-0460-00												1B		1
Marble	38-0109-00							2A					1B		2
Maxine	69-0170-00												1B		1
Mayhew	16-0337-00				2%		X	2A, LAT			X		1B	2	3
Meadow	69-0165-00									1854, MPCA					1
Meat	69-0305-00												1B		1
Medas	38-0403-00												1B		1
Meditation	16-0583-00							2A					1B		2

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
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Medley	69-0183-00												1B		1
Melon	38-0522-00												1B		1
Mesaba	16-0673-00							2A					1B		2
Midas	38-0164-00												1B		1
Middle McDougal	38-0658-00				4%					DNR, 1854, MPCA	X			1	2
Mina	16-0736-00												1B		1
Minerva	38-0354-00												1B		1
Minister	69-0065-00				11%									1	
Mirror	38-0589-00												1B		1
Missing Link	16-0529-00							2A					1B		2
Missionary	38-0398-00							2A, LAT			X		1B		3
Mist	38-0208-00												1B		1
Mitawan	38-0561-00									1854, MPCA					1
Moose	38-0644-00				1%			LKW, TLC	X	DNR, 1854, MPCA			1B	1	4
Moosecamp	38-0816-00												1B		1
Mora	16-0732-00							2A					1B		2
Morris	16-0609-00												1B		1
Mosquito	38-0367-00												1B		1
Mud	38-0742-00									DNR, 1854, MPCA					1
Mud	69-0823-00												1B		1
Mudhole	69-0091-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
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Mudro	69-0078-00							TLC					1B		2
Mueller	38-0193-00												1B		1
Mugwump	38-0114-00												1B		1
Mukooda	69-0684-00				4%			2A, LAT, TLC	X	MPCA	X		1B	1	5
Mule	69-0193-00												1B		1
Museum	38-0478-00												1B		1
Muskeg	16-0427-00												1B		1
Muskeg	38-0788-00									DNR, 1854, MPCA	X		1B		3
Muskrat	38-0376-00												1B		1
Muzzle	38-0519-00												1B		1
Nabek	38-0182-00												1B		1
Nahimana	69-0353-00							2A, LKW, TLC					1B		2
Namakan	69-0693-00					X					X		1B	1	2
Neesh	69-0321-00												1B		1
Neglige	38-0492-00							2A					1B		2
Nels	69-0080-00									DNR, 1854, MPCA					1
Newfound	38-0619-00							S-LKW, TLC		1854, MPCA			1B		3
Newton	38-0784-00							S-TLC		DNR, 1854, MPCA			1B		3
Nibin	69-0208-00												1B		1
Nickel	38-0705-00				16%									1	
Niki	38-0814-00												1B		1

General Info		Risks						Qualities						Total Risk	Total Qualities
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Nina Moose	69-0340-00												1B		1
Nine AM	38-0445-00									DNR, 1854, MPCA					1
No Sleep	16-0509-00												1B		1
Noodle	16-0579-00												1B		1
North	16-0331-00							2A, LAT, TLC		1854, MPCA	X		1B		4
North	69-0488-00								X				1B		2
North Branch Kawishiwi	38-0738-00							TLC					1B		2
North Hegman	69-0075-01												1B		1
North McDougal	38-0686-00				2%					DNR, 1854, MPCA				1	1
North Wilder	38-0452-00												1B		1
No-see-um	38-0802-00												1B		1
Ogishkemuncie	38-0180-00			X				2A, LAT, TLC			X		1B	1	3
Ogle	16-0727-00														
Ojibway	38-0640-00				1%		X	2A, LAT, TLC	X		X		1B	2	4
Ole	69-0175-00												1B		1
One	38-0605-00							LKW, TLC					1B		2
One Pine	69-0061-00				1%					DNR, 1854, MPCA				1	1
Osier	38-0420-00									1854, MPCA					1
Otter	69-0326-00												1B		1
Ottertrack	38-0211-00							LAT, LKW, TLC	X		X		1B		4
Owl	16-0726-00							2A, LAT			X		1B		3

General Info		Risks						Qualities							
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Oyster	69-0330-00							2A, LAT, TLC	X		X		1B		4
Pace	38-0129-00												1B		1
Pagami	38-0639-00												1B		1
Pageant	69-0485-00												1B		1
Pakwene	38-0797-00												1B		1
Pan	38-0151-00												1B		1
Panhandle	38-0150-00												1B		1
Papoose	38-0818-00									DNR, 1854, MPCA			1B		2
Parent	38-0526-00							TLC	X				1B		3
Parley	69-0103-00												1B		1
Path	38-0588-00												1B		1
Paulson	16-0626-00							2A, LAT					1B		2
Pea Soup	38-0739-00									1854, MPCA					1
Pear	38-0200-00												1B		1
Peerless	38-0318-00												1B		1
Pekan	69-0357-00												1B		1
Pelt	38-0463-00												1B		1
Pencil	16-0576-00												1B		1
Perent	38-0220-00							LKW		DNR, 1854, MPCA			1B		3
Peron	38-0148-00												1B		1
Peter	16-0757-00				3%			2A, LAT			X		1B	1	3

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Phantom	38-0653-00									DNR, 1854, MPCA	X				2
Phoebe	16-0808-00									DNR, 1854, MPCA			1B		2
Phospor	38-0592-00												1B		1
Picket	69-0079-00									DNR, 1854, MPCA					1
Pickle	38-0389-00												1B		1
Pietro	38-0584-00												1B		1
Pioneer	38-0457-00												1B		1
Pitfall	38-0176-00												1B		1
Placid	38-0279-00												1B		1
Plume	38-0212-00												1B		1
Pointer	16-0745-00												1B		1
Polly	38-0104-00									1854, MPCA			1B		2
Pompous	38-0298-00												1B		1
Portage	38-0524-00							2A, TLC					1B		2
Pose	38-0455-00									1854, MPCA			1B		2
Posse	69-0363-00												1B		1
Powell	16-0756-00							2A, LAT			X		1B		3
Powwow	38-0308-00												1B		1
Prayer	16-0615-00												1B		1
Promise	38-0320-00												1B		1
Quadga	38-0596-00												1B		1

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Quartz	38-0481-00												1B		1
Rabbit	38-0214-00							2A, LAT			X		1B		3
Railroad	38-0655-00									DNR, 1854, MPCA					1
Rally	16-0590-00												1B		1
Ramshead	69-0339-00												1B		1
Range Line	69-0388-00												1B		1
Rat	38-0567-00				20%					1854, MPCA				1	1
Rattle	16-0720-00												1B		1
Raven	38-0113-00							2A, LAT			X		1B		3
Ray	16-0769-00				4%								1B	1	1
Recline	38-0335-00												1B		1
Red Rock	16-0793-00							2A, LKW, TLC	X		X		1B		4
Redskin	38-0440-00							2A		1854, MPCA			1B		3
Reflection	38-0368-00												1B		1
Regenbogen	69-0081-00							2A					1B		2
Rib	16-0544-00									DNR, 1854, MPCA			1B		2
Rice	38-0465-00									DNR, 1854, MPCA	X		1B		3
Rice	69-0185-00												1B		1
Rice (Little Rice)	69-0180-00									DNR, 1854, MPCA	X		1B		4
Rifle	38-0610-00												1B		1
Ritual	69-0108-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
River	38-0338-00												1B		1
Robin	69-0184-00												1B		1
Rock Island	38-0613-00												1B		1
Rock of Ages	38-0586-00												1B		1
Rocky	69-0342-00												1B		1
Roe	38-0139-00									DNR, 1854, MPCA			1B		2
Rog	16-0765-00				4%			2A					1B	1	2
Romance	16-0630-00												1B		1
Ross	16-0424-00												1B		1
Roy	16-0797-00												1B		1
Ruby	69-0385-00												1B		1
Rush	69-0203-00												1B		1
Saca	69-0298-00												1B		1
Saddle	38-0088-00												1B		1
Saganaga	16-0633-00				<1%			2A, LAT, LKW, TLC	X		X		1B	1	4
Sagus	38-0225-00												1B		1
Sand	38-0735-00		X		<1%	X				DNR, 1854, MPCA	X			3	2
Sand Point	69-0617-00				3%			2A, LKW, TLC	X	DNR, MPCA	X		1B	1	5
Sandpit	38-0786-00												1B		1
Sapphire	38-0446-00									1854, MPCA					1
Sauna	38-0795-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Scarp	38-0058-00							2A		1854, MPCA			1B		3
Schlamm	69-0294-00												1B		1
Scotch	38-0092-00												1B		1
Scott	38-0271-00									DNR, 1854, MPCA					1
Screamer	38-0349-00												1B		1
Sea Gull	16-0629-00				<1%	X		2A, LAT, LKW, TLC	X		X		1B	2	4
Seahorse	16-0786-00												1B		1
Sebeka	16-0423-00												1B		1
Section 29	38-0292-00									1854, MPCA					1
Section Sixteen	38-0801-00												1B		1
Section Twelve	38-0714-00				7%			TLC						1	1
Sedative	38-0359-00												1B		1
Seed	38-0523-00												1B		1
Sema	38-0386-00							2A, LAT			X		1B		3
Shagawa	69-0069-00				24%	X		TLC						2	1
Shell	69-0461-00												1B		1
Shepo	38-0373-00												1B		1
Shohola	69-0336-00												1B		1
Silica	69-0187-00												1B		1
Silver Island	38-0219-00							LKW		DNR, 1854, MPCA					2
Sinneeg	69-0090-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Sinneeg	69-0102-00												1B		1
Siren	38-0119-00												1B		1
Sitka	16-0513-00												1B		1
Skindance	38-0191-00												1B		1
Skoota	38-0381-00												1B		1
Skull	38-0624-00							2A					1B		2
Slate	38-0666-00				15%					DNR, 1854, MPCA				1	1
Slim	69-0181-00							TLC					1B		2
Slim	69-0478-00												1B		1
Slowfoot	38-0482-00												1B		1
Smite	38-0375-00												1B		1
Snatch	38-0370-00												1B		1
Snipe	16-0527-00												1B		1
Snowbank	38-0529-00				<1%			2A, LAT, TLC	X	DNR, 1854, MPCA	X	X	1B	1	6
Snusbox	38-0297-00												1B		1
Solitude	38-0500-00												1B		1
Source	38-0654-00									DNR, 1854, MPCA					1
Sourdough	38-0708-00									DNR, 1854, MPCA					1
South	69-0474-00												1B		1
South Farm	38-0778-00				2%	X		TLC		1854, MPCA			1B	2	3
South Hegman	69-0075-02							TLC	X		X		1B		4

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation		
South McDougal	38-0659-00									DNR, 1854, MPCA					1
South Wilder	38-0453-00												1B		1
Spice	38-0189-00												1B		1
Spider	38-0380-00												1B		1
Spinnan	38-0581-00												1B		1
Splash	38-0531-00							TLC					1B		2
Spoon	38-0388-00							2A, LKW	X				1B		3
Spree	38-0623-00												1B		1
Sprig	38-0118-00												1B		1
Spring	69-0761-00							2A, LKW, TLC	X		X		1B		4
Square	38-0074-00									1854, MPCA					1
Square	69-0261-00												1B		1
Squat	16-0591-00												1B		1
Starlight	38-0474-00												1B		1
Steep	69-0475-00							TLC					1B		2
Sterling	69-0206-00												1B		1
Stony	38-0660-00									DNR, 1854, MPCA	X				2
Struggle	38-0332-00												1B		1
Strup	38-0360-00							2A, LAT			X		1B		3
Stuart	69-0205-00							TLC					1B		2
Sucker	38-0530-00							TLC					1B		2

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation		
Sumpet	38-0283-00												1B		1
Sunday	69-0104-00												1B		1
Sundial	69-0105-00												1B		1
Superstition	38-0593-00												1B		1
Surprise	38-0550-00									1854, MPCA					1
Swallow	38-0668-00									1854, MPCA					1
Swamp	38-0012-00												1B		1
Swamp	38-0285-00									1854, MPCA					1
Swing	38-0506-00												1B		1
Sylvania	38-0395-00									1854, MPCA					1
T	38-0066-00							LKW							1
Takucmich	69-0369-00							2A, LAT, TLC	X		X		1B		4
Tanner	38-0255-00				3%									1	
Tarry	16-0731-00							2A					1B		2
Tenor	16-0613-00												1B		1
Tent	16-0508-00												1B		1
Tepee	16-0621-00												1B		1
Tern	16-0767-00												1B		1
Tesoker	69-0390-00												1B		1
Thirty Three	38-0791-00												1B		1
Thomas	38-0351-00							2A, LAT, TLC	X		X		1B		4

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation		
Three	38-0600-00							LKW, TLC					1B		2
Thumb	69-0352-00							TLC					1B		2
Tickle	38-0009-00												1B		1
Tin Can Mike	38-0785-00				1%								1B	1	1
Toe	69-0213-00							TLC	X				1B		3
Tofte	38-0724-00			X	2%		X	2A					1B	3	2
Tommy	38-0425-00									1854, MPCA					1
Topaz	38-0172-00							2A, TLC	X		X		1B		4
Totem	38-0216-00												1B		1
Town	16-0458-00							2A, LAT			X		1B		3
Townline	38-0871-00												1B		1
Trader	38-0490-00												1B		1
Trail	38-0096-00												1B		1
Trappers	38-0431-00							2A					1B		2
Treasure	38-0154-00												1B		1
Treatme	16-0702-00												1B		1
Triangle	38-0715-00							TLC							1
Trinity	38-0371-00												1B		1
Trygg	69-0389-00							2A					1B		2
Tucker	16-0417-00									1854, MPCA			1B		2
Turkey	38-0333-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	**Lake ID**	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Turtle	38-0704-00												1B		1
Tuscarora	16-0623-00							2A, LAT			X		1B		3
Twin (East Twin)	69-0174-00									1854, MPCA					1
Twin (West Twin)	69-0163-00				2%					DNR, 1854, MPCA				1	1
Twinkle	16-0744-00												1B		1
Two	38-0608-00							LKW, TLC					1B		2
Unnamed	16-0788-00												1B		1
Unnamed	38-0152-00												1B		1
Unnamed	38-0321-00												1B		1
Unnamed	38-0328-00												1B		1
Unnamed	38-0467-00												1B		1
Unnamed	38-0804-00												1B		1
Unnamed	38-0805-00												1B		1
Unnamed	38-0843-00									DNR					1
Unnamed	38-0844-00												1B		1
Unnamed	38-0845-00												1B		1
Unnamed	38-0846-00												1B		1
Unnamed	38-0852-00												1B		1
Unnamed	38-0865-00												1B		1
Unnamed	38-0881-00												1B		1
Unnamed	69-1423-00												1B		1

General Info		Risks						Qualities							
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	Total Risk	Total Qualities
Unnamed (Birdsey)	38-0517-00												1B		1
Unnamed (Swollen Ankle)	16-0545-00												1B		1
Unnamed (Tucker)	16-0416-00									DNR, 1854, MPCA					1
Unnamed (Two Fifty Four)	38-0254-00									1854, MPCA					1
Upper Pauness	69-0465-00									DNR, 1854, MPCA			1B		2
Uranus	38-0719-00												1B		1
Van	38-0117-00												1B		1
Vee	38-0131-00												1B		1
Vera	38-0491-00							2A, TLC		DNR, 1854, MPCA			1B		3
Vesper	16-0414-00												1B		1
Vierge	38-0007-00												1B		1
Violation	16-0507-00												1B		1
Virgin	16-0719-00							2A					1B		2
Wabosons	38-0806-00												1B		1
Wager	38-0458-00									1854, MPCA					1
Wagosh	69-0088-00												1B		1
Waksapiwi	69-0468-00												1B		1
Wampus	38-0685-00									DNR, 1854, MPCA					1
Wanless	38-0049-00									1854, MPCA					1
Washte	38-0626-00												1B		1
Watonwan	38-0079-00									1854, MPCA			1B		2

General Info		Risks						Qualities						Total Risk	Total Qualities
								Coldwater Habitat							
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation		
Weasel	38-0612-00												1B		1
West Chub	38-0675-00									1854, MPCA					1
West Crab	69-0297-00							2A					1B		2
West Fern	16-0718-00							2A, LAT			X		1B		3
Whipped	16-0739-00												1B		1
Whiskey Jack	69-0098-00												1B		1
White Feather	69-0192-00												1B		1
White Iron	69-0004-00				6%	X		LKW, TLC		DNR, 1854, MPCA			1C	2	3
Whiz	38-0323-00												1B		1
Wind	38-0642-00							LKW		DNR, 1854, MPCA			1B		3
Wine	16-0686-00							2A, LAT					1B		2
Wish	16-0533-00												1B		1
Wisini	38-0361-00							2A, LAT			X		1B		3
Witness	38-0643-00												1B		1
Wolf	69-0161-00				7%					1854, MPCA				1	1
Wolverine	38-0105-00												1B		1
Wood	38-0729-00									DNR, 1854, MPCA	X		1B		3
Wren	69-0453-00												1B		1
Wye	38-0042-00									1854, MPCA					1
Yoke	38-0350-00												1B		1
Zenith	16-0689-00												1B		1

General Info		Risks						Qualities								
								Coldwater Habitat								
Lake Name	Lake ID	Aquatic life/Aquatic recreation impairment	"Nearly" Impaired by Eutrophication	Declining water clarity trend	Development density (lakeshore)	Local priorities	Lake phosphorus sensitivity score (LPSS) "A"	Class 2A coldwater lakes& draft proposed lake trout (LKT), whitefish (LKW), and cisco lakes (TLC)	Cisco refuge lakes	Wild rice (DNR/1854 Treaty Authority/Proposed MPCA 2017)	Lakes of Outstanding Biological Significance (DNR)	Lake phosphorus benefit/cost assessment (LBCA) priority	Class 1B & 1C drinking water designation	**Total Risk**	**Total Qualities**
Zephyr	16-0813-00												1B		1
Zitkala	38-0450-00												1B		1

Streams are in alphabetical order in the prioritization criteria table below. Streams in the watershed that did not fit any of these criteria were not included in the table, and some streams were not included in on all datasets. As such this table does not replace use class listings found in Minn. R. ch. 7050, 'Waters of the State'; however it can be a useful initial resource to compare streams within the watershed. The risks and qualities are summed in the "Total" column. Each column represents '1' characteristic as some risks and qualities incorporate more than one data source. For example, there are multiple wild rice datasets maintained by partner agencies. Presence on one or more of these lists is counted as 1 quality. Streams shaded in grey are within or on the boundary of the BWCAW.

Table 32. Individual streams and prioritization criteria.

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Kawishiwi River	09030001-512						DNR, 1854, MPCA		1
Portage River	09030001-522			X				1	
Isabella River	09030001-527						DNR, 1854, MPCA		1
Little Isabella River	09030001-530				X	X			2
Snake River	09030001-531				X				1
South Kawishiwi River	09030001-536						1854, MPCA		1
Moose River	09030001-540						1854, MPCA		1
Snake River	09030001-542				X	X			2
Little Isabella River	09030001-544				X				1
Little Isabella River	09030001-548				X				1
Arrowhead Creek	09030001-550				X				1
Camp E Creek	09030001-552				X				1

General Info		Risks			Qualities				
Stream Name	WID	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	Total Risks	Total Qualities
Camp E Creek	09030001-553				X				1
Unnamed creek	09030001-554				X				1
Harris Creek (Harris Lake Creek)	09030001-555				X				1
Hill Creek	09030001-556				X				1
Little Indian Sioux River	09030001-557						1854, MPCA		1
Inga Creek	09030001-558				X				1
Inga Creek	09030001-559				X				1
Inga Creek	09030001-560				X				1
Little Isabella River	09030001-561				X				1
Little Isabella River	09030001-562				X				1
Island River	09030001-563						MPCA		1
Jack Pine Creek	09030001-564				X	X			2
Longstorff Creek	09030001-565				X				1
Mary Ann Creek	09030001-566				X				1
Kelly Creek (Mike Kelly Creek)	09030001-567				X				1
Mitawan Creek	09030001-568				X	X			2
Mitawan Creek	09030001-569				X				1
Mitawan Creek	09030001-570				X				1
Mitawan Creek	09030001-571				X				1
Nip Creek	09030001-572				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Nira Creek	09030001-573				X				1
Scott Creek	09030001-574				X				1
Section 30 Creek	09030001-575			X	X			1	1
Snake Creek	09030001-576				X				1
Sphagnum Creek	09030001-577				X				1
Tomlinson Creek	09030001-578				X				1
Victor Creek	09030001-579				X				1
Weiss Creek	09030001-580				X				1
Wenho Creek	09030001-581				X				1
Unnamed creek (Arrowhead Creek Tributary)	09030001-582				X				1
Dumbbell River	09030001-583				X		1854		2
Camp Creek	09030001-584				X				1
Camp Creek	09030001-585				X				1
West Camp Creek	09030001-586				X				1
Unnamed creek (Inga Creek Tributary)	09030001-587				X				1
Unnamed creek (Inga Creek Tributary)	09030001-588				X				1
Unnamed creek (Little Isabella River Tributary)	09030001-589				X				1
Unnamed creek (Little Isabella River Tributary)	09030001-590				X				1

General Info		Risks			Qualities				
Stream Name	WID	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	Total Risks	Total Qualities
Unnamed creek (Little Isabella River Tributary)	09030001-591				X				1
Unnamed creek (Little Isabella River Tributary)	09030001-592				X				1
Unnamed creek (Little Isabella River Tributary)	09030001-593				X				1
Unnamed creek (Mitawan Creek Tributary)	09030001-594				X				1
Unnamed creek (Mitawan Creek Tributary)	09030001-595				X				1
Unnamed creek (Scott Creek Tributary)	09030001-596				X				1
Unnamed creek (Scott Creek Tributary)	09030001-597				X				1
Unnamed creek (Scott Creek Tributary)	09030001-598				X		1854, MPCA		2
Unnamed creek (Tomlinson Creek Tributary)	09030001-599				X				1
Unnamed creek (Langley Creek)	09030001-603		X					1	
Bear Island River	09030001-608						DNR, 1854, MPCA		1
Unnamed creek (Camp E Creek)	09030001-623						1854, MPCA		1
Denley Creek	09030001-627					X			1
Dumbbell River	09030001-632				X		1854, MPCA		2
Dumbbell River	09030001-633				X				1
Little Indian Sioux River	09030001-636						1854, MPCA		1
Little Indian Sioux River	09030001-637						1854, MPCA		1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Little Indian Sioux River	09030001-641						1854, MPCA		1
Little Indian Sioux River	09030001-642						1854, MPCA		1
Little Indian Sioux River	09030001-643						DNR, 1854, MPCA		1
Nina Moose River	09030001-650						1854, MPCA		1
Bear Island River	09030001-665						1854, MPCA		1
Spur End Creek	09030001-696			X				1	
Stockade Creek	09030001-697			X				1	
Jackpot Creek	09030001-699				X				1
Johnson Creek	09030001-708			X				1	
Horse River	09030001-719						DNR, 1854, MPCA		1
Unnamed creek (Arrowhead Creek Tributary)	09030001-760				X				1
Unnamed creek (Camp Creek Tributary)	09030001-761				X				1
Unnamed creek (West Camp Creek Tributary)	09030001-762				X				1
Dumbbell River	09030001-764				X				1
Unnamed creek (Dumbbell River Tributary)	09030001-765				X				1
Unnamed creek (Dumbbell River Tributary)	09030001-766				X				1
Unnamed creek (Dumbbell River Tributary)	09030001-767				X				1
Unnamed creek (Dumbbell River Tributary)	09030001-768				X				1

General Info		Risks			Qualities				
Stream Name	WID	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	Total Risks	Total Qualities
Unnamed creek (Folly Creek)	09030001-769				X				1
Green Wing Creek (Folly Creek Tributary)	09030001-770				X				1
Green Wing Creek (Folly Creek Tributary)	09030001-772				X				1
Folly Creek	09030001-773				X				1
Folly Creek	09030001-774				X				1
Unnamed creek (Folly Creek Tributary)	09030001-775				X				1
Unnamed creek (Folly Creek Tributary)	09030001-776				X				1
Unnamed creek (Folly Creek Tributary)	09030001-777				X				1
Folly Creek	09030001-778				X				1
Unnamed creek (Folly Creek Tributary)	09030001-779				X				1
Folly Creek	09030001-780				X				1
Unnamed creek (Harris Creek Tributary)	09030001-782			X	X			1	1
Unnamed creek (Harris Creek Tributary)	09030001-783				X				1
Unnamed creek (Longstorff Creek Tributary)	09030001-786				X				1
Unnamed creek (Longstorff Creek Tributary)	09030001-787				X				1
Unnamed creek (Section 30 Creek Tributary)	09030001-789			X	X			1	1
Unnamed creek (Snake Creek Tributary)	09030001-791				X				1
Unnamed creek (Snake River Tributary)	09030001-792				X				1
Unnamed creek (Tomlinson Creek Tributary)	09030001-793				X				1

General Info		Risks			Qualities			Total Risks	Total Qualities
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice		
Unnamed creek (Tomlinson Creek Tributary)	09030001-794				X				1
Unnamed creek (Tomlinson Creek Tributary)	09030001-795				X				1
Unnamed creek (Tomlinson Creek Tributary)	09030001-796				X				1
Unnamed creek (Tomlinson Creek Tributary)	09030001-797				X				1
Unnamed creek (Wenho Creek Tributary)	09030001-798				X				1
Unnamed creek (Wenho Creek Tributary)	09030001-799				X				1
Trappers Creek	09030001-800				X				1
Trappers Creek	09030001-801				X				1
Trappers Creek	09030001-802				X				1
Nip Creek	09030001-804				X				1
Unnamed creek (Scott Creek Tributary)	09030001-806				X				1
Burntside River	09030001-808			X			1854, MPCA	1	1
Ash River	09030001-818	X			X			1	1
Ash River	09030001-819				X				1
Blackduck River	09030001-820	X			X			1	1
Ash River	09030001-821				X				1
Unnamed creek (Beauty Creek)	09030001-822				X				1
Kinmount Creek	09030001-823				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Kinmount Creek	09030001-824				X				1
Fawn Creek	09030001-825				X				1
Fawn Creek	09030001-826				X				1
Ninemile Creek	09030001-827				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-829				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-830				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-831				X				1
Camp Ninety Creek (Ash River Tributary)	09030001-833				X				1
Unnamed creek (Ash River Tributary)	09030001-834				X				1
Unnamed creek (Ash River Tributary)	09030001-835				X				1
Unnamed creek (Ash River Tributary)	09030001-836				X				1
Unnamed creek (Ash River Tributary)	09030001-837				X				1
Unnamed creek (Ash River Tributary)	09030001-838				X				1
Unnamed creek (Ash River Tributary)	09030001-839				X				1
Unnamed creek (Ash River Tributary)	09030001-840				X				1
Unnamed creek (Ash River Tributary)	09030001-841				X				1
Unnamed creek (Ash River Tributary)	09030001-842				X				1
Unnamed creek (Ash River Tributary)	09030001-843				X				1
Unnamed creek (Ash River Tributary)	09030001-844				X				1
Unnamed creek (Ash River Tributary)	09030001-845				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Unnamed creek (Ash River Tributary)	09030001-846				X				1
Unnamed creek (Ash River Tributary)	09030001-847				X				1
Unnamed creek (Ash River Tributary)	09030001-848				X				1
Unnamed creek (Ash River Tributary)	09030001-850				X				1
Unnamed creek (Blackduck River Tributary)	09030001-851				X				1
Unnamed creek (Blackduck River Tributary)	09030001-852				X				1
Unnamed creek (Blackduck River Tributary)	09030001-853				X				1
Unnamed creek (Blackduck River Tributary)	09030001-854				X				1
Unnamed creek (Blackduck River Tributary)	09030001-855				X				1
Unnamed creek (Blackduck River Tributary)	09030001-856				X				1
Unnamed creek (Blackduck River Tributary)	09030001-857				X				1
Unnamed creek (Blackduck River Tributary)	09030001-858				X				1
Fawn Creek	09030001-865				X				1
Unnamed creek (Ash River Tributary)	09030001-870				X				1
Unnamed creek (Ash River Tributary)	09030001-871				X				1
Unnamed creek (Ash River Tributary)	09030001-872				X				1
Unnamed creek (Ash River Tributary)	09030001-873				X				1
Unnamed creek (Ash River Tributary)	09030001-874				X				1
Unnamed creek (Ash River Tributary)	09030001-875				X				1
Unnamed creek (Ash River Tributary)	09030001-876				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Unnamed creek (Ash River Tributary)	09030001-877				X				1
Unnamed creek (Ash River Tributary)	09030001-880				X				1
Unnamed creek (Ash River Tributary)	09030001-881				X				1
Unnamed creek (Beauty Creek Tributary)	09030001-882				X				1
Unnamed creek (Beauty Creek Tributary)	09030001-883				X				1
Unnamed creek (Beauty Creek Tributary)	09030001-884				X				1
Unnamed creek (Beauty Creek Tributary)	09030001-885				X				1
Unnamed creek (Blackduck River Tributary)	09030001-887				X				1
Unnamed creek (Blackduck River Tributary)	09030001-888				X				1
Unnamed creek (Blackduck River Tributary)	09030001-889				X				1
Unnamed creek (Blackduck River Tributary)	09030001-890				X				1
Unnamed creek (Blackduck River Tributary)	09030001-891				X				1
Unnamed creek (Blackduck River Tributary)	09030001-892				X				1
Unnamed creek (Blackduck River Tributary)	09030001-893				X				1
Unnamed creek (Blackduck River Tributary)	09030001-894				X				1
Unnamed creek (Blackduck River Tributary)	09030001-895				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-896				X				1
Unnamed creek (Kinmount Creek Tributary)	09030001-897				X				1
Unnamed creek (Kinmount Creek Tributary)	09030001-898				X				1
Unnamed creek (Arrowhead Creek Tributary)	09030001-900				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Unnamed creek (Arrowhead Creek Tributary)	09030001-901				X				1
Unnamed creek (Grassy Creek)	09030001-902				X				1
Unnamed creek (Hill Creek Tributary)	09030001-903				X				1
Unnamed creek (Inga Creek Tributary)	09030001-904				X				1
Unnamed creek (Inga Creek Tributary)	09030001-905				X				1
Unnamed creek (Little Isabella Creek Tributary)	09030001-906				X				1
Unnamed creek (Little Isabella Creek Tributary)	09030001-907				X				1
Unnamed creek (Jack Pine Creek Tributary)	09030001-908				X				1
Unnamed creek (Jack Pine Creek Tributary)	09030001-909				X				1
Unnamed creek (Jack Pine Creek Tributary)	09030001-910				X				1
Unnamed creek (Jack Pine Creek Tributary)	09030001-911				X				1
Unnamed creek (Mitawan Creek Tributary)	09030001-912				X				1
Unnamed creek (Mitawan Creek Tributary)	09030001-913				X				1
Unnamed creek (Mitawan Creek Tributary)	09030001-914				X				1
Unnamed creek (Tomlinson Creek Tributary)	09030001-915				X				1
Unnamed creek (Kinmount Creek Tributary)	09030001-916				X				1
Unnamed creek (Kinmount Creek Tributary)	09030001-917			X	X			1	1
Unnamed creek (Ninemile Creek Tributary)	09030001-918				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Unnamed creek (Ninemile Creek Tributary)	09030001-919				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-920				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-921				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-922				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-924				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-925				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-926				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-928				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-929				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-930				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-932				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-933				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-934				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-935				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-936				X				1
Unnamed creek (Ninemile Creek Tributary)	09030001-938				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-941				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-942				X				1
Unnamed creek (Fawn Creek Tributary)	09030001-943				X				1
Unnamed creek (Ash River Tributary)	09030001-944				X				1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Unnamed creek (Ash River Tributary)	09030001-945				X				1
Unnamed creek (Ash River Tributary)	09030001-946				X				1
Unnamed creek (Ash River Tributary)	09030001-947				X				1
Unnamed creek (Ash River Tributary)	09030001-948				X				1
Unnamed creek (Ash River Tributary)	09030001-949				X				1
Unnamed creek (Ash River Tributary)	09030001-950				X				1
Unnamed creek (Ash River Tributary)	09030001-951				X				1
Unnamed creek (Ash River Tributary)	09030001-952				X				1
Unnamed creek (Ash River Tributary)	09030001-953				X				1
Unnamed creek (Ash River Tributary)	09030001-954				X				1
Unnamed creek (Ash River Tributary)	09030001-955				X				1
Unnamed creek (Ash River Tributary)	09030001-956				X				1
Unnamed creek (Ash River Tributary)	09030001-957				X				1
Unnamed creek (Ash River Tributary)	09030001-958				X				1
Unnamed creek (Ash River Tributary)	09030001-959				X				1
Unnamed creek (Blackduck River Tributary)	09030001-960				X				1
Unnamed creek (Blackduck River Tributary)	09030001-961				X				1
Unnamed creek (Blackduck River Tributary)	09030001-962				X				1
Unnamed creek (Blackduck River Tributary)	09030001-963				X				1
Cross River	09030001-966					X			1

General Info		Risks			Qualities				
Stream Name	**WID**	Impaired (aquatic life or recreation)	Disturbance (HSPF reach more than 25% disturbed)	Altered watercourses	Class 2A coldwater	Exceptional use (TALU)	Wild rice	**Total Risks**	**Total Qualities**
Bezhik Creek	09030001-975					X	1854, MPCA		2
Stony River	09030001-985						DNR, 1854, MPCA		1
Dunka River	09030001-987				Proposed		1854, MPCA		2

References

Houston Engineering, Inc. (HEI) 2020a. Technical Memorandum. Rainy Headwaters WRAPS Core Team Kickoff Meeting - Priorities/Protection/Restoration Summary. February 14, 2020.

Houston Engineering, Inc. (HEI) 2020b. Technical Memorandum. Rainy Headwaters HSPF Model – Scenario Modeling. August TBD, 2020.

Minnesota Pollution Control Agency (MPCA). 2017. Rainy River-Headwaters Watershed Monitoring and Assessment Report. June 2017

Appendix E: HSPF Scenario Memo

Appendix E: HSPF Model – Scenario Modeling Technical Memorandum

To: Rainy Headwaters River Core Team

From: Houston Engineering, Inc.

Subject: Rainy Headwaters HSPF Model – Scenario Modeling

Date: October 14, 2020

Project: 6074-0023

Edits from Core Team review incorporated by MPCA June 2021

INTRODUCTION

This technical memorandum (TM) describes the development and results of multiple Hydrologic Simulation Program-Fortran (HSPF) modeling scenarios, created as part of the Watershed Restoration and Protection Strategy (WRAPS) project for the Rainy River Headwaters watershed (watershed).

This TM describes:

- How the scenarios were selected and developed;
- How the scenario concepts were translated info HSPF modifications; and
- The results of the scenarios.

The results of these modeling scenarios will be used in the WRAPS process as criteria to prioritize and target protections and restoration strategies. The results will ultimately be incorporated into the WRAPS report where they can guide implementation via the WRAPS strategies table.

It is important to note that the modeled results are the result of modeling in which there is inherent uncertainty in the breakdown between sources. In forested watersheds, the relative contributions from minor land cover classes and different forest classes are poorly constrained by the HSPF model. In addition, the climate change scenario does not include any changes that might occur to the overall forest community which in turn could also impact forest hydrology. These values are meant to be used in combination of sample data, local knowledge, and professional judgement to assist the development of management decisions.

SCENARIO DEVELOPMENT

On May 1st, 2020, the Rainy River – Headwaters WRAPS Core Team met to begin discussing HSPF scenario modeling for the watershed. The purpose of the meeting was to:

- introduce HSPF modeling to the group;
- describe how modeling scenarios could be incorporated into the WRAPS report; and
- discuss some recommended scenarios.

Following the meeting, on May 5, 2020, a survey was sent out to the Core Team, soliciting input on the modeling scenarios. The survey was closed on May 14, 2020. Survey responses assisted scenario development. The three scenarios focused on included:

1. Increased development, primarily along shorelines;
2. Climate change; and
3. Increased impacts to forests.

INCREASED DEVELOPMENT

With less than three people per square mile, the watershed is currently sparsely developed. Limited road access throughout the watershed combined with the desired types of development (i.e. recreational and/or residential) indicates future development is likely to be largely focused in predictable areas (e.g. lakes, rivers, road access, etc.).

The Core Team provided input of specific lakes and rivers that are likely to see future development. Additionally, the Core Team provided input on which land use types should or should not be considered for potential future development. A key concern for this watershed is shoreland development. This includes development such as residential (e.g. houses and cabins) and commercial/commercial (e.g. resorts and camping). The Core Team provided additional information that was used to better estimate shoreline development in the modeling scenarios.

The following process was used to simulate an increased development HSPF model scenario:

- All privately owned lands (with the exclusion of wetlands) within 500 feet of Core Team identified lakes and rivers were converted to development land use in the model. Key public land exclusions in the watershed include Voyageurs National Park (VNP), Federal/State/Tribal lands, and the Boundary Waters Canoe Area Wilderness (BWCAW). State School Trust lands were included, as they present an opportunity for future sale and development. Core Team identified lakes and rivers included:

Lakes

- Kabetogama
- Namakan
- Burntside
- Shagawa
- White Iron Chain (White Iron, Farm, Garden)
- Bear Island
- Gunflint
- Loon
- Sea Gull Lake
- Fall
- Birch
- Ash
- Black Duck
- Big

Rivers

- Lower Ash

- Ash
- Blackduck
- Dunka

- Additionally, all of the subwatersheds within the model were given a general development increase of 10% (i.e. the amount of developed land in the subwatershed was increased by 10%). This was done to account for generalized non-shoreland development.
- Municipalities within the watershed were converted to entirely developed (i.e. all of the municipality land was considered developed).
- Septic point source loading was increased at a rate consistent with population density loading from the existing model (i.e. where development was added, point source septic loading was scaled to match the development increase).

A comparison of the existing condition developed land use and the increased development scenario land use is shown in **Figure 1** and **Figure 2**.

Figure 1. Existing land use and model subwatershed development percentages.

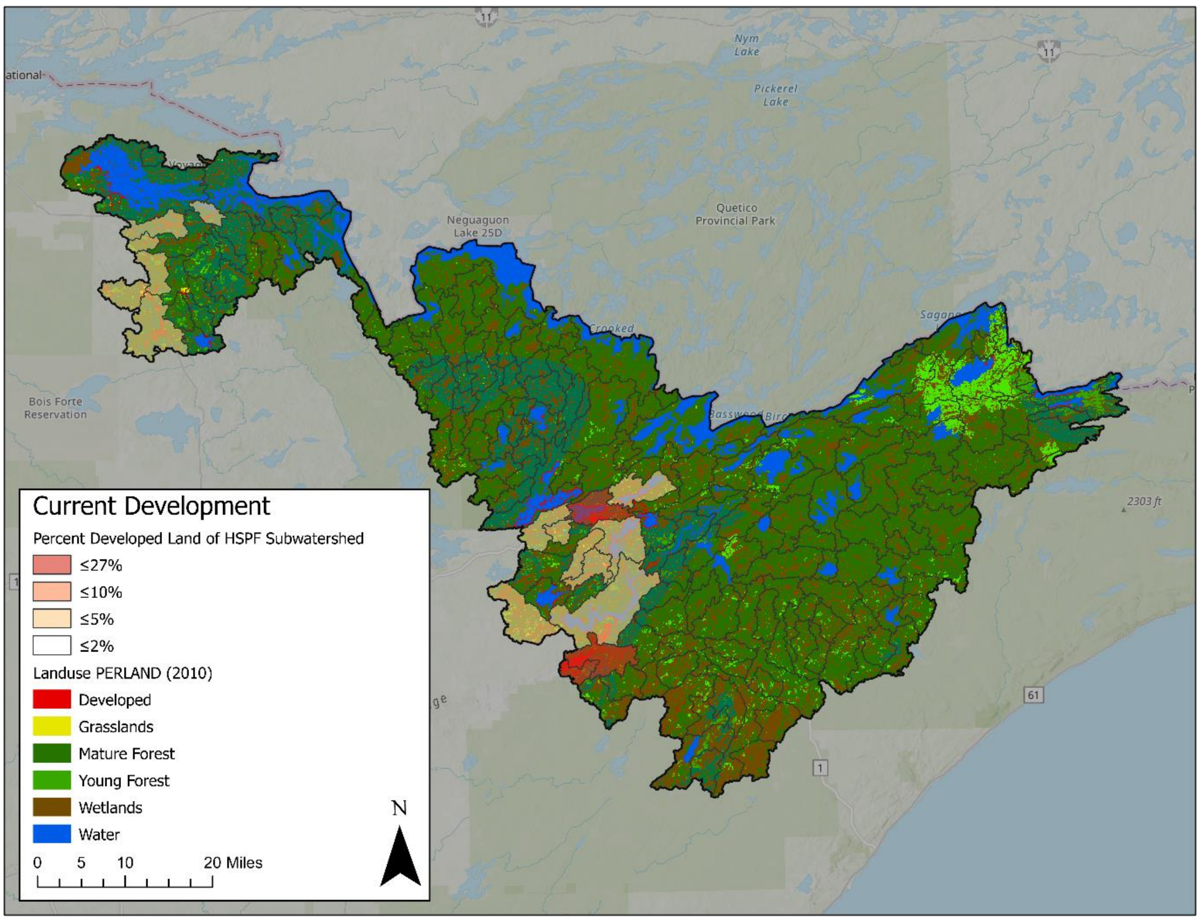
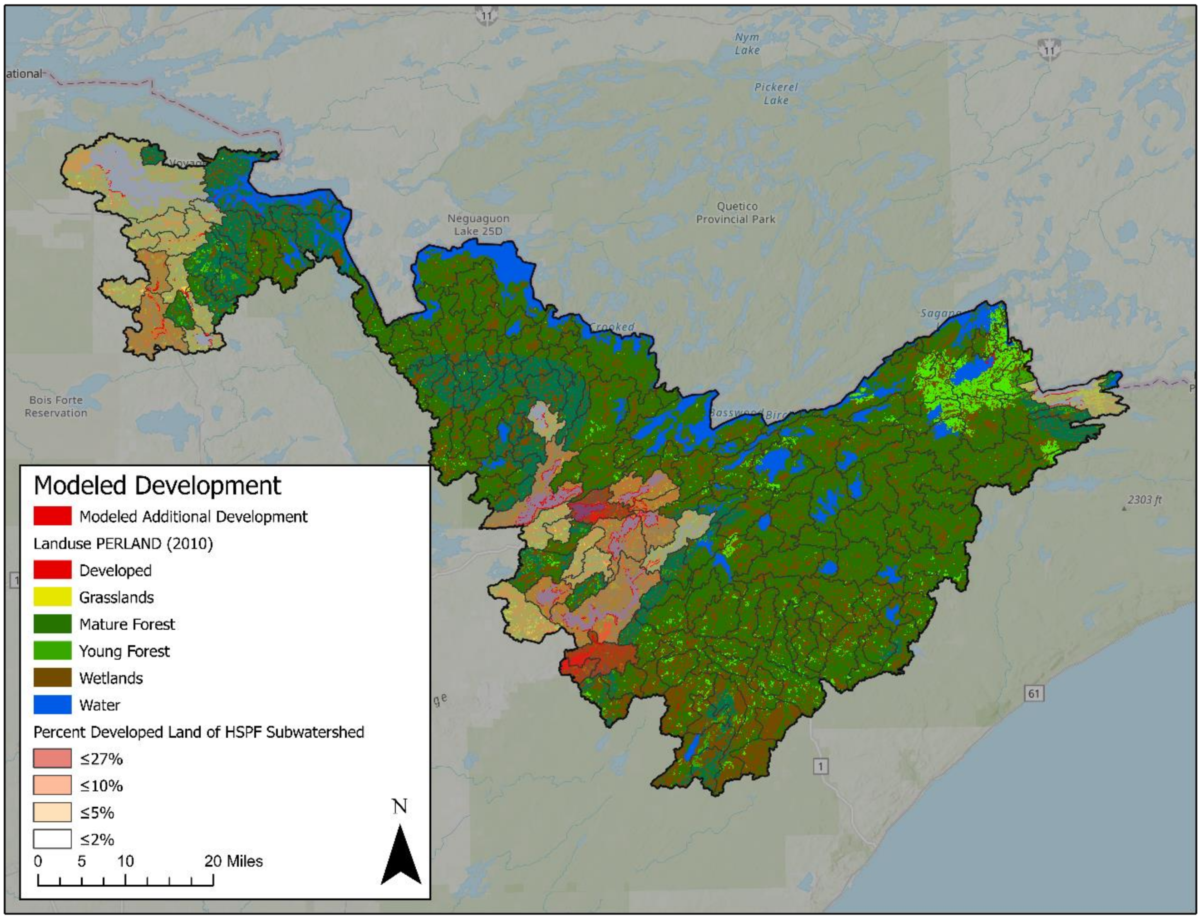


Figure 2. Increased development scenario land use and model subwatershed development percentages.



FOREST DISTURBANCE

Approximately 80% of the watershed is forested. This substantial percentage indicates that forest disturbances could have significant impacts on water quality within the watershed and its resources. Forest disturbance ranges from timber harvesting to large-scale blowdowns and wildfires.

Increased Forest Disturbance

Similar to the increased development scenario, the Core Team provided input on subwatersheds to include in the scenario. All of the RRHW was selected. Additionally, the Core Team provided input on which land use types should or should not be considered for potential future forest disturbance.

The following process was used to simulate the forest disturbance (increased timber harvest) HSPF model scenario:

- Within Core Team identified subwatersheds, all mature forest land uses on public lands (with the exclusion of BWCAW) were reduced and the reduction lands were converted to young forest. State School Trust lands were included (including within the BWCAW), however a proposed land swap with the USFS could reduce school trust lands within the BWCA and increase School Trust lands outside of the BWCA in the RRHW, including in the Dunka River Subwatershed.
- Three different versions of this scenario were modeled, each one representing a greater degree of forest disturbance. The mature forest reductions modeled are 10%, 20%, and 30%. For example, in the 10% simulation, 10% of mature forest within the identified subwatersheds was converted to young forest, to simulate forest disturbance. Modeling several degrees of forest disturbance provides information about how the watershed water quality might respond to increased forest disturbance.

The existing condition forest land use (mature and young forest) are shown in **Figure 3**. The subwatersheds that did not undergo any forest modification are also shown.

Based on the input criteria from the Core Team, the specific areas within the watersheds that were subject to mature forest reduction modifications are shown in **Figure 4**. These specific areas were modified by 10%, 20%, and 30% in the various versions of the scenario and the modifications were extrapolated out to changes in the subwatershed land use percentages.

Figure 3. Existing forest land use and unmodified subwatersheds.

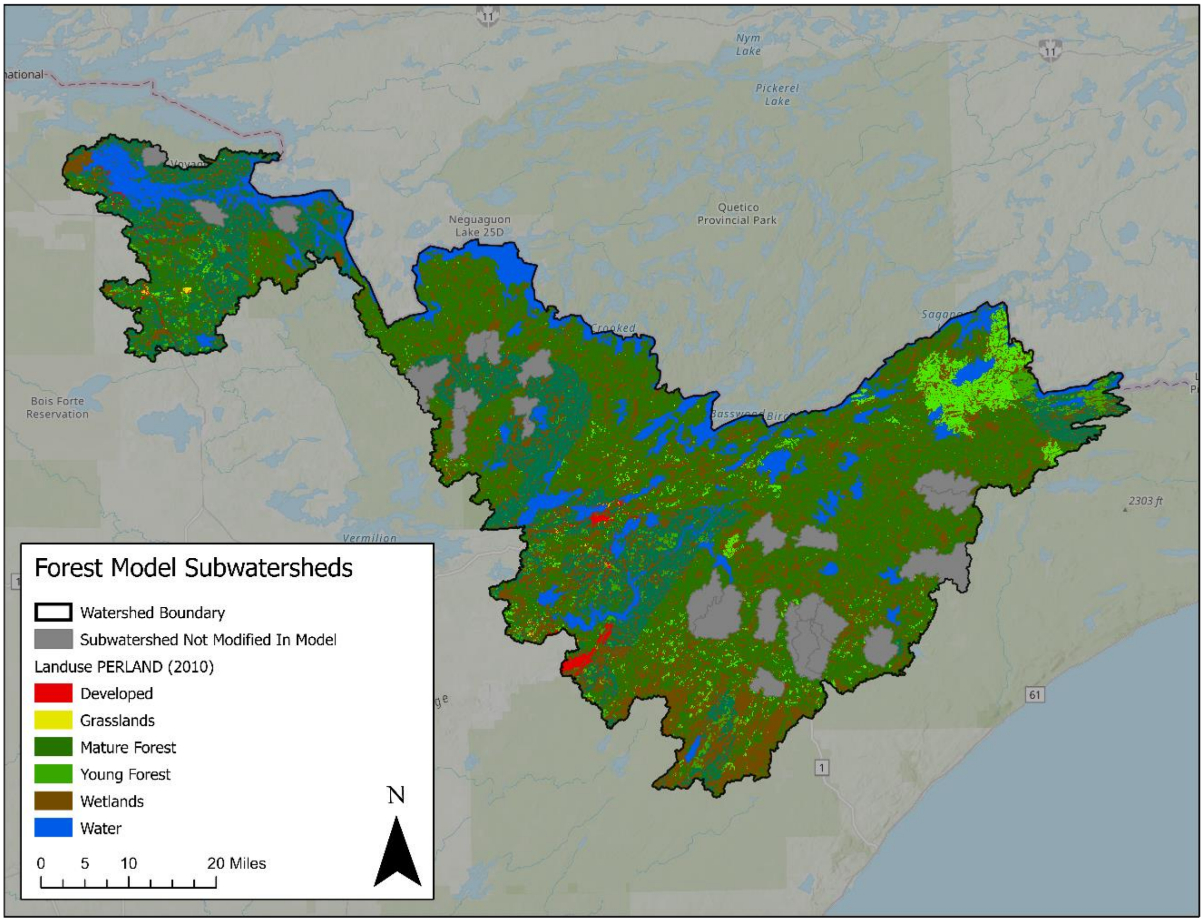
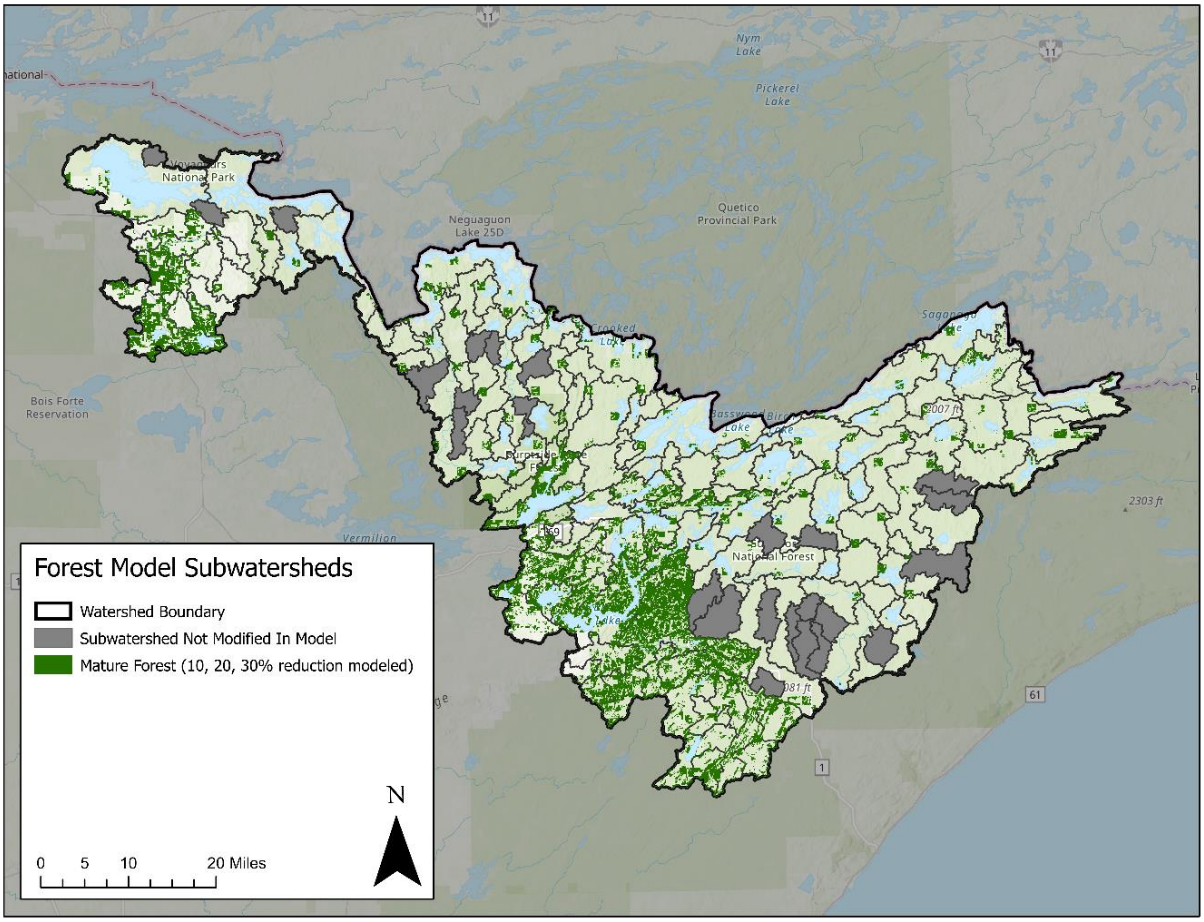


Figure 4. Specific forest land use modified for forest disturbance scenario.



CLIMATE CHANGE

Potential climate related impacts that may occur in the upper Midwest, including areas of the watershed, are described in the National Climate Assessment for the Midwest (Pryor et al., 2014). Some of the impacts discussed include changes in forest composition, increases in heatwave intensity and frequency, increased humidity, degraded air quality, reduced water quality and increased rainfall and flooding. Additional analysis of potential climate impacts to the watershed are included in the Climate Change Scenario Details section of this TM.

The HSPF Scenario Application Manager (HSPF-SAM) includes multiple default climate change scenarios. These scenarios were used to show the impacts of climate change in the watershed. The three climate change options available:

- **Mild**: 1 ˚F increase in average air temperature and 4% increase in extreme precipitation.
- **Moderate**: 2 ˚F increase in average air temperature and 8% increase in extreme precipitation.
- **Severe**: 4 ˚F increase in average air temperature and 12% increase in extreme precipitation.

The climate change options adjust the existing climate record for the HSPF model. For air temperature increases, the change is applied across the whole record. For the change in extreme precipitation, the percent increase in applied to the extreme precipitation events to represent storm intensification due to climate change.

All three climate change options were modeled to show the expected rate of change under the existing climate change projections. Overall, the most probable climate change scenario is best represented in the severe option.

SCENARIO RESULTS

As part of the HSPF scenario development survey, the Core Team provided input about key locations in the watershed (i.e. subwatersheds/resources) where they would like details about how the scenarios impact changes in annual averages (volumes and pollutant loading). This TM presents the scenario modeling results in two formats:

- Figures indicating the percent change in average annual runoff volume and loading (sediment, total phosphorus [TP], and total nitrogen[TN]) as compared to the existing condition. Because of the resolution of the HSPF model, the results are mapped at a subwatershed scale; and
- Tables identifying the numeric changes in loading for key subwatersheds/resources, identified by the Core Team during the scenario development. The table includes the annual average runoff volumes and loading for both the existing condition and the scenario, as well as the percent changes for each parameter.

INCREASED DEVELOPMENT

The scenario results show that the most change in runoff and sediment, and nutrient loading occurred in the areas that already have some disturbance from development, including the Ash River, and the lakes around Ely (White Iron Chain, Shagawa, and Burntside). This is likely the result of the relative amount of area within the watershed converted to ‘Developed’ in the model as the scenario converted all privately-owned lands within 500 feet of lakes and streams. Increased phosphorus runoff to these lakes with additional development in the future range from 26%-33%. Table 1 and Table 2 show the modeled average yields for land types in the RRHW and the HSPF portion of the Rainy River – Rainy Lake model that is part of the RRHW in the NRCS watershed boundary dataset. The differences in these values illustrate the impact development can have on runoff, sediment, and nutrient loading.

The results for the increased development scenario are shown for annual average runoff volume per acre in **Figure 5**, sediment in **Figure 6**, TP loading in **Figure 7**, and TN loading in **Figure 8**. The numeric results at key locations are shown in **Table 3**.

Table 1. Average yields for land types in the RRHW, based on HSPF model result

Land Type	Discharge	Sediment	Nitrogen	Phosphorus
	(acre-ft/acre/year)	(tons/acre/year)	(lbs/acre/year)	(lbs/acre/year)
Wetland	0.688	0.00024	0.385	0.029
Forest mature deciduous	0.775	0.0026	0.785	0.040
Forest regrowth	0.802	0.0132	1.187	0.049
Forest mature evergreen	0.618	0.0013	0.663	0.033
Grassland	0.994	0.0194	1.936	0.066
Cropland high till	0.0	0.0	0.0	0.0
Feedlot	0.0	0.0	0.0	0.0
Developed-all	1.722	0.042	3.279	0.581
Developed-pervious	1.198	0.0397	3.116	0.555
Developed-impervious	23.461	0.1187	10.052	1.640

Table 2. Average yields for land types in the Rainy River - Rainy Lake Watershed, based on HSPF model result

Land type	Discharge	Sediment	Nitrogen	Phosphorus
	(acre-ft/acre/year)	(tons/acre/year)	(lbs/acre/year)	(lbs/acre/year)
Wetland	0.275	0.00001	0.408	0.009
Forest mature deciduous	0.552	0.0027	1.289	0.038
Forest regrowth	0.506	0.0068	1.323	0.061
Forest mature evergreen	0.365	0.0015	0.855	0.025
Grassland	0.659	0.0105	2.072	0.117
Cropland high till	0.544	0.1427	3.659	0.399
Feedlot	1.102	0.0565	8.758	1.263
Developed-all	2.081	0.021	3.288	0.272
Developed-pervious	0.880	0.0174	2.866	0.179
Developed-impervious	17.320	0.0722	8.643	1.453

Figure 5. Changes in annual average runoff volume per acre for the increased development scenario.

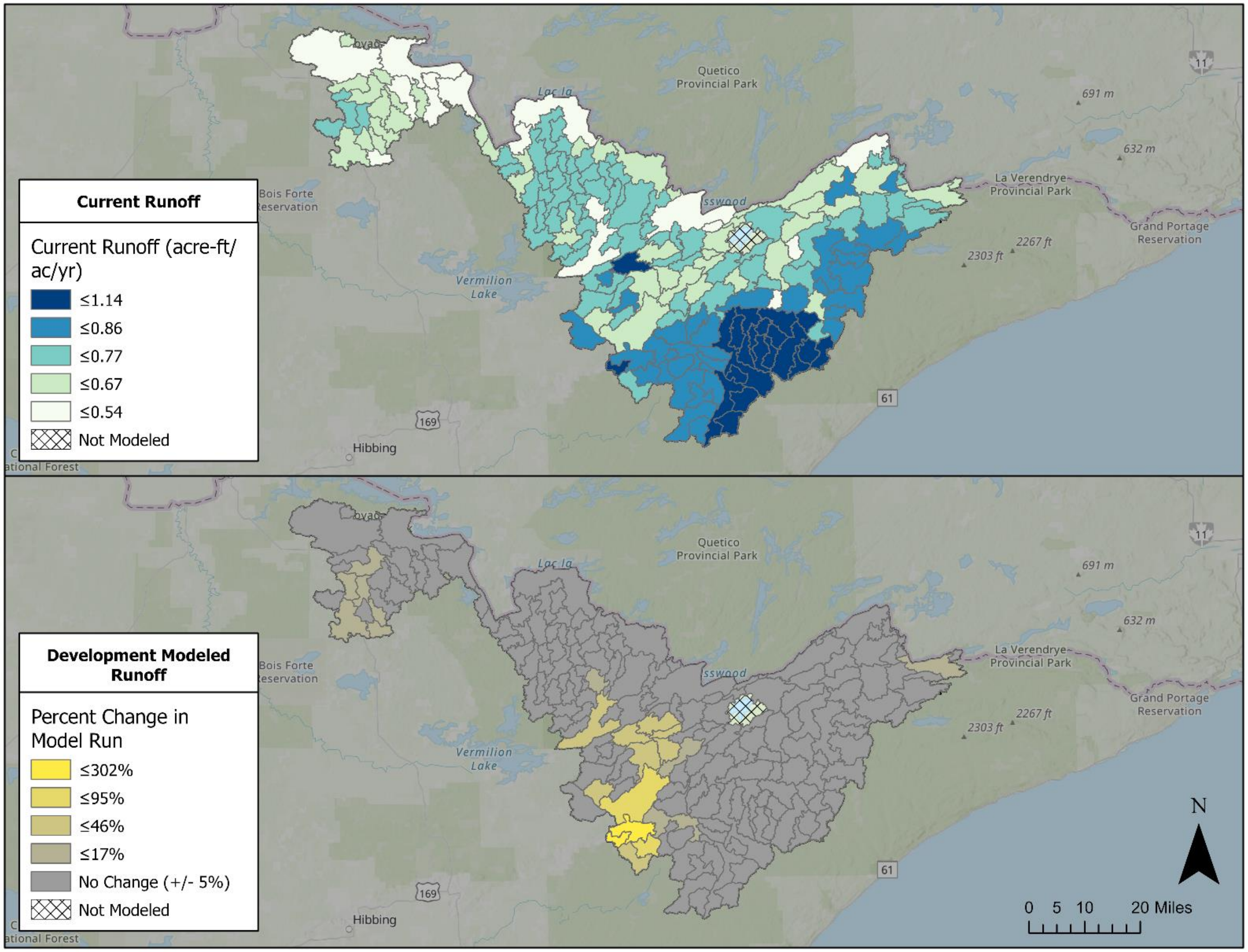


Figure 6. Changes in annual average annual average sediment loading for the increased development scenario.

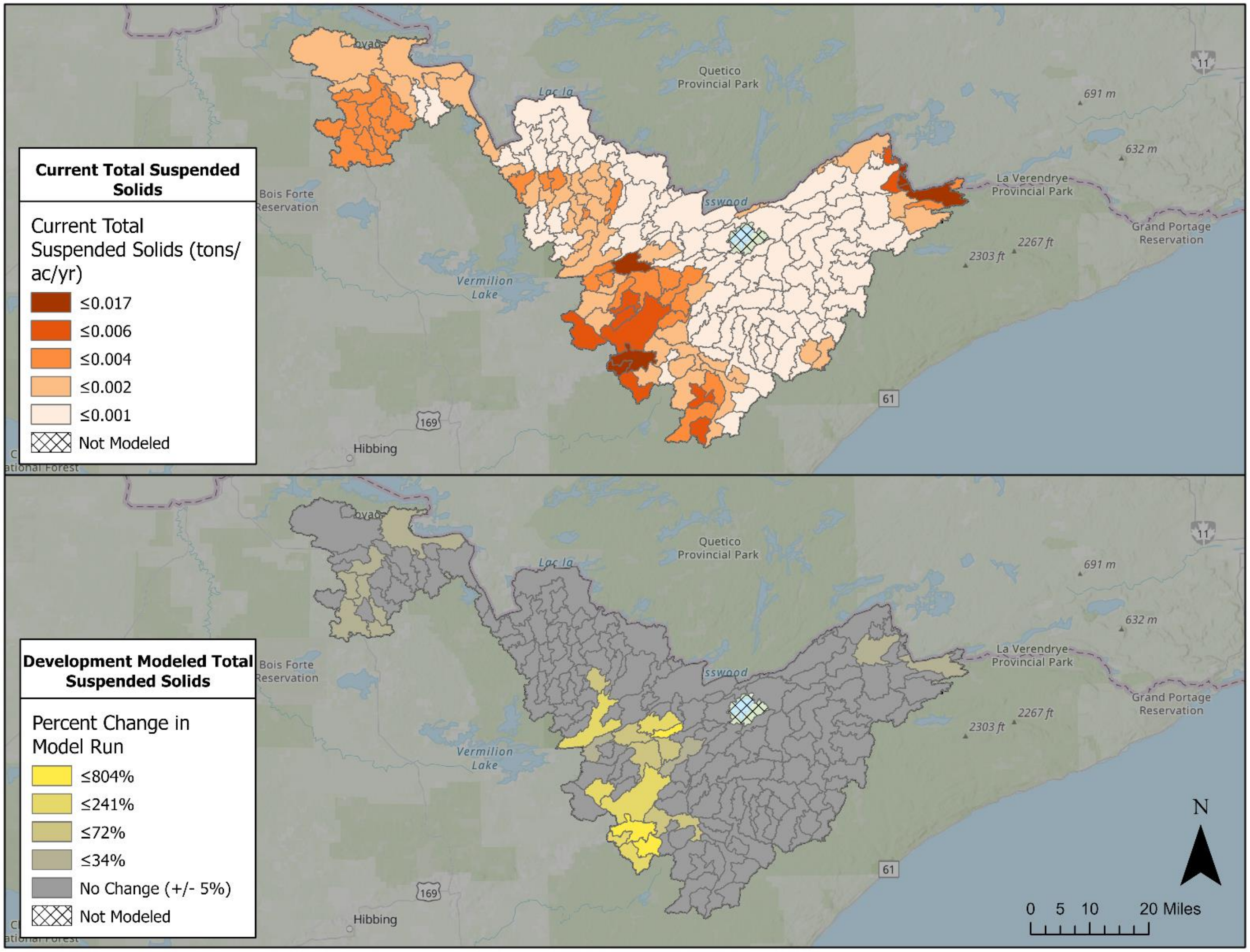


Figure 7. Changes in annual average annual average TP loading for the increased development scenario.

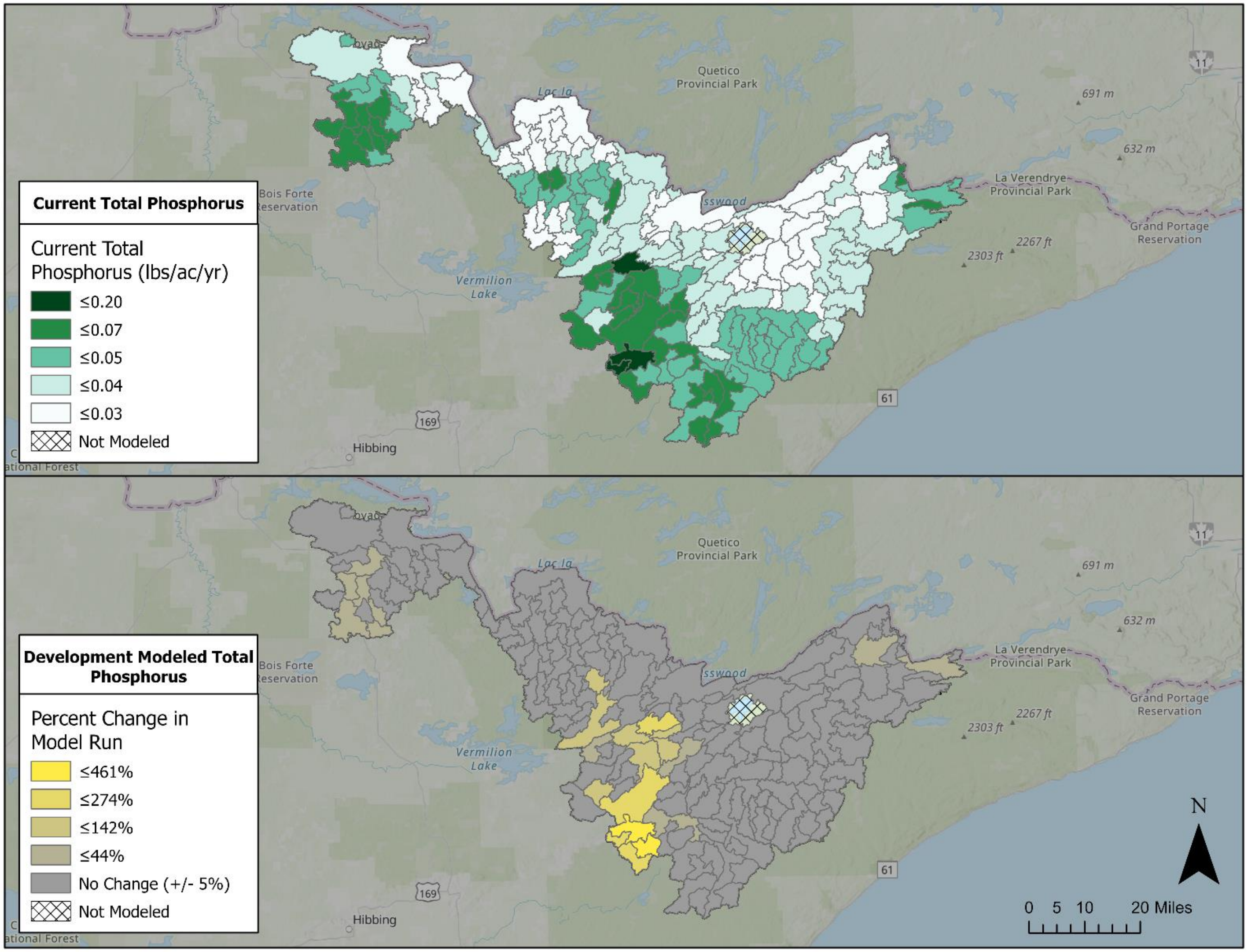


Figure 8. Changes in annual average annual average TN loading for the increased development scenario.

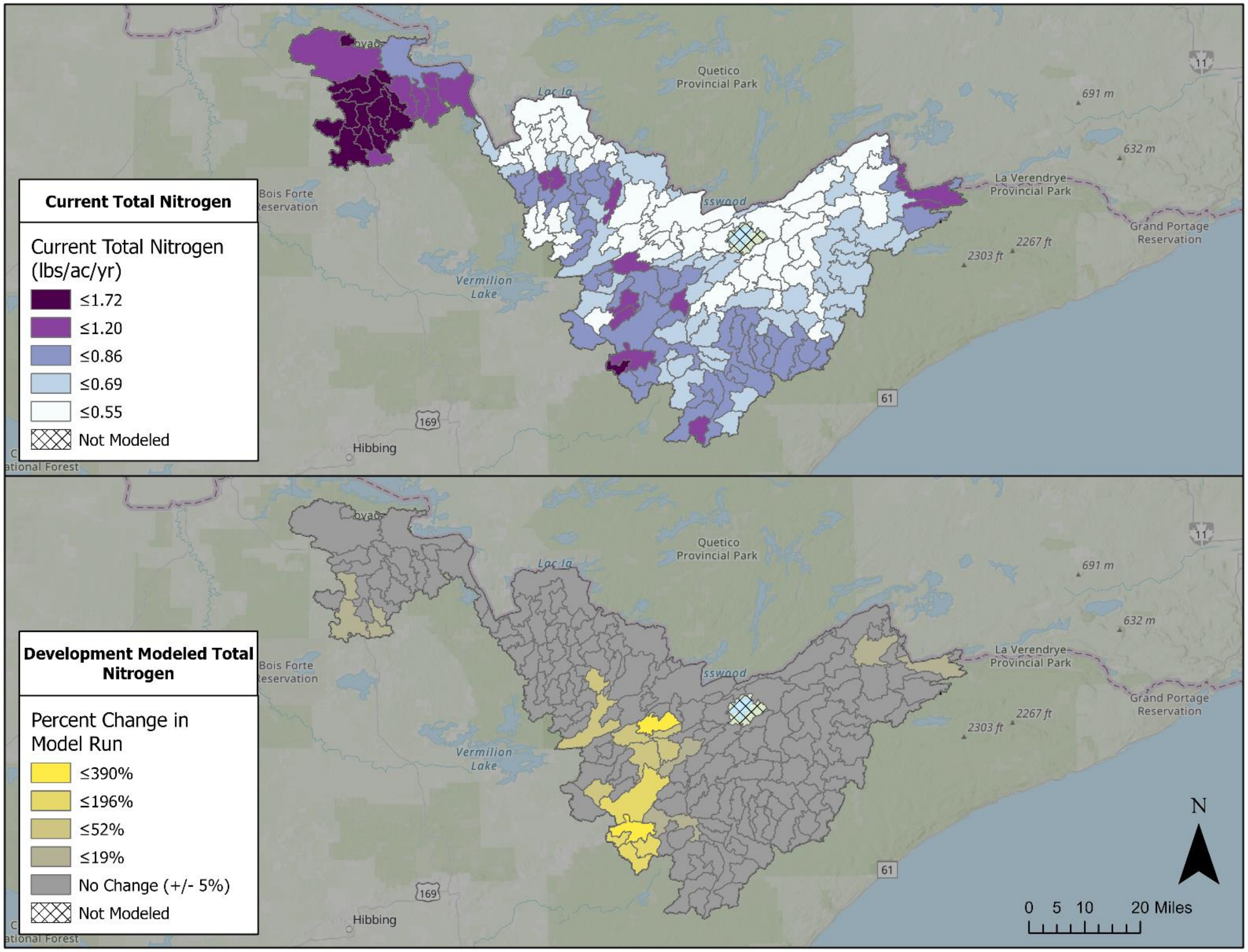


Table 3. Parameter changes at key locations for the increased development scenario.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	15,959	0.0%	53	53	0.1%	1,052	1,052	0.1%	36,517	36,525	0.0%
51	VNP Lake (Tooth)	2,324	2,324	0.0%	7	7	0.0%	148	148	0.0%	5,219	5,219	0.0%
60	Granite River into Saganaga	4,783	4,783	0.0%	36	36	0.0%	242	242	0.0%	5,423	5,423	0.0%
73	Blackduck River	3,354	3,568	6.4%	18	24	33.8%	279	323	15.6%	8,456	9,186	8.6%
81	Blackduck River	5,012	5,456	8.8%	27	30	12.2%	439	488	11.1%	12,457	13,048	4.7%
87	Ash River	5,690	6,569	15.4%	28	34	23.3%	450	547	21.5%	13,560	14,730	8.6%
101	Ash River	7,537	8,065	7.0%	30	34	12.7%	543	601	10.7%	17,506	18,210	4.0%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	25,822	2.0%	89	93	4.2%	1,815	1,872	3.1%	57,814	58,503	1.2%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	22,441	1.2%	82	86	5.8%	1,549	1,602	3.4%	51,936	52,819	1.7%
352	Birch Lake	23,193	39,315	69.5%	196	453	131.2%	2,186	6,052	176.9%	31,409	63,414	101.9%
364	White Iron Chain	10,257	13,005	26.8%	61	100	64.8%	891	1,422	59.6%	12,069	15,179	25.8%
374	Burntside Lake	12,538	16,703	33.2%	40	99	150.3%	840	1,673	99.2%	14,254	19,564	37.2%
382	Shagawa Lake (Ely)	13,121	17,086	30.2%	98	155	57.6%	1,443	2,228	54.4%	12,677	17,565	38.6%
384	Fall Lake (Winton)	7,864	9,650	22.7%	16	39	140.9%	447	1,672	273.7%	6,289	26,945	328.5%
474	Big Lake	4,017	4,702	17.0%	13	23	72.4%	270	461	70.8%	4,876	6,895	41.4%

FOREST DISTURBANCE

Increased Timber Harvesting

Variations in runoff and loading results between subwatersheds are largely a result of differences in amount of existing mature forest. For example, subwatersheds with more mature forest experiencing a 10% change to forest regrowth experience greater change than a watershed that has less mature forest as there is less land converted in the scenario.

Overall, with a 10% increase in forest disturbance, runoff increased from 0%-8% and the sediment load increased by 0% - 32%, except for the reach that contains Big Lake. Big Lake showed the most change with a 54% increase in sediment loading and a 35% increase in TP loading. The runoff, sediment and nutrient loading only increased slightly in the 20% and 30% increase in forest disturbance scenarios.

Furthermore, changes in runoff, sediment, and nutrients are all relative to the average yield of different land types. The overall change in a subwatershed is dependent of the yields from its contained land types. Small changes in loading could be buffered or exaggerated depending on the composition of the subwatershed. Another way to judge the impact of disturbing different land types in the watershed is to look at how the modeled conversion of different land types to Forest Regrowth changed on an acre-by-acre basis. **Table 4 and Table 5** show the overall yields and relative changes of Mature Forest to Forest Regrowth in the RRHW and the HSPF portion of the Rainy River – Rainy Lake model that is part of the RRHW in the NRCS watershed boundary dataset. These values are averaged across the whole watershed. Small differences between climate zones may exist but the averaged values show the potential differences in loading between the Mature Forest land types and the Forest Regrowth land type. These modeled results show a greater change in runoff, sediment, and nutrients from disturbed mature evergreen forest than from mature deciduous.

The results for the forest disturbance – increased timber harvesting scenarios are shown for annual average runoff volume per acre in **Figure 9**, sediment in **Figure 10**, TP loading in **Figure 11**, and TN loading in **Figure 12**. The numeric results at key locations are shown in **Table 6** through **Table 8**.

Table 4. Average yields from forest areas in the RRHW, based on HSPF results

Land type	Discharge	Sediment	Nitrogen	Phosphorus
	(acre-ft/acre/year)	(tons/acre/year)	(lbs/acre/year)	(lbs/acre/year)
Forest mature evergreen	0.618	0.0013	0.663	0.033
Forest mature deciduous	0.775	0.0026	0.785	0.040
Forest regrowth	0.802	0.0132	1.187	0.049
Forest disturbance impact				
Mature evergreen to regrowth change	0.184	0.01189	0.523	0.0160
Percent change from mature evergreen	29.8%	910.9%	78.9%	48.2%
Mature deciduous to regrowth change	0.027	0.01062	0.4020	0.0097
Percent change from mature deciduous	3.4%	411.5%	51.2%	24.5%

Table 5. Average yields from forest areas in the Rainy River - Rainy Lake Watershed, based on HSPF results

Land type	Discharge (acre-ft/acre/year)	Sediment (tons/acre/year)	Nitrogen (lbs/acre/year)	Phosphorus (lbs/acre/year)
Forest mature evergreen	0.365	0.0015	0.855	0.025
Forest mature deciduous	0.552	0.0027	1.289	0.038
Forest regrowth	0.506	0.0068	1.323	0.061
Forest disturbance impact				
Mature evergreen to regrowth change	0.141	0.00526	0.468	0.0360
Percent change from mature evergreen	38.6%	341.7%	54.8%	144.3%
Mature deciduous to regrowth change	-0.046	0.00413	0.0341	0.0232
Percent change from mature deciduous	-8.4%	154.5%	2.6%	61.4%

Figure 9. Changes in annual average runoff volume per acre for the forest disturbance scenarios.

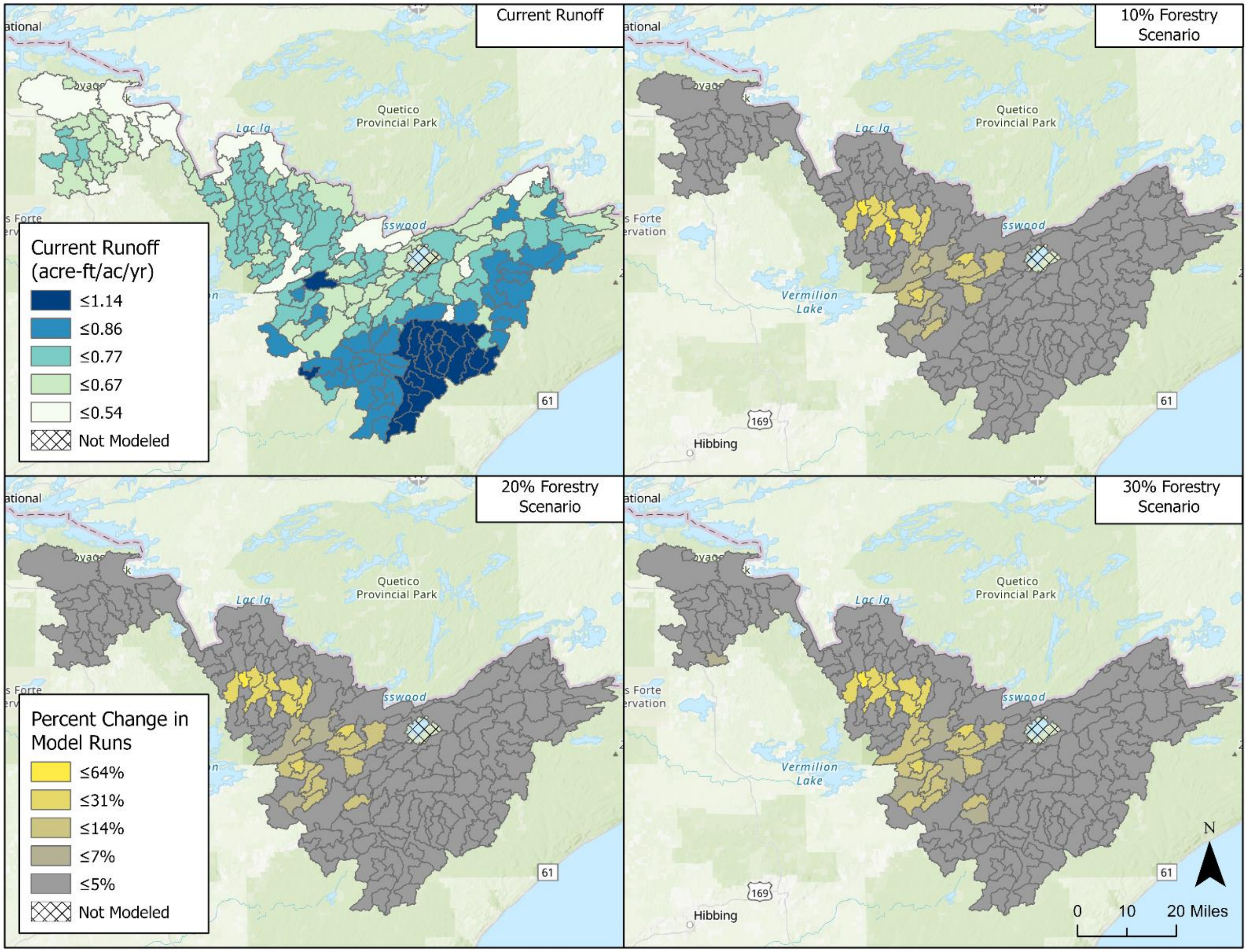


Figure 10. Changes in annual average annual average sediment loading for the forest disturbance scenarios.

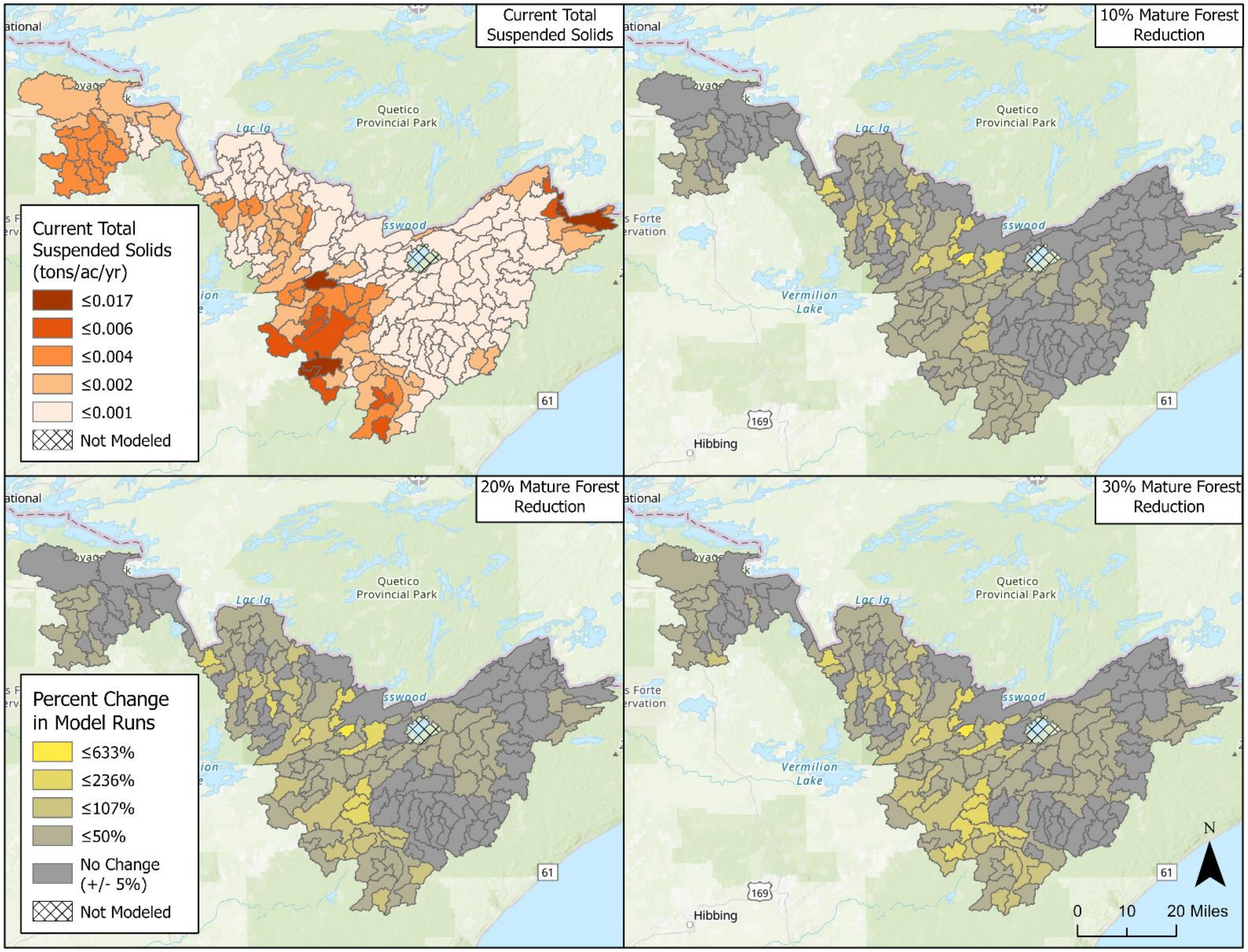


Figure 11. Changes in annual average annual average TP loading for the forest disturbance scenarios.

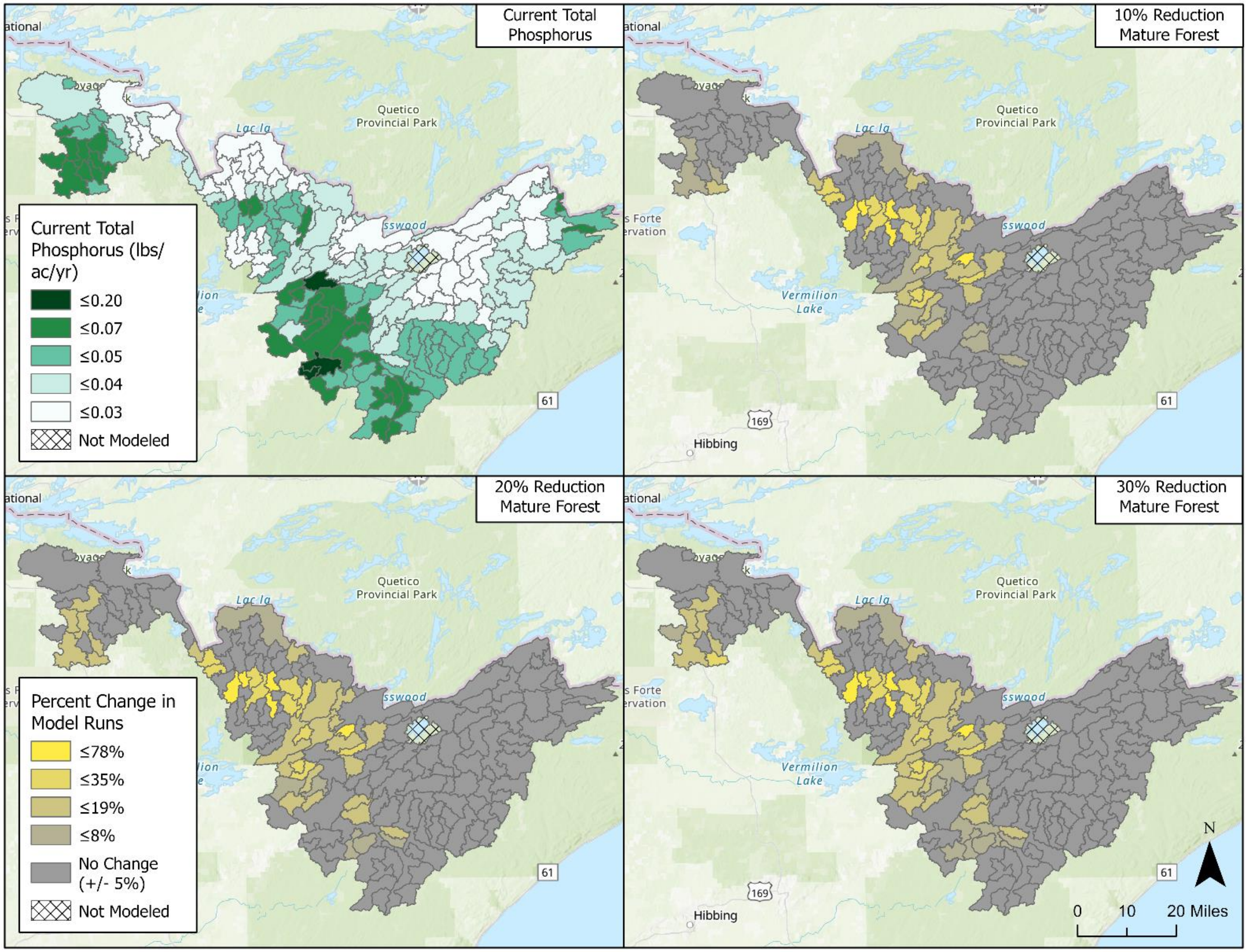


Figure 12. Changes in annual average annual average TN loading for the forest disturbance scenarios.

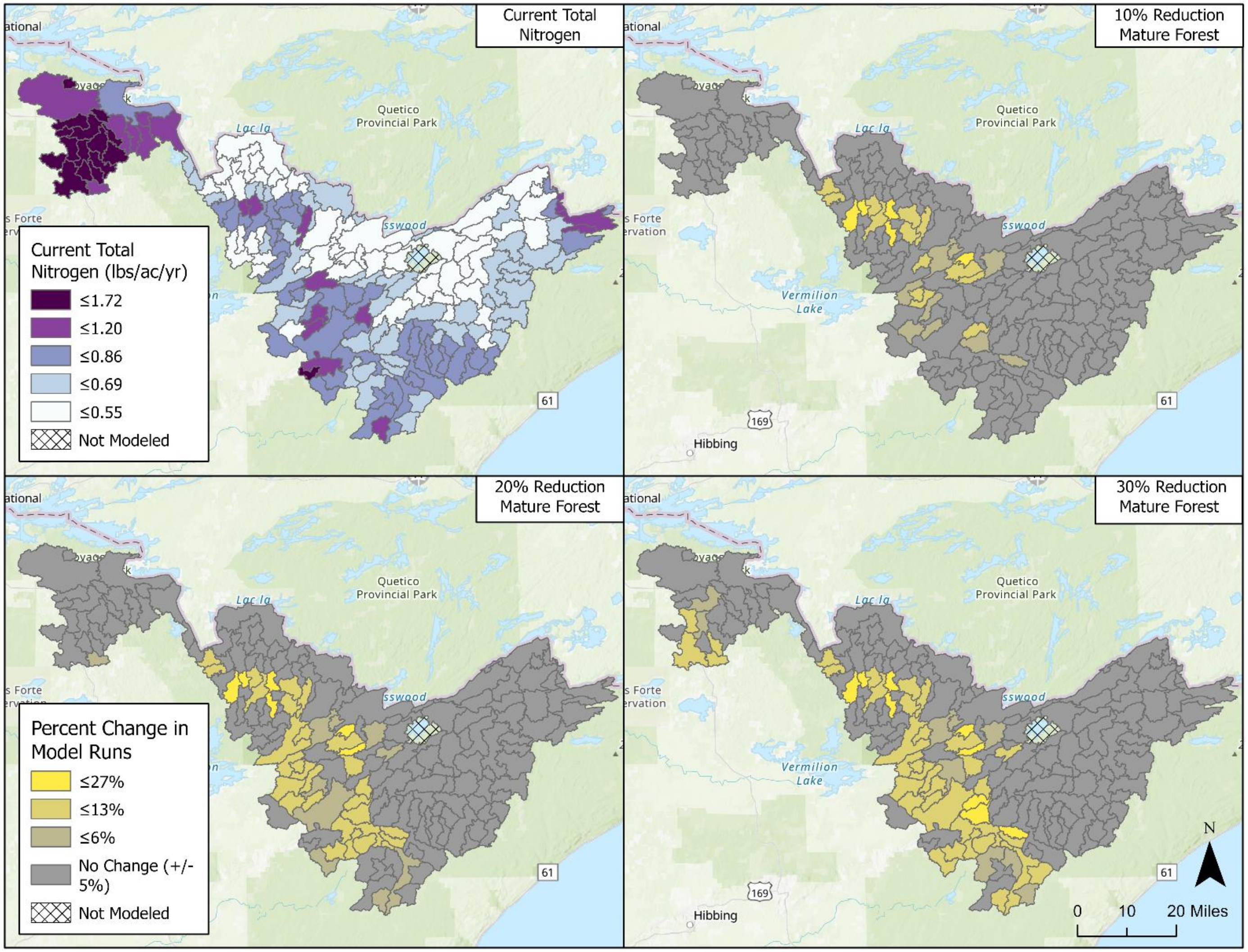


Table 6. Parameter changes at key locations for the forest disturbance, 10% disturbance.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	15,959	0.0%	53	53	0.1%	1,052	1,052	0.0%	36,517	36,522	0.0%
51	VNP Lake (Tooth)	2,324	2,324	0.0%	7	7	0.0%	148	148	0.0%	5,219	5,219	0.0%
60	Granite River into Saganaga	4,783	4,786	0.1%	36	36	0.1%	242	243	0.1%	5,423	5,430	0.0%
73	Blackduck River	3,354	3,403	1.5%	18	20	14.1%	279	295	5.9%	8,456	8,662	2.2%
81	Blackduck River	5,012	5,056	0.9%	27	29	7.9%	439	457	4.1%	12,457	12,665	1.1%
87	Ash River	5,690	5,756	1.1%	28	31	11.7%	450	478	6.2%	13,560	13,879	2.0%
101	Ash River	7,537	7,625	1.2%	30	34	10.1%	543	569	4.8%	17,506	17,811	1.3%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	25,422	0.5%	89	91	2.4%	1,815	1,836	1.1%	57,814	58,042	0.4%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	22,178	0.0%	82	82	0.0%	1,549	1,549	0.0%	51,936	51,935	0.0%
352	Birch Lake	23,193	23,615	1.8%	196	248	26.6%	2,186	2,230	2.0%	31,409	32,397	0.3%
364	White Iron Chain	10,257	10,667	4.0%	61	69	13.7%	891	928	4.1%	12,069	12,451	0.2%
374	Burntside Lake	12,538	13,166	5.0%	40	52	32.3%	840	896	6.7%	14,254	14,900	2.6%
382	Shagawa Lake (Ely)	13,121	13,729	4.6%	98	103	4.6%	1,443	1,497	3.7%	12,677	13,021	0.8%
384	Fall Lake (Winton)	7,864	8,533	8.5%	16	21	28.0%	447	506	13.2%	6,289	6,729	0.2%
474	Big Lake	4,017	5,071	26.2%	13	20	54.0%	270	363	34.6%	4,876	5,447	5.1%

Table 7. Parameter changes at key locations for the forest disturbance, 20% disturbance.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	15,960	0.0%	53	53	0.2%	1,052	1,052	0.1%	36,517	36,526	0.0%
51	VNP Lake (Tooth)	2,324	2,324	0.0%	7	7	0.0%	148	148	0.0%	5,219	5,219	0.0%
60	Granite River into Saganaga	4,783	4,788	0.1%	36	36	0.1%	242	243	0.2%	5,423	5,436	0.2%
73	Blackduck River	3,354	3,453	3.0%	18	23	28.3%	279	312	11.7%	8,456	8,868	4.9%
81	Blackduck River	5,012	5,100	1.7%	27	31	15.7%	439	475	8.1%	12,457	12,874	3.3%
87	Ash River	5,690	5,821	2.3%	28	34	23.5%	450	506	12.4%	13,560	14,199	4.7%
101	Ash River	7,537	7,689	2.0%	30	36	19.8%	543	593	9.3%	17,506	18,103	3.4%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	25,466	0.6%	89	93	4.4%	1,815	1,850	1.9%	57,814	58,229	0.7%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	22,178	0.0%	82	82	0.0%	1,549	1,549	0.0%	51,936	51,935	0.0%
352	Birch Lake	23,193	23,838	2.8%	196	299	52.4%	2,186	2,256	3.2%	31,409	33,278	6.0%
364	White Iron Chain	10,257	10,727	4.6%	61	75	23.7%	891	933	4.8%	12,069	12,647	4.8%
374	Burntside Lake	12,538	13,294	6.0%	40	62	56.3%	840	908	8.0%	14,254	15,279	7.2%
382	Shagawa Lake (Ely)	13,121	13,737	4.7%	98	103	5.1%	1,443	1,498	3.8%	12,677	13,044	2.9%
384	Fall Lake (Winton)	7,864	8,576	9.1%	16	21	30.8%	447	510	14.0%	6,289	6,834	8.7%
474	Big Lake	4,017	5,074	26.3%	13	21	56.3%	270	363	34.7%	4,876	5,456	11.9%

Table 8. Parameter changes at key locations for the forest disturbance, 30% disturbance.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	15,961	0.0%	53	53	0.3%	1,052	1,053	0.1%	36,517	36,531	0.0%
51	VNP Lake (Tooth)	2,324	2,324	0.0%	7	7	0.0%	148	148	0.0%	5,219	5,219	0.0%
60	Granite River into Saganaga	4,783	4,791	0.2%	36	36	0.2%	242	243	0.3%	5,423	5,442	0.3%
73	Blackduck River	3,354	3,502	4.4%	18	25	42.4%	279	328	17.6%	8,456	9,074	7.3%
81	Blackduck River	5,012	5,143	2.6%	27	33	23.6%	439	493	12.2%	12,457	13,082	5.0%
87	Ash River	5,690	5,887	3.4%	28	37	35.2%	450	534	18.6%	13,560	14,518	7.1%
101	Ash River	7,537	7,753	2.9%	30	39	29.5%	543	618	13.8%	17,506	18,394	5.1%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	25,510	0.8%	89	95	6.3%	1,815	1,865	2.8%	57,814	58,416	1.0%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	22,178	0.0%	82	82	0.0%	1,549	1,549	0.0%	51,936	51,934	0.0%
352	Birch Lake	23,193	24,060	3.7%	196	349	78.2%	2,186	2,283	4.4%	31,409	34,158	8.8%
364	White Iron Chain	10,257	10,787	5.2%	61	81	33.7%	891	939	5.4%	12,069	12,843	6.4%
374	Burntside Lake	12,538	13,421	7.0%	40	71	80.3%	840	919	9.4%	14,254	15,658	9.8%
382	Shagawa Lake (Ely)	13,121	13,745	4.8%	98	104	5.7%	1,443	1,498	3.8%	12,677	13,067	3.1%
384	Fall Lake (Winton)	7,864	8,620	9.6%	16	22	33.5%	447	514	14.8%	6,289	6,940	10.4%
474	Big Lake	4,017	5,077	26.4%	13	21	58.6%	270	363	34.8%	4,876	5,465	12.1%

CLIMATE CHANGE

All three climate change options were modeled to estimate the amount of change under the existing climate change projections. HSPF-SAM incorporates change in precipitation along a gradient rather than just an overall increase. Overall, the model increases the total amount of precipitation and surface water runoff in all three scenarios. Additionally, the highest precipitation events increase while the lowest precipitation events are reduced. No change is made to median storm events. Sediment transport is highly influenced by larger storms, which scour and increase sediment wash-off occurring during large events. The increase in surface water runoff and extreme precipitation events in all three scenarios resulted in increased sediment loading.

Additionally, the model incorporates increases in temperatures in all three scenarios. This increases evapotranspiration and decreases 'total runoff', which is a combination of surface runoff and groundwater flow. Although groundwater flow may be small relative to surface runoff from a storm event on a daily timescale, it occurs throughout the year and can be a significant contributor to flow and nutrient loading in a watershed. And although nutrients bound to sediment will increase with increased sediment loading, this decrease in groundwater flow has a stronger influence on the resulting modeled nutrient loading. Overall, with less 'total runoff', nutrient loading decreased.

The results for the climate change scenario are shown for annual average runoff volume in **Figure 13**, sediment in **Figure 14**, TP loading in **Figure 15**, and TN loading in **Figure 16**. The numeric results at key locations are shown in **Table 9** through **Table 11**. The 'severe' option showed decreases in runoff from <1% in Ely to 4% in VNP.

Figure 13. Changes in annual average runoff volume per acre for the climate change scenario

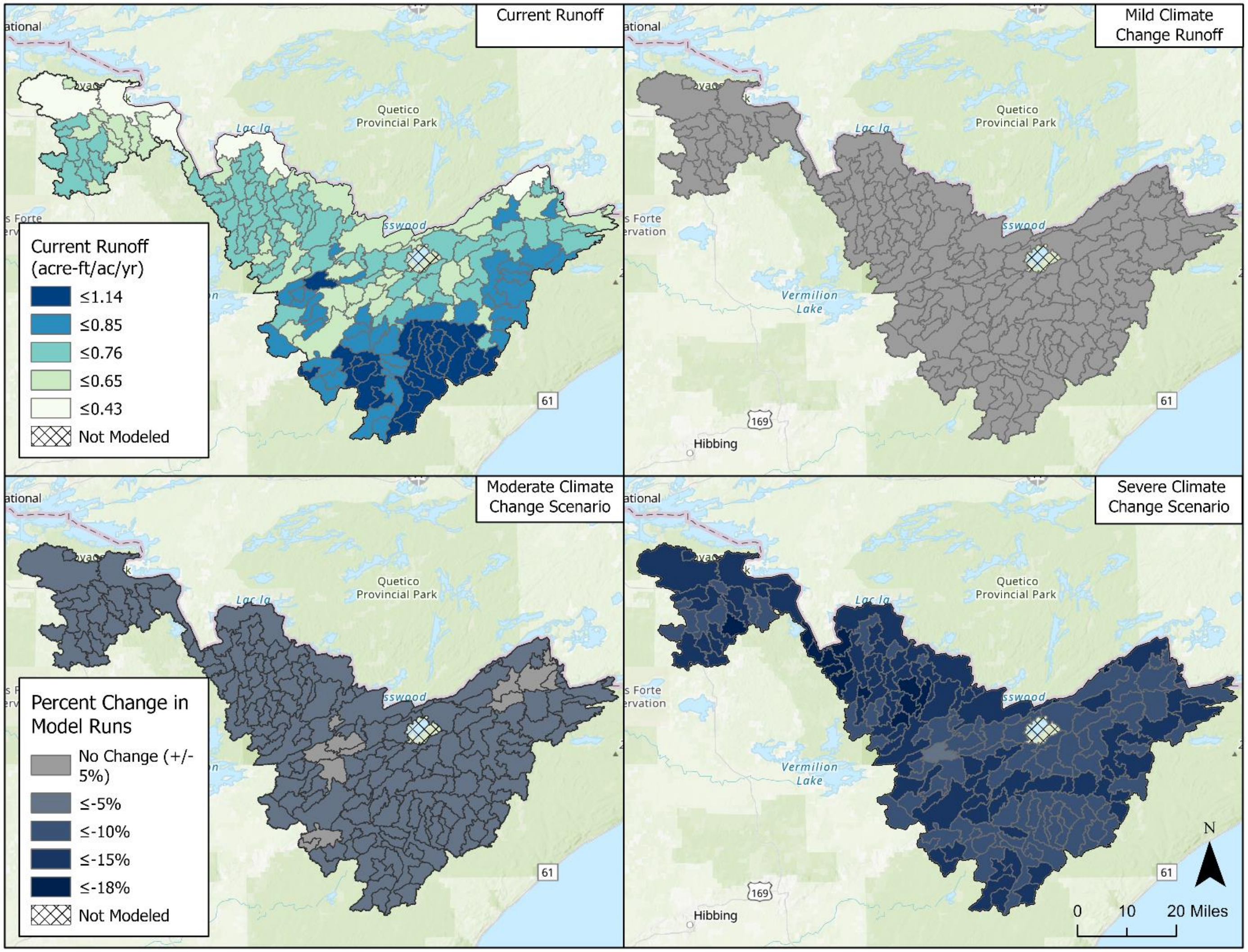


Figure 14. Changes in annual average annual average sediment loading for the climate change scenario

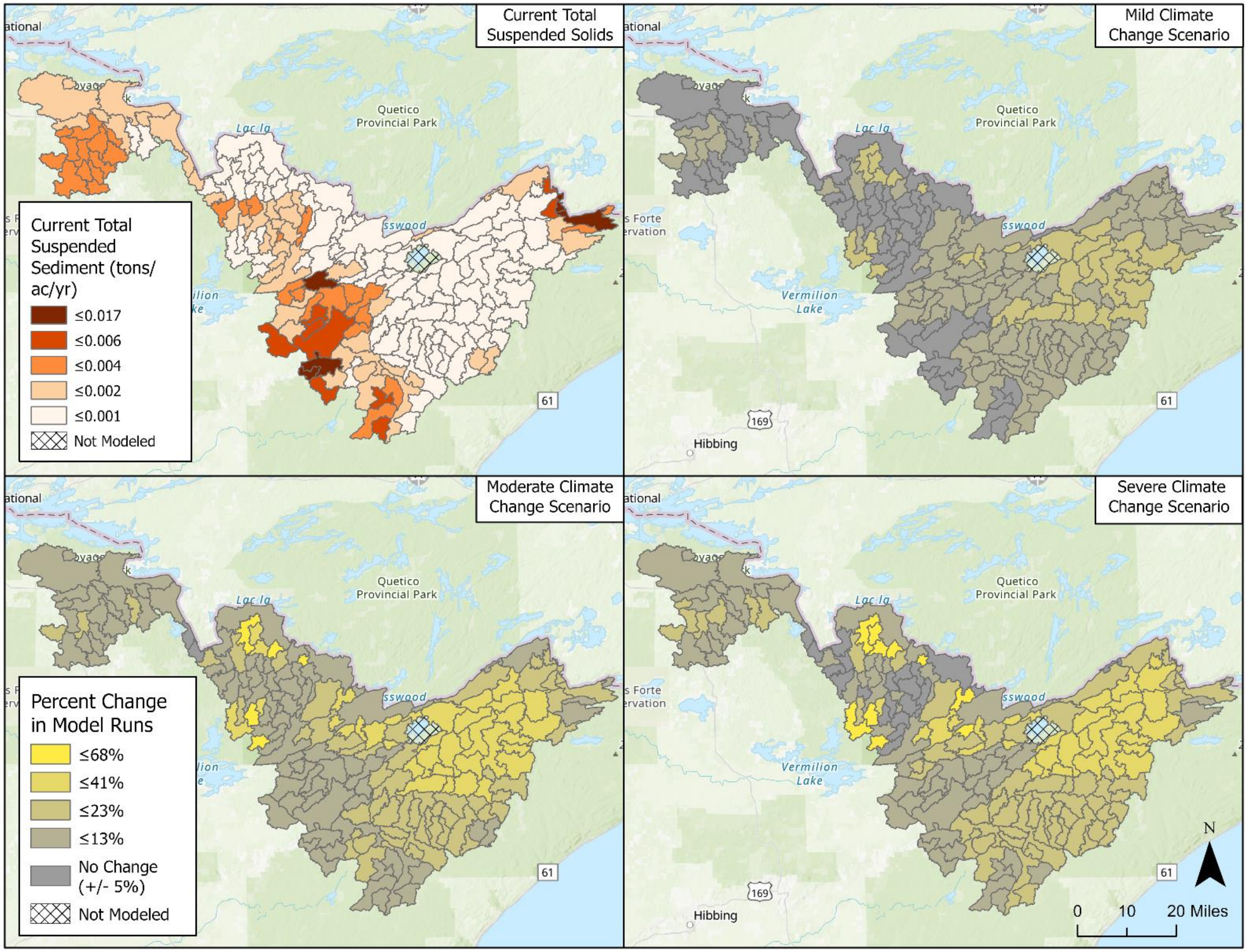


Figure 15. Changes in annual average annual average TP loading for the climate change scenario

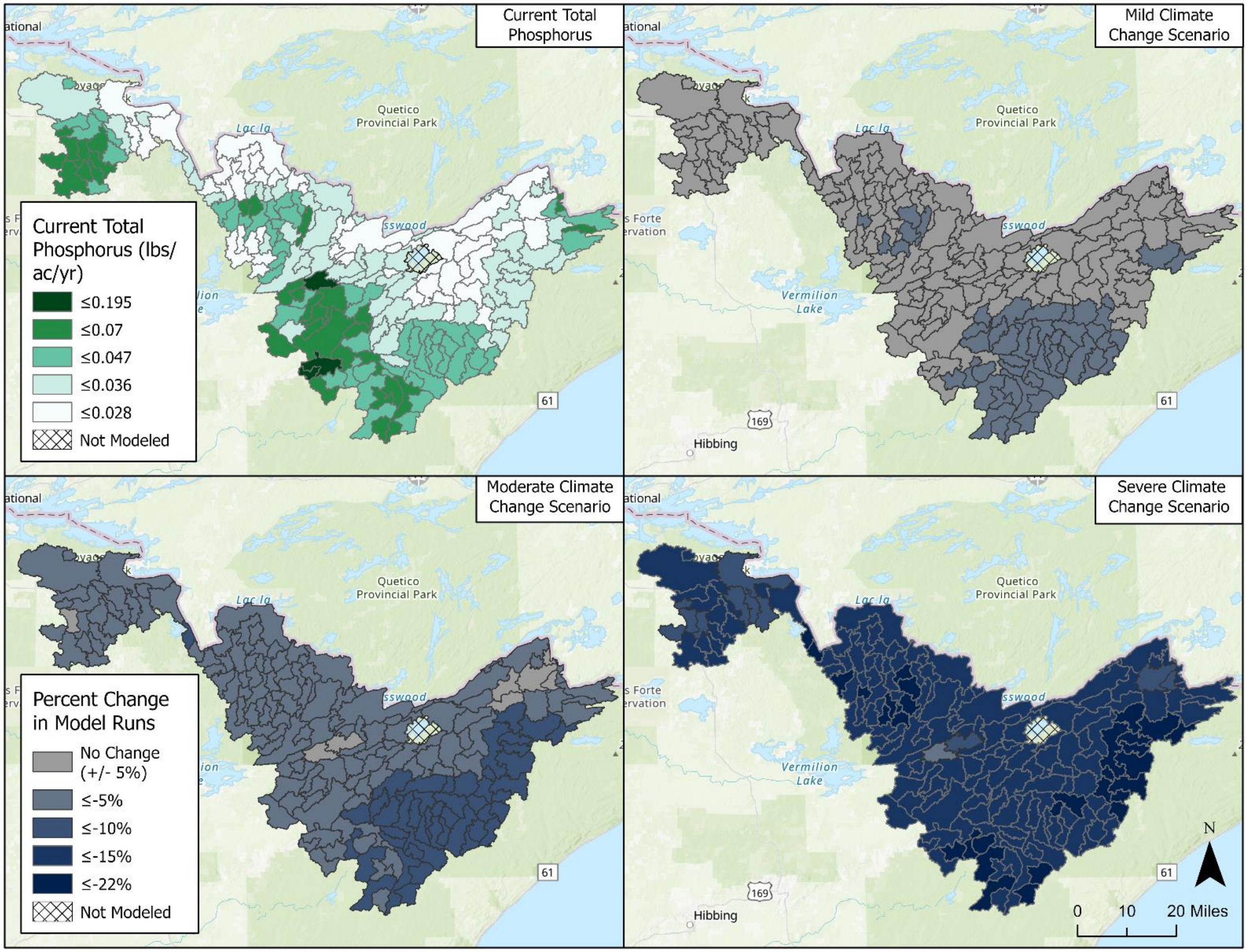


Figure 16. Changes in annual average annual average TN loading for the climate change scenario

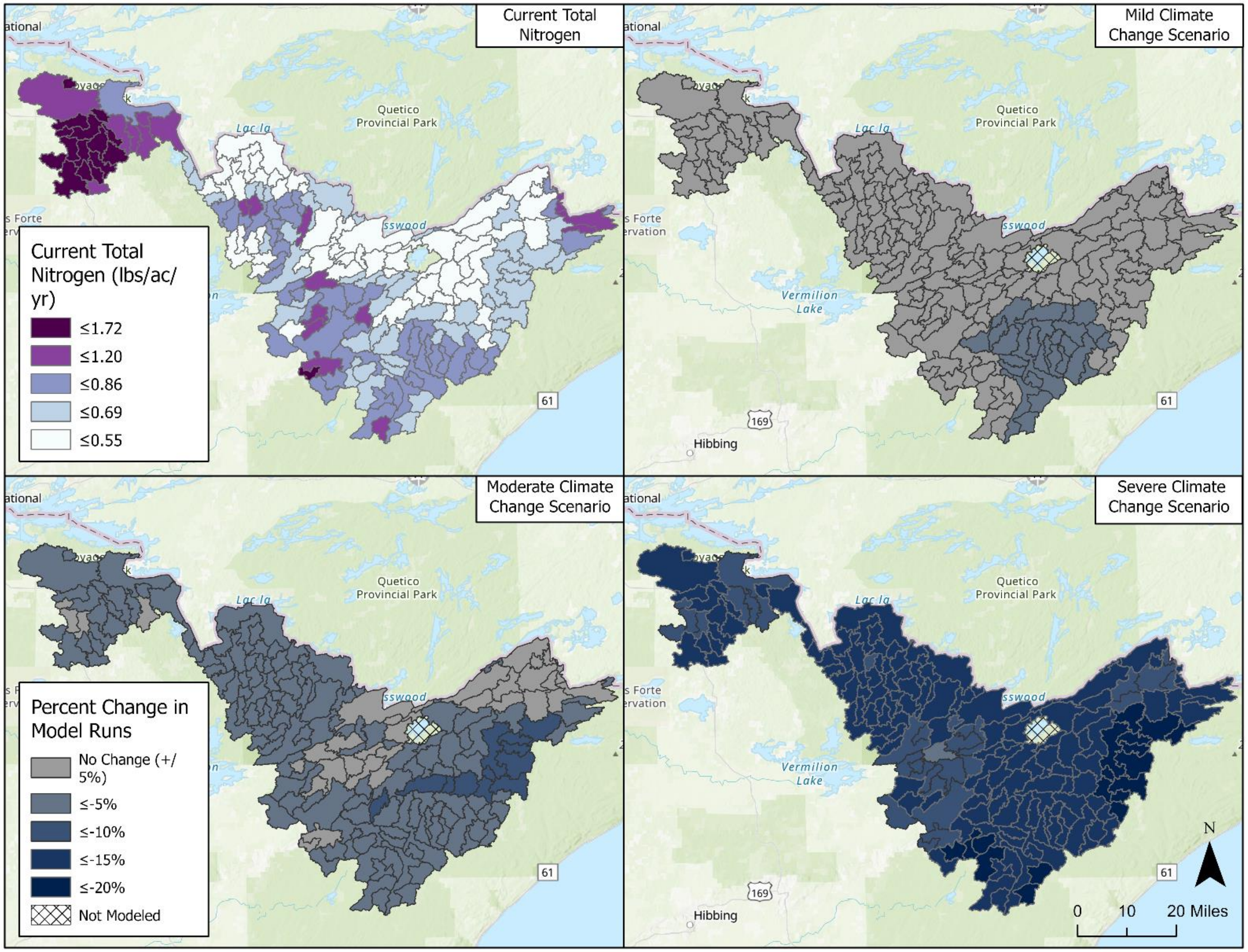


Table 9. Parameter changes at key locations for the mild climate change scenario.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	15,379	-3.6%	53	55	3.3%	1,052	1,028	-2.3%	36,517	35,714	-2.2%
51	VNP Lake (Tooth)	2,324	2,236	-3.8%	7	8	3.2%	148	145	-2.4%	5,219	5,096	-2.3%
60	Granite River into Saganaga	4,783	4,678	-2.2%	36	39	7.0%	242	238	-1.9%	5,423	5,349	-1.4%
73	Blackduck River	3,354	3,240	-3.4%	18	18	3.8%	279	268	-3.9%	8,456	8,145	-3.7%
81	Blackduck River	5,012	4,871	-2.8%	27	28	6.3%	439	429	-2.3%	12,457	12,169	-2.3%
87	Ash River	5,690	5,535	-2.7%	28	29	5.8%	450	441	-2.2%	13,560	13,255	-2.3%
101	Ash River	7,537	7,278	-3.4%	30	32	5.3%	543	529	-2.6%	17,506	17,037	-2.7%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	24,374	-3.7%	89	93	4.8%	1,815	1,771	-2.4%	57,814	56,212	-2.8%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	21,380	-3.6%	82	85	3.7%	1,549	1,515	-2.2%	51,936	50,813	-2.2%
352	Birch Lake	23,193	22,470	-3.1%	196	204	4.2%	2,186	2,110	-3.5%	31,409	30,620	-2.5%
364	White Iron Chain	10,257	10,005	-2.5%	61	64	5.9%	891	868	-2.6%	12,069	11,852	-1.8%
374	Burntside Lake	12,538	12,159	-3.0%	40	41	3.8%	840	808	-3.9%	14,254	13,954	-2.1%
382	Shagawa Lake (Ely)	13,121	13,048	-0.6%	98	103	5.0%	1,443	1,435	-0.5%	12,677	12,584	-0.7%
384	Fall Lake (Winton)	7,864	7,683	-2.3%	16	17	6.8%	447	442	-1.3%	6,289	6,221	-1.1%
474	Big Lake	4,017	3,887	-3.3%	13	14	3.4%	270	256	-5.1%	4,876	4,753	-2.5%

Table 10. Parameter changes at key locations for the moderate climate change scenario.

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	14,899	-6.6%	53	58	8.3%	1,052	992	-5.7%	36,517	34,609	-5.2%
51	VNP Lake (Tooth)	2,324	2,163	-6.9%	7	8	8.0%	148	139	-5.9%	5,219	4,933	-5.5%
60	Granite River into Saganaga	4,783	4,567	-4.5%	36	42	15.3%	242	233	-3.7%	5,423	5,272	-2.8%
73	Blackduck River	3,354	3,135	-6.5%	18	19	8.3%	279	260	-6.6%	8,456	7,925	-6.3%
81	Blackduck River	5,012	4,751	-5.2%	27	30	14.7%	439	416	-5.3%	12,457	11,872	-4.7%
87	Ash River	5,690	5,403	-5.0%	28	31	12.7%	450	428	-5.0%	13,560	12,941	-4.6%
101	Ash River	7,537	7,050	-6.5%	30	34	11.7%	543	511	-5.8%	17,506	16,557	-5.4%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	23,551	-6.9%	89	99	10.5%	1,815	1,712	-5.7%	57,814	54,549	-5.6%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	20,718	-6.6%	82	89	9.1%	1,549	1,465	-5.4%	51,936	49,296	-5.1%
352	Birch Lake	23,193	21,746	-6.2%	196	213	8.4%	2,186	2,016	-7.7%	31,409	29,460	-6.2%
364	White Iron Chain	10,257	9,746	-5.0%	61	67	11.0%	891	843	-5.3%	12,069	11,525	-4.5%
374	Burntside Lake	12,538	11,773	-6.1%	40	43	8.3%	840	776	-7.7%	14,254	13,472	-5.5%
382	Shagawa Lake (Ely)	13,121	12,974	-1.1%	98	108	10.4%	1,443	1,420	-1.6%	12,677	12,419	-2.0%
384	Fall Lake (Winton)	7,864	7,499	-4.6%	16	19	14.7%	447	426	-4.9%	6,289	5,982	-4.9%
474	Big Lake	4,017	3,752	-6.6%	13	14	7.0%	270	245	-9.1%	4,876	4,596	-5.7%

Table 11. Parameter changes at key locations for the severe climate change scenario

		Annual Runoff Volume (ac-ft)			Annual Total Sediment Load (tons)			Annual Total Phosphorus Load (lb)			Annual Total Nitrogen Load (lb)		
HSPF Reach	Key Resources	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change	Existing	Scenario	Percent Change
20	VNP Lakes (Crane, Little Trout, Mukooda, and Sand Point)	15,957	13,326	-16.5%	53	56	5.7%	1,052	890	-15.4%	36,517	30,993	-15.1%
51	VNP Lake (Tooth)	2,324	1,926	-17.1%	7	8	5.2%	148	125	-15.9%	5,219	4,400	-15.7%
60	Granite River into Saganaga	4,783	4,197	-12.2%	36	43	18.2%	242	203	-16.1%	5,423	4,645	-14.4%
73	Blackduck River	3,354	2,834	-15.5%	18	19	7.9%	279	235	-15.9%	8,456	7,164	-15.3%
81	Blackduck River	5,012	4,361	-13.0%	27	31	17.1%	439	374	-14.8%	12,457	10,720	-13.9%
87	Ash River	5,690	4,974	-12.6%	28	32	14.5%	450	386	-14.3%	13,560	11,682	-13.8%
101	Ash River	7,537	6,370	-15.5%	30	34	12.2%	543	454	-16.4%	17,506	14,743	-15.8%
108	VNP Lakes (Elk, Jorgens, Kabetogama, and Unnamed (69-0869-00))	25,304	21,149	-16.4%	89	98	10.3%	1,815	1,523	-16.1%	57,814	48,426	-16.2%
120	VNP Lakes (Agnes, Beast, Cruiser, Namakan, Net, and O'Leary)	22,179	18,541	-16.4%	82	88	7.4%	1,549	1,321	-14.7%	51,936	44,278	-14.7%
352	Birch Lake	23,193	19,649	-15.3%	196	211	7.8%	2,186	1,790	-18.1%	31,409	26,767	-14.8%
364	White Iron Chain	10,257	8,813	-14.1%	61	68	12.8%	891	750	-15.8%	12,069	10,488	-13.1%
374	Burntside Lake	12,538	10,475	-16.5%	40	43	8.0%	840	675	-19.7%	14,254	12,136	-14.9%
382	Shagawa Lake (Ely)	13,121	12,419	-5.3%	98	112	14.4%	1,443	1,329	-7.9%	12,677	11,728	-7.5%
384	Fall Lake (Winton)	7,864	6,805	-13.5%	16	19	20.3%	447	384	-14.2%	6,289	5,499	-12.6%
474	Big Lake	4,017	3,310	-17.6%	13	14	4.7%	270	209	-22.6%	4,876	4,102	-15.9%

CLIMATE CHANGE SCENARIO DETAILS

Potential climate related impacts that may occur in the upper Midwest, including areas of the watershed, are described in the National Climate Assessment for the Midwest (Pryor et al., 2014). Some of the impacts discussed include changes in forest composition, increases in heatwave intensity and frequency, increased humidity, degraded air quality, reduced water quality and increased rainfall and flooding.

The Intergovernmental Panel on Climate Change (IPCC) released the Physical Science Basis Working Group Report for the IPCC 5th Reassessment in 2013 (IPCC, 2013), incorporating results from Global Climate Model (GCM) simulations from the Coupled Model Intercomparison Project round 5 (CMIP5). At higher spatial resolution, the U.S. Geological Survey (USGS) National Climate Change Viewer (NCCV) (https://www2.usgs.gov/landresources/lcs/nccv.asp) provides a quick overview of the range of simulated potential changes in climate for the watershed. The NCCV allows the user to visualize projected changes in climate (maximum and minimum air temperature and precipitation) and the water balance (snow water equivalent, runoff, soil water storage and evaporative deficit) for any state, county and USGS Hydrologic Unit (HUC).

The projections are based on monthly summary data extracted from the 30 Global Circulation Models (GCM) future climate simulations conducted for CMIP5 that have been statistically downscaled for local predictions over the continental U.S. in the NASA Earth Exchange (NEX) Downscaled Climate Projections (NASA NEX-DCP30) dataset (Thrasher et al., 2013). The suite of models is in agreement in predicting a steady increase in maximum and minimum air temperature throughout the 21st century, although trends diverge after about 2050 depending on the greenhouse gas concentration trajectory. There is less agreement as to future trends in precipitation, although most models tend to predict some increase in winter and spring precipitation and a decrease in summer precipitation in the watershed. Rising temperatures will cause winter snowpack to decrease while summer evaporation rates will increase, likely leading to declining soil water storage based on the simple water balance accounting method of McCabe and Wolock (2011). Resulting impacts on runoff, which integrates the effects of precipitation and evaporation are uncertain in the McCabe and Wolock (2011) analysis, although total runoff volume appears likely to not change greatly.

The following summarizes the climate projects from the NCCV for select parameters, including maximum and minimum air temperature, precipitation, and evaporative deficit. Evaporative deficit is the evaporative demand not met by the available water and can be used as an index of the potential effects of drought stress. The summary results are the mean model for the RCP4.5 emissions scenario, in which atmospheric greenhouse gas concentrations are stabilized so as not to exceed a radiative equivalent of about 650 ppm CO2.

Figure 22 shows the average monthly maximum air temperature for the watershed for two periods, 1981-2010 and 2050-2074. The annual average maximum air temperature is 49.1 °F for the 1981-2010 period and a projected 53.8 °F for the 2050-2074, with a projected increase of 4.8 °F between the periods. **Figure 23** shows the average monthly minimum air temperature for the watershed. The annual average minimum air temperature is 27.1 °F for the 1981-2010 period and a projected 32.2 °F for the 2050-2074, with a projected increase of 5.2 °F between the periods.

Figure 22. Average maximum air temperature by month for 1981-2010 and 2050-2074, based on the mean model, for the RCP4.5 emissions scenario.

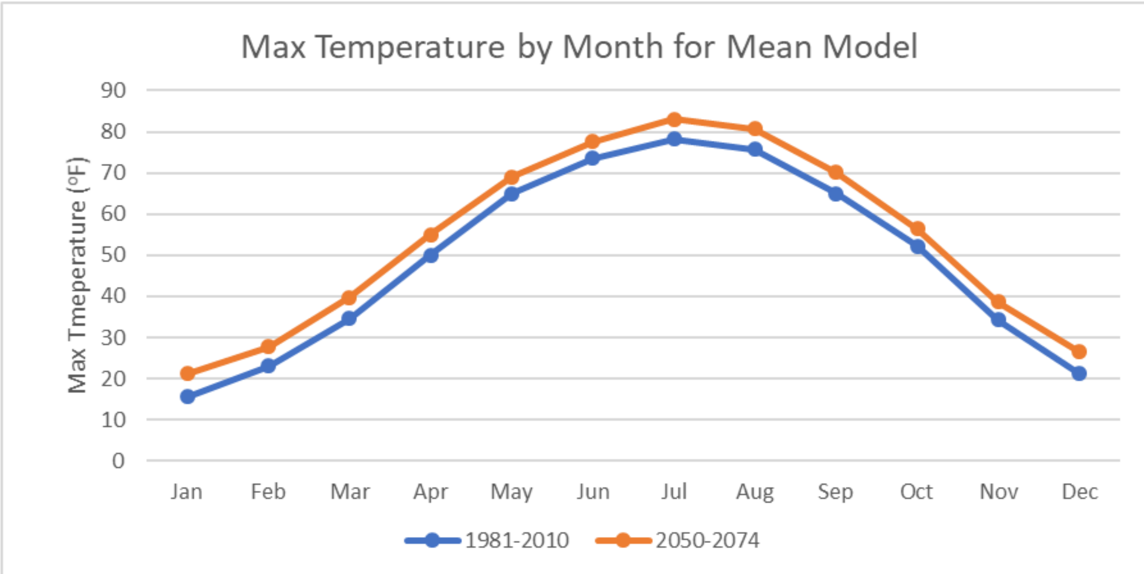


Figure 23. Average minimum air temperature by month for 1981-2010 and 2050-2074, based on the mean model, for the RCP4.5 emissions scenario.

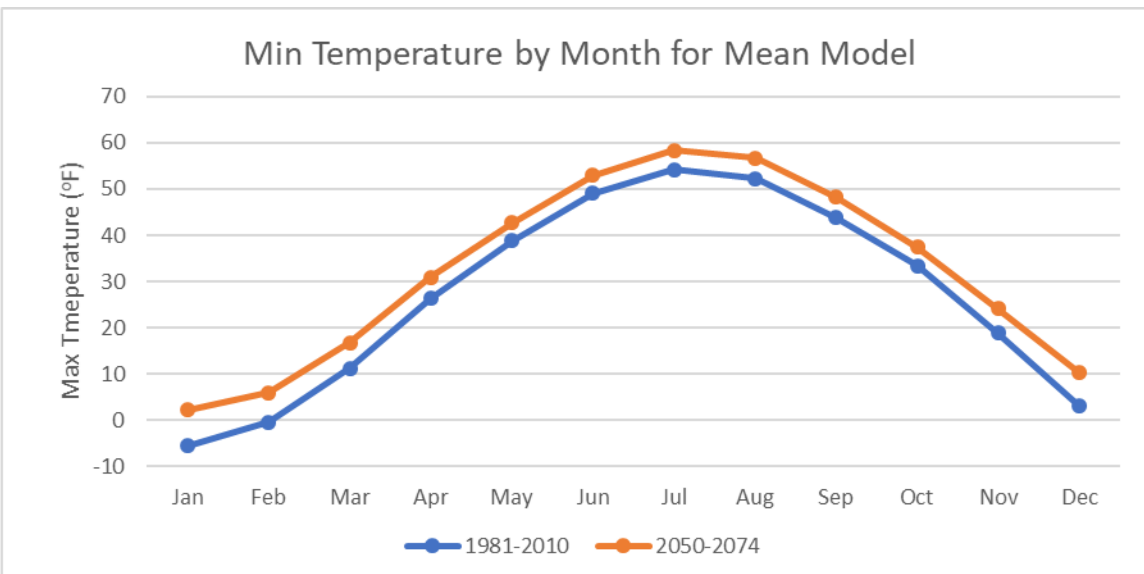


Figure 24 shows the average monthly precipitation for the watershed for two periods, 1981-2010 and 2050-2074. The annual average monthly precipitation is 28.4 inches for the 1981-2010 period and a projected 29.9 inches for the 2050-2074, with a projected increase of 1.6 inches between the periods. **Figure 25** shows the average monthly evaporative deficit for the watershed. The annual average evaporative deficit is 0.92 inches for the 1981-2010 period and a projected 1.88 inches for the 2050-2074, with a projected increase of 0.95 inches between the periods.

Figure 24. Average precipitation by month for 1981-2010 and 2050-2074, based on the mean model, for the RCP4.5 emissions scenario.

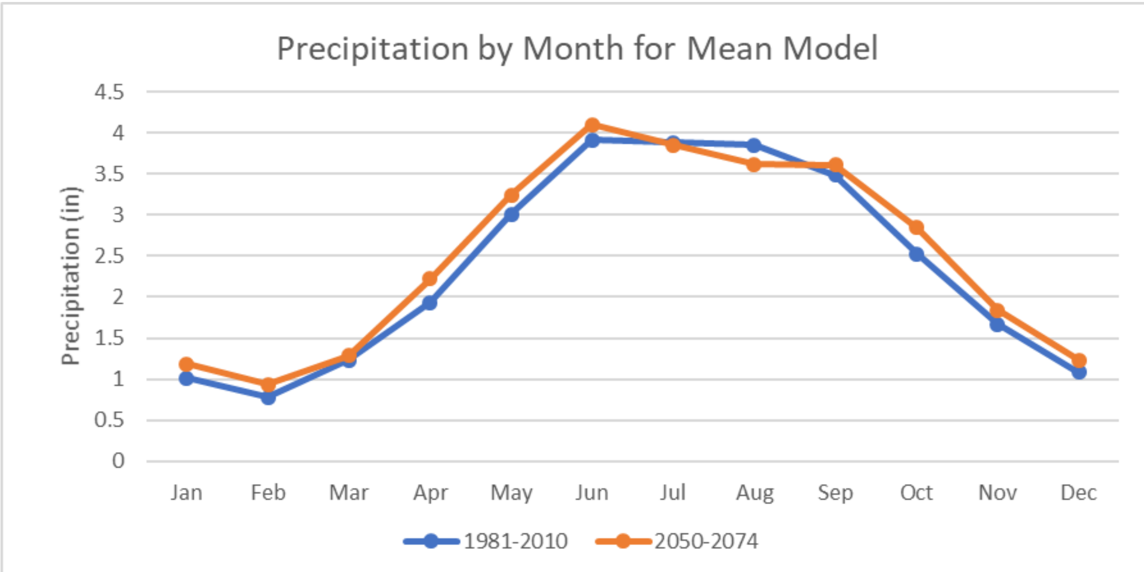
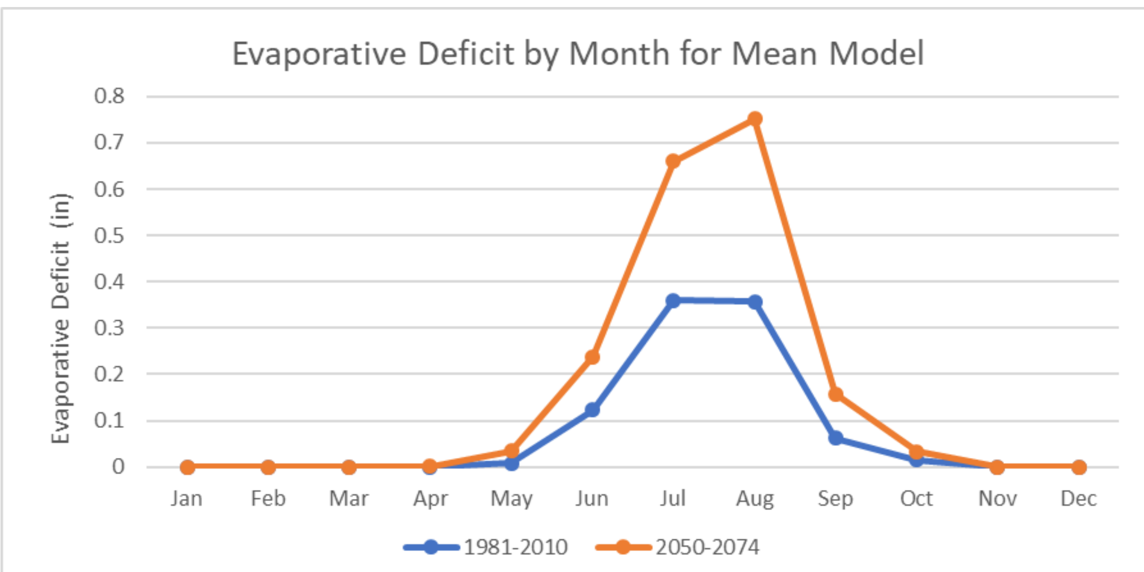


Figure 25. Average evaporative deficit by month for 1981-2010 and 2050-2074, based on the mean model, for the RCP4.5 emissions scenario.



Overall, the watershed is projected to see an increase in air temperature of about 5 °F, an increase in average annual precipitation of 1.5 inches, and an increase in evaporative deficit of 0.97 inches. Potential impacts form these climate changes could include increased peak flows, prolonged drier conditions, and lower annual runoff.

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Appendix F: Lake Assessments Memo

Appendix F: Lake Source Assessments

To: Rainy Headwaters River Core Team

From: Houston Engineering, Inc.

Subject: Rainy River Headwaters – Lake Source Assessments

Date: October 19, 2020

Project: 6074-0023

PURPOSE

This technical memorandum (TM) provides detailed lake source assessment data for five lakes, identified by the Core Team, to be priority lakes within the Rainy River Headwaters Watershed (RRHW). These five lakes include:

- Burntside Lake;
- Farm Lake and South Farm Lake;
- Garden Lake;
- Shagawa Lake; and
- White Iron Lake.

The lake sections of this TM includes details about seasonal water quality dynamics for phosphorus, dissolved oxygen (DO), and chlorophyll-*a* (Chl-*a*). Also included is land use targeting within the lake drainage area, phosphorus source assessment data extracted from the Hydrologic Simulation Program FORTRAN (HSPF) model, and recommendation for goal setting and monitoring. The modeling data is provided as a tool to assist management decisions alongside best professional judgement and actual field data. Farm, South Farm, Garden, and White Iron Lakes drain a large watershed affected by hydropower reservoirs essential to understanding achievable phosphorus reduction goals.

Additionally, this information is meant to supplement the MPCA and DNR Lake Protection Priority list that is summarized in Section 2.5.3 of the Rainy River – Headwaters WRAPS Report. The MPCA and DNR Lake Protection Priority list uses a robust framework to estimate loading and provide a 5% reduction goal. In the future, BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake.

BURNTSIDE LAKE

Burntside Lake is a local priority for the RRHW Core Team and has some risks identified during the RRHW Watershed Restoration and Protection Strategy development. These risks include a declining transparency trend, a developed lakeshore, and the highest level of phosphorus sensitivity. It is designated a Class 1B drinking water lake and provides the drinking water for the City of Ely. It is also designated a Class 2A coldwater lake. These use class designations and risks have made it a priority water protection.

WATER QUALITY

Burntside Lake borders on oligotrophic and mesotrophic and is a deep lake (max depth of 126 feet). Phosphorus concentrations in 1986, 1988, and 1994 average 10 µg/L and remain well below the eutrophication standard for coldwater lakes in the Northern Lakes and Forests (NLF) Ecoregion, which is 20 µg/L. According to the MPCA Water Quality Dashboard, the 10 year average summer phosphorus concentration is 9 µg/L. Phosphorus concentrations remain relatively consistent from July through September, as shown in **Figure 1**.

DO profiles were collected in 2019 and hypolimnion phosphorus samples were collected in 1988 and 1994. **Figure 2** shows that the hypolimnion did not become anoxic (i.e. DO concentrations lower than 5 mg/L) and **Figure 3** shows that the hypolimnion phosphorus concentrations did not indicate internal loading (when the hypolimnion phosphorus concentration is higher than the surface phosphorus concentration). DO concentrations at the bottom of the lake remained higher than 5 mg/L in 2019, which is hospitable to coldwater fisheries such as Cisco.

The Chlorophyll-*a* (Chl-*a*) 10-year average summer concentration in Burntside Lake is 2 µg/L, well below the eutrophication standard for coldwater lakes in the NLF Ecoregion, which is 6 µg/L. Minnesota Pollution Control Agency (MPCA) data comparing user perceptions with Chl-*a* concentrations has concluded that lake users perceive a major algae bloom when the Chl-*a* concentration reaches 20 µg/L (Heiskary & Wilson, 2008). In Burntside Lake, **Figure 4** shows no major algae blooms occurred during the years monitored at EQuIS site 101.

The transparency, expressed via Secchi depth, in Burntside Lake averages 15 feet between 1986-2019. Data shows the transparency remains relatively high all season, as shown in **Figure 5**, and no algal blooms are indicated in **Figure 4**. Long-term trend analysis shows that there is a declining trend in transparency, as shown in **Figure 6**. Continued monitoring is recommended to track this trend into the future.

Figure 1. Seasonal phosphorus concentration dynamics: Burntside Lake (site 101, EQuIS).

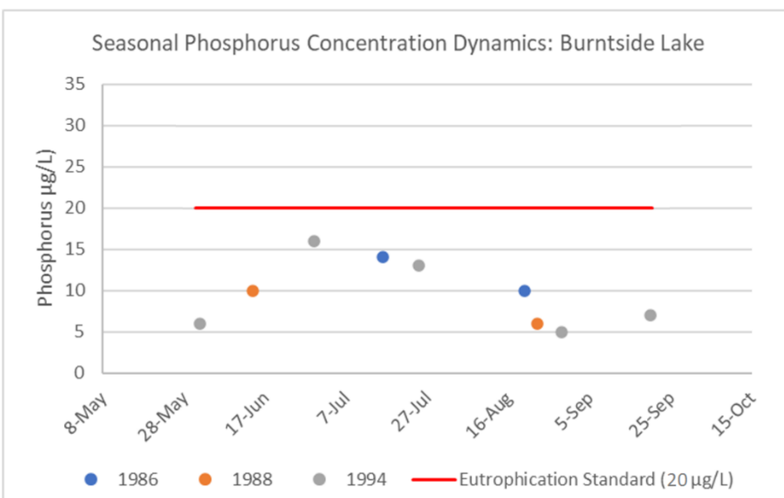


Figure 2. Dissolved oxygen profiles for Burntside Lake in 2019 (site 101, EQuIS).

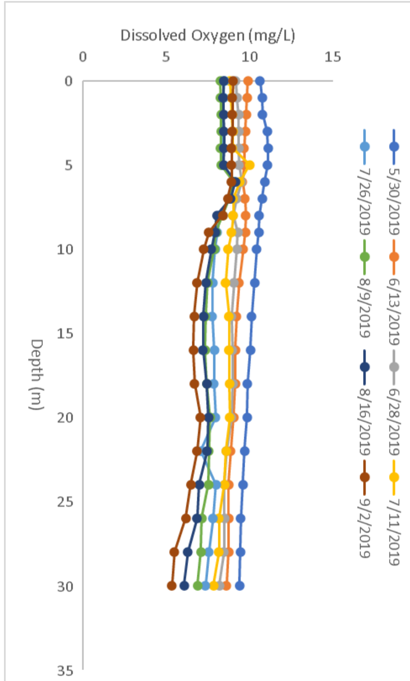


Figure 3. Surface and bottom phosphorus concentrations for Burntside Lake in 1988 and 1994 (site 101, EQuIS).

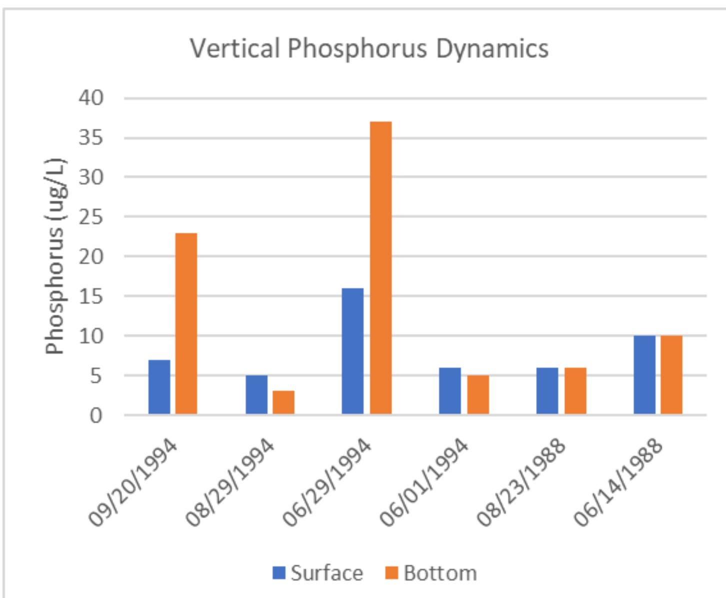


Figure 4. Seasonal Chl-*a* concentration dynamics: Burntside Lake (site 101, EQuIS).

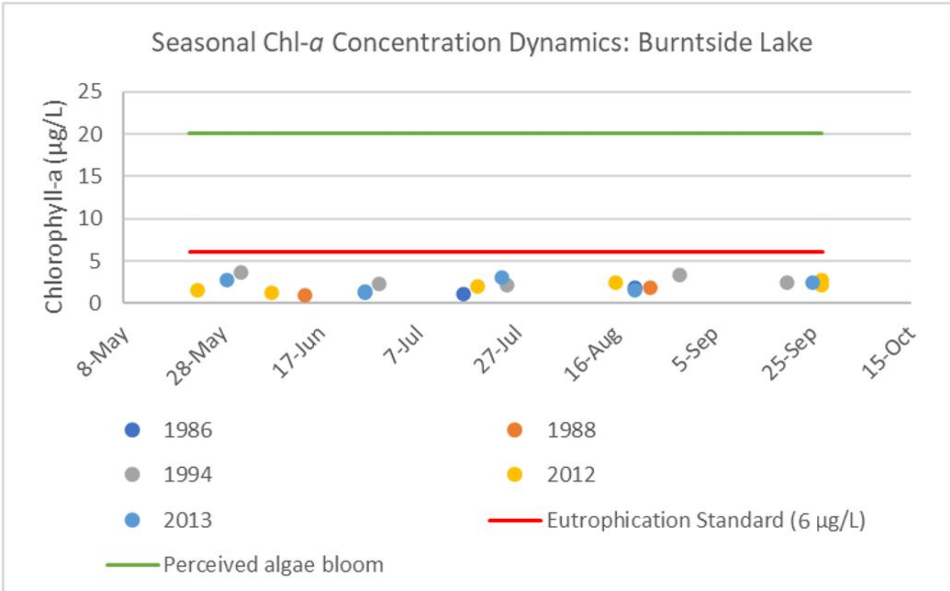


Figure 5. Seasonal transparency dynamics: Burntside Lake (site 101, EQuIS).

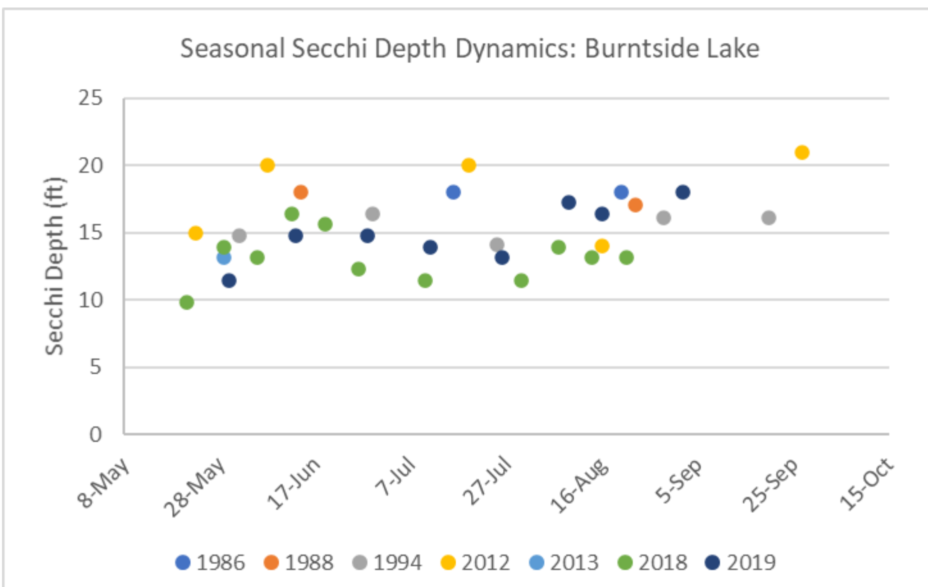
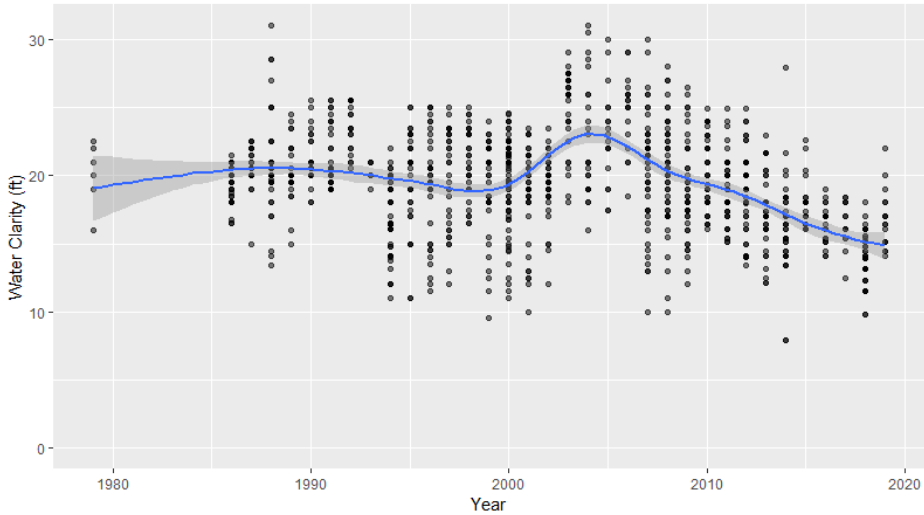


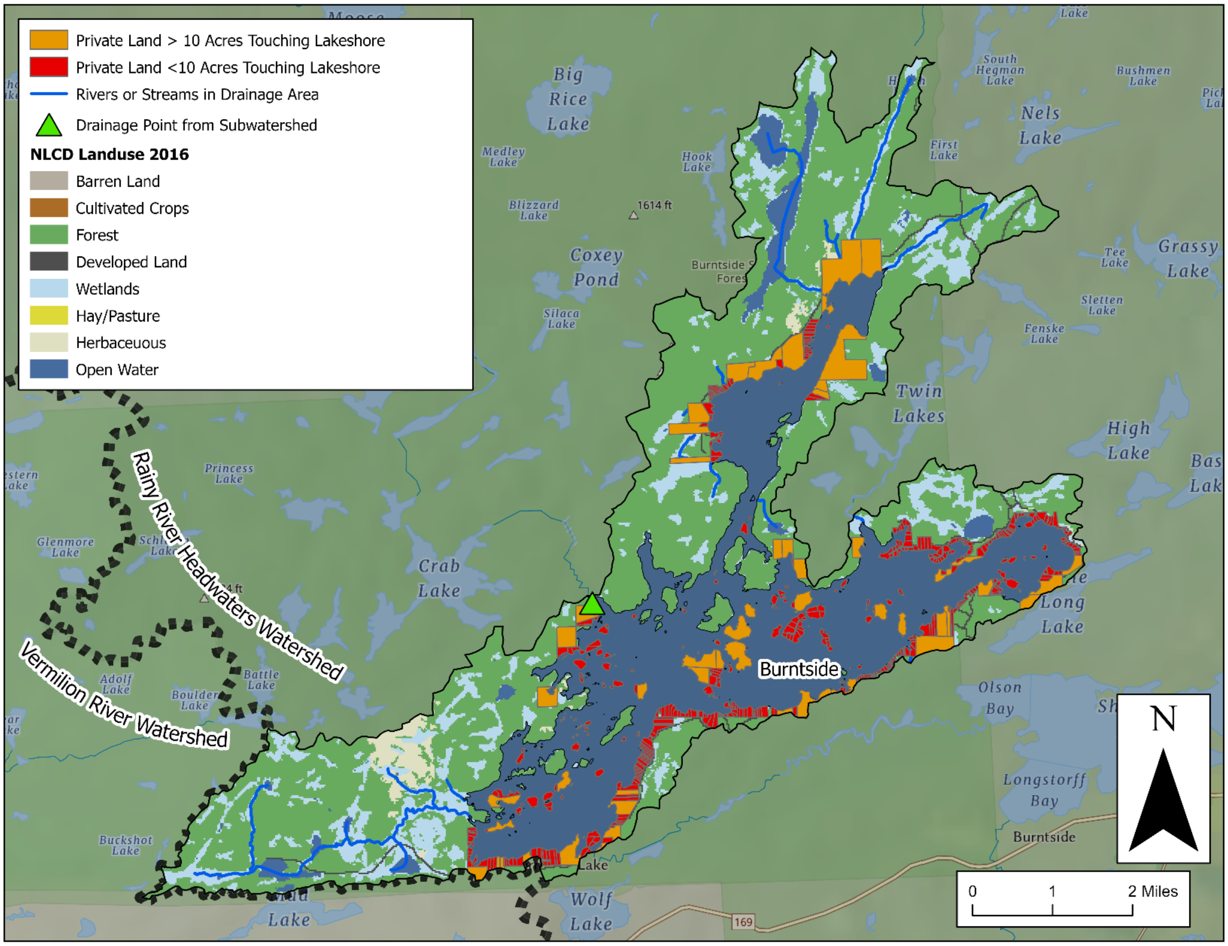
Figure 6. Long-term transparency trend (Secchi depth): Burntside Lake (MPCA Citizen Data website).



LAKE DRAINAGE LAND USE

The land use of the watershed contributing to the lake is primarily forests and wetlands with some development along the lakeshore. There is no agriculture in the watershed. There are some small streams draining into the lake from the southwest, but the drainage area to the lake is relatively small at 3:1 respectively as shown in **Figure 7**.

Figure 7. Land use, tributaries, and developed land identification in the Burntside Lake watershed.



PHOSPHORUS LOADING

The HSPF Scenario Application Manager (SAM) was used for a source assessment analysis to quantify the phosphorus loading to the lake from the different land uses within the lake drainage area. HSPF-SAM is not a lake-specific model and there is significant uncertainty involved. However, these loading percentages are intended to be used as tool for planning and prioritizing efforts and not to indicate day-to-day loading conditions.

According to the model, two small upstream reaches that drain into the lake provide 24% of the phosphorus loading, as shown in **Figure 8**. The remaining 76% of the phosphorus loading comes from the direct drainage area of the lake (i.e. nearshore). Internal loading is not quantified in **Figure 8** or **Figure 9**.

The phosphorus loading to Burntside Lake within its direct drainage area (i.e. HSPF Reach) was broken down by land use in **Figure 9**, which can help guide implementation activities for reducing phosphorus loading to the lake. Given the size of the lake, low development density, and the relatively low loading from the watershed, forests and atmospheric deposition are the highest phosphorus sources to the lake.

The modeling results suggest some areas of phosphorus loading that might be reduced with best management practices. Developed areas contribute 6% and septic systems contribute 2% of the phosphorus loading to the lake as shown in **Figure 9**.

Figure 8. Modeled upstream reach vs. nearshore phosphorus loading to Burntside Lake (HSPF-SAM Basin Source Fate).

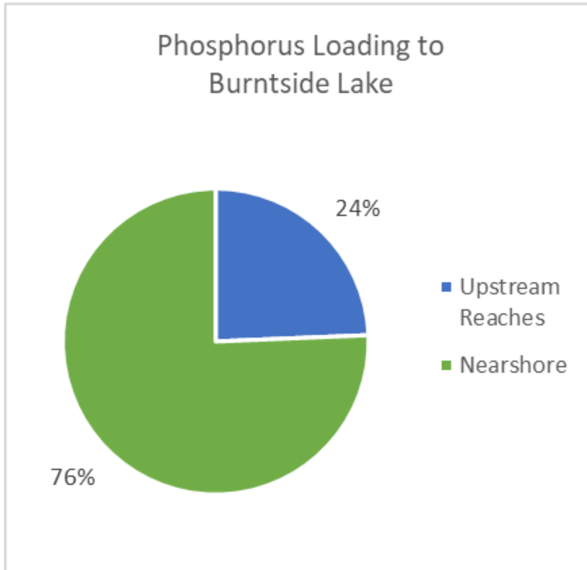
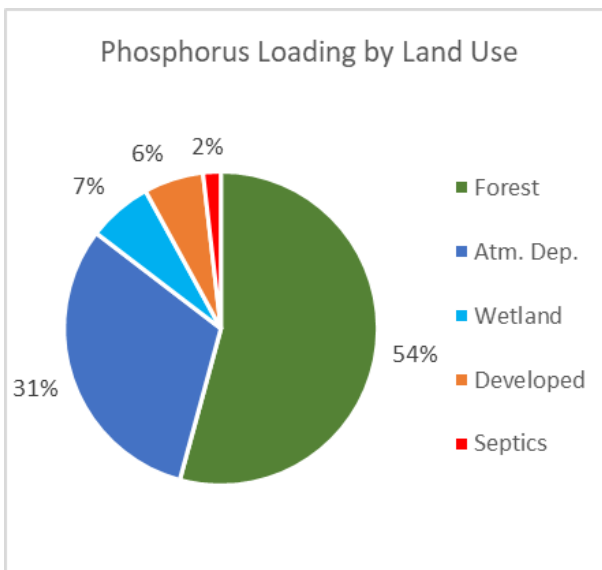


Figure 9. Modeled direct drainage phosphorus loading to Burntside Lake, by land use (HSPF-SAM Source Fate)



GOAL SETTING

Burntside Lake is not impaired, so does not require a total maximum daily load (TMDL) or specific reduction at this time. Any current phosphorus goals would be for protection. Typically, short-term goals (i.e. 10-year timeframe) for lake protection have been set to a 5% reduction based on the Minnesota Department of Natural Resources' (DNR) phosphorus sensitivity modeling analysis (MPCA and DNR, 2019). A reduction could be reached through a combination of stormwater best management practices (BMP) such as rain gardens and lakeshore buffers, septic system inventory and improvements, and education and outreach to lakeshore property owners. The privately-owned lakeshore in **Figure 7** (red and orange) could be targeted for phosphorus reduction practices. Landowners can work with the North St. Louis Soil and Water Conservation District (SWCD) to install these BMPs.

Other protection practices, such as easements and acquisitions, could be targeted on the orange colored parcels (privately-owned lakeshore greater than 10 acres) in **Figure 7**. Protection of these areas could prevent future increases in phosphorus loading to the lake from increased development. Landowners can contact the North St. Louis SWCD or Minnesota Land Trust to learn more about conservation easement options. If there is undeveloped shoreline that is important for fish spawning, the DNR could be contacted for Aquatic Management Area options.

Maintaining forested lands as forest is an important protection measure for this coldwater lake. Coldwater fish species such as cisco are at risk due to increases in water temperature and decreases in DO due to eutrophication. Keeping nutrients low is an important long term goal for this lake.

MONITORING

Burntside Lake has good water quality, but a recent declining trend in transparency. Transparency monitoring should continue every year to track this trend into the future. BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake.

FARM LAKE AND SOUTH FARM LAKE

Farm Lake is a local priority for the RRHW Core Team and has some risks and qualities identified during the RRHW Watershed Restoration and Protection Strategy development. These risks include a declining transparency trend, a developed lakeshore, and the 'Highest' level of phosphorus sensitivity. Qualities include wild rice, an outstanding biological significance, and an active lake association. South Farm Lake is connected to Farm Lake, but is not developed, so is not included in the water quality analysis. Future protection practices can maintain the good water quality of Farm and South Farm Lakes.

WATER QUALITY

Farm Lake is a mesotrophic lake of moderate depth (max depth of 56 feet). Phosphorus concentrations from 2010-2019 average 16 µg/L and remain below the eutrophication standard for the NLF Ecoregion, which is 30 µg/L. Phosphorus concentrations remain relatively consistent from May through September, as shown in **Figure 10**.

Dissolved oxygen (DO) profiles were collected in 2019. **Figure 11** shows that the hypolimnion did not become anoxic (i.e. DO concentrations lower than 5 mg/L). Hypolimnion oxygen concentrations remained above 5 mg/L, which is hospitable to coldwater fisheries such as Cisco.

The Chlorophyll-*a* (Chl-a) concentration in Farm Lake averaged 5 µg/L from 2010-2019 and remains below the eutrophication standard for the NLF Ecoregion (9 µg/L). MPCA data comparing user perceptions with Chl-*a* concentrations has concluded that lake users perceive a major algae bloom when the Chl-*a* concentration reaches 20 µg/L (Heiskary & Wilson, 2008). In Farm Lake, **Figure 12** shows no major algae blooms occurred during the years monitored.

The transparency, expressed via Secchi depth, in Farm Lake averaged 6 feet between 2006-2019. **Figure 13** shows the transparency remains relatively consistent all season. Long-term trend analysis shows that there is a declining trend in transparency, as shown in **Figure 14**. Continued monitoring is recommended to track this trend in the future.

Figure 10. Seasonal phosphorus concentration dynamics: Farm Lake (site 102, EQuIS)

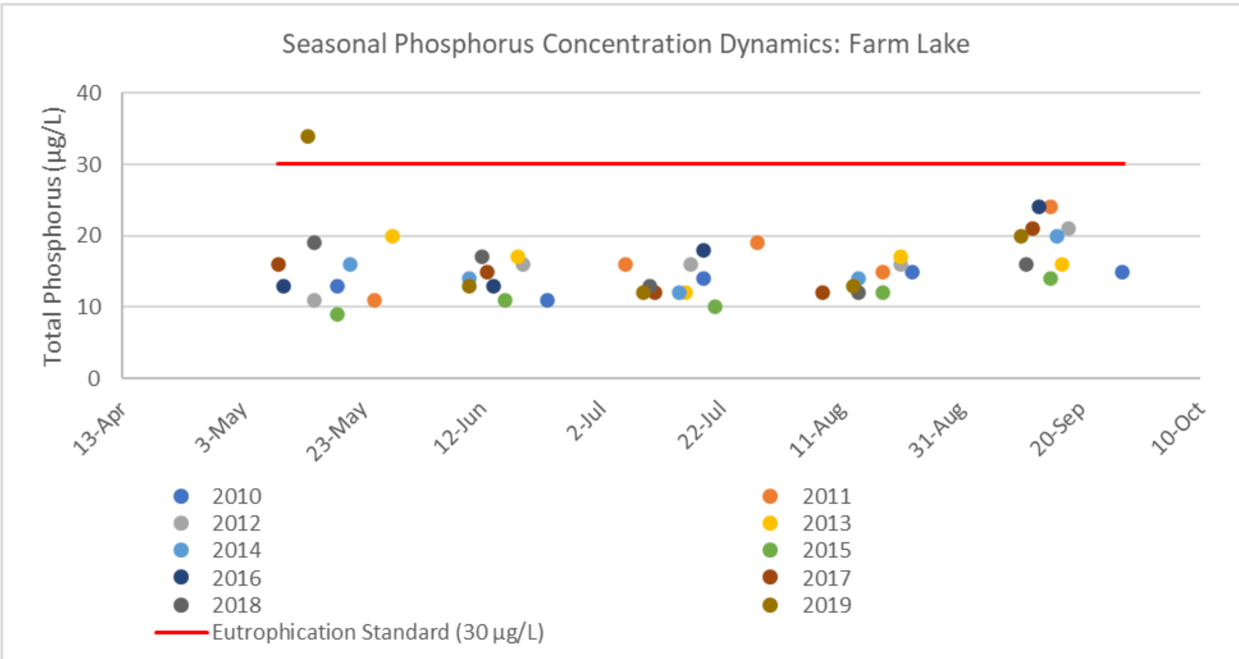


Figure 11. Dissolved oxygen profiles for Farm Lake in 2019 (site 102, EQuIS).

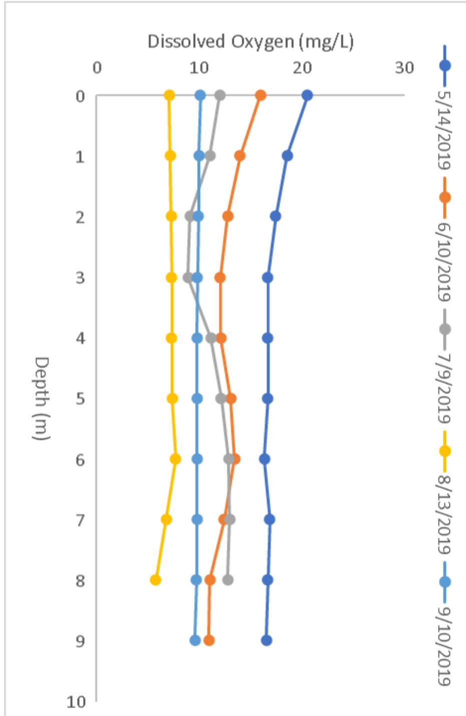


Figure 12. Seasonal Chl-a concentration dynamics: Farm Lake (site 102, EQuIS).

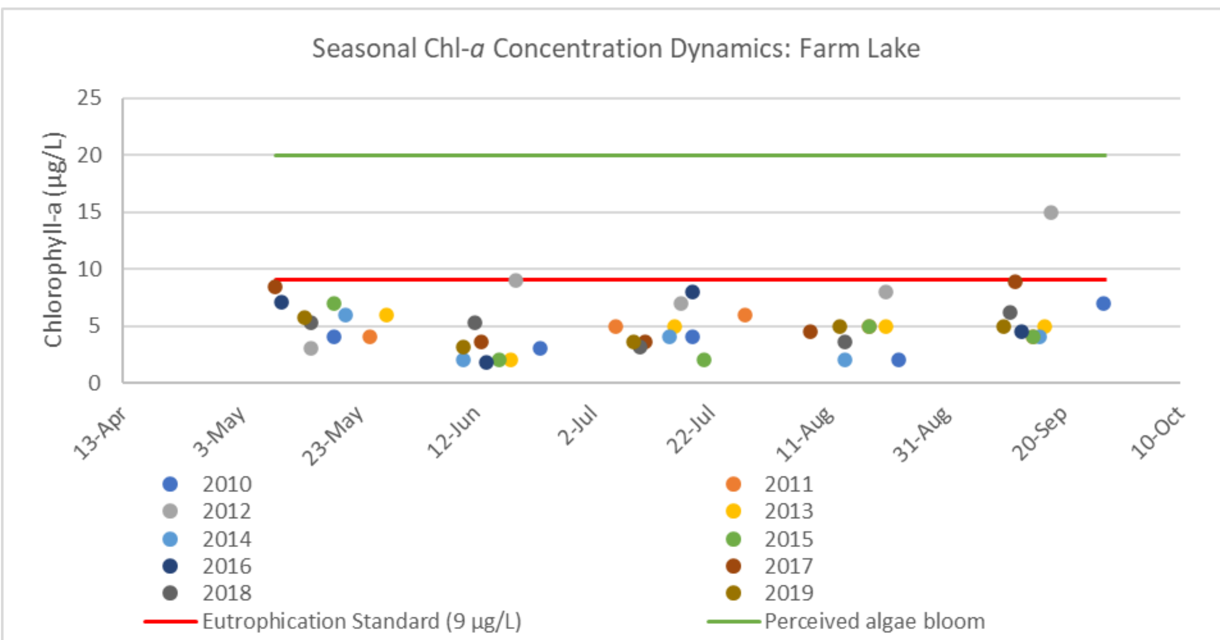


Figure 13. Seasonal transparency (Secchi depth) dynamics: Farm Lake (site 102, EQuIS).

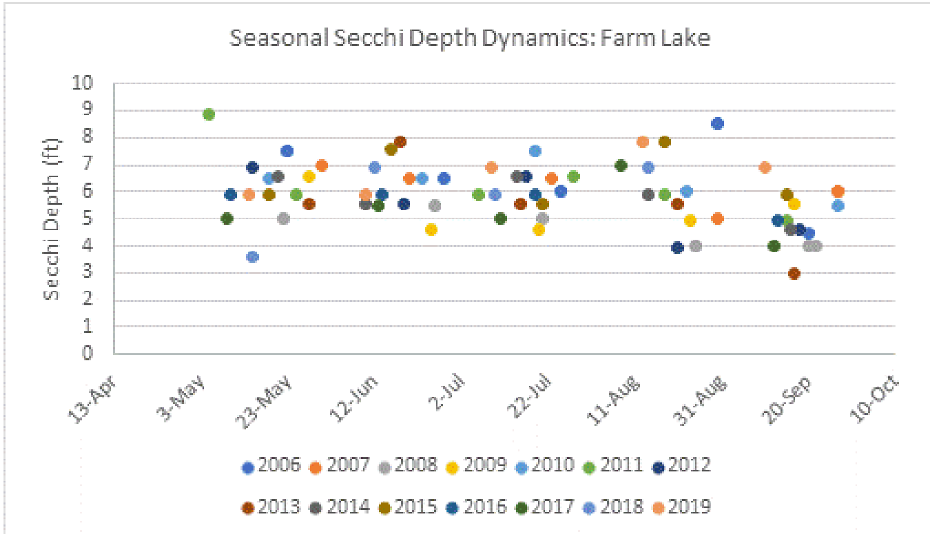
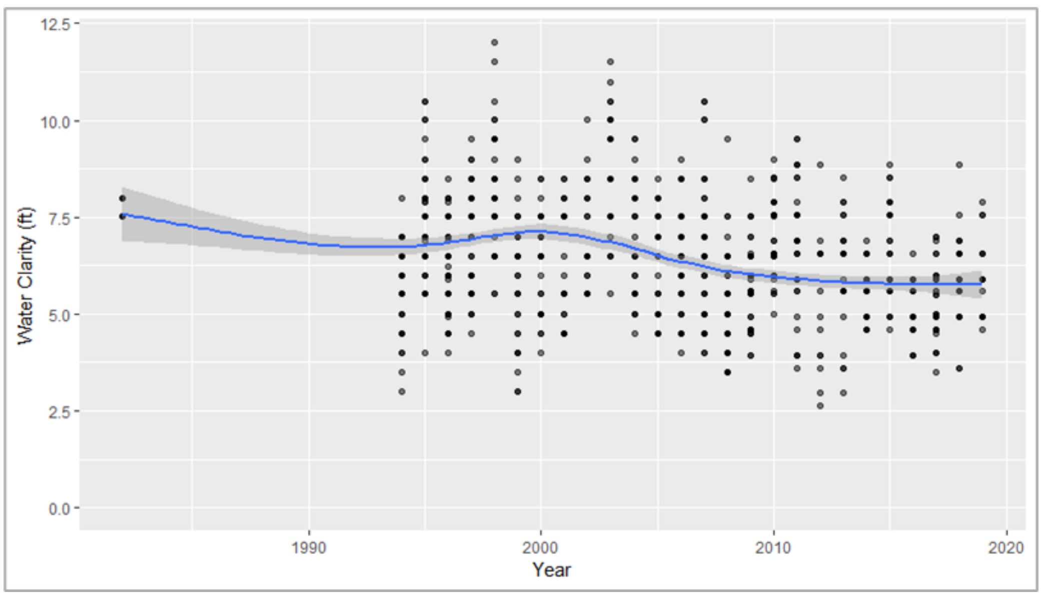


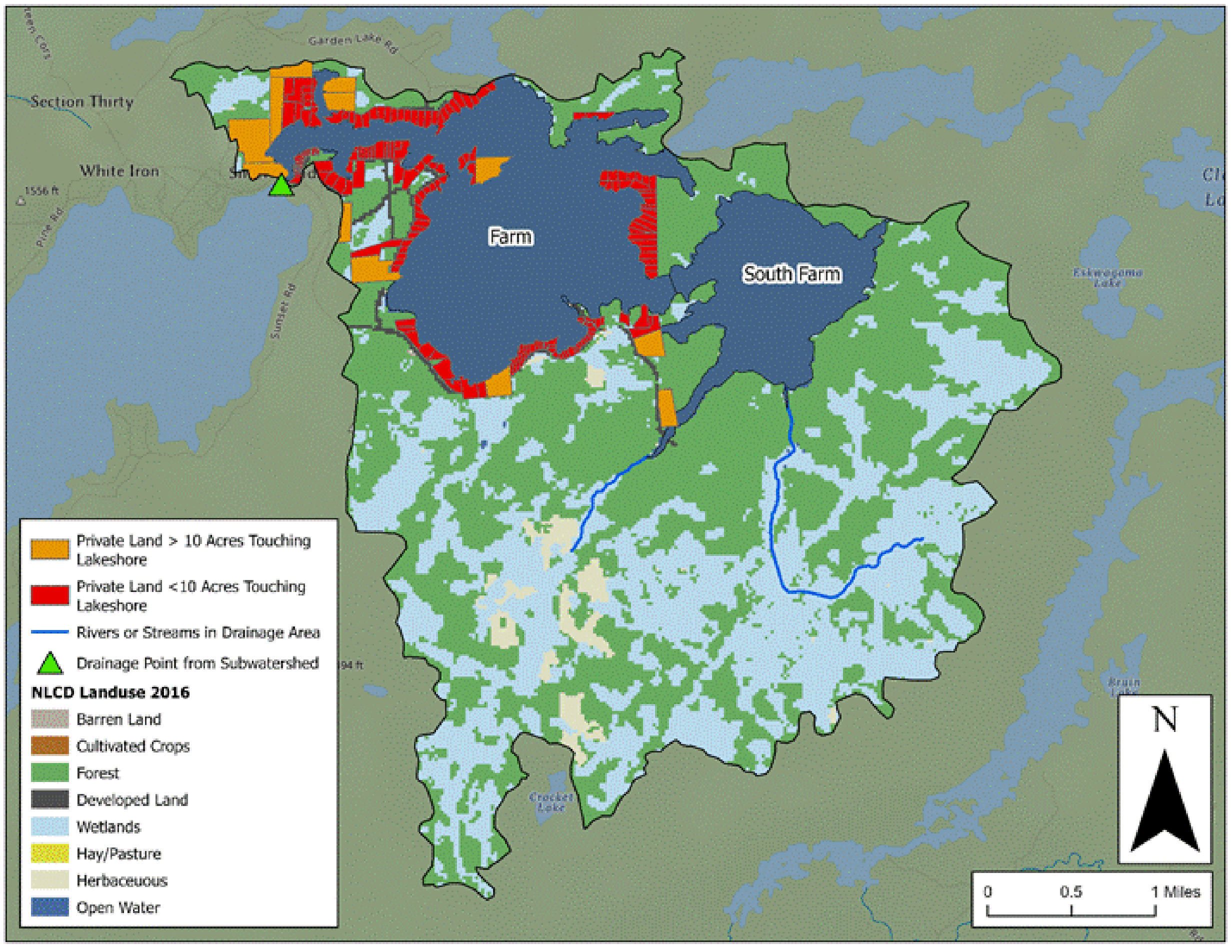
Figure 14. Seasonal transparency (Secchi depth) dynamics: Farm Lake (site 102, EQuIS).



LAKE DRAINAGE LAND USE

The land use of the watershed contributing to Farm and South Farm Lakes is primarily forests and wetlands with some development along the lakeshore. Both White Iron Lake and the Kawishiwi River flow into Farm Lake and then it flows out to Garden Lake as shown in **Figure 15**.

Figure 15. Land use, tributaries, and developed land identification in the Farm and South Farm Lake watershed.



PHOSPHORUS LOADING

The HSPF-SAM was used for a source assessment analysis to quantify the phosphorus loading to the lake from the different land uses within the drainage area. HSPF-SAM is not a lake-specific model and there is significant uncertainty involved. However, these loading numbers are intended to be used as tool for planning and prioritizing efforts and not to indicate day-to-day loading conditions.

According to the model, Farm and South Farm lakes' large watershed provides 96% of the phosphorus loading to the lakes, as shown in **Figure 16**. The remaining 4% of the phosphorus loading comes from the direct drainage area of the lake (i.e. nearshore). Internal loading is not quantified in **Figure 16** or **Figure 17**.

The phosphorus loading to Farm and South Farm Lake within its direct drainage area (i.e. HSPF Reach) was broken down by land use in **Figure 17**, which can help guide implementation activities for reducing phosphorus loading to the lake. Given the large amount of forest cover and low development density in the drainage area, forests are the highest phosphorus source to the lake at 66%.

The modeling results suggest some areas of phosphorus loading might be reduced with best management practices. Developed areas contribute 6% and septic systems contribute 2% of the phosphorus loading to the lake as shown in **Figure 17**.

Figure 16. Upstream reaches vs. nearshore phosphorus loading to Farm and South Farm Lakes (HSPF-SAM Basin Source Fate)

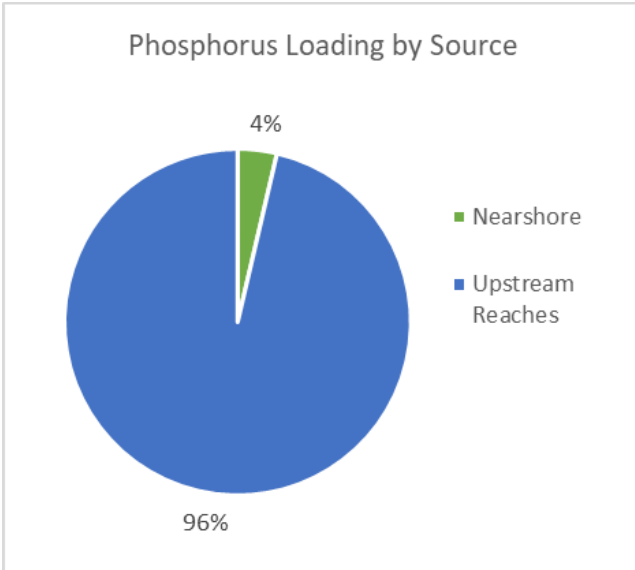
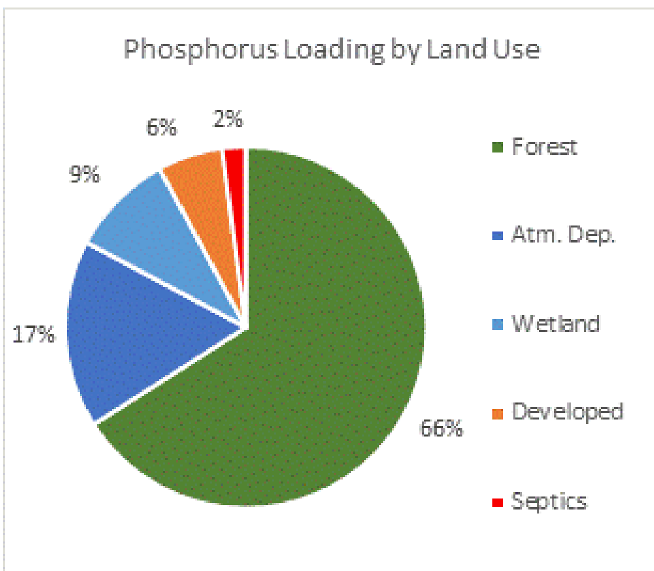


Figure 17. Direct drainage phosphorus loading to Farm and South Farm Lake, by land use (HSPF-SAM Source Fate)



GOAL SETTING

Farm and South Farm Lakes are not impaired, so do not require a TMDL or specific reduction at this time. Any current phosphorus goals would be for protection. Typically, short-term goals (i.e. 10-year timeframe) for lake protection have been set to a 5% reduction based on the DNR's phosphorus sensitivity modeling analysis (MPCA and DNR, 2019). A reduction could be reached through a combination of stormwater best management practices (BMPs) such as rain gardens and lakeshore buffers, septic system inventory and improvements, and education and outreach to lakeshore property owners. The privately-owned lakeshore in **Figure 15** (red and orange) could be targeted for phosphorus reduction practices. Landowners can work with the Lake County SWCD to install these BMPs.

Other protection practices, such as easements and acquisitions, could be targeted on the orange colored parcels (privately-owned lakeshore greater than 10 acres) in **Figure 15**. Protection of these areas could prevent future increases in phosphorus loading to the lake from increased development. Landowners can contact the North St. Louis SWCD or Minnesota Land Trust to learn more about conservation easement options. If there is undeveloped shoreline that is important for fish spawning, the DNR could be contacted for Aquatic Management Area options.

MONITORING

Farm Lake is showing a declining trend in transparency. It is important to continue transparency monitoring to track this trend into the future. If the declining trend continues, BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake.

GARDEN LAKE

Garden Lake is a local priority for the RRHW Core Team and has some risks and qualities identified during the RRHW Watershed Restoration and Protection Strategy development. These risks include a declining transparency trend, a developed lakeshore, and the highest level of phosphorus sensitivity. Qualities include wild rice and outstanding biological significance. Future protection practices can maintain the good water quality of Garden Lake. For more information, see Appendix D of the RRHW WRAPS Report.

WATER QUALITY

Garden Lake is a mesotrophic lake of moderate depth (max depth of 55 feet). Phosphorus concentrations from 2010-2019 average 18 µg/L and remain below the eutrophication standard for the NLF Ecoregion, which is 30 µg/L. Phosphorus concentrations remain relatively consistent from May through September, as shown in **Figure 18**.

DO profiles were collected in 2019. **Figure 19** shows that the hypolimnion did not become anoxic (i.e. DO concentrations lower than 5 mg/L). Hypolimnion oxygen concentrations remained above 5 mg/L, which is hospitable to coldwater fisheries such as Cisco.

The Chlorophyll-a (Chl-*a*) concentration in Garden Lake averaged 5 µg/L from 2010-2019 and remains below the eutrophication standard for the NLF Ecoregion (9 µg/L). MPCA data comparing user perceptions with Chl-*a* concentrations has concluded that lake users perceive a major algae bloom when the Chl-*a* concentration reaches 20 µg/L (Heiskary & Wilson, 2008). In Garden Lake, **Figure 20** shows no major algae blooms occurred during the years monitored.

The transparency, expressed via Secchi depth, in Garden Lake averaged 5 feet between 2010-2019. **Figure 21** shows the transparency remains relatively consistent all season. Long-term trend analysis shows that there is a declining trend in transparency, as shown in **Figure 22**. Continued monitoring is recommended to track this trend in the future.

Figure 18. Seasonal phosphorus dynamics in Garden Lake (site 204, EQuIS).

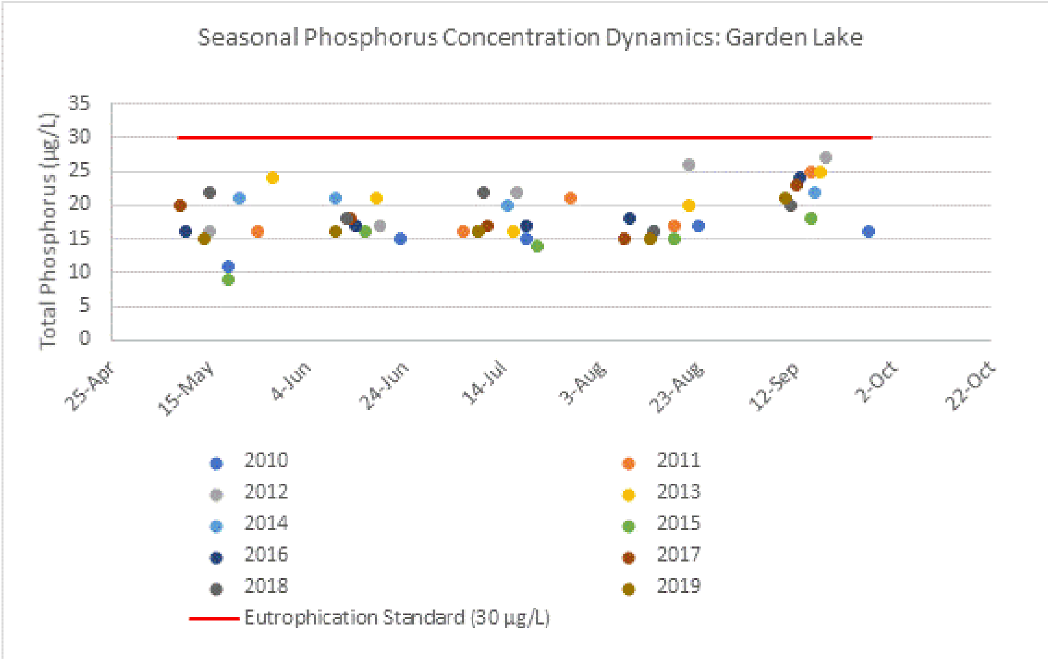


Figure 19. Dissolved oxygen profiles for Garden Lake in 2019 (site 204, EQuIS).

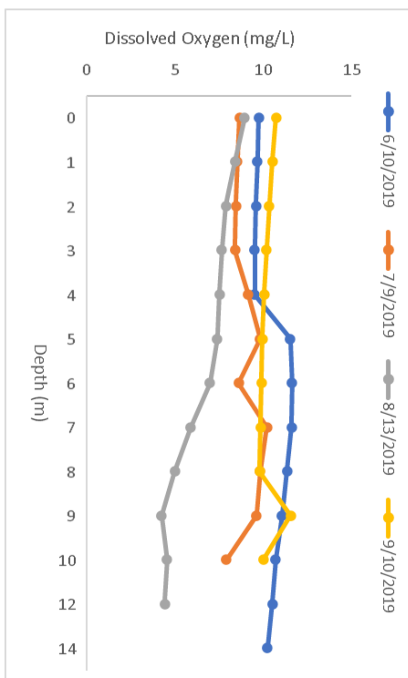


Figure 20. Seasonal Chl-a concentration dynamics: Garden Lake (site 204, EQuIS).

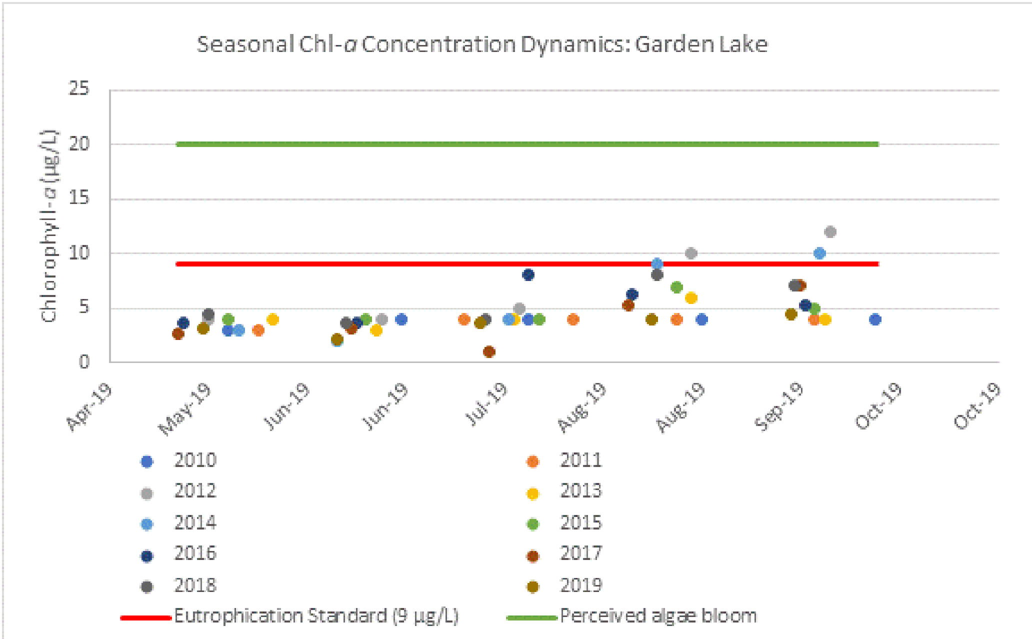


Figure 21. Seasonal transparency (Secchi depth) dynamics: Garden Lake (site 204, EQuIS).

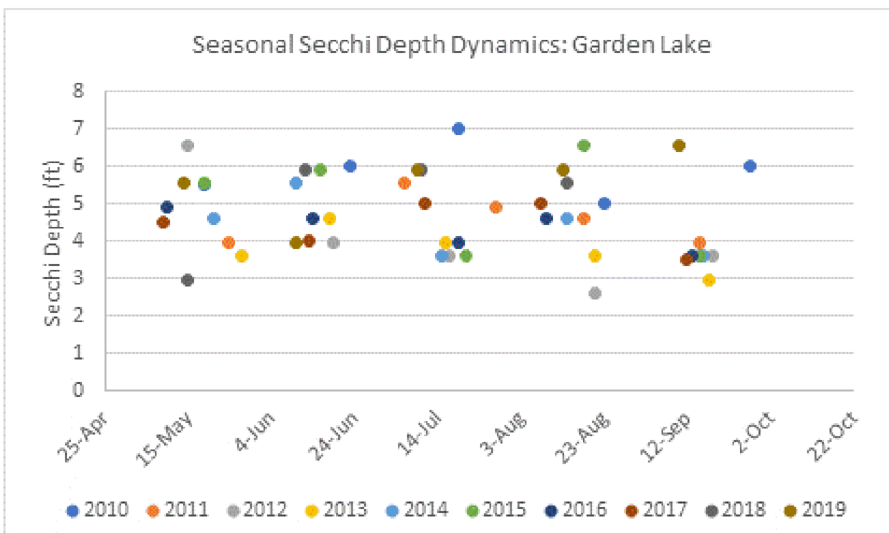
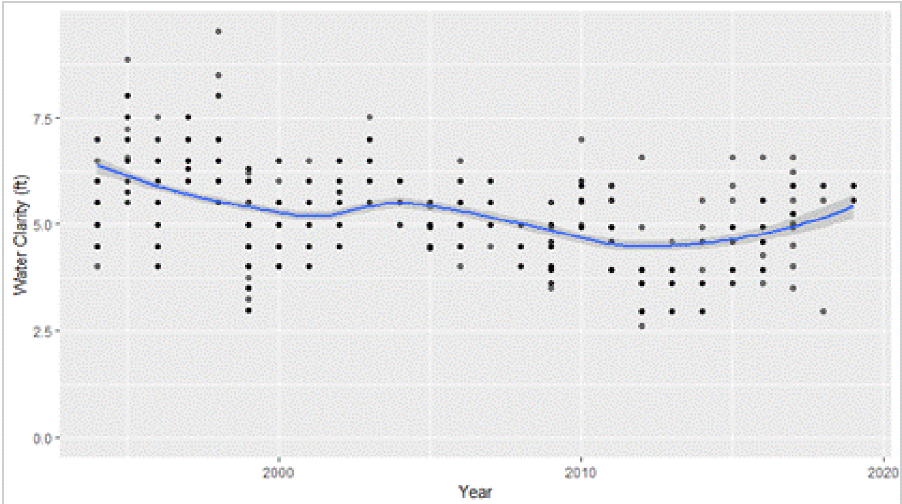


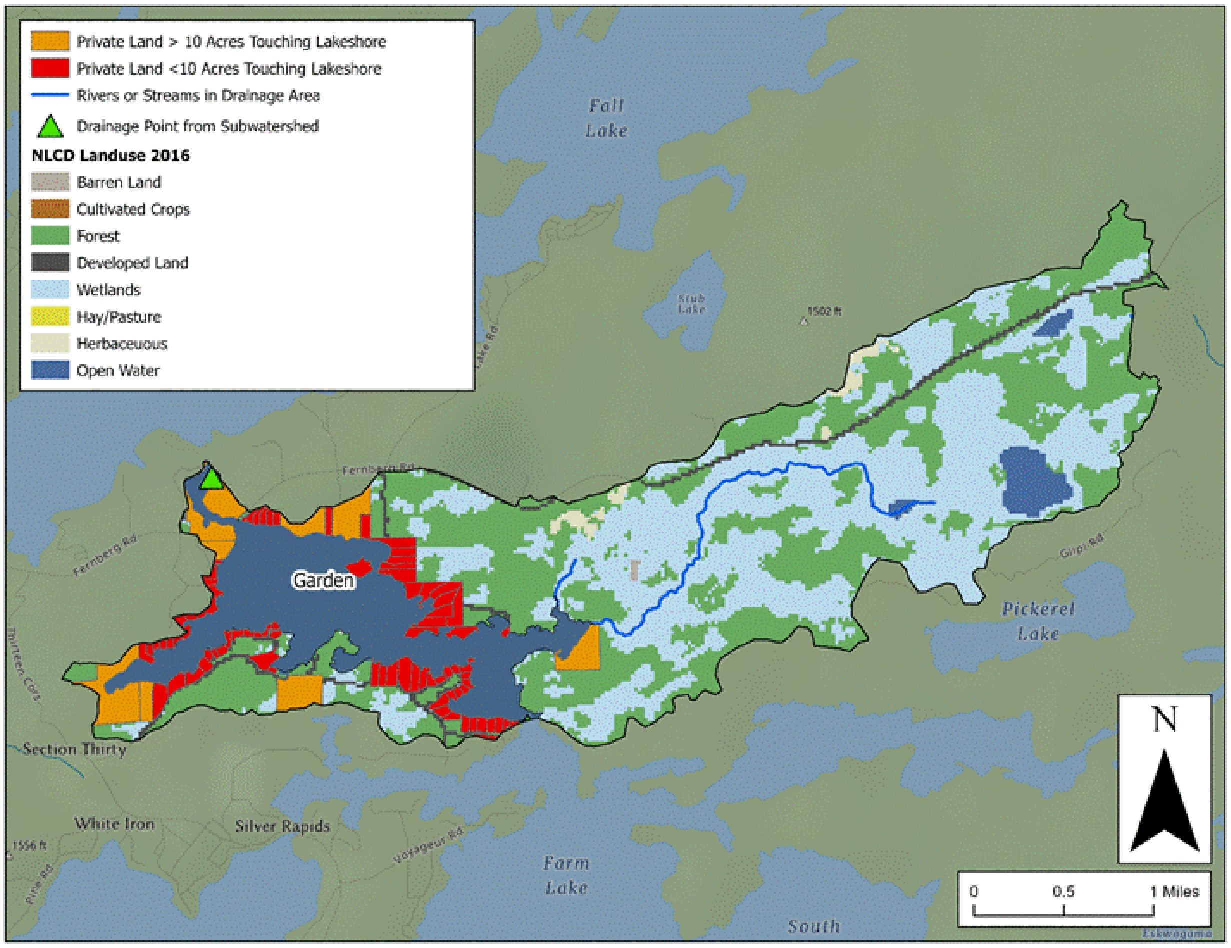
Figure 22. Long-term transparency trend for Garden Lake (MPCA website).



LAKE DRAINAGE LAND USE

The land use of the watershed contributing to Garden Lake is primarily forests and wetlands with some development along the lakeshore. Farm Lake flows into Garden Lake and then it flows out to Fall Lake as shown in **Figure 23**.

Figure 23. Land use, tributaries, and developed land identification in the Garden Lake watershed.



PHOSPHORUS LOADING

HSPF-SAM was used for a source assessment analysis to quantify the phosphorus loading to the lake from the different land uses within the drainage area. HSPF-SAM is not a lake-specific model and there is significant uncertainty involved. However, these loading numbers are intended to be used as tool for planning and prioritizing efforts and not to indicate day-to-day loading conditions.

The model indicates that Garden Lake's large watershed provides 98% of the phosphorus loading to the lake, as shown in **Figure 24**. The remaining 2% of the phosphorus loading comes from the direct drainage area of the lake (i.e. nearshore). Internal loading is not quantified in **Figure 24** or **Figure 25**.

The phosphorus loading to Garden Lake from within its direct drainage area (i.e. HSPF Reach) was broken down by land use in **Figure 25**, which can help guide implementation activities for reducing phosphorus loading to the lake. Given the large amount of forest cover and low development density in the drainage area, forests are the highest phosphorus source to the lake at 59%.

The modeling results showed some areas of phosphorus loading that can be reduced with best management practices. Developed areas contribute 9% and septic systems contribute 4% of the phosphorus loading to the lake as shown in **Figure 25**.

Figure 24. Upstream reaches vs. nearshore phosphorus loading to Garden Lake (HSPF-SAM Basin Source Fate).

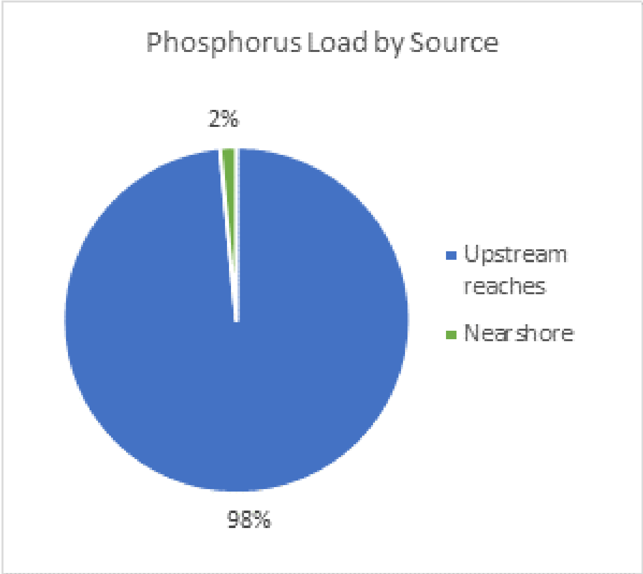
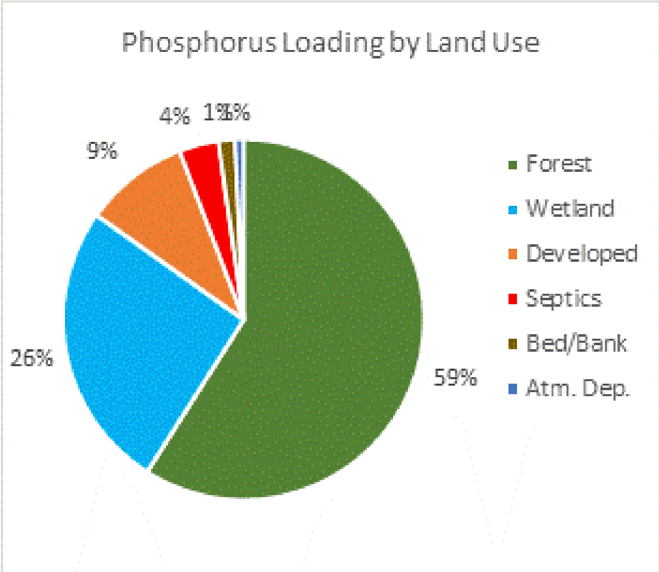


Figure 25. Direct drainage phosphorus loading to Garden Lake, by land use (HSPF-SAM Source Fate).



GOAL SETTING

Garden Lake is not impaired, so does not require a TMDL or specific reduction at this time. Any current phosphorus goals would be for protection. Typically, short-term goals (i.e. 10-year timeframe) for lake protection have been set to a 5% reduction based on the DNR's phosphorus sensitivity modeling analysis (MPCA and DNR, 2019). A reduction could be reached through a combination of stormwater best management practices

(BMPs) such as rain gardens and lakeshore buffers, septic system inventory and improvements, and education and outreach to lakeshore property owners. The privately-owned lakeshore in **Figure 23** (red and orange) could be targeted for phosphorus reduction practices. Landowners can work with the Lake SWCD to install these BMPs.

Other protection practices, such as easements and acquisitions, could be targeted to the orange colored parcels (privately-owned lakeshore greater than 10 acres) in **Figure 23**. Protection of these areas would prevent future increases in phosphorus loading to the lake from increased development. Landowners can contact the Lake SWCD or Minnesota Land Trust to learn more about conservation easement options. If there is undeveloped shoreline that is important for fish spawning, the DNR could be contacted for Aquatic Management Area options.

MONITORING

Garden Lake is showing a declining trend in transparency. It is important to continue transparency monitoring to track this trend into the future. If the declining trend continues, BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake**.**

SHAGAWA LAKE

Shagawa Lake is a local priority for the RRHW Core Team and has some risks and qualities identified during the RRHW Watershed Restoration and Protection Strategy development. Shagawa Lake is near the City of Ely and is an important recreation destination with resorts, and fishing, swimming, and boating use. The lake approaches the water quality standards periodically, which is a concern for future aquatic recreational use. Increased protection and management can keep this lake from becoming impaired.

WATER QUALITY

Shagawa Lake's 10 year average phosphorus concentration of all summer samples is 21 µg/L, well below the warmwater NLF ecoregion standard of 30 µg/L. Phosphorus concentrations increase over the course of the summer as shown in **Figure 26**.

Shagawa Lake is a mesotrophic lake of moderate depth (max depth of 48 feet). DO profiles indicate that the lake may mix periodically in the summer as shown in **Figure 27**.

DO profiles and hypolimnion phosphorus samples were collected in 2009. **Figure 27** shows that the hypolimnion became anoxic (<5 mg/L DO) in August and September and **Figure 28** shows the hypolimnion phosphorus concentration indicated some internal loading could be occurring that year (when the hypolimnion phosphorus concentration is higher than the surface phosphorus concentration.

The Chl-*a* concentration in Shagawa Lake had a ten year average of 6 µg/L according to MPCA's water quality dashboard. **Figure 29** shows that it exceeded the standards at the end of the summer in 2000 and 2008. MPCA data comparing user perceptions with Chl-*a* concentrations has concluded that lake users perceive a major algae bloom when the Chl-*a* concentration reaches 20 µg/L (Heiskary & Wilson, 2008). In Shagawa Lake, an algae bloom was observed in 1998 and 2000.

The transparency, expressed via Secchi depth, in Shagawa Lake averaged 8 feet between 1981-2011.

Figure 30 shows the transparency is highest in June, when it can be as high as 15 feet. In August, the transparency decreases to 5-8 feet as the lake experiences algae blooms. Long-term trend analysis in **Figure 31** shows that there is an improving trend in transparency. Continued monitoring is recommended to track this trend in the future.

Figure 26. Seasonal phosphorus concentration dynamics: Shagawa Lake (site 101, EQuIS).

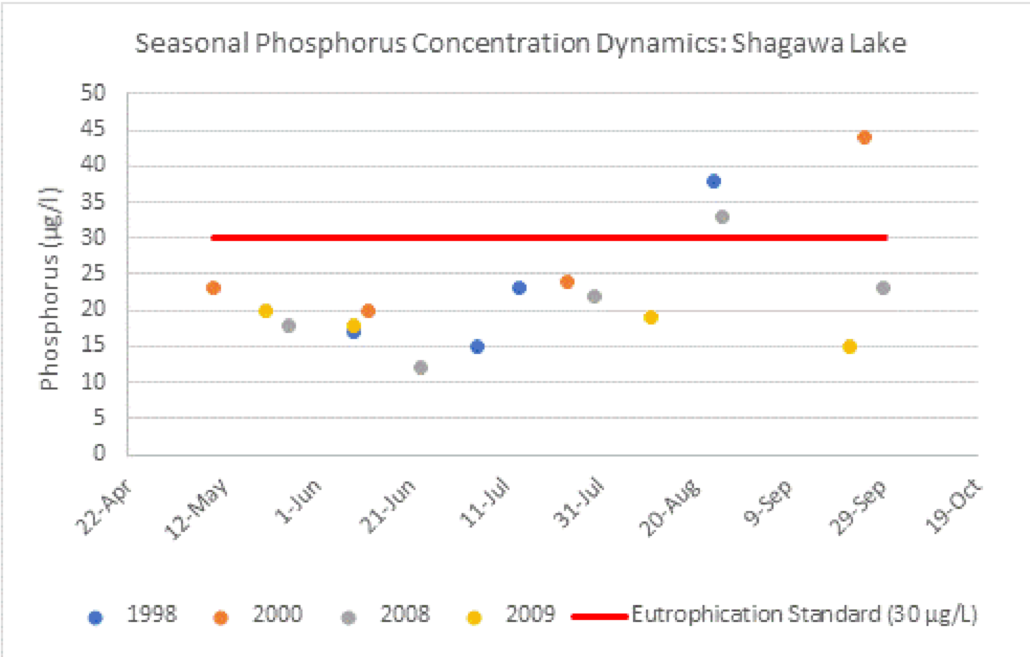


Figure 27. Dissolved oxygen profiles for Shagawa Lake in 2009 (site 101, EQuIS).

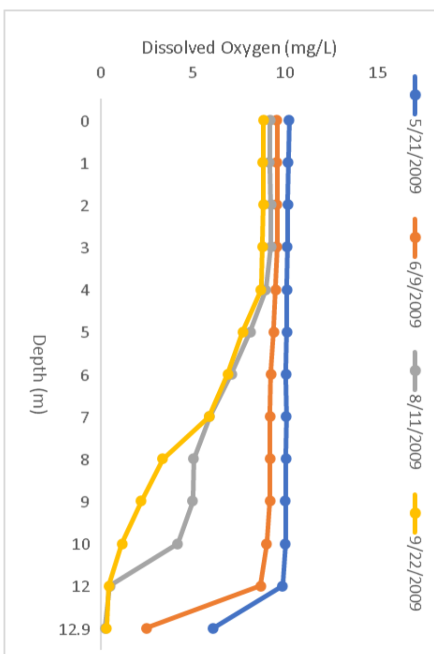


Figure 28. Surface and hypolimnion (bottom) phosphorus concentrations for Shagawa Lake (site 101, EQuIS).

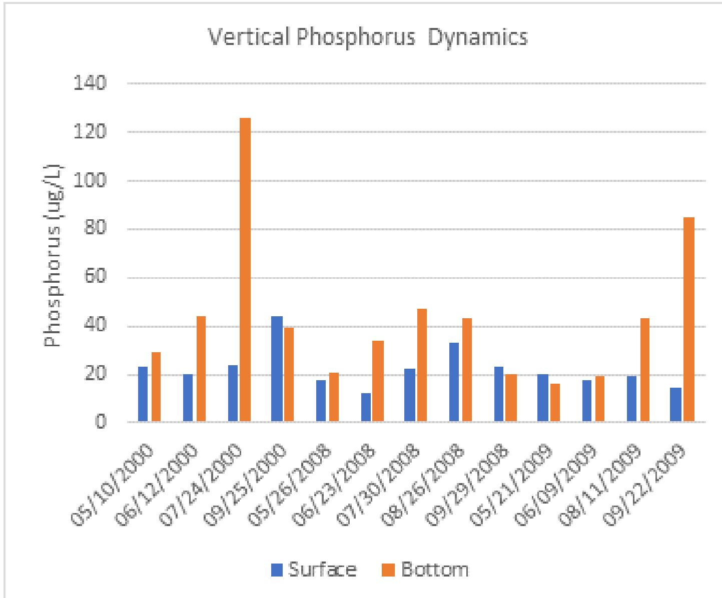


Figure 29. Seasonal Chl-a concentration dynamics: Shagawa Lake (site 101, EQuIS).

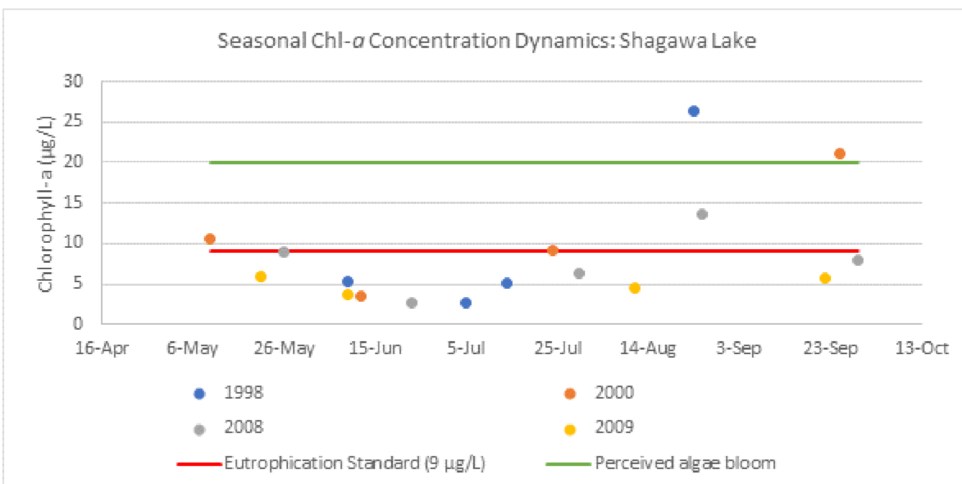


Figure 30. Seasonal transparency dynamics: Shagawa Lake (site 101, EQuIS).

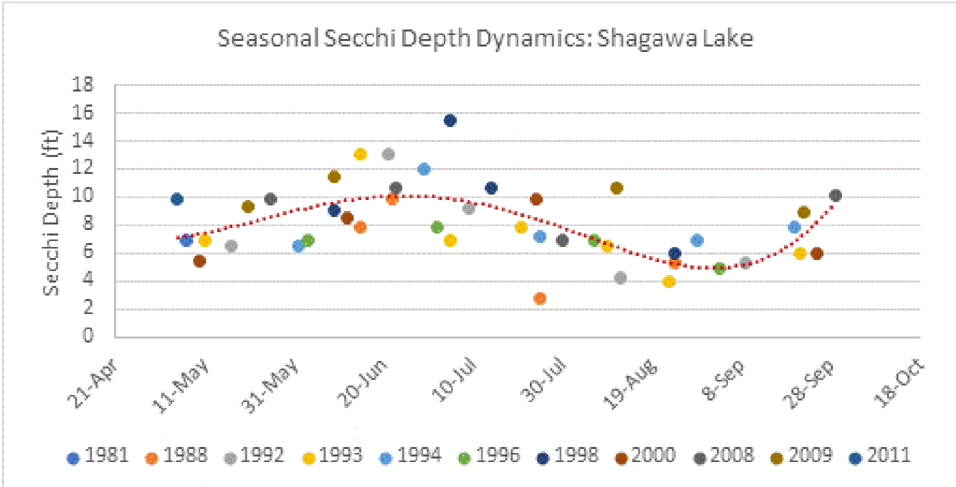
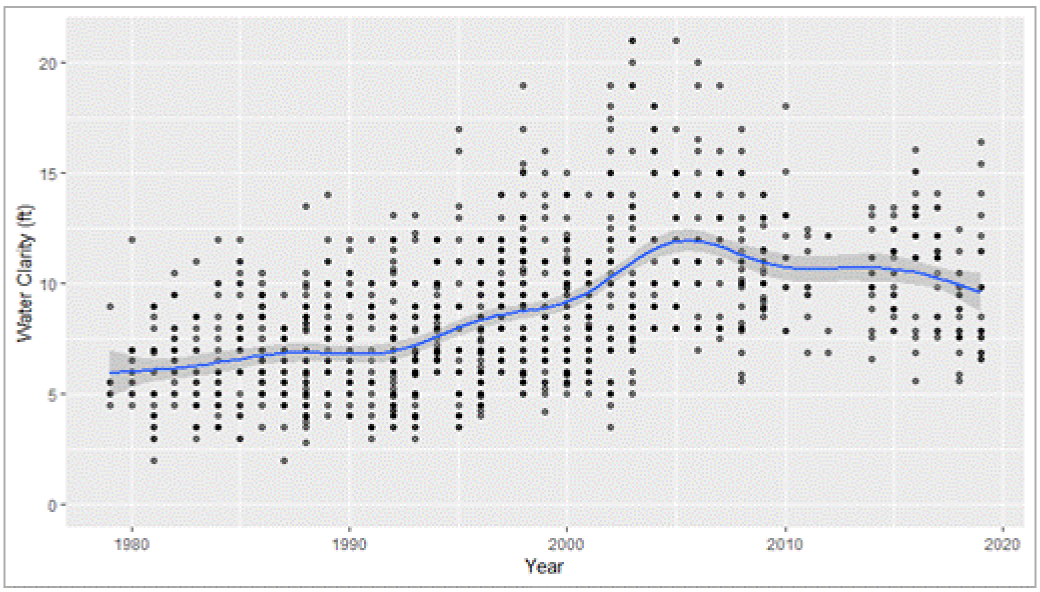


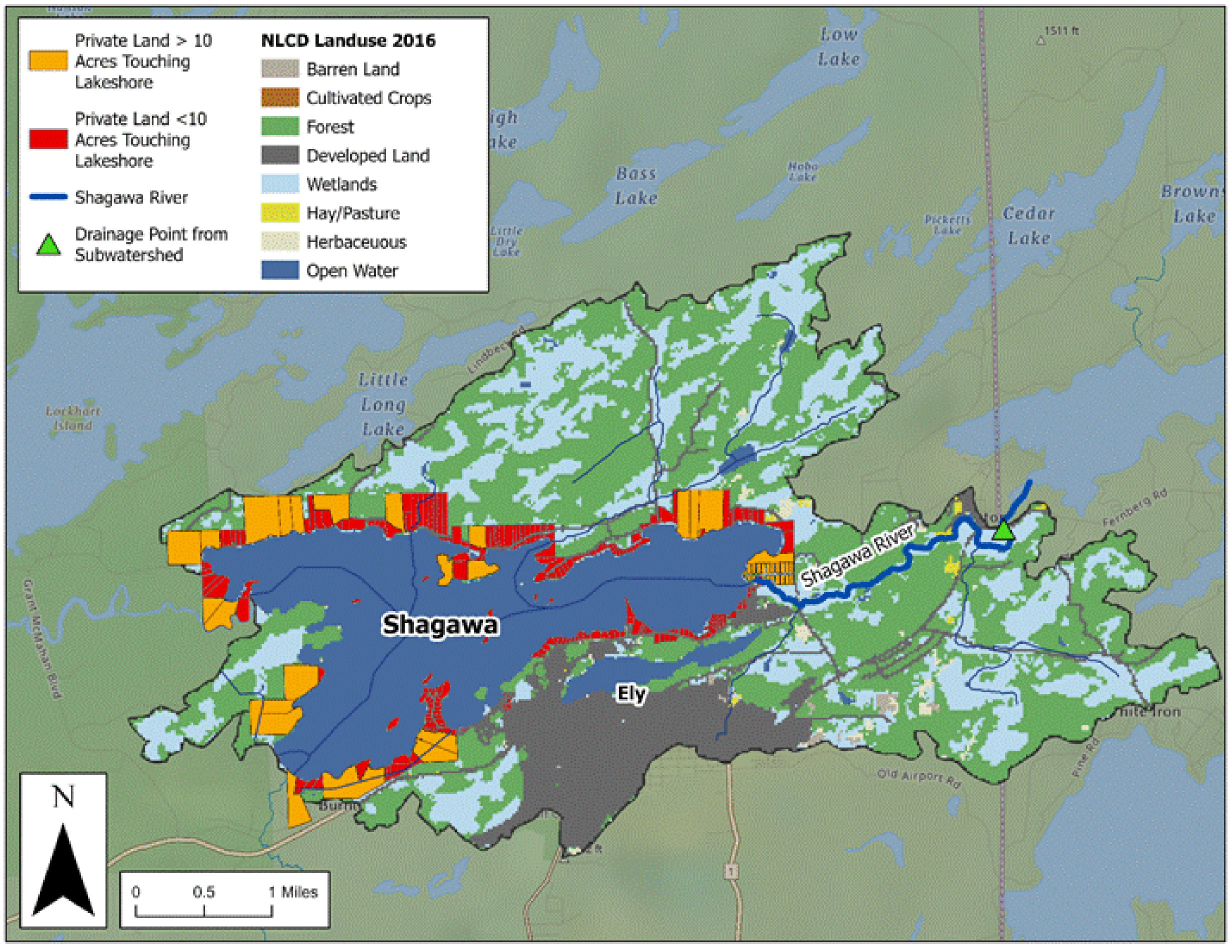
Figure 31. Long-term transparency trend (Secchi depth): Shagawa Lake (MPCA website).



LAKE DRAINAGE LAND USE

The land use of the watershed contributing to the lake is primarily forests and wetlands. There is very little agriculture in the watershed (<1%), and the shoreline of the lake is developed in some areas. The City of Ely sits on the southeast side of the lake. There are some small streams draining into the lake from the south, but the watershed to lake ratio is relatively small (5:1). The Shagawa River outlets the lake on the east and flows into Fall Lake as shown in **Figure 32**.

Figure 32. Land use, tributaries, and developed land identification in the Shagawa Lake watershed.



PHOSPHORUS LOADING

HSPF-SAM was used for a source assessment analysis to quantify the phosphorus loading to the lake from the different land uses within the lake drainage area. HSPF-SAM is not a lake-specific model and there is significant uncertainty involved. However, these loading numbers are intended to be used as tool for planning and prioritizing efforts and not to indicate day-to-day loading conditions.

The model indicates that the 6 stream reaches that drain into the lake provide 49% of the phosphorus loading, as shown in **Figure 33**. The remaining 51% of the phosphorus loading comes from the direct drainage area of the lake (i.e. nearshore). Internal loading is not quantified in **Figure 33** or **Figure 34**.

The phosphorus loading to Shagawa Lake within its direct drainage area (i.e. HSPF Reach) was broken down by land use in **Figure 34**, which can help guide implementation activities for reducing phosphorus loading to the lake. The highest source of phosphorus to the lake was developed land, which makes sense because the City of Ely is in the direct drainage area of Lake Shagawa as shown in **Figure 32**. The point sources are also related to the City of Ely. The modeling results showed some areas of phosphorus loading that can be reduced with best management practices, including developed area and septic systems as shown in **Figure 34**.

Figure 33. Upstream reach vs. nearshore phosphorus loading to Shagawa Lake (HSPF-SAM Basin Source Fate).

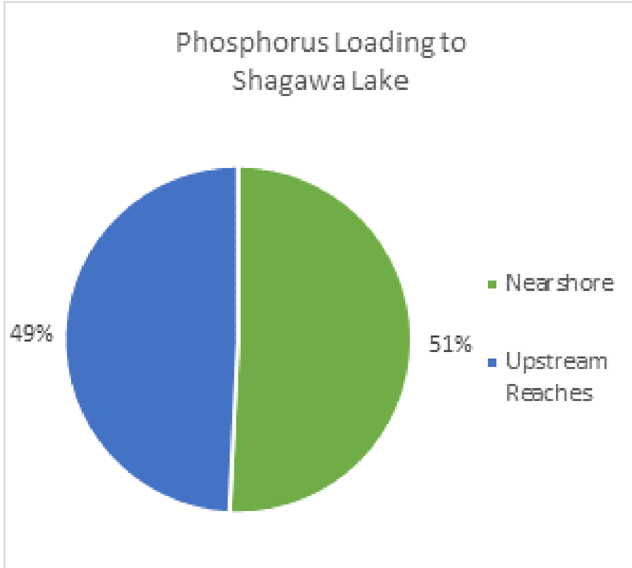
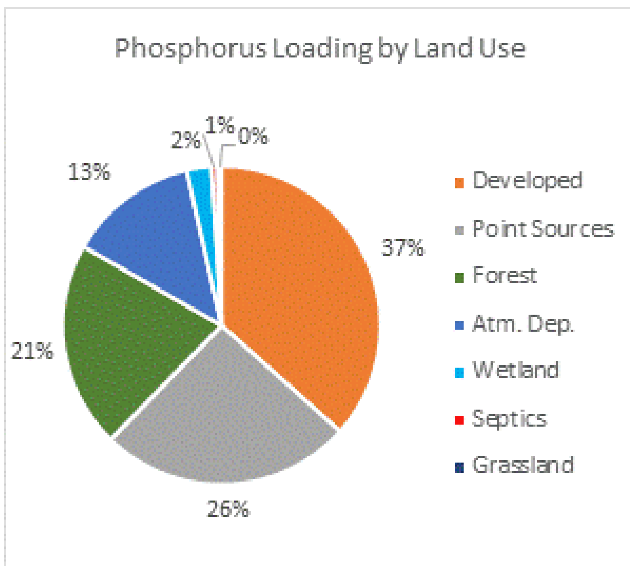


Figure 34. Direct drainage phosphorus loading to Shagawa Lake, by land use (HSPF-SAM Source Fate).



GOAL SETTING

Shagawa Lake is not impaired, so does not require a total maximum daily load (TMDL) or specific reduction at this time. Any current phosphorus goals would be for protection. Typically, short-term goals (i.e. 10-year timeframe) for lake protection have been set to a 5% reduction based on the DNR's phosphorus sensitivity modeling analysis (MPCA and DNR, 2019). A reduction could be reached through a combination of stormwater best management practices (BMPs) such as urban stormwater control, rain gardens and lakeshore buffers, septic system inventory and improvements, and education and outreach to lakeshore property owners. The private lakeshore in **Figure 32** (red and orange) could be targeted for phosphorus reduction practices. Landowners can work with the North St. Louis SWCD to install these BMPs.

Other protection practices, such as easements and acquisitions, could be targeted on the orange colored parcels (privately-owned lakeshore greater than 10 acres) in **Figure 32**. Protection of these areas could prevent future increases in phosphorus loading to the lake from increased development. Landowners can contact the North St. Louis SWCD or Minnesota Land Trust to learn more about conservation easement options. If there is undeveloped shoreline that is important for fish spawning, the DNR could be contacted for Aquatic Management Area options.

MONITORING

Shagawa Lake is vulnerable to decline since it is already close to the impairment standards. Continued monitoring can track any changes to the lake as best management practices are implemented. In addition, a better understanding of the DO dynamics and internal loading can help understand the proportion of phosphorus loading coming from internal sources. BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake.

WHITE IRON LAKE

White Iron Lake is a local priority for the RRHW Core Team and has some risks and qualities identified during the RRHW Watershed Restoration and Protection Strategy development. White Iron Lake is near the City of Ely and has a developed shoreline. It also supports wild rice and is designated a Class 1B drinking water lake. Future protection practices can maintain its good water quality. For more information, see Appendix D of the RRHW WRAPS Report.

WATER QUALITY

Phosphorus concentrations between 2006 and 2019 average 19 µg/L and mostly remain below the state eutrophication standard for the NLF Ecoregion, which is 30 µg/L. Phosphorus concentrations remain relatively consistent over the course of the summer from May to September, as shown in **Figure 35**.

White Iron Lake is a mesotrophic lake of moderate depth (max depth of 47 feet). DO profiles show that the hypolimnion remains well-oxygenated year-round (> 5 mg/L DO) as shown in **Figure 36**. Hypolimnion phosphorus concentrations shown in comparison to surface phosphorus concentrations in **Figure 37**, indicate no internal loading occurred during the years monitored (when the hypolimnion phosphorus concentration is higher than the surface phosphorus concentration).

The Chl-*a* concentration in White Iron Lake averaged 5 µg/L between 2006-2019 and exceeded the standards occasionally. MPCA data comparing user perceptions with Chl-*a* concentrations has concluded that lake users perceive a major algae bloom when the Chl-*a* concentration reaches 20 µg/L (Heiskary & Wilson, 2008). In White Iron Lake, **Figure 38** shows that no algae blooms occurred during the years monitored.

The transparency, expressed via Secchi Depth, in White Iron Lake averaged 4.5 feet from 1995-2019. **Figure 39** shows the transparency is relatively consistent all season long. Long-term trend analysis by the MPCA indicates ups and downs and no significant long-term trend, as shown in **Figure 40**. Continued monitoring is recommended to track trends into the future.

Figure 35. Seasonal phosphorus concentration dynamics: White Iron Lake (site 103, EQuIS).

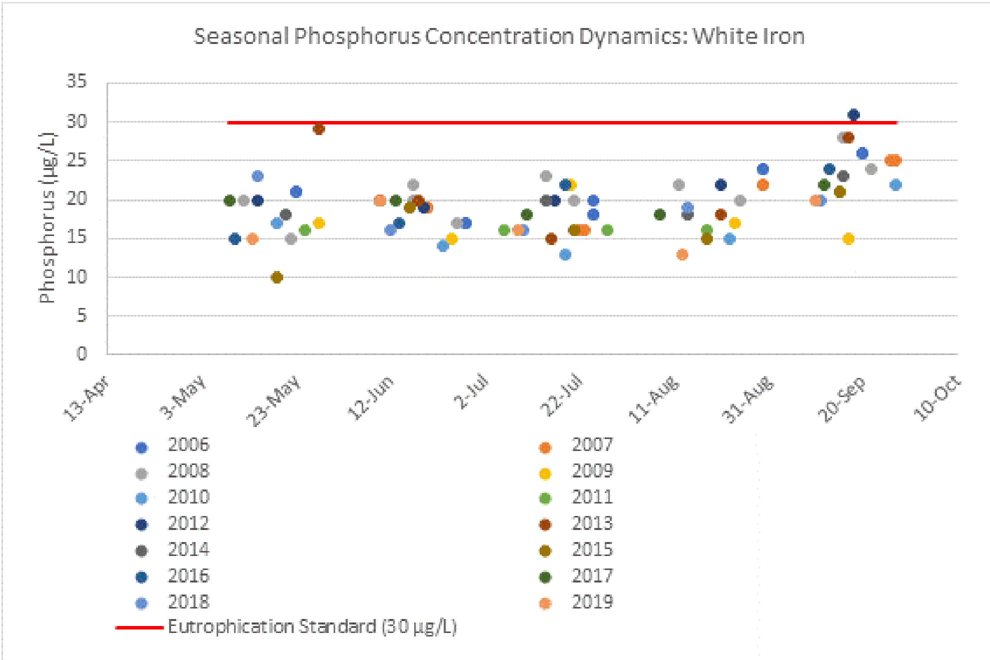


Figure 36. Dissolved oxygen profiles for White Iron Lake in 2019 (site 103, EQuIS).

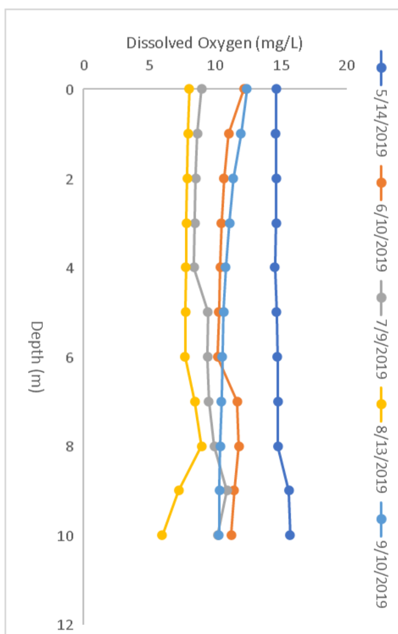


Figure 37. Surface and hypolimnion (bottom) phosphorus concentrations for White Iron Lake in 2008 (site 103, EQuIS).

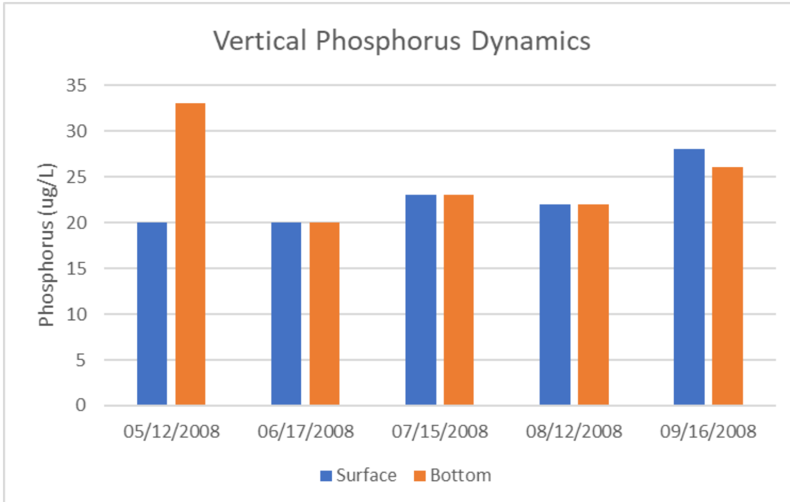


Figure 38. Seasonal Chl-a concentration dynamics: White Iron Lake (site 101, EQuIS).

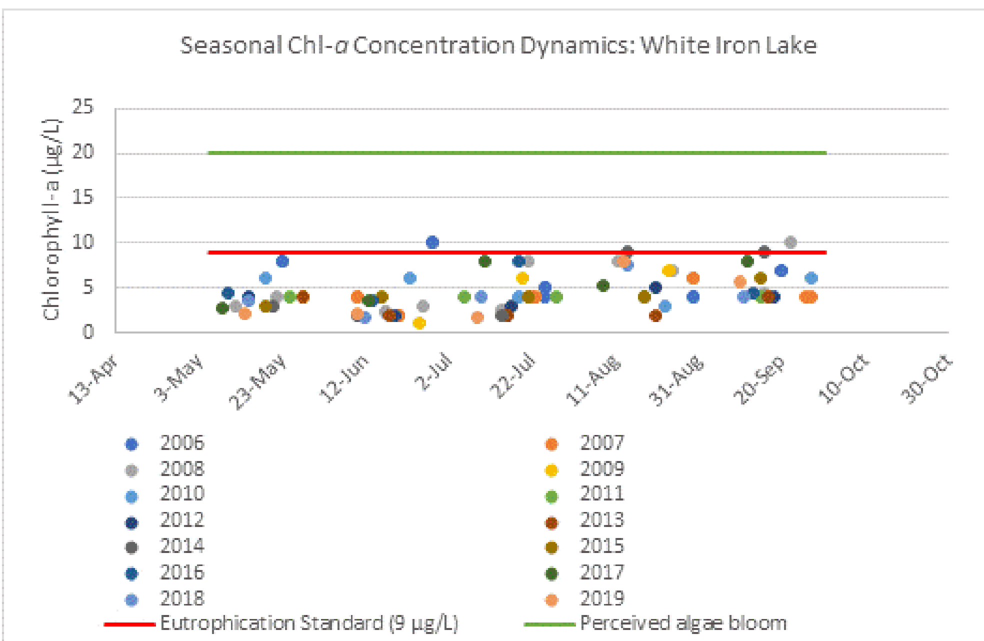


Figure 39. Seasonal transparency dynamics: White Iron Lake (site 103, EQuIS).

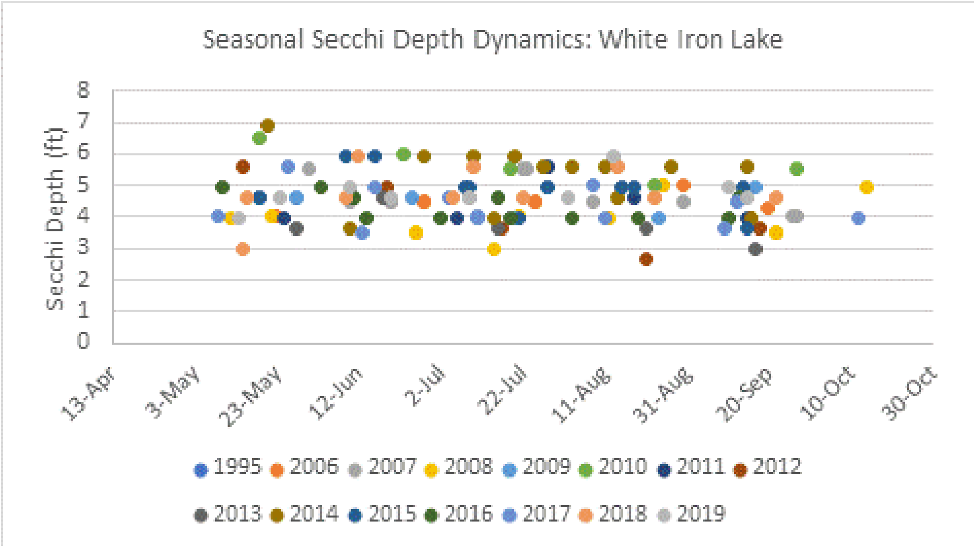
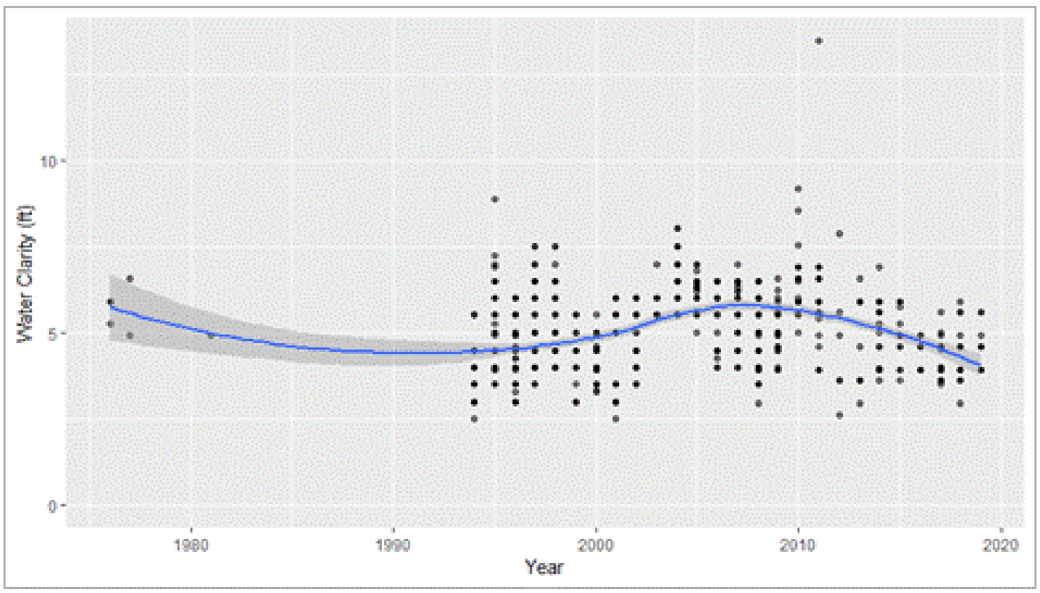


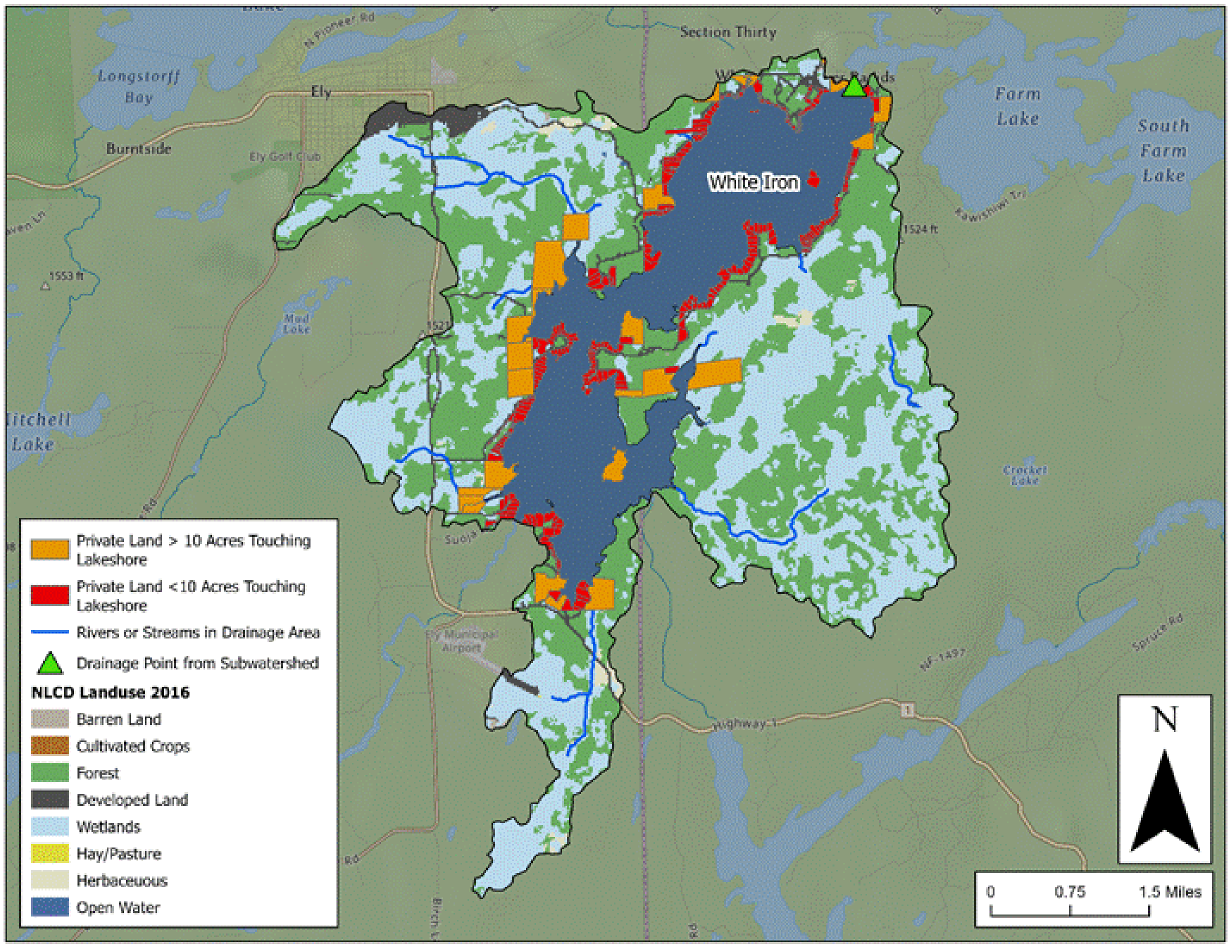
Figure 40. Long-term transparency trend (Secchi Depth): White Iron Lake (MPCA website).



LAKE DRAINAGE LAND USE

The land use of the watershed contributing to the lake is primarily forests and wetlands with development along much of the lakeshore. The City of Ely is in the northwest corner of the drainage area as shown in **Figure 41**.

Figure 41. Land use, tributaries, and developed land identification in the White Iron Lake watershed.



PHOSPHORUS LOADING

HSPF-SAM was used for a source assessment analysis to quantify the phosphorus loading from the different land uses within the lake drainage area. HSPF-SAM is not a lake-specific model and there is significant uncertainty involved. However, these loading numbers are intended to be used as tool for planning and prioritizing efforts and not to indicate day-to-day loading conditions.

The model indicates that White Iron Lake's large watershed provides 95% of the phosphorus loading to the lake, as shown in **Figure 42**. The remaining 5% of the phosphorus loading comes from the direct drainage area of the lake (i.e. nearshore). Internal loading is not quantified in **Figure 42** or **Figure 43**.

The phosphorus loading to White Iron Lake within its direct drainage area (i.e. HSPF Reach) was broken down by land use in **Figure 43**, which can help guide implementation activities for reducing phosphorus loading to the lake. Given the large amount of forest cover and low development density in the drainage area, forests are the highest phosphorus source to the lake at 45%.

The modeling results showed some areas of phosphorus loading that can be reduced with best management practices. Developed areas contribute 20% and septic systems contribute 2% of the phosphorus loading to the lake as shown in **Figure 43**.

Figure 42. Upstream reach vs. nearshore phosphorus loading to White Iron Lake (HSPF-SAM Basin Source Fate).

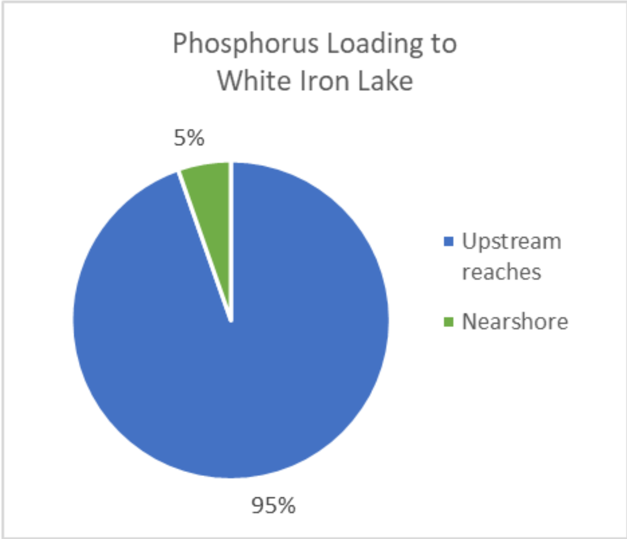
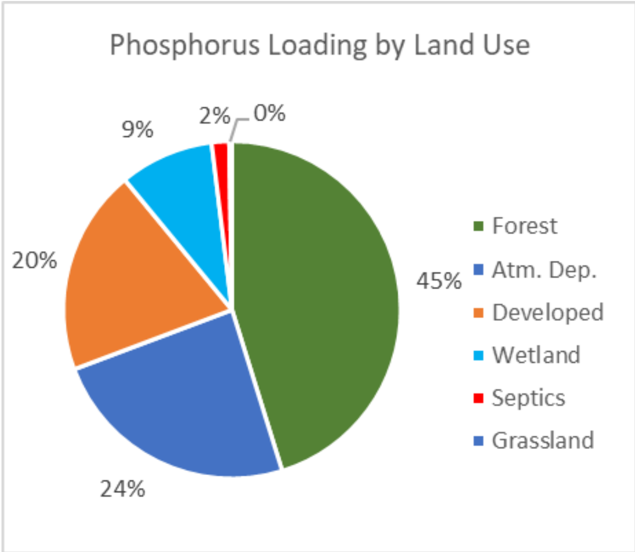


Figure 43. Direct drainage phosphorus loading to White Iron Lake, by land use (HSPF-SAM Source Fate).



GOAL SETTING

White Iron Lake is not impaired, so does not require a TMDL or specific reduction at this time. Any current phosphorus goals would be for protection. Typically, short-term goals (i.e. 10-year timeframe) for lake protection have been set to a 5% reduction based on the DNR's phosphorus sensitivity modeling analysis (MPCA and DNR, 2019). A reduction could be reached through a combination of stormwater best management practices (BMPs) such as rain gardens and lakeshore buffers, septic system inventory and improvements, and education and outreach to lakeshore property owners. The privately-owned lakeshore in **Figure 41** (red and orange) could be targeted for phosphorus reduction practices. Landowners can work with the North St. Louis SWCD to install these BMPs.

Other protection practices, such as easements and acquisitions, could be targeted to the orange colored parcels (privately-owned lakeshore greater than 10 acres) in **Figure 41**. Protection of these areas would prevent future increases in phosphorus loading to the lake from increased development. Landowners can contact the North St. Louis SWCD, Lake County SWCD, or Minnesota Land Trust to learn more about conservation easement options. If there is undeveloped shoreline that is important for fish spawning, the DNR could be contacted for Aquatic Management Area options.

MONITORING

White Iron Lake is showing variable transparency that has been up and down in the past. It is important to continue transparency monitoring to track this trend into the future. BATHTUB, a more lake-specific model than HSPF-SAM, could be used to better detail phosphorus load reductions to the lake.

REFERENCES

Heiskary, Steven and Bruce Wilson. 2008. Minnesota's approach to lake nutrient criteria development. Lake and Reservoir Management. 24(3):282-297.

Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (DNR). 2019. Lakes of Phosphorus Sensitivity Significance (LPSS). May 24, 2019.