Mississippi River Headwaters Watershed Restoration and Protection Strategy Report

August 2018

Watershed Partners

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Key Terms and Acronyms

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

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

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

BWSR: Board of Soil and Water Resources

CLMP: Citizen Lake Monitoring Program

DNR: Minnesota Department of Natural Resources

HSPF: The hydrologic and water quality model **H**ydrologic **S**imulation **P**rogram **F**ortran.

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 Upper Mississippi River Basin is assigned a HUC-4 of 0701 and the Mississippi River Headwaters Watershed is assigned a HUC-8 of 07010101.

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

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

IWM: MPCA's **I**ntensive **W**atershed **M**onitoring, which includes chemistry, habitat, and biological sampling.

LLBO: Leech Lake Band of Ojibwe

MDA: Minnesota Department of Agriculture

MPCA: Minnesota Pollution Control Agency

MSHA: Minnesota Stream Habitat Assessment

MRHW: Mississippi River Headwaters

NCCR: North Central Conservation Roundtable

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

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

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

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

SWAG: Surface Water Assessment Grant

TNC: The Nature Conservancy

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

Executive Summary

The Mississippi River Headwaters Watershed (MRHW) is located in north-central Minnesota as part of the Upper Mississippi River Basin, and covers 1,961 square miles. This large watershed contains the headwaters of the Mississippi River at Lake Itasca in Itasca State Park, and covers parts of six counties including Becker, Beltrami, Cass, Clearwater, Hubbard, and Itasca. The MRHW is rich in surface water resources, with approximately 685 river miles and containing more than 1,000 lakes with a total acreage of 180,375. This wealth of water resources includes some of Minnesota's most famous lakes and streams. Each year, thousands of anglers travel to this watershed in search of walleye and other game fish.

The MRHW is located in the Northern Lakes and Forest Ecoregion within a relatively rural region of the state. The largest city in the watershed is Bemidji, with a population of 14,942 (2016). Other towns in the watershed include Cohasset, Deer River, and Cass Lake. Approximately 44% of the land in this watershed is privately owned, with the remaining portion as state, county or federal public land, or held by tribal land owners. The total population count of the watershed is around 48,410, with an estimated 586 farms (USDA, NRCS). The most prominent land use in the watershed is forested (58%); followed by wetlands, open water, moderate amounts of agricultural lands, and very little urban land use.

The MRHW has a large number of rare or declining species that are dependent on aquatic resources or features. This watershed has several areas of High and Outstanding biodiversity that contain many of the unique plant and animal species listed on the Natural Heritage Database. Several Wildlife Management Areas (WMAs), Scientific and Natural Areas, and the Chippewa National Forest are found within the watershed and provide habitat and recreational opportunities. The Mississippi River provides fish habitat, as well as habitat for native mussels associated with larger river systems. Most of the rare native plant communities are within state parks (Itasca or Lake Bemidji), near Pike Bay of Cass Lake and in the subwatersheds north and east of Itasca State Park (e.g., between the state park and Lake Bemidji).

Biological monitoring was conducted at 39 stream sites during the summer of 2013 throughout the MRHW to assess the status of the watershed's biological assemblages. This sampling was done in cooperation with several partnering state, local and federal agencies and groups, including the Leech Lake Band of Objibwe. Using data from these sampling efforts, most stream reaches were determined to support aquatic recreation and aquatic life. There were three reaches that scored low for their fish or macroinvertebrate communities and were investigated in the Stressor Identification (SID) Report (Section 2.3), and one reach (Fisherman's Brook) that did not meet aquatic life standards (Table 1). Fisherman's Brook is wholly located within the Leech Lake Indian Reservation. Waters that are wholly within reservation boundaries that are identified to be impaired are not placed on the 303d list, but are instead placed on a separate list that is sent to Environmental Protection Agency (EPA) with the notation that the assessments are to be considered advisory in nature.

The Upper Mississippi River was the first of the large rivers in the state to have intensive monitoring done on the main-stem river. Biology and chemistry data were collected in 2013 and 2014 to determine if the river is meeting state water quality standards. Overall, the biological communities of the Mississippi River are in good shape, as fish and macroinvertebrate index of biotic integrity (IBI) scores indicated full support for aquatic life use. With natural conditions contributing low dissolved oxygen (DO) in some parts of the watershed, it is critical that pollutants that could further decrease DO concentrations do not enter the river. Pollutants, such as excess total phosphorus (TP), can cause river eutrophication and increasing biological oxygen demand potentially stressing biological communities.

Using data from the various sampling efforts, including data from the 2013 through 2014 Intensive Watershed Monitoring (IWM) effort, it was determined that 15 lakes do not support the state aquatic recreation standard (nutrient/eutrophication biological indicators), and one of the assessed lakes (Grace Lake) was investigated in the SID Report due to having a fish IBI score close to the impairment threshold. Of the 15 lakes, a TMDL was completed concurrently with this report for two (Irving and Little Turtle, Beltrami County). Five lakes do not meet aquatic recreation standards but are being considered for a future separate shallow lakes standard, and eight did not meet the aquatic recreation standards due to predominantly natural background causes.

In general, lakes in the MRHW have good water quality, with only 15 of the 122 assessed lakes failing to meet water quality standards. However, several stressors could degrade water quality, including climate change, increased riparian development, and increased forest harvest rate. Protection considerations should be a high priority throughout the watershed. More information regarding protection considerations is included in Section 2.5.

Figure 1. LaSalle Creek, Hubbard County

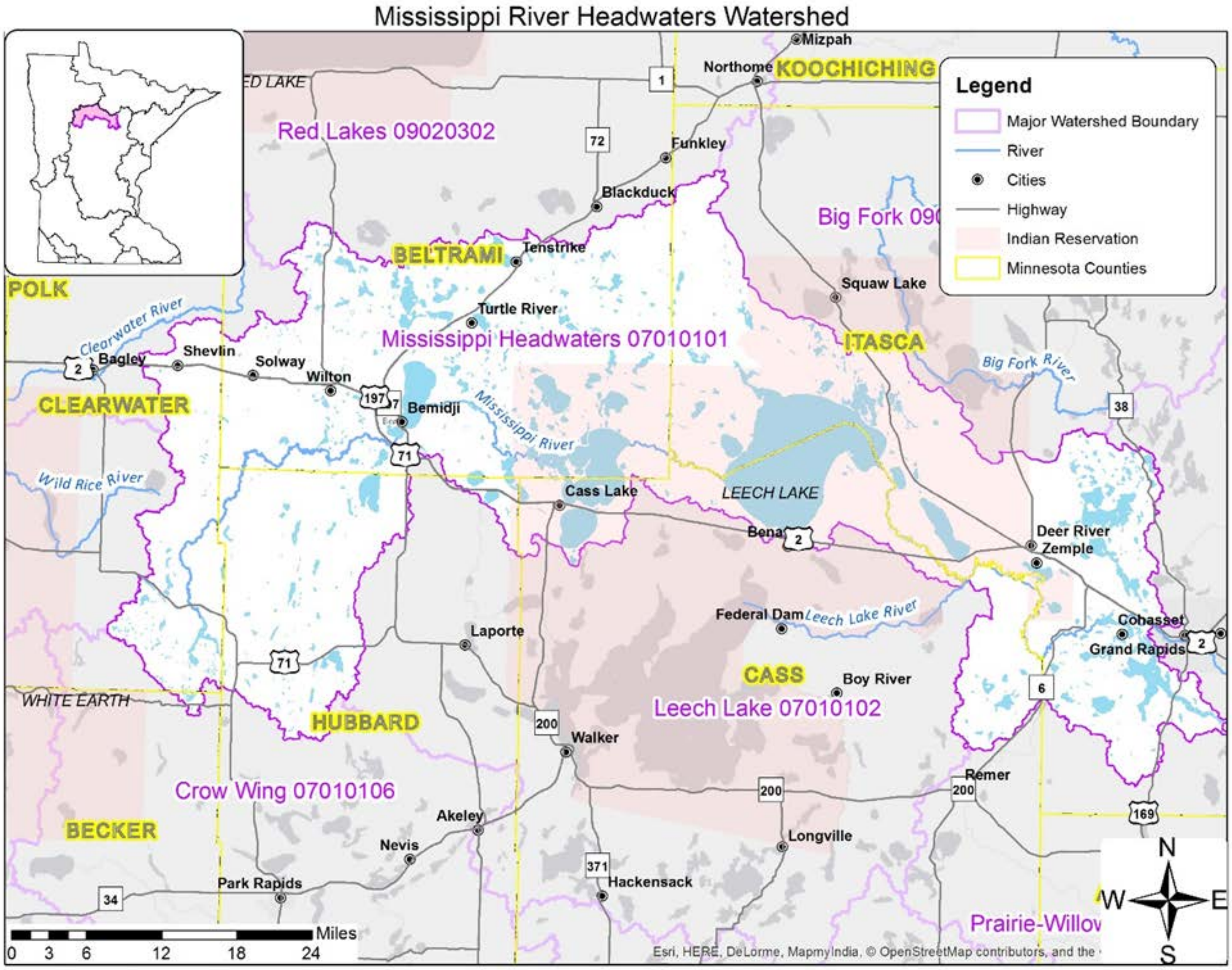


Figure 2. Map of Mississippi River Headwaters Watershed

Additional Mississippi River (Headwaters) Watershed Resources-

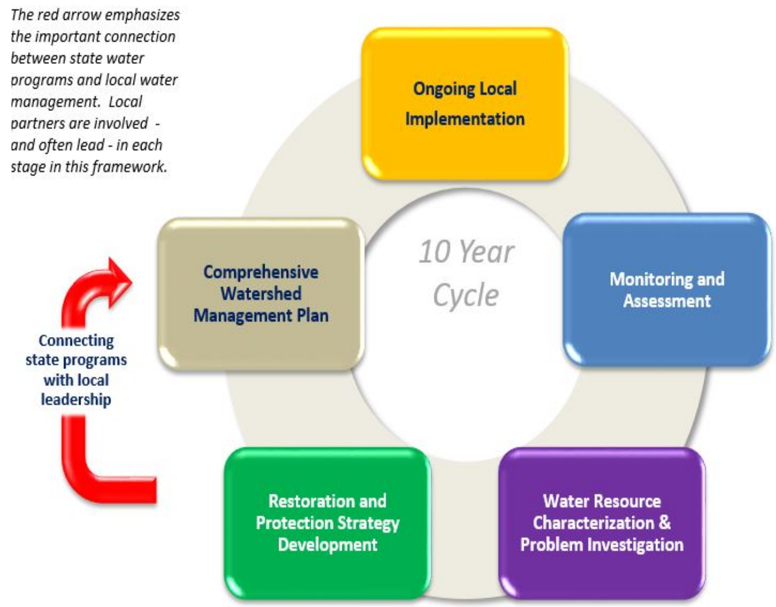
USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Mississippi River (Headwaters) Watershed:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022926.pdf

Minnesota Department of Natural Resources (DNR) Watershed Health Assessment Framework (Watershed Report card) for the Mississippi River (Headwaters) Watershed:
http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_7.pdf

Minnesota Pollution Control Agency (MPCA) Mississippi River Headwaters Watershed:
https://www.pca.state.mn.us/water/watersheds/mississippi-river-headwaters

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 Minnesota Pollution Control Agency (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. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection. Waters not meeting state standards are listed as impaired and Total Maximum Daily Load (TMDL) studies are developed for them, to determine needed pollution reductions. TMDLs are incorporated into WRAPS. Doing this work in the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as the basis for addressing the U.S. EPA Nine Minimum Elements of watershed plans, to help qualify applicants for eligibility for Clean Water Act 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:
  - *Mississippi River Headwaters Watershed Monitoring and Assessment 2017*
  - *Mississippi River Headwaters Watershed Biotic Stressor Identification 2017*
  - *Mississippi River Headwaters Watershed Total Maximum Daily Load 2017*

Scope

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

Audience

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

1. Watershed Background & Description

The MRHW is located in north-central Minnesota as part of the Upper Mississippi River Basin and covers 1,961 square miles. This large watershed contains the headwaters of the Mississippi River at Lake Itasca in Itasca State Park, and covers parts of six counties including Becker, Beltrami, Cass, Clearwater, Hubbard, and Itasca. The MRHW has a wealth of surface water resources, with approximately 685 river miles and containing more than 1,000 lakes with a total acreage of 180,375.

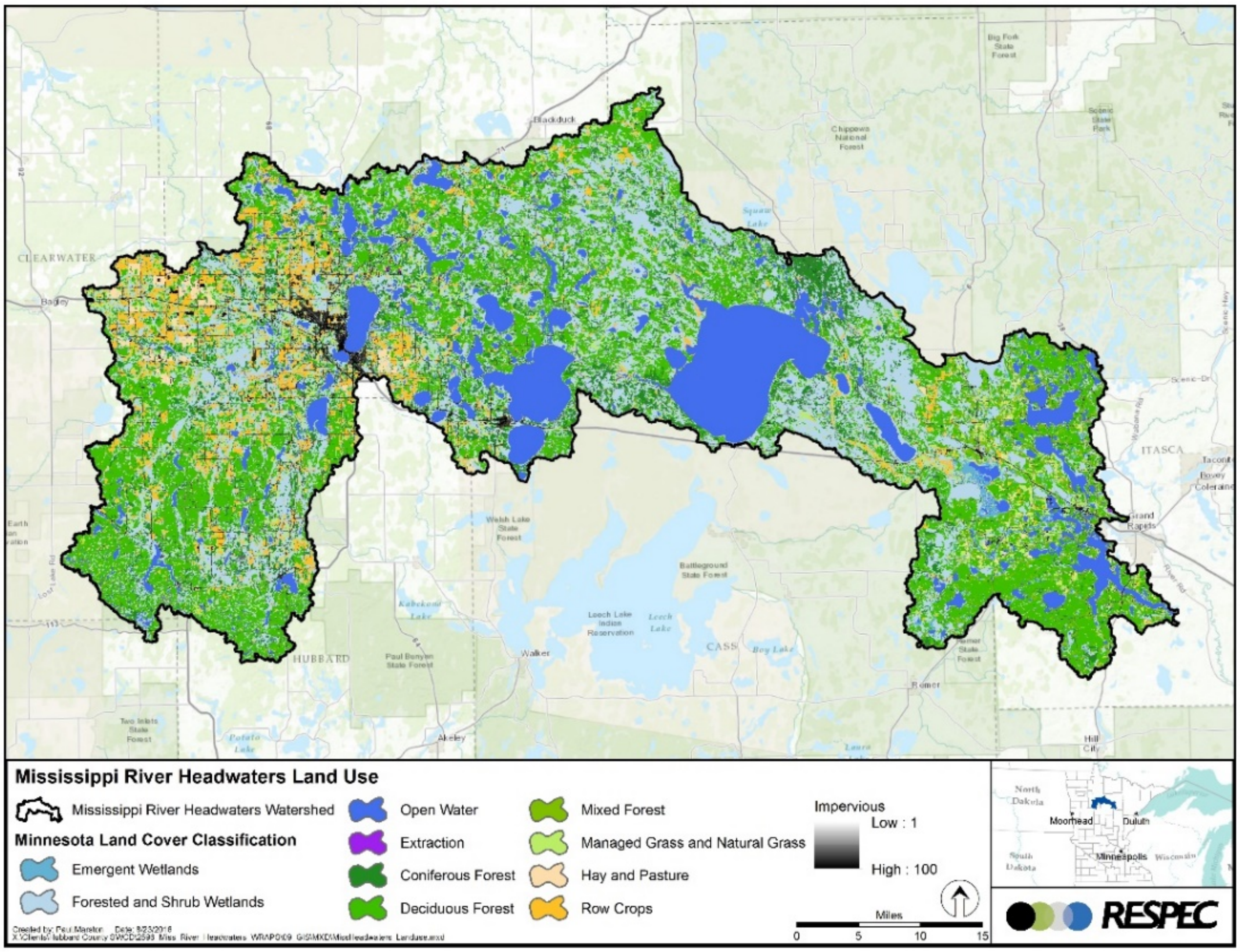


Figure 3. Mississippi River Headwaters Land Use

The MRHW is located in the Northern Lakes and Forest Ecoregion within a more rural region of the state. The largest city, Bemidji, has a population of 14,942 (2016). Other cities in the watershed include Cohasset (population 2,728), Deer River (population 933), and Cass Lake (population 749). Approximately 44% of the land in this watershed is privately owned, with the remaining portion being state, county or federal public land, or held by tribal landowners. The total population count of the watershed is around 48,410, with an estimated 586 farms (USDA, NRCS).

The most prominent land use in the watershed is forested (58%), followed by wetlands (15%), and open water (14%), with urban only accounting for around 3%. Agricultural land use within the watershed is moderate, accounting for approximately 10% of the available acres. (See Figure 3).

2. Watershed Conditions

As the Mississippi River begins its 2,320-mile journey to the Gulf of Mexico, it runs north to north-easterly through the watershed's abundant forest resources and large riverine wetland areas. The forest resources are a vital component to the economy of the area and provide habitat for a variety of wildlife species.

Groundwater springs are present throughout much of the river channel throughout this watershed. These springs are especially common above Lake Bemidji where groundwater contributes approximately two-thirds of the Mississippi River's flow in this section. The MRHW is rich in surface water resources, which includes some of Minnesota's most famous lakes and streams. Each year, thousands of anglers travel to this watershed in search of walleye and other game fish. Several lake associations/citizens throughout the watershed actively participate in water quality monitoring through the Citizen Lake Monitoring Program (CLMP). Several important surface-water-quality diagnostic and implementation projects are ongoing or have been completed in this watershed. In 2013, the Itasca County Soil and Water Conservation District (ISWCD) completed a diagnostic study of Deer and Pokegama Lakes through the Clean Water Partnership (CWP) grant program. Subsequently, the ISWCD received an Enbridge funded Eco-Footprint grant for 2016 through 2018 to implement some of the recommendations from the 2013 Diagnostic study. This project included two years of additional lake monitoring on Deer and Pokegama lakes and a geomorphic study of sixteen subwatersheds and tributary streams, which were identified in 2013 as contributing high loads of phosphorus. As part of this grant, the ISWCD is currently working towards implementing a project with Minnesota Department of Transportation (MnDOT) near the Pokegama causeway to address stormwater runoff velocity.

Local partners and conservation groups within this watershed continue to be active in obtaining comprehensive water quality monitoring and assessment data on the various water resources, while working with landowners on the implementation of best management practices (BMPs) throughout the watershed. It is all part of their ongoing efforts to ensure that the high quality of these surface water resources is protected for future generations.

Stream conditions throughout the MRHW were assessed in 2015 using a range of parameters, including fish and macroinvertebrate IBI scores, bacteria (fecal coliform and *E. coli*), DO, turbidity, and total suspended solids (TSS). Results of the stream IBI scores and water quality data compared to state water quality standards were used to determine stream impairments. Similarly, lake assessment used the same process for water quality parameters, while including the use of the new fish IBI methodology developed for lakes by the Minnesota Department of Natural Resources (DNR). Figure 4 shows the stream and lake impairments in the watershed. See the Mississippi River (Headwaters) Monitoring and Assessment Report for a comprehensive report on the monitoring and assessment of the surface water resources within the MRHW.

Some of the waterbodies in the MRHW are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments, see the [Statewide Mercury Reduction Plan](). If you would like more information on other pollutants visit "[How's the Water?]()" on the MPCA's website.

Mississippi River Headwaters Watershed Impaired Lakes and Streams

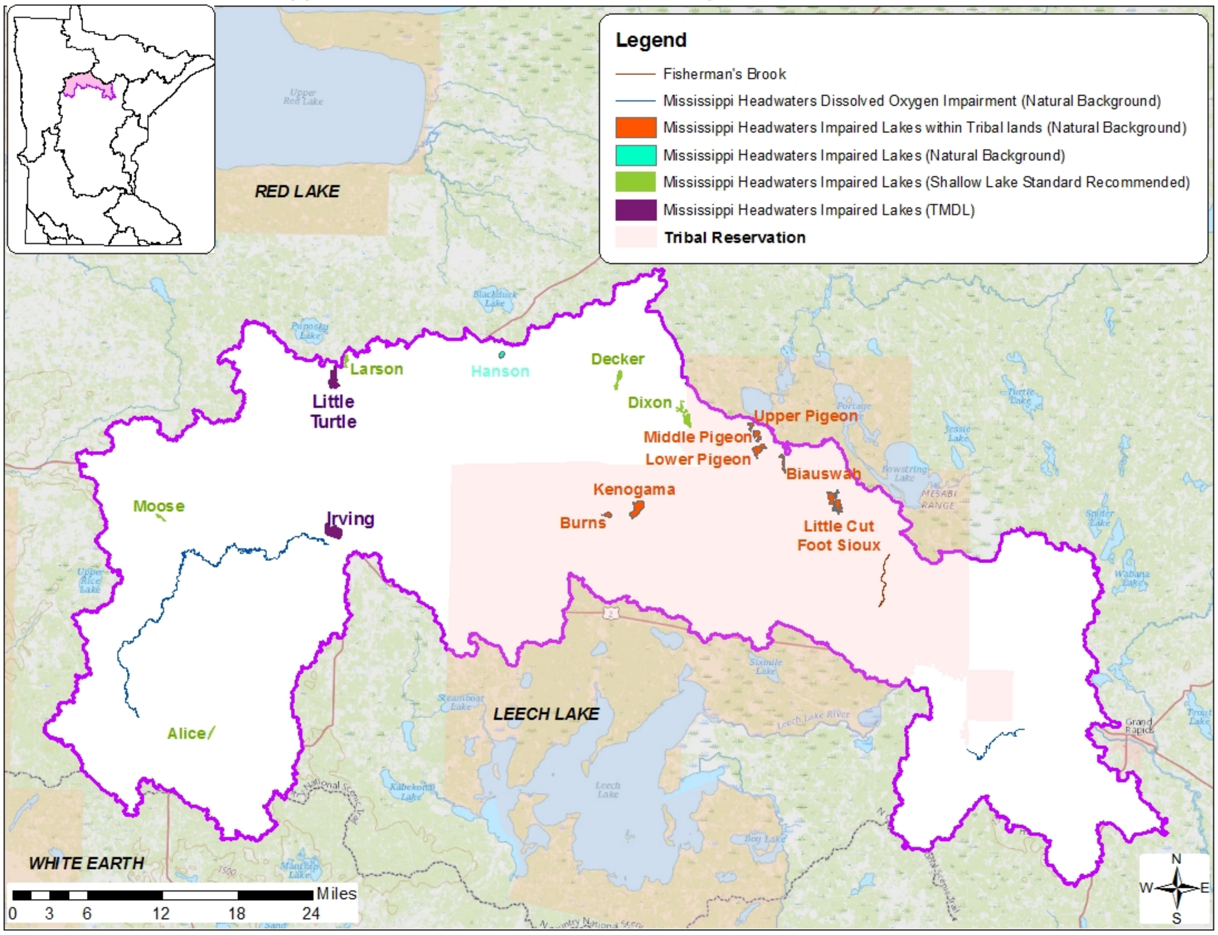


Figure 4. Mississippi River Headwaters Watershed Waterbody Impairments

Due to overall high water quality seen throughout the MRHW, a primary objective of this WRAPS Report is to identify waterbodies that need protection. Protection efforts target waters that have been assessed and fully support aquatic life or recreation, as well as waters that have not been assessed. Additional details about protection considerations are discussed in Sections 2.5 and 3.3 of this report.

2.1 Condition Status

Streams

In 2013 and 2014, the MPCA conducted an intensive monitoring investigation of the MRHW. Nine watershed water chemistry stations were sampled from May through September in 2013, and again June through August of 2014, to provide sufficient water chemistry data to assess waterbody condition compared to the Aquatic Life and Recreation Use Standards. Water chemistry stations were placed at the outlet of each aggregated HUC 12 subwatershed that was larger than 40 square miles in area, per

IWM design. A Surface Water Assessment Grant (SWAG) was awarded to the ISWCD and Headwaters Science Center to intensively collect water chemistry at these nine outlet stations. A SWAG was also awarded to the Leech Lake Band of Ojibwe (LLBO) in partnership with the ISCWD to sample water chemistry at two of the nine chemistry stations that are located on the Leech Lake Reservation. Biological monitoring was conducted at 39 stream sites during this time period throughout the MRHW to assess the status of the watersheds biological assemblages (Figure 5). Using data from these sampling efforts, most stream reaches were determined to support aquatic recreation and aquatic life. There were three reaches that scored low for their fish or macroinvertebrate communities, and were investigated in the SID Report (Section 2.3) and determined to not be impaired. There was one reach (Fisherman's Brook) that did not meet the aquatic life standards due to the observance of a poor fish community (Table 1). Fisherman's Brook is wholly located within the Leech Lake Indian Reservation. Waters that are wholly within reservation boundaries that are identified to be impaired are not placed on the 303d list but are instead placed on a separate list that is sent to the EPA with the notation that the assessments are to be considered advisory in nature. Project communication with the LLBO suggested that continued water quality restoration partnership efforts, under the direction of the LLBO, was the preferred option for the LLBO in dealing with this impairment.

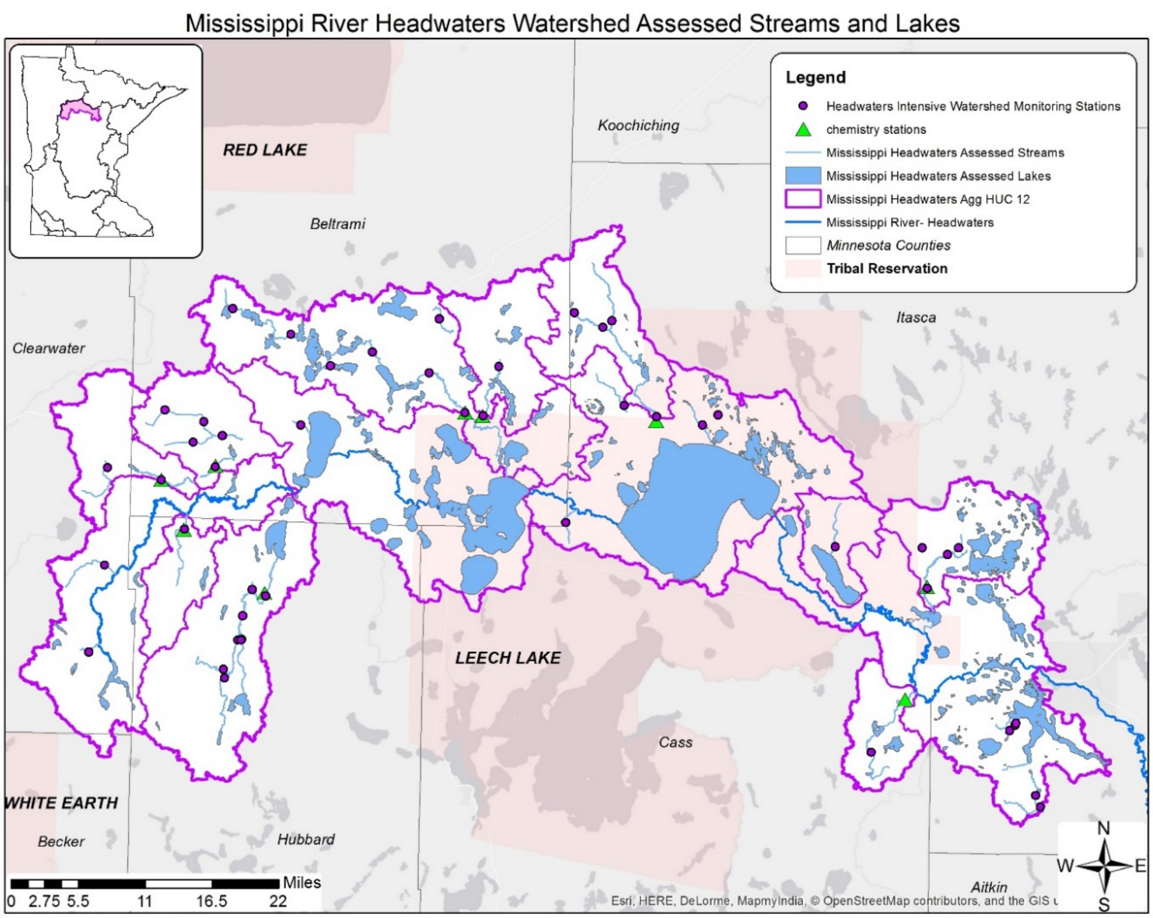


Figure 5. Chemistry stations, assessed streams and lakes in the MRHW.

Conversely, the Schoolcraft River from Frontenac Creek to Lake Plantagenet (07010101-751) in northern Hubbard County was designated as supporting exceptional aquatic life, based on the fish and macroinvertebrate communities (Figure 6). These conditions reflect what might be expected under pre-settlement conditions. This reach should be protected for its high water quality and diverse biological community.

In general, the streams of the MRHW have good water quality, with 28 of the 29 assessed reaches meeting all water quality standards (Table 1). However, several stressors could degrade water quality, including climate change, increased riparian development, and increased forest harvest rate. Protection considerations are vital to address these stressors; more information regarding protection considerations is included in Section 2.5.

Figure 6. Schoolcraft River reach 07010101-751, Hubbard County

Table 1: Stream Aquatic Life Use and Aquatic Recreation Use Assessment Summary

Aggregated HUC 12 Subwatershed	Total Assessed Stream Reaches	Aquatic Life Use				Aquatic Recreation Use			
		SUP	IMP	IF	NA	SUP	IMP	IF	NA
Little Mississippi River	**2**	2	-	-	-	1	-	-	1
Grant Creek	**4**	2	-	1	1	1	-	-	3
Headwaters Mississippi River	**2**	2	-	-	-	-	-	-	2
Hennepin Creek	**1**	1	-	-	-	1	-	-	-
Schoolcraft River	**5**	5	-	-	-	1	-	-	4
Turtle River	**2**	2	-	-	-	1	-	-	1
North Turtle River	**2**	2	-	-	-	1	-	-	1
Cass Lake- Mississippi River	**1**	1	-	-	-	-	-	-	1
Third River	**2**	2	-	-	-	1	-	-	1
Lake Winnibigoshish	**4**	4	-	-	-	-	-	-	4

Aggregated HUC 12 Subwatershed	Total Assessed Stream Reaches	Aquatic Life Use				Aquatic Recreation Use			
		SUP	IMP	IF	NA	SUP	IMP	IF	NA
Deer River	**2**	2	-	-	-	1	-	-	1
Ball Club Lake	**1**	-	1	-	-	-	-	-	1
Vermillion River	**1**	1	-	-	-	1	-	-	-
Pokegama Lake-Mississippi River	**5**	2	-	3	-	-	-	-	5
Total	**34 *(29)**	**28**	**1**	**4**	**1**	**9**	**0**	**0**	**25**
SUP = found to meet the water quality standard									
IMP = does not meet the water quality standard and therefore is impaired									
IF = the data collected was insufficient to make a finding									
NA = not assessed									
* = Assessed Total minus IF and NA streams									

Lakes

As a part of the IWM process, the DNR led a biological monitoring effort conducted in 2013 through 2014 on 48 lakes throughout the MRHW to assess the health of fish and aquatic plant communities. Within the same timeframe, the MPCA sampled water chemistry in 26 lakes to provide sufficient data to assess all components of the Aquatic Life and Recreation Use Standards. Support was provided to the MPCA for lake water chemistry sampling through SWAGs, which were awarded to the Itasca SWCD and Hubbard County for each to sample 13 lakes in the watershed in 2013 and 2014. There are currently 53 volunteers enrolled in the MPCA's CLMP, who are conducting lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period for phosphorus, chlorophyll-*a* and Secchi depth.

Using data from these sampling efforts, it was determined that 15 lakes do not support the state aquatic recreation standard (nutrient/eutrophication biological indicators) and one of the assessed lakes (Grace Lake) was investigated in the SID Report due to having a fish IBI score close to the impairment threshold. Of the 15 lakes, a TMDL report was completed for two (Irving and Little Turtle, Beltrami County), five lakes do not meet aquatic recreation standards but are being considered for a future separate shallow lakes standard, and eight did not meet the aquatic recreation standards due to predominantly natural background causes.

In general, lakes in the MRHW have good water quality, with only 15 of the 122 assessed lakes failing to meet water quality standards (Table 2). However, several stressors could degrade water quality, including climate change, increased riparian development, and increased forest harvest rate. Protection considerations are vital to address these stressors; more information regarding protection considerations is included in Section 2.5.

Table 2. Assessment status summary of lakes in the MRHW, presented North to South

Aggregated HUC 12 Subwatershed	Lakes greater than 10 acres	Total Assessed Lakes	Aquatic Recreation Use				Aquatic Life Use			
			SUP	IMP	IF	NA	SUP	IMP	IF	NA
Little Mississippi River	5	4	2	1	1	-	1	-	-	3
Grant Creek	10	2	2	-	-	-	1	-	-	1
Headwaters Mississippi River	55	12	8	-	4	-	5	-	1	6
Hennepin Creek	3	1	1	-	-	-	1	-	-	-
Schoolcraft River	39	13	7	1	5	-	7	-	3	3
Turtle River	52	31	21	3	7	-	11	-	4	16
North Turtle River	19	9	8	1	-	-	2	-	2	5
Cass Lake- Mississippi River	39	26	20	1	5	-	6	-	4	16
Third River	12	5	-	2	1	2	-	-	2	3
Lake Winnibigoshish	44	20	2	6	7	5	-	-	2	18
Deer River	36	19	15	-	4		6	-	-	13
Ball Club Lake	2	2	2	-	-	-	-	-	1	1
Vermillion River	6	5	2	-	3	-	2	-	1	2
Pokegama Lake-Mississippi River	35	35	17	-	14	4	6	-	3	26
Total	**357**	**184 *(122)**	**107**	**15**	**51**	**11**	**48**	**-**	**23**	**113**

	SUP = found to meet the water quality standard
	IMP = does not meet the water quality standard and therefore is impaired
	IF = the data collected was insufficient to make a finding
	NA = not assessed
	* = Assessed Total minus NA and IF lakes

Main Stem Mississippi River Corridor

The Upper Mississippi River was the first of the large rivers in the state to have intensive monitoring conducted on the main-stem river by the MPCA under its large river IWM monitoring effort. Biology and chemistry data were collected in 2013 and 2014 to determine if the river is meeting state water quality standards. During the Mississippi River IWM, the MPCA and local partners collected data about biology such as fish and bug populations, and chemistry such as phosphorus, nitrogen, sediment, and bacteria to determine if the river is meeting water quality standards. Samples were taken at 34 different sites along the river. Nine were within the Headwaters Watershed. The report on this monitoring effort can be found at https: https://www.pca.state.mn.us/featured/upper-mississippi-river-what-protect-what-fix.

The Mississippi River from the headwaters to approximately Grand Rapids is a complex river system including numerous lakes and expansive wetlands. Monitoring activities have identified low DO in various locations along this portion in the past. In a 2009 study, low DO was found to occur due to a combination of natural factors, including a low gradient stream channel, wetland influences, and groundwater inputs. Two Mississippi River reaches within this watershed (previously 07010101-501 - Mississippi River: Vermillion R to Blackwater/Pokegama Lk and 07010101-924 - Mississippi River: Unnamed creek to Schoolcraft River, now -753 and -756) were therefore reclassified from category 5 DO impairments (1994) to EPA category 3 (2016) based on insufficient data to determine water quality status. This reclassification was done because these reaches were determined to be “not assessable” for DO, because the current standard of 5.0 mg/L is not a reliable indicator of the aquatic health in natural streams heavily influenced by wetlands.

Figure 7. Mississippi River Monitoring Stations and Assessed Reaches

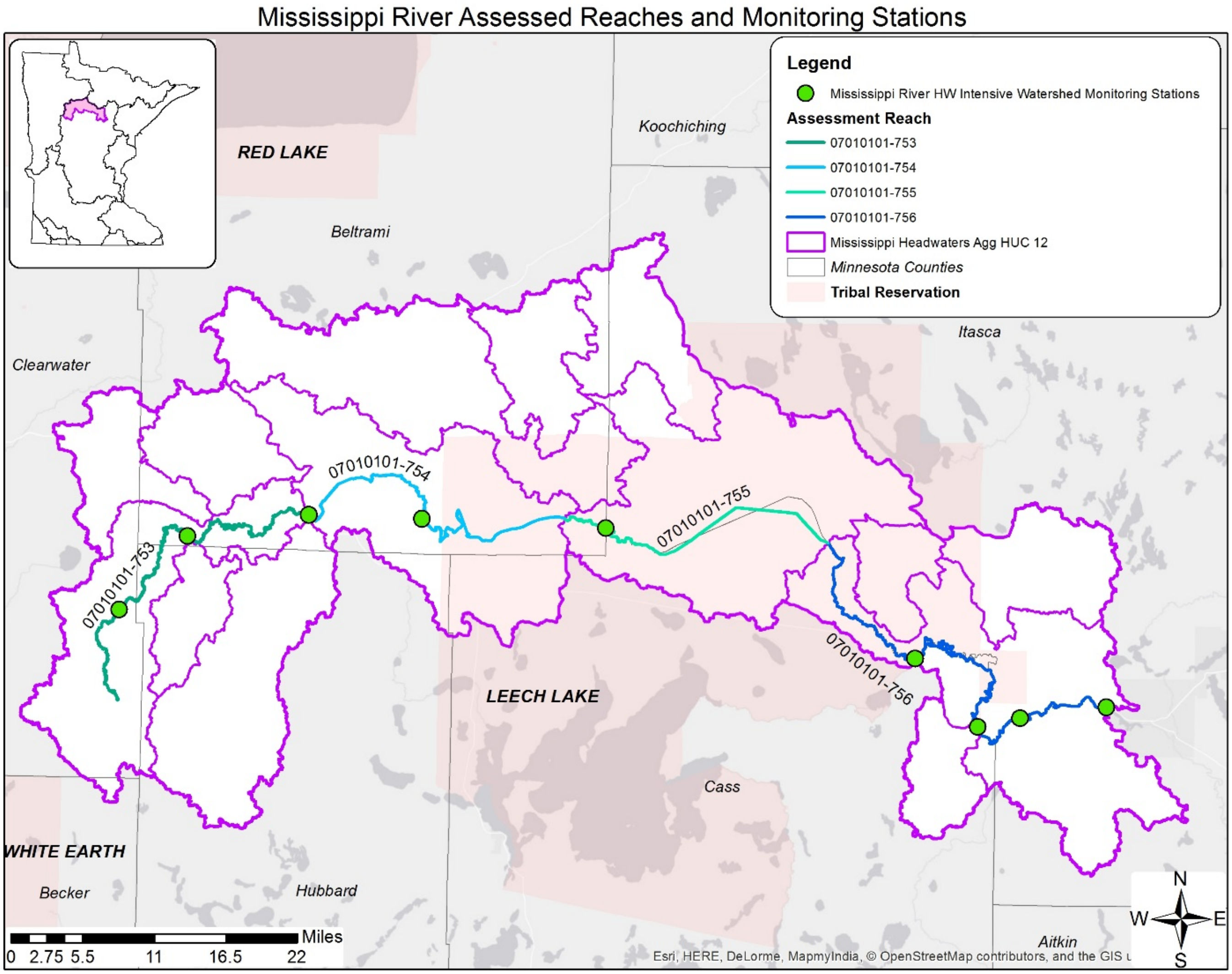


Table 3. Designated use support summary for Upper Mississippi River assessment reaches.

Mississippi River Assessment Reach	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	Impairment Parameter(s)
07010101-753	FS	FS	NS	n/a	mercury in fish tissue
07010101-754	FS	FS	NS	n/a	mercury in fish tissue
07010101-755	FS	FS	NS	n/a	mercury in fish tissue
07010101-756	FS	FS	NS	n/a	mercury in fish tissue

Key for designated use support determinations: FS = full support; NS = non-support; n/a = use not applicable,

Overall, the biological communities of the Mississippi River within the Headwaters Watershed are in good condition, as fish and macroinvertebrate IBI scores indicated full support for aquatic life use. With natural conditions contributing low DO in some parts of the watershed, it is critical that pollutants that could further decrease DO concentrations do not enter the river. Pollutants, such as excess total phosphorus (TP), could cause river eutrophication and increasing biological oxygen demand, potentially stressing biological communities. Excess TP may also promote periphyton growth on streambed substrates and diminish the aesthetic qualities of the Mississippi River.

2.2 Water Quality Trends

The following section summarizes whether lake and stream water quality in the watershed is improving or declining over the last 10+ years. Of the 253 MRHW lakes with transparency data, 18 had sufficient data to detect a long-term trend. Of those, 13 had no trend, four had improving transparency, and one had declining transparency. For stream trend analysis, the findings from the three MPCA Minnesota Milestone Monitoring Program stations located within the MRHW, as well as one just downstream of the watershed outflow, are summarized below.

Streams

Trend analysis has been done by the MPCA in the MRHW using data from the MPCA's former Minnesota Milestone Monitoring Program sites. This program was tasked with collecting data from 80 monitoring locations on rivers and streams across the state of Minnesota. The water quality data analyzed in the trend analysis included the entire period of record (1965 through 2010), as well as a separate trend analysis on the more recent data (1995 through 2010). The analysis was performed using the Seasonal Kendall Test for Trends, which is a nonparametric test that is commonly used in water quality trend analysis and presents results as either increasing, decreasing or identifying no trend. Table 4 below shows the results from this trend analysis for the three sites located in the MRHW, and the one just downstream of the watershed (UM-1172). Improving trends, highlighted in green, indicate improving water quality. Declining trends, highlighted in red, indicate declining water quality. A result of "No Trend" indicates there is no statistically significant trend indicated over the time period analyzed, while a blank indicated there was not enough data available to run the trend analysis. In the most recent 15 years, TP has a declining water quality trend near the headwaters, total suspended solids (TSS) and TP show an improving water quality trend near the outflow, and no trend for the remaining parameters. For the longer-term trend analysis, many improving trends were detected for multiple parameters and locations, as well as two locations with declining water quality based on chloride levels. For more information on the methodology used to determine stream trends, see the report Water Quality Trends for Minnesota Rivers and Streams Milestone Sites.

Table 4. Water quality trends of the Mississippi River through the Mississippi River Headwaters Watershed

Station Information		Parameter					
Monitoring Station	Monitoring History	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
UM-1365 (S000-105) Mississippi River at MN-200 Bridge 0.5 Mi NW of Lake Itasca	1965-2010	Improving	Improving	No Trend	No Trend	Improving	No Trend
	1995-2010	No Trend	Declining	No Trend	No Trend	No Trend	-
UM-1292 (S000-155) Mississippi River at Bridge on CSAH-8 7 Mi E of Bemidji	1967-2010	Improving	Improving	No Trend	Improving	Improving	Declining
	1995-2010	No Trend	No Trend	No Trend	No Trend	No Trend	-
UM-1186 (S000-154) Mississippi River at MN-6 Bridge 8 Mi SW of Cohasset	1967-2010	Improving	Improving	No Trend	Improving	Improving	Declining
	1995-2010	No Trend	No Trend	No Trend	No Trend	No Trend	-
UM-1172 (S000-220) Mississippi River at Bridge on CR-441 1 Mi SW of Blackberry	1974-2010	Improving	Improving	No Trend	Improving	Improving	No Trend
	1995-2010	Improving	Improving	No Trend	No Trend	No Trend	-

Lakes

The MPCA has analyzed 60 lakes in the MRHW for transparency trends using secchi data from its Citizen Lake Monitoring Program (CLMP), as listed in Table 5. The analysis of the CLMP data was conducted using the *R* program to run a seasonal Kendall test, that is applied to all June through September Secchi data for each lake that has a minimum of 8 years of data and 25 pairs (two samples compared that were collected within the same season, spring/summer/fall) of data. The median Secchi is calculated and charted, along with the minimum and maximum measurements for each year. The summer median and a smoothing technique are used to draw the regression line. The resulting trend is reported for each lake.

Improving water quality trends are highlighted in green, and declining water quality trends are highlighted in red.

Table 5. Transparency trends of lakes in the Mississippi River Headwaters Watershed for lakes with at least 8 years of data

Lake Name	Lake ID	Trend
Amen	31-0597-00	No Trend
Andrusia	04-0038-00	Improving
Bass	31-0576-00	Improving
Beauty	29-0292-00	No Trend
Beltrami	04-0135-00	Declining
Bemidji	04-0130-02	No Trend
Big	04-0049-00	No Trend

Lake Name	Lake ID	Trend
Big Bass (East Basin)	04-0132-02	No Trend
Big LaSalle	15-0001-00	No Trend
Black	04-0157-00	No Trend
Buck	04-0097-00	No Trend
Campbell	04-0196-00	Improving
Cass	04-0030-00	Declining

Lake Name	Lake ID	Trend
Cut Foot Sioux (Main Bay)	31-0857-01	No Trend
Decker	31-0934-00	No Trend
Deer	31-0719-00	Improving
Deer	04-0230-00	No Trend
Dixon	31-0921-00	No Trend
Elk	15-0010-00	No Trend
Fox	04-0162-00	No Trend
George	29-0216-00	No Trend
Grace	29-0071-00	No Trend
Guile	31-0569-00	No Trend
Gull	04-0120-00	No Trend
Irving	04-0140-00	No Trend
Itasca	15-0016-00	No Trend
Jay Gould	31-0565-00	No Trend
Johnson	31-0586-00	Declining
Little Bass	04-0110-00	No Trend
Little Moose	31-0610-00	No Trend
Little Turtle	04-0155-00	Declining
Long	04-0076-00	Improving
Long	04-0227-00	No Trend
Long	15-0057-00	No Trend
Loon	31-0571-00	No Trend
Marquette	04-0142-00	Declining
McAvity	31-0585-00	No Trend
Midge	29-0066-00	Improving
Moose	04-0342-00	No Trend
Moose	31-0722-00	No Trend
Movil	04-0152-00	Improving
North Twin	04-0063-00	Improving
Pimushe	04-0032-00	No Trend
Plantagenet	29-0156-00	No Trend
Pokegama (Main Bay)	31-0532-01	No Trend
Pokegama (Wendigo)	31-0532-02	No Trend
Rice	31-0717-00	No Trend
Siseebakwet	31-0554-00	Improving
Smith	31-0547-00	No Trend
South Sugar	31-0555-00	No Trend

Lake Name	Lake ID	Trend
South Twin	04-0053-00	No Trend
Spearhead	29-0239-00	No Trend
Stump	04-0130-01	Improving
Swenson	04-0085-00	No Trend
Three Island	04-0134-00	No Trend
Turtle	04-0159-00	No Trend
Turtle River	04-0111-00	No Trend
Vermillion	11-0029-00	No Trend
Winnibigoshish	11-0147-00	No Trend
Wolf	04-0079-00	Improving

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. Biological SID is done for streams with either fish or macroinvertebrate biota impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g. altered hydrology, fish passage, habitat). 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.

The Mississippi River Headwaters SID Report documents the efforts that were taken to identify the causes, and to some degree the source(s), of impairments to aquatic biological communities in the MRHW. Information on the SID process can be found on the (EPA) website http://www.epa.gov/caddis/. Assessment Unit Identification (AUID) reaches on three streams were brought into the SID process because they had one or both of the sampled biological communities scoring below the impairment thresholds. A fourth AUID, the headwaters AUID of the Mississippi River, received additional monitoring in the SID process to examine a previously listed low DO impairment. The 2015 Assessment determined that none of these streams were biologically impaired, due to the fact that stream conditions are limited by natural factors. The Mississippi River AUID-753 historical DO impairment designation is being changed on the 2016 303(d) list to "not assessable", due to heavy wetland influence, per May 2015 guidance by MPCA's Assessment Policy Team.

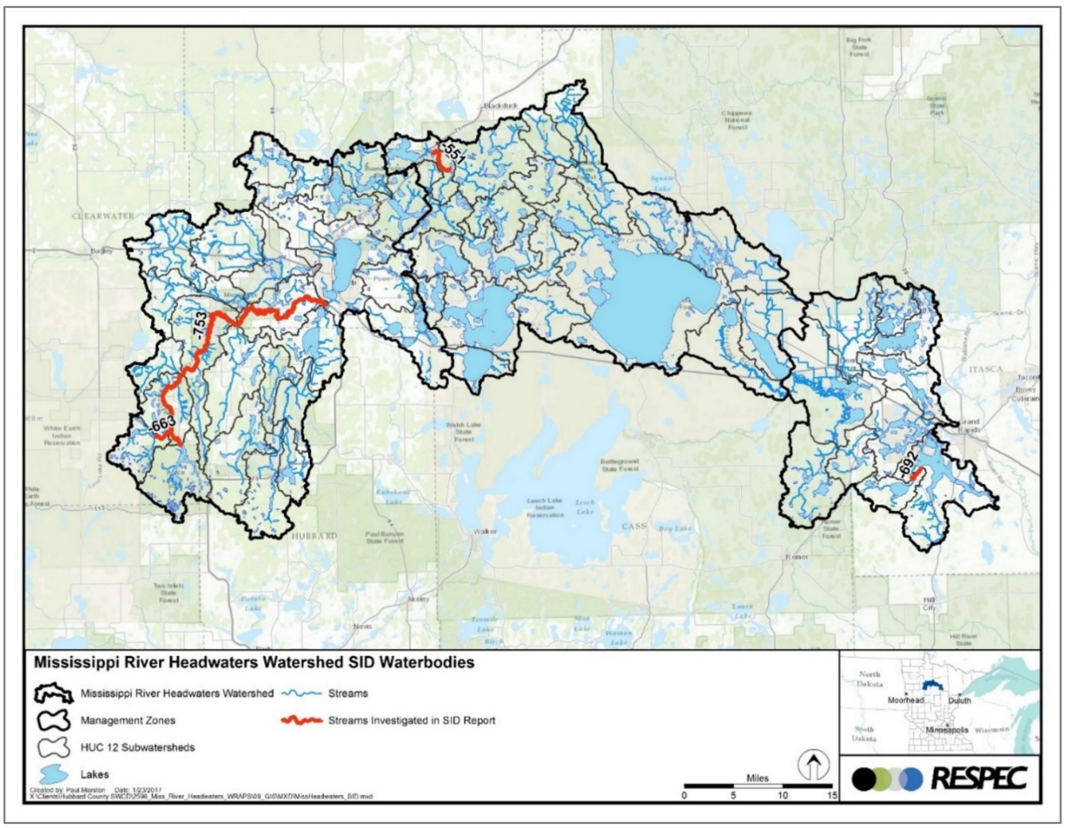


Figure 8. Stream reaches (in red) with Stressor investigations in the MRHW. Labels are Stream AUID number

Streams with low-scoring biological communities and other investigations include:

- Sucker Creek (AUID 07010101-663) - Macroinvertebrates
- Gull River (AUID 07010101-551) - Fish
- Sugar Brook (AUID 07010101-692) – Fish
- Mississippi River (AUID 07010101-753) – 1994 Low-DO 303(d) listing

One lake had a fish IBI near the impairment threshold, and was investigated and included in the SID Report:

- Grace Lake (29-0071-00) - Fish are nearing the impairment threshold, and the lake is considered vulnerable.

Figure 9. Grace Lake-near Bemidji MN. Photo courtesy of Realtor.com

Overall SID Conclusions for the MRHW

The MRHW has no streams that will be added to the impaired waters list as having impaired biological communities. The SID process identified connectivity as the only stressor for two of the three stream reaches that have one of the biological communities below the passing threshold (Table 6). Beaver activity is high in MRHW, as it is in numerous other northern Minnesota watersheds. Their dams are migration barriers for fish in the Gull River and Sugar Brook. The stressor for Sucker Creek may be high iron concentration. There is some uncertainty in that determination because the relationship of macroinvertebrates and iron is not well studied. There is however, some rationale in the research literature to suspect that iron may have detrimental consequences to some macroinvertebrates. In addition, the EPA does have a recommended aquatic life standard for iron (1000 µg/L), which Sucker Creek does exceed at times. As with some smaller streams in other north-central Minnesota watersheds (Crow Wing, Snake, Leech Lake), some streams situated in quite natural landscapes in the MRHW were found to have TP concentrations above the north region river nutrient standard. Sucker Creek and the headwaters AUID of the Mississippi River were studied in the MRHW SID effort to add to knowledge about these streams and their phosphorus dynamics.

Sucker Creek – Streamside spring with high iron content.

Table 6: Primary stressors to aquatic life in biologically impaired reaches in the Mississippi River Headwaters Watershed

Stream	AUID (Last 3 digits)	Reach Description	Biological Impairment+	Primary Stressor		
				Connectivity	Altered Hydrology*	Iron
Sucker Creek	663	Gould Creek to Mississippi River	MI			◊
Gull River	551	Erickson Lake to Nelson Lake Outlet	Fish	o		
Sugar Brook	692	Unnamed Lake (31-0553-00) to Pokegama Lake	Fish	o		

+These are not officially impaired but did have one of the two biological communities with IBI scores below the threshold value.
*Includes intermittency and/or geomorphology/physical channel issues
◊ Possible contributing root cause.
o A stressor, but determined to have very little to no anthropogenic cause. Includes natural wetland and/or groundwater inputs, and beaver dams as natural stressors.

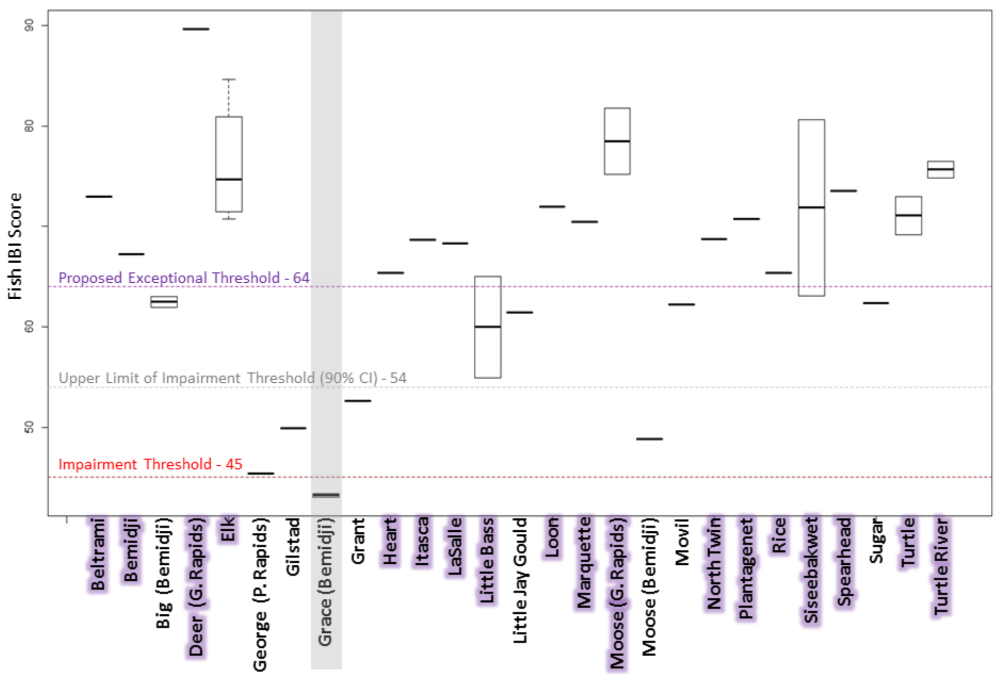


Figure 10. Boxplot of IBI scores for lakes in the MRHW using FIBI Tool 2.

Biological data indicate the fish community of Grace Lake is near the impairment threshold as measured by the FIBI Tool 2. Tool 2 includes 15 standardized metrics of the fish community used to compute an overall FIBI score that is responsive to human disturbances. The FIBI assessment of Grace Lake resulted in the lowest score of the 27 lakes assessed using the FIBI Tool 2 in the MRHW. In contrast, Deer Lake (Itasca County) had the highest FIBI score. Game fish management, aquatic habitat alteration, and watershed and riparian land disturbance are stressors identified in the SID report that may be contributing to the current status of the fish community. Further discussion on these stressors can be found in the SID report. There is concern that additional stress from one or more of these variables may result in a designation of “non-supporting for aquatic life” based on the fish community in future assessments.

Pollutant sources

This section summarizes the sources of pollutants (e.g., phosphorus, nitrogen, or sediment) to lakes and streams in the MRHW, including point sources (such as sewage treatment plants) or nonpoint sources (e.g., runoff from the land). There are very few point sources in the MRHW. Most of the sources of pollutants are nonpoint (blue colored portion of pie charts in Figure 11).

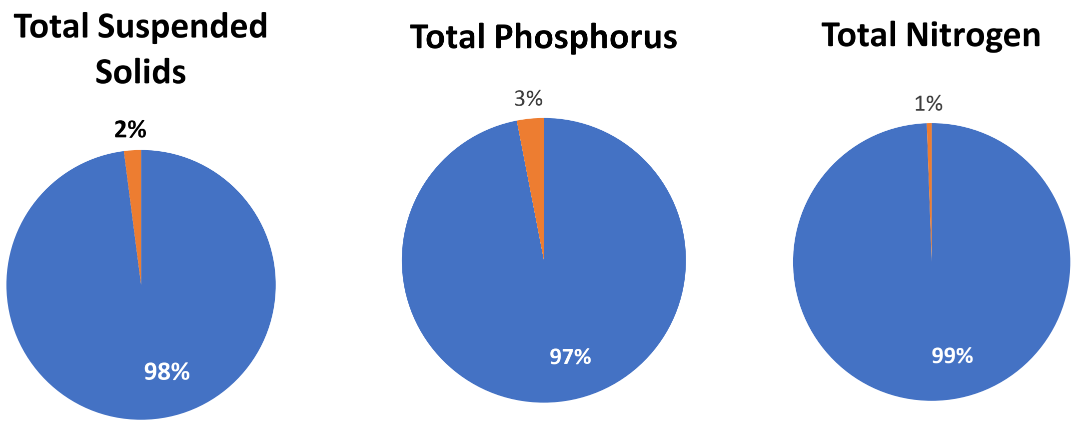


Figure 11. Breakdown of nonpoint source vs. point source pollution in MRHW.

Pollutant sources vary by subwatershed and by stream segment depending on permitted point source dischargers, upstream loading/conditions, near-reach land use, and other nonpoint sources throughout the watershed. Potential pollutant sources in the impaired Little Turtle Lake and Lake Irving Subwatersheds are identified and discussed in the Mississippi River Headwaters TMDL study discussed in Section 2.4.

Point Sources

Point sources are defined as facilities that discharge stormwater or wastewater to a lake or stream and have a National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Permit. Altogether, there are 13 permits in the MRHW.

- 2 Domestic Wastewater NPDES/SDS Permits
- 3 Domestic Wastewater SDS Permits
- 1 Industrial Wastewater
- 1 Industrial noncontact cooling water
- 6 Nonmetallic Mining (MNG49) Industrial Stormwater

None of the point sources require pollutant reductions beyond their current permit conditions or limits. Table 7 lists the permitted point sources and subwatershed location in the MRHW. Locations of these sources are shown in Figure 12.

Table 7: Point Sources in the Mississippi River Headwaters Watershed.

Aggregated HUC 12 Subwatershed	Name	Permit #	Type	Pollutant reduction needed beyond current permit conditions/limits?
Headwaters Mississippi River - 0201	DNR Itasca State Park	MN0033758	Domestic Wastewater-SDS	No
Hennepin Creek-0202	Dale Vogt	MNG490252	Industrial Stormwater	No
Grant Creek -0102	Anderson Contracting Inc	MNG490109	Industrial Stormwater	No
	Northstar Materials Inc dba Knife River Materials	MNG490038	Industrial Stormwater	No
	Bemidji Bituminous Inc	MNG490307	Industrial Stormwater	No
Cass Lake-Mississippi River -0501	Bemidji WWTP	MN0022462	Domestic Wastewater-NPDES	No
	Norway Beach Sewage Treatment Facility	MN0052701	Domestic Wastewater-SDS	No
	Tom's Harbor Owners Association Inc	MN0068403	Domestic Wastewater-SDS	No
	Northwoods Ice of Bemidji Inc	MNG250027	Industrial Noncontact Cooling Water	No
Deer River -0801	Deer River WWTP	MNG580181	Domestic Wastewater-NPDES	No
Pokegama Lake-Mississippi River - 0901	Hawkinson Construction Co Inc	MNG490048	Industrial Stormwater	No
	Osborns Country Pit	MNG490159	Industrial Stormwater	No
	Minnesota Power Inc - Boswell Energy Ctr	MN0001007	Industrial Wastewater	No

Nonpoint Sources

Nonpoint pollution sources, unlike pollution from industrial and sewage treatment plants, comes from many different sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and anthropogenic pollutants and deposits them into lakes and streams. Common possible nonpoint and natural pollutant sources in the MRHW are:

- **Fertilizer and/or manure runoff**: Fertilizer and manure contain high concentrations of phosphorus, nitrogen, and bacteria that can run off into lakes and streams when not properly managed.
- **Feedlots**: While only larger feedlot operations are regulated and permitted, Minnesota law requires most feedlots owners to register their feedlot with the MPCA. Feedlots located in shoreland that maintain 10 animal units (AU) or more and ones located outside of shoreland that maintain 50 AU or more are required to register. An AU is a term used to compare the differences in the production of animal manure. Table 8 below shows the number of feedlots

that are registered in the Mississippi River Headwaters and are grouped in different thresholds that contain different requirements. Any feedlot over 1,000 AU is required to obtain an operating permit, an SDS or NPDES. Anything under 1,000 AU are only required to apply for permit if they are constructing or expanding. Table 8 shows that there are no Concentrated Animal Feedlot Operations (CAFO), which is over 1,000 AU, within the watershed. Most of the feedlots within this watershed are under 300 AU, and their operating requirements are to maintain current registration and notify the MPCA of any construction activities taking place.

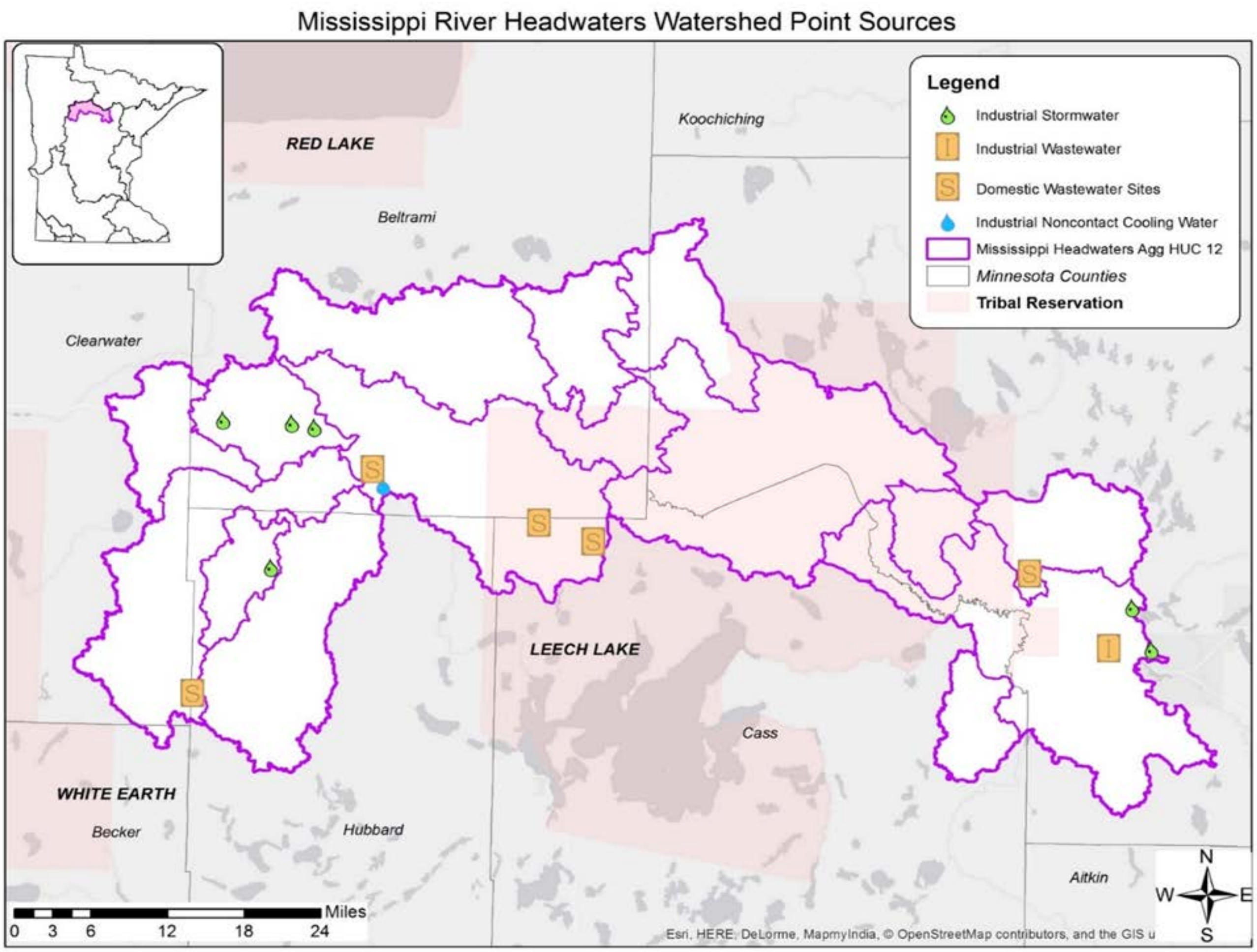


Figure 12. Location of Permitted Point Sources in the MRHW

Table 8. MRHW Feedlot Threshold data

Feedlot Thresholds	Number
CAFO	0
500-999 AU	1
499-300 AU	5
<300 AU	57
Shoreland	7

- **Urban stormwater runoff**: Smaller communities are not regulated stormwater entities. However, stormwater collects and transports pollutants deposited on impervious surfaces, such as sidewalks and streets, directly to local waterbodies if not properly managed.
- **Failing septic systems**: Septic systems that are not maintained or are failing near a lake or stream can contribute excess phosphorus, nitrogen, and bacteria.
- **Peatlands/wetlands**: Peatlands and wetlands in the MRHW have high levels of phosphorus and low levels of DO that can impact downstream streams and lakes.
- **Internal loading**: Lake sediments can contain large amounts of phosphorus that can be released into the lake water through physical mixing or under certain chemical conditions.
- **Upstream lake loading**: Some lakes receive most of their phosphorus from upstream lakes. For these lakes, restoration and protection efforts should focus on improving the water quality of the upstream lake.
- **Livestock overgrazing in streams**: Livestock grazing/watering in the riparian zone can cause localized damage and erosion of the stream bank, and is a source of phosphorus and bacteria pollutants.
- **Wildlife fecal runoff**: Dense or localized populations of wildlife, such as beavers or geese, can contribute phosphorus and bacteria pollutants to streams or ponds.

Fertilizer and stormwater runoff, in-lake sediment phosphorus release (internal loading), and upstream lake loading were identified as the main nonpoint pollutant sources to impaired or threatened lakes and streams in the MRHW.

2.4 TMDL Summary

Two lakes in the MRHW, Little Turtle Lake (04-1550-00) and Lake Irving (04-0140-00) have nutrient/eutrophication biological indicator impairments, and a watershed based TMDL assessment was completed for them.

Did you know? The Minnesota State Record Bluegill 2lb 13oz. was caught in Alice Lake, Hubbard County by Bob Parker, Bemidji, MN 1948.

Per the EPA, "a TMDL establishes the maximum amount of a pollutant allowed in a waterbody and serves as the starting point or planning tool for restoring water quality." A BATHTUB model was developed for each lake to model chlorophyll-*a* and Secchi disk depth (transparency) responses to internal and external phosphorus loads. The TMDL load allocation tables, which show load allocations and reductions necessary to bring Little Turtle Lake and Lake Irving into compliance, are shown in Table 9 and 10, respectively. By Minnesota state statute, Subsurface Sewage Treatment System (SSTS) that are impacting waters of the state must be brought into full compliance and are given a 100% reduction in load for the TMDL. In Little Turtle Lake, load reductions of 100, 100, 38, and 11% were needed from septic systems, internal loading, local watershed sources, and upstream sources, respectively, to attain water quality goals. In Lake Irving, load reductions of 100% were needed from septic systems and internal loading, 44% from non-MS4 local watershed sources, 37% from non-MS4 upstream sources, and 36% from MS4 sources to attain water quality goals. Very small wasteload allocations (less than 0.1% of total allowable loads) with no required reductions are included for construction and industrial stormwater. An approach that applies a combination of both external and internal phosphorus loading reductions to the impaired lakes will provide a higher probability of meeting water quality goals than an approach that does not treat both external and internal sources.

Table 9: Lake Total Maximum Daily Load Summary for Little Turtle Lake

Little Turtle Lake Load Allocation		Existing TP Load		Allowable TP Load		Estimated Load Reduction	
		lb/year	lb/day	lb/year	lb/day	lb/year	%
Loading Capacity				**1,145.89**	**3.14**		
Margin of Safety 10%				**114.59**	**0.31**		
Total Load (excluding MOS)		**1,541.83**	**4.22**	**1,031.30**	**2.82**	**510.53**	**33.11**
Wasteload	**Total WLA**	0.59	**< 0.01**	0.59	**< 0.01**	**< 0.01**	–
	Construction Stormwater	0.14	< 0.01	0.14	< 0.01	< 0.01	–
	Industrial Stormwater	0.45	< 0.01	0.45	< 0.01	< 0.01	–
Load	**Total LA**	**1,541.24**	**4.22**	**1,030.71**	**2.82**	**510.53**	**33.12**
	Turtle River Inlet	967.05	2.65	860.40	2.36	106.65	11.03
	Lakeshed	93.40	0.26	58.21	0.16	35.19	37.68
	Internal Load	341.22	0.93	0	0	341.22	100
	SSTS	27.47	0.08	0	0	27.47	100
	Atmospheric deposition	112.10	0.31	112.10	0.31	0.00	–
Total Load (excluding MOS)		**1,541.83**	**4.22**	**1,031.30**	**2.82**	**510.53**	**33.11**

Table 10: Lake Total Maximum Daily Load Summary for Lake Irving

Irving Lake Load Allocation		Existing TP Load		Allowable TP Load		Estimated Load Reduction	
		lb/year	lb/day	lb/year	lb/day	lb/year	%
Loading Capacity				**11,442.38**	**31.33**		
Margin of Safety 10%				**1,040.22**	**2.85**		
Total Load (excluding MOS)		**24,368.77**	**66.72**	**10,402.16**	**28.48**	**13,966.61**	**57**
Wasteload	**Total WLA**	**742.44**	**2.03**	**474.94**	**1.30**	**267.50**	**36**
	Bemidji MS4	736.34	2.02	468.84	1.28	267.50	36
	Construction Stormwater	2.39	0.01	2.39	0.01	0	-

Irving Lake Load Allocation		Existing TP Load		Allowable TP Load		Estimated Load Reduction	
		lb/year	lb/day	lb/year	lb/day	lb/year	%
	Industrial Stormwater	3.71	0.01	3.71	0.01	0	-
Load	**Total LA**	**23,626.33**	**64.69**	**9,927.22**	**27.18**	**13,699.11**	**58**
	Mississippi Inlet	15,712.46	43.02	9,382.10	25.69	6,330.36	40
	Lakeshed	686.24	1.88	385.8	1.06	300.44	44
	Internal Load	7,004.36	19.18	0	0	7,004.36	100
	SSTS	63.95	0.18	0	0	63.95	100
	Atmospheric deposition	159.32	0.44	159.32	0.44	0	-
Total Load (excluding MOS)		**24,368.77**	**66.72**	**10,402.16**	**28.48**	**13,966.61**	**57**

A TMDL study was deferred to the next IWM cycle for five additional lakes with the same impairment status (Alice-29-0286-00, Decker-31-0934-00, Dixon- 31-0921-00, Larson-04-0154-00 and Moose-04-0342-00). Several factors came into consideration for the decision to defer a TMDL study specifically for these five lakes. This included the ongoing MPCA consideration for developing a lake nutrient standard specifically for shallow lakes within the northern lakes and forests ecoregion of Minnesota, and the natural background contribution of nutrients within the subwatersheds of these lakes. See Appendix A for additional information on the water quality review of these and other similar MRHW lakes.

One lake (Hanson-04-0066-00) was classified under the EPA Category 4D, which is defined as the following: “Impaired or threatened, but doesn't require a TMDL because the impairment is due to natural conditions with only insignificant anthropogenic influence. To be considered "insignificant", the elimination of the anthropogenic influence would not lead to the attainment of water quality standards and it would not be included in formal pollution reduction goal-setting activities. A reach-specific water quality standard based on local natural conditions has yet to be determined. Upon determination, the assessment unit will be considered non-impaired for the natural conditions and re-categorized to an appropriate category”.

Seven additional lakes (Biauswah-31-0862-00, Burns-04-0001-00, Kenogama-31-0928-00, Little Cut Foot Sioux-31-0852-00, Lower Pigeon- 31-0893-00, Middle Pigeon-31-0892-00, Upper Pigeon-31-0908-00) and one stream with an aquatic life impairment from fish bioassessments (Fisherman’s Brook - 07010101-741) were not addressed in the MRHW TMDL assessment, as they lie wholly within the Leech Lake Indian Reservation (see Figure 4). Most of these waters, except for Fisherman’s Brook and possibly Little Cut Foot Sioux Lake, reflected natural background type conditions. Waters that are wholly within reservation boundaries that are identified to be impaired are not placed on the 303d list, but are instead placed on a separate list that is sent to the EPA with the notation that the assessments are to be considered advisory in nature. As noted earlier in Section 2.1, project communication with the LLBO suggested that continued water quality restoration partnership efforts, under the direction of the LLBO, was the preferred option for the LLBO in dealing with the stream impairment, while the lake impairments were predominantly viewed as natural background conditions to be reviewed again in the next IWM cycle.

Figure 13. Two fishermen stand near the opening to Lake Bemidji from Lake Irving. Photo courtesy of the Bemidji Pioneer.

2.5 Protection Considerations

Protecting water resources is vital to the MRHW due to its high water quality and its abundant water resources that are relied upon for recreation, including protecting waterbodies from stresses such as land use change and future climate change. Protection, compared to waiting until restoration is required, is ideal since these efforts prove to be much more cost effective than restoration in the long run, as well as more effective at achieving natural water quality levels. Therefore, prioritizing protection is key to maintaining long term watershed-wide health. Waterbodies that are identified as critical for protection needs are listed in the strategies table in Section 3.3 of this report. These waterbodies are either trending towards impairment, such as Lake Bemidji, or provide great benefits to the local community from a recreation and financial standpoint, such as Pokegama Lake and Deer Lake.

The MRHW is largely undeveloped, which contributes to the high water quality found throughout the watershed. Moving forward, it is important to monitor the level of disturbance at the subwatershed level, as this is a primary driver of water quality. Research indicates watersheds with greater than 40% land disturbance are likely to have destabilization of aquatic communities in its waterbodies (Cross and Jacobson 2013). To quantify the water quality impacts land use change and increased disturbance has on the water resources across the MRHW, scenarios were run using the HSPF model with multiple land use changes simulated. The detailed summary of these scenarios as well as the results can be found in Section 3.1 of this report. Prior to taking action that may increase the area of disturbance within a subwatershed, resource managers should identify the existing percentage of disturbance in a given subwatershed, and refer to the scenarios report to review possible consequences of the changes.

Forest Resource Protection

The MRHW is a heavily forested watershed, with approximately 58% of the land within this cover type. Forestland is very important in keeping our surface and drinking water resources clean. The MRHW has some of the finest water resources in the country, which is a direct correlation to the natural hydrological benefits that a sustainable forested landscape provides. As the name applies, this watershed contains the Headwaters of the Mississippi River. Along with the numerous recreational opportunities that it provides and supports, approximately 1.5 million Minnesotans downstream of the MRHW rely on the Mississippi River for their drinking water supply, as do several million more citizens in states south of our border. In addition to protecting the high quality water resources of the area, the MRHW forestlands support the economy of the region through various forest products and recreational use, while providing critical habitat for numerous flora and fauna species that characterize this region of the state. With the multitude of benefits provided by these forestlands, it is critical that we work to sustain these lands to the extent possible into the future.

Section 9 of the Minnesota Forest Resource Council's (MRFC) North Central Landscape Plan provides a watershed framework for sustainable forest use. See the full document at http://mn.gov/frc/docs/North-Central_Landscape-Plan_Public-Review-DRAFT.pdf

From the Lake Based Watershed Approaches section of the above mentioned document:

"Modeling of over 1300 lakes by the Minnesota DNR Fisheries Research Unit has revealed that phosphorus concentrations in lakes are directly related to land use disturbance in the watershed. Phosphorus concentrations become elevated when land use disturbance reaches 25% of a lake's watershed and are greatly elevated when land use disturbances exceed 60%. These thresholds set the foundation for identifying appropriate water quality management strategies for lakes. Lakes with relatively undisturbed watersheds need protection, while lakes with heavily disturbed watersheds need restoration. Many watersheds in the forested ecoregions of Minnesota are protected by public ownership (federal, state, and county). Lakes in the northern part of the state benefit from extensive public holdings within the Superior and Chippewa National Forests, state forests, state and national parks, state and federal wildlife areas and county lands. Lands in public ownership are usually maintained with relatively undisturbed land cover, including forests, grasslands, and wetlands. Lakes with undisturbed watersheds, with high levels of protection, should maintain good water quality. Considerably less public land exists in the southern, agricultural areas of the state. Using land use disturbance and protection status allows for the categorization and prioritization of lakes and their watersheds into a protection vs. restoration framework.

Vigilance: Lakes with watershed disturbances less than 25% and protection greater than 75% can be considered sufficiently protected. These lakes have the suggested approach of "vigilance" (keeping public lands protected in a forested land cover).

Protection: Lakes with watershed disturbances less than 25%, but levels of protection less than 75% are excellent candidates for protection efforts.

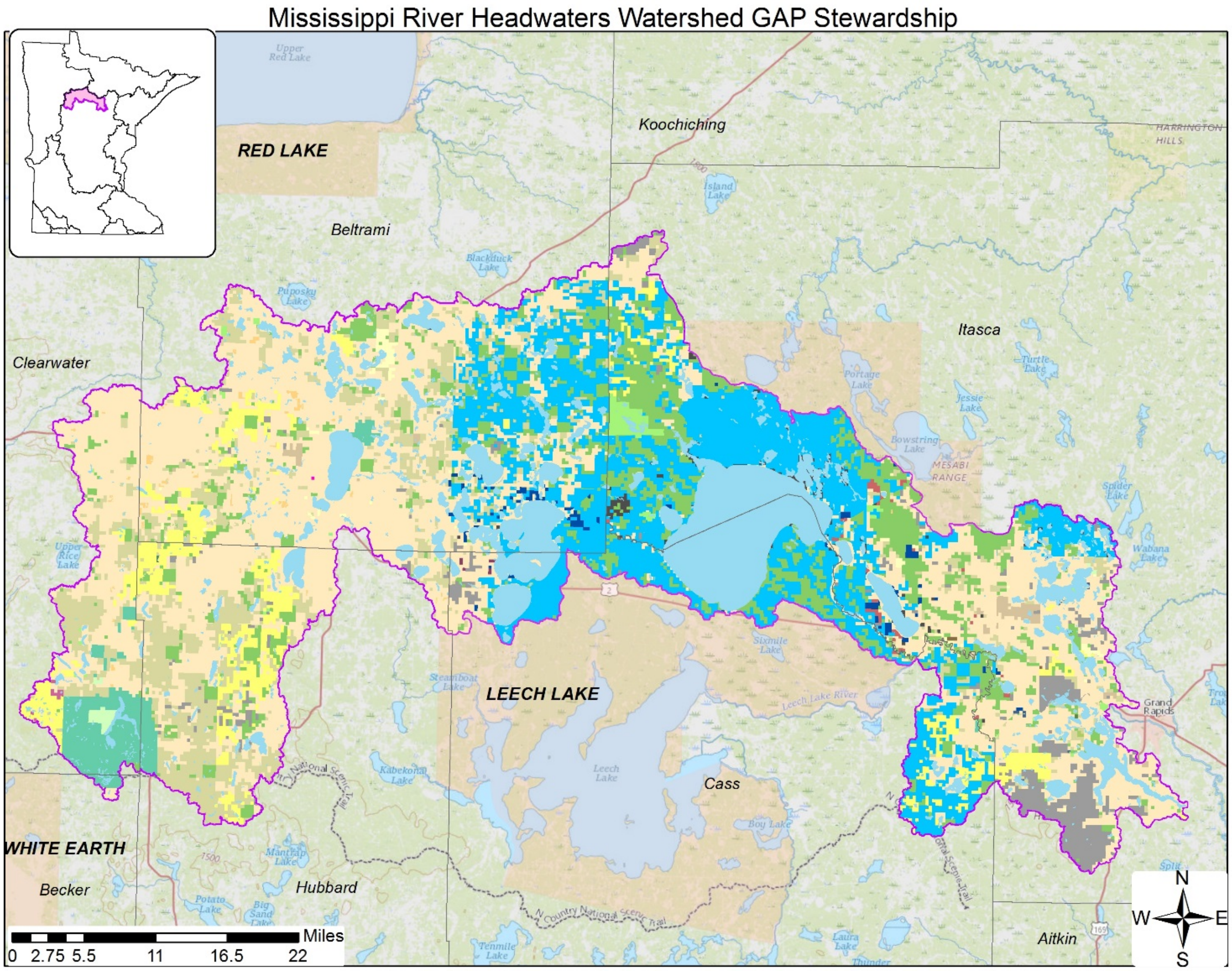
Full Restoration: Lakes with watersheds that have moderate levels of disturbance (25% to 60%) have realistic chances for full restoration of water quality.

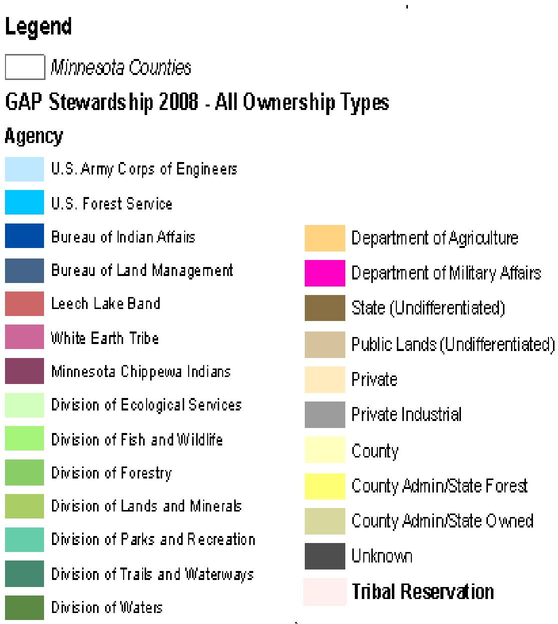
Partial Restoration: Restoration of lakes with intensive urban and agricultural watersheds (greater than 60% disturbance) to natural levels may not be realistic. The suggested approach for these lakes is partial restoration of water quality that restores some degree of ecological integrity (e.g., reducing phosphorus concentrations sufficiently to allow for the establishment of rooted aquatic vegetation in turbid, eutrophic prairie lakes to benefit fish habitat.)"

A specific analysis of the MRHW alone has not been completed. The MFRC North Central Landscape Plan has analyzed HUC-12 watersheds in each County contained in the North Central Landscape. All of the lake based watersheds contained within the MRHW fall within Vigilance/Protection/Full Restoration categories.

Protected land refers to land publicly owned or protected by conservation easement in 2008 Minnesota Gap Analysis Program ownership data. (This inventory was conducted to provide ownership and administration information for the Gap Analysis Project, an effort to identify gaps in biodiversity protection.) Figure 14 shows the land ownership in the MRHW.

Figure 14. Land Ownership in the MRHW.





A large portion of the watershed is owned by the Forest Service and DNR Forestry. This bodes well for being able to keep the forest cover and accompanying water quality benefits.

Forest Disturbance

In conjunction with the MRHW WRAPS project, the DNR conducted an assessment of forest disturbance within the MRHW to obtain information on the risk to water quality forest disturbances pose on a watershed scale. The MRHW and Rum River Watersheds were the first two watersheds conducted under this DNR Pilot Project. Disturbance metrics included: amount of recent disturbance, distribution in time and space and proximity to water. This information establishes a valuable baseline for future watershed planning efforts, while helping identify priority areas within the MRHW watershed to focus future water quality efforts. Figure 15 below shows the cumulative forest disturbance in the MRHW from 2010 through 2014 over the final Zonation Output map produced for the MRHW WRAPS. Areas of darker green indicate a higher conservation priority ranking. For further information on the Zonation Modeling process see Section 3.1. Targeting of Geographic Areas.

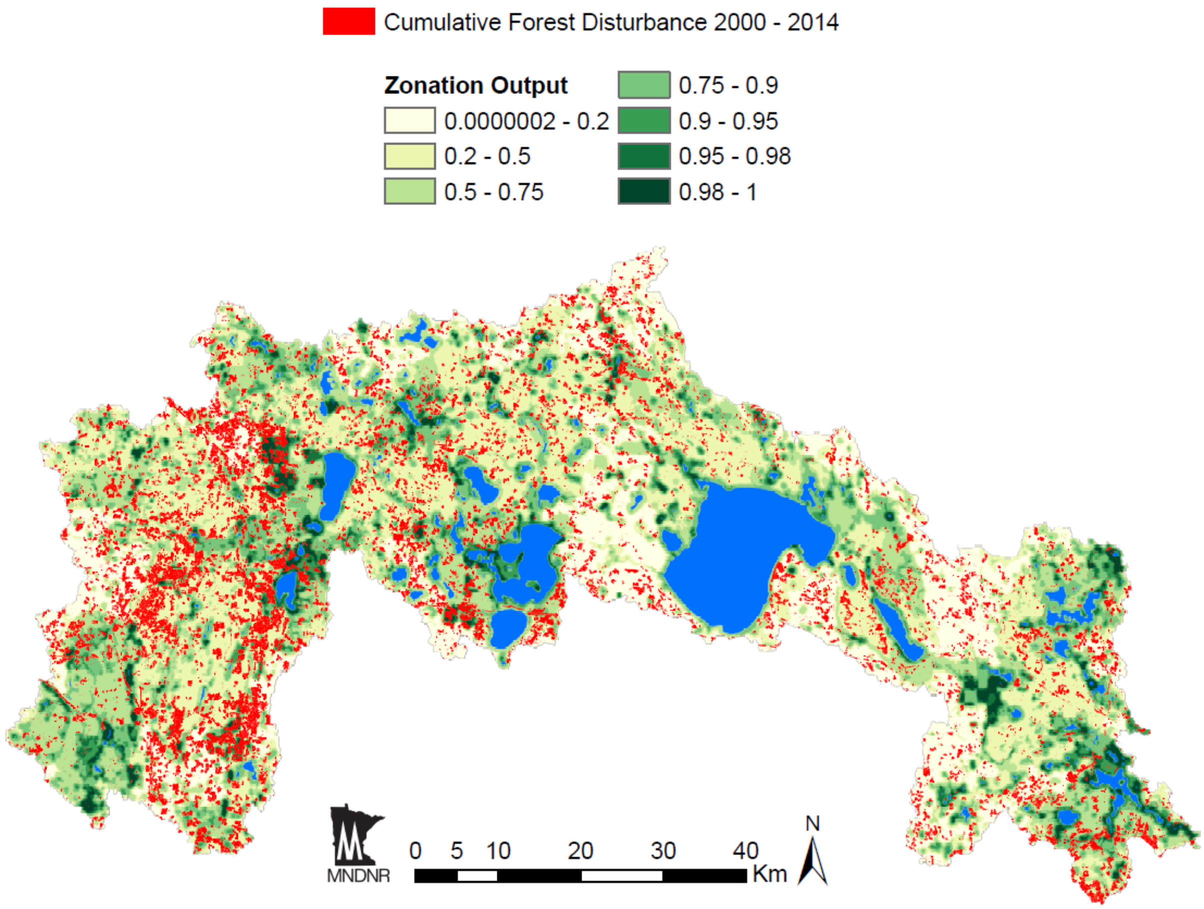


Figure 15. Cumulative forest disturbance in the MHRW 2010-2014, overlaid on the final Zonation Output map.

Forestlands and Climate Variability

As we see subtle changes in the climate of the Upper Midwest, there are subtle changes taking place within the forestlands of northern Minnesota. Forest species more adapted to areas south of the MRHW (e.g. Red Maple) are slowly beginning to make up a larger composition of the forest. A study released in June 2014 by the U.S. Forest Service Northern Research Station looked at 23.5 million acres of forest across northern Minnesota. This study described both the effects of climate that have already been observed in northern Minnesota, as well as projections on what is expected in the future if the current trends continue.

The findings of the study were that trees already at the southern end of their range will do poorly including balsam fir, aspen, white spruce and tamarack. That study also suggested that tree species at the northern edge of their range will do better including basswood, black cherry, white pine, red maple, sugar maple and white oak (Meyers 2017).

Other related issues include the increased frequency of major windstorms and the possibility of increased forest pest activity (including the potential threat of the Emerald Ash Borer). Factoring these important considerations into future forest management practices will be key elements in maintaining healthy and resilient forestlands in the MRHW and across northern Minnesota.

Figure 16. U.S. Forest Service workers assess the damage to the Norway Beach Recreational Area (Cass Lake, MN) after the July 2012 major wind-storm event, which hit a large portion of the southern boundary of the MRHW. Photo courtesy of Minnesota Public Radio.

Groundwater and Hydrogeology

All of the following groundwater information is taken from "Groundwater Report- Mississippi River-Headwaters Watershed, MPCA 2017". For more detailed information, you can find the report in its entirety at https://www.pca.state.mn.us/sites/default/files/wq-ws1-12.pdf.

Groundwater protection should be considered both for quantity and quality. Quantity sustainability is based on the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater withdrawals in the MRHW have decreased by nearly 10% from 1994 to 2013. However, water table elevations in DNR observation wells have displayed decreasing trends over the most recent 20 years of data collected. It is estimated that the development pressure is moderate in some parts of the watershed where land is converted from farms and timberland to recreation and country homes (USDA NRCS). This increase in development is also seen with a slight increase in non-crop irrigation (golf course, athletic field and landscape irrigation) and water supply. The potential groundwater recharge to surficial materials throughout the watershed ranges from very low to very high, with an average of 5.2 inches per year. When comparing the location of the permitted groundwater withdrawals, many locations are correlated with areas of medium to low potential recharge (Figure 17). These permitted groundwater withdrawals include five community Public Water Suppliers (Bemidji, Cass Lake, Cohasset, Deer River, and Grand Rapids). Therefore, although overall groundwater withdrawals have been decreasing, the watershed's water table has been exhibiting signs of decline. While fluctuations due to seasonal variations are normal, long-term changes in elevations should not be ignored. To help ensure the long-term protection of these resources Wellhead Protection Plans (WHPP) have been completed and are being implemented in the communities of Bemidji and Grand Rapids with other public water suppliers currently engaged in developing a WHPP.

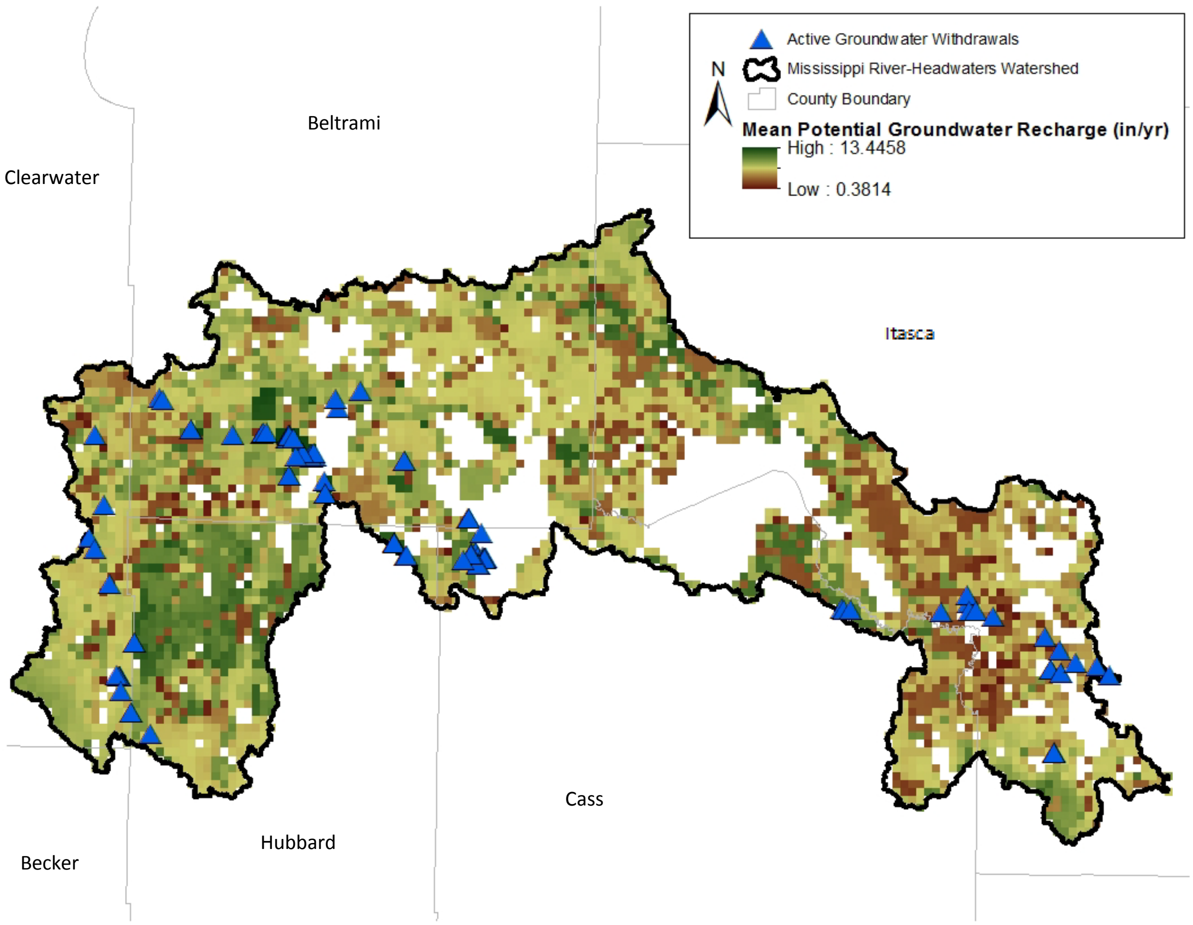


Figure 17. Mean potential groundwater recharge and groundwater permit locations within the Mississippi River-Headwaters Watershed.

The groundwater quality of the watershed appears to be good. The MPCA monitors 19 wells within the watershed, 18 ambient monitoring wells and 1 domestic well. The purpose of this network is to investigate the background chemistry and impact of chemicals on the groundwater. Statistical analysis was completed on these wells for 117 different constituents and parameters to determine concentration, frequency and possible trends. Arsenic, nitrate and chloride detection frequency for 2010 to 2015 was 59.8%, 70.6% and 92.2% of wells, respectively. Only one well had consistent high levels of arsenic, which is likely due to the presence of a clay layer and low DO levels. Nitrate exceeded the maximum contaminant level (MCL) along with chloride exceeding the secondary MCL only once, both in the same well near Bemidji at different times.

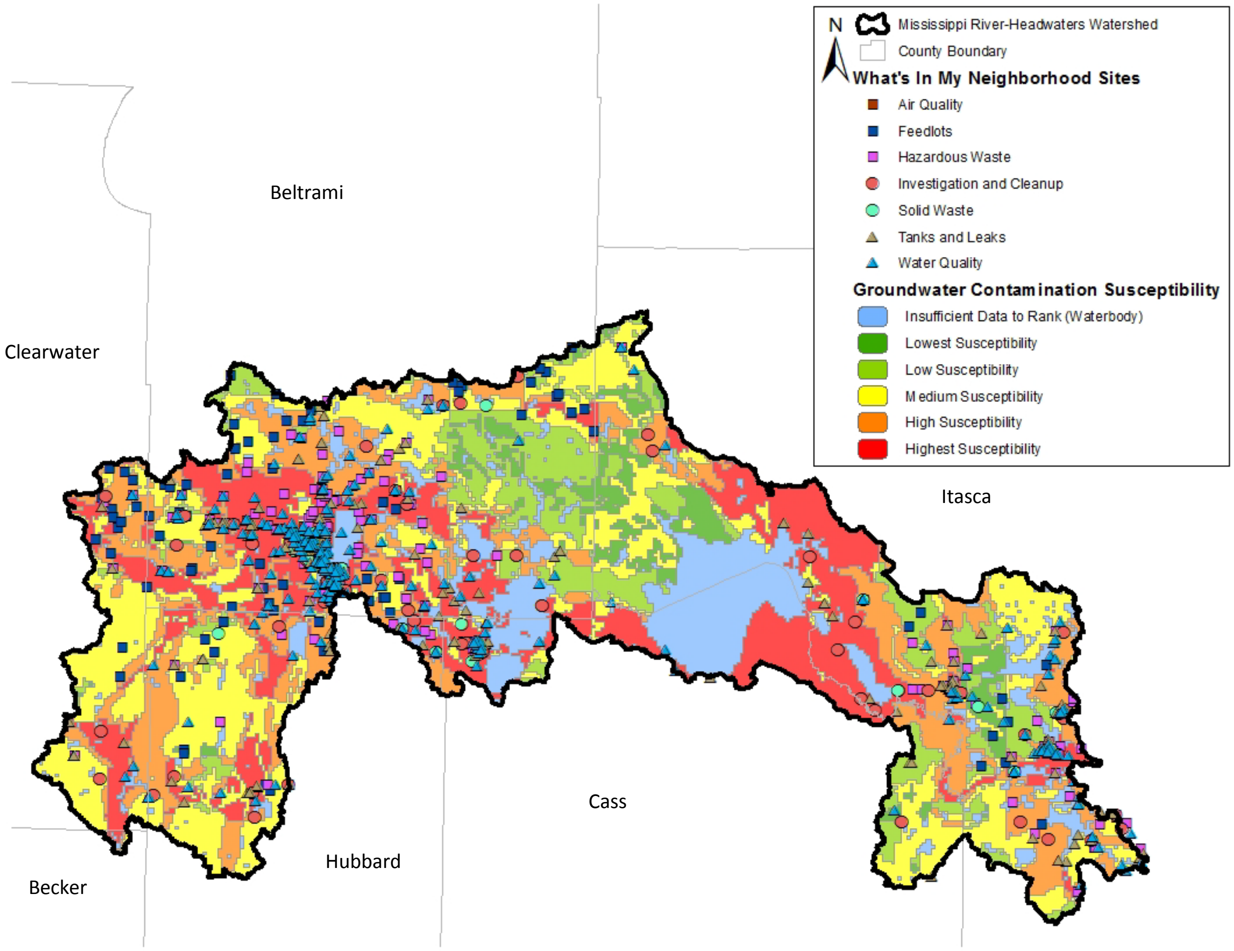


Figure 18. Groundwater contamination susceptibility and WIMN sites within the Mississippi River-Headwaters Watershed.

Groundwater quality is based on the sensitivity of the aquifers and the effects of naturally occurring and anthropogenic constituents found in the water. Factors affecting aquifer sensitivity include: 1) whether the aquifer is shallow or deep, 2) whether the aquifer is unconfined or confined, 3) the material of the aquifer, and 4) groundwater recharge rates. Typically, aquifers that are shallow, unconfined, have low clay content with cobbles and gravel materials, and high recharge tend to have greater sensitivity to contamination. Sources of contamination can be naturally occurring, such as atmospheric deposition or weathering processes, or human influences, such as leaking storage tanks, septic systems, landfills, uncontrolled hazardous waste, and chemical applications to agricultural landscapes or for deicing roads, parking lots, or sidewalks. Although the ambient groundwater quality appears to be good, the MPCA's "What's In My Neighborhood" (WIMN) program has identified a number of potentially contaminated sites and facilities within the MRHW. These types of sites include feedlots, hazardous waste, investigation and cleanup, solid waste, and tanks and leaks sites that have been identified as a potential, current or past contamination site or a site that is not a contamination risk, but required an environmental permit or registration from the MPCA (Figure 18). Due to the higher levels of groundwater contamination susceptibility throughout the watershed, (delineated in red in Figure 19), it is important to continue to monitor these potentially harmful sites in order to inhibit possible water pollution.

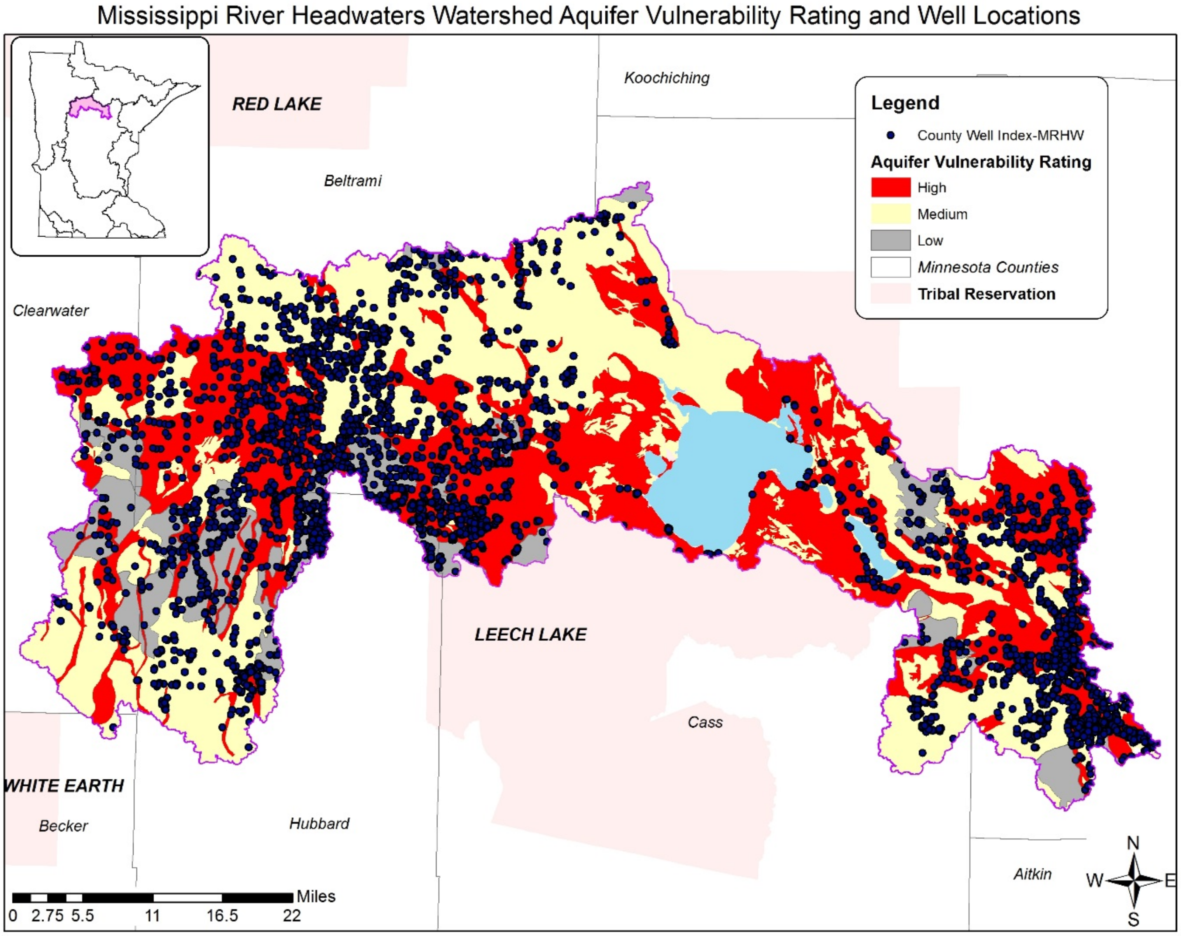


Figure 19. Watershed Aquifer Vulnerability Rating overlaid with well locations.

Groundwater Recommendations

Overall, the groundwater quality of the watershed appears to be healthy, with few exceedances of chemicals of interest and concern. Additional and continued monitoring will benefit the understanding of the health of the watershed and its groundwater resources, and aid in identifying the extent of the issues present and associated risks. Adoption of BMPs will benefit both surface and groundwater. These practices, such as maintaining forest cover, planting cover crops, replacing aging septic systems, and controlling feedlot runoff and chemical application, will help prevent and mitigate negative impacts in the future.

As population and development grows, so does irrigation and water supply demands. The DNR permits and tracks water use by permit holder, and rising demand suggests that the DNR be cautious in granting future permits. Another factor to be considered when determining sustainable withdrawals over time is climate change. Climate change is stimulating changes in precipitation, seasonal length, and droughts, which all can contribute to alterations in groundwater availability. The current state of the MRHW is stable and able to maintain the current demand, but with demand and climate fluctuations in the future, this assumption should be reassessed.

Waterbodies with significant resource values

Protection consideration should be given to waterbodies that have significant resources values, such as DNR lakes of Outstanding Biological Significance, lakes supporting cisco populations, wild rice lakes, and trout lakes and streams. These resources are discussed in more detail in Section 3.1.

3. Prioritizing and Implementing Restoration and Protection

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

This section provides the results of such prioritization and strategy development. The strategies include which of the various government entities (federal, tribal, state, and local) will be involved in the implementation phase. Because many of the nonpoint-source strategies that are outlined in this section rely on voluntary implementation by landowners, land users, and residents of the watershed, creating social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement BMPs is imperative. Thus, effective, ongoing public participation and civic engagement is fully a part of the overall plan for moving forward.

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

Certain issues are not addressed in the strategies tables, including limited local capacity and funding that can greatly affect the outcomes of this report. If resources (e.g., staff or funding) are limited or nonexistent in the project area, the strategies and goals laid out in this report will likely take longer to achieve, if they are achieved at all. Much of this work relies on reductions from non-regulated actions in the watershed, and, to achieve those goals, local relationships and trust need to be built where they may not currently exist. Therefore, as these actions are undertaken, all levels of government and landowners must continue to find ways to support local entities and individuals to ensure that the waterbodies in the MRHW are restored and protected. If this support does not happen, achieving the TMDL reductions and strategies in this report is very unlikely.

3.1 Targeting of Geographic Areas

The MRHW consists of roughly 180,375 acres of lakes and 685 river miles. To effectively address water quality issues for such an expansive set of water resources, prioritization is needed. Prioritization allows watershed stakeholders to focus on the waterbodies that are in greatest need of restoration and protection strategies. Addressing the areas that are most important to the local communities and overall water quality of the watershed provides the best approach given the available, often limited, resources. Current water quality is high across the MRHW, making protection strategies a key focus in this watershed. The cases where restoration is needed align with the lakes identified in the TMDL study highlighted in Section 2.4.

To conduct the prioritization process, a combination of past studies, data analysis, and local feedback were used to identify high priority waterbodies. Several reports have been completed in the region from various entities such as the MPCA, DNR, counties and Mississippi Headwaters Board (MHB). This information was used in conjunction with local feedback from residents and local stakeholders to establish a process that meets the rigor necessary to select the priority waterbodies requiring the most attention, and provide the greatest return.

This section discusses all of the different prioritization tools, starting at the watershed and subwatershed level and moving to specific lakes and streams.

Hydrological Simulation Program – FORTRAN (HSPF) Model

An HSPF model was developed by RESPEC to simulate hydrology and sources of phosphorus, nitrogen, and sediment in the MRHW. Annual average pollutant yields were mapped and ranked by HUC 14 watershed for TP, total nitrogen (TN), and total suspended solids (TSS) to guide prioritizing of restoration and protection throughout the watershed (see Figure 20 through Figure 22). Runoff and pollutant yields are also shown by model land classification in Table 11 below.

Table 11: Average Annual Loading Rates by Land Use

Source	Runoff (ft^3/acre/year)	TSS (lb/acre/year)	TN (lb/acre/year)	TP (lb/acre/year)
Developed	34106	83.8	4.21	0.150
Old Forest	16342	10.6	1.36	0.053
Young Forest	20980	14.6	1.75	0.069
Grassland	24769	30.2	2.48	0.087
Agricultural	29329	78.4	4.19	0.265
Wetlands	26706	10.2	2.12	0.077
Feedlots	34281	333.0	12.74	1.091

Average simulated phosphorus loads (illustrated in Figure 20) are relatively low throughout the watershed, with higher loads occurring in the western and eastern management zones where agricultural practices are more intensive and there are more urban influences. Spatial patterns of nitrogen and sediment loads, (illustrated in Figure 21 and Figure 22, respectively), are similar to those of phosphorus.

Figure 20. HSPF Loading Rates by Subwatershed for Total Phosphorus.

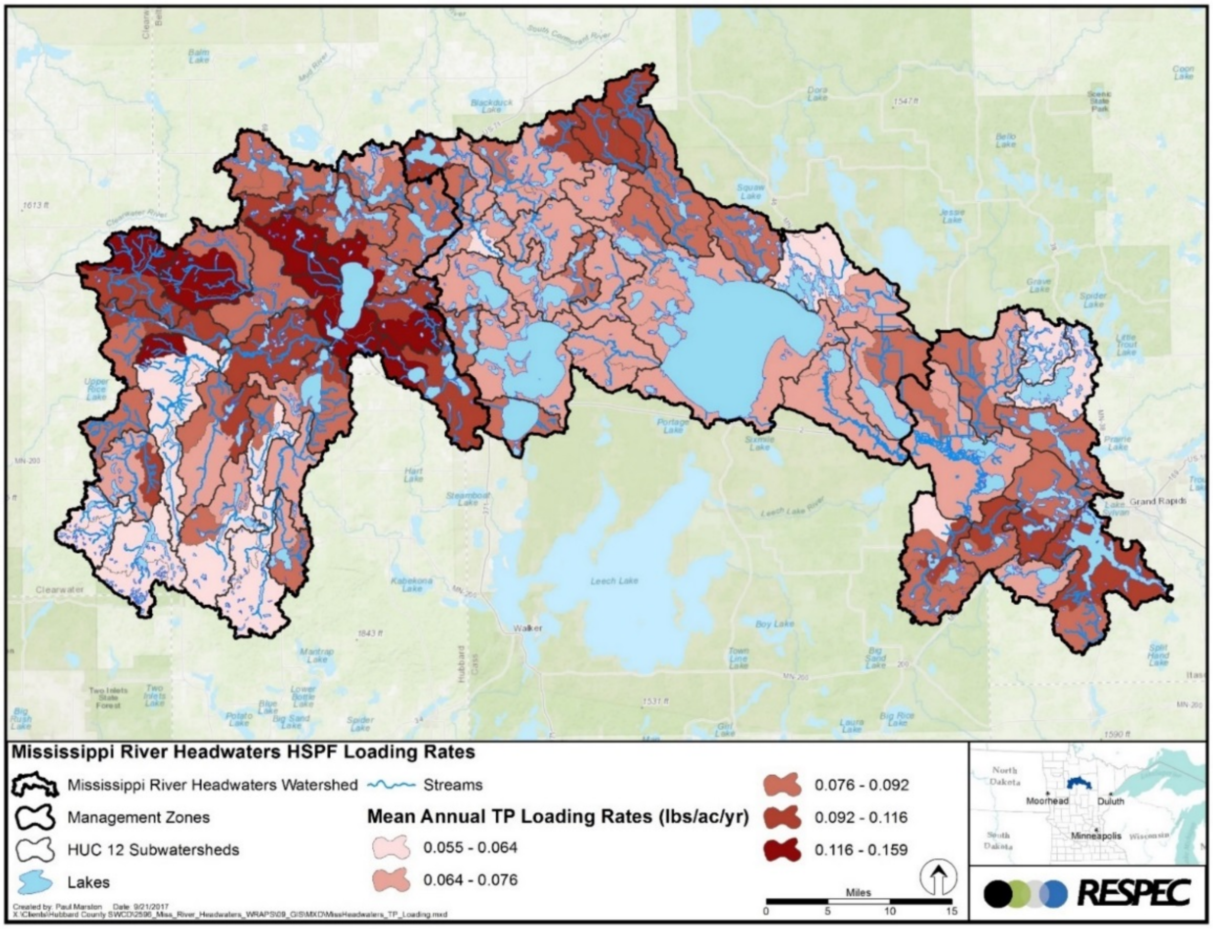


Figure 21: HSPF Loading Rates by Subwatershed for Total Nitrogen

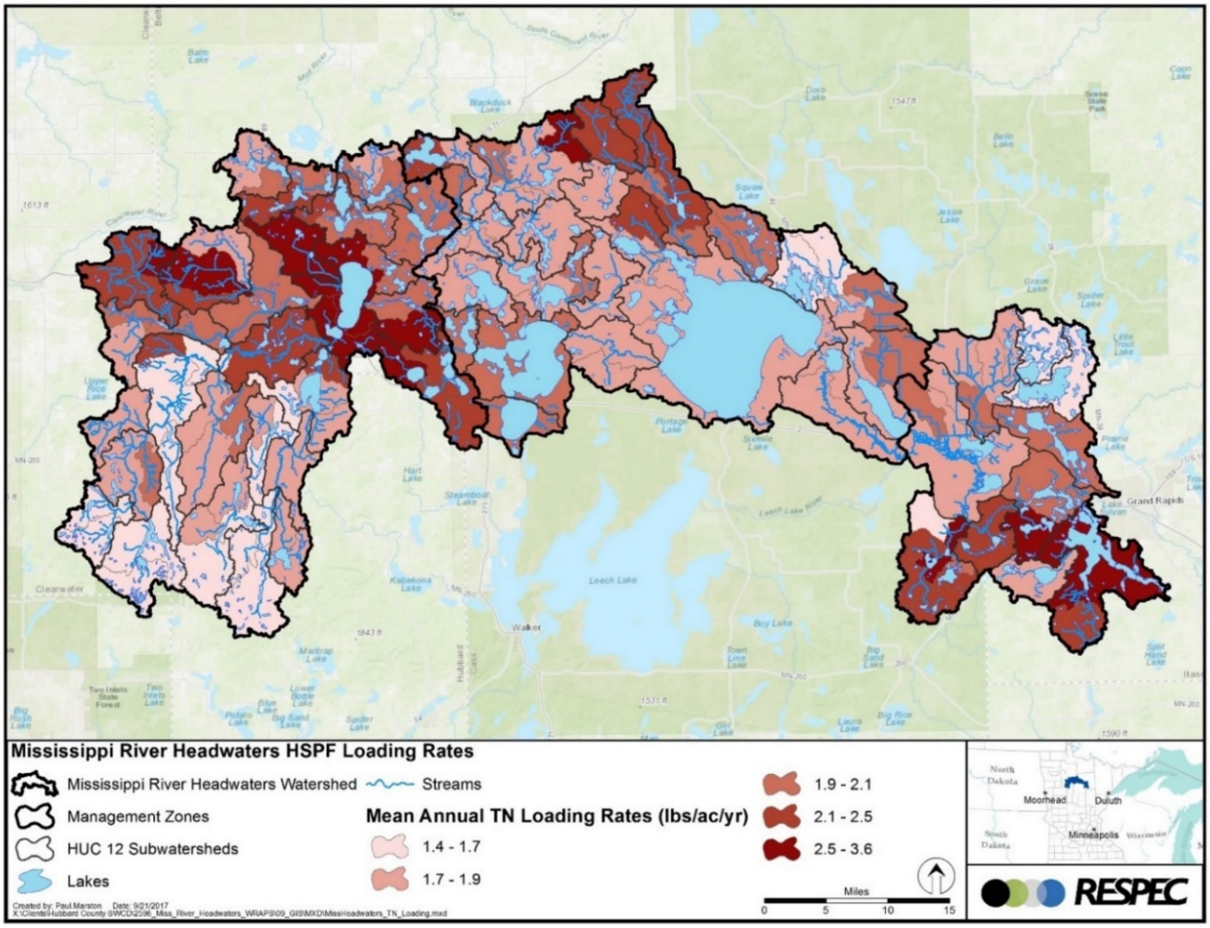
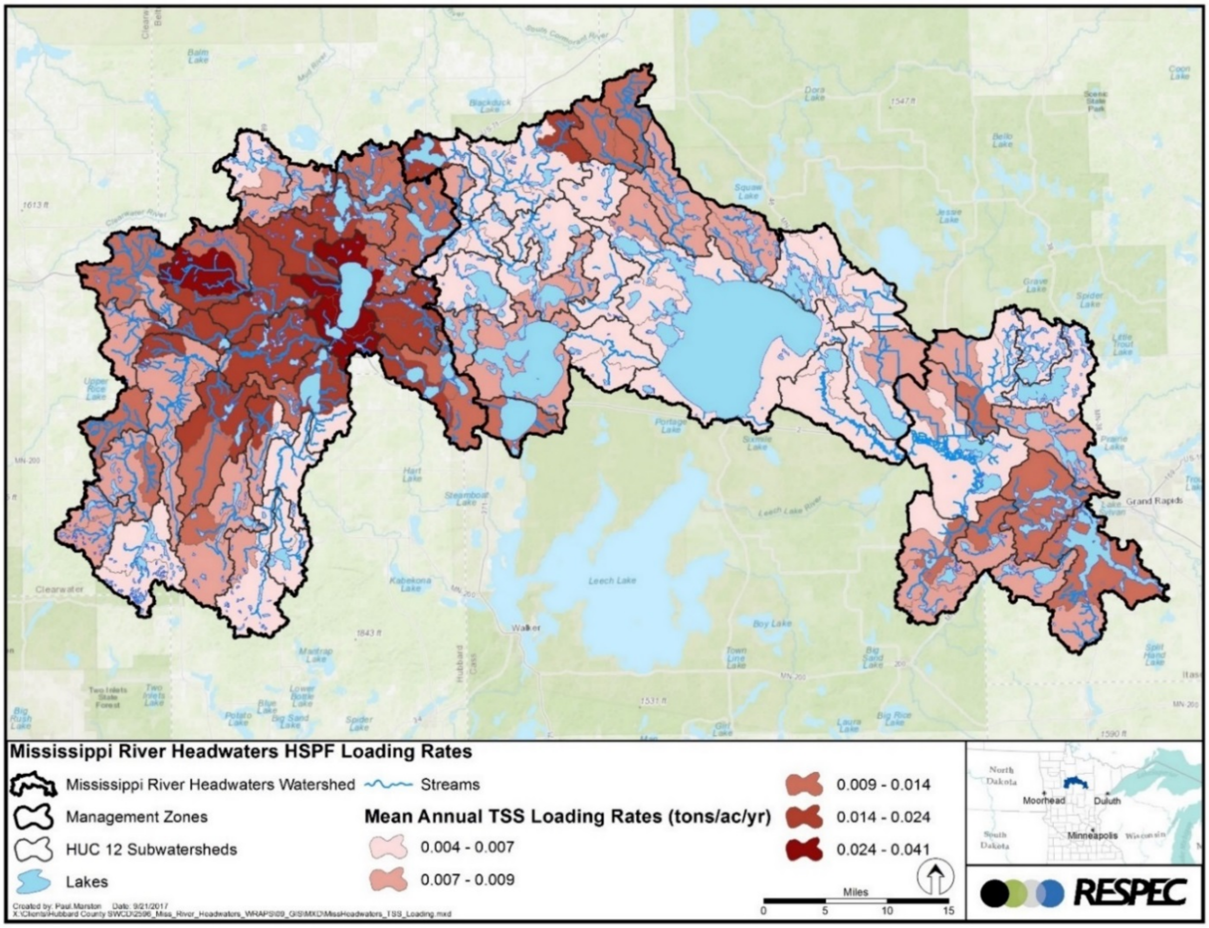


Figure 22. HSPF Loading Rates by Subwatershed for Total Suspended Solids



HSPF Scenarios

The MRHW contains many high-quality surface waters; however, potential impacts from increased development, land use change, and other potential threats to water quality are of primary concern. While much effort has been focused on characterizing past and present conditions of area waterbodies, the Mississippi Headwaters WRAPS team members have also assessed potential impacts of future threats. Realized changes in the landscape and waters provide perspectives for generalizing future conditions. As part of the future forecasting, stakeholder inputs and local and regional experts' professional judgment were used to define a range of potential, future land use changes. The MRHW Hydrological Simulation Program – FORTRAN (HSPF) model was calibrated based on 14 years of hydrologic, climate, and monitoring data and was used to predict impacts of future land use changes, as well as restorative or protective effects from employing generalized BMPs. For this purpose, estimates are provided by percent change, which should be used for a relative comparison of effects. Further, representative sites were selected to depict estimated changes in TSS and TP flow weighted mean concentrations (FWMCs) by scenario. For the purposes of this assessment, the Mississippi Headwaters Basin has been organized into West, Big Lakes (central area), and East Basin management zones, as depicted in each of the loading graphics (see Figure 23). These management zones cover a range of land covers with: the West Zone having the largest agricultural and urban influences; the Big Lake Zone including the large reservoirs and covering the largely tribal and national forest lands; and the East Zone with mixed land covering and Grand Rapids related urbanization downstream of the confluence of Leech Lake River and the Mississippi River. These assessments allow a broad-brush projection of potential impacts (both geographically and propagated along flow networks).

Most of the focus of these future projections are based on changes in loading for TSS and TP, which are well defined in the scientific literature and by Minnesota water quality rules. TN loading changes were added to reflect increasing concern related to groundwater protection and cumulative effects of altered nitrogen to phosphorus (N:P) ratios in receiving waters. As N:P ratios decline, conditions may begin to favor nuisance cyanobacteria.

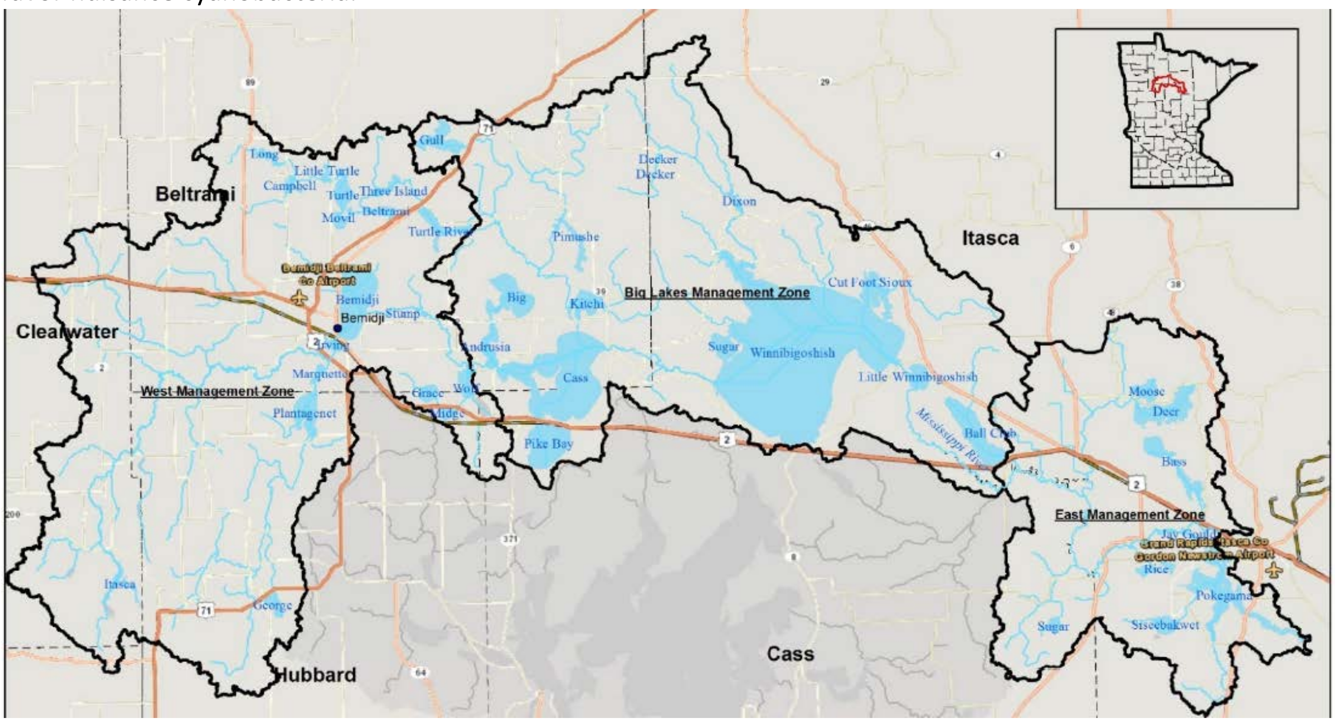


Figure 23. Mississippi River Headwaters Management Zones

Six potential future land use change scenarios that can be appropriately evaluated with the HSPF model were developed to predict potential impacts on watershed flows and water quality, as estimated by percent change in annual average loading for TSS, TP, and TN. Modeling-period average runoff and average loads are tabulated (see https://www.pca.state.mn.us/sites/default/files/wq-ws1-15.pdf - "Mississippi Headwaters Watershed Scenarios Report" for complete HSPF scenario analysis and results information). Each scenario was developed from information provided by stakeholders and local experts, and described herein by scenario. Not all subwatershed areas were predicted as having substantial land use changes; therefore, no changes will be noted in summary graphics unless impacted by upgradient changes. Explicitly modeled subwatersheds have been indicated as stippled areas in graphics for each scenario (Figure 24 through Figure 29). The following figures only depict TP changes. The full report shows percent change for the other parameters, and further discussion of modeled results.

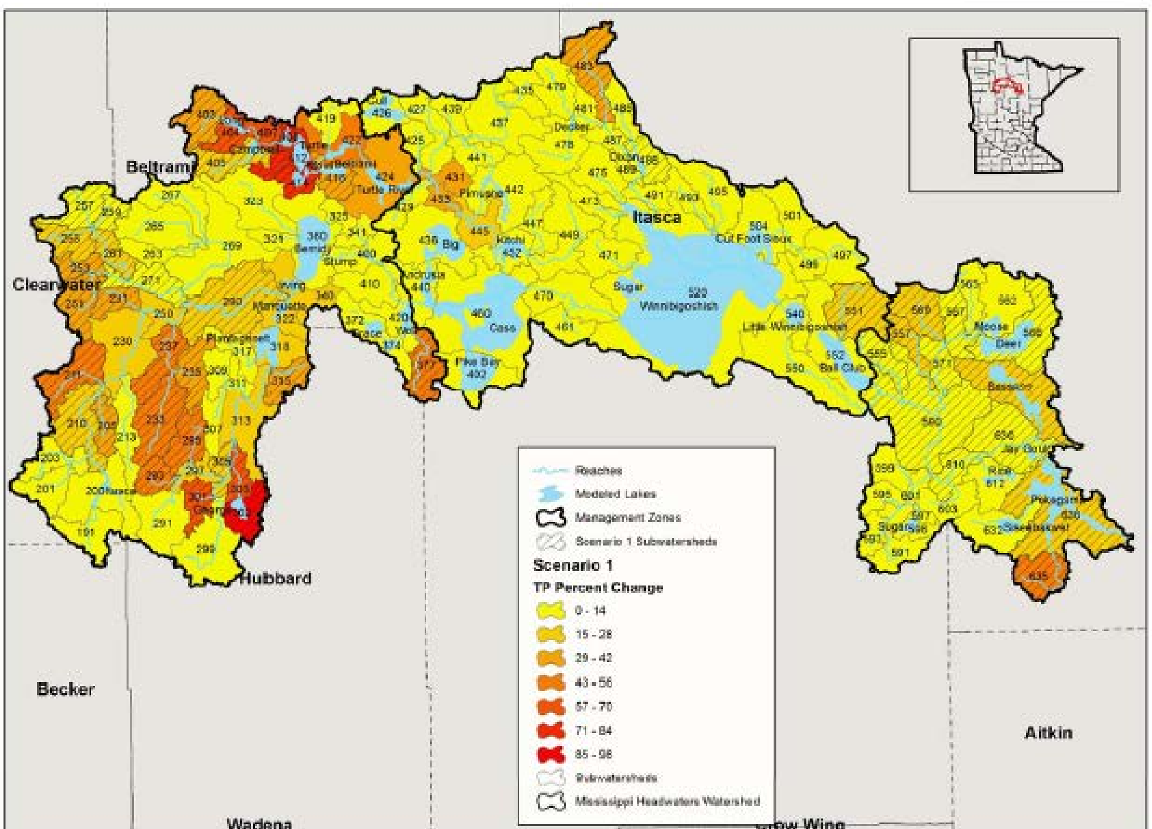
Note that the Leech Lake River, which is not considered part of this Headwaters analysis, drains into the Mississippi River above Grand Rapids, which causes a dilution effect in the Mississippi River. In a similar fashion, the large headwater reservoirs, such as Winnibigoshish, are effective nutrient/sediment traps and, therefore, can strongly mute TSS and TP loads discharged to downstream waters. Hence, projecting cumulative impacts of upland changes on the most downstream portion of Headwaters Mississippi River reflects dilution and trapping effects, thereby influencing apparent load reductions estimated for downstream most reaches. Assessing the potential cumulative impacts of changing land uses on the smaller upgradient and large lakes (Wolf, Cass, Andrusia, and Winnibigoshish) could not be fully addressed in this assessment and should be considered in future efforts. Potential increases resulting from lake sediment internal recycling of phosphorus is one such impact noted by Wilson and McCutcheon [2016] for Lakes Irving and Little Turtle.

Evaluated scenarios included the following TP changes:

<u>Scenario 1 - Conversion of forests to agriculture</u>.

Scenario 1 estimates the impacts from converting 25% of forestland covers to agricultural lands for select subwatersheds, as indicated by the stippled areas. For this modeling, agricultural land is broadly defined as a mix of pasture/hay, cultivated crops, and feedlots.

Figure 24. Scenario 1 Total Phosphorus Percent Change



Substantial increases (e.g. 25% to–90%+) of TSS and TP loadings were widely noted for assessed subwatersheds, particularly for the upper flow path subwatersheds in the West and East Zones. These impacts were propagated downstream along flow paths. If realized, loadings of this magnitude can cause perceptible and measureable negative impacts to receiving waters.

Scenario 2 - Conversion to developed lands (see scenarios 2A and 2B below)

Scenario 2A - Conversion of forest and agricultural land to developed land with increased wastewater and septic loads, representing growth of cities and development near easily accessible lakes and stream corridors. Scenario 2A estimates watershed response that results from increased developed land covers. For this scenario, in subwatersheds identified by stakeholders to be at risk for each conversion, 10% of forestland was converted to developed land, and 15% of agricultural land was converted to developed land. Converted lands are represented as stippled areas in the associated graphics by scenario. In addition to these conversions, point-source loads from Bemidji and Deer River facilities and from septic systems were increased by 15% in selected subwatersheds identified by stakeholders to be at risk for conversion to developed lands.

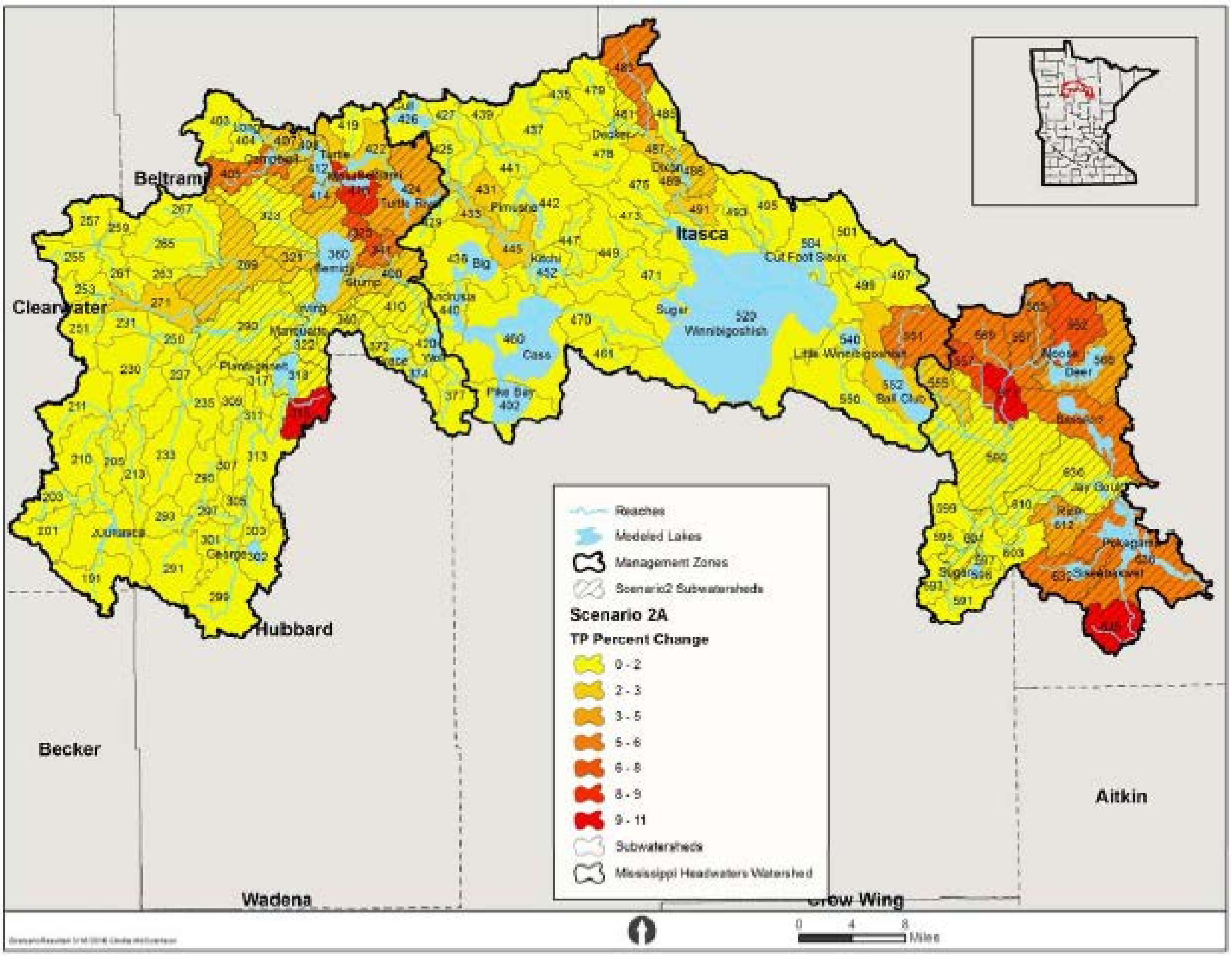


Figure 25. Scenario 2A Total Phosphorus Change.

Projections for the core lake areas of the West and East Zone include TSS load increases from 4% to 23% and TP increases from 2% to 11%.

B. Conversion to developed lands (Scenario 2A) AND employing urban BMPs.

Scenario 2B – This scenario estimates the combined impacts of developing Scenario 2A, as moderated by broadly implementing urban BMPs defined by Minimal Impact Development Standards (MIDS) (MPCA 2014] over 20% of developed lands in subwatersheds that have been identified by stakeholders to be potentially converted to developed land. MIDS reductions that were used in this analysis included 81% for TP, 91% for TSS, 20% for TN, and 91% for flows. TP, TSS, and flow reductions were based upon removal efficiencies to match present-day native forest and prairie conditions [Barr Engineering, Inc. 2011]. Conservative TN removal efficiencies for multiple BMPs were based on Chesapeake Bay recommendations [Hirschman et al. 2008].

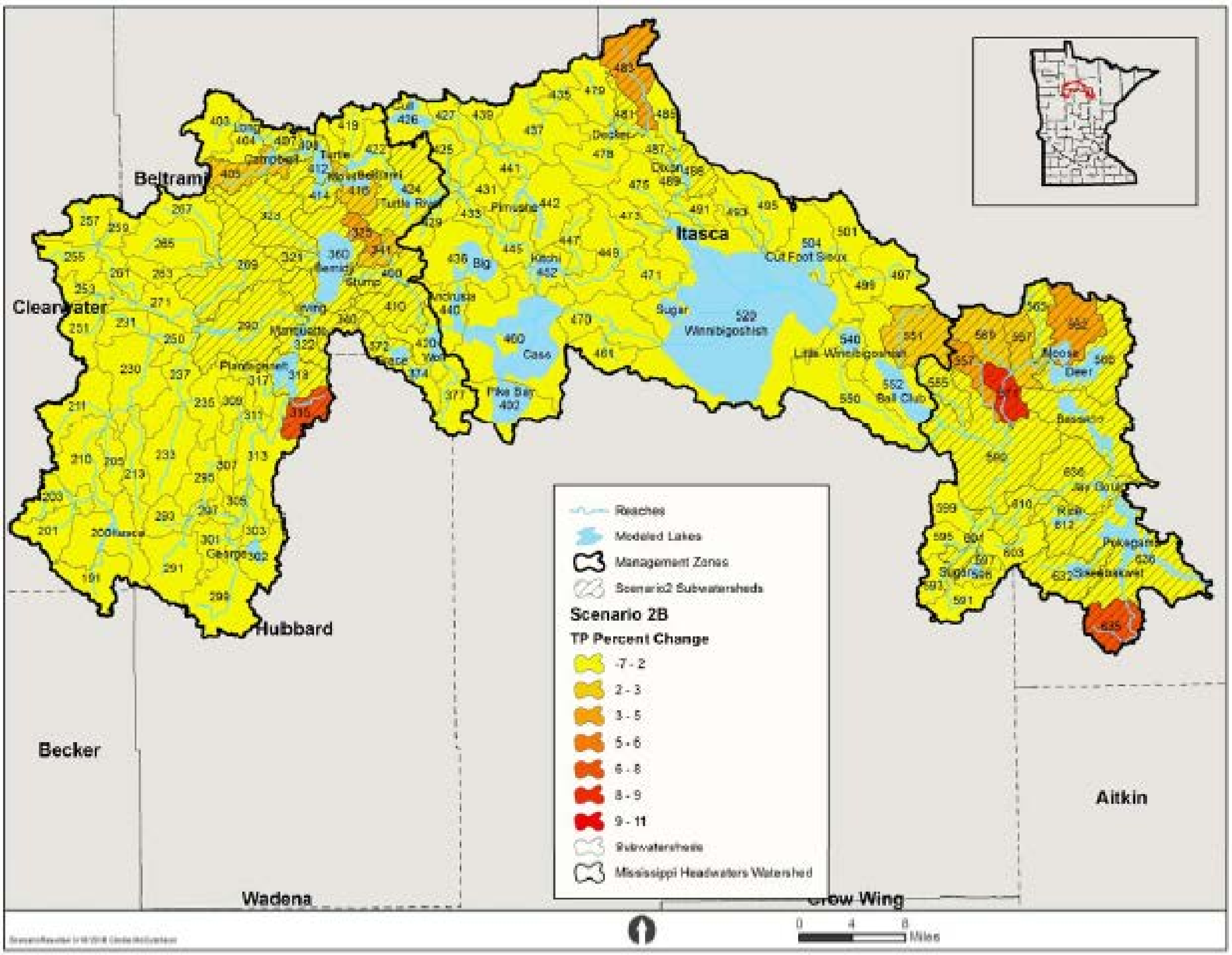


Figure 26. Scenario 2B Total Phosphorus Change.

Implemented MIDS practices were predicted to reduce the effects of increased urban development. However, the net impacts of broad development increases were estimated to result in net increased TSS and TP loads, which would again involve the core lake and riparian areas of the West and East Zones.

Scenario 3 - Intensified forest harvest.

This scenario estimates the impacts of converting 25% of mature forestland cover to new forests in subwatersheds identified by stakeholders as lands for potential forest harvest. These subwatersheds are indicated by the stippled areas in the graphics for this scenario. The highest runoff increases (approximately 1% to 7%) were noted particularly for the West Zone assessed subwatersheds with increases propagated to downstream waters. Similar, but lower runoff increases were generally predicted for East Zone areas with increased forest conversion. In this scenario, converting forest was estimated to result in general runoff increases in select subwatersheds of the Big Lakes Zone and particularly in its eastern portion.

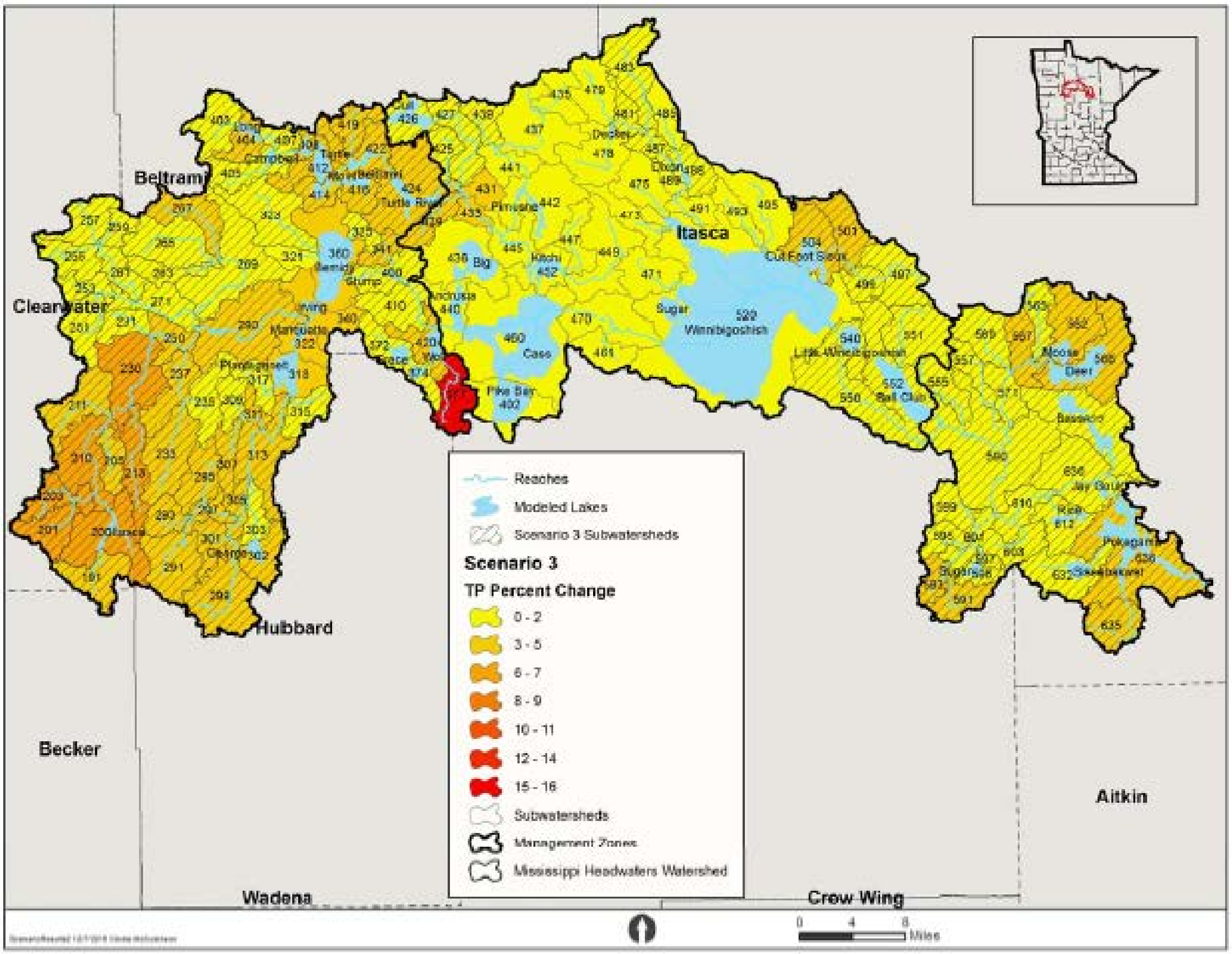


Figure 27. Scenario 3 Total Phosphorus Change.

> Projections indicated that the greatest increases in TP loading (3% to 7%) were evident in the southern reaches of the West Basin and the northern lake district of the West Zone with 3% to 5% increased loadings centering on key northern lake districts of the East Basin. The northeastern portion of the Big Lakes Zone was estimated to have 3% to 5% TP-loading increases.

Scenario 4 - <u>Cumulative effects from increases in agricultural lands (Scenario 1), developed land (Scenario 2A), and intensified forest harvest (Scenario 3).</u>

Scenario 4 estimates the cumulative impacts of the previous scenarios, including increases in agricultural lands, developed lands, and intensified forest harvest (Scenarios 1, 2A, and 3) in the subwatersheds that were identified by stakeholders to be at risk for each conversion. Figure 28 shows modeled TP percent change.

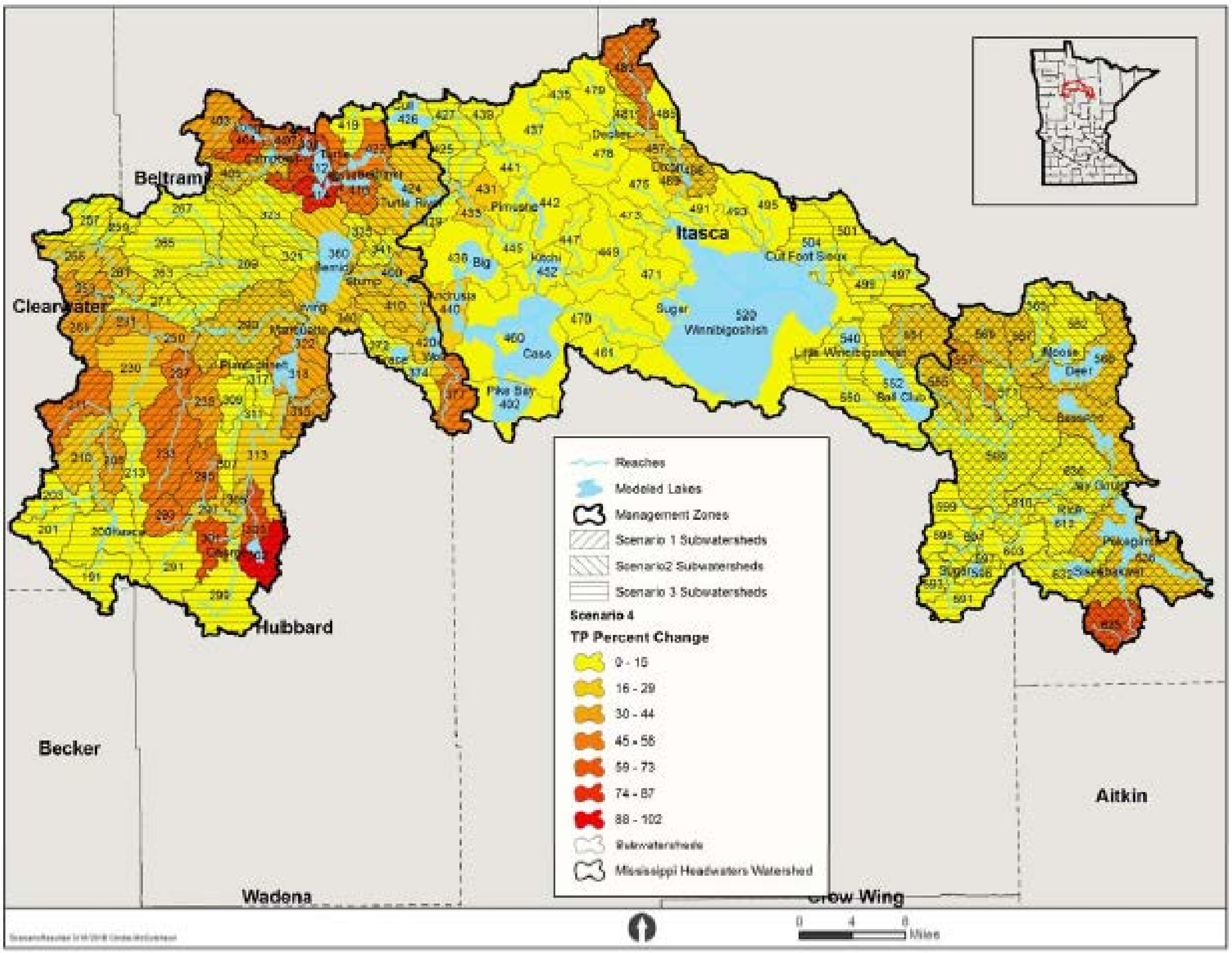


Figure 28. Scenario 4 Total Phosphorus Change.

The cumulative impacts from the increases in intensified land uses were substantial (in excess of 50%) for TSS and TP loadings for many of the assessed subwatersheds of the West and East Zones. Loading projections of this magnitude from this worst-case analysis, if realized, would result in substantial and measureable water quality degradation of many of the assessed subwatersheds and downstream waters, including portions of the Mississippi River. Established lake and stream beneficial uses could also be negatively affected by more subtle increases in flow and TSS and TP loading.

Scenario 5 - Implementation of water quality buffers to portions of agricultural croplands.

Scenario 5 estimates the impacts of buffers being applied to 50% of the cropland in each subwatershed. Buffer pollutant reductions used in this assessment were based on values cited by the Minnesota Department of Agriculture's (MDA's) BMP Handbook [Miller et al. 2012] and included 76% for TSS, 67% for TP, 68% for TN, and 0% reductions for flow. It is estimated that the passage of the Minnesota Buffer Law in 2017 (Minn. Stat 103F.48) has significant helped in the process of the implementation of this scenario.

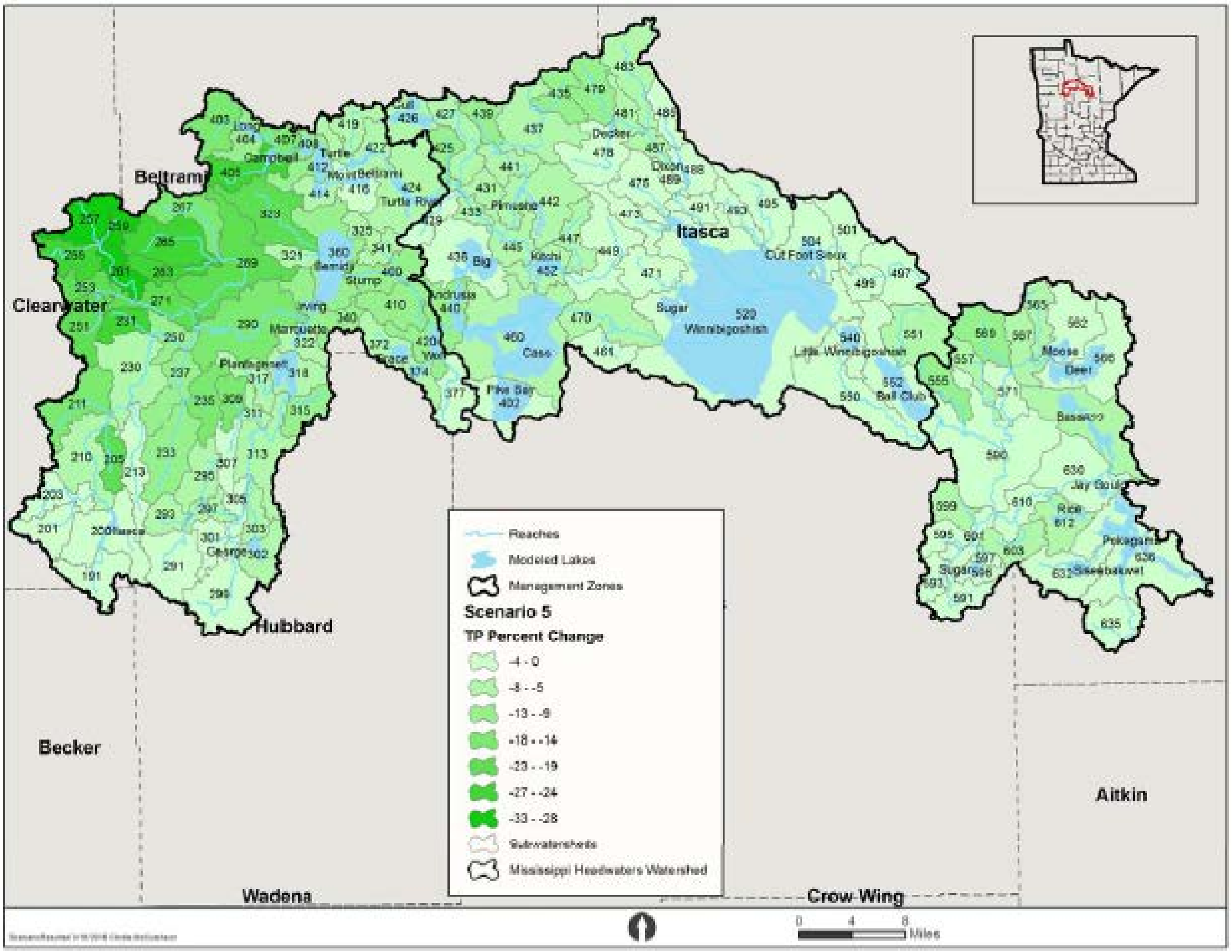


Figure 29. Scenario 5 Total Phosphorus Change

Estimated reductions in TSS loading (approximately 4% to 28%) and TP loading (approximately 3% to 34%) were widely noted for the assessed subwatersheds, particularly in the upper flow path subwatersheds of the West Zone. Similar, but lower reductions of TSS and TP loads were estimated for the Big Lakes and East Zone subwatersheds. These positive impacts were propagated downstream along all flow paths.

Values-Based Modeling to Identify Geographic Areas of High Conservation Potential

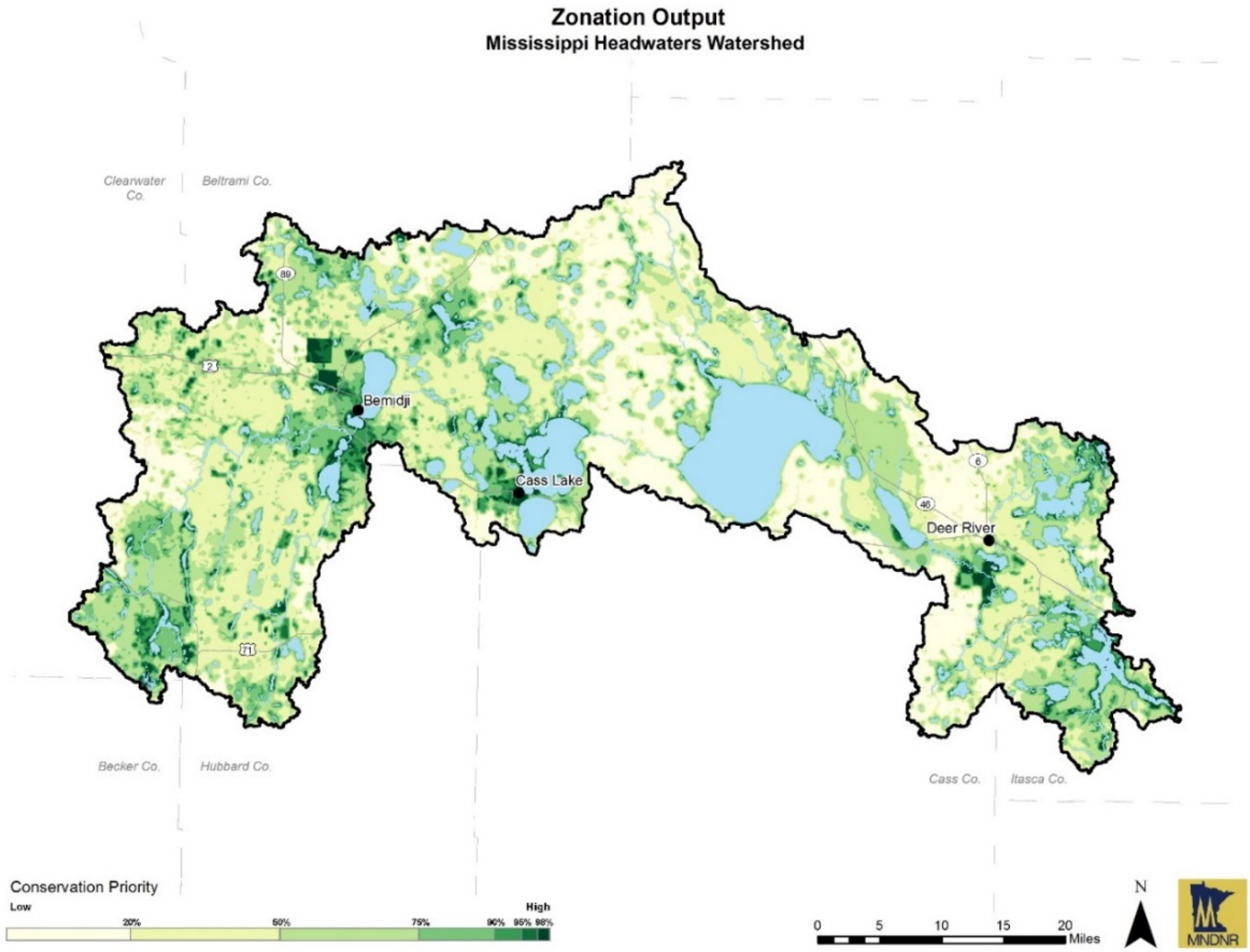
A values-based model (Zonation) was used to prioritize areas for protection and restoration. This model was based on fundamental conservation principles, including biodiversity and connectivity. The DNR's five-component healthy watershed conceptual framework was used to facilitate an organized process to assess and review watershed problems and solutions. The five components for a healthy watershed are: biology, hydrology, water quality, geomorphology, and connectivity. This approach recognizes that attempts to solve our clean water needs are not separate from our other conservation needs; each conservation activity should provide multiple benefits. The values-based model used in this process helps achieve this multiple benefits goal by identifying areas that optimize benefits by incorporating data valued by the community. For example, within the MRHW, the goal was to obtain both clean water benefits and other conservation benefits. The model used a compilation of individual and aggregated criteria of valuable landscape features, with the objective of providing data and maps that prioritize places on the landscape for protection or restoration.

The value model was also used in a civic engagement process. As part of this process, in the first step of the model, a team of natural resource professionals and interested citizens gathered and identified critical conservation features in the MRHW based on the DNR's five healthy watershed components.

Recognizing that some conservation features are more highly valued than others are, the second step in the model set weights for the conservation features. Professionals and citizens participated in a survey questionnaire (written and electronic) that asked them to compare priority conservation features on a broad scale (i.e. components of the healthy watershed) and on a finer scale. The 55 survey respondents prioritized the watershed's broad conservation features in the following order: protect/improve fish and wildlife habitat; protect/improve waters of concern; reduce erosion and runoff; protect/improve lands of concern; protect and restore shoreland; and protect and improve lands of concern.

In the third step, the DNR's Division of Ecological Resources team in Brainerd (Paul Radomski and Kristin Carlson) ran the Zonation model utilizing the results from the questionnaire. The Zonation output map ranked lands as to their importance for land management activities that would provide greater protection of ecosystem functions, especially water quality, and to their importance for application of various land BMPs (Figure 30).

Figure 30. Zonation Output Map- Areas in darker green are higher conservation priority.



As a fourth and final step, the MRHW WRAPS participants were given the opportunity to revise the model results to create a map that will be used to help identify areas within the watershed for potential future conservation investments. This synthesis step captured the knowledge and experiences of the people interested in and informed about the stresses, risks, and vulnerability of water resources within the watershed. See Appendix C for details on methods and results.

The final prioritization map created from Zonation and synthesis analysis is presented in Figure 31. The final priority map identified several focused priority areas. First, priority was given to the riparian lands associated with the Mississippi River corridor (lands within 300 feet of the river or the landward side of its floodplain as determined by DNR terrain analysis, whichever is greater). Second, priority was given to lands in the Lake Bemidji catchment and lands associated with the city of Bemidji's drinking water supply management areas. Third, priority was also given to lands associated with the EPA superfund site in the city of Cass Lake, and numerous stream riparian and floodplain areas. This information was then useful in determining specific protection strategies.

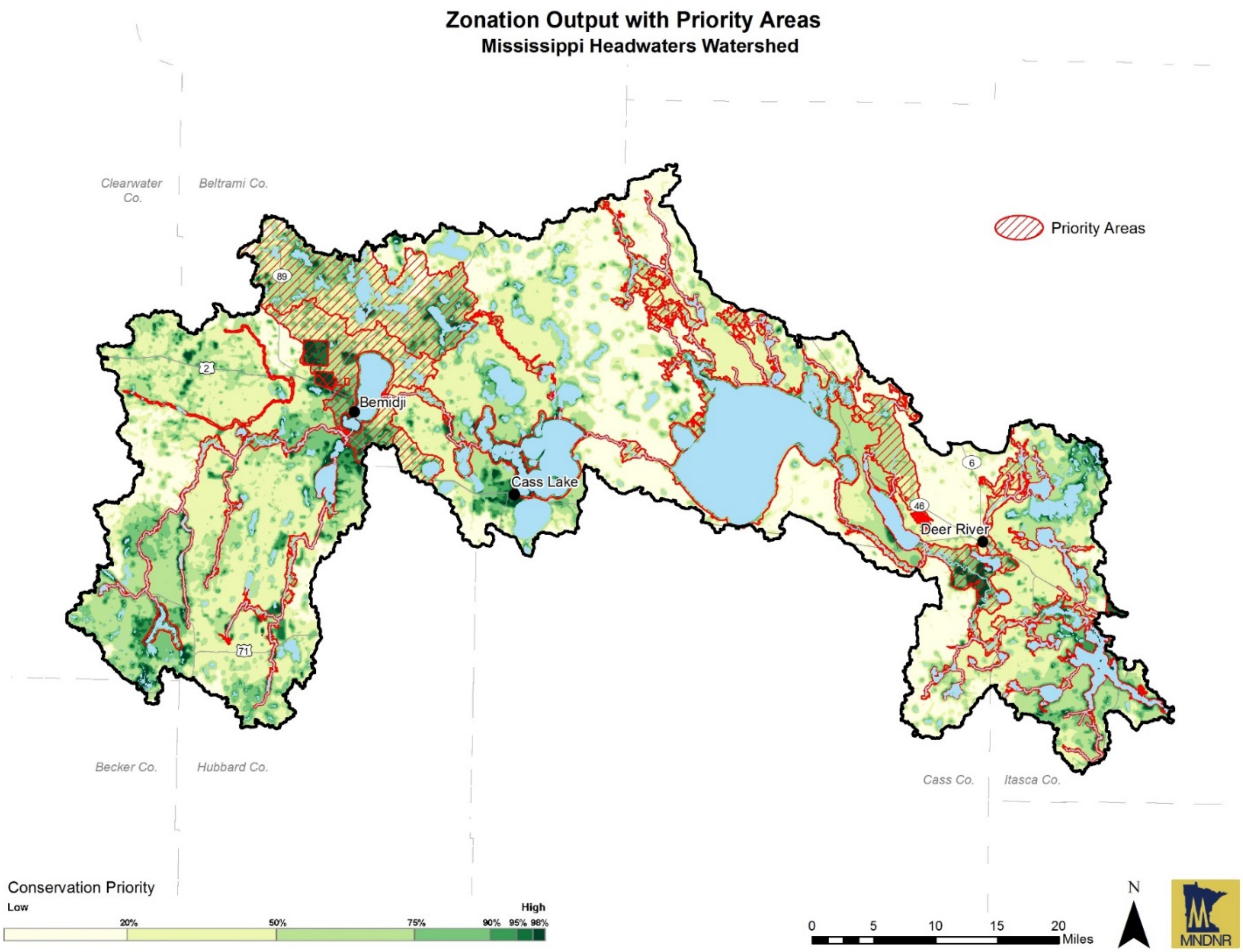


Figure 31. Zonation Output map with priority areas.

The values-based model provided a formal, quantitative planning framework and critical citizen engagement tool that helped the Team identify priority areas of protection investments, which can be integrated with other natural resource priorities to produce multiple conservation benefits. See Appendix C for detailed maps of the final model results, a list of the conservation features identified for the MRHW around the DNR healthy watershed framework, and weighting survey.

The Nature Conservancy's Multiple Benefits Model for Prioritizing Freshwater Conservation Priorities

In 2014, the North Central Conservation Roundtable (NCCR), a collaborative of natural resource agencies and non-governmental organizations (NGOs) working on conservation issues in North Central Minnesota, used the values-based "zonation-modeling" to identify high priority natural resource areas and conservation priorities in a broad multi-county North Central geography, essentially most of the Mississippi River Headwaters region. The NCCR representatives identified the conservation features they desired to have modeled in the Headwaters region.

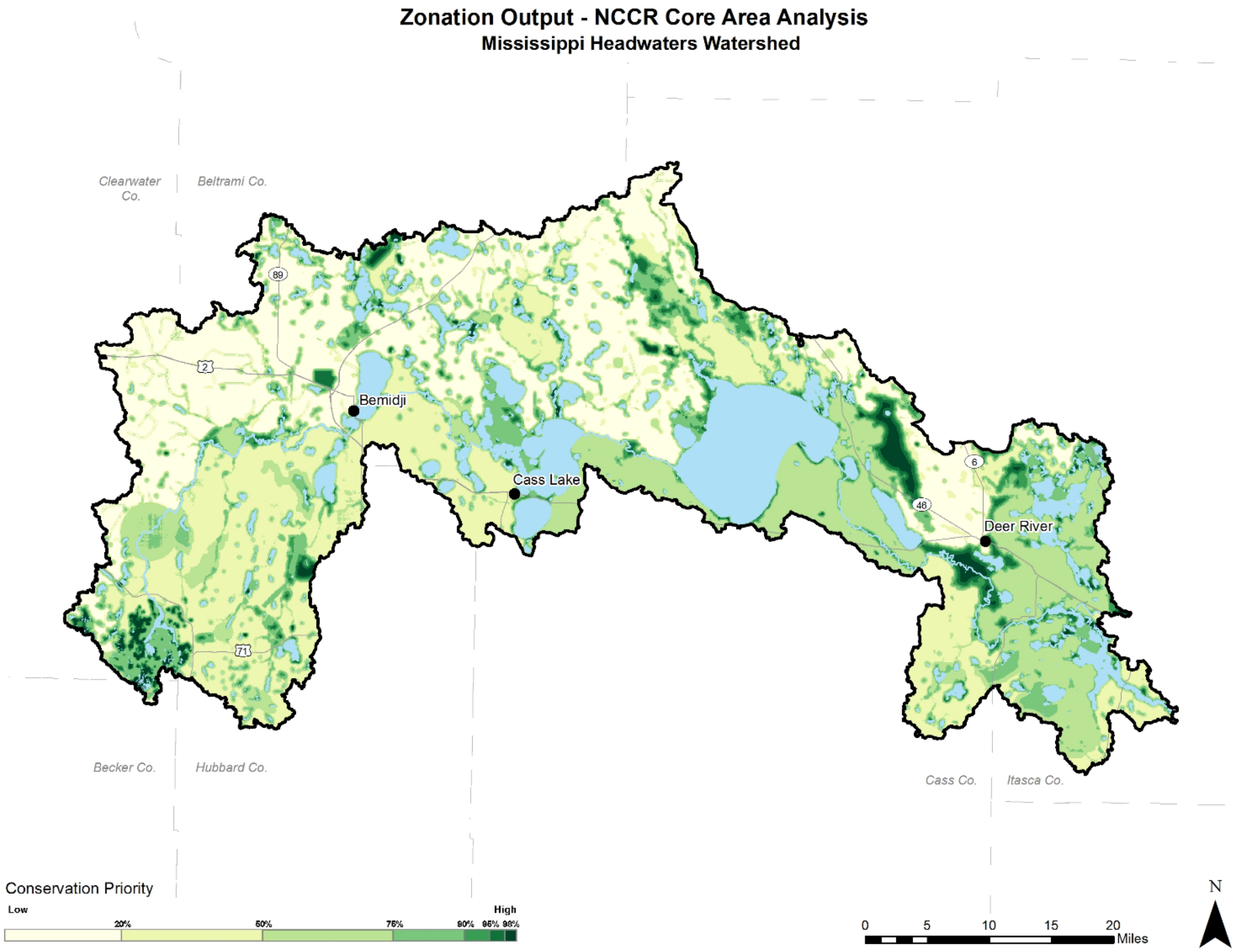
With new data layers available after the NCCR model was completed, TNC, led by Dr. Kristen Blann of their Freshwater Team, took the initiative to develop a second iteration of the zonation model for the entire Mississippi Headwaters to identify areas of high conservation potential that would have multiple conservation benefits.

The goal of TNC's Freshwater Program is to conserve the lands that protect clean water, and to support high-impact conservation projects to protect clean water in Minnesota's lakes and rivers for the benefit of nature, people and the economy. As threats to clean water continue to mount, TNC sees an increasing need to identify and conserve high-priority areas for habitat and clean water benefits. Identifying where on the landscape conservation can provide multiple, overlapping benefits can help more effectively target protection and conservation efforts, and more efficiently utilize limited resources.

The adjusted version of the NCCR Zonation model for the Mississippi Headwaters was broken down into modules, each consisting of 2 to 10 input layers, based on the benefits the combined layers provided. The modules included: 1) fish and wildlife; 2) drinking water and groundwater quality; 3) flooding and erosion; and 4) groundwater quantity. In addition, a shoreland module was isolated that was straightforward and can be used as an independent layer where shoreland protection is identified as a priority.

TNC's model is intended as a tool to help TNC and its partners set programmatic direction goals, as well as identify opportunities and focus areas. It is designed to be used in conjunction with information on opportunities, threats, and costs – none of which the model is designed to account for — to evaluate benefits and tradeoffs among potential conservation projects. The results of TNC's modeling (Figure 32) was considered, along with priority areas identified using the other tools discussed in Section 3.2 and 3.3, to develop strategies for water quality protection in the MRHW. See Appendix D for a more detailed description and additional maps of the TNC multiple benefits modules.

Figure 32. Zonation Output using NCCR Core Area Analysis.



School Trust Lands

School trust lands are common throughout the MRHW, with around 151,272 acres located within the watershed. The DNR manages the school trust lands for maximum long-term economic return, under sound natural resource and conservation practices. Revenues generated from school trust lands are credited to the permanent school fund, which is managed by the State Board of Investment. Most of these lands are currently being managed as sustainable forestlands. Figure 33 and Table 12 below illustrate the School Trust Lands by Best Use Classification in the MRHW. Lands classified as Real Estate present the biggest potential risk of conversion from their current forestland state. Real estate classifications along lakeshore areas pose a potential risk to water quality under a scenario of conversion resulting in development. Being vigilant to monitor the status of these lands, and pursuing opportunities to implement protection strategies to offset the potential conversion risks (e.g. conservation easements), will be protection priority for the MRHW.

Figure 33. School Trust Land in MRHW by Best Use Classification.

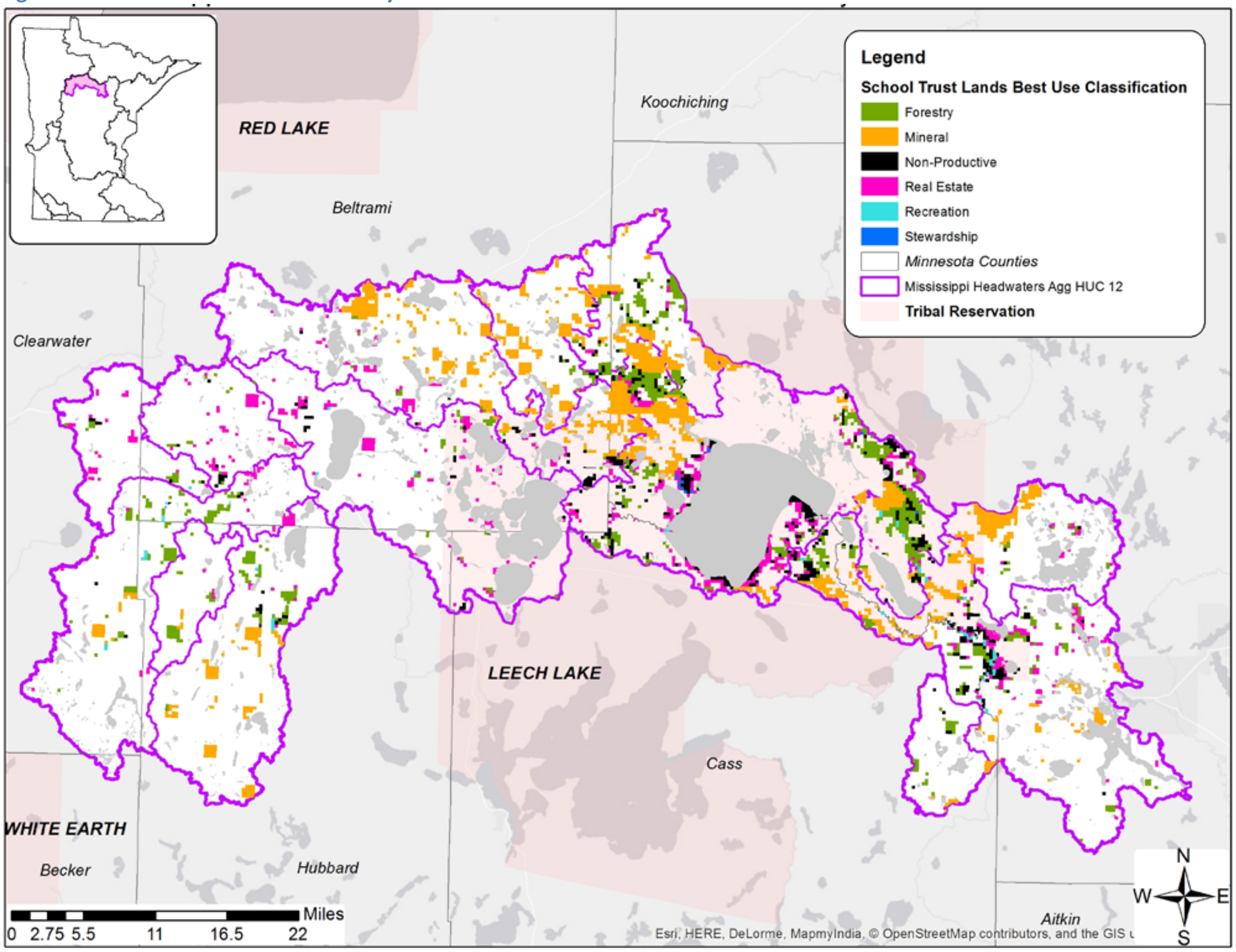


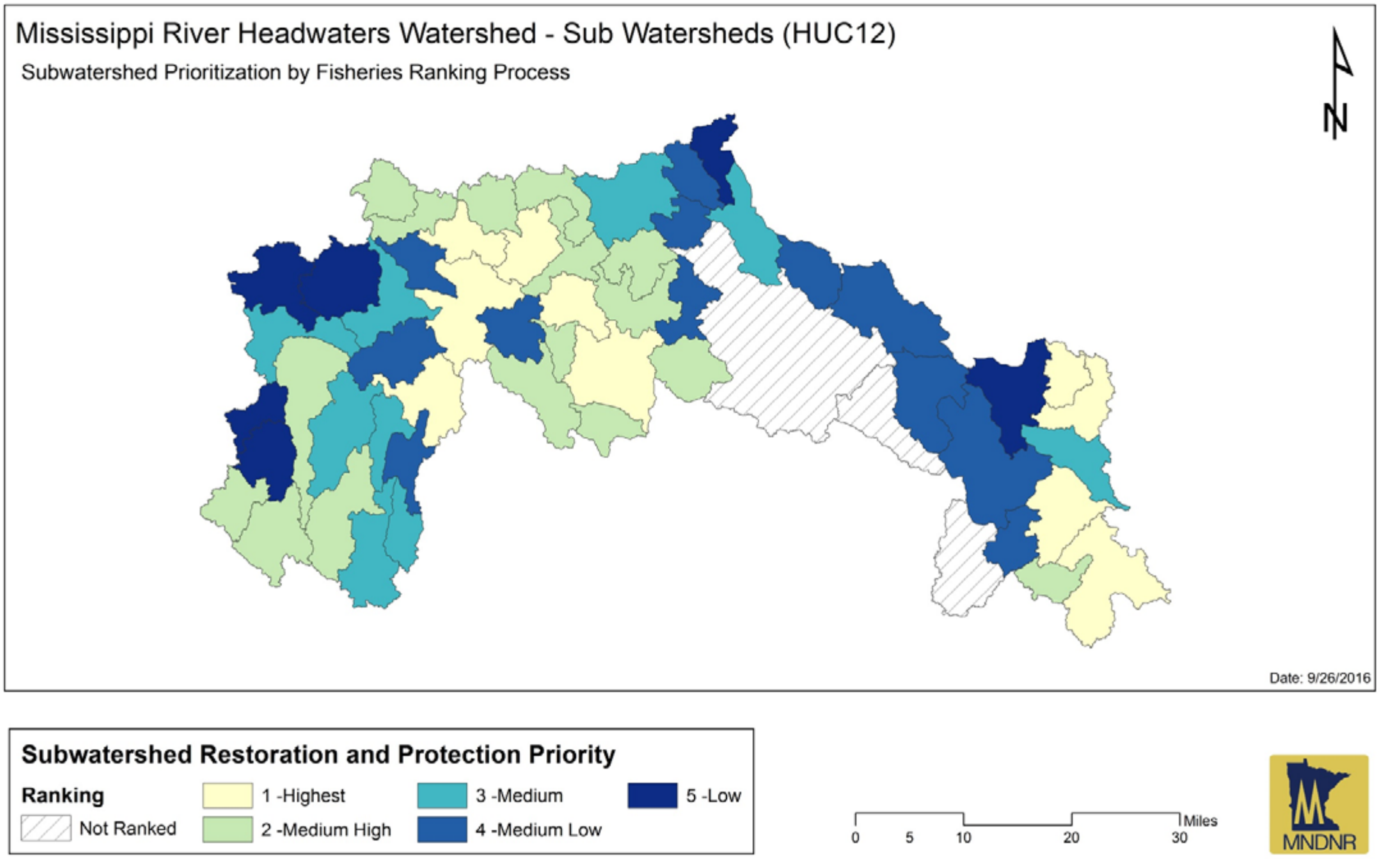
Table 12. Acreages of Best Use Classifications - MRHW School Trust Lands.

Best Use	Acres
Minerals	66,113.84
Forestry	37,936.01
Real Estate	26,220.83
Non- productive	18,493.16
Recreation	2,094.46
Stewardship	414.5
Total	**151,272.8**

Watershed prioritization information from DNR Fisheries

The existing fisheries within the MRHW are some of the finest in the state of Minnesota, and in the country. Protecting these resources is vital in sustaining the economy, the world class recreational opportunities, and the overall way of life within this watershed. The DNR Bemidji and Grand Rapids area fisheries offices provided prioritization information for the MRHW based on fishery management and protection considerations. The prioritization was completed on a HUC 12 level, and will help serve as an important tool in the consideration of the implementation of future strategies where multiple benefits such as fishery protection/enhancement can be achieved. See Figure 34

Figure 34. HUC 12 Prioritization by DNR Fisheries.



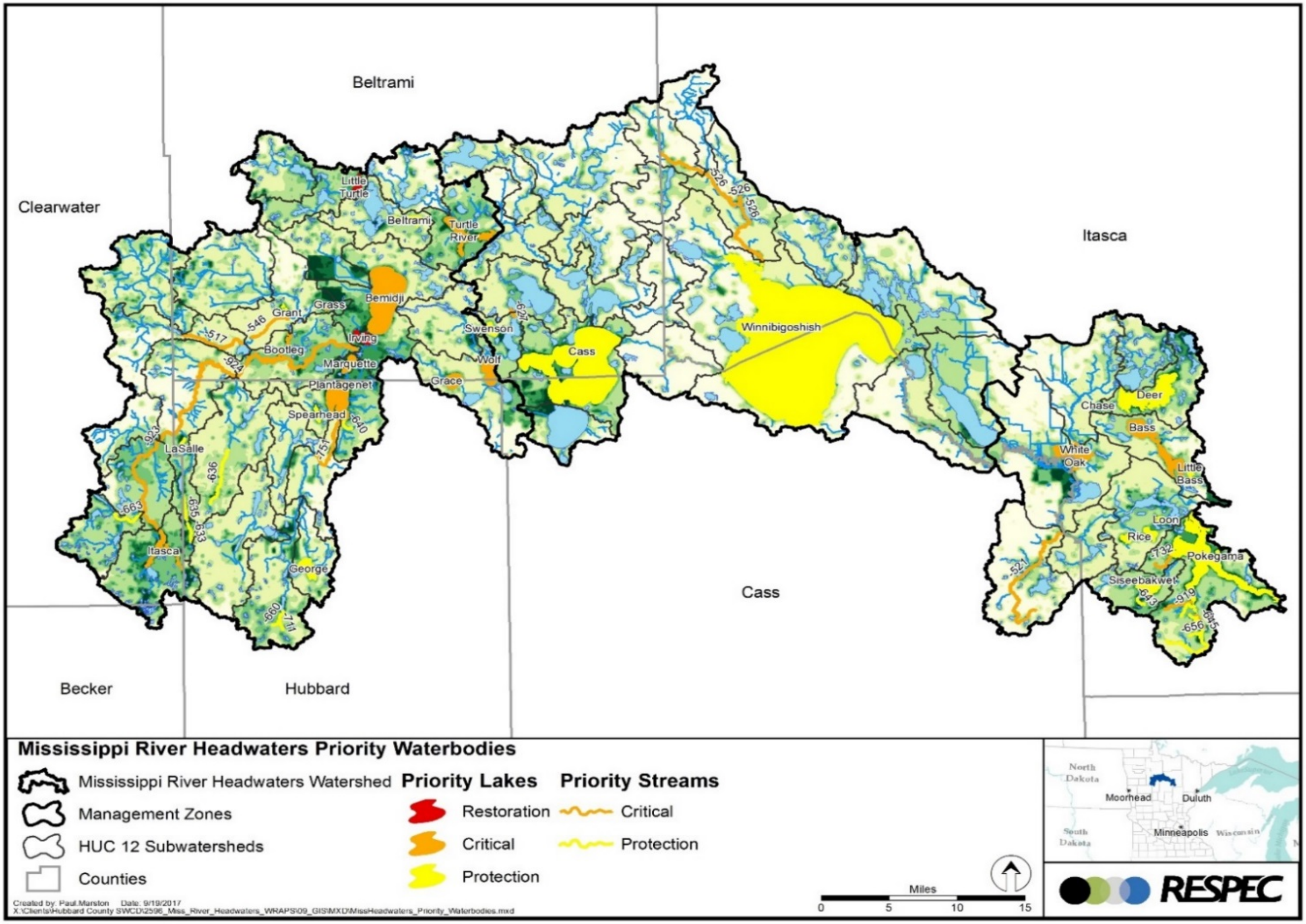
State and Regional Reports

Past work has been done by various levels of government to identify and quantify priority waterbodies in the area for future protection needs. To ensure all existing information is included within the WRAPS report, sensitive waterbodies identified in these various reports were flagged in the prioritization determination. Reports that were included are the Diagnostic Study of Deer Lake and Pokegama Lake by the ISWCD, the Cass County Large Lakes Summary by Cass County Environmental Services Department and the Minnesota Board of Soil and Water Resources (BWSR), the Lakes of Phosphorus Sensitivity Significance by the DNR, the Minnesota's Sensitive Lakeshore Identification Manual by the DNR, and the Comprehensive Management Plan by the MHB. In addition to the aforementioned reports, an important interagency report "Incorporating Lake Protection Strategies into WRAPS Reports" was initiated and developed over the course of the MRHW WRAPS and finalized in July 2017. This report was designed to help identify and prioritize lake protection efforts through a five-step process during the WRAPS process and beyond. Some of the interagency staff that were involved in developing this report were key participants in the development of components of the MRHW WRAPS, thus the steps described in this report are reflected in the MRHW WRAPS. This report will continue to serve as an important tool in helping to prioritize lake protection efforts within the MRHW as work moves towards the implementation of protection strategies and a BWSR-overseen future One Watershed, One Plan effort.

Priority Waterbody Determination

As discussed in section 2.5, protection efforts are the priority in the Mississippi River Headwater Watershed due to the high water quality. Prioritization was done for both lakes and streams with the methodology laid out in this section. The results of the prioritization are 26 priority lakes for protection, 2 priority lakes for restoration, and 26 priority streams for protection (Figure 35). For both lakes and streams, the protection waterbodies are split into two classifications, “Protection” and “Critical”. Waterbodies classified as a “Protection” priority are waterbodies that were identified in the prioritization process that have high water quality and require protection to remain at their current state. Waterbodies listed as a “Critical” priority are waterbodies that are not currently listed as impaired, but are either trending towards impairment, near impairment, or at risk to stresses that could result in an impairment. Restoration will be required for two lakes, Little Turtle Lake and Lake Irving, which are listed as impaired, and addressed in the TMDL study highlighted in Section 2.4 of this report. Table 15 shows the priority list of lakes, and Table 16 lists the priority streams in the MRHW.

Figure 35. Mississippi River Headwaters Watershed Priority Waterbodies



Priority Lake Determination

Identification of priority lakes in the MRHW (Table 13) was based on several factors including:

- Analysis of collected water quality data such as secchi disk data
- Geospatial analysis to identify waterbodies up stream of drinking water protection areas
- Identification of cisco, trout, and wild rice lakes
- Analysis of report results from the DNR such as biological significance ratings and cisco protection candidate
- MPCA's lake phosphorus sensitivity analysis
- Cass County Large Lakes Summary
- MHB County Priority Lakes Study
- Professional judgement of watershed stakeholders

The MRHW stakeholders used various resources to identify, locate, and prioritize lake protection actions. The specific resources and data used were Zonation (developed by DNR and the MPCA), water clarity trends, presence of sensitive fish species and wild rice, existing water quality/sensitivity reports, and the scenarios report. Combining the results from these tools provides a comprehensive analysis of sensitive water bodies based on previous research, current water quality, and relevance to the local community. A full list showing the tools and data that were included for determining priority waterbodies can be found in Appendix E, with the priority protection lakes highlighted in orange and the restoration lakes highlighted in red. Pokegama Lake and Grace Lake are outliers based on the analysis, but were included due to the recreational importance of Lake Pokegama and low fish IBI scores at Grace Lake, as determined from the DNR lake IBI analysis.

Table 13. Characteristics used to determine priority lakes in the Mississippi River Headwaters Watershed.

Lake Name	Acres	Lake ID	Water Quality Trend	Cisco Lake	Cisco Lake Pro-tection Candi-date	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Down-stream Drinking Water Protectio n	Site Specific Projects ID	Cass County Large Lakes Sum-mary	Lake Phos-phorus Sensitivity Analysis	Sensitivity Lakeshore ID	MHB County Priority Lakes	Near the Water Quality Threshold
Bass	2874.6	31-0576-00	Increasing	Yes		Yes	Outstanding	Yes				Higher	Yes		Yes
Beltrami	733.4	04-1350-00	Decreasing	Yes			Outstanding	Yes				Highest			
Bemidji	6600.8	04-1300-02	No Trend	Yes			Outstanding	Yes	Yes			Higher		Yes	Yes
Bootleg	385.1	04-2110-00		Yes		Yes	Outstanding	Yes				Higher		Yes	Yes
Cass	16399	04-0300-00	Decreasing	Yes		Yes	Outstanding				Vigilance	Highest			
Chase	220	31-0749-00		Yes	Yes		Outstanding	Yes				Highest			
Deer	4175	31-0719-00	Increasing	Yes			Outstanding	Yes		Yes		Highest			
George	829.7	29-0216-00		Yes		Yes	Outstanding	Yes				Highest			
Grace	870.8	29-0071-00	No Trend					Yes				Highest			
Grant	211.25	04-2170-00		Yes	Yes		Outstanding	Yes				Highest			
Grass	289.45	04-2160-00				Yes	Moderate	Yes	Yes			Highest			Yes
Irving	695.70	04-1400-00	No Trend	Yes		Yes	Outstanding	Yes	Yes						Impaired
Itasca	1153.98	15-0016-00		Yes		Yes	Outstanding	Yes				Higher			Yes
LaSalle	239.87	29-0309-00		Yes	Yes		Outstanding	Yes				High			
Little Bass	161.49	31-0575-00		Yes	Yes		High	Yes				Highest			
Little Turtle	497.47	04-1550-00	No Trend	Yes		Yes		Yes							Impaired
Loon	233.06	31-0571-00		Yes	Yes		Outstanding	Yes				Highest			
Marquette	553.235	04-1420-00		Yes		Yes	Outstanding	Yes	Yes			Highest			Yes
Plantagenet	2580.87	29-0156-00	No Trend	Yes		Yes	Outstanding	Yes				High			Yes
Pokegama	7022.03	31-0532-00	No Trend			Yes	Outstanding			Yes		Highest			
Rice	952.31	31-0717-00		Yes		Yes	Outstanding	Yes				Highest			
Sisee-bakwet	1222.92	31-0554-00	Increasing	Yes	Yes		Outstanding	Yes				Higher			
Spearhead	193.5	29-0239-00	No Trend	Yes	Yes		Outstanding	Yes				Higher			
Swenson	422.6	04-0850-00		Yes	Yes		Outstanding					Highest			

Lake Name	Acres	Lake ID	Water Quality Trend	Cisco Lake	Cisco Lake Pro-tection Candi-date	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Down-stream Drinking Water Protection	Site Specific Projects ID	Cass County Large Lakes Sum-mary	Lake Phos-phorus Sensitivity Analysis	Sensitivity Lakeshore ID	MHB County Priority Lakes	Near the Water Quality Threshold
Turtle River	1867.6	04-1110-00		Yes		Yes	Outstanding	Yes	Yes			Higher			Yes
White Oak	1959.5	31-0776-00				Yes	Outstanding	Yes				High		Yes	Yes
Winni-bigoshish	60483.3	11-0147-00		Yes		Yes	Outstanding	Yes			Vigilance	Higher			
Wolf	1101.1	04-0790-00		Yes			Outstanding	Yes				High		Yes	Yes

Priority Classification=	Protection Lakes	Restoration Lakes	Critical Lakes

Water Clarity Trends

Water clarity data is the most widely collected water quality data for lakes in the state. This data is collected for numerous lakes and spans a number of years, providing a robust dataset suitable for trend analysis to determine if water clarity in a given lake is improving, declining, or consistent. Water clarity data is useful by providing a general snapshot of the lakes' water quality in regard to sediment and nutrients. Lake clarity is measured using a Secchi disk, and data used for this analysis was collected by citizens through the MPCA's CLMP program. There were 60 lakes in the MRHW with sufficient data to be analyzed for trends using the seasonal Kendall test. For a more detailed summary of the trend analysis methodology and results see Section 2.2 of this report.

The results of the statistical analysis showed there are 11 lakes with an improving water clarity trend, 5 with a declining water clarity trend, with the remaining 44 showing no trend (Figure 36). This data was included in the priority determination by flagging lakes that showed a declining water clarity trend. Of the lakes showing a declining trend, three were included in the list of priority lakes for protection (Marquette, Cass, and Beltrami). The other two lakes with declining water clarity trends are Johnson, which did not meet other criteria, and Little Turtle, which is listed for restoration.

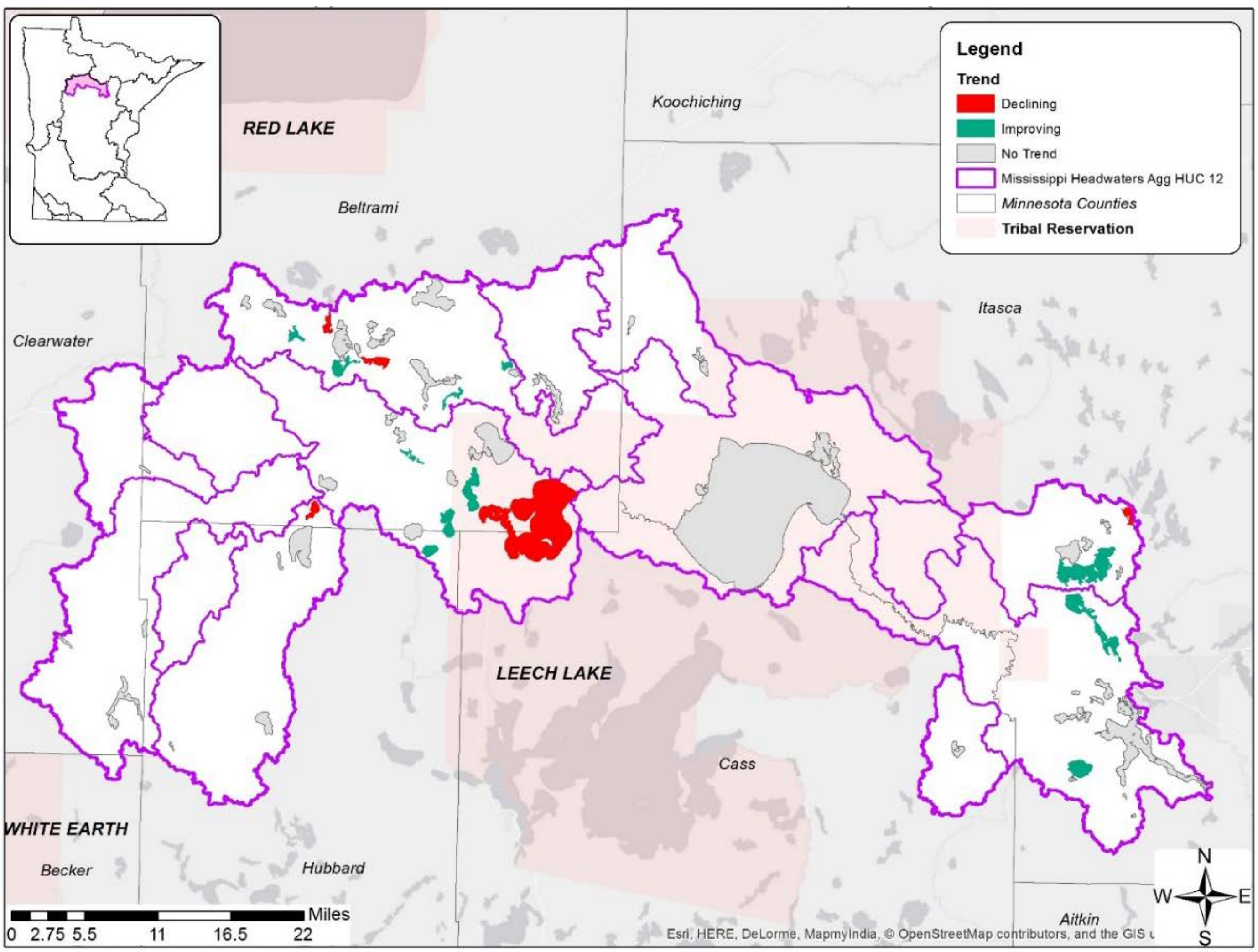


Figure 36. Map of Lake Transparency Trends in the MRHW

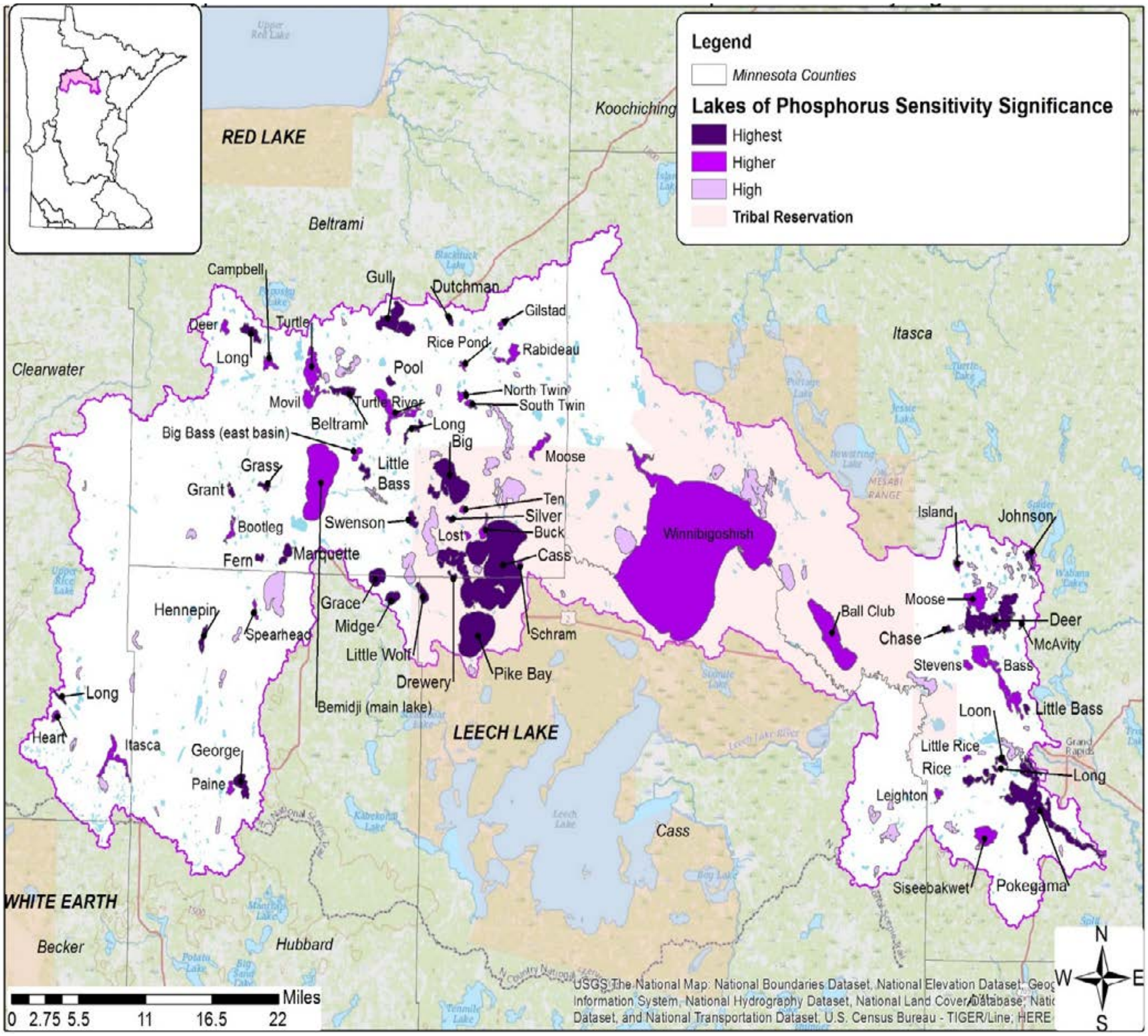
Phosphorus Sensitivity and Load Reduction Goals

Excess phosphorus loading is a major threat to many of Minnesota's lakes, and reducing or maintaining low nutrient pollution loads will be critical to achieving the state's clean water goals and protecting the water quality of the lakes in the MRHW.

Researchers at the DNR, MPCA, and BWSR developed a phosphorus pollution model that predicted annual phosphorus inputs to lakes, and a sensitivity model that ranked priority lakes statewide based on their sensitivity to additional phosphorus inputs and the significance of those inputs. The goal was to identify lakes that were not resilient to additional phosphorus pollution. Lakes were ranked and grouped based on phosphorus sensitivity, the significance of that sensitivity, and the presence of any negative trends in water clarity, and then assigned to one of three priority classes. The most sensitive lakes (highest sensitivity) identified would most likely see substantial declines in water clarity with increasing nutrient phosphorus inputs. The sensitivity ranking includes 2,194 lakes in Minnesota and was based on the latest phosphorus information. This study included 126 lakes in MRHW, of which 28 were within the top 500 ranked as the highest for phosphorus sensitivity, including Grass Lake, which ranked 14th overall. Large, sensitive, or vulnerable lakes near a phosphorus tipping point should be considered for the focus of immediate conservation efforts. Figure 37 shows the lakes with significant P sensitivity.

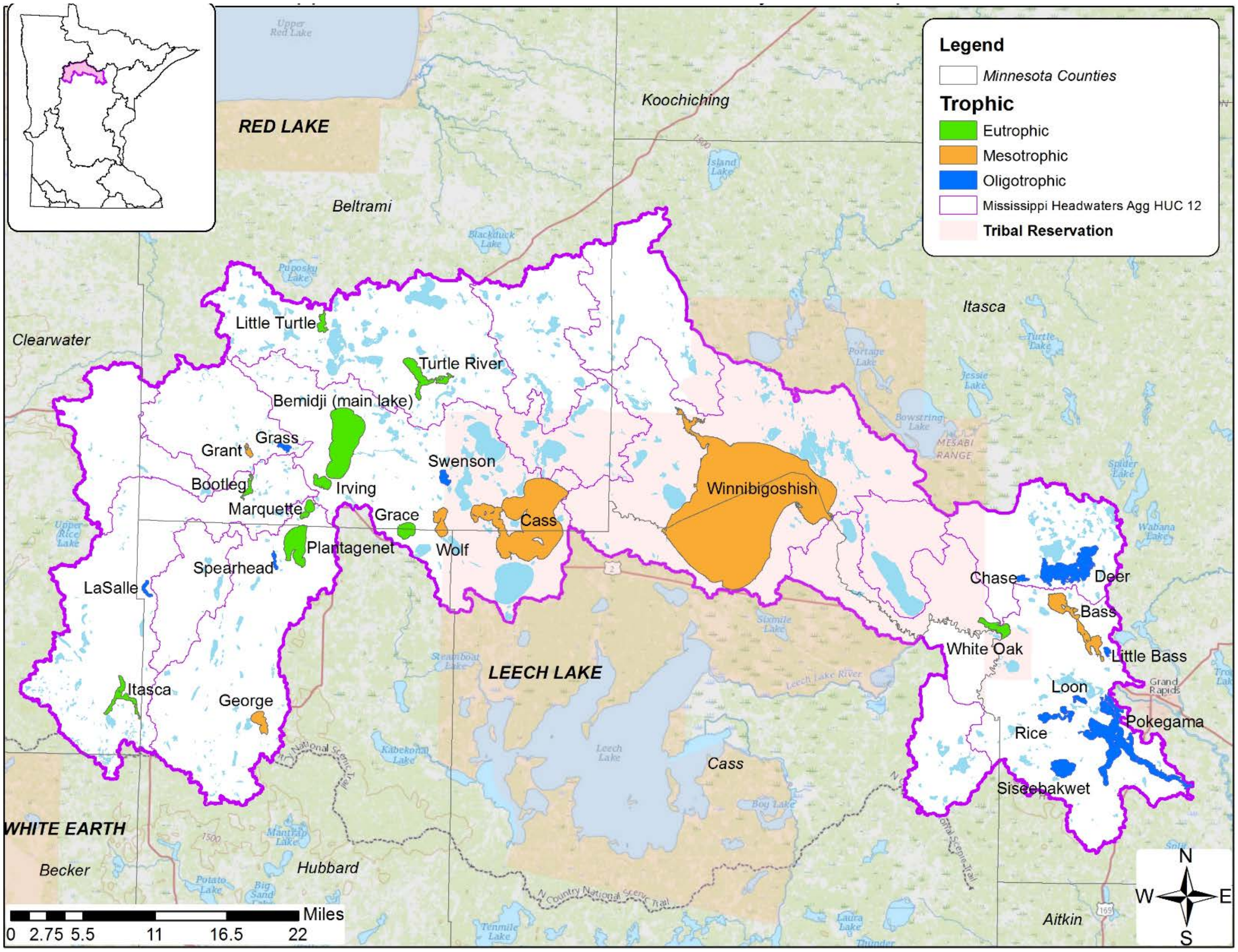
In following along with the evaluation criteria used in the state-wide phosphorus sensitivity study, a 5% phosphorus reduction goal will be set in the effort to maintain the high water quality of the lakes within the MRHW. While a 5% reduction in phosphorus input for a lake appears minor, achieving this phosphorus reduction goal would produce positive lake water quality benefits. The primary goal in this watershed is to maintain the current water quality status and improve where possible. Furthermore, a 5% reduction goal is achievable for many of the priority lakes and provides an incentive for citizen engagement in achieving those goals.

Figure 37. Mississippi River Headwaters Watershed Lakes of Phosphorus Sensitivity Significance.



The phosphorus sensitivity significance index generally produced high values for large, oligotrophic lakes that were vulnerable to phosphorus loading and near their estimated loading threshold and low values for small, hypereutrophic lakes with high estimated phosphorus loading and watershed disturbance. The trophic status of the MRHW WRAPS priority lakes is shown below in Figure 38.

Figure 38. MRHW Priority Lakes Trophic Status



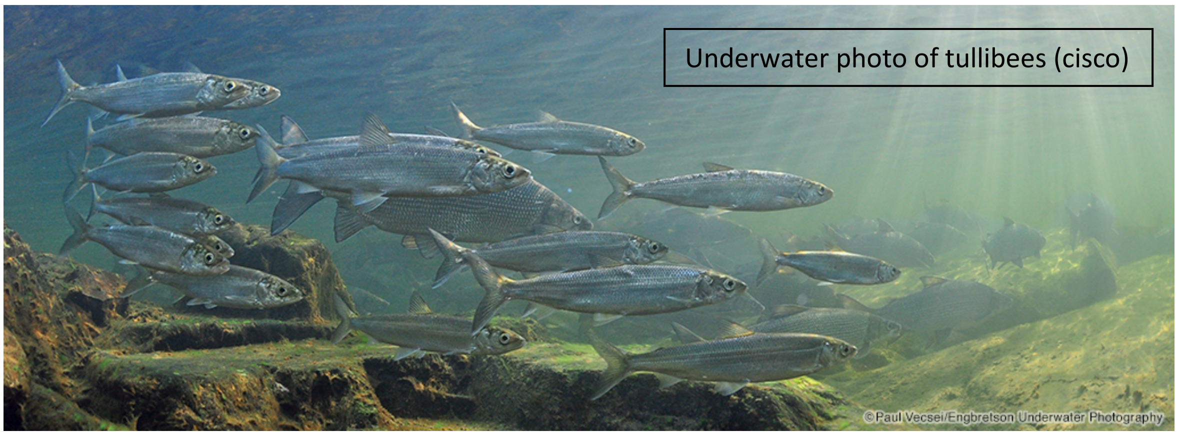
Waterbodies with Sensitive Fish Species and Wild Rice

Waterbodies that are of cultural and recreational significance to the area can be quantified by the presence of sensitive fish species and wild rice. To account for the significance of these waterbodies in the priority determination process, lakes with cisco populations, lakes identified as cisco refuge lakes by the DNR, lakes actively managed by the DNR for lake trout, and lakes with wild rice were flagged. Of the 26 lakes listed as a priority for protection, 22 of 26 have cisco populations, 8 are listed as cisco refuge lakes, 0 are managed trout lakes, and 12 are wild rice lakes.

Cisco Refuge Habitat

Cisco (Tullibee) is a cold water fish species that needs clean, cold and well-oxygenated water to survive. Ciscoes are exceptionally vulnerable to reduction in oxygen below the thermocline - the area in a thermally stratified lake that separates the warm surface waters from the cold deep water. Ciscoes are the most well distributed cold-water species across Minnesota lakes. The wide distribution of ciscoes in

Minnesota makes ciscoes a great indicator species to understand the potential effects of increased nutrient loading and/or climate change on Minnesota lakes. The DNR has completed an extensive study aimed at identifying and selecting potential cisco refuge lakes under projected warmer climate scenarios (Jacobson and Pereira 2010). The DNR categorized Minnesota lakes with a recorded history of cisco presence into three tiers: Tier 1 lakes have the most suitable cold-water fish habitat, Tier 2 lakes have suitable cold-water fish habitats, and Tier 3 lakes are marginal or unsuitable for cisco. Table 13 and Figure 39 show the eight Cisco Tier 1 categorized lakes in the MRHW.

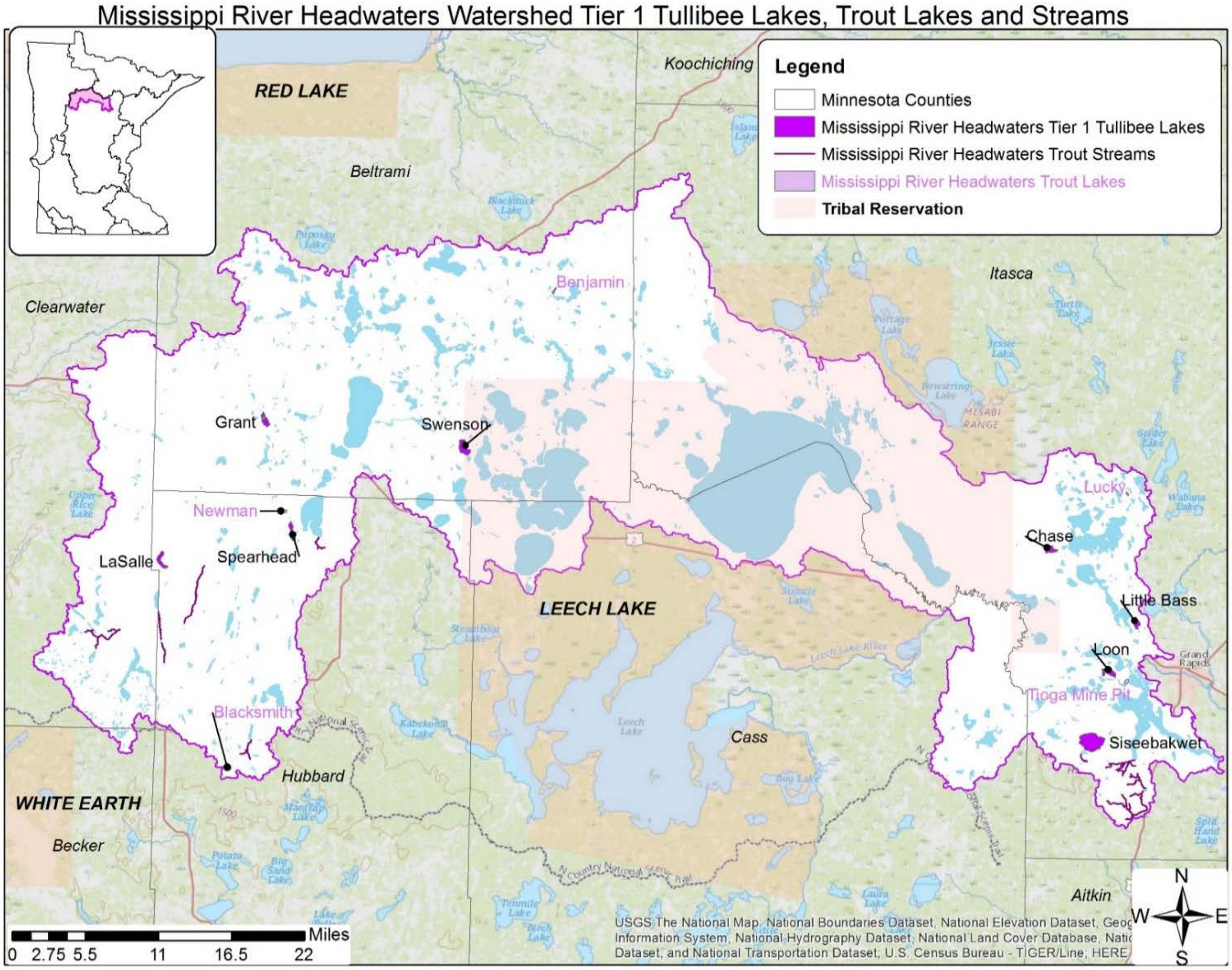


Underwater photo of tullibees (cisco)

Trout Lakes and Streams

Lake and stream trout need clean, cold water to survive. Poor watershed land use practices and ineffective septic systems can add too many nutrients to trout waters and upset the ecological balance that sustains trout habitat. Climate change is also a significant threat to trout habitat, with potential to warm water temperatures beyond trout tolerances. The DNR has done research to determine lakes that have the greatest likelihood of supporting coldwater species like stream and lake trout based on predicted future climate, and will focus efforts to maintain suitable land use in these watersheds through partnerships with non-profits and local governments. See Figure 39 for locations of trout lakes and streams within the MRHW.

Figure 39. MRHW Cisco Refuge Lakes, Trout Lakes and Streams



Wild Rice Lakes

Minnesota has more acres of natural wild rice (*Zizania palustris*) than any other state in the country. Wild rice has been historically documented in 45 of Minnesota's 87 counties and in all corners of the state. Anecdotal information suggests an even broader distribution prior to European settlement. Wild rice is an important social and cultural component for Native American tribes and rural Minnesota communities. See Figure 40 for locations of current wild rice lakes in the MRHW.

Source: http://www.dnr.state.mn.us/wildlife/shallowlakes/wildrice.html

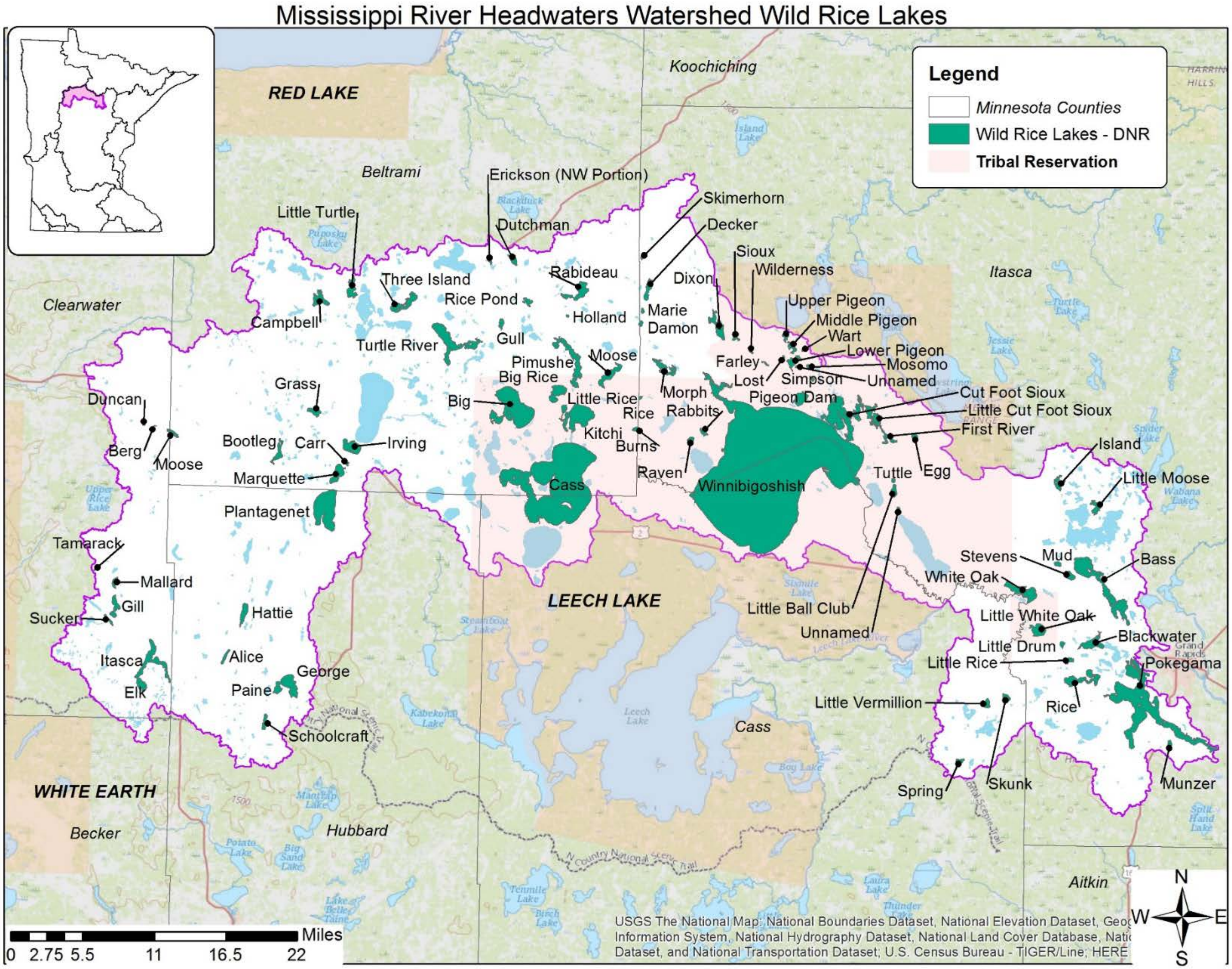
Wild rice is a persistent annual grass that reproduces each year from seed stock deposited in previous fall seasons. The plant typically grows in shallow to moderate water depths (1 to 3 feet), and is affected by water flow, turbidity, water quality and water level fluctuations. Wild rice is sensitive to varying water levels, and production in individual stands from year-to-year is highly variable depending on local water conditions. Wild rice beds are very attractive to migrating waterfowl, and many wild rice areas are traditional waterfowl staging and hunting areas.

Although many of the larger wild rice beds are actively managed, there is a perception that wild rice abundance and distribution have declined over time, especially in many of the smaller beds along the margins of lakes and streams.

A DNR assessment found over 1,200 lakes and rivers in 54 counties that currently contain or historically had wild rice thus showing an overall increase in wild rice acres. Over 64,000 acres of wild rice (out of roughly 2 million wild rice basin acres) were found on these waters. More than half of the acreage was found in Aitkin, Cass, Crow Wing, Itasca, and St. Louis counties.

Bed of wild rice in Northern Minnesota.

Figure 40. Mississippi River Headwaters Watershed Wild Rice Lakes



Lakes of Outstanding Biological Significance

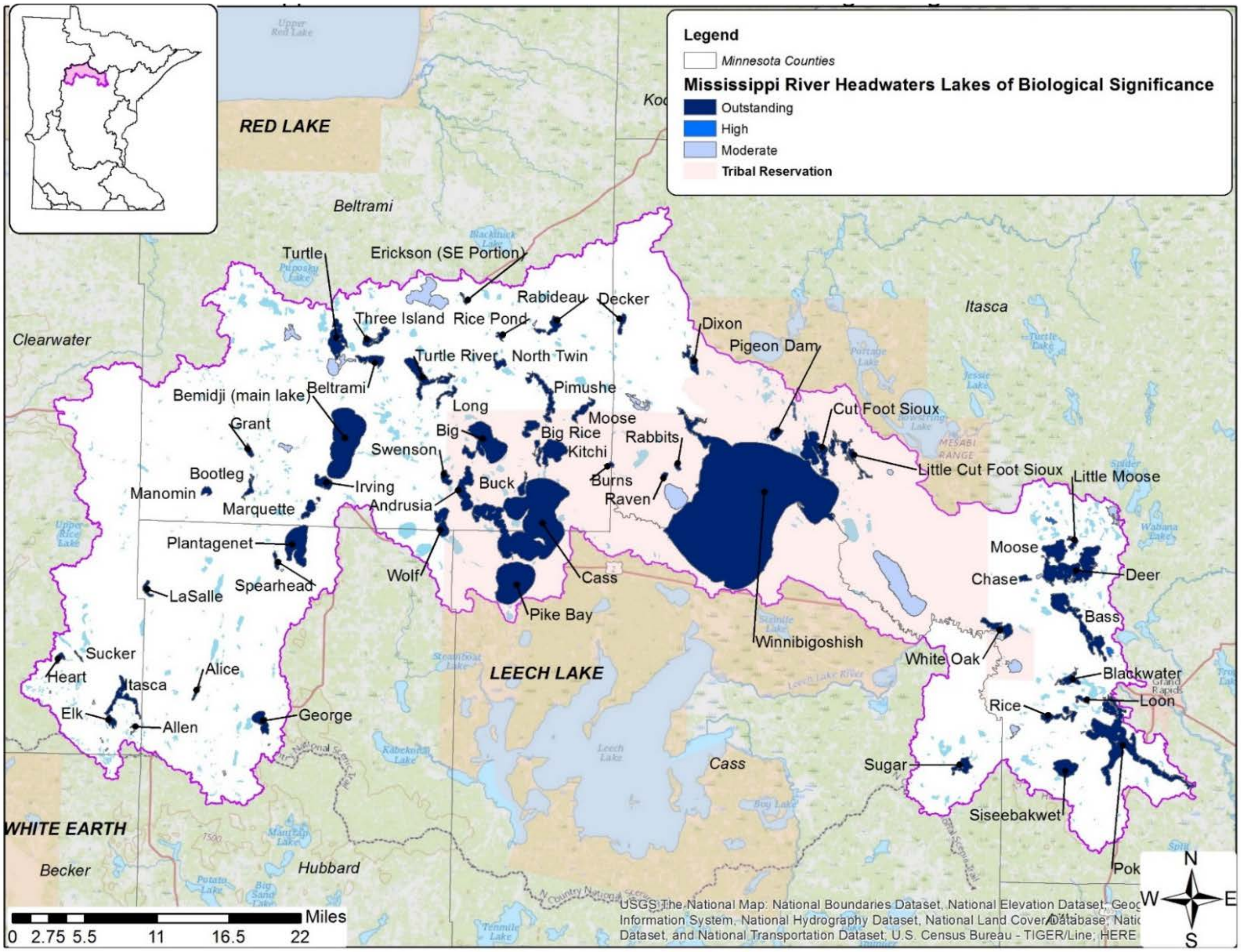
Many of the lakes in the MRHW are highly valued recreational lakes that are sensitive to changes in nutrient (phosphorus) loading and hydrology. The DNR conducted a statewide analysis of lakes of biological significance in 2015 based on dedicated biological sampling. This was measured based on the presence of unique aquatic life and resulted in a ranking system of outstanding, high, and moderate. For a summary of what factors were considered when classifying the samples lakes, see Table 14. This analysis identified 61 lakes in the MRHW that met the criteria for lakes of outstanding biological significance (Figure 41).

To be included in the priority determination, lakes were given a weighted priority flag for being included in the analysis, with "outstanding" being weighted the heaviest. Of the 28 priority lakes, 24 of the lakes were ranked as outstanding, 1 ranked as high, 1 ranked as moderate and two lakes were unranked (Table 13).

Table 14. Classes of Biological Significance (Source: DNR)

Outstanding	High	Moderate
• High aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant species. • Important wild rice lakes. • Exceptional fishery for selected game fish or an outstanding nongame fish community. • One or more of the following: endangered or threatened colonial water-bird nesting area, presence of several endangered, threatened, or special concern lake bird species, or six or more lake bird Species of Greatest Conservation Need.	• Two of the following: high aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant species. • Populations of more than one fish species of special concern and/or Species of Greatest Conservation Need. • One or more of the following: colonial water-bird nesting area, history of endangered or threatened colonial water-bird nesting, presence of endangered, threatened, or special concern lake bird species, or five lake bird Species of Greatest Conservation Need. • Mudpuppy presence.	• High aquatic plant richness, high floristic quality, or a population of an endangered or threatened plant species. • Populations of one fish species of special concern and/or fish Species of Greatest Conservation Need. • One or more of the following: history of colonial water-bird nesting, presence of an endangered, threatened, or special concern lake bird species, or several lake bird Species of Greatest Conservation Need.

Figure 41. All lakes of biological significance in the MRHW.



Drinking Water Protection

Drinking water protection was considered in the priority determination by looking at the wellhead protection areas in the MRHW. While there are no surface waterbodies located within the wellhead protection areas, these areas were considered in the prioritization (e.g. Zonation) process where applicable.

Water Quality Analysis

In addition to water clarity trends, water quality data was analyzed to determine which lakes were nearing the water quality standards for TSS, TP and DO. Due to the overall high water quality across the watershed it is important to identify which lakes may be nearing the water quality standards to ensure no lakes are added to the impairment listing in the future. Analysis of the water quality data shows multiple lakes with values that fell below the standards for TSS, TP, and DO. The low values were not sustained, which prevented certain lakes from being listed as impaired, but low values indicate protection efforts are needed to prevent these lakes from degrading further and resulting in an impairment listing. Lakes identified as having sampled values near or below water quality standards are flagged in the prioritization considerations and include Wolf Lake, Turtle River Lake, Lake Bemidji, Beltrami Lake, Lake Marquette, Bootleg Lake, Grass Lake, Lake Itasca, Lake Plantagenet, Loon Lake, Bass Lake, and White Oak Lake.

Scenario Report

As discussed at the beginning of this section, a series of land use changes were simulated using the HSPF model to determine possible water quality impacts. For inclusion into priority determination, lakes that are located in subwatersheds that were identified in the scenarios report as being susceptible to detrimental future land use changes, such as forested land changing to urban or agriculture, were flagged for priority considerations. Of the priority lakes, 23 of the 26 protection lakes and both restoration lakes are located in a subwatershed identified in the scenarios report as being susceptible to future detrimental land use changes.

Priority Lake Final Output

Table 15 is the culmination of the lake prioritization process the watershed stakeholder group developed. As noted earlier in the Priority Lake Determination section, parameters were used to rank the quality of any given lake in respect to the rest of the lakes in the headwaters watershed. These factors were weighted and summed to reach a “comprehensive score” that determined the highest priority lakes. Lakes that are deemed impaired such as Little Turtle and Irving are listed under the priority designation of “Restoration”. Lakes not already deemed impaired, but that scored high in the priority analysis mentioned above and that show Secchi depths and TP values that are close to or past the standards, are listed under the priority designation of “critical”. The remaining lakes that do not indicate water quality values close to the standard, and that are ranked highly in the priority analysis, are designated under the “protection” designation.

Table 15. Priority Lakes in the Mississippi River Headwaters Watershed.

Priority Classification	Lake Name	Lake ID	Acres
Protection	Beltrami	04-0135-00	733
	Cass	04-0030-00	16399
	Chase	31-0749-00	220
	Deer	31-0719-00	4175
	George	29-0216-00	830
	Grant	04-0217-00	211
	LaSalle	29-0309-00	240
	Little Bass	31-0575-00	161
	Loon	31-0571-00	233
	Pokegama	31-0532-00	7022
	Rice	31-0717-00	952
	Siseebakwet	31-0554-00	1223
	Spearhead	29-0239-00	193
	Swenson	04-0085-00	423
	Winnibigoshish	11-0147-00	60483
Critical	Bass	31-0576-00	2875
	Bemidji	04-0130-02	6601
	Bootleg	04-0211-00	385
	Grace Lake	29-0071-00	871
	Grass	04-0216-00	289
	Itasca	15-0016-00	1154
	Marquette	04-0142-00	553
	Plantagenet	29-0156-00	2581
	Turtle River	04-0111-00	1868
	White Oak	31-0776-00	1960
	Wolf	04-0079-00	1101
Restoration	Irving	04-0140-00	696
	Little Turtle	04-0155-00	497

Priority Stream Determination

The MRHW stakeholders used various resources to identify, locate, and prioritize stream protection actions. Considerations used in the prioritization determination include identifying trout streams, subwatersheds prone to future detrimental land use conversion, exceptional use streams based on biological sampling, and water quality analysis. Combining the results from the analysis of these considerations provides a comprehensive listing of sensitive water bodies based on previous research, current water quality, and relevance to the local community

(Table 16). A full list showing the results of this analysis that resulted in determining the priority waterbodies can be found in Appendix F with the priority protection streams highlighted in orange.

Trout Streams

Streams provide many recreational opportunities, which was important to quantify as a part of the prioritization determination. To do this, trout streams were flagged to identify streams, which provide desirable fisheries. Of the 26 priority streams, 17 are identified as trout streams. See Figure 39.

Scenario Report

For inclusion in priority determination, streams that are located in subwatersheds that were identified in the scenarios report as being susceptible to future detrimental land use changes, such as forested land changing to urban or agriculture, were flagged for priority considerations. Of the priority streams, 25 of the 26 streams are located in a subwatershed identified in the scenarios report as being more susceptible to future detrimental land use changes.

Exceptional Use

As a part of the MPCAs tiered aquatic life uses (TALU) framework, streams are ranked based on their sampled biologic communities. Following monitoring in the MRHW, it was determined that the Schoolcraft River (reach (07010101-751) is an Exceptional Use stream based on the abundance and richness of the sampled taxa (Figure 42). This was flagged as a part of the priority determination to ensure this pristine waterbody in the watershed is protected and maintains its exceptional listing.

Figure 42. Schoolcraft River, Hubbard County

Water Quality Analysis

Water quality data was analyzed to determine which streams were nearing the water quality standards for TSS, TP, and DO. Due to the overall high water quality across the watershed it is important to identify which streams may be nearing the water quality standards to ensure no streams are added to the impairment listing in the future. Analysis of the water quality data shows multiple streams with values that fell below the standards for TSS, TP, and DO. The low values were not sustained, which prevented certain streams from being listed as impaired, but low values indicate protection efforts are needed to prevent these streams from degrading further and resulting in an impairment listing. Streams identified as having values near or below water quality standards are flagged in the prioritization considerations and include stream reaches 07010101-645, -659, -751, -517, -521, -923, -526, -732, -546, -924, and -627.

Priority Stream Final Output

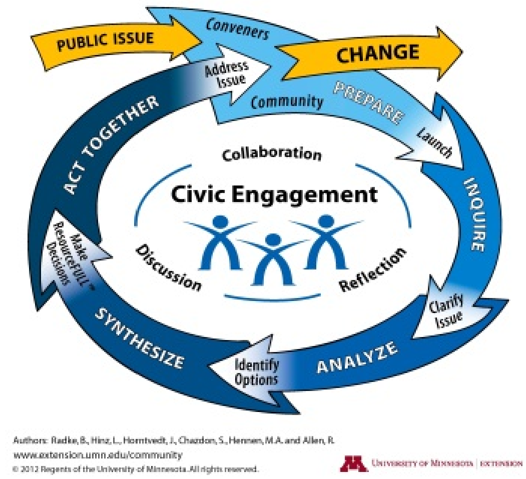
The result of the above prioritization actions resulted in the list of prioritized streams below (Table 16).

Table 16: Priority Streams in the Mississippi River Headwaters Watershed

Priority Classification	Stream Name	AUID	Stream Length (mi)	Reach Description
Protection	LaSalle Creek	07010101-633	1.71	T143 R35W S6, south line to Unamed Lk (29-0302-00)
	LaSalle Creek	07010101-635	2.33	Unnamed Lk (29-0302-00) to T144 R35W S19, west line
	Hennepin Creek	07010101-636	5.59	T144 R35W S21, south line to T145 R35W S34, east line
	Cold Creek	07010101-640	1.54	T145 R33W S19, east line to Lk Plantagenet
	Unnamed creek (Siseebakwet Creek)	07010101-643	0.93	Headwaters to South Sugar Lk (31-0555-00)
	Smith Creek	07010101-644	6.23	Headwaters to Smith Lk
	Unnamed creek	07010101-656	1.05	Headwaters to Smith Cr
	Schoolcraft River (Schoolcraft Creek)	07010101-660	1.76	Headwaters to Schoolcraft Lk
	Sucker Creek	07010101-663	2.39	Gould Cr to Mississippi R
	Sucker Creek	07010101-664	1.15	Sucker Lk to Gould Cr
	Unnamed creek (Little Pokegama Creek)	07010101-696	0.33	Headwaters to Unnamed Cr
	Unnamed creek (Schoolcraft River Tributary)	07010101-711	0.82	Headwaters to Schoolcraft R
	Unnamed creek (Matuska's Creek)	07010101-917	0.69	Headwaters to Smith Cr
	Unnamed creek (Smith Creek Tributary)	07010101-918	1.15	Headwaters to Smith Cr
	Unnamed creek (Little Pokegama Creek)	07010101-919	1.44	Unnamed Cr to Little Pokegama Lk
Critical	Little Mississippi River	07010101-517	8.73	Moose Lk to Grant Cr
	Vermillion River	07010101-521	15.59	Headwaters to Mississippi R
	Third River	07010101-526	24.82	Skimmerhorn Lk to Lk Winnibigoshish
	Grant Creek	07010101-546	4.25	Grant Lk outlet to Unnamed Cr
	Big Lake Creek	07010101-627	1.2	Lk Andrusia to Big Lk
	Smith Creek	07010101-645	1.65	Smith Lk to Little Pokegama Lk
	Unnamed creek (Pokegama Creek)	07010101-659	2.73	Headwaters to Sherry Lk
	Unnamed creek	07010101-732	2.17	Headwaters to Pokegama Lk
	Schoolcraft River	07010101-751	7.78	Frontenac Cr to Plantagenet Lk
	Mississippi River	07010101-923	29.57	Headwaters to Unnamed Cr
	Mississippi River	07010101-924	28.6	Unnamed Cr to Schoolcraft R

3.2 Civic Engagement

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



Stakeholder and WRAPS Team Meetings

The MRHW WRAPS process was guided by a variety of stakeholders involved at various levels throughout the course of the project. They were both informed and given many opportunities to provide input on the restoration and protection of water quality within the MRHW. These stakeholders included representatives of local governments (SWCD, county, township and municipal), LLBO, the business and education community, interested public, and numerous professionals from various state government agencies. Other essential partners included representatives from the U.S. Forest Service (Chippewa National Forest), Natural Resource Conservation Service, lake associations and non-profit organizations.

A CE stakeholder team was formed early in the WRAPS process and played an integral role throughout the course of the project. Early CE efforts were geared towards planning and hosting two watershed kick-off events (Cass Lake (Figure 43) and Deer River). After the kick-off events, the CE stakeholder team met several times to develop a CE strategic plan using a "strategic doing" model developed and facilitated by the University of Minnesota Watershed Planning Team. The model mapped assets (local expertise, relationships, organized coalitions, champions, ongoing communications, and past efforts with influence) for effective CE in the watershed. The plan helped guide CE activities throughout the remainder of the project. The CE stakeholder Team was also involved in a scoping session facilitated by the University of Minnesota Extension staff to identify other education opportunities in the community that Extension could assist with delivery.

The CE Stakeholder Team coordinated a “Values-Driven” Conservation Priorities mapping project referred to as the “Zonation Model”; details can be found in Section 3.1. The four-step process of selecting conservation features for the map data layers, value weighting of the features, running the map algorithms, and synthesizing the data took place from May 2014 through December 2015. The final model was a valuable tool used to identify priority areas within the watershed on which to focus restoration and protection activities.

Figure 43. MRHW Watershed Kickoff (West) brochure for Pike Bay Town Hall Event, Cass Lake MN.

The MPCA along with local partners and engaged stakeholders realized the importance of public involvement in the MRHW WRAPS process. Throughout the WRAPS process, a number of public and team meetings were held, along with project updates communicated to stakeholders and publicized and/or broadcasted through local media outlets. These outlets included newsletters and websites of several watershed partner organizations. Since the waters of the MRHW are predominantly pristine and healthy, the general overall CE theme for the project was “Pristine Lakes and Waters for Future

Generations". CE activities focused on growing a communications network for the public and targeted stakeholders, while establishing a watershed identify that would help build ownership and incentives to further engage watershed stakeholders/interested citizens in the future implementation of water quality restoration and protection strategies, as identified in this WRAPS and other watershed partners' complementary plans.

Table 17 is a chronology of public and stakeholder meetings held since the WRAPS kickoff in February 2013.

Table 17. Public and Stakeholder meetings for the MRHW WRAPS.

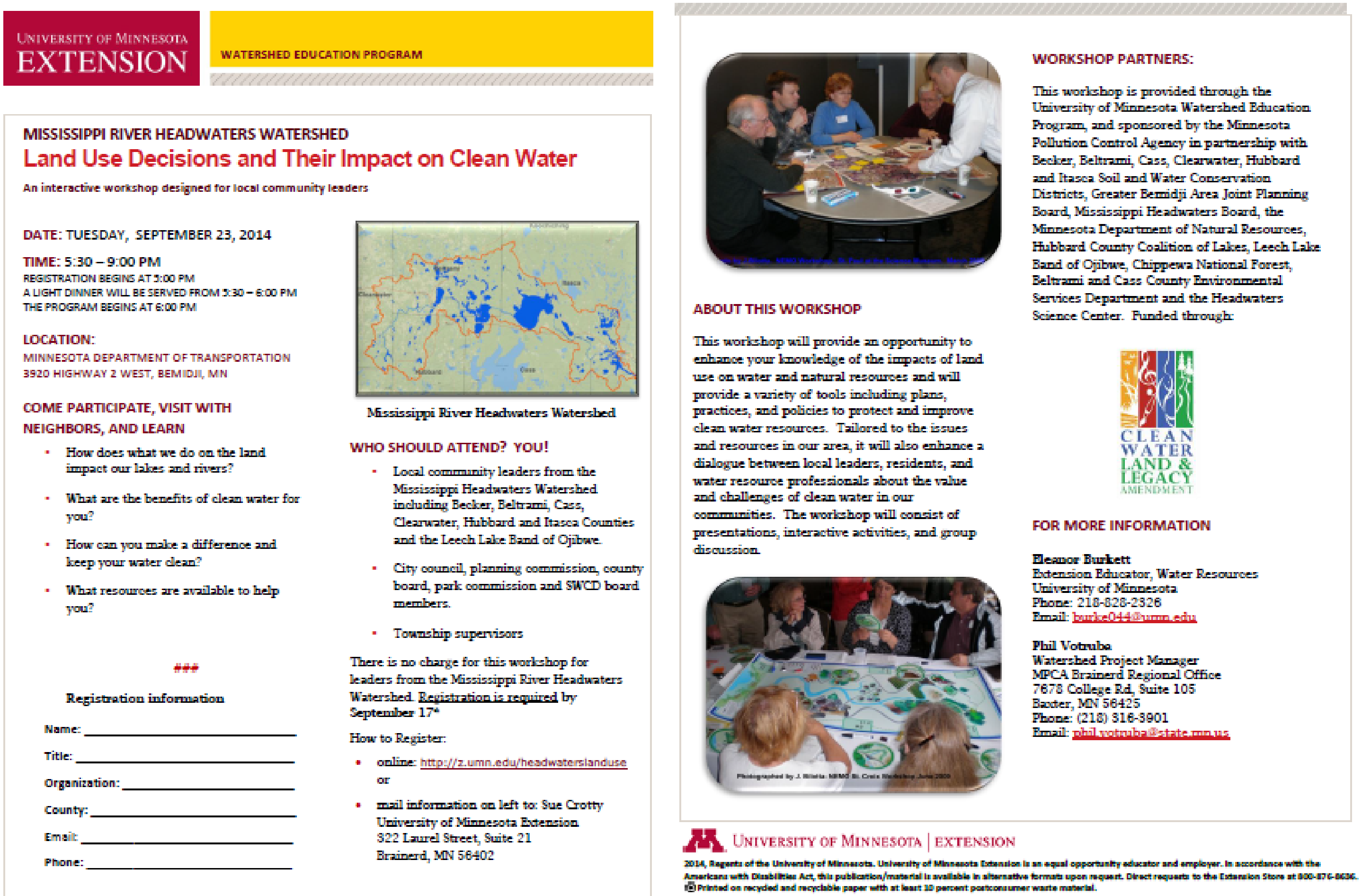
Date	Location	Focus of Meeting
2/5, 5/3, 5/15 5/29/2013	Conference call(s) (CC)	Watershed Kickoff event planning calls/discussion
6/4/2013	Cass Lake – Pike Bay Town Hall	Mississippi River Headwaters (MRH) – WRAPS Kick-Off Public Meeting (West)
6/6/2013	Deer River High School	MRH – WRAPS Kick-Off Public Meeting (East)
7/30/2013	Brainerd, MN	HSPF modeling meeting for the Pine River, Leech Lake River & Mississippi River Headwaters watersheds
9/27/2013	Bemidji, MN	Minnesota SWCD Area VIII annual conference – WRAPS/water quality presentation
10/21/2013	Bemidji, MN	MRH WRAPS Stakeholder meeting
12/6/2013	Bemidji, MN	MRH WRAPS Civic Engagement (CE) planning meeting
1/29/2014	CC	MRH WRAPS CE planning discussion
2/18/2014	Bemidji, MN	MRH WRAPS CE strategic planning meeting
2/26/2014	Guthrie, MN	Hubbard County Grazing Workshop
3/18/2014	CC	MRH WRAPS CE strategic planning discussion
4/17/2014	CC	MRH WRAPS – Nonpoint Education for Municipal Official (NEMO)/Nonpoint Education for Rural officials (NERO) planning discussion
4/22/2014	Bemidji, MN	MRH Stressor Identification meeting with DNR
5/7/2014	CC	MRH WRAPS CE strategic planning discussion
5/29/2014	Bemidji, MN	Zonation Model- Stakeholder Initial meeting
6/16/2014	CC	MRH WRAPS NEMO/NERO planning session
7/10/2014	Bemidji, MN	MRH WRAPS Zonation Model - Survey preparation
7/14/2014	CC	MRH WRAPS NEMO/NERO planning session
7/21/2014	CC	MRH WRAPS CE Stakeholder Team discussion
8/18/2014	CC	MRH WRAPS NEMO/NERO planning session
9/3/2014	CC	MRH WRAPS NEMO/NERO planning session
9/23/2014	MnDOT, Bemidji, MN	MRH WRAPS NEMO/NERO training session
10/10/2014	CC	MRH WRAPS NEMO/NERO final wrap up session
10/31/2014	CC	MRH WRAPS CE strategic planning discussion
11/13/2014	CC	MRH WRAPS CE strategic planning discussion
1/22/2015	CC	MRH WRAPS CE/Core Team discussion
2/22/2015	Guthrie, MN	Hubbard County Grazing Workshop
2/25/2015	CC	MRH WRAPS Core Team discussion
6/8/2015	CC	Discussion- DNR Forest Disturbance project (MissR Headwaters & Rum River Watersheds)

Date	Location	Focus of Meeting
6/18/2015	Bemidji, MN	Professional Judgement Group meeting – Review of MRH watershed assessments
7/16/2015	CC	MRH WRAPS Core Team discussion on watershed assessments
10/1/2015	Brainerd, MN	Upper Mississippi River (Large River) Watershed Assessment Team mtg.
10/19/2015	Bemidji, MN	Watershed HSPF Scenario discussion and Zonation Modeling results mtg.
11/19/2015	CC	MRH WRAPS Core Team discussion on HSPF watershed scenarios
12/10/2015	Bemidji, MN	Zonation Modeling synthesis and HSPF Scenario results presentation
1/13/2016	Brainerd, MN	Upper Mississippi River (Large River)- Professional Judgement Group mtg.
2/10/2016	Guthrie, MN	Hubbard County Grazing Workshop
2/18/2016	Bemidji, MN	TMDL stormwater discussion with City of Bemidji
3/30/2016	Bemidji, MN	MRH WRAPS Stakeholder/Core Team meeting
5/23/2016	Brainerd, MN	Radio interview for MN Public Radio on general water quality issues in northern MN
6/9/2016	CC	MRH WRAPS CE planning discussion
7/11/2016	Bemidji, MN	Presentation on the MRH WRAPS/TMDL to the Beltrami County Board of Commissioners & City Of Bemidji (joint meeting)
8/8/2016	Brainerd, MN	WebEx presentation of the general background of the MRH WRAPS project and the process/results of the MRH WRAPS Zonation Modeling effort
10/5/2016	Cohasset, MN	Protecting High Quality Resources in the Mississippi Headwaters Watershed – with focus on HSPF watershed scenarios
12/7/2016	Cohasset, MN	Presentation on the MRH WRAPS/TMDL project to the City of Cohasset Planning & Zoning Committee
1/2/2017	Brainerd, MN	Radio interview for KAXE Radio on the MRH WRAPS/TMDL project and general water quality issues in northern MN
1/12/2017	Bemidji, MN	Public meeting on the MRH WRAPS/TMDL project, priority planning focus
1/26/2017	Cohasset, MN	Public meeting on the MRH WRAPS/TMDL project, priority planning focus
2/20/2017	Bemidji, MN	Presentation on the MRH WRAPS/TMDL project to the Bemidji Rotary Club
2/28/2017	Guthrie, MN	Hubbard County Grazing Workshop
6/12/2017	Bemidji, MN	Presentation on the MRH WRAPS/TMDL project (Lake Irving TMDL) to the City of Bemidji
6/20/2017	Bemidji, MN	Public meeting on the MRH WRAPS/TMDL project (focus on MRH TMDLs)
7/20/2017	Bemidji, MN	Presentation on the MRH WRAPS/TMDL project at the Beltrami SWCD monthly Board meeting
8/16/2017	Brainerd, MN	Radio interview for KAXE Radio on the MRH WRAPS/TMDL project and general water quality issues impacting Lake Bemidji and Lake Irving
9/13/2017	Bemidji, MN	Governor Town Hall 25% by 2025 meeting – Bemidji State University
10/13/2017	Bemidji, MN	Water quality presentation (including MRH WRAPS/TMDL project) at the Minnesota Association of Planning & Zoning Administrators – Annual Conference

Accomplishments and Future Plans

Phase I CE activities were focused on informing the public and stakeholders about the WRAPS and the IWM effort taking place within the MRHW. Initially efforts were geared towards planning for a watershed kickoff event(s). Due to the large nature of the watershed, two watershed kickoff meetings (Cass Lake and Deer River) were held in June 2013. These events successfully helped set the stage for the project by bringing stakeholders together to listen to and discuss water quality issues and concerns, while establishing relationships that would carry forward through the project and beyond. Identifying key stakeholders within the watershed was an important element in Phase I, as these stakeholders were put on the contact list for the project and were kept informed throughout the course of the WRAPS process. A CE team was developed early in the project, which in turn served in a leadership capacity in planning for WRAPS CE efforts. This CE team met and/or had discussions several times early in the WRAPS, which helped build a strong collaborative leadership foundation for the project. To help in the overall development of the CE plan for the WRAPS, staff from the University of Minnesota (U of M) Extension (Leadership and CE Division) worked with the CE team. Through this consultation, the CE team developed a CE plan using the "strategic doing" model with a mission statement of "Pristine Lakes and Waters for Future Generations". The CE Team also worked with the U of M Extension to plan and host a Nonpoint Education for Municipal Official (NEMO)/Nonpoint Education for Rural officials (NERO) session, which was held at MnDOT facility in Bemidji (see Figure 44). This event was well attended and included interactive activities where attendees had the opportunity to participate in the "Watershed Game".

Figure 44. Brochure for Nonpoint Education for Municipal/Rural Officials.


UNIVERSITY OF MINNESOTA EXTENSION

WATERSHED EDUCATION PROGRAM

MISSISSIPPI RIVER HEADWATERS WATERSHED

Land Use Decisions and Their Impact on Clean Water

An interactive workshop designed for local community leaders

DATE: TUESDAY, SEPTEMBER 23, 2014

TIME: 5:30 – 9:00 PM
REGISTRATION BEGINS AT 5:00 PM
A LIGHT DINNER WILL BE SERVED FROM 5:30 – 6:00 PM
THE PROGRAM BEGINS AT 6:00 PM

LOCATION:
MINNESOTA DEPARTMENT OF TRANSPORTATION
3920 HIGHWAY 2 WEST, BEMIDJI, MN

COME PARTICIPATE, VISIT WITH NEIGHBORS, AND LEARN

- How does what we do on the land impact our lakes and rivers?
- What are the benefits of clean water for you?
- How can you make a difference and keep your water clean?
- What resources are available to help you?

###

Registration information

Name: ______________________
Title: ______________________
Organization: ______________________
County: ______________________
Email: ______________________
Phone: ______________________

Mississippi River Headwaters Watershed

WHO SHOULD ATTEND? YOU!

- Local community leaders from the Mississippi Headwaters Watershed including Becker, Beltrami, Cass, Clearwater, Hubbard and Itasca Counties and the Leech Lake Band of Ojibwe.
- City council, planning commission, county board, park commission and SWCD board members.
- Township supervisors

There is no charge for this workshop for leaders from the Mississippi River Headwaters Watershed. Registration is required by September 17th

How to Register:

- online: http://z.umn.edu/headwaterslanduse
  or
- mail information on left to: Sue Crotty
  University of Minnesota Extension
  322 Laurel Street, Suite 21
  Brainerd, MN 56402

ABOUT THIS WORKSHOP

This workshop will provide an opportunity to enhance your knowledge of the impacts of land use on water and natural resources and will provide a variety of tools including plans, practices, and policies to protect and improve clean water resources. Tailored to the issues and resources in our area, it will also enhance a dialogue between local leaders, residents, and water resource professionals about the value and challenges of clean water in our communities. The workshop will consist of presentations, interactive activities, and group discussion.

WORKSHOP PARTNERS:

This workshop is provided through the University of Minnesota Watershed Education Program, and sponsored by the Minnesota Pollution Control Agency in partnership with Becker, Beltrami, Cass, Clearwater, Hubbard and Itasca Soil and Water Conservation Districts, Greater Bemidji Area Joint Planning Board, Mississippi Headwaters Board, the Minnesota Department of Natural Resources, Hubbard County Coalition of Lakes, Leech Lake Band of Ojibwe, Chippewa National Forest, Beltrami and Cass County Environmental Services Department and the Headwaters Science Center. Funded through:

CLEAN WATER LAND & LEGACY AMENDMENT

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The second phase of the WRAPS project brought forth numerous opportunities to engage with the public, while communicating the water quality status of the watershed and gathering stakeholder/citizen input on water quality restoration and protection strategies. One of these opportunities was coordinated by the DNR through the Schoolcraft Learning Community (SLC), (Bemidji, Minnesota), which has been working with DNR to educate students on water issues locally in Minnesota as well as globally. To help spread the water quality message during the WRAPS development, the DNR worked with the SLC (June 2015) to help spread the word about keeping Minnesota's waters clean. Through this effort the kids at the SLC created posters (see Figure 45), a video interviewing members of the community on what clean water means to them, stories on the history of water…from the eyes of the water, along with work on radio advertisements.

Figure 45. Schoolcraft Learning Center, clean water posters (June 2015).

The CE team worked cooperatively with representatives from the DNR Division of Ecological Resources team in Brainerd, Minnesota (Paul Radomski and Kristin Carlson) to start and complete the Zonation Modeling process for the MRHW. The four-step “values driven” conservation priorities mapping project included stakeholder participation throughout the 1.5-year effort. In addition to the presentations and activities at stakeholder meetings on the Zonation Modeling effort, a WebEx presentation was also held to further help communicate the overall MRHW Zonation Modeling process and final mapping outputs to watershed stakeholders/local decision makers.

Numerous stakeholder and public meetings were held during the second phase of the WRAPS. These meetings included updates on the WRAPS project in general, and on the Professional Judgement Group (PJG) meetings where the proposed watershed assessment results were presented to inform key stakeholders and provide an opportunity for input on the proposed assessments. Starting in 2013, another related water quality effort began that complemented the MRHW WRAPS project - the MPCA Large River Monitoring project, which involved the monitoring and assessing of the Upper Mississippi River (headwaters to Upper St. Anthony Falls Dam) was piloted by the MPCA. A PJG meeting was held on the overall assessments of the surface water resources within the MRHW and the Upper Mississippi River. The MRHW is primarily a healthy watershed with the vast majority of the surface water resources meeting state water quality standards. However, a few impairments exist with TMDLs written as a component of the MRHW WRAPS to address the nutrient impairments of two lakes in Beltrami County (Lake Irving (Bemidji) and Little Turtle Lake). Several meetings (both stakeholder and public) were held in 2016-2017 to communicate these impairments to stakeholders, while gathering input on the impairments and the TMDL process. Stakeholder and public meetings were also held with the specific intention of gathering stakeholder input on the identification of areas within the MRHW for potential restoration and protection strategies. These meetings provided an excellent opportunity for interactive discussions among watershed stakeholders (Figure 46).

Figure 46. MRHW Stakeholder meeting – January 12, 2017, Bemidji City Hall.

During the course of the WRAPS project, and as the water quality restoration and protection message was communicated more and more to the public, several requests from stakeholders/partners to give additional presentations in person or via radio interviews on the project were received. These were welcome opportunities, which further aided in educating and engaging the public on the WRAPS and the importance of clean water, while in turn helping to strengthen existing or establish new working water quality partnerships. From 2016-2017, as the communication on the status of the watershed was gaining strong momentum, several presentations were provided by request. These presentations included appearances for the City of Bemidji/City Council, Beltrami County Board of Commissioners, Bemidji Rotary Club, City of Cohasset Planning and Zoning, Beltrami SWCD Board of Supervisors and NRCS, Minnesota Association of Planning & Zoning Administrators – Annual Conference, and public radio interviews for Minnesota Public Radio and KAXE.

Figure 47. Picture from Mississippi River Headwaters Watershed Story Map. Sunset on Norway Beach, Cass Lake.

The CE team discussed strategies on developing and utilizing unique and interesting tools in communicating the message on the WRAPS project and general water quality considerations within the MRHW. After some discussion, it was decided to develop a [Mississippi River Headwaters Watershed Story Map.](#) The Story Map provides an interesting, colorful, scenic and thought provoking water quality message for the MRHW and the WRAPS project. It is also a CE tool that can be easily shared among partners to effectively communicate the important message of water quality restoration and protection within the MRHW.

Several county water plans (Beltrami, Cass, Hubbard, and Itasca) were being revised concurrently with the WRAPS process. A significant portion of the information generated through the MRHW WRAPS was incorporated into these local water planning documents even before the completion of the final WRAPS/TMDL reports. The city of Bemidji has been very cooperative throughout the WRAPS and has shown exemplary water quality leadership in working with the MPCA and other partners "in doing their part" in addressing their applicable portion of the restoration strategy (TMDL) for Lake Irving. Other entities, such as the MHB, Chippewa National Forest, the LLBO, the Nature Conservancy, Lake Irving Association, Friends of Lake Bemidji and other key WRAPS partners are committed to implementing the strategies in the WRAPS plan as funding is available. The WRAPS will also significantly help set the stage for a future "One Watershed One Plan" effort down the road. Future water quality collaborative implementation efforts with state local and federal agency watershed partners are highly anticipated.

The overall CE effort will not end with the completion of the WRAPS report. The MRHW contains some of the most treasured and high quality water resources in the country along with some of the most committed watershed stakeholders. At present, the vast majority of the MRHW water resources are healthy. It is the goal of the watershed partners to continue engaging the public to the extent possible as it is realized that if the mission statement of "Pristine Lakes and Waters for Future Generations" is to be achieved it will take us all working successfully in collaboration together.

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 June 4, 2018, to July 5 2018.

3.3 Restoration & Protection Strategies

Strategies Development

With high water quality resources stretching across the watershed, protection strategies are the major focus for the MRHW. In the below strategies table, the existing water quality strategies listed are geared towards the parameter(s) of primary concern. Since most waterbodies are currently meeting water quality standards, no specific reductions were denoted in most cases, but rather general statements aimed at maintaining or improving water quality. In many areas across the MRHW, future land use change towards urban, agriculture or increasing forestry practices pose the greatest risk to degrading future water quality. Many other strategies are geared towards managing lakeshore property along many of the priority lakes.

Figure 48. HUC 12 Subwatersheds in the Mississippi River Headwaters Watershed.

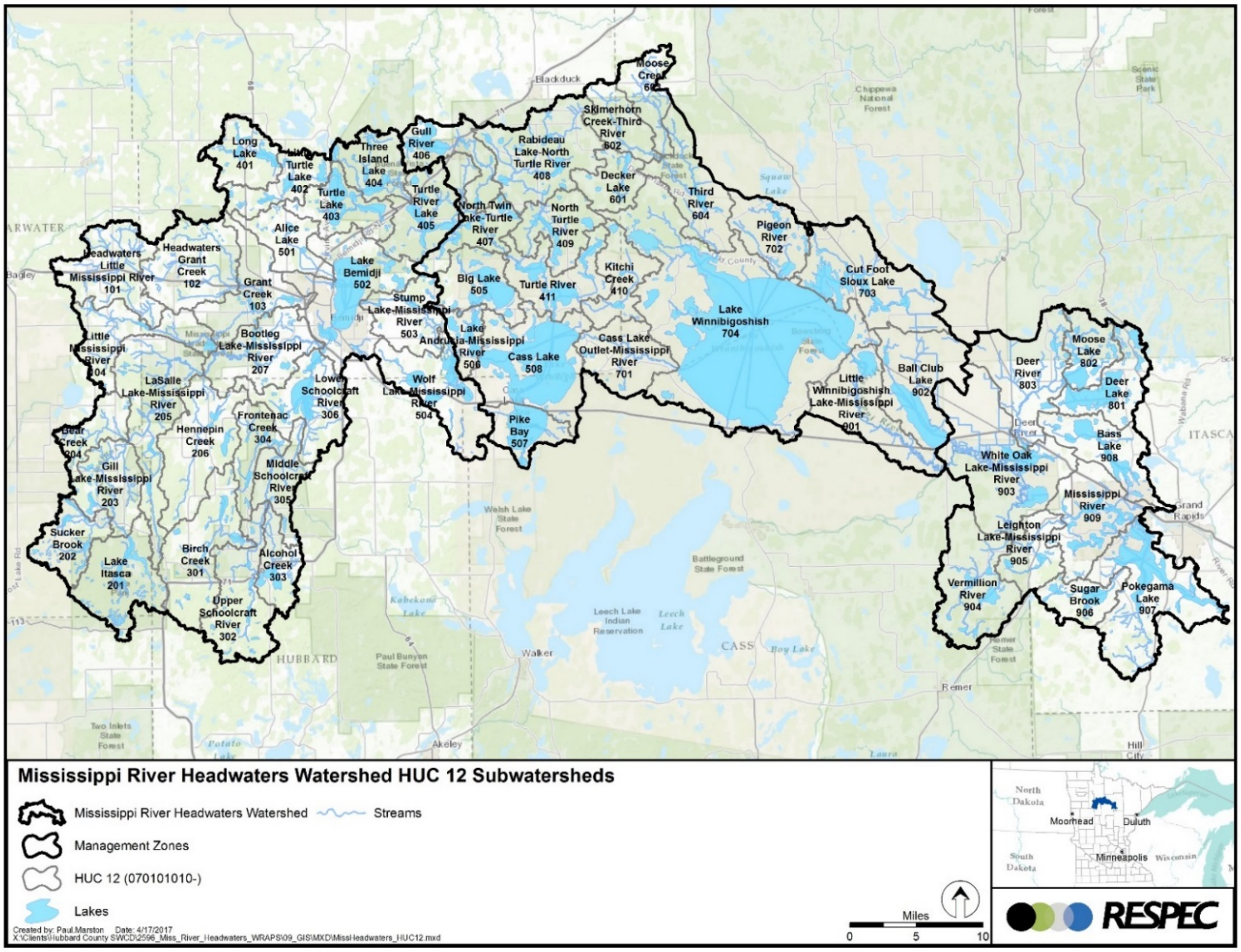


Table 18: Key for Strategies Column

Parameter	Strategy Key	
	Description	Example BMPs/actions
TSS	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Cover crops
		Water and sediment basins, terraces
		Rotations including perennials
		Conservation cover easements
		Grassed waterways
		Strategies to reduce flow- some of flow reduction strategies should be targeted to ravine subwatersheds
		Residue management - conservation tillage
		Forage and biomass planting
		Open tile inlet controls - riser pipes, French drains
		Contour farming
		Field edge buffers, borders, windbreaks and/or filter strips
		Stripcropping
	Protect/stabilize banks/bluffs: Reduce collapse of bluffs and erosion of streambank by reducing peak river flows and using vegetation to stabilize these areas.	Strategies for altered hydrology (reducing peak flow)
		Streambank stabilization
		Riparian forest buffer
		Livestock exclusion - controlled stream crossings
	Stabilize ravines: Reducing erosion of ravines by dispersing and infiltrating field runoff and increasing vegetative cover near ravines. Also, may include earthwork/regrading and revegetation of ravine.	Field edge buffers, borders, windbreaks and/or filter strips
		Contour farming and contour buffer strips
		Diversions
		Water and sediment control basin
		Terrace
		Conservation crop rotation
		Cover crop
		Residue management - conservation tillage
	Stream Channel Restoration	Addressing road crossings (direct erosion) and floodplain cut-offs
		Clear water discharge: urban areas, ag tiling etc. – direct energy dissipation
		Two-stage ditches
		Large-scale restoration – channel dimensions match current hydrology & sediment loads,
		Stream channel restoration using vertical energy dissipation: step pool morphology

Parameter	Strategy Key	
	Description	Example BMPs/actions
	Forestry management	Proper Water Crossings and road construction
		Forest Roads - Cross-Drainage
		Maintaining and aligning active Forest Roads
		Closure of Inactive Roads & Post-Harvest
		Location & Sizing of Landings
		Riparian Management Zone Widths and/or filter strips
	Improve urban stormwater management [to reduce sediment and flow]	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
Nitrogen (TN) or Nitrate	Increase fertilizer and manure efficiency: Adding fertilizer and manure additions at rates and ways that maximize crop uptake while minimizing leaching losses to waters	Nitrogen rates at Maximum Return to Nitrogen (U of MN rec's)
		Timing of application closer to crop use (spring or split applications)
		Nitrification inhibitors
		Manure application based on nutrient testing, calibrated equipment, recommended rates, etc.
	Store and treat tile drainage waters: Managing tile drainage waters so that nitrate can be denitrified or so that water volumes and loads from tile drains are reduced	Saturated buffers
		Restored or constructed wetlands
		Controlled drainage
		Woodchip bioreactors
		Two-stage ditch
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and capturing of soil nitrate by roots during the spring, summer and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
		Crop conversion to low nutrient-demanding crops (e.g., hay).
Phosphorus (TP)	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Strategies to reduce sediment from fields (see above - upland field surface runoff)
		Constructed wetlands
		Pasture management
	Reduce bank/bluff/ravine erosion	Strategies to reduce TSS from banks/bluffs/ravines (see above for sediment)
	Increase vegetative cover/root duration: Planting crops and vegetation	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands

Parameter	Strategy Key	
	Description	Example BMPs/actions
	that maximize vegetative cover and minimize erosion and soil losses to waters, especially during the spring and fall.	Cover crops
		Rotations that include perennials
	Preventing feedlot runoff: Using manure storage, water diversions, reduced lot sizes and vegetative filter strips to reduce open lot phosphorus losses	Open lot runoff management to meet 7020 rules
		Manure storage in ways that prevent runoff
	Improve fertilizer and manure application management: Applying phosphorus fertilizer and manure onto soils where it is most needed using techniques which limit exposure of phosphorus to rainfall and runoff.	Soil P testing and applying nutrients on fields needing phosphorus
		Incorporating/injecting nutrients below the soil
		Manure application meeting all 7020 rule setback requirements
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Sewering around lakes
		Eliminating straight pipes, surface seepages
	Reduce in-water loading: Minimizing the internal release of phosphorus within lakes	Rough fish management
		Curly-leaf pondweed management
Phosphorus (TP)		Alum treatment
		Lake drawdown
		Hypolimnetic withdrawal
	Forestry Management	See forest strategies for sediment control
	Reduce Industrial/Municipal wastewater TP	Municipal and industrial treatment of wastewater P
		Upgrades/expansion. Address inflow/infiltration.
	Treat tile drainage waters: Treating tile drainage waters to reduce phosphorus entering water by running water through a medium which captures phosphorus	Phosphorus-removing treatment systems, including bioreactors
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
E. coli	Reducing livestock bacteria in surface runoff: Preventing manure from entering streams by keeping it in	Strategies to reduce field TSS (applied to manured fields, see above)
		Improved field manure (nutrient) management
		Adhere/increase application setbacks

Parameter	Strategy Key	
	Description	Example BMPs/actions
	storage or below the soil surface and by limiting access of animals to waters.	Improve feedlot runoff control
		Animal mortality facility
		Manure spreading setbacks and incorporation near wells and sinkholes
		Rotational grazing and livestock exclusion (pasture management)
	Reduce urban bacteria: Limiting exposure of pet or waterfowl waste to rainfall	Pet waste management
		Filter strips and buffers
		See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Replace failing septic (SSTS) systems
		Maintain septic (SSTS) systems
	Reduce Industrial/Municipal wastewater bacteria	Reduce straight pipe (untreated) residential discharges
		Reduce WWTP untreated (emergency) releases
Dissolved Oxygen	Reduce phosphorus	See strategies above for reducing phosphorus
	Increase river flow during low flow years	See strategies above for altered hydrology
	In-channel restoration: Actions to address altered portions of streams.	Goal of channel stability: transporting the water and sediment of a watershed without aggrading or degrading.
		Restore riffle substrate
Chloride	Road salt management	[Strategies found in the Twin Cities Metro Area Chloride Management Plan] https://www.pca.state.mn.us/sites/default/files/wq-iw11-06ff.pdf Also see MPCA website at: https://www.pca.state.mn.us/water/salt-and-water-quality
Altered hydrology; peak flow and/or low base flow (Fish/Macroinvertebrate IBI)	Increase living cover: Planting crops and vegetation that maximize vegetative cover and evapotranspiration especially during the high flow spring months.	Grassed waterways
		Cover crops
		Conservation cover (easements & buffers of native grass & trees, pollinator habitat)
		Rotations including perennials
	Improve drainage management: Managing drainage waters to store tile drainage waters in fields or at constructed collection points and releasing stored waters after peak flow periods.	Treatment wetlands
		Restored wetlands

Parameter	Strategy Key	
	Description	Example BMPs/actions
	Reduce rural runoff by increasing infiltration: Decrease surface runoff contributions to peak flow through soil and water conservation practices.	Conservation tillage (no-till or strip till w/ high residue)
		Water and sediment basins, terraces
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Improve irrigation water management: Increase groundwater contributions to surface waters by withdrawing less water for irrigation or other purposes.	Groundwater pumping reductions and irrigation management
Poor Habitat (Fish/Macroinvertebrate IBI)	Improve riparian vegetation: Planting and improving perennial vegetation in riparian areas to stabilize soil, filter pollutants and increase biodiversity	50' vegetated buffer on waterways
		One rod ditch buffers
		Lake shoreland buffers
		Increase conservation cover: in/near water bodies, to create corridors
		Improve/increase natural habitat in riparian, control invasive species
		Tree planting to increase shading
		Streambank and shoreline protection/stabilization
		Wetland restoration
		Accurately size bridges and culverts to improve stream stability
	Restore/enhance channel: Various restoration efforts largely aimed at providing substrate and natural stream morphology.	Retrofit dams with multi-level intakes
		Restore riffle substrate
		Two-stage ditch
		Dam operation to mimic natural conditions
		Restore natural meander and complexity
Water Temperature	Urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Improve riparian vegetation: Actions primarily to increase shading, but also some infiltration of surface runoff.	Riparian vegetative buffers
		Tree planting to increase shading
Connectivity (Fish IBI)	Removal fish passage barriers: Identify and address barriers.	Remove impoundments
		Properly size and place culverts for flow and fish passage
		Construct by-pass

Parameter	Strategy Key	
	Description	Example BMPs/actions
All (protection-related)	Implement volume control / limited-impact development: This is aimed at development of undeveloped land to provide no net increase in volume and pollutants	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php
All (Agricultural related)	This is a 2017 update of the Agricultural BMP Handbook for Minnesota. The original 2012 publication was developed as a literature review of empirical research on the effectiveness of 30 BMPs implemented in Minnesota, and was co-authored with Emmons & Olivier Resources, Inc.	See Agricultural BMP Handbook for Minnesota 2017 (second edition). https://bbe.umn.edu/sites/bbe.umn.edu/files/agricultural-best-management-practices-handbook-for-minnesota-second-edition.pdf

Table 1: Strategies and actions proposed for the entire Mississippi River Headwaters Watershed.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Management Zone	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
												MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Watershed Wide Strategies																									
ALL	All	All	All	All HUC – 12 Watersheds	All	-	-	-	SFIA new contracts and renewals (maintain or improve)	SFIA will protect privately held forest lands from being developed or otherwise converted through tax relief incentives to property owners	Mississippi River Headwaters Watershed		X			X		X	X				X	Continuing	Itasca County: 20 new contracts
ALL	All	All	All	All HUC – 12 Watersheds	All	-	-	-	NRCS EQIP Projects	The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland. EQIP may also help producers meet Federal, State, Tribal, and local environmental regulations.	Mississippi River Headwaters Watershed		X	X				X		X		X	X	Continuing	Itasca County: Forestry practices applied to 70 acres, prescribed grazing applied to 40 acres, forest manage-ment plans written for 1,500 acres, and upland wildlife habitat manage-ment practices applied to 5,000 acres

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Management Zone	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
												MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Watershed Wide Strategies																									
ALL	All	All	All	All HUC – 12 Watersheds	All	-	-	-	NRCS CRP & CREP Projects	The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner	Mississippi River Headwaters Watershed		X	X				X	X	X			X	Continuing	Itasca County: Applied to 20 acres of land
ALL	All	All	All	All HUC – 12 Watersheds	All	-	-	-	RIM Conservation Easements new contracts and renewals (maintain or improve)	RIM will protect privately held environmentally sensitive lands from being developed and maintained in the natural state through financial incentives to the property owners	Mississippi River Headwaters Watershed		X					X	X					Continuing	Itasca County: 20 new contracts
ALL	All	All	All	All HUC – 12 Watersheds	All	-	-	-	Pilot Volunteer River Monitoring Program	Organize volunteer river monitoring program to engage public in water quality monitoring process	Mississippi River Headwaters Watershed	X	X					X					X		
ALL	All	All	All	All HUC – 12 Watersheds	Invasive Species	Protection of the aquatic ecosystem	Varies	Maintain or improve	Aquatic Invasive Species Prevention Aid	Increase resources and habitat for native aquatic species	Mississippi River Headwaters Watershed		X	X	X	X			X		X	X	X	Continuing	Prevention of invasive species within the Mississippi River Headwaters Watershed.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Management Zone	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
												MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Watershed Wide Strategies																									
All	All	All	All	All HUC – 12 Watersheds	All parameters	Varies	Varies	Maintain or improve	The Continuation of the Citizen Lake Monitoring Program, and potential for river watch program expansion	Landowner and Agency Involvement, monitor for changes in water quality	Mississippi River Headwaters Watershed	X	X			X	X	X	X	X		X		Continuing	Landowner-based assessments have continued and add to existing monitoring data
All	All	All	All	All HUC – 12 Watersheds	All Parameters	Varies	Varies	Maintain or improve	Public Education	Create an editorial series about water quality & watershed issues in the Upper Mississippi River - Headwaters Watershed to be distributed by media	Mississippi River Headwaters Watershed	X	X			X			X		X		X	Continuing	Itasca County: Release at least five articles
All	All	All	All	Specific HUCs TBD	All Parameters	Varies	Varies	Maintain or improve	Vegetated Buffer Management	Provide landowners information and assistance with implementation of vegetated buffers for all public waters	Mississippi River Headwaters Watershed	X	X	X	X	X	X	X	X	X				2016 - Continuing	Full compliance with the implementati on of buffers on all public waters across the Upper Mississippi River - Headwaters Watershed.
All	All	All	All	Specific HUCs TBD	All Parameters	Varies	Varies	Maintain or improve	Civic Engagement	Engage Leech Lake Band of Objibwe in watershed discussions	Mississippi River Headwaters Watershed	X	X			X					X	X	X	2017 - Continuing	Begin regular meetings between the MPCA, SWCD's, and Tribal Representativ es

Table 2. Itasca County Subwatershed strategies

HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
All	Big Lakes & East	All	Select HUC – 12 watersheds	Disturbance	Determined via project	Varies	Maintain or improve	Sediment reduction, nutrient load reduction	Mississippi River Canoe Carry down Access Point and Camp Site Assessments	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X			X	X				X		X	2018-2028	Phase I completed, Phase II in Progress where 6 BMPs are implemented
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Shore-land Project Planning Assistance	Shore-land stabilization and storm water management with landowners	Itasca County portion of the Upper Mississippi River - Headwaters Watershed	X	X	X	X			X						Continuing	Project planning assistance provided to 60 landowners, with at least 30 projects implemented. These projects will result in 2,000 linear feet of frontage stabilized and approximately 7,500 square feet stabilized from sheet erosion, with established buffers.
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Shore-land Projects Cost Shared by SWCD	Shore-land stabilization and storm water management on priority sites	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X	X		X		X					X	Continuing	At least three projects implemented of bio-stabilization to reduce & prevent wave action erosion and ice push (100 lineal feet/project). At least three projects implemented of rock rip-rap stabilization on

HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
																								sites with excessive ice & wave erosion (100 lineal feet/project). At least two riparian buffer plantings (1,000 square feet/project).
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Variance Condition Planning	Native buffer re-establishment	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X	X				X		X		X	X	Continuing	At least 10 plans implemented, with approximately 7,500 total square feet of buffer established
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Buffer Law Assistance	Buffer law assistance, verification, and violation remediation	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X		X	X	X	X						2016 - Continuing	Assist at least one landowner or 45,000 square feet of riparian buffer establishment
All	Big Lakes & East	All	Specific HUCs TBD	All Parameters	Varies	Varies	Maintain or improve	Shore Land Alterations Site Visits	Provide technical assistance for sustainable development and shore land-use	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X	X	X	X		X						2016 - Continuing	At least ten site visits per year resulting in assistance planning; water diversions, path design, water access, rip rap shore stabilization, and biological stabilization geared towards minimal impact.

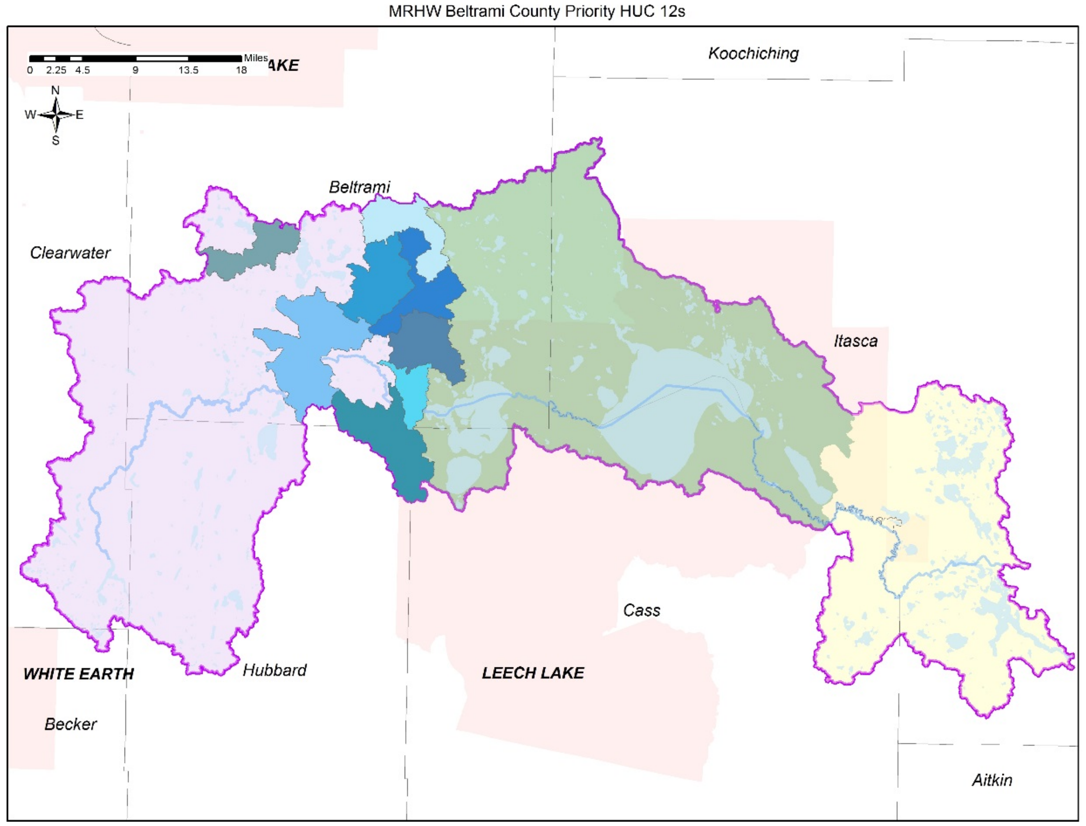
HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Soil Loss Ordinance Assistance	Assist land owners with soil loss ordinance violations, project assistance and verification	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X	X				X		X				2016-Continuing	At least 0.5 acres of improved soil stabilization
All	Big Lakes & East	All	Specific HUCs TBD	All Parameters	Varies	Varies	Maintain or improve	Forest and Watershed Management Assistance	Assist landowners with stewardship and management plans	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X		X	X		X					X	Continuing	Assist at least 50 landowners with management and stewardship plans, resulting in maintained and improved watershed functions on approximately 2,000 acres
All	Big Lakes & East	All	Specific HUCs TBD	TSS & TP	Varies	Varies	Maintain or improve	Supply Native Planting Stock	Supply property owners with native plants for projects and watershed benefits	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X			X		X						Continuing	Supply property owners in the Upper Mississippi River - Headwaters Watershed with native planting stock of approximately 10,000 plants/500 orders
All	Big Lakes & East	All	Specific HUCs TBD	All Parameters	Varies	Varies	Maintain or improve	Wetland Impact Avoidance	Potential wetland impacts avoided by conversations, site visits, and replacement plans	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X	X		X		X						Continuing	At least five acres of potential impacts avoided

HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
All	Big Lakes & East	All	All HUC-12 Watersheds	Invasive Species	Determined via Project	Varies	Maintain or improve	Increase viability of terrestrial habitat and in turn aquatic habitat. Reduce erosion by eliminating monoculture of root systems.	Terrestrial Invasive Species Inventory	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X		X	X	X					X		Continuing	Assessment complete and a plan in place for eradication and prevention
All	Big Lakes & East	All	All HUC-12 Watersheds	Flow Rates/Sedimentation	Varies	Varies	Reduce sedimentation from in-channel scour and improve aquatic passage	Culvert inventory	Culvert assessment and inventory using MNDNR inspection protocol	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X		X	X	X				X			2018-2028	Identify all culverts which are undersized or failing and add inventory to a geodatabase with updates added as necessary
Where needed	Big Lakes & East	All	Where needed	Flow Rates/Sedimentation	Will be determined by culvert assessment	Varies	Reduce sedimentation from in-channel scour and improve aquatic passage	Correct flow rates in system and assist in improving turtle habitat (culverts as a safe passage for turtles)	Culvert Repair for Sedimentation reduction and Improved Wildlife Habitat	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X			X	X				X			Upon completion of culvert assessments by 2024	Culverts replaced/resized based on what is needed from previous culvert assessment
All	Big Lakes & East	All	All HUC – 12 Watersheds	All	Varies	Varies	Maintain or Improve	Education & Civic Engagement	School-age Watershed Education	Itasca County portion of the Upper Mississippi River - Headwaters Watershed		X						X					Continuing	Provide for students who are now nearing adult age to become better stewards of the land.
Varies	Big Lakes & East	All	All High Priority lakes listed	TP, Chl-a, & Secchi	Varies	Varies	Expand dataset	Water Quality Monitoring	Monitor water quality and continue building towards establishing long-term trends	Itasca County portion of the Upper Mississippi River - Headwaters Watershed	X	X			X					X	X		Continuing	Continue Monitoring to acquire water quality data sufficient to establish a trend, with annual sampling, five times May-September.

HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
All	Big Lakes & East	All	All HUC – 12 Watersheds	Aquatic Invasive Species	Varies	Varies	Maintain or improve	Purple Loosestrife Control	Monitoring and control of purple loosestrife populations through both localized herbicide application and biological control	Localized and widespread populations watershed wide		X			X		X	X		X	X		On-going	Maintain or improve upon current populations and densities
All	Big Lakes & East	All	All HUC – 12 Watersheds	TP, TSS, and E. coli	Varies	Varies	Reduce sediment, Phosphorus, and E. coli loads	Farm Certification	Enroll new farms in the Water Quality Farm Certification Program	As approved throughout watershed		X	X				X		X				On-going	At least 10 farms enrolled
All	Big Lakes and East	All	All HUC – 12 Watersheds	TP, TN, Mercury, and other chemical constituents	Varies	Varies	Maintain or improve resources based on further study	Atmospheric Deposition Study	Analyze spatial and seasonal patterns of atmospheric deposition through a County-wide network of rainfall analysis	Approximately 15 volunteers across the watershed (50 volunteers County-wide)		X				X	X	X					2018-2050	Establish a network and analyze rainfall data
All	Big Lakes and East	All	All HUC – 12 Watersheds	Hypolimnetic Oxygen Demand	Varies	Varies	Maintain or improve resources based on further study	Study of Hypolimnetic Oxygen Demand	Analyze lakes of various size/depth/trophic status and monitor for two years of Hypolimnetic Oxygen Demand	Approximately 15 lakes across the watershed (50 lakes County-wide)	X	X					X	X					2018-2050	Establish study and monitor each lake for one year of data
All	Big Lakes and East	All	All HUC – 12 Watersheds	All	Varies	Varies	Maintain or improve resources based on further study	Study of Groundwater Transport	Create a network of private well owners to submit samples in addition to installation of an observation well grid to be monitored for two years of data on groundwater chemistry to pair with regional soil maps and water elevations to estimate	Approximately 15 wells across the watershed (50 County-wide)		X			X		X	X					2018- 2050	Establish a well network and analyze groundwater data

HUC-12 Subwater-shed	Management Zone	Waterbody (ID)	HSPF Subwater-shed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Itasca County Strategies																								
									groundwater transport rates															
All	East	All	All HUC – 12 Watersheds	TP, TN, TSS	Varies	Varies	Maintain or improve resources based on further study	Water quality study	Study upstream lakes from Deer and Pokegama to understand nutrient export impacts from historical logging	Watershed wide	X	X						X					2017-2047	Study downstream impacts from upstream nutrient export
All	East	All	All HUC – 12 Watersheds	TP, TN, TSS	Varies	Varies	Maintain or improve resources based on further study	Conservation effectiveness study of forest management BMPs	Establish monitoring stations on stream reaches within logged lands to develop a case study for conservation effectiveness of modern forestry BMPs compared to historical logging practices	Watershed wide	X	X		X	X		X	X		X			2017-2047	Create a working partnership with land management agencies and a framework for BMP study

MRHW Beltrami County Priority HUC 12s



MRHW Beltrami County Priority HUC 12s

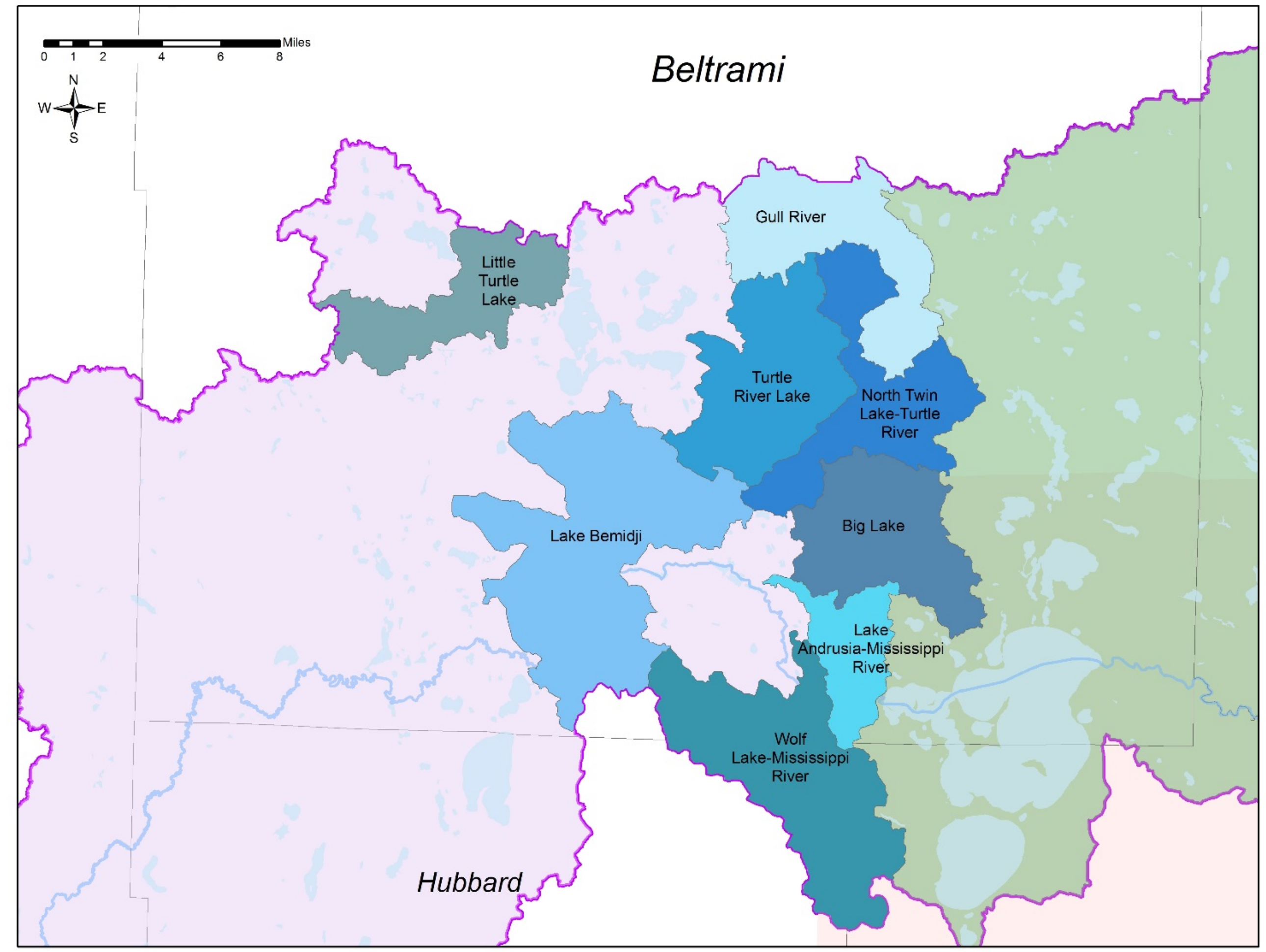


Table 3. Beltrami County Specific strategies

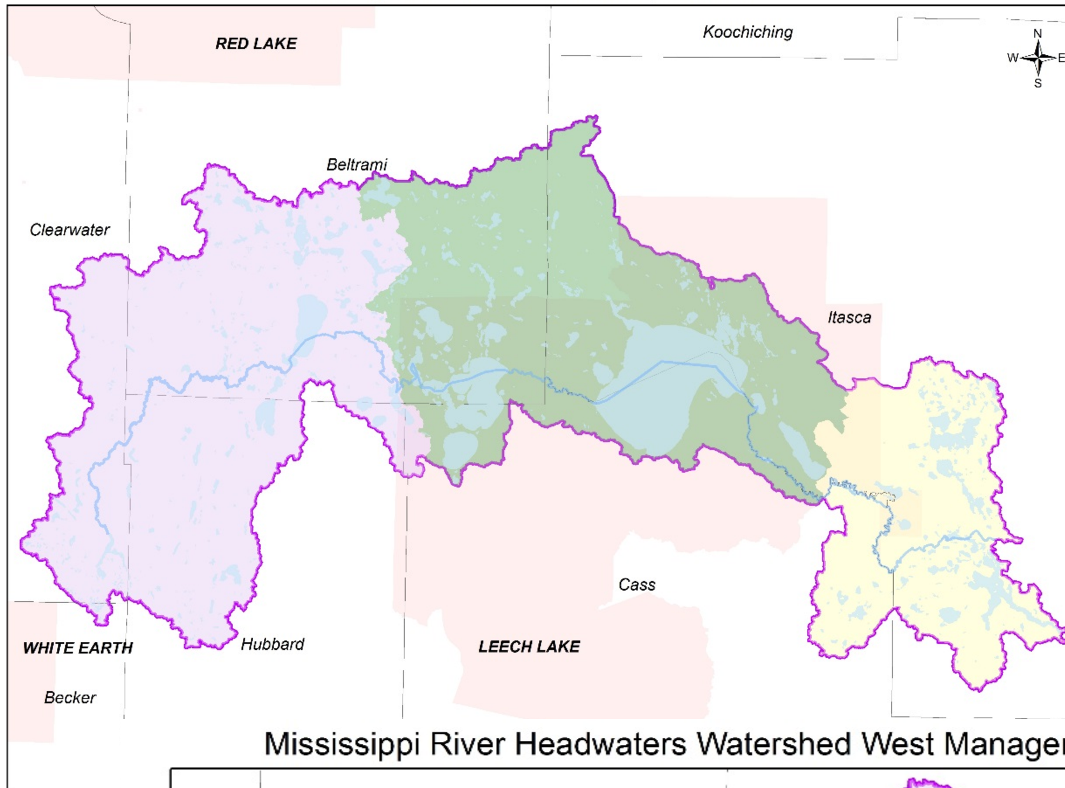
HUC-12 Subwatershed	Management Zone	Waterbody (ID)	HSPF Subwatershed per county water plan	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Beltrami County Strategies																								
Lake Bemidji	West	All	7071- Lake Bemidji	TP, TN, TSS, E. coli	At Risk	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	At Risk, watercourse recovery, SSTS, data collection, education & outreach, AIS	Watershed wide	X	X			X	X	X					X	2017- 2027	*See* Beltrami County Local Water Plan *Table 1*

HUC-12 Subwatershed	Management Zone	Waterbody (ID)	HSPF Subwatershed per county water plan	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Beltrami County Strategies																								
									mgmt. stormwater mgmt., NP Source, groundwater protection															
Lake Bemidji	West	All	7114- Lake Irving	TP, TN, TSS, E.coli	Impaired Waters (Irving), At Risk	TP - Lake Irving	Reduce TP loading into Lake Irving (Restore) & Lake Bemidji (Protect)	Priority Listing per Beltrami County Local Water Plan	Impaired waters, watercourse recovery, SSTS, data collection, education & outreach, AIS mgmt. stormwater mgmt., groundwater protection, NP Source	Watershed wide	X	X	X		X	X	X					X	2018-2048	2017- 2027 *See* Beltrami County Local Water Plan *Table 1*
Lake Bemidji	West	All	7116- Little Bass	TP, TN, TSS, E.coli	Meets Standards	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	Unique High Value, forest stewardship, groundwater protection, stormwater mgmt., AIS mgmt., SSTS, NP source, data collection, education & outreach	Watershed wide	X	X	X	X	X	X	X					X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
Wolf Lake Mississippi River	West	All	7086-Grace Lake	TP, TN, TSS, E.coli	At Risk	Biological conditions - Grace Lake	Maintain or improve resources based on further study, improve biological conditions along shoreline/littoral area – Grace Lake	Priority Listing per Beltrami County Local Water Plan	At Risk, groundwater protection, forest stewardship, AIS mgmt., SSTS, data collection, education & outreach	Watershed wide, Grace Lake subwatershed priority area	X	X	X	X	X	X	X					X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*

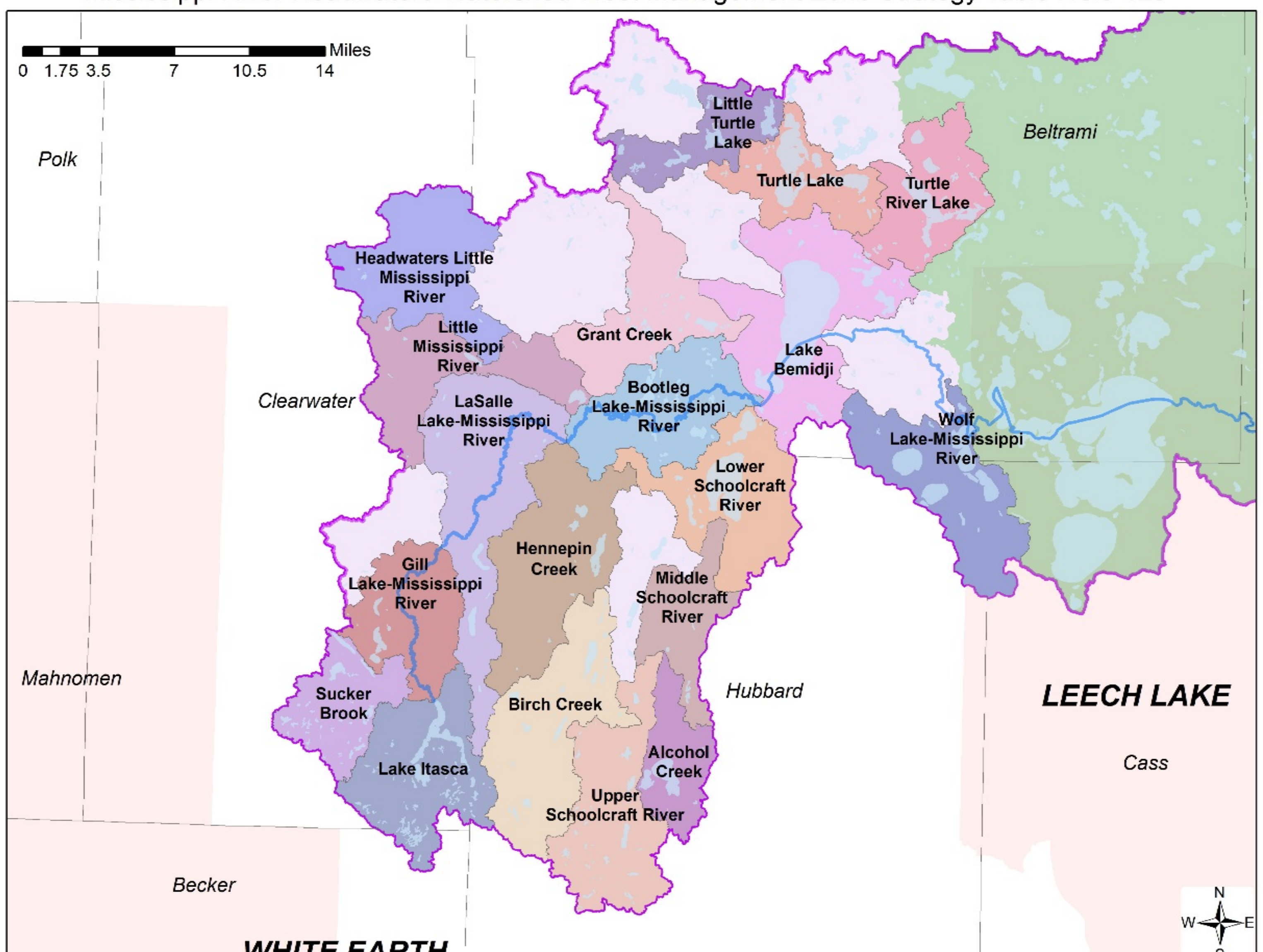
HUC-12 Subwatershed	Management Zone	Waterbody (ID)	HSPF Subwatershed per county water plan	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Beltrami County Strategies																								
Turtle River Lake	West	All	7102- Turtle River Lake	TP, TN, TSS, E.coli	At Risk	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	At Risk, Groundwater protection, stormwater mgmt., forest stewardship, AIS mgmt., SSTS, NP source, data collection, education & outreach	Watershed wide	X	X	X	X	X	X	X					X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
Little Turtle Lake	West	All	7107- Little Turtle Lake	TP, TN, TSS, E.coli	Impaired Waters (Little Turtle Lake)	Excessive nutrients-Little Turtle Lake	Reduce TP loading into Little Turtle Lake (Restore) and Maintain & Improve other waters	Priority Listing per Beltrami County Local Water Plan	Groundwater protection, stormwater mgmt., forest stewardship, AIS mgmt., SSTS, NP source, data collection, education & outreach	Watershed wide	X	X	X	X	X	X	X					X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
Big Lake	Big Lakes	All	7101-Big Lakes	TP, TN, TSS	At Risk	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	At Risk, Groundwater protection, stormwater mgmt., forest stewardship, AIS mgmt., SSTS, NP source, data collection, water course recovery, education & outreach	Watershed wide	X	X	X	X	X	X	X			X	X	X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
North Twin Lake Turtle River	Big Lakes	All	7099-Turtle River	TP, TN, TSS, Biological Conditions	Unique High Value	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	Unique High Value, groundwater, stormwater, SSTS, Data Collection, Education & Outreach	Watershed wide	X	X	X	X	X	X	X			X	X	X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*

HUC-12 Subwatershed	Management Zone	Waterbody (ID)	HSPF Subwatershed per county water plan	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Beltrami County Strategies																								
North Twin Lake Turtle River	Big Lakes	All	7117-Long Lake	TP, TN, TSS, Biological Conditions	Unique High Value	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	Unique High Value, groundwater, stormwater, forest stewardship, SSTS, AIS mgmt., Data Collection, Education & Outreach	Watershed Wide	X	X	X	X	X	X	X			X	X	X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
Lake Andrusia-Mississippi River	Big Lakes	All	7089-Andrusia	TP, TN, TSS, Biological Conditions	Unique High Value	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	Unique High Value, groundwater, stormwater, forest stewardship, SSTS, AIS mgmt., Data Collection, Education & Outreach	Watershed Wide	X	X	X	X	X	X	X			X	X	X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*
Gull River	Big Lakes	All	7103-Gull Lake	TP, TN, TSS, Biological Conditions	At Risk	Varies	Maintain or improve resources based on further study	Priority Listing per Beltrami County Local Water Plan	At Risk, groundwater, stormwater, forest stewardship, SSTS, AIS mgmt., Data Collection, Education & Outreach	Watershed Wide	X	X	X	X	X	X	X			X	X	X	2017-2027	*See* Beltrami County Local Water Plan *Table 1*

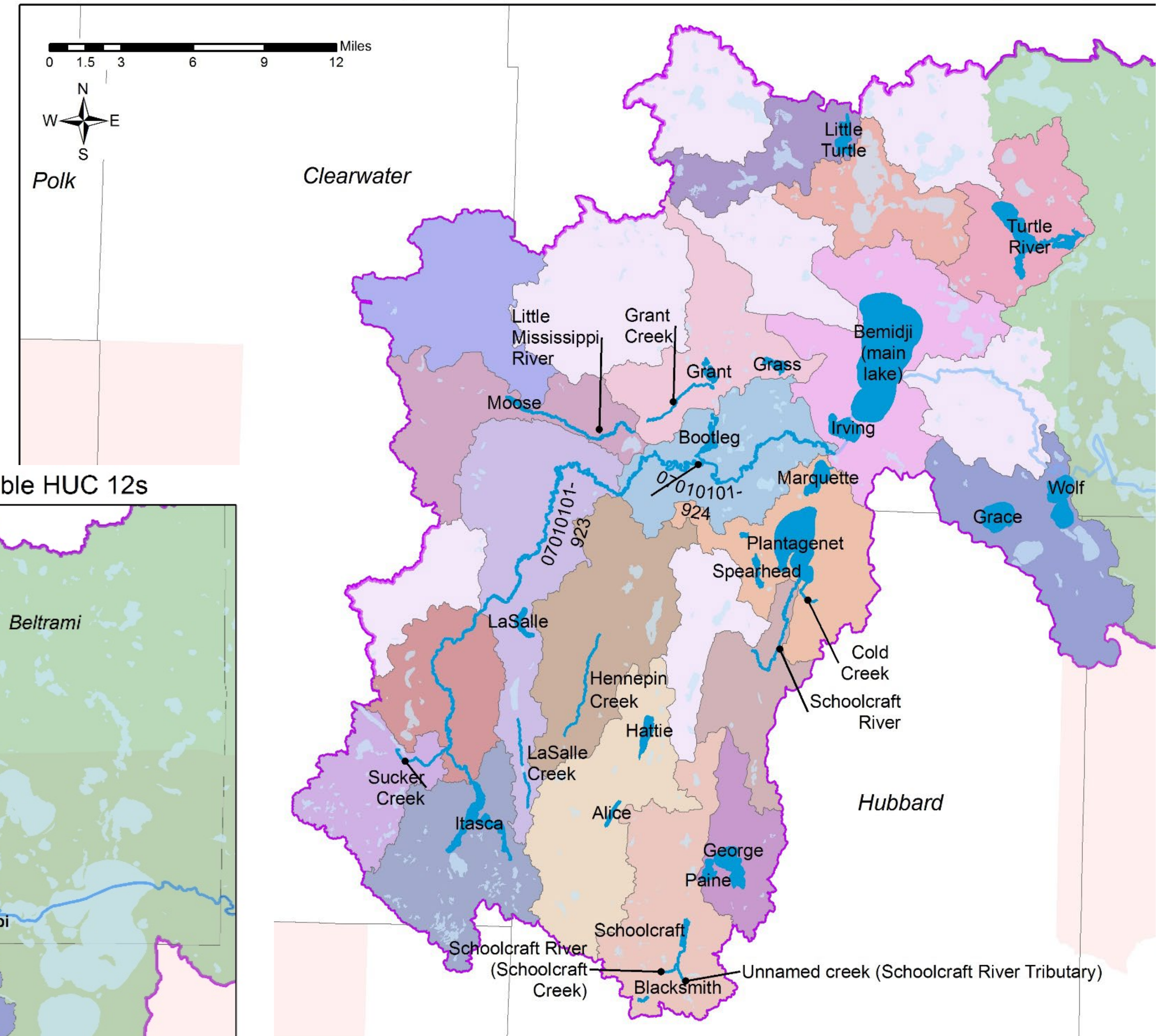
Mississippi River Headwaters Watershed Management Zones



Mississippi River Headwaters Watershed West Management Zone Strategy Table HUC 12s



Mississippi Headwaters Watershed- West Zone Strategy Table Lakes and Streams



HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Sub-watershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table 19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/ Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
West Management Zone Waterbody Specific Strategies																								
Upper Schoolcraft River 070101010302	Hubbard	Schoolcraft River 07010101-660 Unnamed Creek 07010101-711 Blacksmith Lake 29-0275-00 Schoolcraft Lake 29-0215-00	299	Land Disturbance	9% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain/Vigilance Enhance/protect High Biological significance (e.g. Trout - Blacksmith Lake, Wild Rice – Schoolcraft Lake)	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X	X	X	X	X	X							1-5 years	Identify subwatershed areas of highest sensitivity
Alcohol Creek 070101010303	Hubbard	Lake George 29-0216-00, Paine Lake 29-0217-00	302	Land Disturbance	20% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain or reduce 5% of watershed TP load Enhance/ protect High Biological Significance (e.g. wild rice)	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X		X							1-5 years	Identify subwatershed areas of highest sensitivity
Alcohol Creek 070101010303	Hubbard	Lake George 29-0216-00, Paine Lake 29-0217-00	302	TP, TN, TSS	142 lb. TP	Meets Standards (Protection)	Maintain or reduce 5% of watershed TP load Enhance/ protect High Biological Significance (e.g. wild rice)	Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake George & Lake Paine shoreline		X	X	X	X	X	X						1-5 years	Shoreline survey/ vegetation inventory
Alcohol Creek 070101010303	Hubbard	Lake George 29-0216-00, Paine Lake 29-0217-00	302	TP, TN, TSS	142 lb. TP	Meets Standards (Protection)	Maintain or reduce 5% of watershed TP load Enhance/ protect High Biological Significance (e.g. wild rice)	Riparian Buffers	Increase native vegetation along shoreline	Lake George & Lake Paine shoreline		X	X	X	X		X						1-5 years	Shoreline survey/ vegetation inventory
Alcohol Creek 070101010303	Hubbard	Lake George 29-0216-00, Paine Lake 29-0217-00	302	TP, E. coli	142 lb. TP	Meets Standards (Protection)	Maintain or reduce 5% of watershed TP load Enhance/ protect High Biological Significance (e.g. wild rice)	Septic System Management	Replace failing systems	Lake George Residents	X	X		X		X	X	X					5-10 years	Assess SSTS/Inventory
Alcohol Creek 070101010303	Hubbard	Lake George 29-0216-00, Paine Lake 29-0217-00	302	TP, E. coli	142 lb. TP	Meets Standards (Protection)	Maintain or reduce 5% of watershed TP load Enhance/ protect High Biological Significance (e.g. wild rice)	Septic System Management	Connect community to sanitary sewer system	Lake George Residents	X	X		X		X	X	X					5-10 years	Assess SSTS/Inventory
Middle Schoolcraft River 070101010305	Hubbard	Schoolcraft River 07010101-751	313	Disturbance	16% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use	Sub-watershed wide	X		X	X	X	X							1-5 years	Inventory, monitor and protect the most sensitive lands

									conversions occur															
				TP, TN, TSS	2,293 lb. TP		Reduce load by 5%	Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X	X	X				1-5 years	Reduce TP loads by 5% by 2023. Increase cover crop acreage by 25%
								Riparian Buffers	50-ft buffers along river	Along Schoolcraft River		X	X		X		X						1-3 years	Verify buffer status of reach
								Nutrient Management	Follow U of M Extension Nutrient Management Guidance	Ag Land in sub-watershed							X		X				1-5 years	Follow up/Meet with 3-5 landowners to discuss nutrient management
Lower Schoolcraft River 07010101 0306		Cold Creek 07010101-640	315	Disturbance	18% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X									1-5 years	Identify subwatershed areas of highest sensitivity
				TP, TN, TSS	256 lb. TP 5,391 lb. TN 20 tons TSS		Maintain	Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X							
								Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop acreage by 25%
								Riparian Buffers	50-ft buffers along river	Along Cold Creek		X	X				X						1-3 years	Shoreline survey/ vegetation inventory
		Spearhead Lake 29-0239-00, Newman Lake 29-0237-00	317	Disturbance	18% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain Enhance/protect High Biological significance	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X									1-5 years	Identify subwatershed areas of highest sensitivity
				TP, TN, TSS	196 lb. TP 4,362 lb. TN 37 tons TSS			Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X							
		Lake Plantagenet 29-0156-00	318	Disturbance	18% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain or Improve	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed Wide	X		X	X									1-5 years	Inventory, monitor and protect the most sensitive lands
				TP, TN, TSS	2,438 lb. TP 46,978 lb. TN 195 tons TSS 11.71 µg/L Chl-a		Reduce loads by 5%	Forestry Management	Forestry BMPs	Sub-watershed Wide		X	X	X	X		X							
				TP, E. coli				Septic System Management	Replace failing systems	Lake Plantagenet Residents	X	X		X		X	X	X					5-10 years	Assess SSTS/Inventory
									Connect community to sanitary sewer system															

Lower Schoolcraft River 07010101 0306				TP, TN, TSS				Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop acreage by 25%
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake Plantagenet shoreline		X	X	X	X		X							Implement 3 or more shoreline BMPs
								Riparian Buffers	Increase native vegetation along shoreline	Lake Plantagenet shoreline		X	X	X			X							Work with shoreline owners to install 3 native shoreline plantings
	Beltrami	Lake Marquette 04-0142-00	322	Disturbance	18% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain or Improve	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed-Wide	X		X	X									1-5 years	Inventory, monitor and protect the most sensitive lands
				TP, TN, TSS	2,514 lb. TP 46,598 lb. TN 156 tons TSS 9.28 µg/L Chl-a		Reduce loads by 5%	Forestry Management	Forestry BMPs	Sub-watershed-Wide		X	X	X	X		X							
Lower Schoolcraft River 07010101 0306				TP, E. coli				Septic System Management	Replace failing systems Connect community to sanitary sewer system	Lake Marquette Residents	X	X		X		X	X	X					5-10 years	Assess SSTS/Inventory
				TP, TN, TSS				Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X		X				1-5 years	Increase cover crop acreage by 25%
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake Marquette shoreline		X	X	X	X		X							Implement 3 or more shoreline BMPs
								Riparian Buffers	Increase native vegetation along shoreline	Lake Marquette shoreline		X	X	X			X						1-5 years	Work with shoreline owners to install 3 native shoreline plantings
Hennepin Creek 07010101 0206	Hubbard	Hennepin Creek 07010101-636	233	Disturbance	21% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain or Reduce loads by 5% Protect trout stream habitat	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X	X								1-5 years	Identify subwatershed areas of highest sensitivity

				TP, TN, TSS	507 lb. TP 11,918 lb. TN 111 tons TSS			Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X							
				Connectivity	-			Wildlife Management	Assess beaver dam locations and impacts on connectivity	At beaver dams					X		X							
Lake Itasca 07010101 0201	Clearwater	Lake Itasca 15-0016-00	200	Disturbance	5% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X	X	X	X	X								1-5 years	Identify subwatershed areas of highest sensitivity
Sucker Brook 07010101 0202		Sucker Creek 07010101-664	203	Disturbance	6% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed Wide	X		X	X									1-5 years	Identify subwatershed areas of highest sensitivity
				TP, TN, TSS	70 lb. TP 8,707 lb. TN 111 tons TSS			Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop acreage by 25%
								Riparian Buffers	50-ft buffers along river	Along Sucker Creek		X	X				X						1-5 years	Shoreline survey/ vegetation inventory
		Sucker Creek 07010101-663		Disturbance	6% Land Disturbance in Subwatershed			Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X	X								1-5 years	Identify subwatershed areas of highest sensitivity
Gill Lake-Mississippi River 070101010203 & LaSalle Lake-Mississippi River 070101010205	Clearwater/ Hubbard/B eltrami	Mississippi River 07010101-923	230	Disturbance	13% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed Wide	X		X	X		X							1-5 years	Identify subwatershed areas of highest sensitivity
				TP, TN, TSS	2581 lb. TP 55,835 lb. TN 473 tons TSS		Reduce loads by 5%	Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X		X				1-5 years	Increase cover crop acreage by 25%
								Riparian Buffers	50-ft buffers along river	Along the Mississippi River		X	X				X						1-3 years	Identify sensitive shoreline areas
								Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X						1-5 years	Identify subwatershed areas of highest sensitivity

LaSalle Lake-Mississippi River 070101010205	Hubbard	LaSalle Creek 07010101-633	213	Disturbance	13% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain/Vigilance Protect trout stream habitat	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide, along pipeline corridor	X		X	X	X								Ongoing	Identify subwatershed areas of highest sensitivity, work with DNR to utilize LaSalle Lake SRA as a public educational tool for surface water protection, continue to work with pipeline company on practices to protect water quality.
		LaSalle Creek 07010101-635									X		X	X	X									
		LaSalle Lake 29-0309-00					Maintain, LaSalle Lake high degree of biological significance				X		X	X	X									
		LaSalle Lake 29-0309-00	213	TP, TN, TSS	400 lb. TP 4,544 lb. TN 50 tons TSS			Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed, also maintain adequate cover along pipeline corridor		X	X		X		X					X		
LaSalle Lake-Mississippi River 070101010205 & Bootleg Lake-Mississippi River 070101010207	Beltrami	Mississippi River 07010101-924	290	Disturbance	34% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X		X							1-5 years	Inventory, monitor and protect the most sensitive lands
				TP, E. coli	7,652 lb. TP 184,208 lb. TN 400 tons TSS		Reduce loads by 5%	Septic System Management	Replace failing systems	Sub-watershed wide	X	X		X		X	X	X				X	5-10 years	Assess SSTS/Inventory
									Connect community to sanitary sewer system													X	5-10 years	Evaluate eastern portion of Bootleg Lake HUC for community/ sanitary survey alternatives
				TP, TN, TSS				Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop acreage by 25%
								Riparian Buffers	50-ft buffers along river	Along the Mississippi River		X	X				X						1-3 years	Identify sensitive shoreline areas and work with landowners to maintain adequate cover.
								Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X						5-10 years	Identify subwatershed areas of highest Sensitivity. Evaluate status of forest stewardship plans on private lands.
Little Mississippi River 070101010104		Little Mississippi River 07010101-517,	271	Disturbance	25% Land Disturbance in Subwatershed	Meets Standards (Critical): Little	Maintain	Limit impact development	Manage % disturbed as future development/ land use	Sub-watershed wide	X		X	X									1-5 years	Inventory, monitor and protect the most sensitive lands.

	Moose Lake 04-0342-00				Mississippi River Fails to meet existing TP standards: Moose lake			conversions occur															Continued monitoring of Moose Lake to gather additional data towards potential natural background determination.
			TP, TN, TSS	3,972 lb. TP 89,211 lb. TN 993 tons TSS		Reduce loads by 5%	Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						5-7 years	
							Riparian Buffers	50-ft buffers along river	Along the Little Mississippi River		X	X				X						1-3 years	Identify sensitive shoreline areas and work with landowners to maintain adequate cover.
							Forestry Management	Forestry BMPs	Sub-watershed wide		X	X	X	X		X						5-10 years	Identify subwatershed areas of highest sensitivity. Evaluate status of forest stewardship plans on private lands.
			Connectivity	-		Maintain or Improve	Wildlife Management	Assess beaver dam locations and impacts on connectivity	At beaver dams		X		X	X		X						3-5 years	Evaluate subwatershed to identify highest priority connectivity issues, follow up with landowners as needed.
Grant Creek 070101010103	Grass Lake 04-0216-00	269	Disturbance	30% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain or Improve	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X	X	X							1-5 years	Inventory, monitor and protect the most sensitive lands.
			TP, TN, TSS	3,972 lb. TP 89,211 lb. TN 993 tons TSS		Reduce loads by 5%	Nutrient Management	Follow U of M Extension Nutrient Management Guidance	Sub-watershed wide		X					X		X				1-5 years	Continue to work with the City of Bemidji, MNDOT and landowners on nutrient/stormwater management strategies.
							Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop acreage by 25%.
							Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Grass Lake south shoreline at private Airport base		X	X	X	X		X						3-5 years	Cooperatively work with Airport management to determine if existing shoreline buffer is adequate.
							Riparian Buffers	Increase native vegetation along shoreline															
Grant Creek	Grant Lake 04-0217-00	269	Disturbance	30% Land Disturbance in Subwatershed	Meets Standards (Protection)	Maintain	Limit impact development	Manage % disturbed as future	Sub-watershed wide	X		X	X									Ongoing	Work with the landowner of the gravel pit area to the

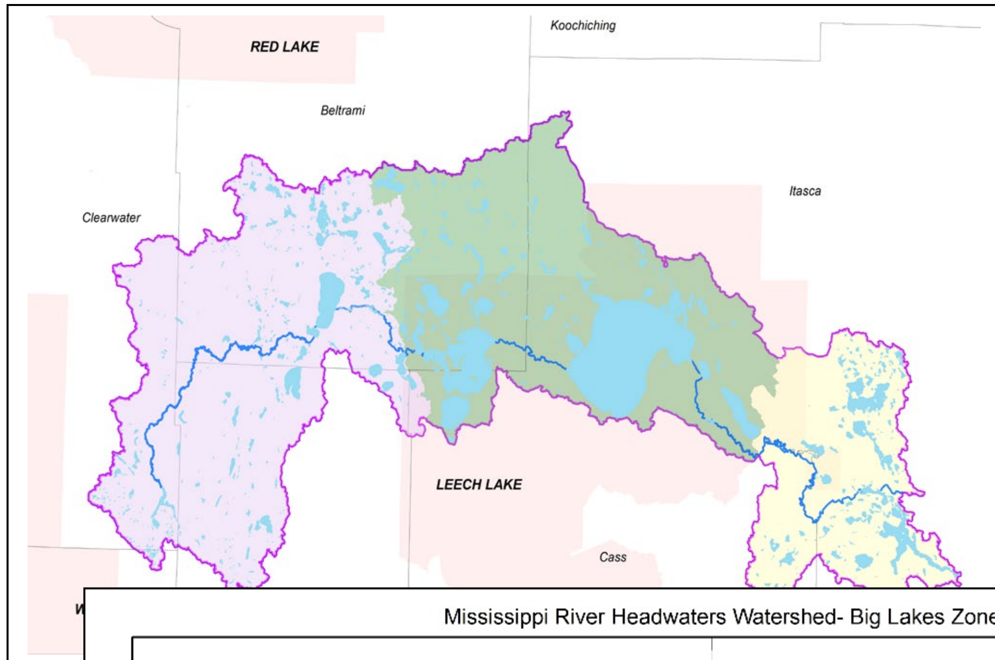
070101010 103									development/ land use conversions occur															west of Grant Lake to ensure long term protection of Grant Lake.
				TP, TN, TSS	3,972 lb. TP 89,211 lb. TN 993 tons TSS			Increase vegetative cover, maintain adequate vegetation along pipeline corridor and Grant Lake Shoreline	Plant cover crops, establish/ Increase native vegetation along shoreline	Ag Land in sub-watershed, Pipeline Corridor, Grant Lake Shoreline		X	X				X						1-5 years	Increase overall cover crop and permanent vegetative cover acreage by 25%.
Grant Creek 070101010 103		Grant Creek 07010101-546	269	Disturbance	30% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X									1-5 years	Inventory, monitor and protect the most sensitive lands, increase permanent vegetative cover by 25%.
				TP, TN, TSS	3,972 lb. TP 89,211 lb. TN 993 tons TSS		Reduce loads by 5%	Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X							
Bootleg Lake-Mississippi River 070101010 207		Bootleg Lake 04-0211-00	290	Disturbance	34% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X									1-5 years	Identify subwatershed areas of highest sensitivity.
				TP, E. coli	-		Reduce loads by 5%	Septic System Management	Replace failing systems, connect community to sanitary sewer system	Sub-watershed wide	X	X		X		X	X						5-10 years	Assess/Inventory SSTS around shoreland areas.
				TP, TN, TSS				Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						1-5 years	Increase cover crop/vegetative cover acreage by 25%.
Birch Creek 070101010 301	Hubbard	Lake Hattie 29-0300-00	291	Disturbance	-	Meets Standards (Protection)	Maintain/ Protect (wild rice)	Limit impact development	Manage % disturbed areas as future development/ land use conversions occur	Sub-watershed wide	X	X	X	X	X		X						1-5 years	Identify subwatershed areas of highest sensitivity.
		Lake Alice 29-0286-00	291	Disturbance	-	Impaired (restoration)	Reduce loads by 5%	Shoreline Management	Implement BMPs to slow, capture and	Lake Alice Shoreline	X	X		X			X						3-5 years	Review shoreland for SSTS Compliance

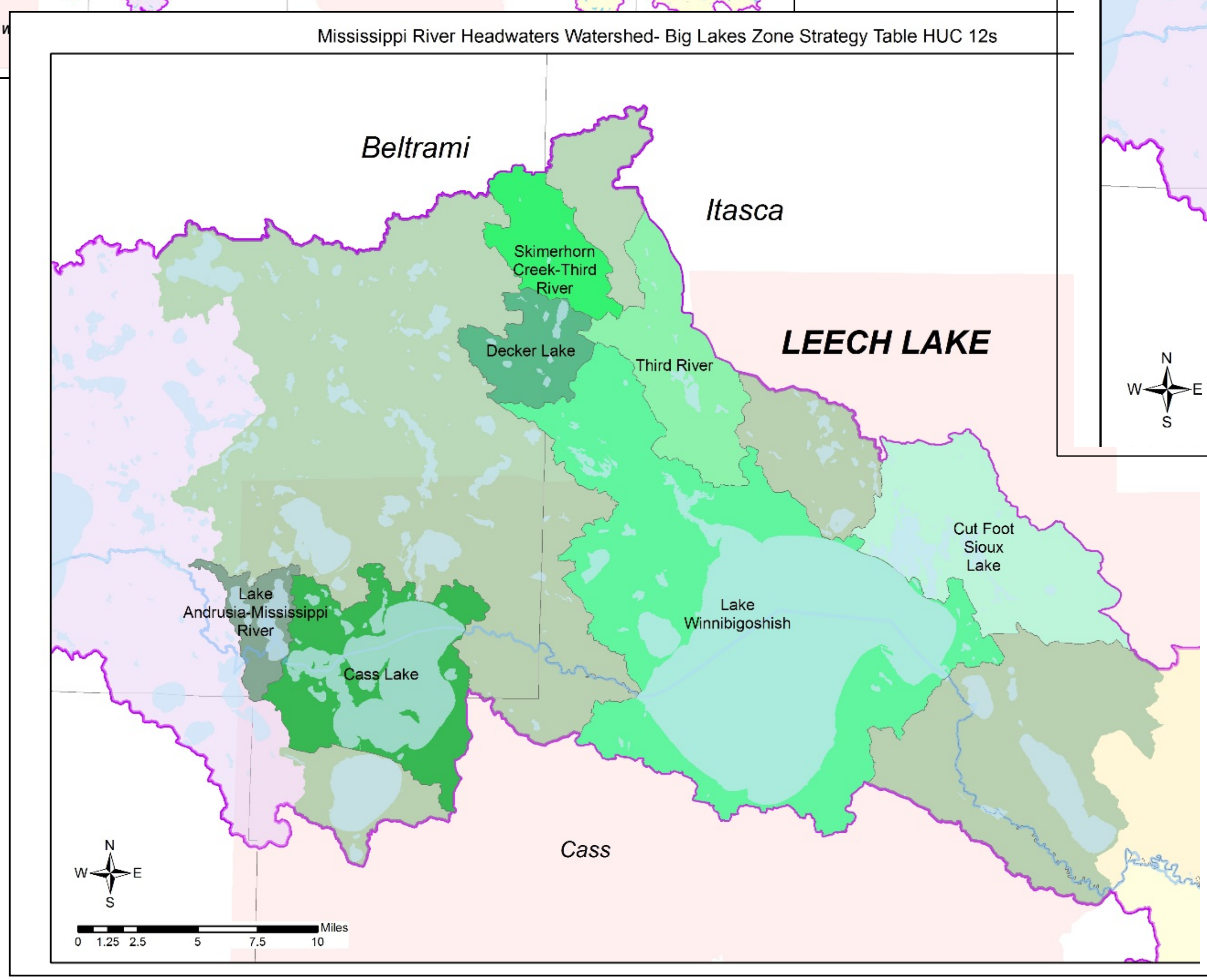
				TP, E. coli					treat runoff prior to reaching the lake															Review for shallow lake standard and/or natural background determination.
Lake Bemidji 070101010 502	Beltrami	Lake Irving 04-0140-00	340	Disturbance	34% Land Disturbance in Subwatershed	Impaired (restoration) ***See Mississippi River Headwaters TMDL Report**	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X	X	X	X			X						Ongoing	Identify subwatershed areas of highest sensitivity
				TP, E. coli	9,899 lb. TP 227,788 lb. TN 1,799 tons TSS		Reduce Loads to meet water quality standards	Septic System Management	Replace failing systems, Connect community to sanitary sewer system	Sub-watershed wide	X	X		X		X	X	X					Ongoing	Connect new Elementary School to City of Bemidji sanitary system upon completion of construction. Evaluate opportunities to expand connection to other developments along sanitary corridor.
				TP, TN, TSS				Stormwater Management	Reduce runoff contributions to Lake Irving from impervious surfaces	Sub-Watershed wide	X	X			X	X						X	5-10 years	Work with the City of Bemidji, MHB and other partners to address existing stormwater conveyance systems for possible treatment options. Continue to monitor storm water systems to determine loading from these systems. Work with the City of Bemidji and private contractor to evaluate and relocate snow disposal area.
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake Irving shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (including the Lake Irving Lake Association, city of Bemidji, Beltrami SWCD & DNR) to communicate and educate shoreline BMPs to residents.
								Riparian Buffers	Increase native vegetation along shoreline	Lake Irving shoreline		X	X	X			X							
Lake Bemidji 070101010 502		Lake Bemidji 04-0130-02	360	Disturbance	34% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain	Limit impact development	Manage % disturbed as future development/ land use	Sub-watershed wide	X	X	X	X	X	X	X						Ongoing	Work in addressing development issues as they arise in city, county and in Northern Township.

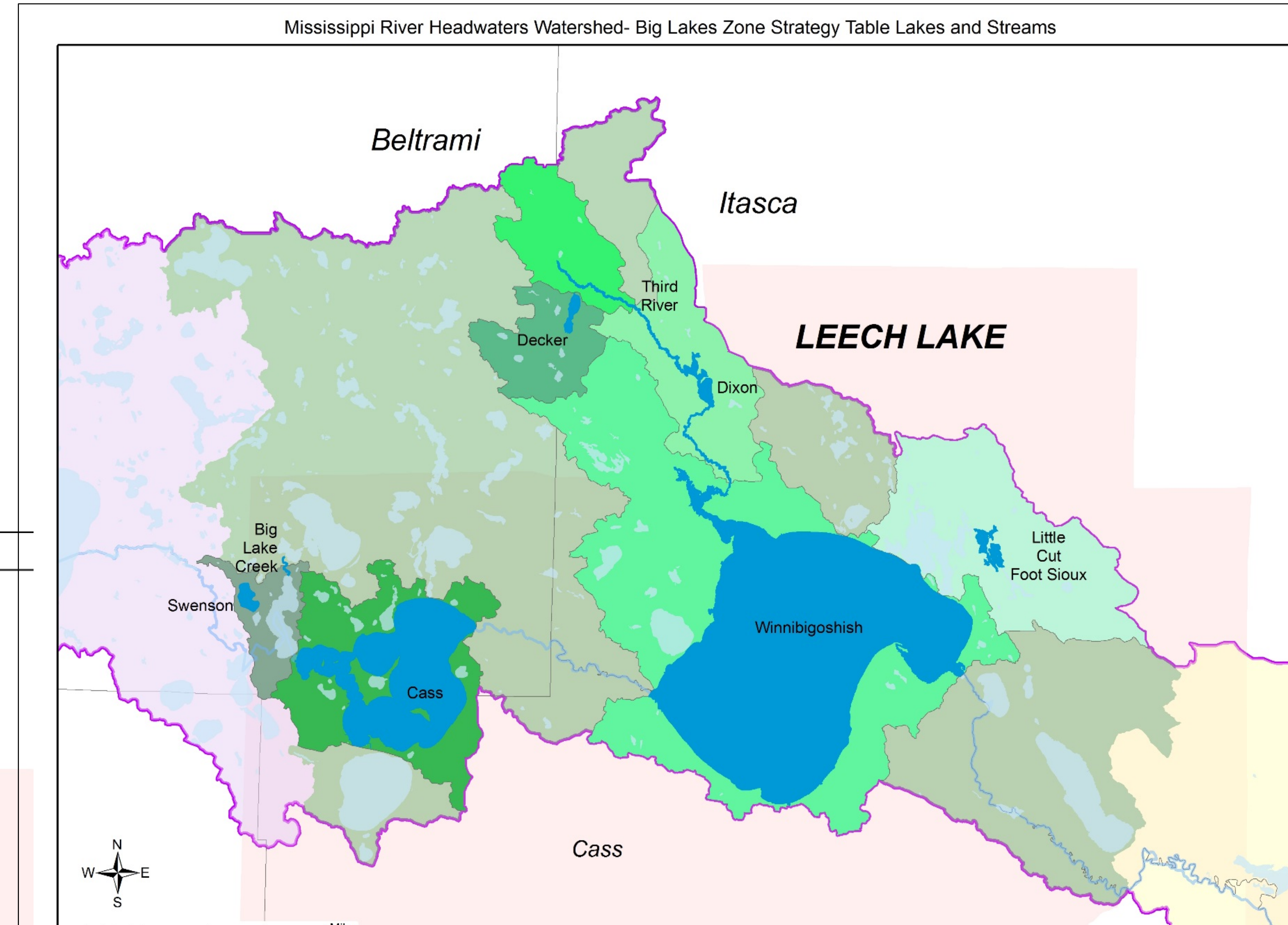
								conversions occur															Redevelopment of homes/properties along Lake Bemidji increasing.
			TP, E. coli	11,477 lb. TP 167,008 lb. TN 885 tons TSS		Reduce loads by 5%	Septic System Management	Replace failing systems, connect community to sanitary sewer system	Sub-watershed wide	X	X		X		X	X					X	5-10 years	City of Bemidji & Northern Twp. work with to address SSTS concerns and community sewer possibilities along the North Shore of Lake Bemidji.
			TP, TN, TSS				Stormwater Management	Reduce runoff contributions to Lake Bemidji from impervious surfaces	Sub-watershed wide	X	X				X		X				X	5-10 years	Work with MHB to help fund & install Extended Detention Basins covering 262.6 acres, Curb-Contained Bio-retention 4.4 acres, & Permeable Pavement 3.6 acres.
							Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake Bemidji shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (including the Friends of Lake Bemidji Association, city of Bemidji, Beltrami SWCD & DNR) to communicate and educate shoreline BMPs to residents.
							Riparian Buffers	Increase native vegetation along shoreline	Lake Bemidji shoreline														
Little Turtle Lake 070101010 402	Little Turtle Lake 04-0155-00	408	Disturbance	24% Land Disturbance in Subwatershed	Impaired (restoration) ***See Mississippi River Headwaters TMDL Report**	Maintain	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X	X	X	X			X						Ongoing	Work in addressing development issues as they arise in the Little Turtle subwatershed. Identify subwatershed areas of highest sensitivity.
			TP, TN, TSS, E. coli	503 lb. TP 9,678 lb. TN 13 tons TSS		Reduce Loads to meet water quality standards	Livestock Management	Manage livestock access to stream and site runoff	Sub-watershed wide	X	X	X		X		X		X				3-5 years	Work with landowners within the subwatershed to address livestock access issues to the Turtle River. Explore cost sharing options for BMPs.
							Increase vegetative cover	Plant cover crops	Ag Land in sub-watershed		X	X				X						3-5 years	Inventory, monitor and protect the most sensitive lands, increase permanent vegetative cover/cover crop in subwatershed by 25%.

								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Little Turtle Lake shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (including the Little Turtle Lake Association, Beltrami SWCD & DNR) to communicate and educate shoreline BMPs to residents. Coordinate 2-3 BMPs/shoreline vegetation projects.
								Riparian Buffers	Increase native vegetation along shoreline															
Turtle River Lake 070101010405		Turtle River Lake 04-0111-00	424	TP, TN, TSS	1,702 lb. TP 28,008 lb. TN 82 tons TSS	Meets Standards (Critical)	Reduce loads by 5%	Riparian Buffers	Increase native vegetation along shoreline of Turtle River	Golf Course	X	X					X						1-3 years	Cooperatively work with Golf Course management to determine if existing shoreline buffer is adequate.
								Nutrient Management	Nutrient management for golf course fertilizer applications	Golf Course	X						X						Ongoing	Annually communicate with Golf Course staff on nutrient management considerations.
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Turtle River Lake shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (the Turtle River Lake Association, Beltrami SWCD & DNR) to communicate and educate shoreline BMPs to residents. Coordinate 2-3 BMPs/shoreline vegetation projects.
								Riparian Buffers	Increase native vegetation along shoreline	Turtle River Lake shoreline	X	X	X				X							
Wolf Lake-Mississippi River 070101010504	Hubbard/ Beltrami	Grace Lake 29-0071-00	372	Disturbance	22% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain or improve	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-watershed wide	X		X	X										Work with lakeshore owners to improve shoreland and littoral habitat.
				TP, TN, TSS, DO, FIBI	291 lb. TP 2,544 lb. TN 7 tons TSS		Reduce loads by 5%	Stormwater Management	Manage stormwater directly flowing into lake	North Shore of Grace Lake	X			X									3-5 years	Work with Grace Lake Association to address stormwater runoff issues.
								Wetland Restoration	Restore wetlands	Northwest Shore of Grace Lake	X	X		X	X								3-5 years	Work with Grace Lake Association, to address feasibility of wetland restorations in NW shore of Grace Lake.

								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Grace Lake shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (the Grace Lake Association, Beltrami/Hubbard SWCDs & DNR) to communicate and educate shoreline BMPs to residents. Coordinate 3-4 BMPs/shoreline vegetation projects.
								Riparian Buffers	Increase native vegetation along shoreline	Grace Lake shoreline		X	X	X			X							
Wolf Lake-Mississippi River 070101010504	Hubbard/ Beltrami	Wolf Lake 04-0079-00	420	Disturbance	22% Land Disturbance in Subwatershed	Meets Standards (Critical)	Maintain, High Biological Significance	Limit impact development	Manage % disturbed as future development/ land use conversions occur	Sub-Watershed wide	X		X	X									Ongoing	Wolf Lake is a lake vulnerable due to its extremely large watershed (watershed to lake ratio of 400:1). The land surrounding the lake is primarily privately owned.
				TP, TN, TSS	13,261 lb. TP 185,718 lb. TN 842 tons TSS		Reduce loads by 5%	Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Wolf Lake shoreline		X	X	X	X		X						Ongoing	Intensively developed SE Shoreline (Hubbard County) is an area where shoreline BMPs may be warranted. High conservation easement potential along undeveloped eastern shoreline.
								Riparian Buffers	Increase native vegetation along shoreline	Wolf Lake shoreline		X	X	X			X							


RED LAKE
Koochiching
Beltrami
Clearwater
Itasca
LEECH LAKE
Cass

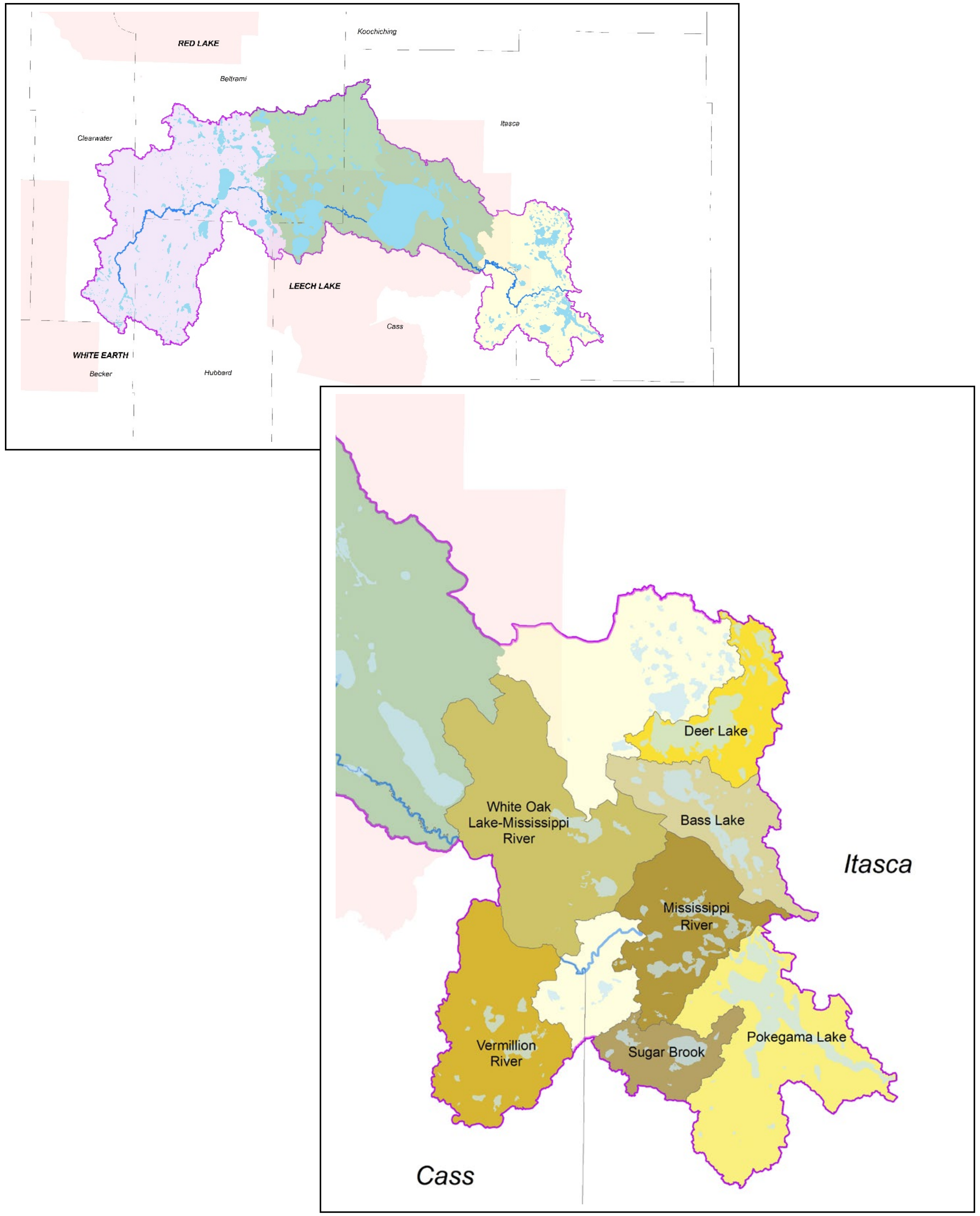

Mississippi River Headwaters Watershed- Big Lakes Zone Strategy Table HUC 12s
Beltrami
Itasca
LEECH LAKE
Skimerhorn Creek-Third River
Decker Lake
Third River
Cut Foot Sioux Lake
Lake Winnibigoshish
Lake Andrusia-Mississippi River
Cass Lake
Cass
N
W
E
S
0 1.25 2.5 5 7.5 10
Miles

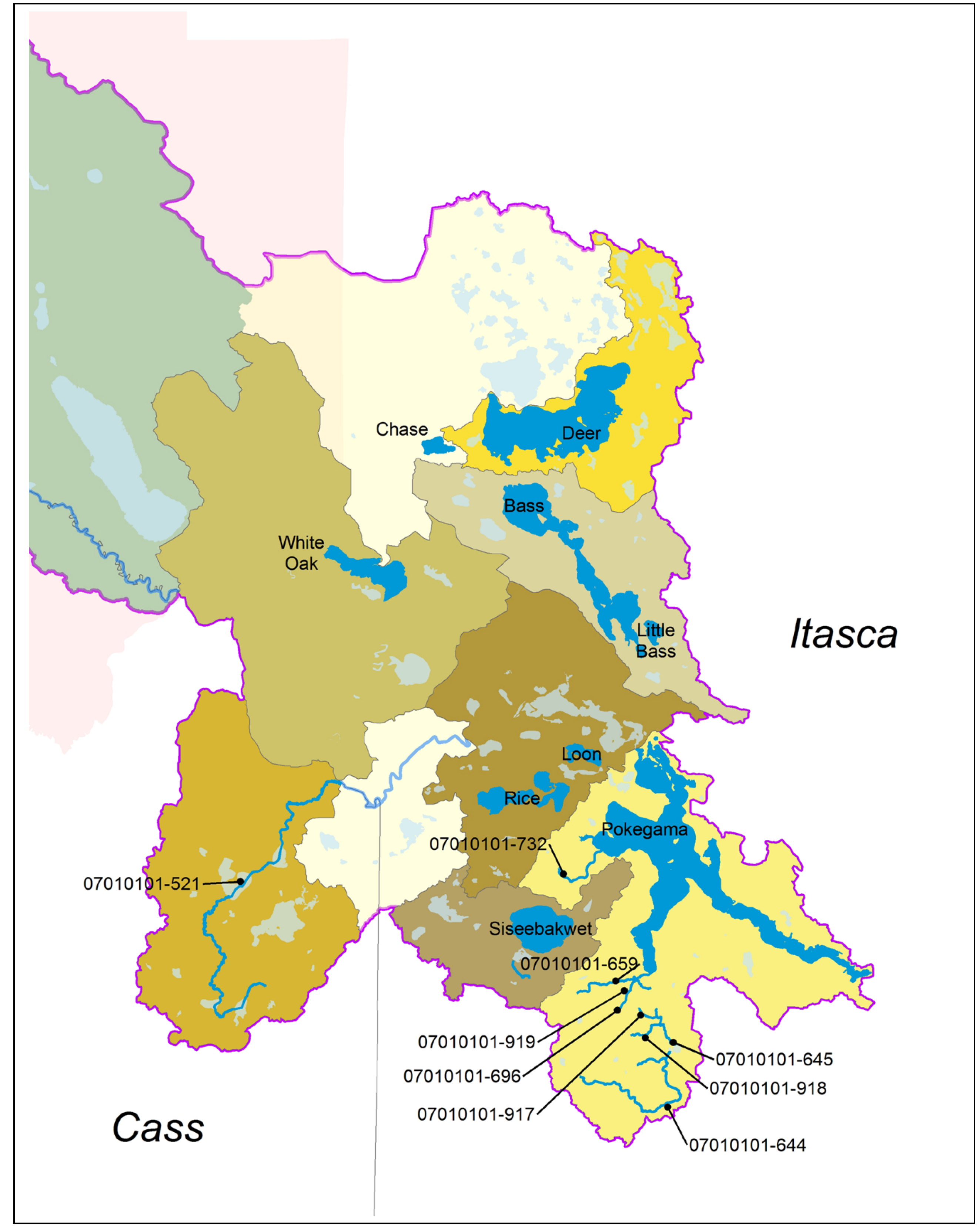

Mississippi River Headwaters Watershed- Big Lakes Zone Strategy Table Lakes and Streams
Beltrami
Itasca
LEECH LAKE
Third River
Decker
Dixon
Little Cut Foot Sioux
Big Lake Creek
Swenson
Winnibigoshish
Cass
Cass
N
W
E
S

Big Lakes section

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
Big Lakes Management Zone Waterbody Specific Strategies																								
Lake Andrusia-Mississippi River 07010101 0506	Beltrami	Swenson Lake 04-0085-00	440	TP, TN, TSS	-	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Increase/ Protect vegetative cover	Plant cover crops/protect existing cover	Ag Land in subwatershed		X	X	X	X		X			X	X		Ongoing	Look for conservation easement possibilities within lakeshed. One of the highest quality lakes with the watershed. Vigilance needed in the protection of forested cover and natural hydrology.
	Beltrami	Big Lake Creek 07010101-627				Meets Standards (Critical)	Maintain or Improve	Increase/ Protect vegetative cover	Protect existing cover	Sub-watershed wide		X	X	X	X					X	X		Ongoing	Big Lake Creek provides vital walleye spawning habitat, important walleye stripping station located on creek.
Cass Lake 07010101 0508	Cass/ Beltrami	Cass Lake 04-0030-00	460	TP, TN, TSS, E. coli	16,615 lb. TP 237,137 lb. TN 343 tons TSS	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Septic System Management	Replace failing systems	Sub-watershed wide	X	X		X		X	X	X		X	X	X	3-5 years	Assess/Inventory SSTS around shoreland areas. Look for opportunities to make community sewer connections.
									Connect community to sanitary sewer system		X	X		X		X	X	X		X	X	X		
								Stormwater Management	Reduce runoff contributions to Cass Lake from impervious surfaces	Subwatershed-Wide	X					X				X	X		Ongoing	Work with the City of Cass Lake and resort community on stormwater management strategies/improvements.
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Cass Lake shoreline		X	X	X	X		X						3-5 years	Work with watershed partners (including the City of Cass Lake & Resort community) to communicate and educate shoreline BMPs to residents. Maintain public land ownership along shoreline to the extent possible. Coordinate 2-3 BMPs/shoreline vegetation projects.
								Riparian Buffers	Increase native vegetation along shoreline	Cass Lake shoreline		X	X	X			X							
Skimerhorn Creek-Third River 07010101 0602	Itasca	Third River 07010101-526	491	TP, TN, TSS	1,497 lb. TP 43,843 lb. TN 148 tons TSS	Meets Standards (Critical)	Reduce loads by 5%	Forestry Management	Forestry BMPs	Subwatershed-Wide		X	X	X	X		X			X			Ongoing	Continue working to protect forest health within the subwatershed. Potential future Emerald Ash borer outbreak impact threatens existing black ash
		Dixon 31-0921-00		TP		Impaired (restoration) Possible		Forestry Management,	Forestry BMPs, Implement shoreline BMPs	Forestry BMPs Subwatershed-Wide,														

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table19 for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
		Decker 31-0934-00				Natural background candidates		Shoreline Management	to slow, capture and treat runoff prior to reaching the lake	Shoreline BMPs along Dixon & Decker shorelines														stands. Look at opportunities to restore shorelines along Dixon and Decker Lakes. Evaluate SSTS within shoreland. Additional monitoring needed on Dixon & Decker Lakes to determine if these lakes are natural background candidates. Look at opportunities for conservation easements. High degree of School Trust lands within subwatershed.
Lake Winnibigoshish h 07010101 0704	Itasca/Cass	Lake Winnibigoshis h 11-0147-00	520	TP, TN, TSS	19,275 lb. TP 296,570 lb. TN 399 tons TSS	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Shoreline Management	Maintain public land ownership along shoreline	Lake Winnibigoshis h shoreline		X	X	X	X		X						3-5 years	Evaluate/ Inventory public lands to determine lands at highest risk (e.g. School Trust Lands) for private transfer. Look into various conservation easement possibilities.
				Aquatic Invasive Species			Maintain or improve	Starry Stonewort Control	Monitor spread of starry stonewort and research control methods	Itasca portion of Lake Winnibigoshis h basin		X			X		X	X		X			On-going	Maintain or improve upon current populations and densities.
								Zebra Mussel Control	Monitor spread of zebra mussel population and research control methods			X			X		X	X		X				
	Itasca	Little Cut Foot Sioux 31-0852-00		TP		Impaired (restoration) Possible Natural background candidate	Reduce loads by 5%	Forestry Management, Additional monitoring	Forestry BMPs, follow up monitoring	Subwatershed wide	X	X		X	X					X	X		5-8 years	Determination made on status of TP conditions of lake prior to next IWM Cycle in 2023.


RED LAKE
Koochiching
Beltrami
Clearwater
Itasca
LEECH LAKE
Cass
WHITE EARTH
Becker
Hubbard
Deer Lake
White Oak
Lake-Mississippi
River
Bass Lake
Itasca
Mississippi
River
Vermillion
River
Sugar Brook
Pokegama Lake
Cass


Chase
Deer
Bass
White
Oak
Little
Bass
Itasca
Loon
Rice
Pokegama
07010101-732
07010101-521
Siseebakwet
07010101-659
07010101-919
07010101-696
07010101-917
07010101-645
07010101-918
07010101-644
Cass

East Zone Strategies

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Deer Lake 07010101 0704	Itasca	Deer Lake 31-0719-00 Deer Lake is extremely sensitive to increased phosphorus loading.	566	Connectivity	277 lb. TP 6,053 lb. TN 1.4 tons TSS	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Hydrology Management	Winter management of culverts to ensure no blockages	North Shore of Deer Lake	X	X		X	X	X	X						1-3 years	Work with landowner(s) to resolve hydrology issue which is causing localized flooding and erosion on shoreline.
				TP, TN, TSS, E. coli				Septic System Management	Replace failing systems Connect community to sanitary sewer system	Subwater-shed Wide	X	X		X		X	X	X					3-5 years	Assess/Inventory SSTS around shoreland areas. Look for potential opportunities to make community/cluster sewer connections (e.g. feasibility study).
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Deer Lake shoreline		X	X	X	X		X			X			3-5 years	Work with watershed partners (Deer Lake Association) to communicate and educate shoreline BMPs to residents. Protect shoreland vegetation/forestland. Maintain public land ownership along shoreline to the extent possible. Coordinate 2-3 BMPs/shoreline vegetation projects.
								Riparian Buffers	Increase native vegetation along shoreline	Deer Lake shoreline		X	X	X			X							
				TP, TN, and TSS			Reduce sediment and nutrient loads	Forest Management	Selective harvest practices and preservation of first order headwaters in lakesheds	Lakesheds		X	X	X	X	X	X						On-going	Discussions and partnerships established to conserve forested conditions in the headwaters area.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
	Itasca							Shore stabilization	Increase buffer plantings on shoreland which has previously been mowed to the water's edge	Education and outreach on the importance of buffers		X					X	X					On-going	At least 8 buffer plantings completed.
									Stabilize severe erosion on shorelines with rock rip rap and biological methods	As needed		X					X						On-going	At least 15 projects installed on Pokegama Lake and 7 on Deer Lake.
				TP, TN, TSS, and Habitat			Maintain or improve resources based on further study	Stream Monitoring and Remediation	Perform longitudinal stream analyses of priority management subwatersheds, create management plans for nutrient and erosion control, install BMPs and monitor BMP effectiveness	Analysis of 7 identified subwatersheds		X					X						2016 to 2026	Geomorphic study completed and at least 2 BMPs installed.
				TP, Chl-a, and Clarity				Bell-weather Lake Water Monitoring	Monitor at least one site every year to track temporal changes in water quality	Minimum of six samples per year	X	X					X	X					On-going	Minimum of ten years of data to establish temporal trends
				TP, TN, E. coli, and pharmaceuticals			Reduce sediment, nutrients, and E. coli loads	Septic System Management	Itasca Water Legacy Partnership (IWLP) in cooperation with local officials and citizens to promote inspections of septic systems and aid landowners in finding financial support to upgrade and replace failing septic systems.	Survey for septic system compliance and potential aid funding sources identified	X	X		X		X	X	X					On-going	Survey completed for both lakes.
				TP, TN, TSS, and Chloride			Reduce sediment and nutrient loads	Stormwater Management	Engineer and install stormwater management projects	As possible		X		X		X	X	X					2017-2037	At least one project identified and designed for each lake.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
									Community consideration for the adoption stormwater ordinance language within the Minimum Impact Design Standards Community Assistance Package developed by the MPCA		X	X		X		X	X	X					2017-2037	Community conversations have begun.
				Hypolimnetic Oxygen Demand			Maintain or improve resources based on further study	Hypolimnetic Aeration	Create and install hypolimnetic aeration devices, with two years of monitoring prior and after installation, and evaluate economic feasibility of sustained operation	Four total years of monitoring oxygen consumption, and building /installation of speece cones with surface vents		X			X		X	X					2018 to 2050	Identify potential funding sources and partnerships, and begin the pre-monitoring.
				All			Reduce sediment and nutrient loads	Conservation Zoning	County wide consideration for adoption of land use conservation zoning overlays related to future development	County-wide zoning updates		X		X		X	X	X					2017-2037	Community conversations have begun.
							Maintain or improve resources based on further study	Groundwater Monitoring	Install groundwater monitoring wells and control wells for monitoring temporal trends	Approximately 20 Wells		X			X		X	X					2018 to 2050	Establish a well network and analyze groundwater data.
		Chase Lake 31-0749-00	567	TP, TSS, and Habitat	-	Meets Standards (Protection)	Reduce sediment and nutrients loads	Tullibee Lakes Forest Stewardship	Promote Tullibee habitat through forest stewardship plans and shoreline stabilization	As approved throughout the lake watershed		X			X		X						2016 and continuing	At least one parcel enrolled.
White Oak Lake-Mississippi River 07010101 0903	Itasca	White Oak Lake 31-0776-00	590	TP	-	Meets Standards (Critical)	Maintain or Improve	Hydrology and stormwater management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Subwatershed wide	X	X			X	X				X			3-5 years	Continue to monitor lake as it is getting closer to the impairment threshold for nutrients. Evaluate NE corner of lake for possible

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
																								improvements to/loading contributions from existing drainage system.
Vermillion River 07010101 0904	Cass	Vermillion River 07010101-521	601	TP, DO, Habitat	1,029 lb. TP 25,433 lb. TN 103 tons TSS	Meets Standards (Critical)	Reduce loads by 5%	Forestry Management	Promote habitat through forest health management	Subwatershed wide		X			X		X			X			Ongoing	One new parcel with Forest Stewardship Plan in next 2-3 years. Stream has naturally low DO levels.
Bass Lake 07010101 0908	Itasca	Little Bass Lake 31-0575-00	622	TP, TSS, and Habitat	-	Meets Standards (Protection)	Reduce sediment and nutrients loads	Tullibee Lakes Forest Stewardship	Promote Tullibee habitat through forest stewardship plans and shoreline stabilization	As approved throughout the lake watershed		X	X		X		X						2016 and continuing	At least one parcel enrolled.
		Bass Lake 31-0576-00	622	TP, Habitat	-	Meets Standards (Protection)	Maintain or Improve	Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Bass Lake Shoreline		X	X		X	X	X						3-5 years	Coordinate 2-3 BMPs/shoreline vegetation projects. Evaluate options for sanitary sewer connections to community system (city of Cohasset).
Mississippi River 07010101 0909	Itasca	Rice Lake 31-0717-00	612	TP, TN, TSS, E. coli	-	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Rice Lake Shoreline		X	X	X	X	X	X							Identify shoreline areas of highest sensitivity.
								Riparian Buffers	Increase native vegetation along shoreline	Rice Lake Shoreline														
		Loon Lake 31-0571-00	630	Flow, TSS	-	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Hydrology Management	Manage excess sediment to reduce blowouts	Outlet to river	X	X		X	X									Evaluate hydrology issue, install BMPs to reduce sedimentation.
				TP, TSS, and Habitat			Reduce sediment and nutrients loads	Tullibee Lakes Forest Stewardship	Promote Tullibee habitat through forest stewardship plans and shoreline stabilization	As approved throughout the lake watershed		X			X		X						2016 and continuing	At least one parcel enrolled.
Sugar Brook 07010101 0906	Itasca	Siseebakwet Creek 07010101-643	632	TP, TSS, and Habitat	-	Meets Standards (Protection)	Maintain or Improve	Tullibee Lakes Forest Stewardship	Promote Tullibee habitat through forest stewardship plans	Subwatershed wide		X			X		X							

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
		Siseebakwet Lake 31-0554-00	632	Flow	-	Meets Standards (Protection)	Maintain or Improve	Hydrology Management	Manage outflow structure	Outlet to river	X	X			X									Continue to work with Sugar Lodge on golf course/nutrient management BMP strategies.
				TP, TSS, and Habitat			Reduce sediment and nutrients loads	Tullibee Lakes Forest Stewardship	Promote Tullibee habitat through forest stewardship plans and shoreline stabilization	As approved throughout the lake watershed		X			X		X							At least one parcel enrolled. Need to recruit a citizen monitor for the lake.
Pokegama Lake 07010101 0907	Itasca	Unnamed Creek 07010101-732	636	TP, TN, TSS, E. coli	-	Meets Standards (Critical)	Reduce loads by 5%	Livestock Management	Manage livestock access to stream and site runoff	Feedlots	X						X						1-3 years	Work with landowner on practice to restrict cattle access to stream. Explore cost sharing options.
		Smith Creek (Headwaters to Smith Lake) 07010101-644	635	TP, TN, TSS	-	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Forestry Management	Forestry BMPs	Subwatershed-Wide		X	X	X	X		X						2017-2037	Partnerships, projects, and funding sourced Identified.
								Trout Habitat Improvement	Work with industrial forest landowners on forest management for Brook Trout habitat as well as in-stream habitat improvement	Smith Creek from the headwaters to Pokegama Lake		X					X	X						
								Bioengineered Bank Stabilization	Toe-wood bioengineered bank stabilization along a segment of Smith Creek (upstream of Smith Lake) destabilized during heavy rain events in 2012-2013 which blew out a culvert, and is now contributing to nutrient & sediment export downstream to Smith and Pokegama lakes	Approximately 350 linear ft. of Smith Creek, 50 ft. downstream from new bridge		X					X	X						
		Smith Creek (Smith Lake to Little Pokegama	635	TP, TN, TSS	270 lb. TP 8,332 lb. TN	Meets Standards (Critical)	Reduce loads by 5%	Riparian Buffers	Increase native vegetation along shoreline	Along banks of Smith Creek		X	X	X			X						2017-2037	Partnerships, projects, and funding sourced Identified.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907		Lake) 07010101-645			64 tons TSS			Trout Habitat Improvement	Work with industrial forest landowners on forest management for Brook Trout habitat as well as in-stream habitat improvement	Smith Creek from the headwaters to Pokegama Lake		X					X	X						
								Bioengineered Bank Stabilization	Toe-wood bioengineered bank stabilization along a segment of Smith Creek (upstream of Smith Lake) destabilized during heavy rain events in 2012-2013 which blew out a culvert, and is now contributing to nutrient & sediment export downstream to Smith and Pokegama lakes	Approximately 350 linear ft. of Smith Creek, 50 ft. downstream from new bridge		X					X	X					2017-2037	Partnerships, projects, and funding sources Identified.
		Unnamed Creek 07010101-656	635	TP, TN, TSS	-	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Forestry Management	Forestry BMPs	Subwatershed-Wide		X	X	X	X		X						5-10 years	Work with agency partners and private citizens to evaluate/inventory forest health. On private acres look at increasing Forest Stewardship Plans.
		Unnamed Creek 07010101-918					Maintain or Improve					X	X	X	X		X							
		Matuska's Creek 07010101-917										X	X	X	X		X							
		Little Pokegama Creek	636									X	X	X	X		X							

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907		07010101-696																						
		Little Pokegama Creek 07010101-919										X	X	X	X		X							
		Pokegama Creek 07010101-659	636	TP, TN, TSS	-	Meets Standards (Critical)	Maintain or Improve	Forestry Management	Forestry BMPs	Subwatershed-Wide		X	X	X	X		X						5-10 years	Work with agency partners and private citizens to evaluate/ inventory forest health. On private acres look at increasing Forest Stewardship Plans.
		Pokegama Lake 31-0532-01	636	TP, TN, TSS	1,374 lb TP 24,532 lb TN 26 tons TSS	Meets Standards (Protection)	Maintain or Reduce loads by 5%	Nutrient Management	Manage the amount and timing of nutrient applications	Golf Course	X	X				X	X						Ongoing	Continue to work with Golf Course mgmt./staff in implementing nutrient management practices.
								Stormwater Management	Implement LID for developing area along Hwy 169.	North of Lake Pokegama off of Hwy 169	X	X				X	X						10-20 years	Education and Outreach activities to promote LID efforts.
								Aquatic invasive species management	Provide regular monitoring of watercrafts entering and exiting waterbody at public landings and provide decontamination stations.	Public accesses to Pokegama Lake		X		X	X	X							Ongoing	Continue to work towards preventing the spread of AIS.
								Shoreline Management	Implement BMPs to slow, capture and treat runoff prior to reaching the lake	Lake Pokegama shoreline		X	X	X	X		X						3-5 years	Work towards completing 5 native shoreline/BMP projects in next 5 years.
								Riparian Buffers	Increase native vegetation along shoreline	Lake Pokegama Shoreline		X	X	X			X							

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907							Reduce sediment and nutrient loads	Forest Management	Selective harvest practices and preservation of first order headwaters in lakesheds	Lakesheds		X		X	X		X						On-going	Discussions and partnerships established to conserve forested conditions in the headwaters area.
							Reduce sediment and nutrient loads	Shore stabilization	Increase buffer plantings on shoreland which has previously been mowed to the water's edge	Education and outreach on the importance of buffers		X		X	X		X	X					On-going	At least 8 buffer plantings completed.
							Reduce sediment and nutrient loads	Shore stabilization	Stabilize severe erosion on shorelines with rock rip rap and biological methods	As needed		X					X						On-going	At least 15 projects installed on Pokegama Lake and 7 on Deer Lake.
							Reduce nutrient export to Lake Pokegama	Agricultural BMPs	Work with private landowners to implement NRCS agricultural BMPs, and consider dredging the farm field pond which would limit nutrient export to Pokegama Lake	Subwatershed p3 identified in the 2017 Deer & Pokegama Geomorphic Report		X	X				X						2017-2027	Discussions with landowners in the subwatershed and potential projects identified.
							Reduce sediment and nutrient loads	Stormwater Management	Engineer and install stormwater management projects for the Lakeshed	As possible		X		X		X	X	X					2017-2037	At least one project identified and designed for each lake.
				TP, TN, TSS, and Chloride			Reduce sediment and nutrient loads	Stormwater Management	Community consideration for the adoption stormwater ordinance language within the Minimum Impact Design Standards Community Assistance Package developed by the MPCA	As possible	X	X		X		X	X	X					2017-2037	Community conversations have begun.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907							Reduce sediment, Phosphorus and Chloride loads	Road Drainage Modification at MN 169 Pokegama Causeway	Hold a community roundtable discussion on options and support of modifications to drainage for the Pokegama causeway, and seek funding & engineering for identified projects	Communit y input and partnershi ps established to design project concepts	X	X		X		X	X	X					2017-2027	Discussions and partnerships established.
							Reduce sediment, Phosphorus, and Chloride loads	Road Drainage Modification at MN 169 Pokegama Causeway	Install ditch check dams along Pokegama causeway	Drainage area Northeast of 169 Pokegama Causeway		X		X		X	X	X					2017-2027	Discussions and partnerships established, and engineered designs produced.
				TP, TN, TSS, and E.coli			Reduce sediment, nutrients, and E. coli loads	Private Landowner Management Plans	Work with private landowners to implement NRCS agricultural BMPs, and consideration of buffer plantings and cattle exclosures for the stream to limit sediment and nutrient export to Pokegama Lake.	Tributary to Poole's Bay on Lake Pokegama (Subwaters hed p9 from 2017 Deer & Pokegama Geomorphi c Report)		X					X						2017-2037	Partnerships, projects, and funding sources Identified.
							Reduce sediment, nutrients, and E. coli loads	Beaver Dam Removal and Population Control	Work with Landowners to remove the beaver dam and restore the hydrology of the tributary to Poole's Bay on Lake Pokegama	Tributary to Poole's Bay on Lake Pokegama (Subwaters hed p9 from 2017 Deer & Pokegama Geomorphi c Report)		X			X		X						2017-2037	Partnerships, projects, and funding sources Identified.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907				TP, TN, TSS, and Habitat			Maintain or improve resources based on further study	Stream Monitoring and Remediation	Perform longitudinal stream analyses of priority management subwatersheds, create management plans for nutrient and erosion control, install BMPs and monitor BMP effectiveness	Analysis of 9 identified subwatersheds		X					X						2016 to 2026	Geomorphic study completed and at least 2 BMPs installed.
				TP, Chl-a, and Clarity			Maintain or improve resources based on further study	Bell-weather Lake Water Monitoring	Monitor at least one site in each lake every year to track temporal changes in water quality	Minimum of six samples per year	X	X					X	X					On-going	Minimum of ten years of data to establish temporal trends.
				TP, TN, E. coli, and pharmaceuticals			Reduce sediment, nutrients, and E. coli loads	Septic System Management	Itasca Water Legacy Partnership (IWLP) in cooperation with local officials and citizens to promote inspections of septic systems and aid landowners in finding financial support to upgrade and replace failing septic systems.	Survey for septic system compliance and potential aid funding sources identified	X	X		X		X	X	X		X			On-going	SSTS survey completed.
				TP, TN, TSS, and Aquatic Invasive Species			Reduce nutrient flux and potential for AIS infestation	Mississippi River Backflow to Pokegama	Implement discussions between the community and the US Army Corps of Engineers about policy and or engineering solutions to decrease nutrient flux from backflow of the Mississippi River Dam.	Coordinated efforts between the community and the US Army Corps of Engineers about backflow from the dam into Lake Pokegama		X		X	X	X	X	X					2017-2037	Discussions and partnerships established.

HUC-12 Subwatershed	County Location and Upstream Influence Counties	Waterbody (ID)	HSPF Subwatershed	Water Quality Parameter of Concern (Including Non-pollutant Stressors)	Water Quality Current Conditions (Loads are annual totals)	Water Quality Standards (Priority Listing)	Water Quality Goals/Targets	Strategies (See Table XX for Descriptions and Implementation Tools; See link on pg. 6 for Applicable NRCS Codes)	Strategy Type/Description	Estimated Scale of Adoption Needed	Governmental Units and Entities With Primary Responsibility												Timeline	Interim 10-Year Milestones
											MPCA	SWCD	NRCS	County	DNR	Cities/ Townships	Landowners	Nonprofits	MDA	Other Federal (USFS, ACOE)	LLBO	MHB		
East Management Zone Waterbody Specific Strategies																								
Pokegama Lake 07010101 0907				Aquatic Invasive Species			Maintain or improve	Curly Leaf Pond Weed Control	Removal of curly leaf pondweed through both physical removal and localized herbicide application	Localized areas within the lake basin		X			X	X	X	X					On-going	Maintain or improve upon current populations and densities.
				Hypolimnetic Oxygen Demand			Maintain or improve resources based on further study	Hypolimnetic Aeration	Create and install hypolimnetic aeration devices, with two years of monitoring prior and after installation, and evaluate economic feasibility of sustained operation	Four total years of monitoring oxygen consumption, and building /installation of speece cones with surface vents		X			X		X	X					2018 to 2050	Identify potential funding sources and partnerships, and begin the pre-monitoring.
				All			Reduce sediment and nutrient loads	Conservation Zoning	County wide consideration for adoption of land use conservation zoning overlays related to future development	County-wide zoning updates		X		X		X	X	X					2017-2037	Community conversations have begun.
				All			Maintain or improve resources based on further study	Groundwater Monitoring	Install groundwater monitoring wells and control wells for monitoring temporal trends	Approximately 20 Wells		X			X		X	X					2018 to 2050	Establish a well network and analyze groundwater data.

4. Monitoring Plan

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction/and water quality protection. Accordingly, as a very general guideline, progress benchmarks are established for this watershed that assume that improvements will occur resulting in a water quality pollutant concentration decline each year equivalent to approximately 1% of the starting (i.e., long-term) pollutant concentration. For example, for a lake with a long-term growing season TP concentration of 90 µg/L, by year 10 it would be 90 – (10 * 0.9) = 81 µg/L.

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

Ongoing Monitoring Efforts

Data from three monitoring programs will continue to be collected and analyzed for the MRHW Watershed as part of Minnesota's Water Quality Monitoring Strategy - 2011-2021 (MPCA 2011). These monitoring programs are summarized below:

1. Through the IWM approach, chemistry and biological data is collected throughout each major watershed once every 10 years. (See Watershed Approach to Restoring and Protecting Water Quality.) This work is scheduled for its second iteration in the MRHW Watershed in 2023. This data provides a periodic but intensive “snapshot” of water quality throughout the watershed. In addition to the monitoring conducted in association with this process, other watershed partner organizations (e.g. local, state, federal, tribal) within the watershed may have their own monitoring activities. All data collected locally should be submitted regularly to the MPCA for entry into the EQuIS database system for ultimate use in water quality assessments.
2. The Watershed Pollutant Load Monitoring Network intensively collects pollutant samples and flow data to calculate sediment and nutrient loads on either an annual or seasonal (no-ice) basis. In the MRHW, there are two subwatershed pollutant load monitoring sites. These two sites include the Mississippi River at CSAH 11 S001-897 and the Mississippi River at Ottertail Dam on CSAH-12, 4 Miles east of Bemidji S002-034.
3. The Citizen Surface Water Monitoring Program is a network of volunteers who make monthly lake and river transparency readings. Several dozen data collection locations exist within the MRHW. This data provides a continuous record of one water quality parameter (transparency/turbidity) throughout much of the watershed.

Figure 49. Citizen Lake Monitor Volunteer using Secchi Disk to measure lake clarity

In addition to the monitoring conducted in association with these processes noted above, there are other monitoring programs where data has been and will continue to be collected on surface water resources within or associated with this watershed. The programs include the following:

Sentinel Lakes Monitoring Program - Biological and chemical changes are monitored in a select sample of lakes to obtain representative data on Minnesota's most common lakes. Elk Lake in Clearwater County (within Itasca State park) is included in this monitoring program.

Elk Lake (Itasca State Park) – Clearwater County

Minnesota's Fish Contaminant Monitoring Program (MPCA 2008) - This program helps support human health and environmental protection programs within Minnesota by providing information for fish consumption, mercury cycling/trends, and analysis of potential newly identified bioaccumulative pollutants.

Wetland monitoring and assessment - Wetlands are an integral part of Minnesota's water resources, and wetland monitoring information will be an essential component in the implementation of efforts to protect and restore lakes and streams.

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Appendix A

October 8, 2015

Mr. Phil Votruba
Minnesota Pollution Control Agency
7678 College Road
Brainerd, MN 56425

Dear Mr. Votruba:

RE: Upper Mississippi Headwaters Lakes: Water Quality Review of Select Lakes for Natural Background Exceedances of Water Quality Standards

EXECUTIVE SUMMARY

This water quality review was conducted to evaluate natural background conditions and to provide recommendations for the appropriateness and need for conducting additional studies on select shallow lakes of the Upper Mississippi River Headwaters watershed (Headwaters Lakes) including Alice (29-0286), Decker (31-0934), Dixon (31-0921), Larson (04-0154), Little Cut Foot Sioux (31-0852), and Moose (04-342). All of these lakes have been identified as shallow in this assessment and exceed lake water quality standards for phosphorus (P) along with one or both eutrophication responses (chlorophyll *a* and Secchi transparency). Minnesota Lake Eutrophication Analysis Procedure (MINLEAP) modeling of the lakes indicated that all of the lakes, except for Larson Lake, may exceed the Northern Lakes and Forests aquatic ecoregion (NLF) P standard given their watershed areas and estimated mean depths. It is recommended that Total Maximum Daily Loads (TMDLs) **not be completed** until the Minnesota Pollution Control Agency (MPCA) has completed its review of shallow lake data for the NLF.

By their nature, shallow lakes have less volume to dilute runoff and are subject to larger lake-level fluctuations and wind mixing that may reduce sedimentation and thereby increase lake P concentrations. The growing season and peak summer temperatures have increased in recent years in this region. Considerable growing season dry and wet period gyrations were noted that may: (1) contribute periodic watershed runoff and P loading pulses; and (2) encourage pulsing of nutrients from up-gradient wetlands and organic deposits subject to dry period digestion (in effect a system Sediment Oxygen Demand) and release P during wet periods. Both types of pulses may be enhanced by historical drainage practices.

Three lakes (Decker, Little Cut Foot Sioux, and Moose) exceed lake eutrophication standards and all have large contributing watersheds suggesting that these lakes (1) may have more reservoir-like characteristics, and (2) larger annual runoff P loads that in effect, may have become legacy loads being expressed via sediment diagenesis (internal loading). Climatic trends will tend to provide conditions favoring lake internal P loading characteristics noted for all of these lakes. However, the deeper twin-basin configured Dixon Lake, noted to have thermal stratification, has an improving water quality trend based on 25 years of Secchi transparency measurements. The remaining lakes did not have sufficient data for trend detection purposes.

CLIMATE

Basic hydrologic cycle and other climate information were reviewed to aid in defining natural background conditions affecting lake water quality. This includes typical monthly temperature and precipitation information (normals), tabulation of annual precipitation, growing season lengths, dry and wet periods and peak summer temperatures. Climate variability for the Headwaters' area was assessed using available long-term data for sites that included Leech Lake Dam, the Minnesota Department of Natural Resources' (MDNR's) gridded precipitation and National Oceanic and Atmospheric Administration's (NOAA's) databases summarized for north-central Minnesota (Climate Division 2).

Leech Lake monthly climate average precipitation and maximum, mean, and minimum temperatures for the 1981–2010 period are plotted in Figure 1 with precipitation peaking during the growing season (e.g., approximately 4.25 inches noted for July). Total annual precipitation for the period of 1970 to 2014 is plotted in Figure 2, Annual precipitation ranged from 14.9 inches (1976) to 33.3 inches (1981) with an average of approximately 25.3 inches during this period. The past 10 years of Leech Lake Dam monitoring station data averaged slightly less (25.1 inches) and with a narrower range of values from 20.2 (2006) to 29.8 inches (2010).

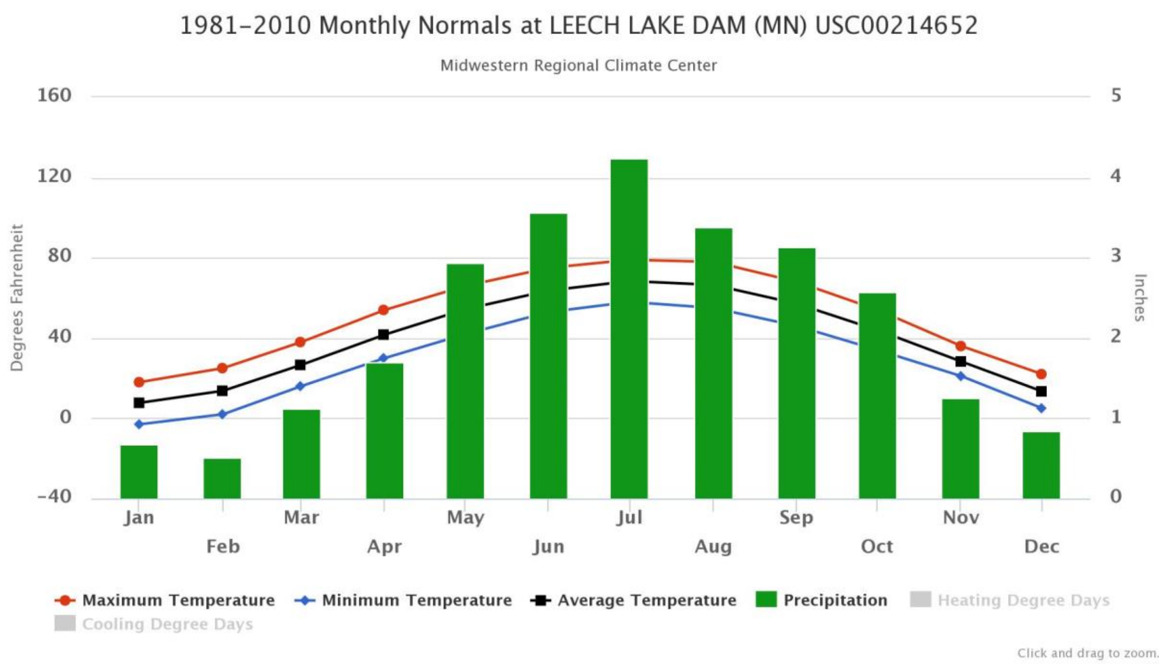


Figure 1. Monthly Normals for 1981 to 2010 [Midwestern Regional Climate Center, 2015].

Annual precipitation (1970–2014) summarized for Climate Division 2 [Midwestern Regional Climate Center, 2015] further highlights the inter-year variability and is illustrated in Figure 3. The smoothed time-series data, represented by the green binomial filter line, indicate less precipitation in recent years following a peak noted in the 1990s into 2001. The use of the smoothed time series allows observation of longer period wet and dry precipitation patterns affecting NLF lakes which were noted to have water residence times on the order of 0.5 to 15 years [Wilson and Walker, 1989]. Water residence time is the amount of time it would take to fill an empty lake basin or replace its entire volume.

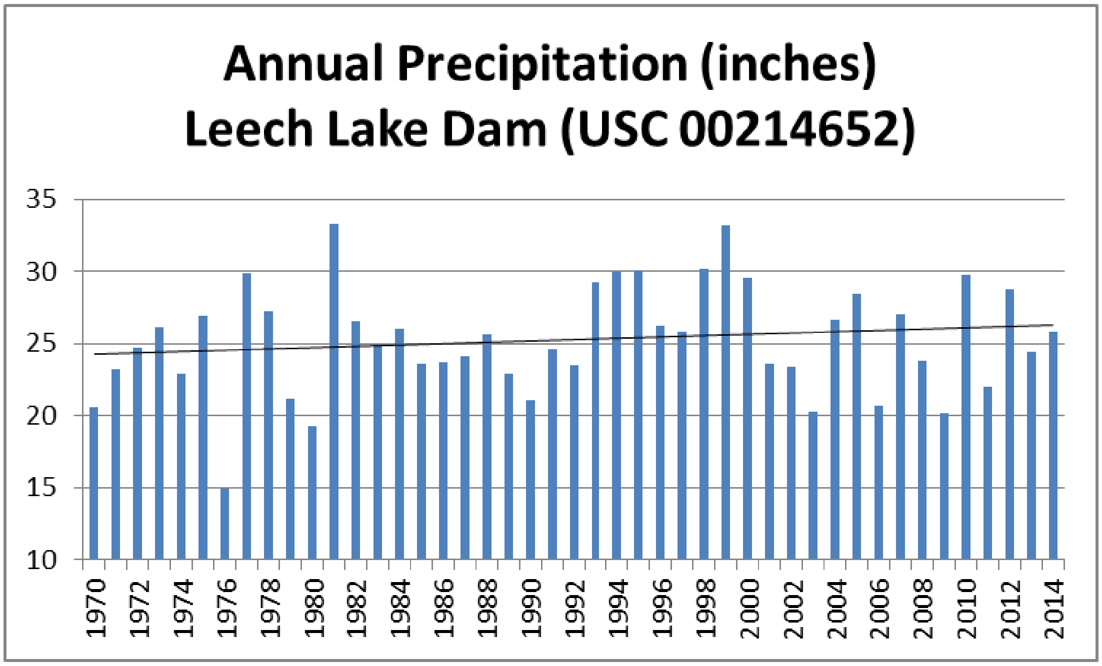


Figure 2. Climate Data for Leech Lake Dam (USC 02214652).

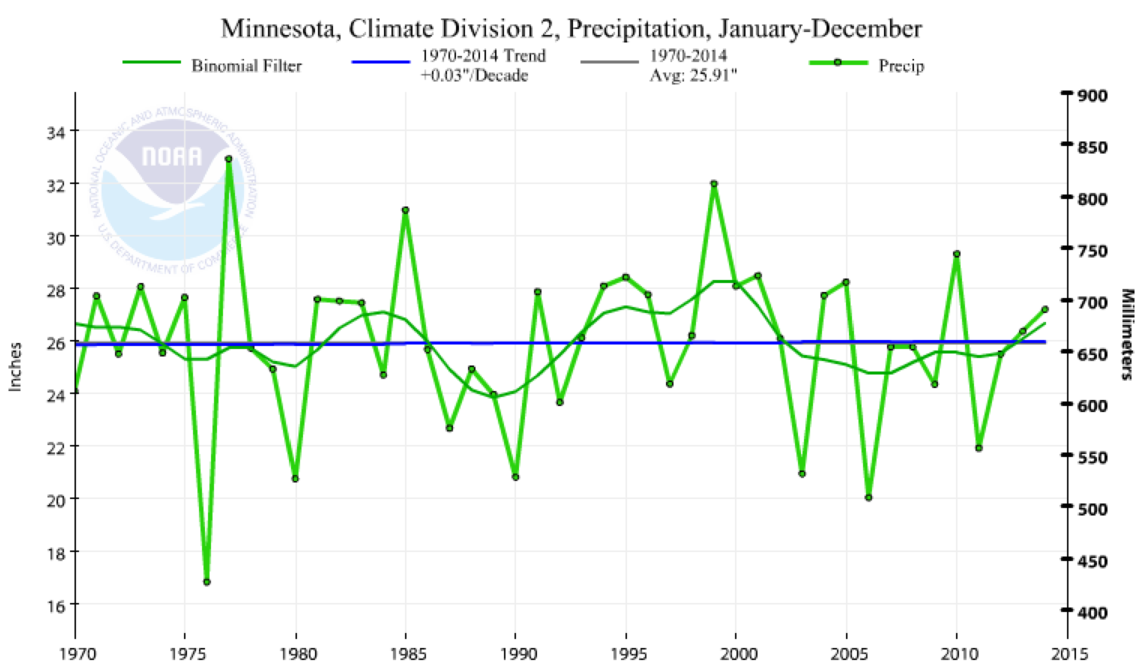


Figure 3. Annual Precipitation 1970–2014 from the National Oceanic and Atmospheric Administration Climate Division 2 [2015].

Annual evaporation from shallow lakes, estimated based on pan evaporation measurements, range from about 30 to 34 inches per year [NOAA, 1982] for this part of Minnesota. Hence, annual average evaporation can exceed annual average precipitation for a large part of the western Headwater's region.

Characterization of Storm Events

The NOAA, in cooperation with the MPCA, MDNR State Climatology Office and Minnesota Department of Transportation, has recently updated precipitation intensity and duration data for the entire state, referred to as Atlas 14. Storm-event totals, such as reported in various media weather reports, are typically for 24-hour periods. An example of the updated data for Solway, Minnesota, is tabulated in Appendix B. In this example, the 24-hour storms range from 2.1 inches (yearly) to 10.1 inches (the 1,000-year event). However, back-to-back storms over several days often generate much larger totals and are often associated with peak runoff events. For example, back-to-back storms tabulated for 2-day to 10-day wet periods at Solway, Minnesota, can be expected to have cumulative rainfall amounts varying from 2.38 inches to 3.9 inches (yearly) to 4.16 inches to 6.08 inches (every 10 years). Accordingly, wet periods can have large cumulative storm totals affecting watershed runoff.

Precipitation Variability

A closer examination of year-to-year and within-year precipitation variability was evaluated for Moose Creek Township (Clearwater County, near Moose Lake) using data from the MDNR's Precipitation Data Retrieval from a Gridded Database [MDNR State Climatology, 2015]. Data were summarized by month and by year and are presented in Table 1. In this evaluation, June through September wet months (greater than 70 percentile) were color coded blue and dry months (less than 30 percentile) were color coded brown. From this analysis, there were numerous shifts between growing season wet and dry periods observed for most years with dry periods tending to occur more commonly in the peak of the growing season during July and August. These observations underscore the number of wet and dry period gyrations that may affect lake and wetland hydrology and associated runoff chemistries.

The NOAA has parsed the number of precipitation events per month greater than 0.01-inch, 0.1-inch, 0.5-inch, and 1.0-inch events with data for Leech Lake Dam (Site USC 02214652) and is summarized in Table 2. Focusing on the larger storm events occurring during the growing season, there are approximately two to three rainfall events per month greater than or equal to 0.5 inch and approximately one event per month greater than or equal to 1.0 inch. These events may be expected to generate runoff depending on storm intensities and durations as moderated by vegetation evapotranspiration and the amount of impervious surfaces.

Growing Season Length and Maximum Temperatures

Growing season length and maximum average summer ambient temperatures were examined as they affect lake temperatures, lake algal growth, and sediment reactions (kinetics). The growing season, as defined by the number of days between the last 32°F days of spring and the first 32°F day of autumn, were tabulated from Leech Lake Dam (USC00214652) data and averaged about 133 days from 1970 to 2014. A long-term increasing pattern was noted from 1940 to present and is illustrated in Figure 4. During this same period, monthly mean maximum temperatures in Minnesota's Climate Division 2 (north-central Minnesota) for July increased with greater variability observed in the most recent 10 years, as illustrated in Figure 5. Hence, the Headwater Lakes area has experienced longer growing seasons coupled with warmer peak growing season maximum average temperatures.

Table 1. Monthly Precipitation by Year for Moose Creek Township, Minnesota [MDNR State Climatology, 2015].

	January	February	March	April	May	June	July	August	September	October	November	December	Warm	Annual
30%	0.36	0.31	0.71	1.23	1.94	2.82	2.42	2.06	1.77	1.06	0.57	0.46	13.92	21.64
70%	0.85	0.7	1.32	2.18	3.54	4.96	4.03	3.86	3.1	2.35	1.29	0.97	18.22	26.72
mean	0.68	0.58	1.05	1.82	2.88	4.04	3.49	3.2	2.58	1.92	1.04	0.75	16.17	24.02
normal	0.66	0.55	1.13	1.59	3	4.47	3.99	3.01	3.04	2.62	1.21	0.79	17.49	26.03
Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Warm**	**Annual**
2015	0.55	0.55	0.71	0.7	5.33	NA	NA	NA	NA	NA	NA	NA	NA	NA
2014	0.68	0.35	0.73	2.15	4.43	6.42	2.98	1.71	1.42	1.06	0.57	0.19	16.96	22.69
2013	1.42	1.45	1.49	1.73	3.64	3.62	2.97	1.23	2.46	2.95	0.92	1.47	13.92	25.35
2012	0.87	0.83	1.82	1.52	1.98	2.25	2.44	2.29	0.31	2.77	0.61	0.57	9.27	18.26
2011	0.85	0.19	0.49	3.34	3.87	3.59	3.04	3.93	1.27	0.41	0.39	0.46	15.7	21.83
2010	0.84	0.4	1	1.35	3.89	5.08	5.45	4.11	6.41	2.44	1.36	1	24.94	33.33
2009	0.52	1.02	3.77	0.86	2.19	2.42	1.96	2.82	2.2	4.11	0.66	0.77	11.59	23.3
2008	0.1	0.37	0.39	3.26	1.73	5.18	3.06	1.46	4.96	4.95	1.37	1.48	16.39	28.31
2007	0.24	0.85	2.02	2.83	2.85	4.24	2.05	1.1	3.38	4.07	0.58	1.04	13.62	25.25
2006	0.36	0.83	1.78	1.22	3.03	1.21	1.71	0.66	3.3	1.6	0.25	1.01	9.91	16.96
2005	1.1	0.36	0.33	0.92	5.53	5.84	1.25	2.39	3.03	2.33	3.27	0.97	18.04	27.32
2004	0.91	0.42	1.19	0.34	3.66	1.33	4.02	1.76	5.32	6.48	0.26	0.99	16.09	26.68
2003	0.24	0.33	0.59	0.85	3.16	5.39	2.87	2.19	1.9	1.05	1.07	0.75	15.51	20.39
2002	0.27	0.15	0.9	1.66	1.93	9.07	6.28	4.82	1.38	1.29	0.49	0.49	23.48	28.73
2001	0.23	0.7	0.09	3.65	6.53	2.52	3.01	3.09	1.66	3.44	0.9	0.42	16.81	26.24
2000	0.04	0.44	1.58	1.16	2.29	6.09	1.89	6.04	2.57	3.67	3.87	0.68	18.88	30.32
1999	1.28	0.36	1.57	1.74	5.3	5.38	6.49	4.83	4.75	0.86	0.05	0.32	26.75	32.93
1998	0.47	0.88	0.65	1.45	4.44	5.86	2.98	1.42	1.89	3.76	1.84	0.65	16.59	26.29
1997	0.82	0.25	0.85	1.93	3.01	6.96	5.31	1.46	3.1	3.16	1.23	0.32	19.84	28.4
1996	1.33	1.11	0.75	0.73	2.97	2.84	3.7	1.98	2.84	4.09	2.17	0.98	14.33	25.49

Wet period (> 70%)

Dry month (< 30%)

Table 2. Precipitation Events by Month for Leech Lake Dam (NOAA 2015)

Month	No. of Days Total ≥ 0.01 Inch	No. of Days Total ≥ 0.10 Inch	No. of Days Total ≥ 0.50 Inch	No. of Days Total ≥ 1.00 Inch
January	7.1	2.7	0.1	0
February	5.4	1.7	0.1	0
March	6.7	3.3	0.5	0
April	7	4.1	1	0.2
May	10	6	1.7	0.5
June	12	7.5	2.7	0.9
July	11.6	7.5	3	1
August	10.5	6.4	2.3	1.1
September	10.4	6.2	1.8	0.5
October	7.9	4.4	1.5	0.8
November	6.7	3.4	0.6	0.1
December	6.7	2.6	0.2	0
Annual	102	56.1	15.6	5
Winter	19.3	7	0.3	0
Spring	23.8	13.4	3.1	0.7
Summer	33.8	21.4	8	3
Fall	25.1	14.1	4	1.3

*Annual/seasonal totals may differ from the sum of the monthly totals because of rounding.

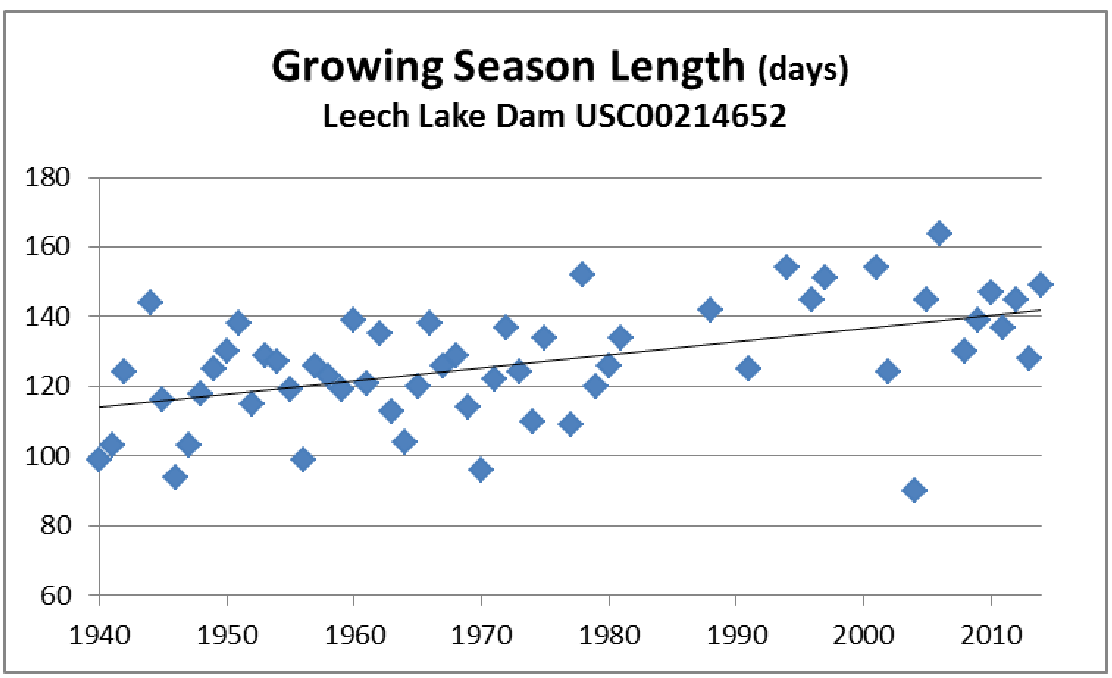


Figure 4. Growing Season Data for Leech Lake Dam (USC0021652) [Midwest Regional Climate Center].

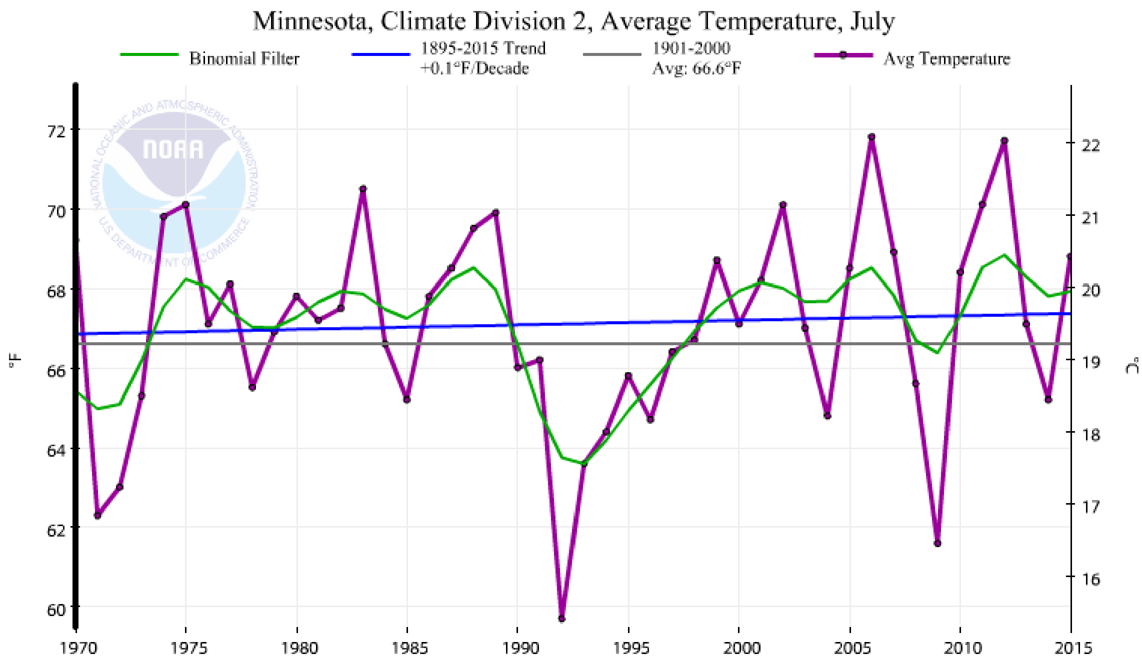


Figure 5. July Maximum Average Monthly Data 1970 to 2014 [NOAA, 2015].

WATERSHEDS

Contributing watershed areas and total upland wetland areas (based on National Land Cover Database 2011) were determined for each lake using ArcGIS. Lake surface areas were defined from MDNR lake maps. These data are summarized in Table 3.

Watershed drainage area to lake surface area ratios were generally large (approximately 40:1 to 100:1) with the exception of Larson Lake with a much smaller ratio of 4:1. Northern lake watershed area to lake-surface ratios are typically less than 10:1 to 15:1, with an average watershed area to lake area ratio of 2.6 defined for minimally impacted NLF lakes reported in Heiskary and Wilson [2005]. The much higher ratios (greater than approximately 40:1) encountered in five of the select Headwaters Lakes are suggestive of reservoir-type systems. As such, these large contributing watersheds generate larger annual P loads that may have become a legacy impact affecting present day lake internal loading dynamics. Secondly, large contributing wetland areas may exert substantial influences on total runoff if they are P sources. This suggests that these wetland areas should be examined for channelization and P pulsing caused by alternating dry and wet growing season periods. Historical records and aerial maps should be reviewed for potential historical P sources; for example, wastewater, historic animal units and the use of P-based forest fire suppressants.

LAKE DATA REVIEW

Lake Morphometry

Minnesota Rule 7050.0150 defines a "shallow lake" as an enclosed basin filled or partially filled with standing fresh water with a maximum depth of 15 feet or less, or with 80 percent or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (the littoral zone). It is uncommon for shallow lakes to thermally stratify during the summer…" [Minnesota State Legislature, 2008.]. Accordingly, all of the select Headwaters lakes are classified as shallow in this assessment. These lakes also have maximum fetches aligned with typical summer storm winds (e.g., north or northwest) indicating higher mixing potentials. Morphometric data are summarized in Table 4. Additional morphometric/configuration considerations include:

- Larson Lake has a twin basin configuration and north-south orientation with the larger north basin having a maximum depth of about 48 feet and larger fetch.
- Likewise Dixon Lake also has a twin basin configuration, north-south orientation with the southern basin having a maximum depth of approximately 30 feet. Both basins have relatively long fetches.
- Alice Lake has a general elliptical northeast-southwest configuration with a maximum depth of 25 feet.
- Moose and Little Cut Foot Sioux are shallow systems with a maximum depth of 15 feet. Ten Mile Creek enters the north basin of Little Cut Foot Sioux Lake relatively near the lake outlet.
- Decker Lake is shallow with a maximum depth of approximately 10 feet.
- Decker, Alice, and Moose Lakes are shallow lakes with simple bowl-shaped basins and maximum depths of 10 to 15 feet.

Table 3. Summary Watershed, Wetland, and Lake Summary Data

Lake	Lake I.D.	Drainage Area (acres)	Wetland Area (acres)	Percent Wetland	Lake Surface Area (acres)	Watershed-to-Lake Surface Area Ratio
Alice	29-0286	12,434	928	7	121	103
Decker	31-0934	11,278	5,242	46	300	38
Dixon	31-0921	50,624	21,582	43	607	83
Larson	04-0154	757	25	3	178	4
Little Cut Foot Sioux	31-0852	23,145	11,123	48	619	37
Moose	04-0342	13,499	1,338	10	131.8	102

Shallow Lake Conditions Affecting Lake Phosphorus Concentrations

The large watershed-to-lake surface areas for most of the select Headwaters lakes may generate hydraulic loads causing larger lake level fluctuations. Shallow lakes, by their nature, may also experience relatively substantial changes in lake levels relative to their volumes. An example of this impact is that a 1-foot water level increase in a lake with an average depth of less than 7.5 feet would have approximately a 13 percent increase in volume whereas a 1-foot water level increase in a lake with an average depth of 20 feet would have approximately a 5 percent increase in volume. Larger volumetric changes induced by wet periods may mean that shallow lakes may more quickly respond to watershed runoff concentrations because there is less dilution potential than with deeper lakes. Additionally, annual evaporation of approximately 30 to 34 inches per year in this part of the state may act to concentrate pollutants in shallow lakes during dry periods with warmer ambient temperatures. Also, shallow lakes are prone to lower net sedimentation rates and higher TP concentration than deeper lakes because of wind resuspension and mixing. Hence, shallow lake nutrient concentrations may be subject to greater interyear variation than deeper lakes which have volumetric buffering, thermal stratification and higher net P sedimentation.

Table 4. Summary of Lake Morphometric Characteristics

Lake	Surface Area (acres)	Littoral Area (acres)	Maximum Depth (feet)	Percent Littoral	Sediment Notes From Lake map	Proposed Designation
Alice	121	96	21	79		Shallow[(a)]
Decker	300	300	12	100		Shallow
Dixon	607.3	478	29	79		Shallow[(a)]
Larson	178	164	48	92	Muck and sand	Shallow
Little Cut Foot Sioux	619	300	12	48		Shallow
Moose	131.8	131.8	13	100	Muck and sand	Shallow

(a) Alice and Dixon Lakes were proposed in this assessment to be designated as shallow lakes with 79% littoral areas. The remaining lakes proposed to be designated as shallow lakes otherwise meet MN Rule definition.

Example Dixon Lake. MNDNR's lake-level data were available for Dixon Lake which has an established Ordinary High Water Level (OHW) of 1,303.0 feet. From 2005 through 2014, water levels have fluctuated up to approximately 5.5 feet (ranging between approximately 1,301 and 1,306.5 feet), representing potentially large volumetric fluctuations in this lake (see Figure 6.) Assuming a 2-foot normal fluctuation, water volumes may fluctuate as much as 15 to 30 percent or more during wet periods. For example, the summer of 2010 had much greater than normal growing season precipitation (24.9 inches versus a long-term average of 17.5 inches) that resulted in higher water levels into 2011. Higher rainfalls in May and June of 2014 similarly corresponded to observed higher lake levels.

Lake Water Quality Assessment

Lake data were downloaded from the MPCA Environmental Analysis and Outcome Division's developed E-Services web-link, assembled and summarized in an Excel spreadsheet format with a primary focus on the June through September regulatory season for lake standard parameters. Mean June through September values from the past 10 years are summarized in Table 5. Accordingly, conclusions include:

- There is sufficient data for these assessments and for the lake standards compliance review process.
- The number of years with June through September Secchi transparency data used to define trends varied from 25 years (Dixon Lake) to 9 years (Moose Lake).
- There is insufficient growing season Secchi data to detect trend analyses on Decker Lake (7 years), Little Cut Foot Sioux Lake (3 years), Larson (2 years) and Alice Lake (2 years).
- There is generally insufficient number of years of data for trend detection based on total P (TP) for all lakes.

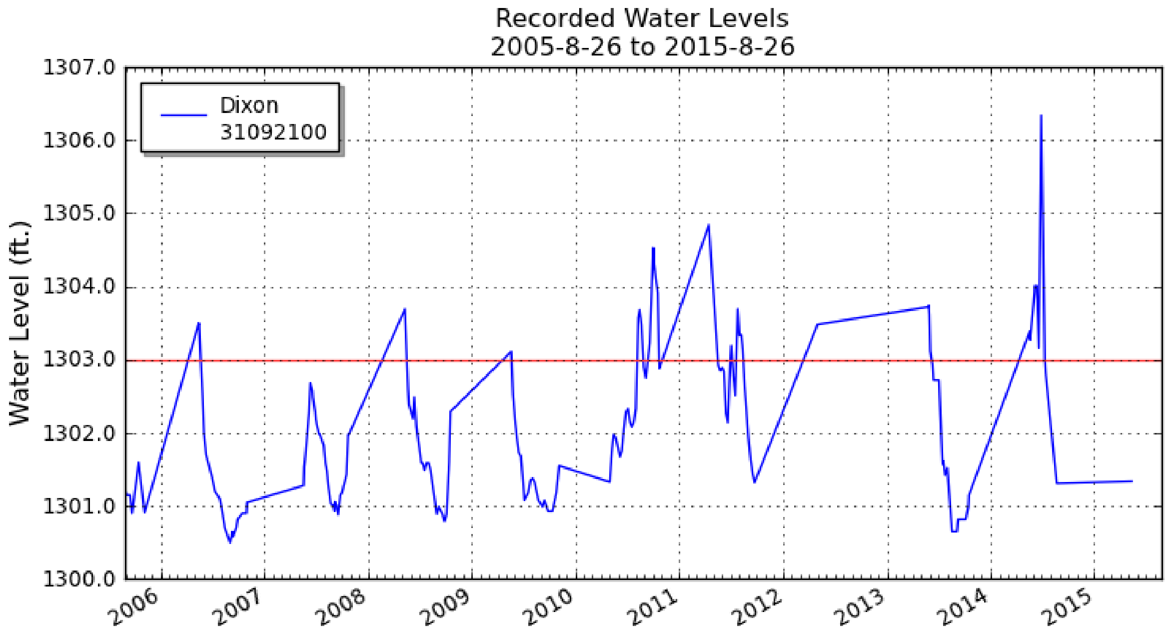


Figure 6. Minnesota Department of Natural Resources Lake Level Data for Dixon Lake.

Table 5. Summary of Water Quality Data for Select Headwaters Lakes

Lake	Total Phosphorus (µg/L) *Standard = 30 (µg/L)*			Chlorophyll *a* (µg/L) *Standard = 9 (µg/L)*			Secchi Disk Depth (m) *Standard = 2.0 (m)*		
	Mean	Standard Error	N	Mean	Standard Error	N	Mean	Standard Error	N
Alice	38	3	9	18.6	3.5	9	2.18	0.25	8
Decker	53	17	5	20.7	8.7	9	1.04	0.14	7
Dixon	47	4	12	18.3	2.9	14	1.68	0.09	58
Larson	39	3	10	16.3	2.9	10	2.07	0.11	10
Little Cut Foot Sioux	52	9	9	18.3	3.6	9	1.47	0.27	7
Moose	50	5	17	26.6	5.4	17	1.37	0.1	36

MINLEAP MODELING

The MINLEAP model [Wilson and Walker, 1989] was used to estimate lake water quality based on its aquatic ecoregion, watershed area and lake surface area and compared to observed values to define lakes with average water quality better or worse than expected. MINLEAP predicted values, shown in Table 6, exceed the NLF Class 2B water lake standards for all of the lakes, with the exception of Larson Lake, with this lake's predicted values expected to achieve the P and eutrophication responses (chlorophyll *a* and Secchi). The MINLEAP modeling suggests that most of these lakes with the exception of Alice Lake, have higher phosphorus loading rates from external and/or internal sources, than would be typically expected.

Table 6. MINLEAP Predicted Versus Observed Lake Water Quality

Average Lake Value	Alice		Decker		Dixon		Larson		Little Cut Foot Sioux		Moose	
	Observed	MINLEAP	Observed	MINLEAP	Observed	MINLEAP	Observed	MINLEAP	Observed	MINLEAP	Observed	MINLEAP
Total Phosphorus (µg/L)	**38**	**39**	**53**	**35**	**47**	**38**	**39**	20	**52**	**37**	**50**	**42**
Chlororphyll *a* (µg/L)	**18.6**	**14.2**	**20.7**	**12**	**18.3**	**13.6**	**16.3**	5.1	**18.3**	**12.9**	**26.6**	**15.5**
Secchi Depth (m)	2.18	**1.6**	**1.04**	**1.8**	**1.68**	**1.7**	2.07	3	**1.47**	**1.7**	**1.37**	**1.5**

Observed exceedance of NLF Class 2B water standards

MINLEAP predictions exceeding NLF Class 2B waters bolded

EVALUATION OF INTERNAL PHOSPHORUS LOADING POTENTIAL

Potential internal loading of P was evaluated by assessing available lake data as follows: (1) the progression of June through September monthly mean TP, chlorophyll *a*, and Secchi transparency values; (2) vertical profiles of temperature and dissolved oxygen; and (3) bottom water peak summer temperatures and P concentrations. Monthly mean values were determined by averaging all calendar month data for the period of record. In general, substantial oxygen depletion was noted with values frequently less than 2.0 mg/L noted.

All of the lakes, except Little Cut Foot Sioux, exhibit June-September increases in monthly mean TP and chlorophyll *a* with general declines of Secchi transparencies. TP concentrations in Little Cut Foot Sioux exhibit general fluctuations between 40 to 50 µg /L with a peak value of 80 µg /L noted in September. Corresponding chlorophyll *a* mean monthly values fluctuated between 10 to 20 µg/L with a peak of about 27 µg/L in July. The Little Cut Foot Sioux Lake fluctuations indicate more complex factors are affecting lake phosphorus dynamics.

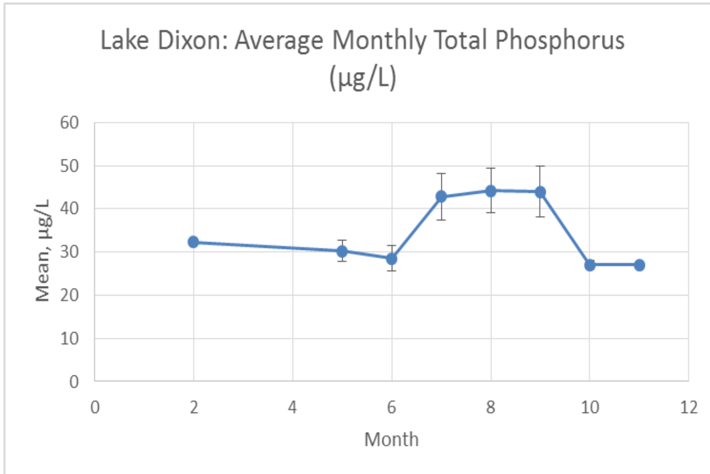
Figure 7 illustrates the average monthly TP concentrations increase from June to a plateau followed by reduction occurring during fall overturn in Dixon Lake. A more distinct increase in monthly mean chlorophyll *a* over the growing season was noted along with corresponding reductions in lake transparency.

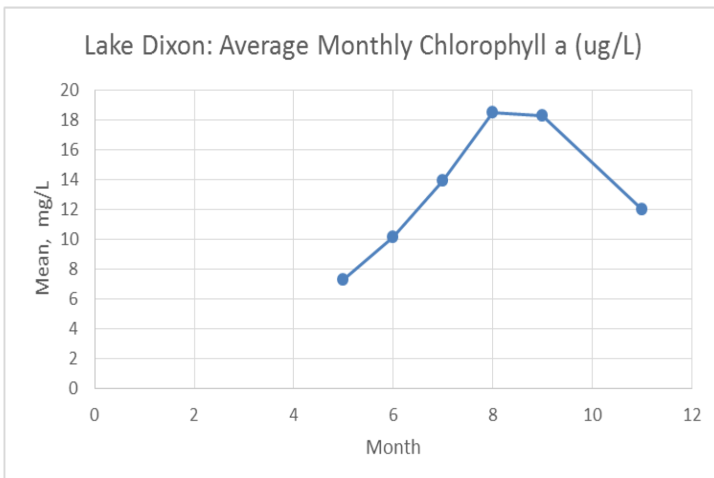
Available bottom water P data was limited. Peak bottom P values were noted as follows: (1) Little Cut Foot Sioux Lake with 125 µg/L at 5 meters on July 25, 2001; Dixon Lake with 136 µg/L about 8 meters depth on July 26, 2004 and 114 µg/L on June 16, 2004.

DISSOLVED OXYGEN AND TEMPERATURE PROFILES

Temperature and dissolved oxygen (DO) profile (measurements by depth) data were available for all lakes except for Larson Lake. Discussion will focus on three categories of observed summer thermal conditions: (1) generally well-mixed with little difference in top to bottom temperature values; (2) temporary stratification noted with minor degree of thermal stratification; and (3) more pronounced thermal stratification. Temperature and dissolved oxygen plots by lake are depicted in Figures 8 through 17.

- **Well-mixed.** Data from Decker and Moose Lakes indicate generally well mixed conditions as evidenced by relatively small differences in surface to bottom temperatures with maximum depths less than 5 meters (approximately 15 feet). The peak bottom water temperatures at Moose Lake and Decker Lake were approximately 24°C and 25°C, respectively, which indicates substantial mixing that increased lake bottom temperatures from spring minimum values (e.g., 9° to 13°C). Both lakes exhibited strong clinograde-like loss of DO during the growing season, as concentrations declined quickly to less than 5.0 milligrams per liter (mg/L) at approximately 2 to 3 meters of depth with bottom water concentrations less than 1 mg/L.
- **Temporary stratification.** Little Cut Foot Sioux Lake data from June 19 and July 16, 2013, indicate a temporary metalimnetic zone with temperatures declining from approximately 22°C to approximately 12°C. During the growing season of 2013, dissolved oxygen (DO) concentrations declined to less and 5.0 mg/L but remained above approximately 3 mg/L. Little Cut Foot Sioux Lake was noted to have cisco and was evaluated for a oxythermal habitat variable called temperature at 3 mg/L of dissolved oxygen (TDO3) following the methodology of Jacobson et al





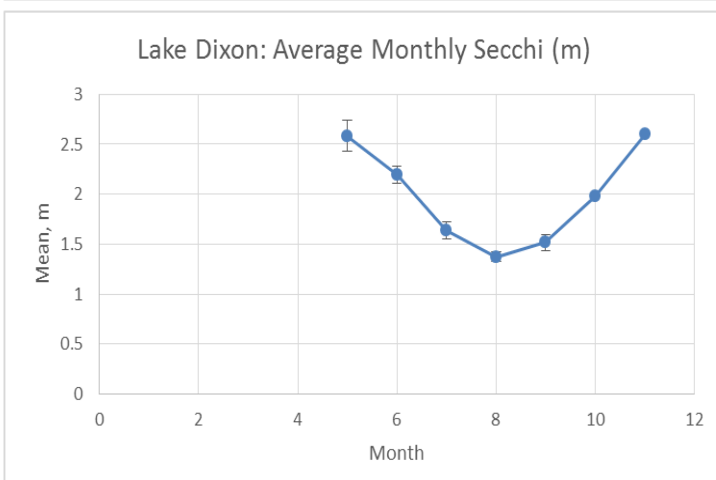


Figure 7. Lake Dixon Period of Record Average Monthly Total Phosphorus, Chlorophyll *a*, and Secchi Transparency.

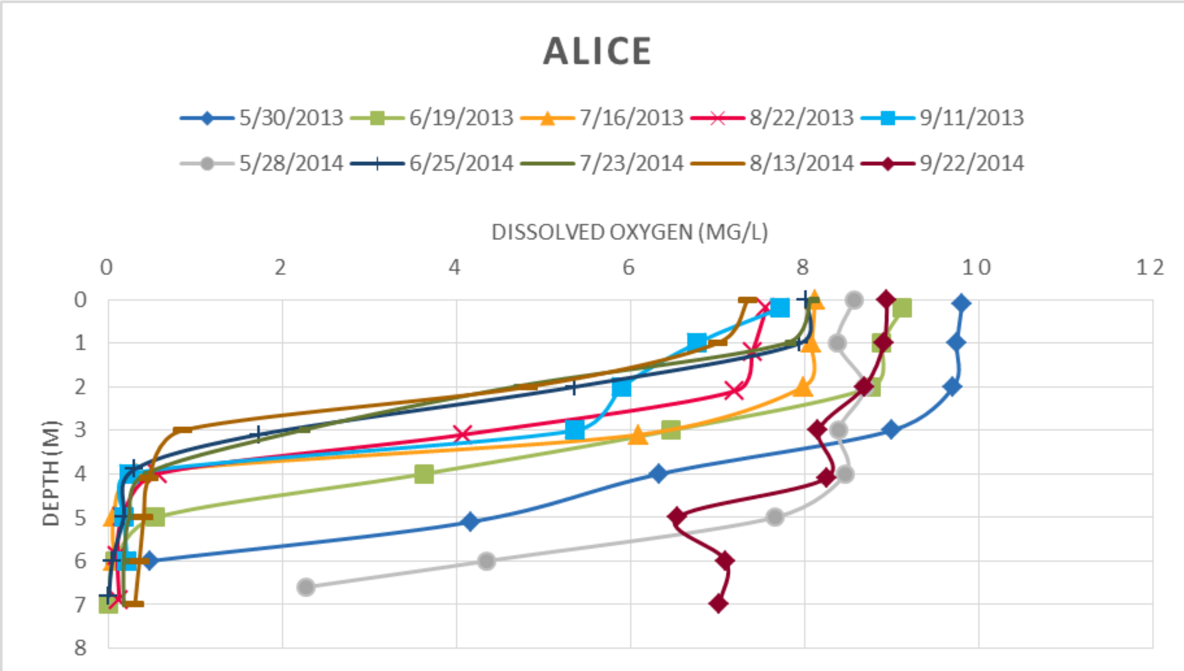


Figure 8. Lake Alice Dissolved Oxygen Profiles.

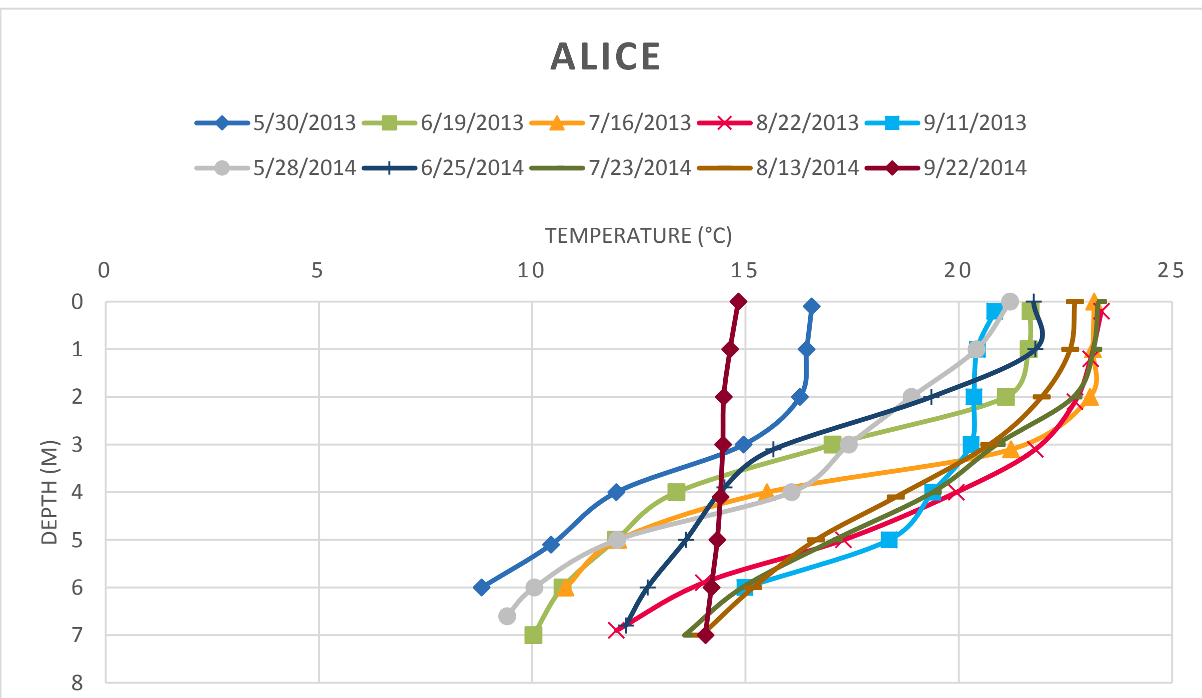


Figure 9. Temperature Profile for Alice Lake.

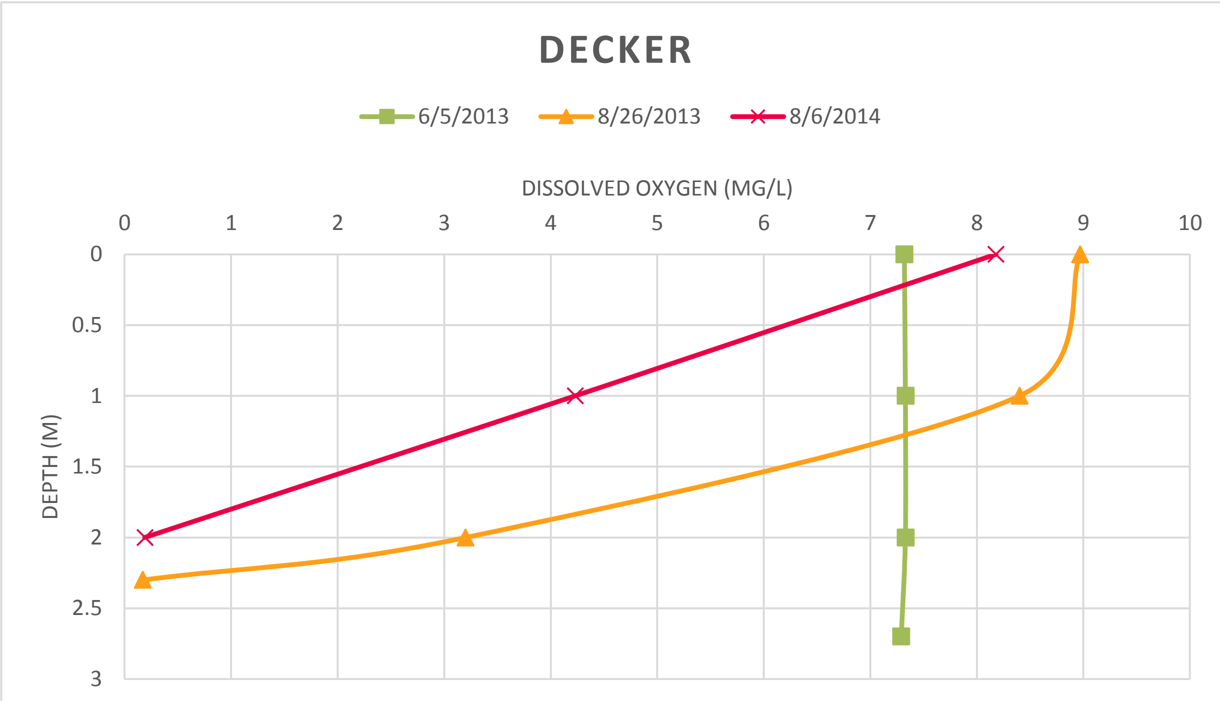


Figure 8. Dissolved Oxygen Profile for Decker Lake.

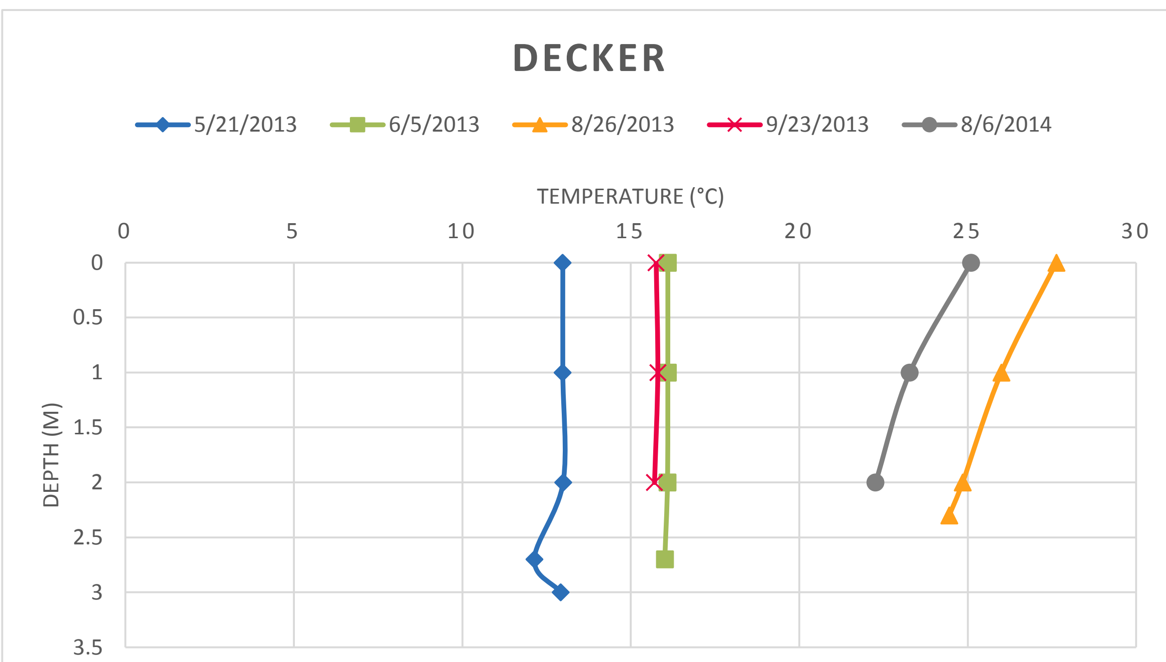


Figure 9. Temperature Profile for Decker Lake.

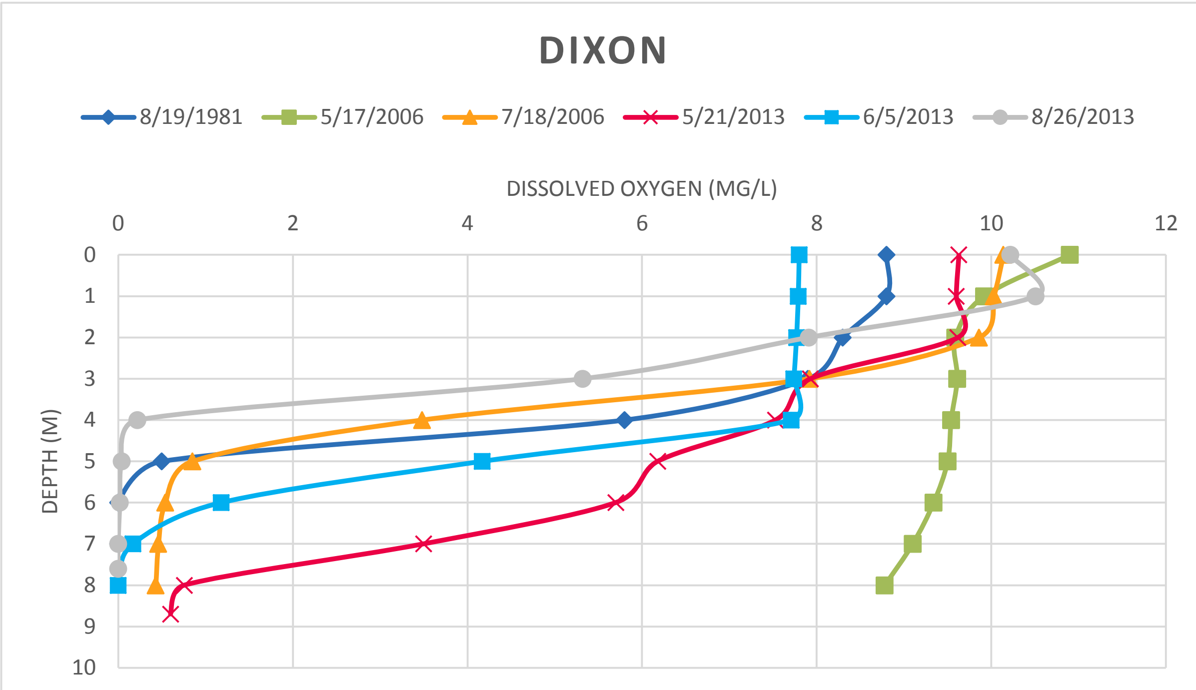


Figure 10. Dissolved Oxygen Profile for Dixon Lake.

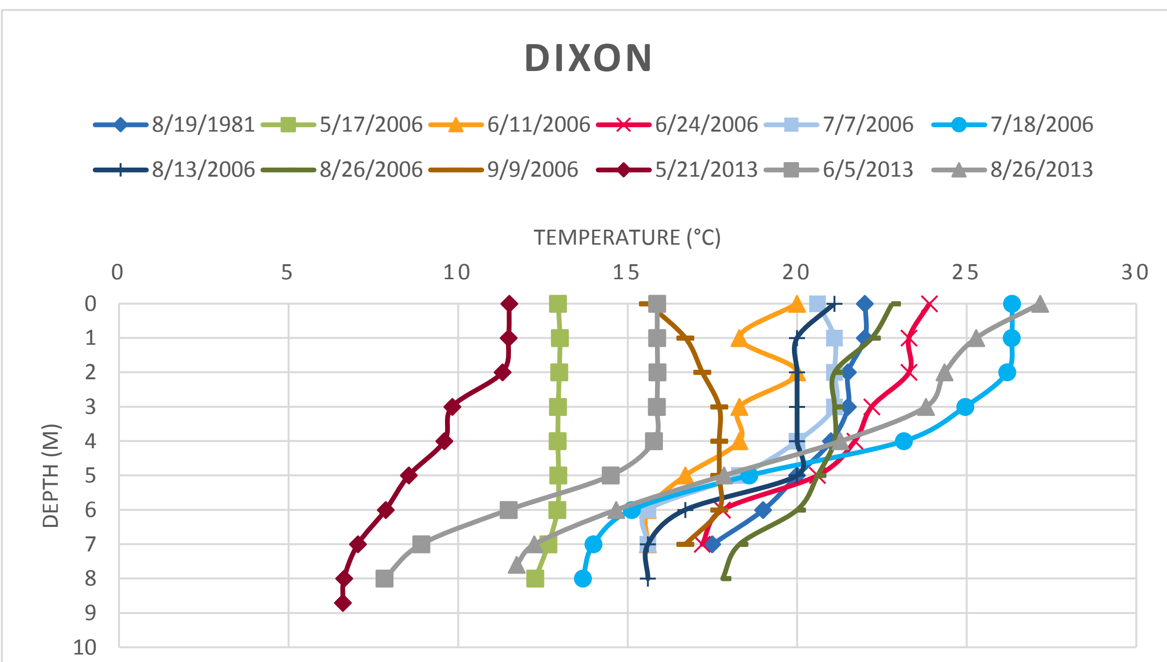


Figure 11. Temperature Profile for Dixon Lake.

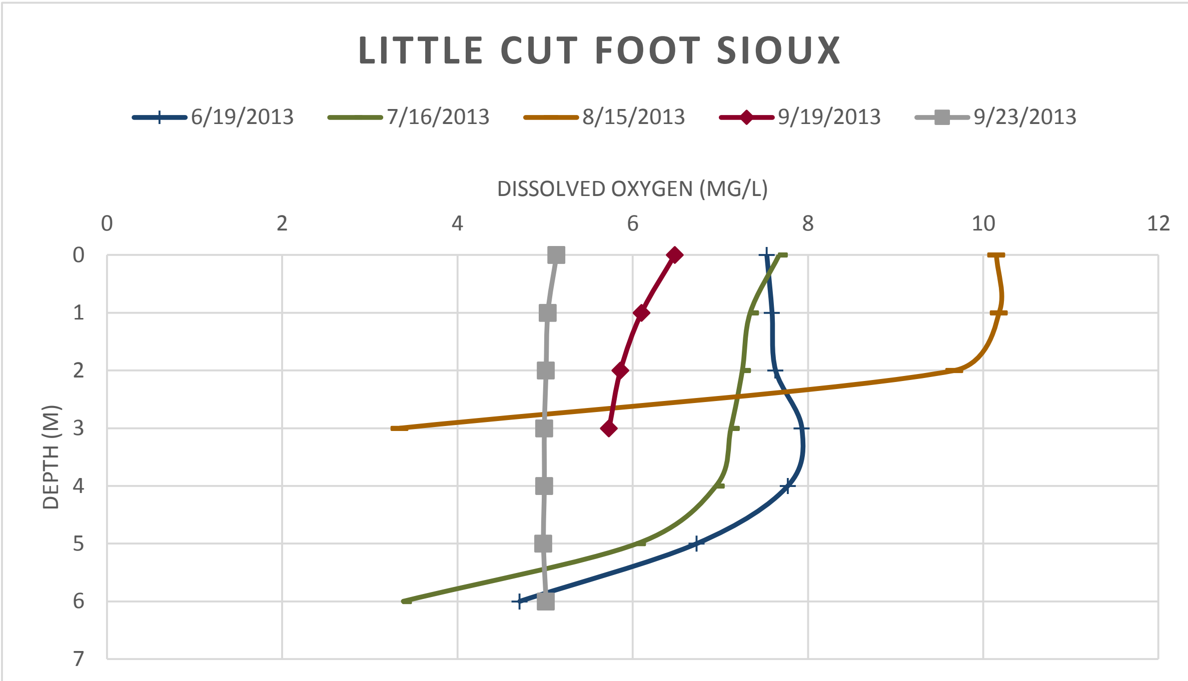


Figure 12. Dissolved Oxygen Profile for Little Cut Foot Sioux Lake.

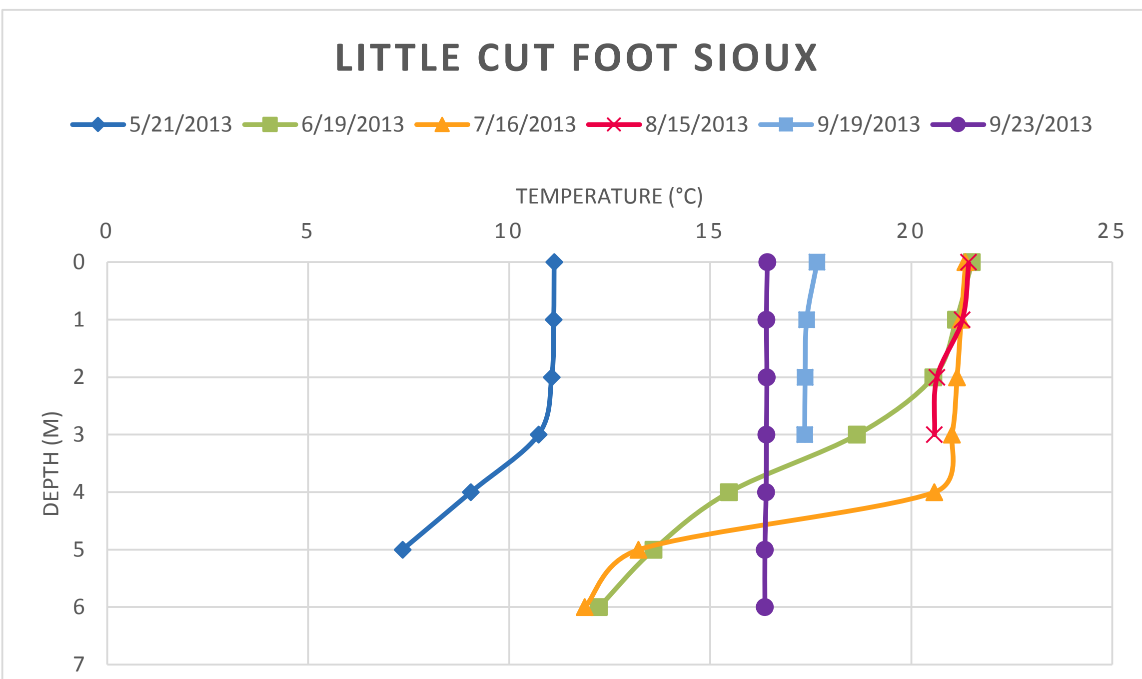


Figure 13. Temperature Profile for Little Cut Foot Sioux Lake

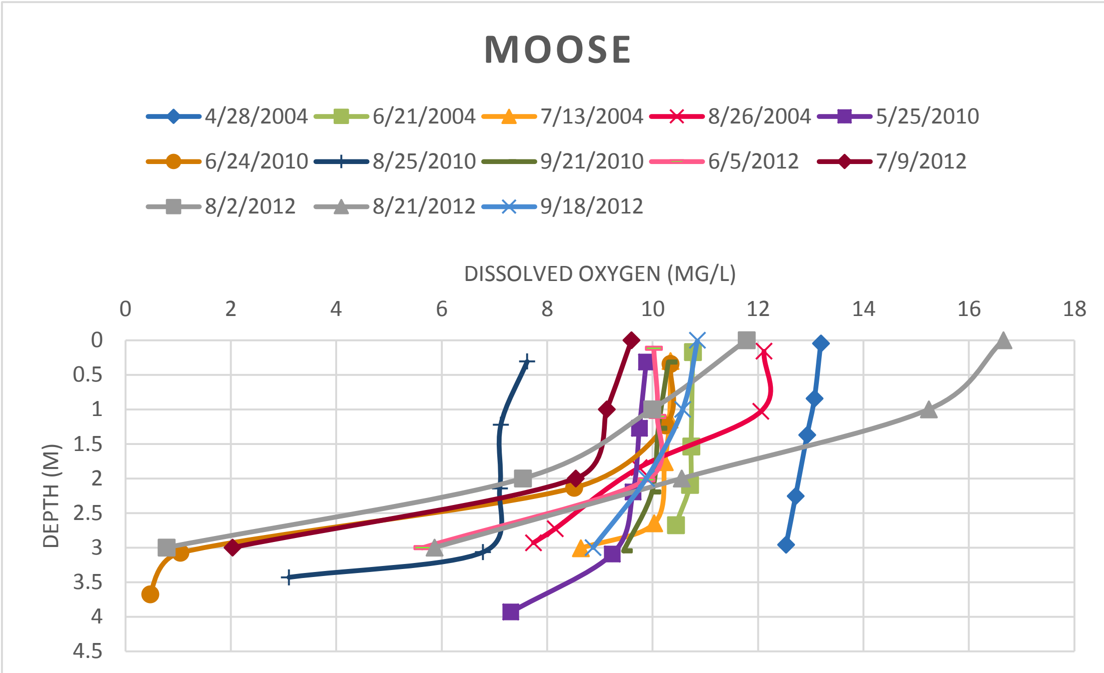


Figure 14. Dissolved Oxygen Profile for Moose Lake.

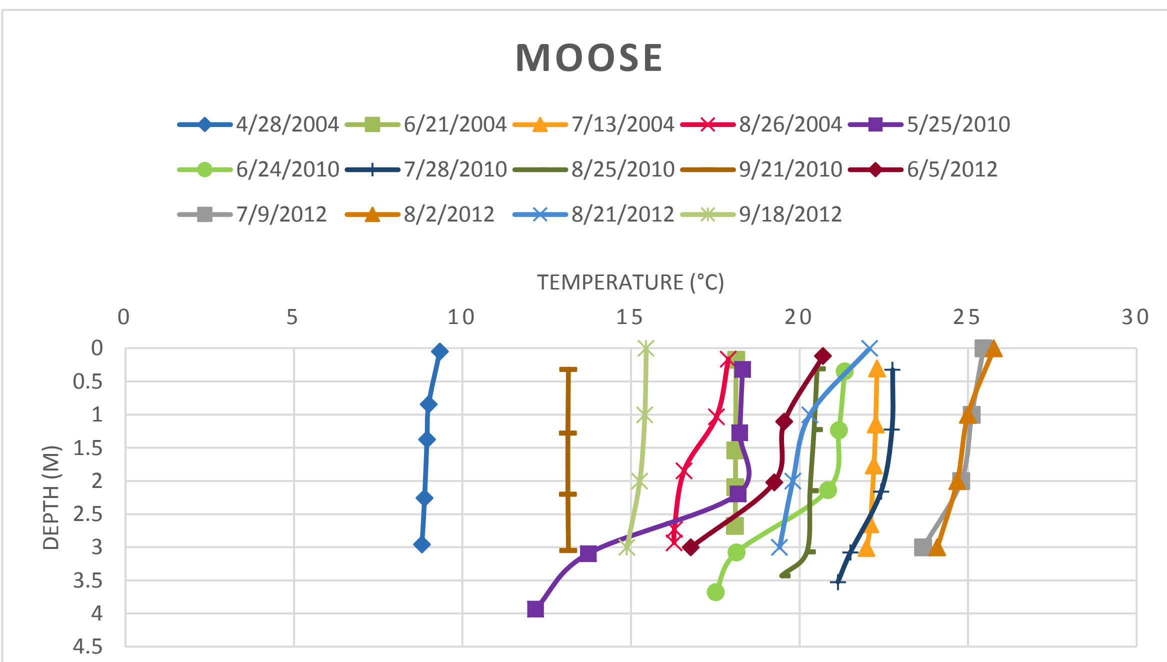


Figure 15. Temperature Profile for Moose Lake.

[2010] and Fang et al. [2010]. Based on 2013 lake profile data, Little Cut Foot Sioux Lake was estimated to be a TDO3 Tier 3 lake. Peak bottom water temperatures ranged from approximately 7° to 16°C.

- **More pronounced stratification.** Profiling data for Alice and Dixon Lakes monitored in 2013, indicate a more pronounced decline of temperatures from surface to bottom waters with differences of up to 10°C+ noted in July (2006) and August (2013), creating thermoclines between 3 to 6 meters in depth. Summer DO declined to less than 5.0 mg/L at depths greater than approximately 2 to 4 meters and less than 1.0 mg/L at depths greater than approximately 3 to 5 meters. Values less than 1.0 mg/L suggest increased internal loading potential from periods of low oxygen. Peak bottom temperatures were noted to range from approximately 14° to 18°C indicating periodic top to bottom mixing events.

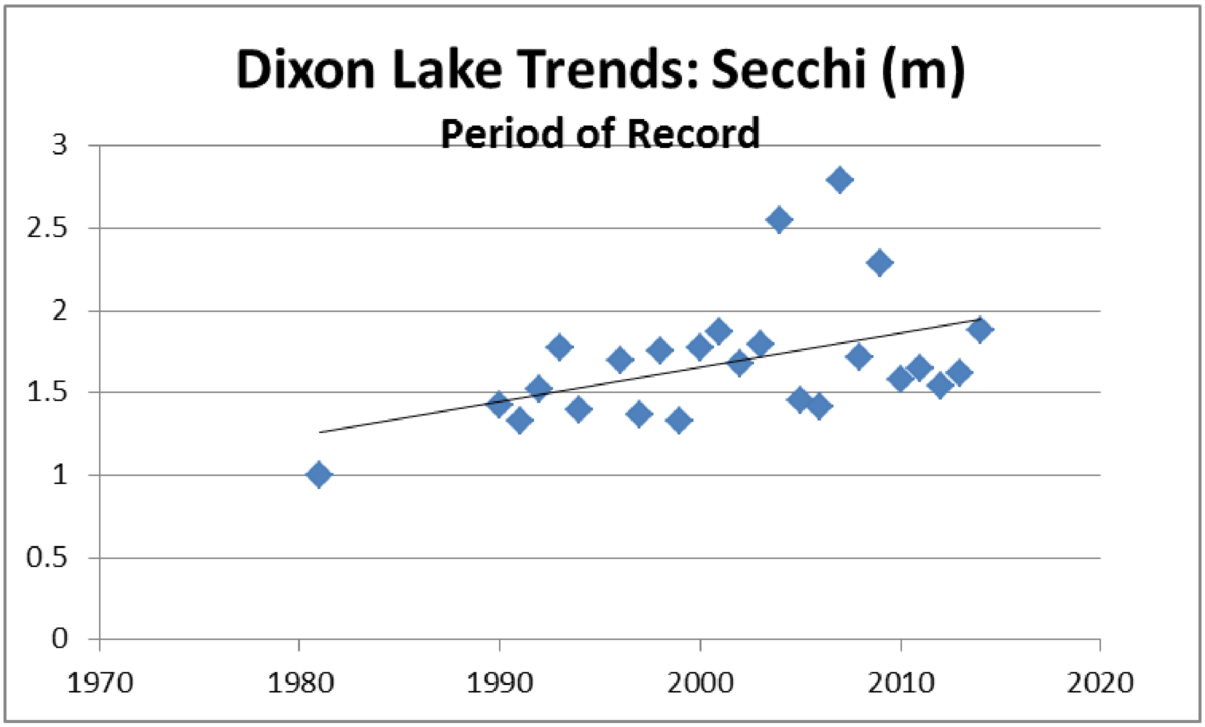


Figure 16. Dixon Lake Average Secchi Trend.

WATER QUALITY TRENDS

Trend detection focused on Secchi transparency because of the larger number of available measurements and well-defined variance components associated with this parameter. A Seasonal Kendall Tau test, which performs the Mann-Kendal trend test for individual seasons of the year and then combines the individual results into one overall test to determine whether the dependent variable changes in a consistent direction over time, was run on the growing season data (June through September) for each lake. Only one lake (Dixon) had more than 10 years of data, which is recommended for detection of a serial correlation [Helsel et al., 2006]. An increasing Secchi transparency pattern (Figure 16) was identified for Dixon Lake (statistically significant Seasonal Kendall Tau p = 0.05). Although very slight increasing Secchi patterns were visually noted for Moose Lake, which had 9 years of data, the seasonal Kendall Tau test was not significantly significant. There was insufficient data for meaningful pattern detection at the other four lakes. The limited amount of TP data (less than 10 years) precluded trend analyses for this parameter. Future volunteer Secchi monitoring with 10 to 12 measurements during the growing season will improve the ability to detect trends statistically.

LAKE WATER QUALITY SUMMARY

By their nature, shallow lakes can be less resilient due to a number of factors: (1) generally less volume to dilute runoff, particularly from large contributing watersheds; (2) are subject to larger lake level fluctuations; (3) lower sedimentation rates due to wind mixing; (4) and climate effects. The growing season and peak summer temperatures have increased. Considerable dry-wet monthly growing season variability was noted over the past 20 years with most years having frequent month-to-month shifts. Dry and wet period gyrations noted during the growing season may tend to: (1) contribute periodic shock P loads and (2) encourage pulsing of nutrients from upgradient channelized wetlands and organic deposits subject to dry period digestion (in effect a system Sediment Oxygen Demand) and release P during wet periods. Climatic trends will tend to provide conditions favoring lake internal P loading characteristics noted for all of these lakes. Hence, vigilance is required to minimize P loading to these lakes from all intense land uses (development, agriculture) and associated artificial drainage activities.

Hence, it is recommended that six Headwaters Lakes described in this letter not have formal TMDLs calculated at this time pending further MPCA evaluations of shallow lake conditions.

CONCLUSIONS

A review of six Headwaters Lakes' watershed, lake and climate data are summarized as follows:

- **Water Quality Standards.** Six Mississippi Headwaters lakes were assessed for compliance to Minnesota water quality rules and all six exceed established standards.
- **Shallow Lakes.** All of these lakes have been identified in this assessment as shallow lakes.
- **Climate Variability.** Basic hydrologic cycle and other climate information were reviewed to aid in defining natural background conditions affecting lake water quality. Growing season length and maximum July mean temperatures have increased relative to the 1940–2014 records. There has been considerable dry-wet monthly variability over the past 20 years with most years noted to have shifts between wet and dry periods.
- **Watershed Drainage Areas.** Watershed drainage area to lake surface area ratios were generally large (approximately 40:1 to 100:1) and more representative of reservoir systems. In effect, large historical watershed generated P loads may influence present day conditions as legacy impacts. Secondly, wetland areas for the select Headwaters Lakes comprise either less than approximately 10 percent or about 50 percent of the total watershed contributing areas suggesting that wetland related runoff may exert substantial influences upon total watershed runoff characteristics. These wetland areas should be examined for channelization and P pulsing caused by alternating dry and wet cycles occurring over the growing season.
- **Water Levels.** Dixon Lake water levels vary over 5 feet from recent MDNR lake level records which indicate substantial volumetric changes occur in this shallow lake. The other lakes lacked lake-level data.

- **Mixing.** Three temperature and DO patterns were observed ranging from well-mixed (Decker and Moose Lakes) to temporary stratification (Little Cut Foot Sioux Lake) to thermal stratification (Alice and Dixon Lakes). All lakes had elevated bottom water temperatures indicating that top to bottom mixing events occur over the growing season. No temperature and DO profiling data were available for Larson Lake.
- **Internal Loading Potential.** All of the six lakes exhibited distinct or nearly distinct growing season increases in P and chlorophyll *a* along with declining Secchi transparencies potentially indicating internal phosphorus loading. The low number of bottom water P data limits further assessment of internal loading. Future monitoring may include bottom water layer total iron concentrations as a guide with a 3:1 ratio of total iron to TP being a useful benchmark indicator of iron available to complex with sediment generated P. All of the lakes are shallow with substantial DO depletion rates and elevated temperatures noted in bottom waters that will increase lake sediment reaction rates and internal P loading potential. Internal loading characteristics may be more dictated by variable climate related to dry-wet period loadings and wetland hysteresis (greater P loads following dry periods that are diluted during wet periods). Hence, vigilance is required to minimize P loading to these lakes from all intense land uses (development, agriculture) and associated artificial drainage activities.
- **Trends:** A statistically significant improving Secchi transparency trend was noted for Dixon Lake. There was insufficient data for trend detection in the other Headwaters Lakes.
- **Recommendation:** It is not recommended that six Headwaters Lakes described in this letter have formal Total Maximum Daily Loads assessed at this time pending further MPCA evaluations of shallow lake conditions.

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Thank you for the opportunity to work on this project. If you have questions or need further information, please contact Bruce Wilson by telephone (651.246.9039) or email (*bruce.wilson@respec.com*).

Sincerely,

C. Bruce Wilson
Senior Scientist

Cindie M. McCutcheon
Staff Engineer

cc: Project Central File 2596 — Category A

ATTACHMENT A

AVERAGE MONTHLY TOTAL PHOSPHORUS, CHLOROPHYLL *A*, AND SECCHI PLOTS BY LAKE

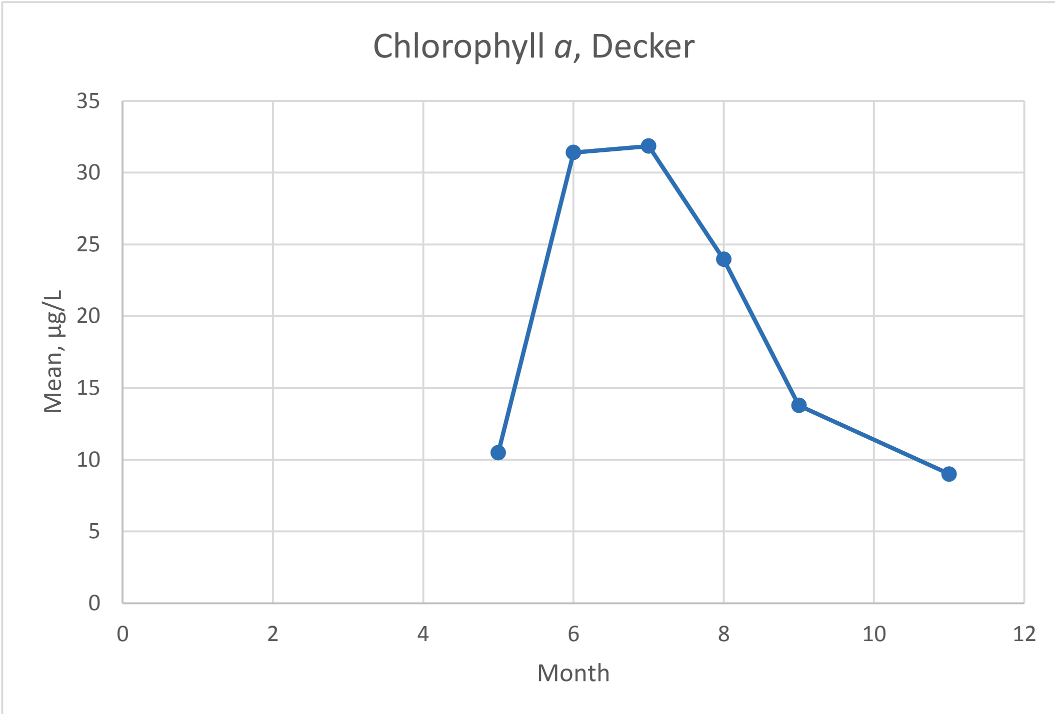


Figure A-1. Monthly Average Chlorophyll *a* (Decker).

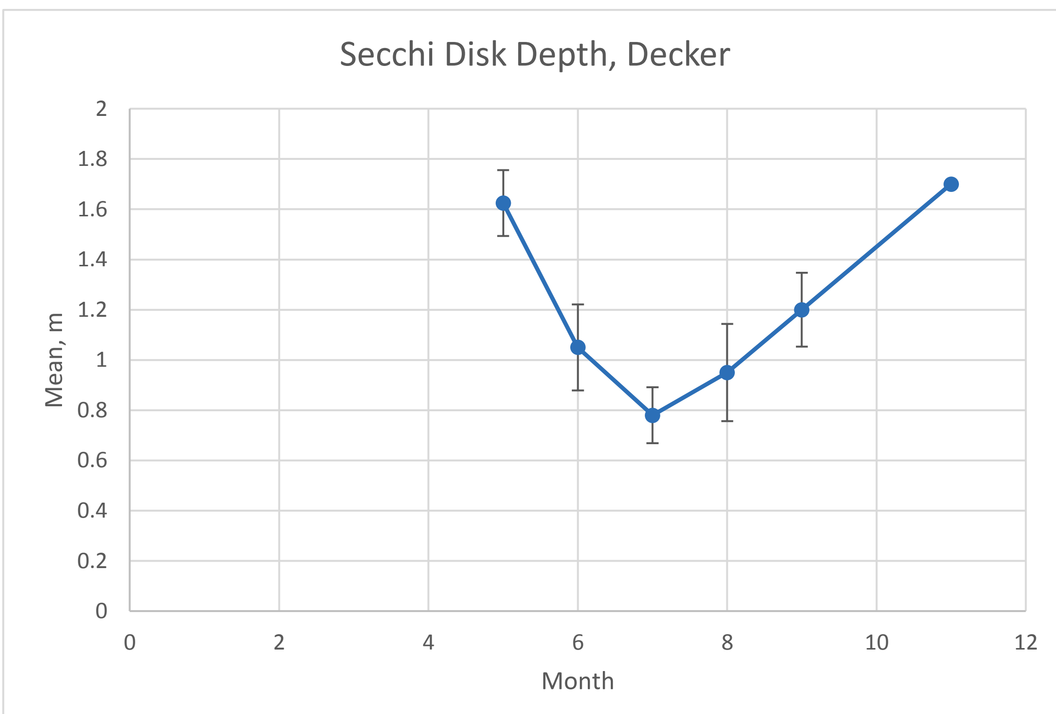


Figure A-2. Monthly Average Secchi Disk Depth (Decker).

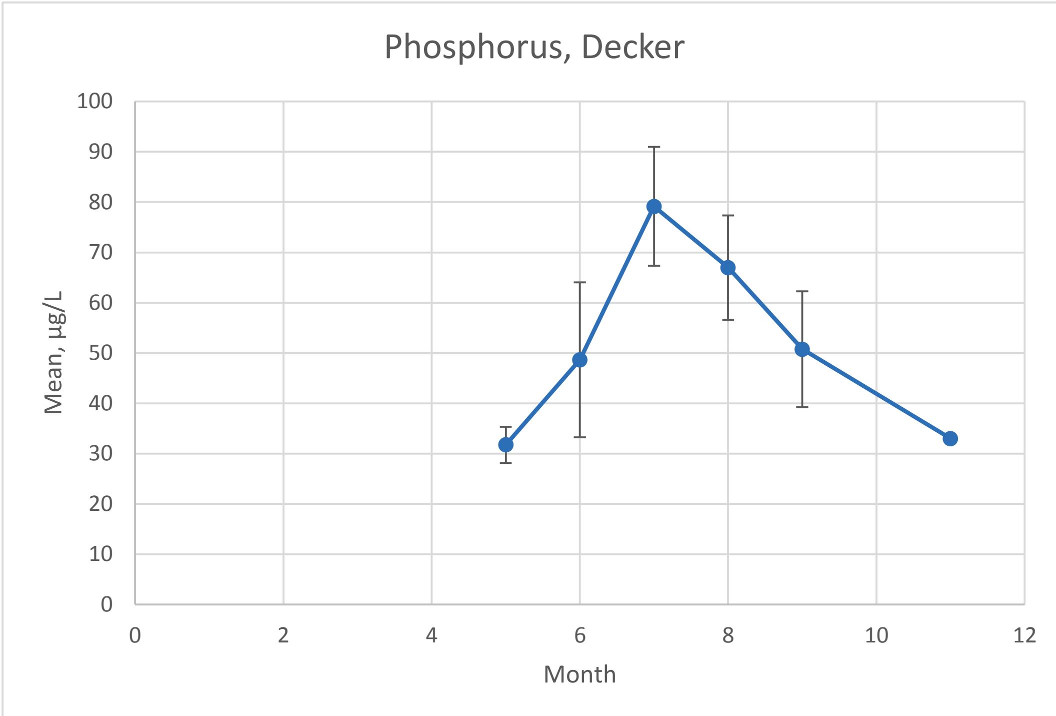


Figure A-3. Monthly Average Phosphorus (Decker).

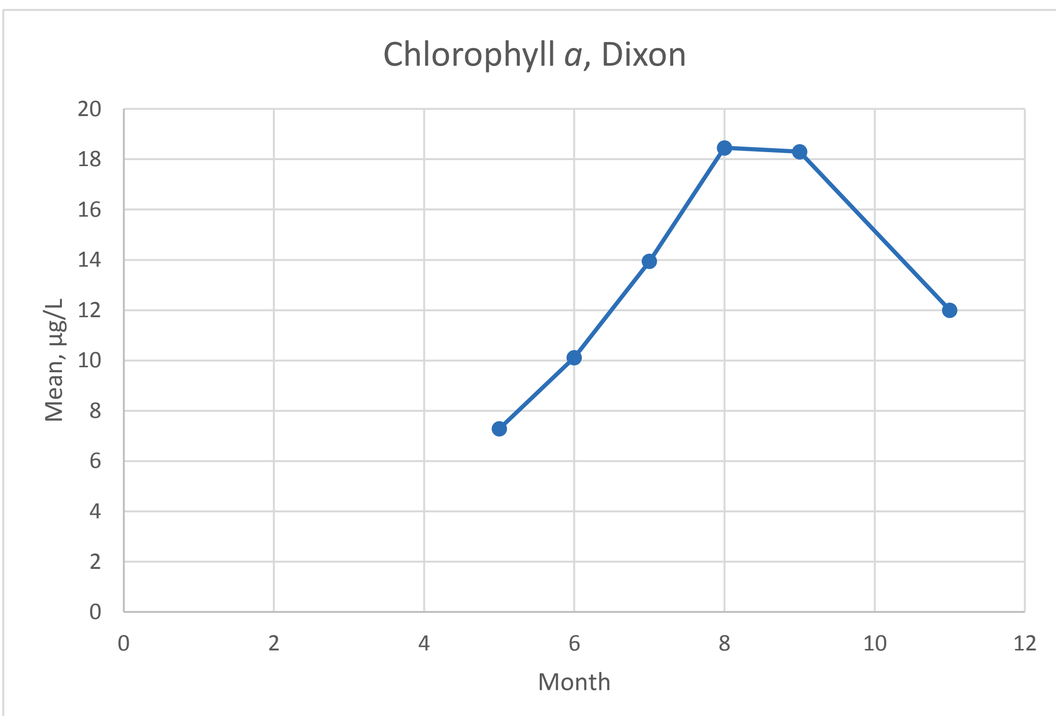


Figure A-4. Monthly Average Chlorophyll *a* (Dixon).

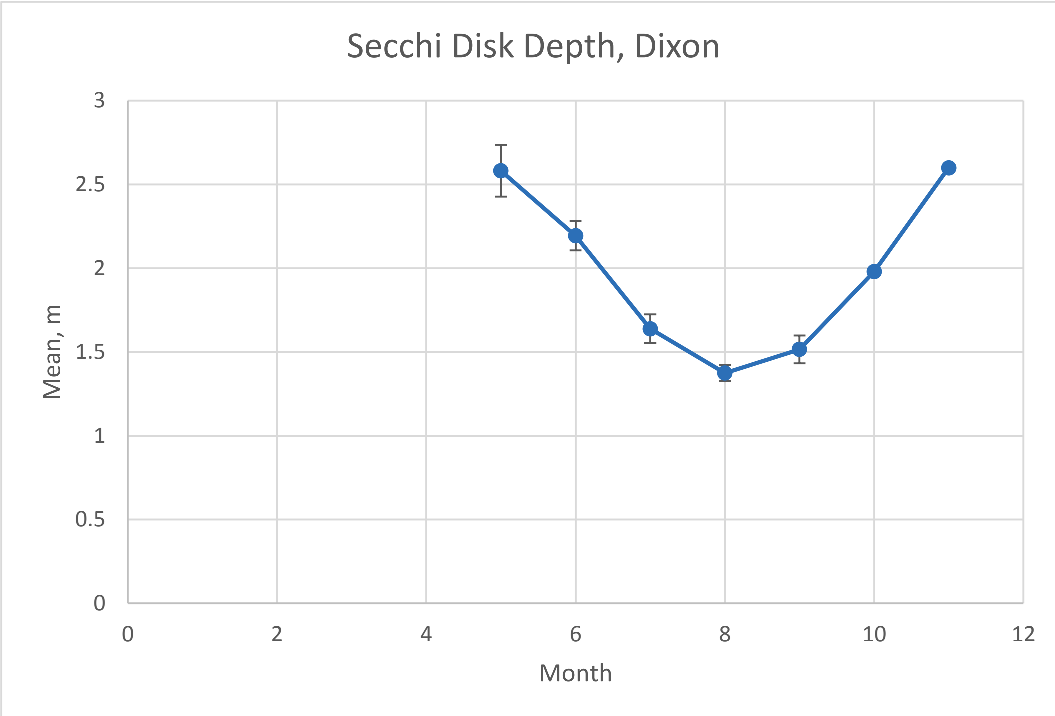


Figure A-5. Monthly Average Secchi Disk Depth (Dixon).

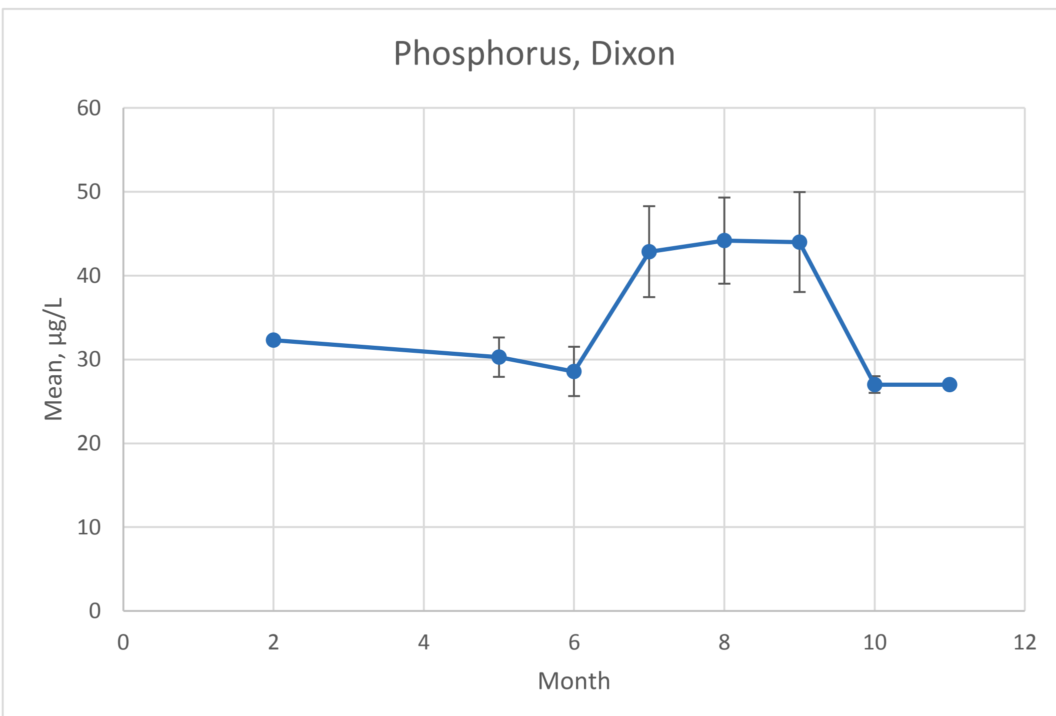


Figure A-6. Monthly Average Total Phosphorus (Dixon).

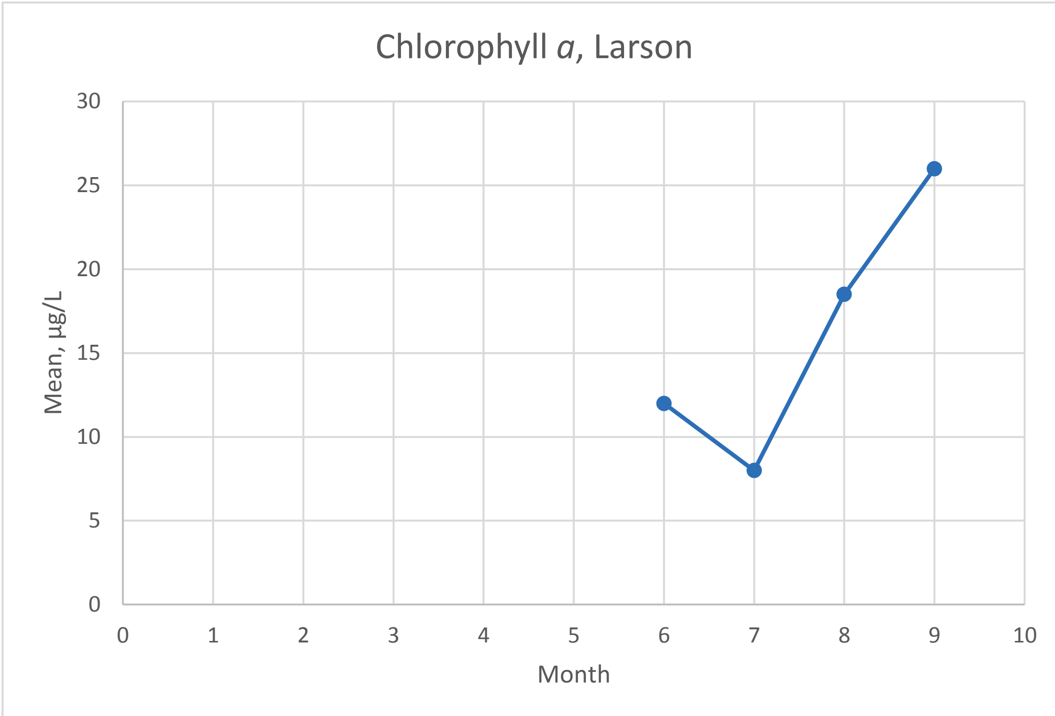


Figure A-7. Monthly Average Chlorophyll *a* (Larson).

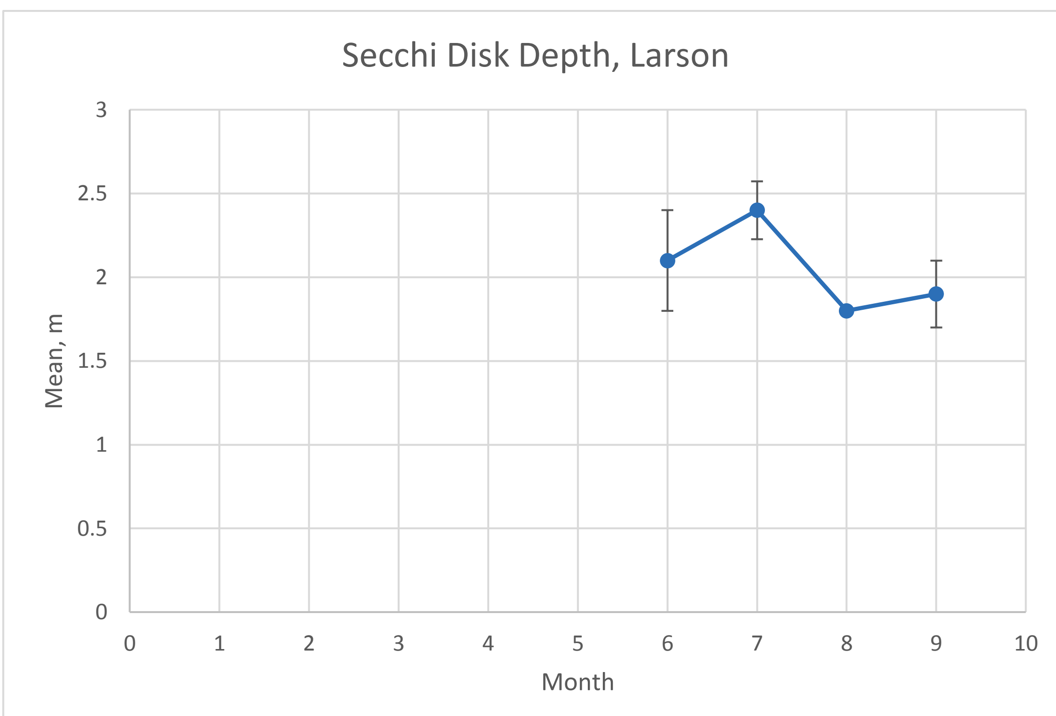


Figure A-8. Monthly Average Secchi Disk Depth (Larson).

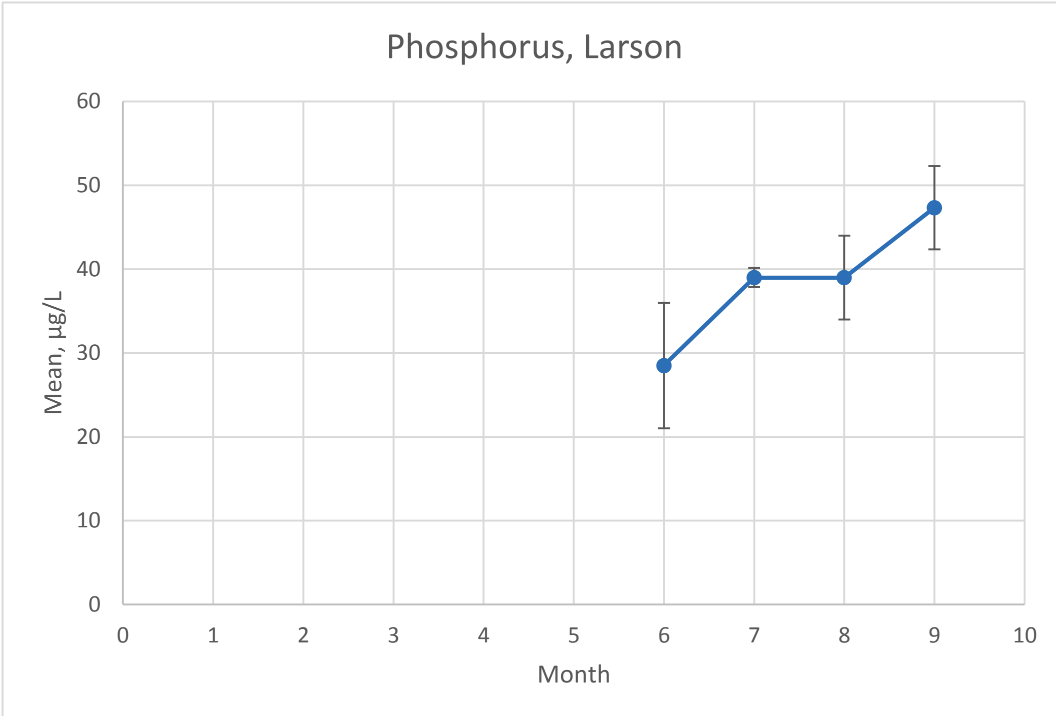


Figure A-9. Monthly Average Total Phosphorus (Larson).

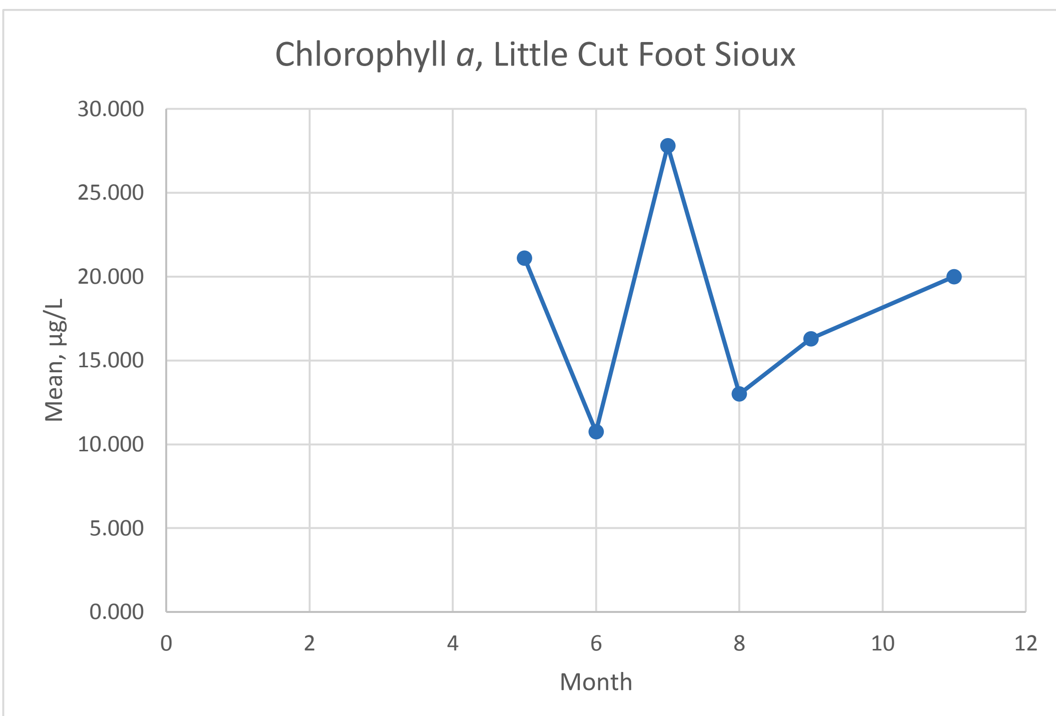


Figure A-10. Monthly Average Chlorophyll *a* (Little Cut Foot Sioux).

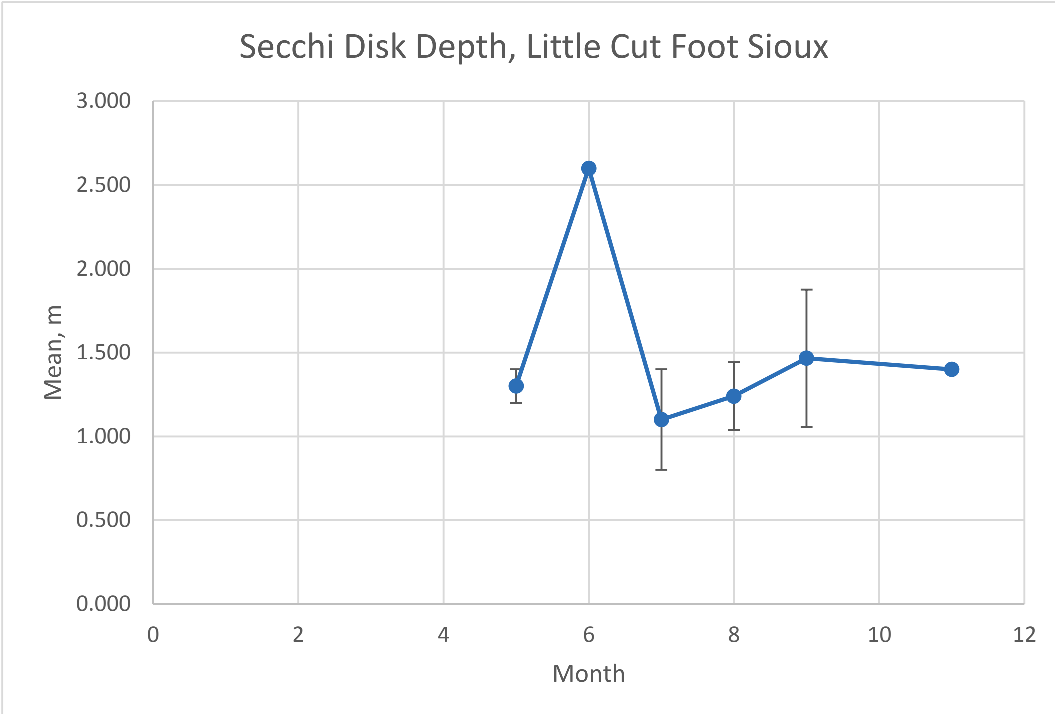


Figure A-11. Monthly Average Secchi Disk Depth (Little Cut Foot Sioux).

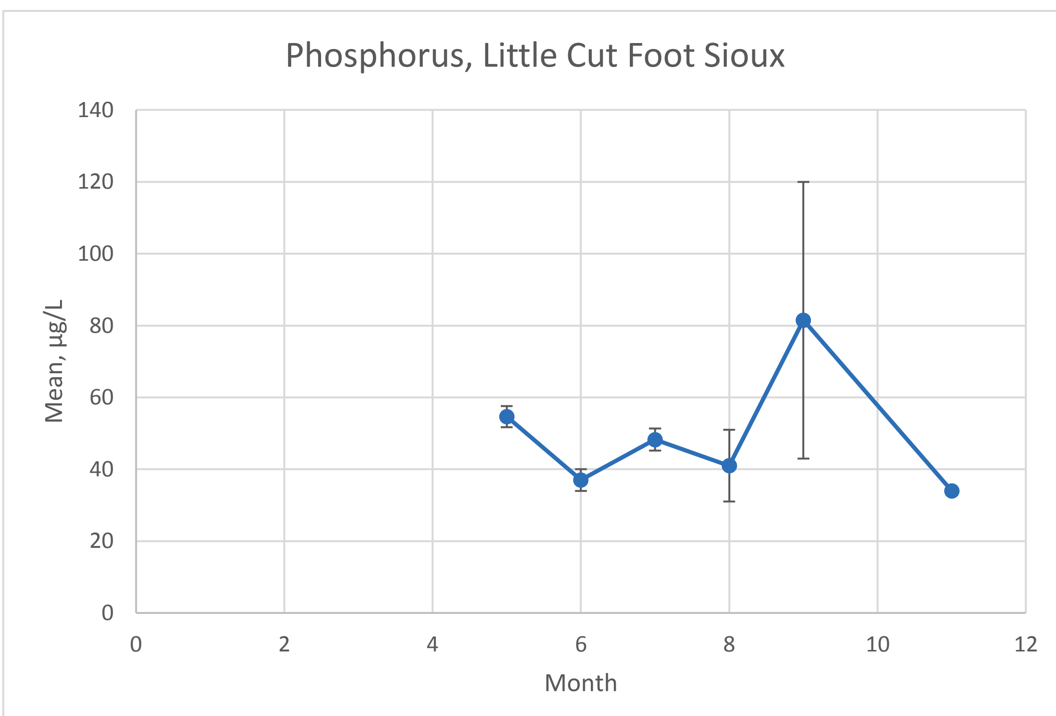


Figure A-12. Monthly Average Total Phosphorus (Little Cut Foot Sioux).

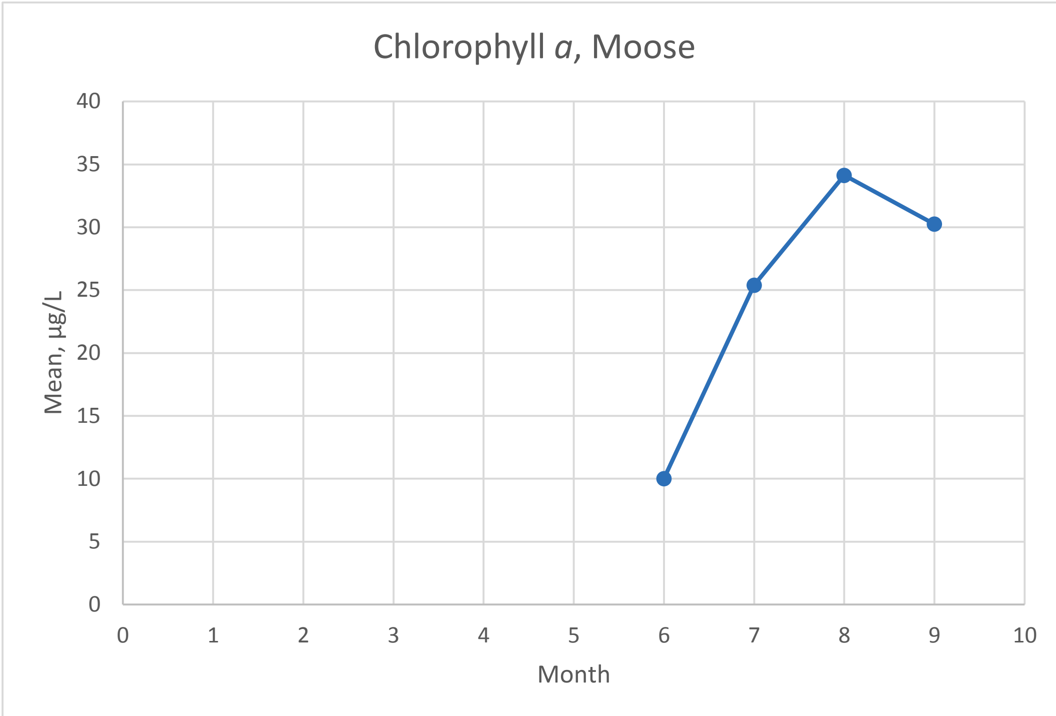


Figure A-13. Monthly Average Chlorophyll *a* (Moose).

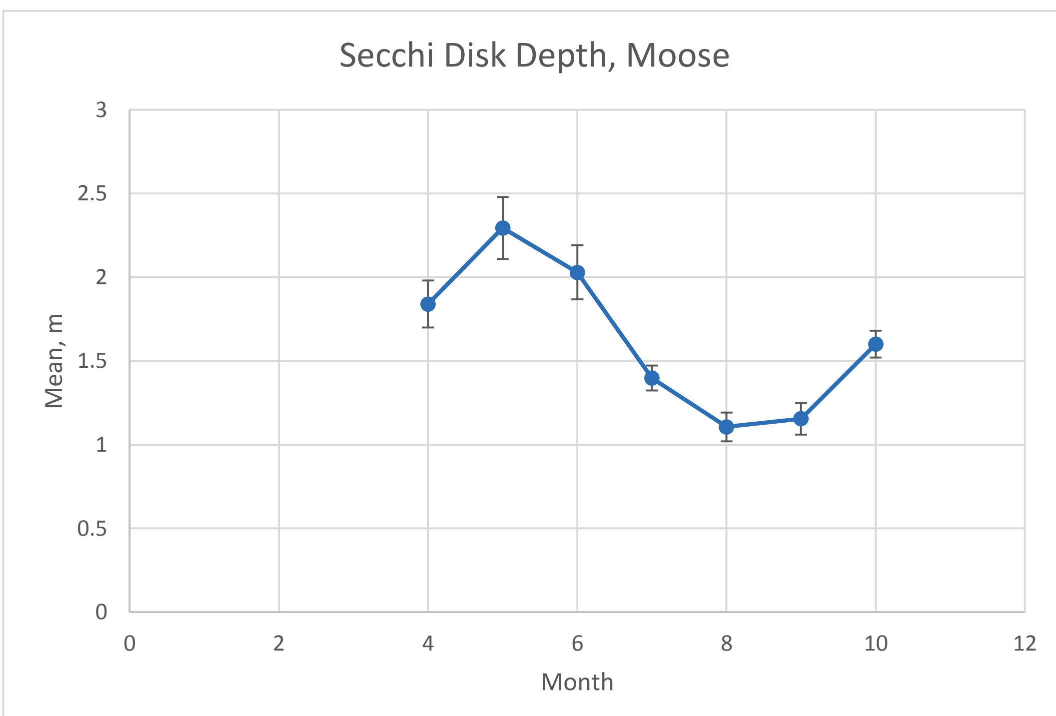


Figure A-14. Monthly Average Secchi Disk Depth (Moose).

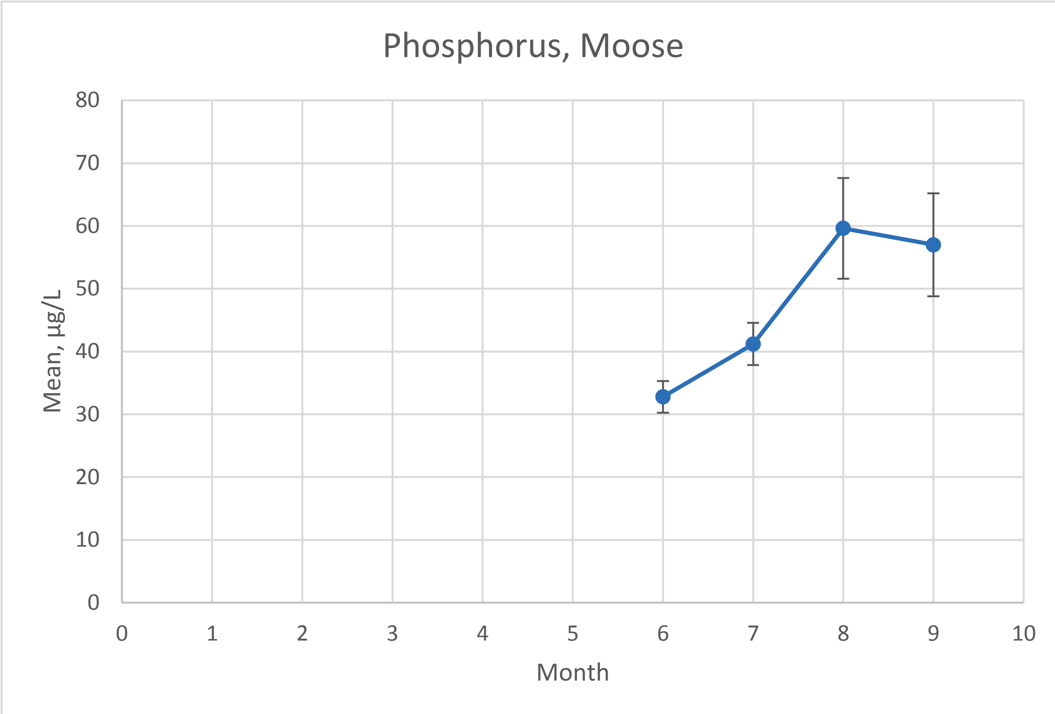


Figure A-15. Monthly Average Total Phosphorus (Moose).

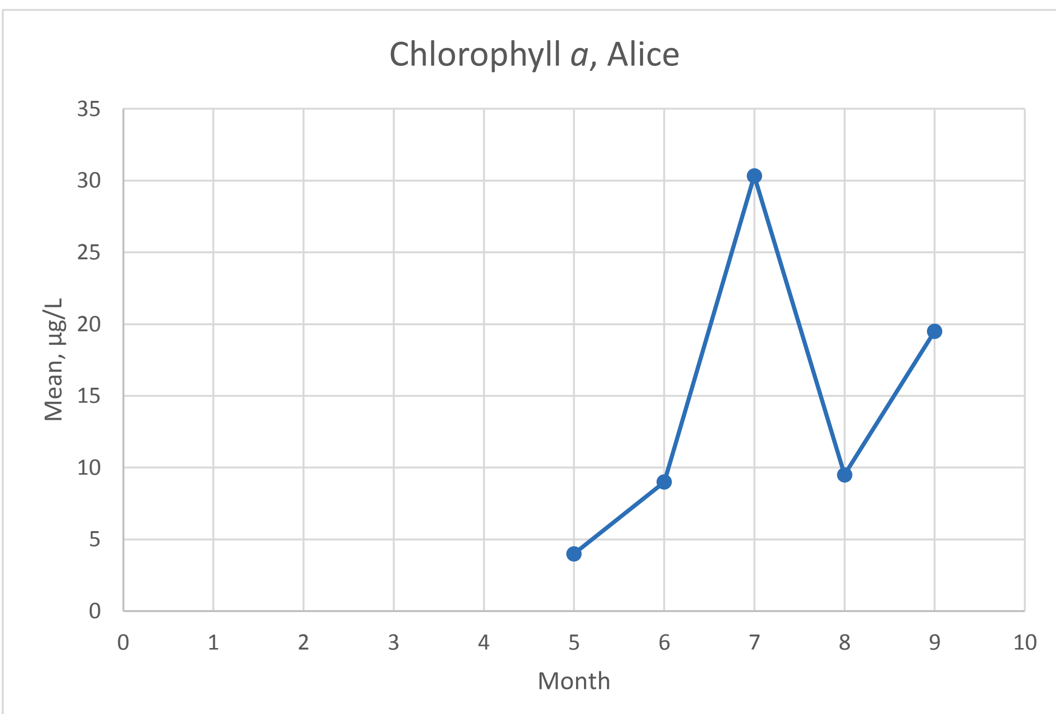


Figure A-16. Monthly Average Chlorophyll *a* (Alice).

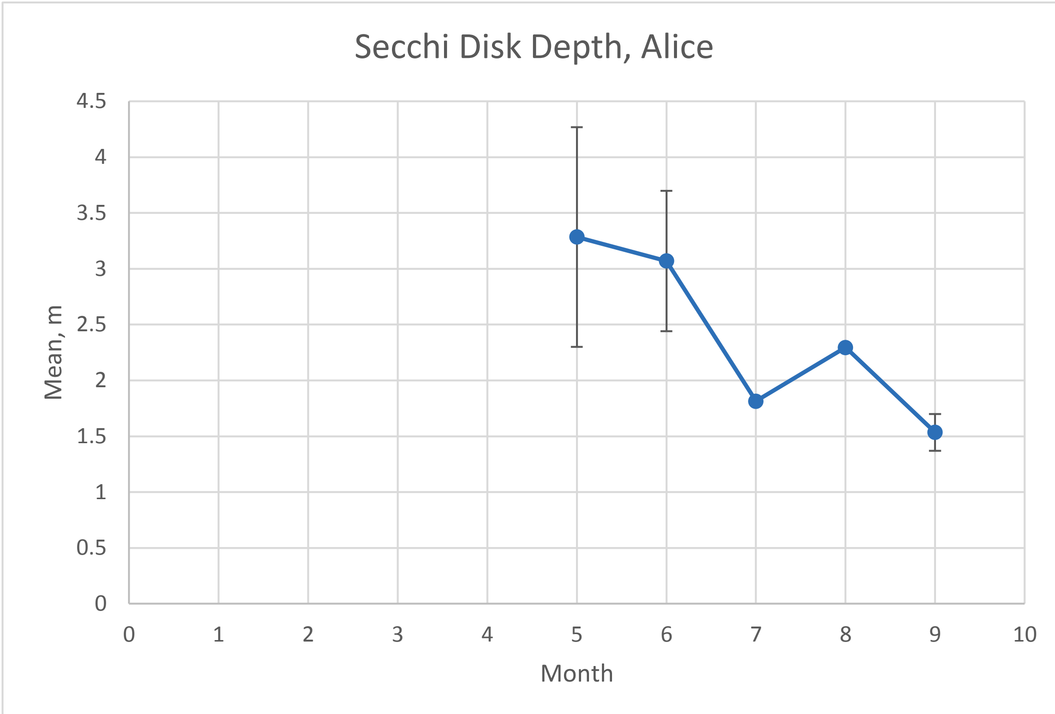


Figure A-17. Monthly Average Secchi Disk Depth (Alice).

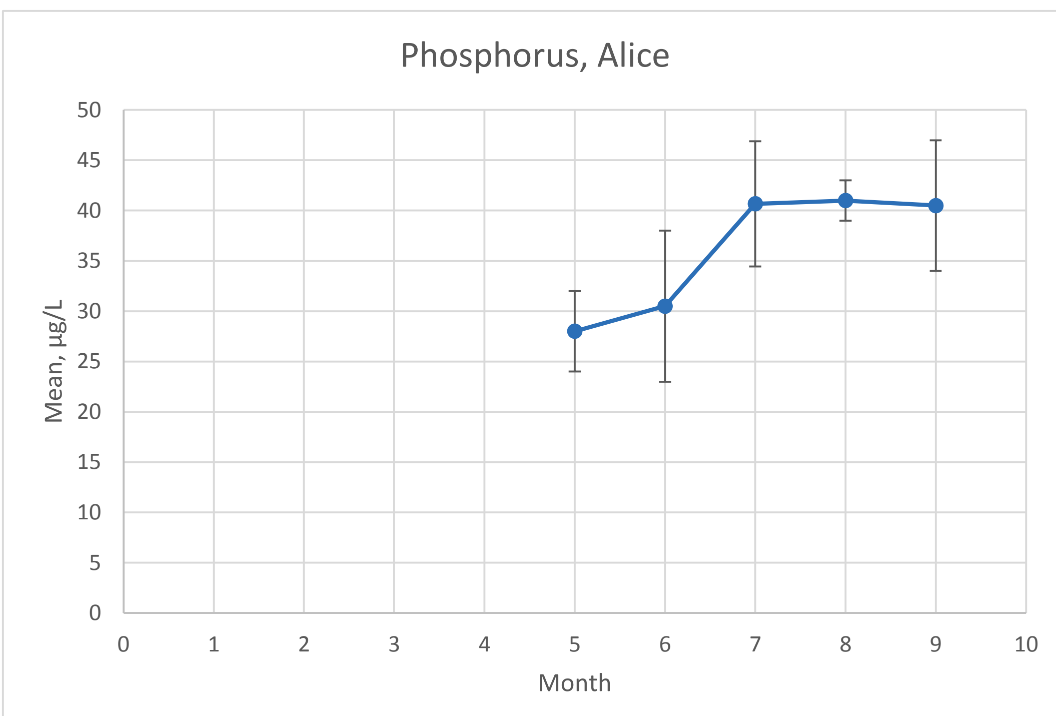


Figure A-18. Monthly Average Total Phosphorus (Alice).

ATTACHMENT B

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION ATLAS 14 PRECIPITATION INTENSITY AND DURATION SUMMARY FOR SOLWAY, MINNESOTA

Table 7. National Oceanic and Atmospheric Administration Atlas 14 Precipitation Intensity and Duration Summary for Solway, Minnesota (Page 1 of 2)

Partial Duration Series-Based Precipitation Frequency Estimates With 90% Confidence Intervals (in Inches)[(a)]										
Duration	**Average Recurrence Interval (years)**									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1,000**
5 Minutes	**0.326**	**0.391**	**0.5**	**0.594**	**0.728**	**0.835**	**0.944**	**1.06**	**1.21**	**1.34**
	(0.255-0.420)	(0.306-0.505)	(0.390-0.648)	(0.461-0.773)	(0.547-0.984)	(0.612-1.14)	(0.669-1.33)	(0.720-1.53)	(0.794-1.81)	(0.850-2.02)
10 Minutes	**0.477**	**0.572**	**0.733**	**0.87**	**1.07**	**1.22**	**1.38**	**1.55**	**1.78**	**1.96**
	(0.373-0.615)	(0.448-0.739)	(0.572-0.949)	(0.675-1.13)	(0.801-1.44)	(0.896-1.68)	(0.980-1.94)	(1.05-2.24)	(1.16-2.65)	(1.25-2.95)
15 Minutes	**0.581**	**0.698**	**0.894**	**1.06**	**1.3**	**1.49**	**1.69**	**1.89**	**2.17**	**2.38**
	(0.455-0.750)	(0.546-0.901)	(0.697-1.16)	(0.823-1.38)	(0.977-1.76)	(1.09-2.04)	(1.20-2.37)	(1.29-2.73)	(1.42-3.23)	(1.52-3.60)
30 Minutes	**0.804**	**0.969**	**1.25**	**1.49**	**1.82**	**2.09**	**2.37**	**2.66**	**3.05**	**3.36**
	(0.630-1.04)	(0.759-1.25)	(0.973-1.62)	(1.15-1.93)	(1.37-2.47)	(1.54-2.87)	(1.68-3.33)	(1.81-3.85)	(2.00-4.54)	(2.14-5.07)
60 Minutes	**1.02**	**1.23**	**1.6**	**1.91**	**2.37**	**2.75**	**3.14**	**3.56**	**4.13**	**4.59**
	(0.799-1.32)	(0.964-1.59)	(1.24-2.07)	(1.48-2.49)	(1.79-3.22)	(2.02-3.78)	(2.23-4.43)	(2.42-5.16)	(2.71-6.16)	(2.92-6.92)
2 Hours	**1.24**	**1.49**	**1.94**	**2.34**	**2.92**	**3.41**	**3.91**	**4.45**	**5.21**	**5.81**
	(0.978-1.58)	(1.18-1.91)	(1.53-2.49)	(1.83-3.01)	(2.23-3.94)	(2.53-4.64)	(2.81-5.47)	(3.07-6.40)	(3.45-7.71)	(3.74-8.69)
3 Hours	**1.36**	**1.64**	**2.14**	**2.58**	**3.25**	**3.81**	**4.41**	**5.05**	**5.96**	**6.69**
	(1.08-1.73)	(1.31-2.08)	(1.69-2.72)	(2.04-3.30)	(2.50-4.37)	(2.85-5.18)	(3.19-6.14)	(3.50-7.24)	(3.97-8.78)	(4.33-9.95)
6 Hours	**1.59**	**1.89**	**2.45**	**2.96**	**3.76**	**4.43**	**5.17**	**5.97**	**7.12**	**8.05**
	(1.28-1.99)	(1.52-2.37)	(1.96-3.08)	(2.36-3.75)	(2.93-5.02)	(3.36-5.98)	(3.78-7.15)	(4.19-8.49)	(4.80-10.4)	(5.26-11.9)
12 Hours	**1.84**	**2.16**	**2.75**	**3.31**	**4.18**	**4.94**	**5.77**	**6.69**	**8.02**	**9.11**
	(1.50-2.28)	(1.75-2.67)	(2.22-3.42)	(2.66-4.13)	(3.31-5.54)	(3.79-6.61)	(4.28-7.92)	(4.75-9.44)	(5.47-11.6)	(6.01-13.3)
24 Hours	**2.1**	**2.44**	**3.07**	**3.68**	**4.64**	**5.47**	**6.38**	**7.39**	**8.86**	**10.1**
	(1.73-2.57)	(2.00-2.99)	(2.52-3.78)	(3.00-4.55)	(3.71-6.08)	(4.24-7.24)	(4.78-8.67)	(5.30-10.3)	(6.10-12.7)	(6.71-14.5)
2 Days	**2.38**	**2.77**	**3.48**	**4.16**	**5.22**	**6.13**	**7.13**	**8.22**	**9.81**	**11.1**
	(1.98-2.88)	(2.30-3.35)	(2.88-4.23)	(3.42-5.08)	(4.21-6.75)	(4.80-8.01)	(5.39-9.56)	(5.96-11.4)	(6.82-13.9)	(7.48-15.9)
3 Days	**2.6**	**3.02**	**3.78**	**4.5**	**5.6**	**6.55**	**7.58**	**8.72**	**10.3**	**11.7**
	(2.18-3.13)	(2.52-3.63)	(3.15-4.56)	(3.72-5.45)	(4.54-7.19)	(5.16-8.50)	(5.77-10.1)	(6.35-11.9)	(7.24-14.6)	(7.91-16.6)
4 Days	**2.81**	**3.24**	**4.03**	**4.77**	**5.9**	**6.86**	**7.9**	**9.05**	**10.7**	**12**
	(2.36-3.36)	(2.72-3.88)	(3.37-4.84)	(3.97-5.75)	(4.80-7.51)	(5.43-8.84)	(6.03-10.5)	(6.62-12.3)	(7.50-15.0)	(8.18-17.0)
7 Days	**3.39**	**3.85**	**4.68**	**5.44**	**6.58**	**7.55**	**8.59**	**9.71**	**11.3**	**12.6**
	(2.87-4.01)	(3.26-4.56)	(3.95-5.56)	(4.56-6.50)	(5.39-8.27)	(6.02-9.61)	(6.60-11.2)	(7.15-13.1)	(8.00-15.7)	(8.64-17.7)

Table 8. National Oceanic and Atmospheric Administration Atlas 14 Precipitation Intensity and Duration Summary for Solway, Minnesota (Page 2 of 2)

Partial Duration Series-Based Precipitation Frequency Estimates With 90% Confidence Intervals (in Inches)[(a)]										
Duration	**Average Recurrence Interval (years)**									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1,000**
10 Days	**3.9**	**4.4**	**5.29**	**6.08**	**7.25**	**8.22**	**9.24**	**10.3**	**11.9**	**13.1**
	(3.33-4.59)	(3.75-5.19)	(4.49-6.25)	(5.13-7.22)	(5.95-9.01)	(6.57-10.4)	(7.14-12.0)	(7.65-13.8)	(8.45-16.4)	(9.05-18.3)
20 Days	**5.34**	**6.02**	**7.14**	**8.08**	**9.4**	**10.4**	**11.5**	**12.5**	**14**	**15.1**
	(4.61-6.21)	(5.19-7.00)	(6.13-8.33)	(6.90-9.48)	(7.75-11.4)	(8.40-12.9)	(8.92-14.6)	(9.34-16.5)	(10.0-19.0)	(10.5-20.8)
30 Days	**6.53**	**7.37**	**8.71**	**9.8**	**11.3**	**12.4**	**13.5**	**14.5**	**15.9**	**16.9**
	(5.67-7.54)	(6.39-8.51)	(7.53-10.1)	(8.43-11.4)	(9.33-13.5)	(10.0-15.1)	(10.5-16.9)	(10.9-18.9)	(11.4-21.4)	(11.9-23.3)
45 Days	**8.04**	**9.08**	**10.7**	**12**	**13.7**	**14.9**	**16**	**17.1**	**18.5**	**19.4**
	(7.03-9.22)	(7.93-10.4)	(9.32-12.3)	(10.4-13.9)	(11.4-16.2)	(12.1-18.0)	(12.6-20.0)	(12.9-22.0)	(13.3-24.6)	(13.7-26.5)
60 Days	**9.34**	**10.5**	**12.4**	**13.8**	**15.7**	**17**	**18.2**	**19.4**	**20.7**	**21.6**
	(8.20-10.6)	(9.25-12.0)	(10.8-14.2)	(12.0-15.9)	(13.1-18.5)	(13.9-20.4)	(14.4-22.6)	(14.6-24.7)	(15.0-27.4)	(15.3-29.3)

(a) Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90 percent confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5 percent. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Appendix B

Monitoring and Assessment Results for Streams and Lakes in the MRHW

Table 19: Assessment status of stream reaches in the Mississippi River Headwaters Watershed

Aggregated HUC-12 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Little Mississippi River	738	Unnamed Creek	Headwaters to Duncan Lk	MTS	--	IF	IF	NA
	517	Little Mississippi River	Moose Lk to Grant Cr	MTS	MTS	NA	MTS	SUP
Grant Creek	748	Unnamed Ditch	T147 R35W S25, north line to Grant Cr	MTS	--	IF	IF	NA
	739	Unnamed Ditch	Headwaters to Unnamed Ditch	NA	--	IF	IF	NA
	670	Grant Creek	Unnamed Ditch to Unnamed Cr	MTS	--	IF	IF	NA
	546	Grant Creek	Grant Lk outlet to Unnamed Cr	NA	--	EXS	MTS	SUP
Headwaters Mississippi River	663	Sucker Creek	Gould Cr to Mississippi R	MTS	MTS	IF	IF	NA
	631	Bear Creek	T145 R36W S31, south line to Mississippi R	MTS	MTS	IF	IF	NA
Hennepin Creek	637	Hennepin Creek	T145 R35W S35, west line to Mississippi R	MTS	MTS	IF	MTS	SUP
Schoolcraft River	752	Schoolcraft River	Schoolcraft Lk to Frontenac Cr	MTS	MTS	IF	IF	NA
	573	Birch Creek	Lk Hattie outlet to Schoolcraft R	MTS	MTS	IF	IF	NA
	651	Frontenac Creek	Unnamed Lk (29-0497-00) to T145 R34W S34, south line	MTS	--	IF	IF	NA
	638	Alcohol Creek	Lk George to Schoolcraft R	MTS	MTS	IF	IF	NA
	751	Schoolcraft River	Frontenac Cr to Plantagenet Lk	MTS	MTS	IF	MTS	SUP
Turtle River	510	Turtle River	Headwaters (Stray Horse Lk 04-0246-00) to Cass Lk	MTS	MTS	IF	MTS	SUP
	551	Gull River	Erickson Lk to Nelson Lk outlet	NA	MTS	IF	IF	NA
North Turtle River	570	North Turtle River	Little Rice Pond outlet to Pimushe Lk	MTS	--	IF	IF	NA
	548	North Turtle River	Pimushe Lk to Turtle R	MTS	MTS	IF	MTS	SUP
Cass Lake-Mississippi River	750	Unnamed Creek	Unnamed Cr to Lk Bemidji	MTS	MTS	IF	IF	NA

Aggregated HUC-12 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Third River	581	Moose Creek	Unnamed Cr to Third R	NA	MTS	IF	IF	NA
	526	Third River	Skimmerhorn Lk to Lk Winnibigoshish	MTS	MTS	IF	MTS	SUP
Lake Winnibigoshish	549	Lydick Brook	Headwaters to Mississippi R	MTS	--	IF	IF	NA
	590	Castle Creek	Headwaters to Unnamed Cr	MTS	--	IF	IF	NA
	606	Farley Creek	Farley Lk to Unnamed lk (31-0895-00)	MTS	NA	IF	IF	NA
	620	Pigeon River	T147 R27W S18, west line to Unnamed Cr	MTS	--	IF	IF	NA
Deer River	619	Island lake Creek	Hansen Lk outlet to Deer R	MTS	--	IF	IF	NA
	505	Deer River	Bay Lk to Mississippi R	MTS	MTS	IF	IF	SUP
Ball Club Lake	741	Fisherman's Brook	Headwaters to Ball Club Lk	EXS	MTS	IF	IF	NA
Vermillion River	521	Vermillion River	Headwaters to Mississippi R	NA	MTS	NA	MTS	SUP
Pokegama Lake-Mississippi River	692	Sugar Brook	Unnamed Lk (31-0553-00) to Pokegama Lk	MTS	MTS	IF	MTS	NA
	732	Unnamed Creek	Headwaters to Pokegama Lk	--	--	IF	MTS	NA
	659	Unnamed Creek (Pokegama Creek)	Headwaters to Sherry Lk	--	--	IF	IF	NA
	644	Smith Creek	Headwaters to Smith Lk	MTS	MTS	IF	IF	NA
	645	Smith Creek	Smith Lk to Little Pokegama Lk	--	--	IF	IF	NA

MTS = Meets Standard, EXS = Fails Standard, IF = insufficient data to make an assessment, NA = not assessed, -- = No Data, SUP = Full Support, IMP = Impaired

Table 20: Assessment status of lakes in the Mississippi River Headwaters Watershed, presented North to South

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
Little Mississippi River	04-0286-00	Manomin	IF	NA
	04-0342-00	Moose	NS	FS
	15-0022-00	Daniel	FS	NA
	15-0023-00	Dahlberg	FS	NA
Grant Creek	04-0216-00	Grass	FS	NA
	04-0217-00	Grant	FS	FS
	04-0211-00	Bootleg	IF	NA

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
Headwaters Mississippi River	04-0212-00	Steinbrook	IF	NA
Headwaters Mississippi River	04-0215-00	Fern	FS	NA
	15-0001-00	Big LaSalle	FS	FS
	15-0005-00	Ozawindib	FS	NA
	15-0010-00	Elk	FS	FS
	15-0016-00	Itasca	IF	FS
	15-0018-00	Mallard	FS	NA
	15-0020-00	Sucker	IF	NA
	15-0057-00	Long	FS	IF
	15-0058-00	Heart	FS	FS
	29-0309-00	LaSalle	FS	FS
Hennepin Creek	29-0246-00	Hennepin	FS	FS
Schoolcraft River	04-0142-00	Marquette	FS	FS
	29-0156-00	Plantagenet	FS	FS
	29-0215-00	Schoolcraft	IF	FS
	29-0216-00	George	FS	FS
	29-0217-00	Paine	FS	IF
	29-0227-00	Evergreen	FS	FS
	29-0238-00	Little Spearhead	IF	NA
	29-0239-00	Spearhead	FS	FS
	29-0241-00	Frontenac	FS	FS
	29-0286-00	Alice	NS	NA
	29-0292-00	Beauty	FS	NA
	29-0303-00	Lost	IF	IF
Turtle River	31-0942-00	Rice	IF	NA
	04-0001-00	Burns	NS	NA
	04-0007-00	Kitchi	IF	NA
	04-0011-00	Moose	FS	FS
	04-0014-00	Popple	FS	IF
	04-0015-00	Little Rice	FS	NA
	04-0031-00	Big Rice	IF	NA
	04-0050-00	Meadow	FS	NA
	04-0053-00	South Twin	FS	IF
	04-0063-00	North Twin	FS	FS
	04-0064-00	Gull	IF	IF
	04-0076-00	Long	FS	NA

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
	04-0097-00	Buck	IF	NA
Turtle River	04-0111-00	Turtle River	FS	FS
	04-0114-00	School	IF	NA
	04-0120-00	Gull	FS	FS
	04-0134-00	Three Island	FS	FS
	04-0135-00	Beltrami	FS	FS
	04-0152-00	Movil	FS	FS
	04-0153-00	Lindgren	FS	NA
	04-0154-00	Larson	NS	NA
	04-0155-00	Little Turtle	NS	FS
	04-0157-00	Black	FS	NA
	04-0159-00	Turtle	FS	FS
	04-0162-00	Fox	FS	IF
	04-0196-00	Campbell	IF	FS
	04-0227-00	Long	FS	NA
	04-0230-00	Deer	FS	FS
	04-0234-00	Wolf	FS	NA
	04-0235-00	Peterson	FS	NA
	04-0237-00	Pony	FS	NA
North Turtle River	04-0008-00	Little Moose	FS	NA
	04-0019-00	Anderson	FS	NA
	04-0024-00	Gilstad	FS	FS
	04-0032-00	Pimushe	FS	IF
	04-0033-00	Benjamin	FS	IF
	04-0034-00	Rabideau	FS	FS
	04-0059-00	Rice Pond	FS	NA
	04-0066-00	Hanson	NS	NA
	04-0067-00	Dutchman	FS	NA
Cass Lake-Mississippi River	29-0066-00	Midge	IF	FS
	29-0071-00	Grace	IF	IF
	04-0005-00	Schram	FS	NA
	04-0030-00	Cass	FS	NA
	04-0036-00	Drewery	FS	NA
	04-0038-00	Andrusia	FS	NA
	04-0039-00	Silver	FS	NA
	04-0041-00	Ten	FS	NA
	04-0042-00	Buck	FS	NA

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
Cass Lake-Mississippi River	04-0043-00	Lost	FS	NA
	04-0048-00	Windigo	FS	NA
	04-0049-00	Big	FS	IF
	04-0051-00	Flora	FS	NA
	04-0079-00	Wolf	FS	NA
	04-0085-00	Swenson	FS	NA
	04-0099-00	Unnamed	FS	NA
	04-0110-00	Little Bass	FS	NA
	04-0130-01	Stump	FS	IF
	04-0130-02	Bemidji (main lake)	IF	FS
	04-0132-01	Big Bass (west basin)	FS	NA
	04-0132-02	Big Bass (east basin)	FS	FS
	04-0140-00	Irving	NS	FS
	04-0141-00	Carr	IF	NA
	11-0415-00	Pike Bay	FS	IF
	11-0485-00	Moss	FS	NA
	11-0505-00	Little Wolf	IF	FS
Third River	31-0907-00	Sioux	NA	NA
	31-0921-00	Dixon	NS	IF
	31-0934-00	Decker	NS	IF
	31-0943-00	Coleman	IF	NA
	31-0944-00	Damon	NA	NA
Lake Winnibigoshish	31-0892-00	Middle Pigeon	NS	NA
	31-0893-00	Lower Pigeon	NS	IF
	31-0894-00	Pigeon Dam	IF	NA
	31-0895-00	Unnamed	IF	NA
	31-0908-00	Upper Pigeon	NS	NA
	31-0926-00	Sugar	IF	NA
	31-0928-00	Kenogama	NS	NA
	31-0929-00	Morph	IF	NA
	11-0147-00	Winnibigoshish	FS	IF
	31-0819-00	Tibbett	IF	NA
	31-0820-00	Unnamed	NA	NA
	31-0823-00	Two Mile	IF	NA
	31-0852-00	Little Cut Foot Sioux	NS	NA
	31-0855-00	Goodwin	NA	NA

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
Lake Winnibigoshish	31-0857-01	Cut Foot Sioux(Main Bay)	FS	NA
	31-0859-00	Wart	NA	NA
	31-0862-00	Biauswah	NS	NA
	31-0867-00	Simpson	IF	NA
	31-0870-00	Unnamed	NA	NA
	31-0871-00	Unnamed	NA	NA
Deer River	31-0578-00	Clarke	FS	NA
	31-0585-00	McAvity	FS	NA
	31-0586-00	Johnson	FS	FS
	31-0587-00	Orange	FS	NA
	31-0588-00	Little Horn	IF	NA
	31-0590-00	Beaver	FS	NA
	31-0594-00	Cottonwood	FS	FS
	31-0597-00	Amen	FS	NA
	31-0598-00	Big Horn	IF	NA
	31-0602-00	Pughole	FS	NA
	31-0609-00	Fawn	FS	NA
	31-0610-00	Little Moose	FS	FS
	31-0611-00	Dead Horse	IF	NA
	31-0719-00	Deer	FS	FS
	31-0722-00	Moose	FS	FS
	31-0749-00	Chase	FS	NA
	31-0751-00	Little Deer	FS	NA
	31-0754-00	Island	FS	FS
	31-0761-00	Alp	IF	NA
Ball Club Lake	31-0812-00	Ball Club	FS	IF
	31-0822-00	Little Ball Club	FS	NA
Vermillion River	11-0022-00	Spring	IF	NA
	11-0023-00	Long	FS	NA
	11-0026-00	Sugar	IF	FS
	11-0029-00	Vermillion	IF	FS
	11-0030-00	Little Vermillion	FS	NA
Pokegama Lake-Mississippi River	31-0946-00	Tioga Mine Pit	IF	NA
	31-0358-00	Stokey	IF	NA
	31-0359-00	Unnamed	IF	NA
	31-0360-00	Munzer	FS	NA

Aggregated HUC-12 Subwatershed	Lake ID	Lake	Aquatic Recreation	Aquatic Life
Pokegama Lake-Mississippi River	31-0532-01	Pokegama (Main Bay)	FS	IF
	31-0532-02	Pokegama (Wendigo)	FS	IF
	31-0547-00	Smith	IF	NA
	31-0549-00	Unnamed	IF	NA
	31-0554-00	Siseebakwet	FS	FS
	31-0555-00	South Sugar	FS	NA
	31-0557-00	Unnamed	IF	NA
	31-0559-00	Unnamed	IF	NA
	31-0563-00	Warburg	IF	NA
	31-0564-00	Unnamed	IF	NA
	31-0565-00	Jay Gould	FS	FS
	31-0566-00	Little Jay Gould	FS	FS
	31-0569-00	Guile	IF	NA
	31-0570-00	Long	FS	IF
	31-0571-00	Loon	FS	FS
	31-0573-00	Salter Pond	NA	NA
	31-0575-00	Little Bass	FS	FS
	31-0576-00	Bass	FS	NA
	31-0583-00	Mallard	NA	NA
	31-0716-00	Little Rice	FS	NA
	31-0717-00	Rice	FS	FS
	31-0718-00	Stevens	FS	NA
	31-0733-00	Little Siseebakwet	FS	NA
	31-0735-00	Spring	IF	NA
	31-0736-00	Skelly	IF	NA
	31-0739-00	Leighton	FS	NA
	31-0740-00	Little White Oak	IF	NA
	31-0741-00	Little Drum	NA	NA
	31-0748-00	Miller	NA	NA
	31-0776-00	White Oak	IF	NA
	31-0850-00	Little Winnibigoshish	FS	NA

Imp = impaired for impacts to aquatic recreation, FS = fully supporting aquatic recreation, NS = non-supporting of aquatic recreation, IF = insufficient data to make an assessment, NA = not assessed

Monitoring and Assessment Results for Mississippi River

Mississippi River - 07010101-753 - Headwaters to Schoolcraft River

The Mississippi River Headwaters HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010101-753. This reach originates in the headwaters at Lake Itasca and extends to the confluence with the Schoolcraft River, 58 miles downstream. Both aquatic life and aquatic recreation use were found to be full support during the 2015 assessment cycle. In addition, a correction to the impaired waters list was made to remove the previous DO impairment within the reach. The reach is considered impaired for aquatic consumption (mercury in fish tissue).

Prior to the establishment of AUID 07010101-753, as part of the MPCA's large river monitoring and assessment strategy, this reach was described as AUID 07010101-504 and found to be impaired for aquatic life use based on DO during the 1994 assessment cycle. As a result, the Upper Mississippi River TMDL Project conducted follow up dissolved oxygen monitoring from 2000 through 2003. This work resulted in splitting AUID 07010101-504 into two separate AUID's (07010101-923 and 07010101-924) in order to maintain the existing DO impairment on the downstream portion while designating the upper portion as impaired but due to natural background conditions, therefore not requiring a TMDL. During the 2015 assessment cycle's review of all existing data, patterns of low dissolved oxygen were found to occur due to a combination of natural factors including a low gradient stream channel, wetland influences, and groundwater inputs throughout the reach. Therefore, AUID 753 was determined to be "not assessable" for dissolved oxygen because the current standard of 5.0 mg/L is not a reliable indicator of the aquatic health in natural streams heavily influenced by wetlands. The "not assessable" determination at the parameter level for DO is based on assessment guidance defining cases where natural factors are principally influencing the DO regime and other indicators of aquatic life indicate full support (i.e. fish-IBI, macroinvertebrate-IBI, and water chemistry). All other indicators of aquatic health were indicating support of the aquatic life use, including fish and macroinvertebrate communities (Table 20). Therefore, this reach (AUID 070101001-753) was assessed as meeting its aquatic life use and the previous DO impairments will be removed from the impaired waters list as a correction.

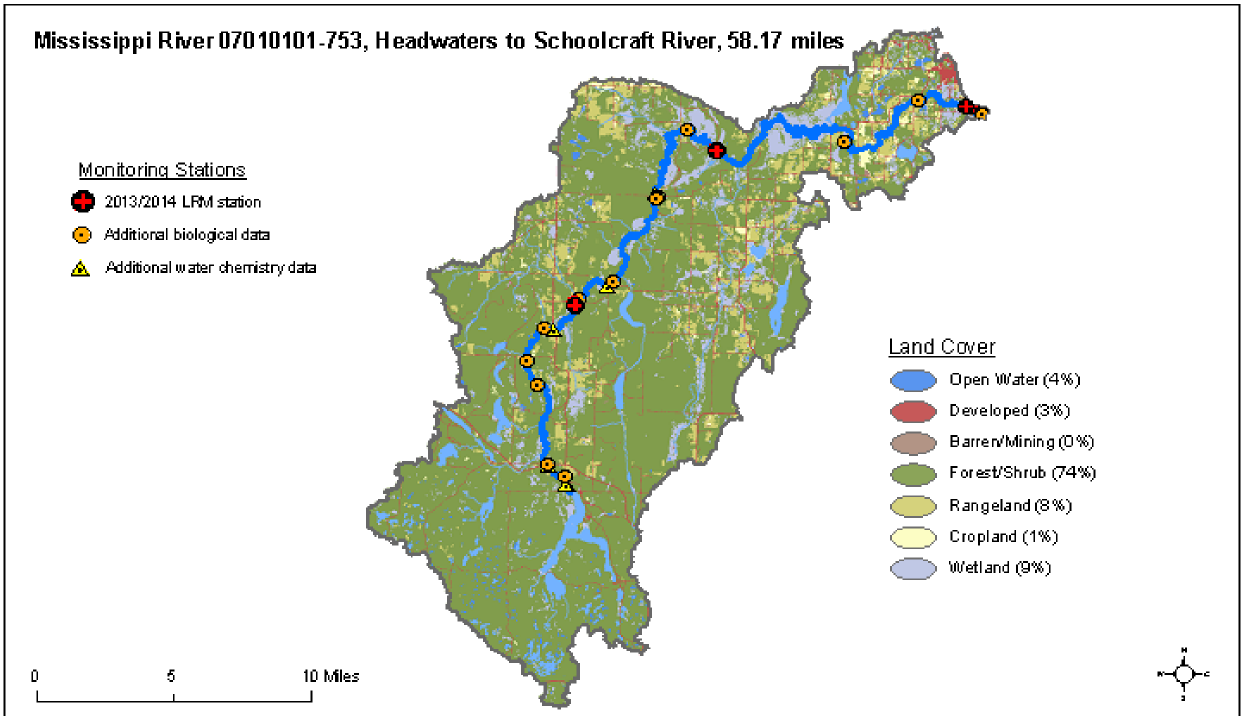
TP was the only additional water quality parameter to show an exceedance. TP is the causative variable as described in the river eutrophication standard. Although TP concentrations are just above the standard (50 ug/L) no response was observed in Chl-*a* or BOD concentrations, indicating that river eutrophication is not currently a stressor to aquatic life within this reach.

Because both upstream Lake Itasca and downstream Lake Irving are currently listed for aquatic consumption (mercury in fish tissue) and fish have direct access to the Mississippi River reach between them, AUID 07010101-753 is also considered impaired for aquatic consumption.

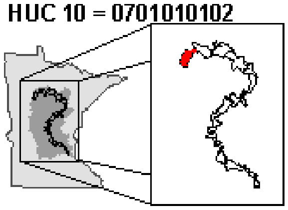
Table 21. Designated use support assessments on Mississippi River assessment reach – 07010101-753, Headwaters to Schoolcraft River.

			Aquatic Life Indicators:									Eutrophication				
AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Recreation** (Bacteria)	**Aquatic Consumption**
07010101-753, ***Mississippi River,*** *Headwaters to Schoolcraft River*	58.17	2Bg	MTS	MTS	NA	MTS	MTS	MTS	MTS	MTS	IF	EXS	MTS	FS	FS	NS

Abbreviations for indicator evaluations: **--** = no data, **MTS** = meets standard; **EXS** = exceeds standard; **IF** = insufficient information
Abbreviations for designated use support determinations: **NA** = not assessed, **IF** = insufficient information, **FS** = full support (meets criteria); **NS** = non-support (fails criteria)
Key for cell shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for use class: **2Bg** = warmwater general, **2Bm** = warmwater modified, **2Be** = warmwater exceptional, **2Ag** = coldwater general, **2Ae** = coldwater exceptional, **7** = limited resource value water.
***2Bdg** = warmwater general use class that is also protected as a source of drinking water.



HUC 10 = 0701010102



Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Full Support	
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in fish tissue

Figure 50. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010101-753.

Mississippi River - 07010101-754 - Schoolcraft River through Cass Lake

The Cass Lake - Mississippi River HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010101-754. This reach originates at the Schoolcraft River confluence and extends through Cass Lake, 33 miles downstream. Prior to the establishment of AUID 07010101-754, as part of the MPCA's large river monitoring and assessment strategy, this reach consisted of 12 smaller segments alternating between lake and stream segments.

There were no impairments on any of the stream segments but each lake within the flowage (including Bemidji, Andrusia, and Cass) has an approved TMDL plan for mercury in fish tissue (aquatic consumption use). Because fish have access and frequently travel between lake and river reaches, the new consolidated AUID (07010101-754) is considered impaired for aquatic consumption use (mercury in fish tissue). Aquatic life use was found to be full support during the 2015 assessment cycle based on multiple parameters, including fish-IBI (Table 21). This reach was also determined to be supporting of the aquatic recreation use.

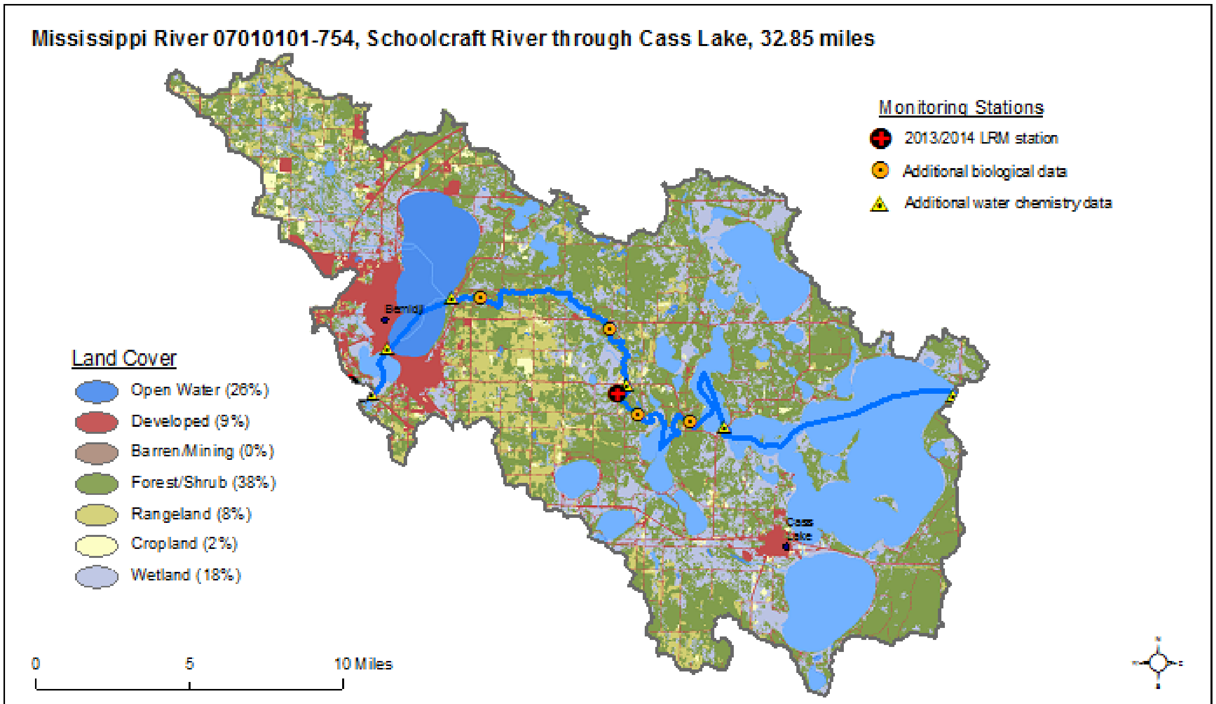
As indicated, this reach of the Mississippi River flows through a network of lakes including Lake Irving which is impaired for aquatic recreation use due to eutrophication/excess nutrients. TP concentrations decease as the Mississippi River exits Lake Bemidji and as it flows through Stump Lake. The majority of water quality data was collected between Stump Lake and Wolf Lake at CSAH 8, 6.5 miles NW of Cass Lake. The remaining portion of the reach consists of Lake Andrusia and Cass Lake, both of which have good water quality.

The many lakes along this reach act as a sink for TP but periphyton growth has been documented at nuisance levels on the bed sediments of the river. Although the Mississippi River is currently in good condition throughout this reach, the city of Bemidji, Minnesota and surrounding urban development could potentially impact the health of the Mississippi River and eutrophication may be a future concern.

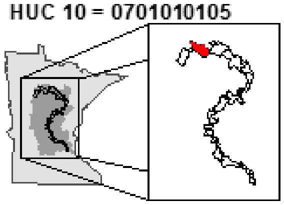
Table 22. Designated use support assessments on Mississippi River assessment reach – 07010101-754, Schoolcraft River through Cass Lake.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication: Phosphorus	Eutrophication: Response Indicator	Aquatic Life	Aquatic Recreation (Bacteria)	Aquatic Consumption
07010101-754, ***Mississippi River***, *Schoolcraft River through Cass Lake*	32.85	2Bg	MTS	--	IF	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS	FS	FS	NS

Abbreviations for indicator evaluations: **--** = no data, **MTS** = meets standard; **EXS** = exceeds standard; **IF** = insufficient information
Abbreviations for designated use support determinations: **NA** = not assessed, **IF** = insufficient information, **FS** = full support (meets criteria); **NS** = non-support (fails criteria)
Key for cell shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for use class: **2Bg** = warmwater general, **2Bm** = warmwater modified, **2Be** = warmwater exceptional, **2Ag** = coldwater general, **2Ae** = coldwater exceptional, **7** = limited resource value water.
***2Bdg** = warmwater general use class that is also protected as a source of drinking water.



HUC 10 = 0701010105



Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Full Support	
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in fish tissue

Figure 51. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010101-754.

Mississippi River - 07010101-755 - Cass Lake through Lake Winnibigoshish

The Lake Winnibigoshish HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010101-755. This reach originates at the outlet of Cass Lake and extends through Lake Winnibigoshish, 26 miles downstream. However, Lake Winnibigoshish comprises a significant portion of the reach and the actual riverine portion of the Mississippi River between the two lakes is roughly 10 miles in length. Both aquatic life and aquatic recreation use were found to be full support during the 2015 assessment cycle. Aquatic consumption use is not supporting (mercury in fish tissue).

Water chemistry data available within the reach generally indicated supporting conditions or was insufficient (Table 23). However, due to the location of water chemistry stations within the reach, water chemistry data was determined to be more representative of lake conditions and not appropriate to compare to standards developed for stream and river conditions. Therefore, aquatic life use was assessed using only fish IBI data, which indicates a healthy biological community.

Because both Winnibigoshish and Cass Lake are currently listed for aquatic consumption (mercury in fish tissue) and fish have access to the Mississippi River reach between them, AUID 07010101-755 is also considered impaired for aquatic consumption.

Table 23. Designated use support assessments on Mississippi River assessment reach – 07010101-755, Cass Lake through Lake Winnibigoshish.

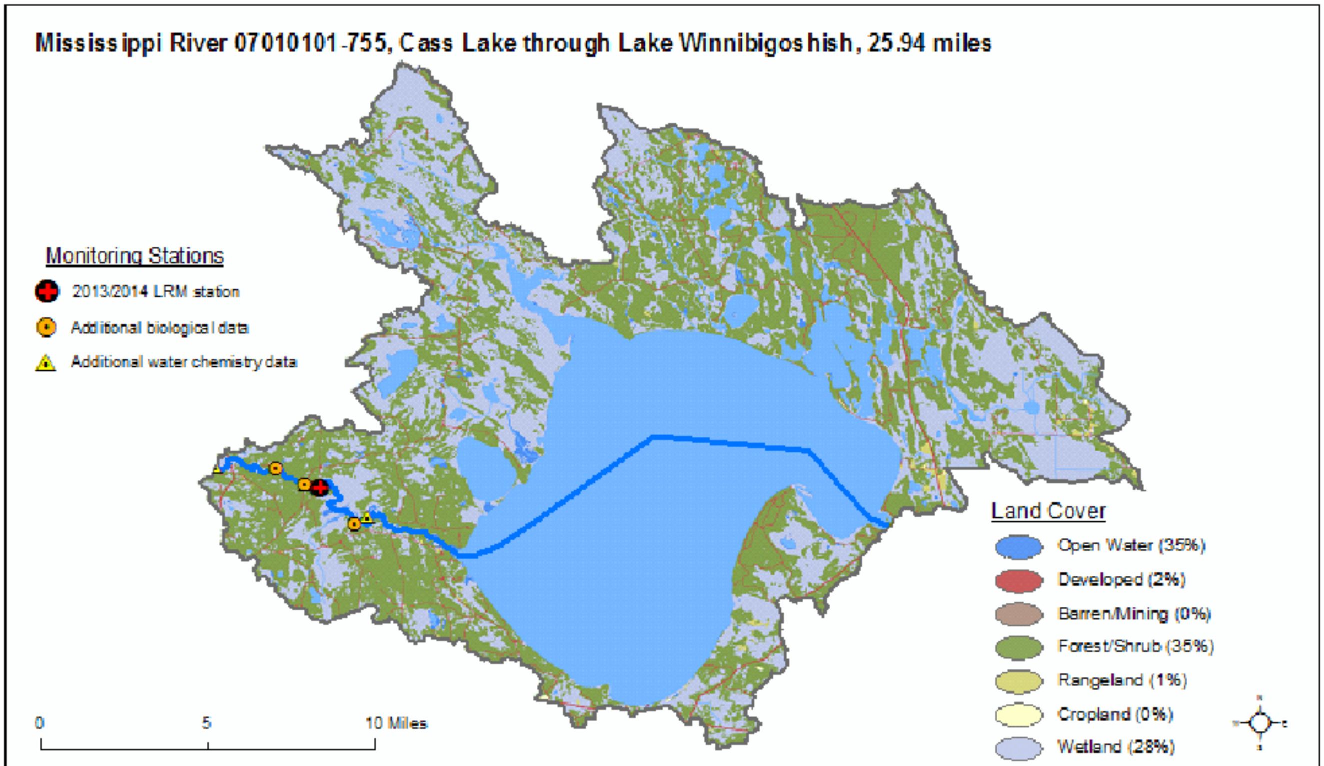
AUID ***Reach Name***, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	**Eutrophication** Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Recreation** (Bacteria)	**Aquatic Consumption**
07010101-755, ***Mississippi River***, *Cass Lake through Lake Winnibigoshish*	25.94	2Bg	MTS	--	IF	IF	MTS	MTS	MTS	MTS	--	MTS	--	FS	FS	NS

Abbreviations for indicator evaluations: **--** = no data, **MTS** = meets standard; **EXS** = exceeds standard; **IF** = insufficient information
Abbreviations for designated use support determinations: **NA** = not assessed, **IF** = insufficient information, **FS** = full support (meets criteria); **NS** = non-support (fails criteria)

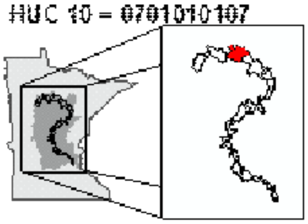
Key for cell shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for use class: **2Bg** = warmwater general, **2Bm** = warmwater modified, **2Be** = warmwater exceptional, **2Ag** = coldwater general, **2Ae** = coldwater exceptional, **7** = limited resource value water.
***2Bdg** = warmwater general use class that is also protected as a source of drinking water.

Figure 52. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010101-755.



HUC 10 = 0701010107



Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Full Support	
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in fish tissue

Mississippi River - 07010101-756 - Lake Winnibigoshish to Cohasset Dam

The Pokegama Lake - Mississippi River HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010101-756. This reach originates at the outlet of Lake Winnibigoshish and extends to the Cohasset Dam, 57 miles downstream. Both aquatic life and aquatic recreation use were found to be full support during the 2015 assessment cycle. The previous dissolved oxygen impairment within the reach was removed from the impaired waters list as a correction. The reach is considered impaired for aquatic consumption (mercury in fish tissue).

Prior to the establishment of AUID 07010101-756, as part of the MPCA's large river monitoring and assessment strategy, a segment of this consolidated reach was assigned as AUID 07010101-501 and was found to be impaired for aquatic life use based on dissolved oxygen during the 1994 assessment cycle. In 2009, the AUID was studied to better understand wetland influences on dissolved oxygen in "deep marsh" riverine reaches. Low dissolved oxygen was found to occur due to a combination of natural factors including a low gradient stream channel, wetland influences, and groundwater inputs. As a result, the 2015 assessment of AUID 07010101-756 was determined to be "not assessable" for dissolved oxygen because the current standard of 5.0 mg/L is not a reliable indicator of the aquatic health in natural streams heavily influenced by wetlands. The "not assessable" determination at the parameter level for DO is based on assessment guidance defining cases where natural factors are principally influencing the DO regime and other indicators of aquatic life indicate full support (i.e. fish-IBI, macroinvertebrate-IBI, and water chemistry). All other indicators of aquatic health with sufficient data were indicating support of the aquatic life use, including healthy fish communities (Table 23). Therefore, this reach (AUID 070101001-756) was assessed as meeting its aquatic life use and the previous DO impairment will be removed from the impaired waters list as a correction.

The consolidated HUC-10 reach (AUID 07010101-756) combined eleven smaller segments, two of which are lakes that are impaired for aquatic consumption use (mercury in fish tissue) and have approved TMDL plans. One of the former stream segments (07010101-725) also has an approved TMDL plan for mercury in fish tissue. Since there are no known obstructions to prevent fish movement upstream or downstream throughout the reach, the aquatic consumption use impairment will be applied to the entire consolidated reach (07010101-756).

Table 24. Designated use support assessments on Mississippi River assessment reach – 07010101-756, Lake Winnibigoshish to Cohasset Dam.

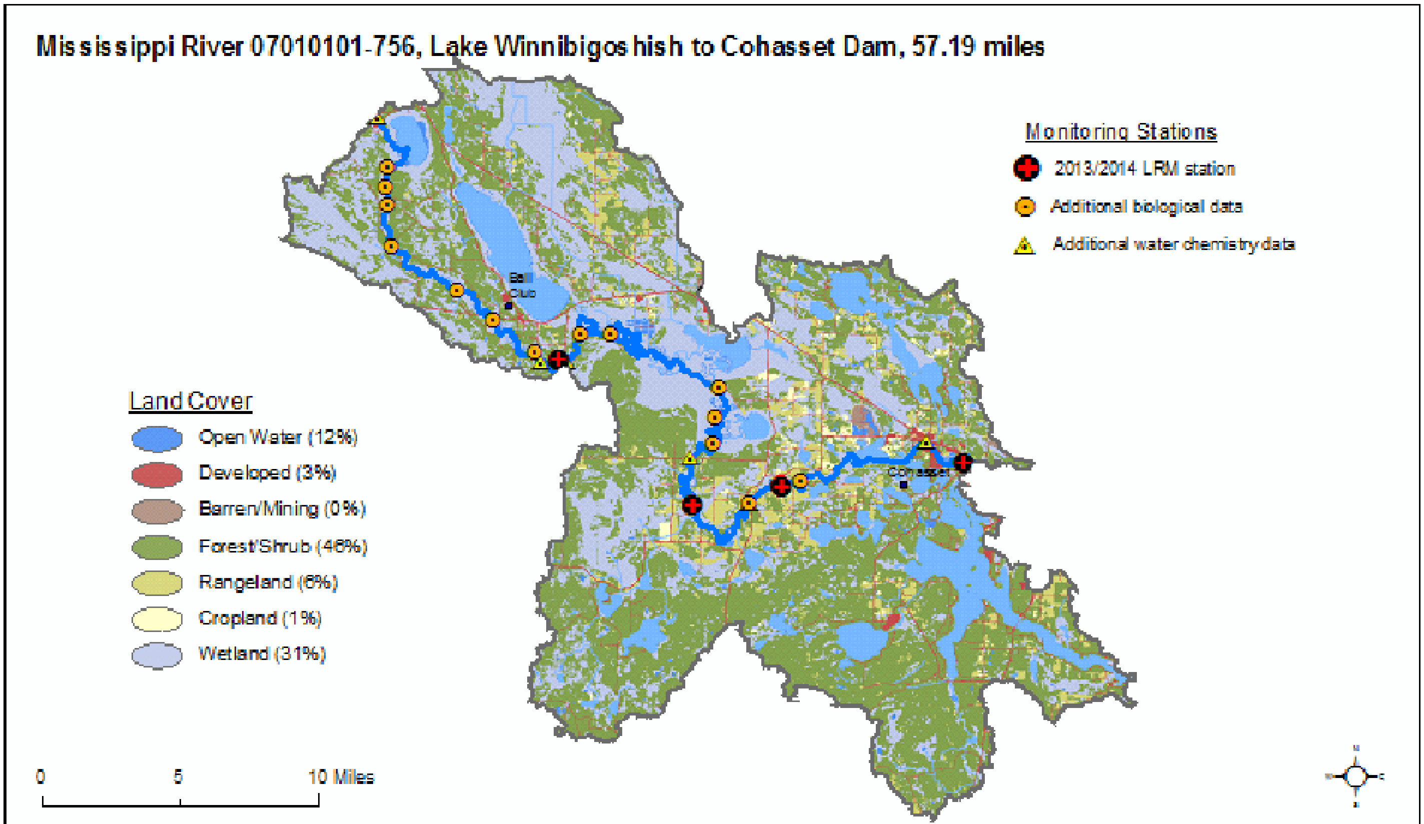
AUID ***Reach Name***, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	**Eutrophication** Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Recreation** (Bacteria)	**Aquatic Consumption**
07010101-756, ***Mississippi River***, *Lake Winnibigoshish to Cohasset Dam*	57.19	2Bg	MTS	IF	NA	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS	FS	FS	NS

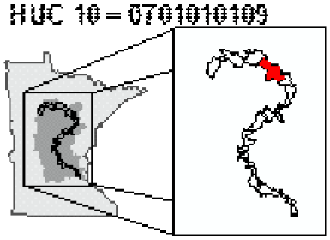
Abbreviations for indicator evaluations: **--** = no data, **MTS** = meets standard; **EXS** = exceeds standard; **IF** = insufficient information
Abbreviations for designated use support determinations: **NA** = not assessed, **IF** = insufficient information, **FS** = full support (meets criteria); **NS** = non-support (fails criteria)

Key for cell shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for use class: **2Bg** = warmwater general, **2Bm** = warmwater modified, **2Be** = warmwater exceptional, **2Ag** = coldwater general, **2Ae** = coldwater exceptional, **7** = limited resource value water.

***2Bdg** = warmwater general use class that is also protected as a source of drinking water.





Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Full Support	
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in Fish tissue

Figure 53. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010101-756.

Appendix C
Zonation

Appendix C
Zonation Modeling

Description of Prioritization Approach and Methods
By Paul J. Radomski and Kristin Carlson

Prioritization Overview

As threats to Minnesota's watersheds continue to mount, it is becoming increasingly important to identify and conserve high-priority areas. There are multiple opportunities for protection or restoration in any watershed. Identifying which practices to implement and where in the landscape to implement them can help more effectively target efforts and more efficiently utilize limited resources. A number of information technology tools are available for prioritizing and targeting land for conservation efforts within a watershed.

A systematic approach aimed at optimizing environmental benefits is critical. Two of the most common approaches for conservation prioritization are system-based models and value-based models. One of the major strengths of system-based models is that they require us to think deeply about a system by writing down our mental models of how we believe the system functions. For many watersheds this has been done using the HSPF hydrologic system model, which simulates watershed hydrology and water quality at the catchment scale. However, we often do not have system models that can accurately identify where in the watershed specific good management practices should be applied or that have the ability to simulate alternative land management actions and predict consequences at specific locations in the watershed.

Values-based models use a compilation of individual criteria of valuable landscape features (heterogeneous content) and aggregated criteria (context and connections) with an objective function to prioritize places within the landscape for conservation. Although there are some shortcomings of using value models over system models (value models only allow exploration of tradeoffs and optimization, and they do not provide guidance on what practices should be implemented where), the use of value models is an efficient method for prioritizing places for protection or restoration.

The values-based model prioritization approach we used is based on fundamental conservation principles, including content, context, heterogeneity, and connectivity. We used the DNR's five-component healthy watershed conceptual model to facilitate an organized process to assess and review watershed problems and solutions. The five components are: biology, hydrology, water quality, geomorphology, and connectivity. This approach recognizes that attempts to solve our clean water needs are not separate from our other conservation needs; each conservation activity should provide multiple benefits. Value models help achieve this multiple benefits goal by identifying areas that optimize benefits by accounting for what the community values. The use of an additive benefits objective function in the value model allows for the retention of high quality occurrences of as many conservation features as possible while reducing interference between competing land uses (e.g., row crop areas). Value models also can be used in a public participation process, whereby participants can decide on what features are valued and the ranking of those valued features. Addressing conservation goals effectively necessitates a collaborative approach, and value-based models provide a structure for collaborative efforts. In addition, value models and the five-component conceptual model used to structure the content in the value models are simple concepts that are easy to explain and apply at the local government scale.

Methods

The value models were developed using Zonation software (Moilanen et al. 2009). Zonation produces a nested hierarchy of conservation priorities. It begins with the full landscape and iteratively removes parcels (cells) that contribute least to conservation; therefore, the removal order is the reverse order of the priority ranking for conservation. Zonation assumes that the full watershed is available for conservation. In our model, the lakes were masked out prior to analysis. This focused the prioritization on the terrestrial parcels, in accordance with the conservation goals of the Mississippi-Headwaters watershed. Zonation's algorithms seek maximal retention of weighted normalized conservation features.

Weights are used to influence which features are valued more. Within the five-component healthy watershed framework, for example, water quality conservation features could be weighted higher than biological features. The feature-specific weights used in the value models reflect social valuation, and they were set using the analytic hierarchy process (AHP; Saaty and Peniwati 2007). A survey comprised of pairwise comparisons was used to solicit the preferences of individuals. Features used in the comparison were based loosely on the DNR's five-component healthy watershed approach, with the addition of alternative land uses or economic features representing a social component. The pairwise survey was structured to gather value preferences. Each individual taking the survey used his or her judgment about the relative importance of all elements at each level of the hierarchy. The relative importance values included "equal," "prefer," and "strongly prefer." The use of abbreviated pairwise importance values helped reduce the cognitive burdens associated with a large number of pairwise comparisons. Individual responses were aggregated with a geometric mean, and the pairwise comparison matrix was constructed to compute the feature-specific weights consistent with the AHP.

There are three commonly definable objective functions possible in Zonation: core area, target-based planning, and additive benefit functions. The core area objective function aims to retain high-quality occurrences of each feature. This function is most appropriate when there is a definite set of conservation features and all of them are to be conserved. The target-based planning objective function is a prescriptive approach where requirements are specified *a priori* for each feature. This function produces a minimum set coverage solution, and is most appropriate when a defined proportion of the watershed is assigned for conservation.

We used the additive benefit function variant of Zonation, which aggregates values by summation across features: $V(P) = \Sigma w_j N_j(P)^{z}{}_{j}$

where the value of a parcel $V(P)$ is equal to the summation of weighted w normalized conservation features of the parcel $N_j(P)$ to the power of z (set to 0.25 for all features).

The conservation features used in the analysis are found in Table 1, and each layer was on the same grid with a resolution of 30 by 30m. We used high-resolution data to maximize conservation planning realism and for greater practicality in local government conservation planning and implementation.
The additive benefit function is appropriate when tradeoffs between conservation features are allowed and it is necessary to account for alternative land use features. In our analyses, we developed prioritizations that would minimize interference with important agricultural areas. Additionally,

Zonation allows ranking to be influenced by neighboring parcels, so that highly valued areas can be aggregated. This minimizes fragmentation of conservation within the landscape. We utilized the distribution-smoothing algorithm in Zonation, which uses an aggregation kernel α parameter. Using this algorithm assumes that fragmentation (low connectivity) generally should be avoided for all conservation features. Initial analyses indicate that an aggregation kernel α of 0.01, which corresponds to a connectivity distance of 200m, may be appropriate for conservation efforts targeted at the watershed scale. We found that very small connectivity distances made no difference in parcel prioritization, since the connectivity effect did not extend very far into neighboring parcels, and very large connectivity distances aggregated parcels across unrealistically large areas. We also found that across a modest range of connectivity distances the results were minor.

The final step in identifying areas for potential protection and restoration included a mapping exercise. Participants used their knowledge and experiences within the watershed to revise the Zonation output maps to create a final map that may be used to provide guidance on which areas within the watershed may be priorities for potential future conservation investments. This synthesis step captured the wisdom of the group of people interested and knowledgeable about the stresses, risks, and vulnerability of water resources within the watershed.

Results

Survey questionnaire participants gave the highest weight to the *Protect/Improve Fish & Wildlife Habitat* component of the value model. The *Protect/Improve Waters of Concern* and *Reduce Erosion & Runoff* components were also highly ranked (Figure 1 and Table 2).

The Zonation model was run using the results from the questionnaire. The Zonation output map ranked lands as to their importance for land management activities that would provide greater protection of ecosystem functions, especially water quality, and to their importance for application of various land best management practices (Figures 2 and 3).

The final prioritization map created from Zonation and synthesis analysis is presented in Figure 4. The final priority map identified several focused priority areas. First, priority was given to the riparian lands associated with the Mississippi River corridor (lands within 300 feet of the river or the landward side of its floodplain as determined by DNR terrain analysis, whichever is greater). Second, priority was given to lands in the Lake Bemidji catchment and lands associated with the City of Bemidji's drinking water supply management areas. Third, priority was also given to lands associated with the EPA superfund site in the City of Cass Lake, and numerous stream riparian and floodplain areas.

References

Moilanen, A., H. Kujala, and J. Leathwick. 2009. The Zonation framework and software for conservation prioritization. Pages 196-210 in A. Moilanen, K. A. Wilson, and H. P. Possingham, editors. Spatial conservation prioritization: quantitative methods and computational tools. Oxford University Press, Oxford, UK.

Saaty, T.L., and K. Peniwati. 2007. Group decision-making: Drawing out and reconciling differences. Pittsburgh, PA: RWS Publications.

Table 1. Variable descriptions for content used in land prioritization value models.

Objective	Description
Protect or Improve **Water Quality**	Water quality refers to the chemical, physical, and biological characteristics of water. Water quality changes when human activities or pollutants upset the basic conditions of the system. Poor water quality can lead to multiple problems, including algal blooms, deposition of sediment in streams, and health problems in waterfowl and fish.
Reduce **Erosion & Runoff**	Erosion and runoff can be become more prevalent and severe due to human alteration of the land. When wetlands are removed, water runs off the land faster. Also, more water runs off land with impervious surfaces in urban areas and areas that have lost vegetation.
Protect or Improve **Fish & Wildlife Habitat**	Habitat provides food, shelter, and breeding territory for animals. The size, shape, and distance between habitat parcels are all important to sustaining populations of plants and animals.
Protect or Restore **Shoreland**	The use and development of lake shorelands, which are state designated land within 1000 feet of a lake, may have consequences on the economic and environmental values of a lakeshore. If the shoreland is naturally vegetated, it can serve as a buffer between land and water and filter out pollutants.
Protect or Improve **Waters of Concern**	Waters of concern include vulnerable groundwater or drinking water supplies, designated impaired lakes, catchments of lakes and rivers with high pollution loads, catchments of lakes with declining water quality, and catchments of lakes vulnerable to pollution (nutrient) addition.
Protect or Improve **Lands of Concern**	This objective includes the protection of valuable timber land, cultural valuable land, and lands near existing protected lands and high-growth areas. It also involves identification of project areas for best management practices on agricultural lands.

Objective	Description
Protect or Improve Waters of Concern	
Focus on Drinking Water Supply Management Area (DWSMA) vulnerability	The risk associated with potential contaminant sources within a public water supply DWSMA to contaminate its drinking water supply. This risk is based on the aquifer's inherent geologic sensitivity, the assessed vulnerability of the public water supply well(s), and the composition of the groundwater. In highly vulnerable DWSMAs, there is a strong causal relationship between land use

	activities on the surface and groundwater quality. Includes Special Well and Boring Construction Areas as designated by the Minnesota Department of Health (MDH).
Focus on Impaired waters	Catchments (i.e., drainage basins) upstream of aquatic life impaired lakes within the watershed. Identified as impaired by the Minnesota Pollution Control Agency.
Focus on Catchments with higher pollution	Estimated total suspended solids, total nitrogen, and total phosphorus by catchment as determined by hydrological models.
Focus on Catchments of lakes with declining water quality	Lakes where long-term data suggest declining water quality.
Focus on Groundwater contamination susceptibility	The relative susceptibility of an area to groundwater contamination (based on geologic stratigraphy, aquifer transmissivity, and recharge potential).
Focus on Catchments identified as at risk by MDNR-Fisheries	Catchments that have between 25 and 60 percent land cover disturbance and that are less than 75 percent protected (publicly owned or protected by conservation easement). Determined by Minnesota Department of Natural Resources (MDNR) – Section of Fisheries for water quality habitat purposes.
Focus on Catchments of lakes vulnerable to phosphorus addition	Catchments of lakes that are vulnerable to nutrient loading. Determined by MDNR using water mass balance hydrologic models.

Reduce Erosion & Runoff	
Reduce Soil erosion risk	Susceptibility of soils to erosion. This variable is from the BWSR and UMN's Environmental Benefits Index; it was calculated from a subset of the universal soil loss equation.
Focus on Areas with high erosive potential	Stream Power index: This is an index of the channelized flow erosive potential. Calculated from LiDAR data.
Focus on Areas close to water	Lands close to a stream and lake are more valuable in the protection of water quality than those farther away. The data are the inverse distance from water.
Protect Existing wetlands	Remaining wetlands as documented by the National Wetland Inventory (NWI).
Protect or Restore Stream riparian areas	Stream riparian areas and potential flood zones (based on location, elevation and soil type). [Exceptional stream reaches from PCA may also be included here or used as a separate feature]

Protect or Improve Fish & Wildlife Habitat	
Protect Sites of biodiversity significance	Areas with varying levels of native biodiversity that may contain high quality native plant communities, rare plants, rare animals, and/or animal aggregations. Identified by Minnesota Biological Survey.
Protect Ecological connections	Ecological corridors between generally large, intact, native or “semi-natural” terrestrial habitat patches.
Protect or Restore Lakes of biological significance	Catchments of high quality lakes. MDNR list of high quality lakes based on dedicated biological sampling.
Protect High-value forests	MDNR designated high conservation value forests due to plant and animals present and MDNR designed old-growth forests.
Protect or Restore Trout stream catchments	MDNR designated trout stream catchments.
Protect Rare features	Locations of species currently tracked by the MDNR, including Endangered, Threatened, and Special Concern plant and animal species as well as animal aggregation sites.

Protect or Improve Lands of Concern	
Implement BMPs on Pasture/hay lands	Land cover type is pasture or hay (areas used for livestock grazing or planted with perennial or hay crops).
Implement BMPs on Cultivated croplands	Land cover type is cultivated crops (areas used for the production of annual crops or actively tilled areas).
Protect Valuable timber lands	Forest lands that have been identified by forestry managers as important.
Protect Lands close to protected lands	Lands close to protected lands may be more important for conservation, as larger, contiguous areas often have more value than smaller, fragmented lands. The data are the inverse distance to existing protected lands.
Protect Cultural valuable lands	Cultural lands valuable to native peoples and other citizens of the watershed.
Protect Lands in high growth areas	Lands close to existing development may be more likely to be developed, and some of these lands that provide ecosystem services may be of conservation value.

Table 2. Broad-scale and fine-scale weights used in the value models from a questionnaire using the analytic hierarchy process (AHP; weights sum to 100).

Broad-Scale Prioritization	**AHP Derived Weight**	**Weights Used in Model**
Reduce Erosion & Runoff	21.4	
Protect/Improve Fish & Wildlife Habitat	23.9	
Protect/Restore Shoreland	17.9	
Protect/Improve Waters of Concern	21.8	
Protect/Improve Lands of Concern	15.0	
Fine-scale Prioritization		
Drink Water	13.8	3.0
Focus on impaired waters	10.0	2.2
Catchments with higher pollution	11.3	2.5
Catchments with declining water quality	15.1	3.3
Groundwater Contamination Susceptibility	19.4	4.2
Catchments identified by at risk by Fisheries	14.5	3.2
Focus on lake catchments vulnerable to phosphorus	15.9	3.5
Soil erosion risk	10.9	2.3
Areas with high erosive potential	18.3	3.9
Areas close to water	23.3	5.0
Existing wetlands	17.0	3.6
Stream riparian areas	30.4	6.5
Sites of biodiversity significance	15.8	3.8
Ecological connections	13.6	3.3
Lakes of Biological Significance	21.4	5.1
High value forests	17.4	4.2
Trout stream catchments	17.4	4.2
Rare features	14.3	3.4
BMPs on Pasture/hay lands	10.7	1.6
BMPs on Cultivated croplands	20.0	3.0
Valuable timber lands	17.8	2.7
Lands close to protected lands	11.9	1.8
Culturally valuable lands	13.4	2.0
Undeveloped lands in high growth areas	26.3	3.9

Figure 1. The broad-scale weights used in the value models from a questionnaire using the analytic hierarchy process (AHP; weights sum to 100).

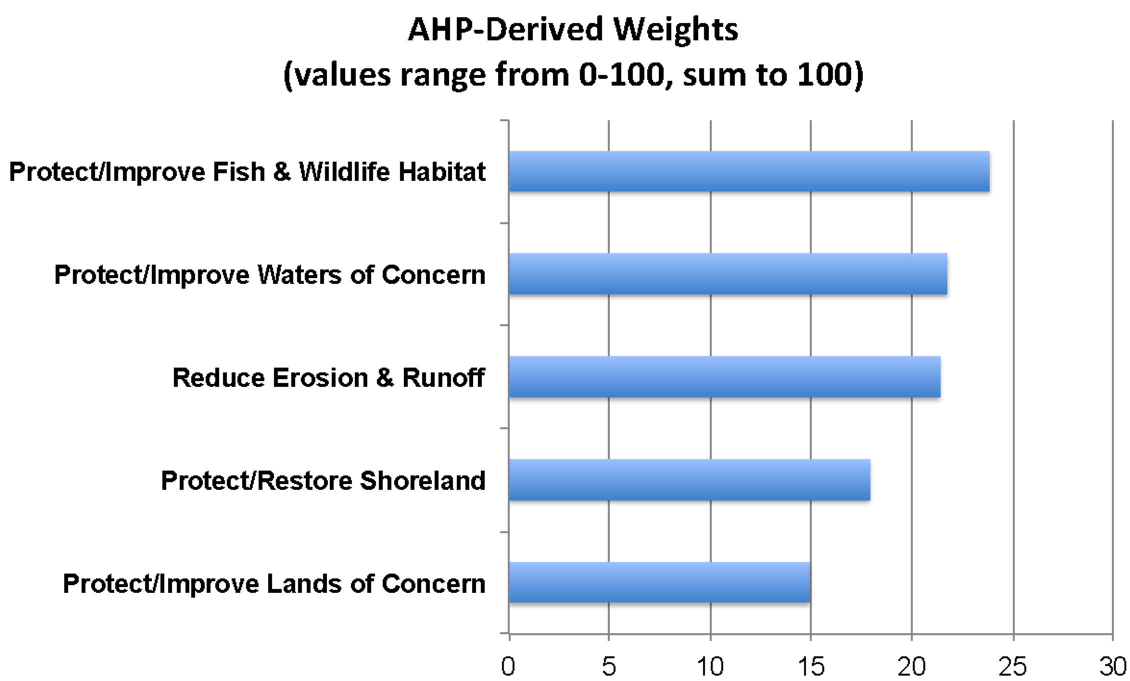


Figure 2. Conservation priority map from Zonation analysis.

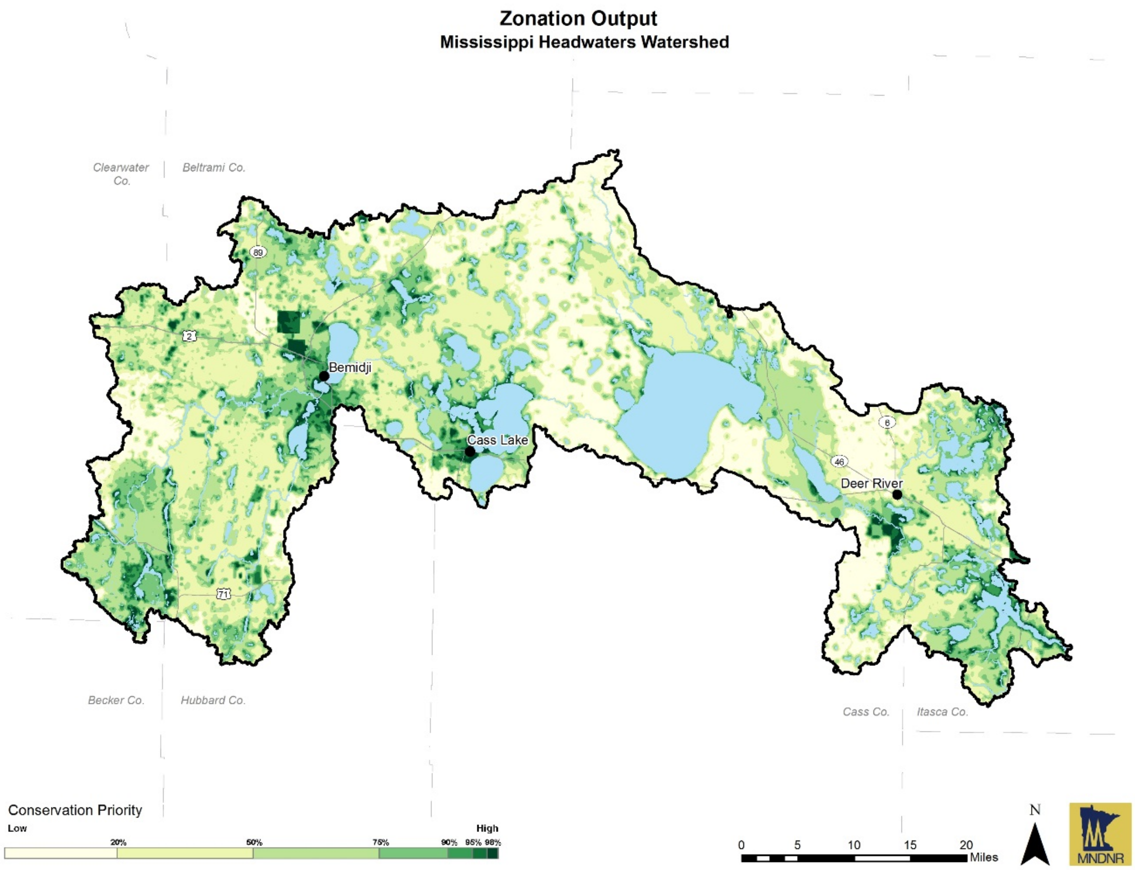


Figure 3. Priority map from Zonation and land use.

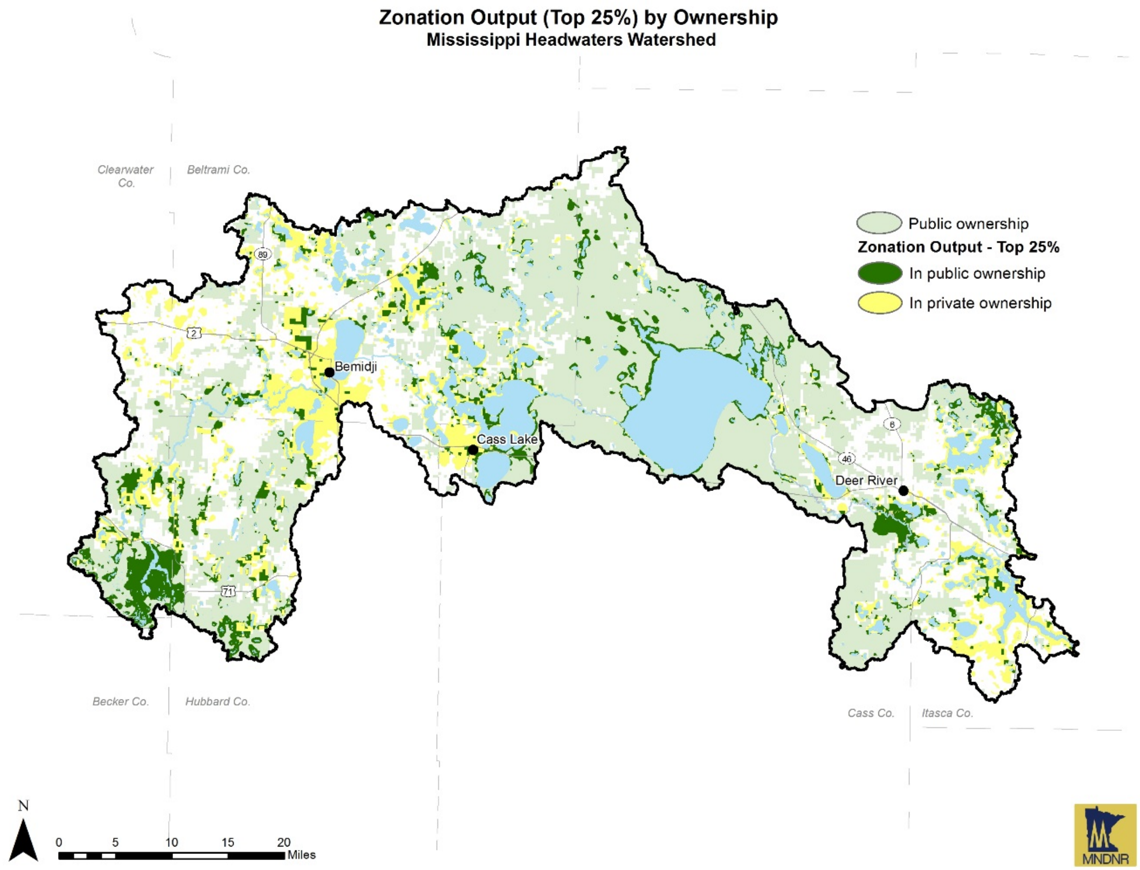
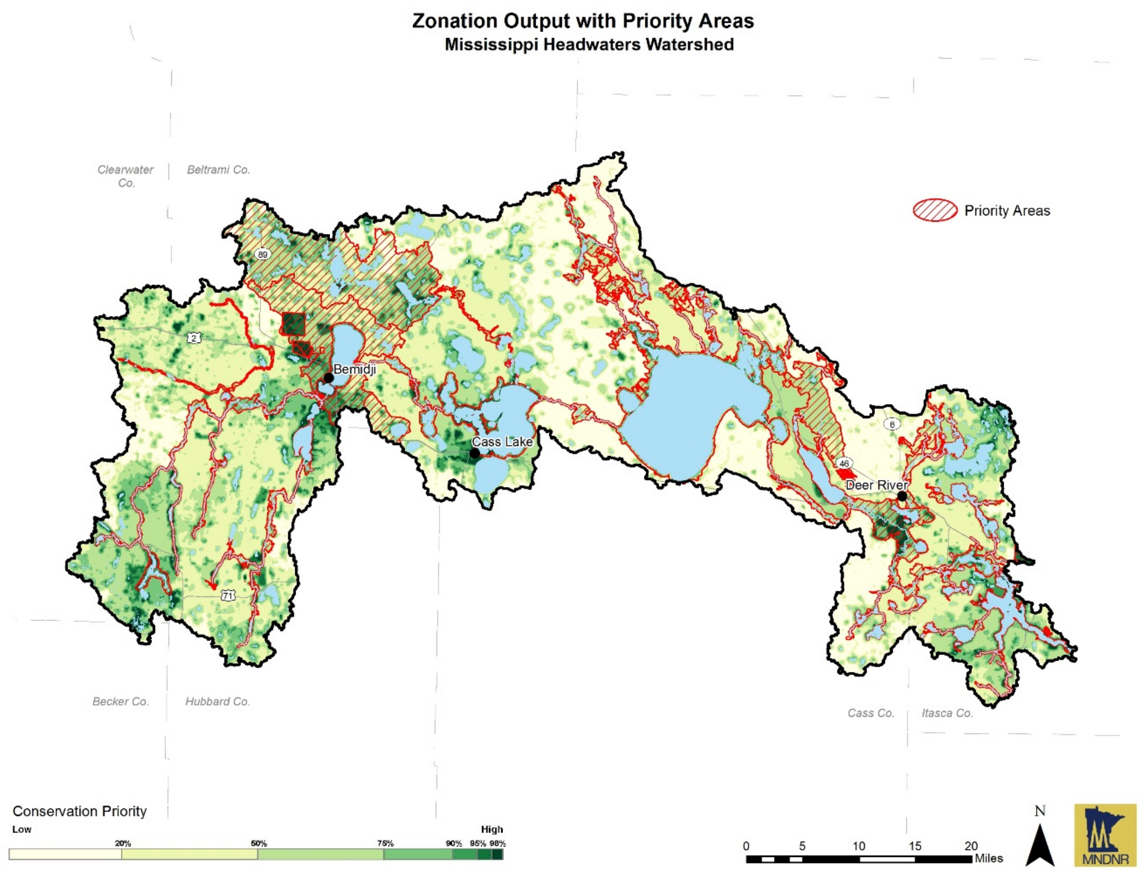


Figure 4. Conservation priority map from Zonation analysis and synthesis analysis.



Appendix D
TCN Modules

Multiple Benefits for People and Nature:

Mapping and Modeling Tools to Identify Priorities for the Nature Conservancy's Freshwater Program and the Minnesota Headwaters Fund

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The goal of the Conservancy's freshwater program is to conserve the lands that protect clean water, and to support high-impact conservation projects to protect clean water in Minnesota's lakes and rivers for the benefit of nature, people and the economy. As threats to continue to mount, it is becoming increasingly important to identify and conserve high-priority areas for habitat and clean water benefits. Identifying where in the landscape conservation can provide multiple, overlapping benefits can help more effectively target efforts and more efficiently utilize limited resources. Examples of protection and conservation approaches throughout the Upper Mississippi River basin include easements, stream bank and floodplain restoration, and other projects that prevent pollutants such as nitrates and sediment from entering key rivers and lakes.

This document and accompanying spreadsheet describes the methodology and criteria developed to make recommendations for investments to support clean water for people and nature. The purpose of this exercise was initially to support TNC in developing programmatic priorities for freshwater, and to set goals and targets for the Freshwater Business Plan. This includes recommendations for Protection, Restoration & Management, as well as investments in natural infrastructure for multiple ecosystem service benefits.

The intent of the process was to develop and score priorities **<u>according to specific but multiple cross-cutting needs, and looking for the "Sweet Spot"</u>** where multiple benefits overlap (habitat, water quality, water user benefit, flood benefit). We conducted priority area mapping based on criteria and key attributes for determining freshwater priorities.

Evaluation criteria should be dynamic, reflecting the evolution of better and more accurate tools, and may include

- Aquatic Protection priorities
- Terrestrial protection priorities
- Lands important to drinking water quality or other benefits to people
    - Close to a threshold
    - Vulnerable to conversion
    - Important or disproportionate impact on water quality

We also attempted to develop a map-based classification for STRATEGY (Protection vs Restoration). Ongoing needs include the need to better understand threats, thresholds, and how much conservation is enough at multiple watershed scales (small watersheds, large watersheds, and river basins); to identify management/habitat improvement opportunities on already public/protected land; which lands need to be acquired to reach those desired goals; measuring and documenting the effectiveness of habitat restoration and protection activities; and setting targets and goals for landscape scale conservation. Interpretation of output needs to consider appropriate SCALE (major Huc8 watershed, minor Huc12 watershed, project-based).

MULTIPLE BENEFITS MODULES FOR PRIORITIZING FRESHWATER CONSERVATION INVESTMENTS

We built on a systematic approach originally pursued by NCCR in 2014, working with MNDNR's Division of Ecological Resources team in Brainerd (Paul Radomski and Kristin Carlson), to develop a "blueprint" of conservation priorities across the Mississippi headwaters region. The approach uses a software tool called "Zonation", which allows stakeholders to aggregate multiple layers representing landscape features and conservation criteria, using an objective weighting function. The weighting is based on the relative value participants ascribe to each layer. The result is a map showing weighted priorities within the landscape for conservation, protection or restoration. This approach has been widely adopted at the major watershed (Huc-8) scale in the context of the MPCA's Watershed Restoration and Protection Strategy (WRAPS) planning process. In part because not all WRAPS in the Mississippi headwaters basin are on the same timeline, nor are they being done exactly the same way, the NCCR chose to conduct a prioritization model that would be consistent across the entire Mississippi headwaters.

The initial blueprint was reviewed, tweaked, and adopted by NCCR to help inform and coordinate support for partner priority projects across the Headwaters. However, at the time it was observed that the blueprint scored equally high large areas across , and that in some cases component layers may have contributed to scores that were counterintuitive to that which best professional judgement. Furthermore a number of new data layers became available only after the NCCR Zonation model was completed. In addition, partners were concerned that the final output layer showing all the combined outputs for protection, drinking water, and restoration was difficult to interpret. For example, priority scores for pollutant load reduction might effectively "cancel out" priority areas for habitat protection in the final weighting; therefore there was a desire to separate out the major model components to facilitate interpretation and development of appropriate strategies.
Finally, the NCCR geographic scope did not include the entire Mississippi headwaters, rather it extended only as far downstream as the Mississippi River – Platte River major watershed at Little Falls.

Based on all of these considerations, the Nature Conservancy took the initiative to develop a second iteration of this approach for the entire Mississippi headwaters that would incorporate newly available data layers, include the entire Mississippi headwaters, and be designed to be modular based on similar types of benefits.

Multiple Benefits v2.0 Methods and Data Layers

The tool is composed of 4 primary modules:

1. Fish and Wildlife
2. Drinking Water and Groundwater Quality
3. Flooding and Erosion
4. Groundwater Quantity

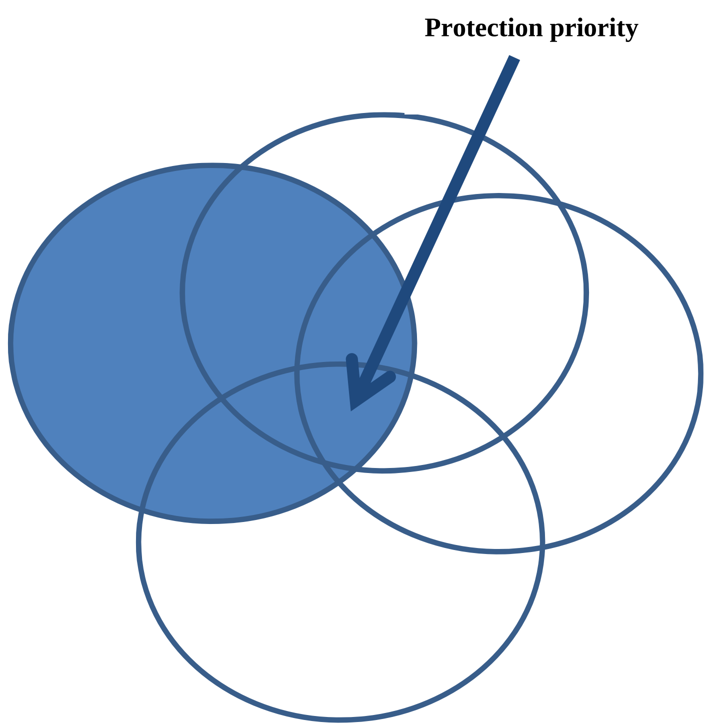
In addition, the Shoreland module is straightforward and can be viewed as an independent auxiliary layer where shoreland protection is identified as a priority for its own sake.

Fish & Wildlife Habitat Benefits
- Ecological patches and connections
- Protected lands
- Rare features
- Sites of biodiversity significance
- Sensitive lakeshore
- High quality wild rice lakes
- High quality cisco lakes
- High Conservation Value Forests
- Old Growth Forests

Drinking Water/Source Water Benefits
- Drinking water management supply area vulnerability
- Groundwater contamination susceptibility
- Proximity to water

Reduce Erosion, Enhance Storage, and Reduce Hydrologic Alteration
- Existing wetlands, riparian areas, and floodplains providing storage and retention benefits
- Areas vulnerable to erosion

Protect Groundwater Quantity – Protect recharge and managed withdrawals



Detailed Methods

Fish and Wildlife Module

The Fish and Wildlife module is intended to represent priority areas for ***protection*** based primarily on aquatic habitat protection value and secondarily on terrestrial fish and wildlife benefits. The module incorporates available data layers designed to represent parts of the basin where protection will have the highest benefits to fish and wildlife and their habitats. Much of the northern half of the Basin, including Itasca State Park, Leech and Cass Lake, the area around the Chippewa National Forest, northern Brainerd Lakes and Gull lake areas, Lake Alexander, Mille Lacs, and the Mississippi River corridor score highest on this module.

Components – Each of the component layers described below is re-scaled so that contributes equal weight in the final fish and wildlife module (3 of 30 points). For more information on how each individual layer is scored and weighted in the model, see the Appendix.

1. RWI Benefit to Species Value: This layer is a component of the Restorable Wetland Prioritization Tool developed by researchers at the University of Minnesota- Duluth Natural Resources Research Institute to prioritize wetland restoration and protection[1]. The *Species benefits* layer was developed using a subset of the individual habitat components from the Ecological Benefits Index (EBI) including sites of biodiversity significance, Species of greatest conservation need (SGCN) (number of species of greatest conservation need for which the land may provide suitable habitat); Potential bird habitat (probable number of birds from a modeled set of 17 that might use that habitat); and weighted habitat protection – the number of terrestrial vertebrate species potentially using this land weighted by the current level of habitat protection statewide for each species. The individual EBI inputs were combined using a weighting process to form a single species benefits decision layer designed to predict potential habitat enhancements that would result from wetland restoration or protection. This layer was included in the module as a statewide data layer representing overall habitat value weighted approximately equally for aquatic and terrestrial species and SGCN. *Caveats: this layer is more updated and less redundant with the layers below than the layer from the LCCMR Strategic Habitat Plan used by LSOHC. It should perhaps be replaced by the Wildlife Action Network from the 2015 MN Wildlife Action Plan Update.*

2. Biodiversity Significance Score: The Minnesota Biological Survey has assigned a biodiversity significance rank to surveyed sites across the state intended to reflect landscape context and ecological function, existing native plant community quality and rarity, and species quality and rarity. There are four biodiversity significance rankings: outstanding, high, moderate, and below. This layer is included in the freshwater Fish and Wildlife module to give greater weight in the final model to areas with moderate (1 pt), high (2 pts) and outstanding (3 pts) biodiversity.

3. Lakes of Biological Significance: This layer is based on the lake catchment for lakes designated as **Lakes of Biological Significance (LBS)[2]**. Lakes were identified and classified by DNR subject matter experts on objective criteria for four community types (aquatic plants, fish, amphibians, birds); or if the lake is included in the Conservancy's lake portfolio. Scored meeting standard (1 pt), higher (2 pts) and highest (3 pts).

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[1] http://www.mnwetlandrestore.org/project-description/subtopic-copy/subtopic-copy-2/

[2] https://gisdata.mn.gov/el/dataset/env-lakes-of-biological-signific

4. Index of Biological Integrity: This layer includes lake catchments with outstanding IBI scores based on the preliminary fisheries lake IBI[3]. The IBI *(Index of Biotic Integrity)* is a biologically-based, multi-metric method for measuring the integrity of aquatic systems. Minnesota DNR Fisheries Research has developed a fish-based lake IBI that incorporates fish data collected by various methods (trap nets, gill nets, shoreline seines, and backpack electrofishing units) into 8-15 metrics in three categories: species richness, community assemblage, and trophic composition. Lake catchments are scored based on the highest scoring lake meeting the IBI standard: meeting standard (1 pt) above standard (2 pts) and exceptional (3 pts), plus (+1 pt) if catchment contains a lake in the TNC lake portfolio.

5. Wild rice catchments: Wild rice is a unique resource in Minnesota, important culturally as well as to migrating waterfowl and other wildlife. Because wild rice is so important as well as sensitive to hydrologic and water quality disturbance, lake catchments identified as having significant wild rice were included as a layer in this module.

6. Coldwater refuge - cisco – This layer represents the level 8 DNR lake catchments for lakes identified by the Minnesota DNR to be the most resilient, likely refugia for ciscoes (tullibee, *Coregonus artedi*), a keystone species for Minnesota's deep, coldwater lake class. Because these lakes are likely to be the most resilient in the face of climate change, they are priorities for protection in the Minnesota DNR Aquatic Habitat Strategic Plan.

7. High Conservation Value Forests: The original NCCR model only included forests designated as "old-growth". We used FLEET results (ecological value) for northern headwaters. However, because FLEET does not extend beyond the Superior Mixed Forest ecoregion to include the entire Mississippi River headwaters basin, we rescaled the USFWS Upper Mississippi River Forest Partnership Priority Forest for Drinking Water to use those scores for the portion of the Basin not covered by FLEET. Caveat: This obviously results in a problem, since the methodology is not the same across the study area, especially significant when evaluating finer scale scores along the Superior Mixed Forest border. Future iterations of the tool could be revised to use a cumulative forest disturbance layer currently being developed by MN DNR (Corcoran 2015). For this version we made the choice to use the ecological value layer.

8. Ecological Patches or Connections: Statewide, riparian corridors constitute some of the most extensive and complete terrestrial habitat corridors for fish and wildlife, particularly in areas disturbed by urban or agricultural land use. We created a layer representing landscape habitat connectivity for both aquatic and terrestrial species based on perennial lands within the Active River Area (ARA) layer as derived for the Mississippi headwaters (2014).

9. Proximity (inverse distance) to protected lands This layer is scaled 0-100 based on inverse distance to protected lands, on the assumption that all else being equally, lands more closely connected to an existing network of protected lands are of relatively higher conservation value.

10. Proximity (inverse distance) to water. This layer is scaled 0-33 based on inverse distance to water features, on the assumption that the value of lands to fish and wildlife is in direct proportion to their distance from water.

[3] https://gisdata.mn.gov/el/dataset/env-ibi-lakes-fisheries

Drinking Water Quality Module

The Drinking Water module is intended to represent priority areas for protection ***and/or*** restoration, weighted on the relative potential impact on estimated actual users where they obtain their drinking water. This module may be used with or without the groundwater recharge module. Inclusion of the groundwater recharge module reduces the apparent resolution of the visual output from the module, because the latter is based on larger, coarser grid cell resolution of the Smith et al. (2015) analysis.

Caveats:

- Because of the limitations of the resolution and projection accuracy of the groundwater susceptibility component in particular, parcel scores evaluated on this module should not be over-interpreted in local project context.
- The methodology for assigning relative importance of ARA lands upstream in terms of influence on downstream surface water drinking intakes is approximate, and could be improved in collaboration with the drinking water utilities and others working to develop similar tools.

Module Components

1. Drinking Water Management Supply Area Vulnerability: This is a delineation of areas of concern for and relative risk for a potential contaminant source within the drinking water supply management are to contaminate a public water supply well based on the aquifer's inherent geological sensitivity; and the chemical and isotopic composition of the ground water. Source: MDH.

   Wellhead Protected Areas: WPA is the surface and subsurface area surrounding a public water supply well or well field that supplies a public water system, through which contaminants are likely to move toward and reach the well or well field. Source: MDH.

   The maximum score for these two layers is scored 1-5 (0 for non-DWSMA or WHPA areas). (They do not have 100% overlap).

2. Groundwater Contamination Susceptibility: A broad, generalized interpretation of ground water contamination susceptibility for the state, based on modeling relying on data inputs from the MLMIS40 (40-acre raster) soils and geology data, with additional geology inputs[4]. The parameters that control ground water susceptibility to contamination are quite varied and overlapping, and include: soil media, topography, depth to water, aquifer media, vadose zone materials, net recharge, hydraulic conductivity of aquifer, hydraulic gradient, distance to nearest drinking water supply, depth to bedrock, unsaturated zone permeability and thickness, and net precipitation. *Caveats: this layer does not display accurately into UTM15 NAD83 projection; it is offset by up to 300 m. Metadata reinforces that it is not appropriate for site-specific use.*

3. Proximity to mainstem river water supply (Mississippi River and Major Tributaries) Lands within the ARA upstream of surface water intakes for major drinking water supply areas are assigned zonal values based on downstream distance to the supply area.

4. Private well density – This layer summarizes the County Well Index (CWI) layer (Source: MDH[5]) by Huc12 watershed to summarize the number of private domestic water supply wells in each 12-digit

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[4] http://www.mngeo.state.mn.us/chouse/metadata/gwc.html

[5] http://www.health.state.mn.us/divs/eh/cwi/

watershed that are located in a vulnerable or highly vulnerable groundwater area, and is converted to 10 density classes by Huc12. The CWI layer is known to be dated and incomplete, but represents an accurate representation of the population density relying on private domestic groundwater wells.

Flooding and Erosion Module Components:

1. Benefits to Water (RWI)[6]: This water quality later predicts the potential water quality benefits in the form of reduced erosion risk from wetland restoration or protection. The layer utilizes the data inputs soil erosion risk and water quality risk from the Environmental Benefits Index along with the downstream flow distance to open water. The EBI is an ecological ranking tool (30 m grids) developed by Minnesota Board of Soil and Water Resources (MNBWSR) and NRRI.
    - The soil erosion layer estimates the potential risk of soil erosion on a 0-100 scale based on components of the Universal Soil Loss Equation (USLE) (rainfall runoff factor, slope length slope gradient, and soil erodibility factor) at a 30 m resolution. NRRI modified the layer to predict the potential flow accumulated soil erosion risk downstream to the nearest second order stream for each 30 m cell.
    - The water quality risk layer estimates each 30 m cell's risk to water quality based on the likelihood of overland flow during a rain event and its proximity to water. The likelihood of overland flow was estimated from stream power index (SPI). The downstream flow distance to water measures the closest downstream distance to water.

    The flow accumulated soil erosion risk, water quality risk and downstream flow distance to water were combined through a weighting process to form a single water quality/erosion benefits layer.

2. Sediment Retention Benefits: Mosaic of the following 3 layers, then averaged over a focal statistics rectangle 9 cells wide & tall.
    - Existing Perennial cover x Sediment Retention from Invest Model: InVest – Integrated Valuation of Ecosystem Services and Tradeoffs is an open-source software suite aimed at quantifying and mapping ecosystem services. The nutrient and sediment loading models are described elsewhere. The sediment results were generated January-February 2015 using InVEST 3_1_0b1 version of the sediment delivery and retention model. This layer represents the lands already in perennial land cover that had the highest scores for sediment retention.
    - Existing ARA x Sediment Retention from Invest Model : This layer represents the lands within the Active River Area that had the highest scores for sediment retention (see above).
    - Existing NWI x Sediment Retention from Invest model : This layer represents wetlands with the highest scores for sediment retention (see above).

3. Total upstream contributing area / wetland acres (storage) : Relative ecosystem service value of existing wetland storage. This layer represents the ratio of upstream watershed delivery area to existing wetlands, on the assumption that the greater the upstream contributing area, the greater the relative contribution to storage of any given area of wetland storage. Research suggests that the value of remaining wetland storage increases exponentially as percentage of wetlands decreases, and that there is a hydrologic threshold at around 10% wetlands.

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[6] http://www.mnwetlandrestore.org/project-description/subtopic-copy/subtopic-copy-2/

Groundwater Recharge Module Components

1. Groundwater Recharge (inches/year) (Smith et. al 2015) and Groundwater recharge (inches/year) (Lorenz and Delin 2007)

   The two layers are averaged together to yield a long term potential average recharge (in inches / year of rainfall that recharges groundwater and supports streamflow).

2. Water use vulnerability Index, Predicted Vulnerability -- DNR Watershed Health Assessment Framework Catchment Score
   http://www.dnr.state.mn.us/whaf/about/scores/hydrology/waterwithdraw.html

   The index is based on the sum of permitted withdrawal from surface water and groundwater. Using the State Water Use Database (SWUD), total potential consumption was calculated by summing permitted use and comparing to annual runoff. The "water use vulnerability index" is scaled as the greater the amount of water used as percent of runoff, the lower the score. The Catchment Predicted Vulnerability is the five year trend in reported use as a percentage of runoff.

Multiple Benefits Map

An overlay of the top quartile scoring areas for each of the Fish and Wildlife, Drinking Water, Flooding and Erosion, and Groundwater Quantity Modules. The value is the total number of modules for which the area scores in the top quartile.

Combined Quartile Scores

A combined overlay of the quartile scores for each of the Fish and Wildlife, Drinking Water, Flooding and Erosion, and Groundwater Quantity Modules, where each layer is scored 1-4 with 4 representing the highest quartile. The value is the total sum of quartile scores.

Interpreting and Using Mapped Results to Implement Conservation

Mapped scores are intended to reflect priority areas for protection and/or restoration based on multiple benefits. High scores for riparian lands, shorelands, and large floodplain areas, including the Mississippi River corridor from Grand Rapids to St. Cloud reflect the fact that these lands score on multiple modules. The lake-rich areas south of Walker and Aitkin and north of Brainerd and Grand Rapids also score high. This reflects the high priority of shorelands as well as the fact that shorelands often occur in areas of high groundwater contaminant susceptibility, and along the river corridors in proximity to important drinking water supply areas (e.g., Park Rapids, Grand Rapids, St. Cloud).

The model is intended as a tool to help the Conservancy and our partners set programmatic direction goals as well as identify opportunities and focus areas. It is designed to be used in conjunction with information on ***opportunities, threats,*** and ***costs***–none of which the model is designed to account for--to evaluate benefits and tradeoffs among potential conservation projects.

Already Protected Lands:

Protected.tif --All publicly or privately owned lands managed for natural resource values, plus privately owned wetlands nominally (effectively?) protected under the Minnesota Wetland Conservation Act.

Pubownease.tif—Publicly owned lands as well as privately owned lands with natural resource easements

Prioritizing Protection.

Protect.tif ➔ This layer shows the final multiple benefits scores for the complete module *for lands already in perennial cover only*, with already protected lands and waters "zeroed" out. It represents the relative multiple benefits scores for all lands that are privately owned and therefore not protected.

Protect_grass.tif ➔ This layer shows the final multiple benefits scores for the complete module *for lands identified as in grass/pasture*, with already protected lands and waters "zeroed" out. It represents the relative multiple benefits scores for all lands that are privately owned and therefore not protected.

Protect_wetlands.tif ➔ This layer shows the final multiple benefits scores for the complete module *for lands identified in the National Wetlands Inventory/Minnesota Wetlands* layer as protected wetlands. Despite the fact that wetlands are protected by law, recent analysis suggests Minnesota continues to lose wetlands to agriculture and development (Lark et al. 2015).

Prioritizing Restoration

Restore.tif ➔ This layer shows the final multiple benefits scores for the complete module *for lands identified in agriculture* . It represents areas with multiple benefits for lands that are in row crop agriculture.

These could be interpreted as priority areas where BMPs targeted to the appropriate existing land use are likely to have disproportionate benefits to water. However, planning specific projects, strategies, and answering the question of “how much is enough?” should be done with additional resources.

Restore_wetlands.tif ➔ This layer shows the final multiple benefits scores for the complete module *for lands identified as Restorable Wetlands* using the NRRI Restorable Wetlands Prioritization Tool (http://www.mnwetlandrestore.org/media/cms_page_media/53/rwi_meta.htm). It represents areas with multiple benefits for lands that are in row crop agriculture, overlaid with the multiple benefits quartile score.

Emerging and Companion Tools

-Threat Assessments
- Minnesota DNR Watershed Health Assessment Framework (WHAF)
- HSPF model nutrient loading and flow results
- Scenario Application Manager

Appendix E
Lakes Prioritization

Appendix E
Lake Prioritization

Lake Name	Acres	Lake ID	Water Clarity Trend	Tullibee (Cisco) Lake	Cisco Refuge Lake	Trout Lake	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Drinking Water Protection	Site-Specific Projects Identified	Cass County Large Lakes Summary	Lake Phosphorus Sensitivity Analysis	Sensitivity Lakeshore Identification	MHB County Priority Lakes	Near the Water Quality Threshold	Comprehensive Score
Marquette	553.235	04-1420-00	Decreasing	Yes			Yes	Outstanding	Yes				Highest			Yes	14
Bass	2874.586	31-0576-00	Improving	Yes			Yes	Outstanding	Yes				Higher	Yes		Yes	12
Bootleg	385.068	04-2110-00		Yes			Yes	Outstanding	Yes				Higher		Yes	Yes	12
Cass	16398.984	04-0300-00	Decreasing	Yes			Yes	Outstanding				Vigilance	Highest				11
Loon	233.06	31-0571-00	No Trend	Yes	Yes			Outstanding	Yes				Highest				11
Chase	219.799	31-0749-00		Yes	Yes			Outstanding	Yes				Highest				11
Grant	211.247	04-2170-00		Yes	Yes			Outstanding	Yes				Highest				11
Turtle River	1867.607	04-1110-00	No Trend	Yes			Yes	Outstanding	Yes				Higher			Yes	11
Bemidji	6600.814	04-1300-02	No Trend	Yes				Outstanding	Yes				Higher		Yes	Yes	11
Itasca	1153.978	15-0016-00	No Trend	Yes			Yes	Outstanding	Yes				Higher			Yes	11
Siseebakwet	1222.918	31-0554-00	Improving	Yes	Yes			Outstanding	Yes				Higher				10
Swenson	422.571	04-0850-00	No Trend	Yes	Yes			Outstanding					Highest				10
Spearhead	193.484	29-0239-00	No Trend	Yes	Yes			Outstanding	Yes				Higher				10
Little Bass	161.485	31-0575-00		Yes	Yes			High	Yes				Highest				10
Beltrami	733.365	04-1350-00	Decreasing	Yes				Outstanding	Yes				Highest				10
Plantagenet	2580.872	29-0156-00	No Trend	Yes			Yes	Outstanding	Yes				High			Yes	10
White Oak	1959.506	31-0776-00					Yes	Outstanding	Yes				High		Yes	Yes	10
Wolf	1101.069	04-0790-00	Improving	Yes				Outstanding	Yes				High		Yes	Yes	10
Deer	4174.979	31-0719-00	Improving	Yes				Outstanding	Yes		Yes		Highest				9
Winnibigoshish	60483.267	11-0147-00	No Trend	Yes			Yes	Outstanding	Yes			Vigilance	Higher				9
Rice	952.308	31-0717-00	No Trend	Yes			Yes	Outstanding	Yes				Highest				9
George	829.676	29-0216-00	No Trend	Yes			Yes	Outstanding	Yes				Highest				9
LaSalle	239.874	29-0309-00		Yes	Yes			Outstanding	Yes				High				9
Grass	289.452	04-2160-00					Yes	Moderate	Yes				Highest			Yes	9
Pike Bay	4899.159	11-0415-00		Yes				Outstanding				Vigilance	Highest				8
Big	3893.441	04-0490-00	No Trend	Yes			Yes	Outstanding					Highest				8
Pokegama	7022.034	31-0532-00					Yes	Outstanding			Yes		Highest				8
Blackwater	906.273	31-0561-00		Yes			Yes	Outstanding	Yes						Yes		7
Turtle	1665.929	04-1590-00	No Trend	Yes				Outstanding	Yes				Higher				7
Moose	1289.983	31-0722-00	No Trend	Yes				Outstanding	Yes				Higher				7
Three Island	852.228	04-1340-00	No Trend	Yes			Yes	Outstanding	Yes				High				7
Rabideau	732.178	04-0340-00		Yes			Yes	Outstanding					Higher				7
Long	458.616	04-0760-00	Improving					Outstanding	Yes				Highest				7
Elk	323.925	15-0010-00	No Trend	Yes			Yes	Outstanding	Yes				High				7
Little Moose	312.809	31-0610-00	No Trend	Yes			Yes	Outstanding	Yes				High				7
Johnson	493.479	31-0586-00	Decreasing					Moderate	Yes				Highest				7

Lake Name	Acres	Lake ID	Water Clarity Trend	Tullibee (Cisco) Lake	Cisco Refuge Lake	Trout Lake	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Drinking Water Protection	Site-Specific Projects Identified	Cass County Large Lakes Summary	Lake Phosphorus Sensitivity Analysis	Sensitivity Lakeshore Identification	MHB County Priority Lakes	Near the Water Quality Threshold	Comprehensive Score
Irving	695.703	04-1400-00	No Trend	Yes			Yes	Outstanding	Yes								6
Carr	52.679	04-1410-00		Yes			Yes	Outstanding	Yes								6
Campbell	540.666	04-1960-00	Improving	Yes			Yes	Moderate	Yes				Higher				6
Kitchi	2074.921	04-0070-00		Yes			Yes	Outstanding					High				6
Pimushe	1336.85	04-0320-00	No Trend	Yes			Yes	Outstanding					High				6
Big Rice	1224.865	04-0310-00		Yes			Yes	Outstanding					High				6
Little Cut Foot Sioux	759.986	31-0852-00		Yes			Yes	Outstanding	Yes								6
Moose	717.166	04-0110-00					Yes	Outstanding					Higher				6
Sugar	709.656	11-0026-00						Outstanding	Yes			Vigilance	High				6
Dixon	676.033	31-0921-00	No Trend	Yes			Yes	Outstanding	Yes								6
Little Wolf	546.088	11-0505-00							Yes			Protection	Highest				6
Buck	384.951	04-0420-00		Yes				Outstanding					Higher				6
Leighton	326.809	31-0739-00		Yes			Yes	Moderate	Yes				Higher				6
Rice Pond	252.962	04-0590-00					Yes	Outstanding					Higher				6
Heart	229.475	15-0058-00						Outstanding	Yes				Higher				6
Little Rice	149.252	04-0150-00		Yes			Yes	Outstanding					High				6
Ball Club	4657.671	31-0812-00		Yes				Moderate	Yes				Higher				5
Gull	2327.537	04-1200-00	No Trend					Moderate	Yes				Highest				5
Andrusia	1672.947	04-0380-00	Improving	Yes				Outstanding					High				5
Movil	865.731	04-1520-00	Improving	Yes				Moderate	Yes				Higher				5
First River	612.183	31-0818-00					Yes	Outstanding	Yes								5
Pigeon Dam	522.831	31-0894-00					Yes	Outstanding					High				5
Manomin	354.77	04-2860-00						Outstanding	Yes				High				5
North Twin	330.738	04-0630-00	Improving					Outstanding					Higher				5
Dutchman	184.152	04-0670-00					Yes		Yes				Highest				5
Alice	157.128	29-0286-00					Yes	Outstanding	Yes								5
Little Rice	154.139	31-0716-00		Yes			Yes		Yes				Higher				5
Sucker	79.48	15-0020-00					Yes	Outstanding	Yes								5
Erickson	52.567	04-0680-01					Yes	Outstanding	Yes								5
Little Turtle	497.471	04-1550-00	Decreasing	Yes			Yes		Yes								5
Jay Gould	560.555	31-0565-00	No Trend	Yes					Yes				High		Yes		4
Long	699.791	04-2270-00	No Trend						Yes				Highest				4
Deer	310.865	04-2300-00	No Trend	Yes					Yes				Higher				4
Grace	870.801	29-0071-00	No Trend						Yes				Highest				4
Rabbits	615.908	31-0923-00					Yes	Outstanding									4

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Midge	569.605	29-0066-00	Improving						Yes				Highest				4
Vermillion	439.742	11-0029-00	No Trend						Yes			Protection	High				4
Hennepin	430.209	29-0246-00							Yes				Highest				4
Little Bass	383.65	04-1100-00	No Trend						Yes				Highest				4
Decker	361.24	31-0934-00	No Trend				Yes	Outstanding									4
Island	313.026	31-0754-00					Yes		Yes				Higher				4
Raven	291.057	31-0925-00					Yes	Outstanding									4
Stevens	252.049	31-0718-00					Yes		Yes				Higher				4
Paine	251.994	29-0217-00					Yes		Yes				Higher				4
Burns	250.282	04-0010-00					Yes	Outstanding									4
Pool	221.912	04-1150-00							Yes				Highest				4
Fern	196.679	04-2150-00							Yes				Highest				4
Little Vermillion	164.116	11-0030-00		Yes			Yes		Yes				High				4
Long	159.693	15-0057-00	No Trend						Yes				Highest				4
Long	139.3	31-0570-00							Yes				Highest				4
Cottonwood	133.168	31-0594-00						High	Yes				High				4
Erickson	64.233	04-0680-02						Outstanding	Yes								4
Allen	36.507	15-0174-00						Outstanding	Yes								4
Little Jay Gould	160.596	31-0566-00		Yes					Yes				High				3
Guile	91.328	31-0569-00	No Trend						Yes				High		Yes		3
Little Drum	85.497	31-0741-00					Yes		Yes						Yes		3
Little Winnibigoshish	1506.5	31-0850-00		Yes					Yes				High				3
Little White Oak	1326.404	31-0740-00					Yes	Moderate	Yes								3
Hattie	431.99	29-0300-00		Yes			Yes		Yes								3
Egg	405.639	31-0817-00					Yes	Moderate	Yes								3
Big Bass	336.986	04-1320-02	No Trend						Yes				Higher				3
Black	282.7	04-1570-00	No Trend	Yes					Yes				High				3
Gilstad	260.862	04-0240-00		Yes									Higher				3
Big LaSalle	240.086	15-0001-00	No Trend	Yes					Yes				High				3
Frontenac	220.642	29-0241-00		Yes					Yes				High				3
Fawn	216.661	31-0609-00		Yes					Yes				High				3
Little Ball Club	190.871	31-0822-00					Yes		Yes				High				3
Schoolcraft	188.025	29-0215-00					Yes		Yes				High				3
Drewery	186.507	04-0360-00											Highest				3

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Fox	184.077	04-1620-00	No Trend	Yes					Yes				High				3
Gull	182.286	04-0640-00					Yes		Yes				High				3
McAvity	152.505	31-0585-00	No Trend						Yes				Higher				3
Munzer	139.503	31-0360-00					Yes		Yes				High				3
Silver	137.448	04-0390-00											Highest				3
Mallard	108.87	15-0018-00					Yes		Yes				High				3
South Sugar	91.505	31-0555-00	No Trend	Yes					Yes				High				3
Little Deer	67.731	31-0751-00						Moderate	Yes				High				3
Bay	57.329	31-0723-00						High	Yes								3
Newman	46.074	29-0237-00		Yes		Yes			Yes								3
Benjamin	35.745	04-0330-00				Yes		Moderate					High				3
Whipple	26.019	15-0014-00						High	Yes								3
Deer Park	23.744	15-0011-00						High	Yes								3
Lucky	16.272	31-0603-00				Yes			Yes				High				3
Stump	511.407	04-1300-01	Improving						Yes				High		Yes		3
Tamarack	15.919	15-0056-00					Yes		Yes						Yes		3
Forsythe	156.062	31-0560-00							Yes				High				2
Unnamed	47.345	04-1500-00							Yes						Yes		2
Warburg	42.781	31-0563-00							Yes						Yes		2
Lost	38.345	31-0567-00							Yes						Yes		2
Unnamed	35.718	04-1490-00							Yes						Yes		2
Cut-Off	27.928	31-0568-00							Yes						Yes		2
Unnamed	14.597	04-4010-00							Yes						Yes		2
Bowstring	10774.746	31-0813-00		Yes					Yes								2
Sugar	1588.398	31-0926-00						Moderate					High				2
Morph	1568.278	31-0929-00					Yes	Moderate									2
Gill	363.611	15-0019-00					Yes		Yes								2
Little Siseebakwet	341.539	31-0733-00							Yes				High				2
Pughole	255.586	31-0602-00							Yes				High				2
Amen	236.076	31-0597-00	No Trend						Yes				High				2
South Twin	225.739	04-0530-00	No Trend										Higher				2
Evergreen	220.619	29-0227-00							Yes				High				2
Skunk	208.435	11-0027-00					Yes		Yes								2
Ten	190.819	04-0410-00											Higher				2
Ozawindib	181.295	15-0005-00							Yes				High				2

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Biauswah	174.451	31-0862-00						High									2
Moose	158.379	04-3420-00	No Trend				Yes		Yes								2
Schram	147.498	04-0050-00											Higher				2
Lost	132.881	04-0430-00											Higher				2
Long	130.047	11-0023-00							Yes				High				2
Orange	118.05	31-0587-00							Yes				High				2
Meadow	115.545	04-0500-00							Yes				High				2
Spring	110.229	11-0022-00					Yes		Yes								2
Mud	109.159	31-0750-00					Yes		Yes								2
Damon	88.14	31-0944-00					Yes						High				2
Lindgren	83.807	04-1530-00							Yes				High				2
Sioux	77.808	31-0907-00					Yes		Yes								2
Daniel	70.797	15-0022-00							Yes				High				2
Beaver	68.143	31-0590-00							Yes				High				2
Loon	66.56	31-0579-00		Yes					Yes								2
Lawrence	65.242	31-0604-00							Yes				High				2
Hill	61.921	31-0600-00							Yes				High				2
Beauty	57.34	29-0292-00	No Trend						Yes				High				2
Tuttle	56.409	31-0821-00					Yes		Yes								2
Tioga Mine Pit	50.854	31-0946-00				Yes			Yes								2
Pine	46.013	29-0197-00						Moderate	Yes								2
Smith	45.982	31-0547-00	No Trend						Yes				High				2
Blacksmith	42.12	29-0275-00				Yes			Yes								2
Little Horn	41.565	31-0588-00							Yes				High				2
Clarke	35.086	31-0578-00							Yes				High				2
Bohall	29.317	15-0009-00						Moderate	Yes								2
Lilypad	26.319	29-0240-00						Moderate	Yes								2
Unnamed	21.931	31-0815-00					Yes		Yes								2
Duncan	21.724	15-0024-00					Yes		Yes								2
Little Elk	21.52	15-0015-00						Moderate	Yes								2
Berg	15.619	15-0025-00					Yes		Yes								2
Unnamed	12.204	15-0211-00						Moderate	Yes								2
Unnamed	207.363	11-0928-00							Yes						Yes		2
Unnamed	131.74	31-1088-00							Yes						Yes		2
Robinson	97.341	15-0017-00							Yes						Yes		2
Mud	93.322	29-0065-00							Yes						Yes		2

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Bowman	74.138	29-0068-00							Yes						Yes		2
Unnamed	73.662	04-1060-00							Yes						Yes		2
Ose	67.66	04-0890-00							Yes						Yes		2
Unnamed	66.469	04-1080-00							Yes						Yes		2
Unnamed	61.652	15-0180-00							Yes						Yes		2
Unnamed	58.346	15-0026-00							Yes						Yes		2
Unnamed	50.197	15-0185-00							Yes						Yes		2
School	45.979	04-0870-00							Yes						Yes		2
Unnamed	45.312	04-1310-00							Yes						Yes		2
Unnamed	41.276	04-5330-00							Yes						Yes		2
Unnamed	33.521	04-0910-00							Yes						Yes		2
Unnamed	33.37	15-0339-00							Yes						Yes		2
Unnamed	33.158	15-0436-00							Yes						Yes		2
Unnamed	30.112	11-0927-00							Yes						Yes		2
Unnamed	28.975	04-2100-00							Yes						Yes		2
Unnamed	28.959	15-0184-00							Yes						Yes		2
Unnamed	26.925	04-0900-00							Yes						Yes		2
Unnamed	21.999	31-1226-00							Yes						Yes		2
Unnamed	18.642	15-0189-00							Yes						Yes		2
Unnamed	17.859	04-0880-00							Yes						Yes		2
Unnamed	15.296	04-1090-00							Yes						Yes		2
Unnamed	13.292	04-1070-00							Yes						Yes		2
Unnamed	12.438	15-0181-00							Yes						Yes		2
Unnamed	10.889	04-4560-00							Yes						Yes		2
Unnamed	10.342	04-0840-00							Yes						Yes		2
Unnamed	10.326	31-1197-00							Yes						Yes		2
Unnamed	7.7	04-4550-00							Yes						Yes		2
Unnamed	33.504	04-1460-00							Yes								1
Unnamed	109.681	04-4450-01							Yes								1
Alice	91.088	04-1510-00							Yes								1
Stone	59.937	04-2140-00							Yes								1
Unnamed	52.954	04-4380-00							Yes								1
Unnamed	46.166	04-3560-00							Yes								1
Unnamed	43.59	04-4390-00							Yes								1
Unnamed	42.693	04-4410-00							Yes								1
Unnamed	38.768	04-4450-02							Yes								1

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Miller	38.727	04-2130-00							Yes								1
Unnamed	35.183	04-2050-00							Yes								1
Unnamed	28.982	04-2090-00							Yes								1
Unnamed	26.861	04-2060-00							Yes								1
Steinbrook	25.344	04-2120-00							Yes								1
Miss	24.493	04-2080-00							Yes								1
Unnamed	20.784	04-5380-00							Yes								1
Unnamed	20.479	04-4370-00							Yes								1
Unnamed	18.978	04-4360-00							Yes								1
Unnamed	13.629	04-5250-00							Yes								1
Unnamed	12.359	04-1450-00							Yes								1
Unnamed	12.308	04-2070-00							Yes								1
Unnamed	12.071	04-5290-00							Yes								1
Peterson	299.41	04-2350-00							Yes								1
Unnamed	132.27	04-4340-00							Yes								1
Stray Horse	65.672	04-2460-00							Yes								1
Erick	64.059	04-2290-00							Yes								1
Fawn	61.744	04-2480-00							Yes								1
Unnamed	32.251	04-2320-00							Yes								1
Unnamed	10.966	04-1440-00							Yes								1
Cut Foot Sioux(Main Bay)	2569.861	31-0857-01	No Trend						Yes								1
Pokegama	1199.339	31-0532-02	No Trend						Yes								1
Cut Foot Sioux(East Bay)	586.56	31-0857-02							Yes								1
George	394.352	29-0321-00							Yes								1
Lower Pigeon	319.419	31-0893-00					Yes										1
Diamond	274.428	29-0307-00							Yes								1
Larson	258.657	04-1540-00							Yes								1
Moss	210.086	11-0485-00											High				1
Meadow	208.419	04-2190-00							Yes								1
Middle Pigeon	205.102	31-0892-00					Yes										1
Windigo	199.698	04-0480-00											High				1
Hernando DeSoto	199.509	30-0320-00							Yes								1
Deer	193.005	31-0857-03							Yes								1

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School	185.856	04-1140-00							Yes								1
Flora	178.143	04-0510-00											High				1
Unnamed	165.403	29-0497-00							Yes								1
Unnamed	140.226	31-0357-00							Yes								1
Hale	133.19	31-0361-00							Yes								1
Unnamed	129.813	29-0540-00							Yes								1
Upper Pigeon	116.085	31-0908-00					Yes										1
Rice	113.301	31-0942-00					Yes										1
Lost	112.683	29-0303-00							Yes								1
Pony	111.645	04-2370-00							Yes								1
Little Cottonwood	110.048	31-0595-00							Yes								1
Unnamed	108.84	31-1087-00							Yes								1
Muskrat	106.063	04-2400-00							Yes								1
Unnamed	105.354	29-0541-00							Yes								1
Unnamed	101.644	31-0577-00							Yes								1
Reed	97.634	29-0308-00							Yes								1
Twin	96.754	15-0008-00							Yes								1
Hanson	93.593	04-0660-00							Yes								1
Twenty	93.448	29-0231-00							Yes								1
Anderson	93.159	04-0190-00											High				1
Wolf	91.89	04-2340-00							Yes								1
Dry Creek	91.191	31-0869-00							Yes								1
Cranberry	88.594	31-0591-00							Yes								1
Morrison	86.377	30-0490-00							Yes								1
Amik	80.762	31-0865-00							Yes								1
Unnamed	79.841	29-0535-00							Yes								1
Unnamed	79.327	31-0715-00							Yes								1
Hubbard	78.411	29-0233-00							Yes								1
Peterson	77.571	04-1190-00							Yes								1
Hansen	77.42	31-0721-00							Yes								1
Minnie	76.78	29-0234-00							Yes								1
Crane	75.955	31-0606-00							Yes								1
Goodwin	75.496	31-0855-00							Yes								1
Sugar Bush	73.76	15-0066-00							Yes								1
Spider	71.944	29-0291-00							Yes								1

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Skelly	70.314	31-0736-00							Yes								1
Poverty	68.908	31-0720-00							Yes								1
Lydick	68.84	11-0314-00											High				1
Little Leighton	68.404	31-0747-00							Yes								1
Marie	67.655	31-0937-00					Yes										1
Farley	67.079	31-0902-00					Yes										1
Unnamed	65.336	04-4020-00							Yes								1
Beauty	64.626	29-0301-00							Yes								1
Miller	63.006	31-0748-00							Yes								1
Harley	62.843	04-2240-00							Yes								1
Little Midge	62.267	29-0067-00							Yes								1
Unnamed	62.053	30-0340-00							Yes								1
Birch	61.051	29-0199-00							Yes								1
Van Patter	59.322	31-0745-00							Yes								1
Dirty Nose	59.281	11-0040-00							Yes								1
Otter	59.202	31-0608-00							Yes								1
Mary	59.18	29-0289-00							Yes								1
Cavanaugh	58.012	31-0572-01							Yes								1
Unnamed	56.94	15-0190-00							Yes								1
Holland	56.934	04-0230-00					Yes										1
Unnamed	56.7	04-1120-00							Yes								1
Unnamed	55.965	04-3500-00							Yes								1
Nelson	55.545	04-0570-00							Yes								1
Upper Lindgren	54.809	04-1790-00							Yes								1
Sawyer	54.452	29-0202-00							Yes								1
Unnamed	54.196	29-0269-00							Yes								1
Big Green	52.742	31-0593-00							Yes								1
Clarke	52.297	15-0012-00							Yes								1
Big Bass (west basin)	52.238	04-1320-01							Yes								1
Unnamed	51.757	29-0546-00							Yes								1
Unnamed	51.373	04-4630-00							Yes								1
Round	50.263	04-2280-00							Yes								1
Mosomo	49.604	31-0861-00					Yes										1
Long	48.951	31-0605-00							Yes								1
Unnamed	48.722	15-0183-00							Yes								1

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Skimerhorn	48.7	31-0939-00					Yes										1
Unnamed	48.597	11-0950-00							Yes								1
Unnamed	48.576	29-0491-00							Yes								1
Unnamed	48.476	04-2040-00							Yes								1
Pickerel	48.248	31-0752-00							Yes								1
Unnamed	48.172	04-1000-00							Yes								1
Sunken	47.575	31-0866-00							Yes								1
Unnamed	47.552	04-1170-00							Yes								1
Alp	47.498	31-0761-00							Yes								1
Hirts	46.425	29-0235-00							Yes								1
Horseman	45.751	04-1640-00							Yes								1
Unnamed	45.338	04-0940-00							Yes								1
Roadside	45.172	04-0750-00							Yes								1
Unnamed	44.473	04-2390-00							Yes								1
Spring	44.148	31-0735-00							Yes								1
Unnamed	44.119	04-2030-00							Yes								1
Unnamed	44.029	11-0902-00							Yes								1
Unnamed	43.99	04-2880-00							Yes								1
Johnson	43.632	11-0028-00							Yes								1
Dalton	43.585	31-0592-00							Yes								1
Unnamed	43.571	31-0582-00							Yes								1
Unnamed	43.038	29-0564-00							Yes								1
Button	42.913	04-0980-00							Yes								1
Unnamed	42.883	11-0949-00							Yes								1
Bond	42.552	29-0304-00							Yes								1
Unnamed	42.495	29-0562-00							Yes								1
Unnamed	42.491	04-2230-00							Yes								1
Buck	42.337	04-0970-00	No Trend						Yes								1
Des Moines	42.195	04-1610-00							Yes								1
Unnamed	41.929	04-1630-00							Yes								1
Unnamed	41.848	04-0780-00							Yes								1
Unnamed	41.685	29-0533-00							Yes								1
Unnamed	41.556	29-0302-00							Yes								1
Unnamed	41.492	04-1580-00							Yes								1
Unnamed	41.385	04-5470-00							Yes								1
Bogus	41.227	15-0004-00							Yes								1

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Unnamed	40.337	29-0230-00							Yes								1
Unnamed	39.937	04-4520-00							Yes								1
Little Gnat	39.821	04-1330-00							Yes								1
Carpenter	39.25	31-0641-00							Yes								1
Big Horn	38.862	31-0598-00							Yes								1
Unnamed	38.853	04-0990-00							Yes								1
Mallard	38.638	31-0583-00							Yes								1
Unnamed	38.59	04-5310-00							Yes								1
Twin	38.208	29-0293-00							Yes								1
Lost	37.884	31-0900-00					Yes										1
Camp Five	37.037	31-1091-00							Yes								1
Unnamed	36.169	04-5530-00							Yes								1
Ragged	36.094	04-2310-00							Yes								1
Unnamed	35.598	11-0033-00							Yes								1
Unnamed	35.318	04-2180-00							Yes								1
Unnamed	35.178	04-4460-00							Yes								1
Simpson	35.06	31-0867-00					Yes										1
Brisbane	34.695	29-0288-00							Yes								1
Mikenna	33.989	31-1150-00							Yes								1
Unnamed	33.913	04-4030-00							Yes								1
Gallagher (Rhoda)	33.492	04-0920-00							Yes								1
Unnamed	33.302	31-0553-00							Yes								1
Tamarack	33.261	15-0168-00							Yes								1
Emma	33.043	29-0245-00							Yes								1
Little Cavanaugh	32.938	31-0572-02							Yes								1
Unnamed	32.852	15-0438-00							Yes								1
Wilderness	32.555	31-0901-00					Yes										1
Unnamed	31.74	04-4430-00							Yes								1
Fagen	31.732	04-0600-00							Yes								1
Brokaw	31.589	29-0228-00							Yes								1
Lynn	31.44	04-1020-00							Yes								1
Carter	31.369	04-0560-00							Yes								1
Little Spearhead	30.112	29-0238-00							Yes								1
Range Line	29.912	04-1560-00							Yes								1

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Lee	29.32	31-0614-00							Yes								1
Unnamed	29.297	29-0570-00							Yes								1
Doam	29.28	31-0612-00							Yes								1
Unnamed	28.812	31-1199-00							Yes								1
Unnamed	28.471	04-1260-00							Yes								1
Unnamed	28.124	04-5420-00							Yes								1
Hall	27.914	15-0172-00							Yes								1
Unnamed	27.817	04-2890-00							Yes								1
Green	27.579	31-0607-00							Yes								1
Unnamed	27.505	15-0208-00							Yes								1
Unnamed	27.357	04-2870-00							Yes								1
Kahlstorf	27.119	29-0221-00							Yes								1
Unnamed	27.098	04-5640-00							Yes								1
Unnamed	27.009	15-0416-00							Yes								1
Unnamed	26.914	15-0337-00							Yes								1
Unnamed	25.943	29-0229-00							Yes								1
Unnamed	25.913	31-0870-00							Yes								1
Greeley	25.63	31-0863-00							Yes								1
Unnamed	25.612	04-4130-00							Yes								1
Unnamed	25.515	04-4510-00							Yes								1
Unnamed	25.51	29-0498-00							Yes								1
Unnamed	25.49	04-4470-00							Yes								1
Unnamed	25.258	15-0415-00							Yes								1
Unnamed	25.229	29-0499-00							Yes								1
Assawa	25.179	29-0297-00							Yes								1
Unnamed	24.901	29-0290-00							Yes								1
Unnamed	24.216	04-4170-00							Yes								1
Figure Eight	23.928	31-0732-00							Yes								1
Unnamed	23.841	15-0177-00							Yes								1
Spike	23.6	11-0906-00							Yes								1
Unnamed	23.586	15-0209-00							Yes								1
Salter Pond	23.584	31-0573-00							Yes								1
Unnamed	23.516	04-5320-00							Yes								1
Unnamed	23.23	15-0421-00							Yes								1
Unnamed	23.115	29-0488-00							Yes								1
Unnamed	23.101	04-3780-00							Yes								1

Lake Name	Acres	Lake ID	Water Clarity Trend	Tullibee (Cisco) Lake	Cisco Refuge Lake	Trout Lake	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Drinking Water Protection	Site-Specific Projects Identified	Cass County Large Lakes Summary	Lake Phosphorus Sensitivity Analysis	Sensitivity Lakeshore Identification	MHB County Priority Lakes	Near the Water Quality Threshold	Comprehensive Score
Unnamed	23.072	04-4190-00							Yes								1
Unnamed	22.951	15-0176-00							Yes								1
Unnamed	22.768	29-0563-00							Yes								1
Unnamed	22.657	04-2200-00							Yes								1
Unnamed	22.544	31-1200-00							Yes								1
Unnamed	22.52	04-5370-00							Yes								1
Gage	22.476	29-0223-00							Yes								1
Unnamed	22.405	31-1140-00							Yes								1
Unnamed	22.374	04-1470-00							Yes								1
Unnamed	22.232	29-0285-00							Yes								1
Brown	22.218	29-0232-00							Yes								1
Unnamed	22.165	31-0860-00					Yes										1
Unnamed	21.883	31-0549-00							Yes								1
Unnamed	21.666	31-1100-00							Yes								1
Unnamed	21.403	29-0542-00							Yes								1
Edd	21.384	31-0755-00							Yes								1
Unnamed	21.287	11-0914-00							Yes								1
Unnamed	21.189	15-0188-00							Yes								1
Camp	21.145	29-0226-00							Yes								1
Unnamed	21.039	31-1148-00							Yes								1
Dahlberg	21.038	15-0023-00							Yes								1
Unnamed	20.793	31-0731-00							Yes								1
Mink	20.388	15-0007-00							Yes								1
Unnamed	20.329	04-1010-00							Yes								1
Little Pughole	20.251	31-0601-00							Yes								1
Unnamed	20.152	04-2900-00							Yes								1
Little Skunk	20.09	11-0031-00							Yes								1
Frielund	19.966	29-0268-00							Yes								1
Unnamed	19.898	04-2850-00							Yes								1
Myrtle	19.871	15-0175-00							Yes								1
Unnamed	19.869	04-3970-00							Yes								1
Unnamed	19.833	29-0296-00							Yes								1
Unnamed	19.464	31-1201-00							Yes								1
Unnamed	19.455	04-5400-00							Yes								1
Camel	19.443	11-0032-00							Yes								1
Unnamed	19.438	31-1147-00							Yes								1

Lake Name	Acres	Lake ID	Water Clarity Trend	Tullibee (Cisco) Lake	Cisco Refuge Lake	Trout Lake	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Drinking Water Protection	Site-Specific Projects Identified	Cass County Large Lakes Summary	Lake Phosphorus Sensitivity Analysis	Sensitivity Lakeshore Identification	MHB County Priority Lakes	Near the Water Quality Threshold	Comprehensive Score
Unnamed	19.334	31-0557-00							Yes								1
Unnamed	19.263	04-5240-00							Yes								1
Dead Horse	19.251	31-0611-00							Yes								1
Kirk	19.226	15-0178-00							Yes								1
Unnamed	19.2	04-0950-00							Yes								1
Unnamed	18.957	15-0316-00							Yes								1
Lyendecker	18.836	15-0167-00							Yes								1
Unnamed	18.657	29-0487-00							Yes								1
Unnamed	18.604	31-1090-00							Yes								1
Unnamed	18.56	04-3730-00							Yes								1
Long	18.515	31-0556-00							Yes								1
Wart	18.405	31-0859-00					Yes										1
Alex	18.311	31-0753-00							Yes								1
Unnamed	18.256	31-0971-00							Yes								1
Unnamed	18.166	04-2020-00							Yes								1
Middle LaSalle	17.979	29-0298-00							Yes								1
Unnamed	17.761	04-4150-00							Yes								1
Unnamed	17.582	31-0359-00							Yes								1
Unnamed	17.562	04-4180-00							Yes								1
Unnamed	17.512	04-2360-00							Yes								1
Cranberry	17.201	29-0287-00							Yes								1
Unnamed	17.106	04-0930-00							Yes								1
Unnamed	17.037	31-0990-00							Yes								1
Mud	16.978	04-2330-00							Yes								1
Unnamed	16.911	04-5390-00							Yes								1
Unnamed	16.625	15-0169-00							Yes								1
Unnamed	16.617	15-0426-00							Yes								1
Mink	16.568	15-0166-00							Yes								1
Unnamed	16.528	04-3630-00							Yes								1
Unnamed	16.523	04-3980-00							Yes								1
Unnamed	16.294	04-2250-00							Yes								1
Miller	16.262	31-0596-00							Yes								1
Dead Horse Slough	16.255	11-0034-00							Yes								1
Pickard	15.962	15-0179-00							Yes								1
Unnamed	15.949	15-0204-00							Yes								1

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Unnamed	15.908	15-0420-00							Yes								1
Little Bear	15.831	31-0599-00							Yes								1
Unnamed	15.797	15-0327-00							Yes								1
Ways	15.755	15-0324-00							Yes								1
Unnamed	15.675	29-0528-00							Yes								1
Unnamed	15.436	04-5540-00							Yes								1
Unnamed	15.387	15-0182-00							Yes								1
Unnamed	15.312	04-3540-00							Yes								1
Crystal	15.275	29-0306-00							Yes								1
Unnamed	14.982	15-0064-00							Yes								1
Unnamed	14.863	15-0192-00							Yes								1
Unnamed	14.86	04-5460-00							Yes								1
Unnamed	14.545	04-5210-00							Yes								1
Unnamed	14.535	04-3790-00							Yes								1
Unnamed	14.356	29-0571-00							Yes								1
Unnamed	14.304	04-4160-00							Yes								1
Stevens	14.176	31-0574-00							Yes								1
Unnamed	14.083	04-2920-00							Yes								1
Unnamed	14.053	04-5520-00							Yes								1
Unnamed	14.029	29-0531-00							Yes								1
Nicollet Middle	14.026	15-0171-00							Yes								1
Unnamed	13.966	04-3750-00							Yes								1
Unnamed	13.82	29-0573-00							Yes								1
Unnamed	13.803	11-0802-00							Yes								1
Demning	13.802	29-0294-00							Yes								1
Unnamed	13.798	29-0561-00							Yes								1
Unnamed	13.662	04-5440-00							Yes								1
Unnamed	13.591	04-3960-00							Yes								1
Unnamed	13.488	15-0336-00							Yes								1
Unnamed	13.331	15-0333-00							Yes								1
Unnamed	13.209	15-0210-00							Yes								1
Tibbett	13.154	31-0819-00							Yes								1
Unnamed	12.964	04-4440-00							Yes								1
Unnamed	12.903	29-0196-00							Yes								1
Hirt	12.827	29-0236-00							Yes								1
Unnamed	12.819	11-0926-00							Yes								1

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Unnamed	12.815	15-0205-00							Yes								1
Unnamed	12.814	15-0212-00							Yes								1
Unnamed	12.74	15-0338-00							Yes								1
Unnamed	12.734	31-0548-00							Yes								1
Unnamed	12.667	29-0560-00							Yes								1
Unnamed	12.624	04-5410-00							Yes								1
Unnamed	12.499	04-1160-00							Yes								1
Unnamed	12.409	04-5300-00							Yes								1
Smith	12.395	29-0305-00							Yes								1
Unnamed	12.341	15-0422-00							Yes								1
Unnamed	12.274	11-0021-00							Yes								1
Reed	12.257	29-0069-00							Yes								1
Unnamed	12.182	04-5350-00							Yes								1
Unnamed	12.142	15-0332-00							Yes								1
Wettersten	12.133	15-0173-00							Yes								1
Spruce	11.868	31-0734-00							Yes								1
Myrtle	11.839	15-0006-00							Yes								1
Unnamed	11.826	30-6980-00							Yes								1
Unnamed	11.801	04-3840-00							Yes								1
Unnamed	11.772	15-0425-00							Yes								1
Unnamed	11.746	04-3990-00							Yes								1
Stokey	11.693	31-0358-00							Yes								1
Unnamed	11.676	15-0423-00							Yes								1
Perch	11.596	31-0584-00							Yes								1
Unnamed	11.547	04-2220-00							Yes								1
Unnamed	11.482	04-2800-00							Yes								1
Unnamed	11.479	31-0872-00							Yes								1
Unnamed	11.427	31-0864-00							Yes								1
Unnamed	11.413	29-0525-00							Yes								1
Unnamed	11.379	04-5550-00							Yes								1
Coal	11.376	29-0244-00							Yes								1
Unnamed	11.371	04-3720-00							Yes								1
Unnamed	11.358	04-5430-00							Yes								1
Unnamed	11.354	31-0871-00							Yes								1
Unnamed	11.288	04-3820-00							Yes								1
Unnamed	11.201	15-0414-00							Yes								1

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Josephine	11.101	29-0295-00							Yes								1
Unnamed	11.066	04-5450-00							Yes								1
Unnamed	11.044	31-0559-00							Yes								1
Unnamed	11.003	04-5340-00							Yes								1
Unnamed	10.954	04-5260-00							Yes								1
Grave	10.905	04-1600-00							Yes								1
Unnamed	10.898	29-0532-00							Yes								1
Unnamed	10.862	31-0997-00							Yes								1
Unnamed	10.646	04-3770-00							Yes								1
Unnamed	10.623	31-1139-00							Yes								1
Minking	10.552	29-0198-00							Yes								1
Unnamed	10.4	04-5480-00							Yes								1
Unnamed	10.371	15-0424-00							Yes								1
Unnamed	10.307	04-4000-00							Yes								1
Unnamed	10.29	04-2210-00							Yes								1
Zimmerman	10.236	11-0079-00							Yes								1
Unnamed	10.217	04-4140-00							Yes								1
Clancy	10.171	29-0538-00							Yes								1
Unnamed	10.161	15-0315-00							Yes								1
Unnamed	10.046	04-5510-00							Yes								1
Unnamed	10.027	31-1196-00							Yes								1
Unnamed	9.984	04-1130-00							Yes								1
Unnamed	9.947	15-0330-00							Yes								1
Unnamed	9.758	04-5360-00							Yes								1
Hays	9.732	15-0170-00							Yes								1
Unnamed	9.042	04-3510-00							Yes								1
Unnamed	8.427	29-0545-00							Yes								1
Dead Horse	8.363	11-0900-00							Yes								1
Unnamed	8.246	15-0427-00							Yes								1
Unnamed	8.017	31-0558-00							Yes								1
Unnamed	7.577	31-0854-00							Yes								1
Unnamed	7.415	15-0334-00							Yes								1
Unnamed	7.355	29-0572-00							Yes								1
Long	6.79	29-0222-00							Yes								1
Unnamed	6.661	04-4420-00							Yes								1
Unnamed	6.62	11-0801-00							Yes								1

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Unnamed	5.786	29-0529-00							Yes								1
Unnamed	4.448	31-1140-00							Yes								1
Unnamed	4.365	31-1146-00							Yes								1
Unnamed	3.445	29-0527-00							Yes								1
Tamarack	2.739	15-0329-00							Yes								1
Unnamed	2.677	15-0413-00							Yes								1
Kenogama	564.725	31-0928-00															0
Little Moose	310.415	04-0080-00															0
Ten	235.372	11-0300-00															0
Unnamed	223.111	04-3700-00															0
Unnamed	217.451	04-4580-00															0
Unnamed	198.255	04-4590-00															0
Popple	180.634	04-0140-00															0
Unnamed	129.798	04-0800-00															0
Minisogama	126.532	31-0930-00															0
Hale	110.607	31-0903-00															0
Pug Hole	94.655	04-0030-00															0
Stocking	91.642	04-0860-00															0
Bass	81.399	04-0620-00															0
Unnamed	78.635	04-3640-00															0
Unnamed	78.564	31-0895-00															0
Unnamed	74.254	31-1223-00															0
Tamarack	72.241	11-0139-00															0
Unnamed	72.198	04-0770-00															0
Gimmer	68.656	04-0200-00															0
Chinaman	60.827	04-0170-00															0
Unnamed	60.503	04-3710-00															0
Unnamed	57.899	11-0925-00															0
Unnamed	57.416	31-1220-00															0
Coleman	56.658	31-0943-00															0
School House	55.55	31-0851-00															0
Little Lost	53.638	04-0450-00															0
Jessie	49.734	04-0520-00															0
Unnamed	49.497	04-5500-00															0
Webster	48.038	04-0220-00															0
Unnamed	47.64	11-0907-00															0

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Loon	47.475	04-0550-00															0
McDonald	44.922	04-0040-00															0
Strawberry	41.761	11-0409-00															0
Unnamed	39.695	31-1218-00															0
Bog	39.453	31-0931-00															0
Unnamed	38.663	04-4640-00															0
Unnamed	37.322	04-4540-00															0
Little Gilstad	37.106	04-0160-00															0
Muskrat	37.018	04-0540-00															0
Unnamed	35.792	31-0998-00															0
Little Dixon	35.464	31-0936-00															0
Blue Sky	35.424	04-0400-00															0
Ten Section	35.041	11-0495-00															0
Drury	34.112	04-0610-00															0
Unnamed	33.829	04-3620-00															0
Unnamed	32.648	31-0938-00															0
Unnamed	32.556	04-5270-00															0
Unnamed	32.081	04-6390-00															0
Mission	30.839	04-0460-00															0
Carla	30.603	04-0580-00															0
South Upper Twin	30.164	31-0932-00															0
Little Rabideau	30.092	04-3590-00															0
Unnamed	29.433	31-1222-00															0
Unnamed	29.256	04-0650-00															0
Unnamed	28.038	31-1117-00															0
Unnamed	27.816	31-0820-00															0
Unnamed	27.127	04-5490-00															0
Bullhead	26.597	04-0020-00															0
Luck	25.454	04-0440-00															0
Ellis	24.253	04-0180-00															0
Unnamed	24.053	31-1221-00															0
Unnamed	22.767	31-0999-00															0
Little Pimushe	22.601	04-0120-00															0
Unnamed	22.582	31-0856-00															0
Unnamed	20.996	04-1050-00															0

Lake Name	Acres	Lake ID	Water Clarity Trend	Tullibee (Cisco) Lake	Cisco Refuge Lake	Trout Lake	Wild Rice Lake	Lake Biological Significance	Detrimental Land Use Conversion Forecasted	Drinking Water Protection	Site-Specific Projects Identified	Cass County Large Lakes Summary	Lake Phosphorus Sensitivity Analysis	Sensitivity Lakeshore Identification	MHB County Priority Lakes	Near the Water Quality Threshold	Comprehensive Score
Unnamed	20.864	04-0960-00															0
Unnamed	20.385	04-0470-00															0
Unnamed	20.214	04-0810-00															0
Mark	20.189	11-0407-00															0
Unnamed	19.553	04-0130-00															0
Preston	19.502	04-0090-00															0
Unnamed	19.425	31-1120-00															0
Unnamed	19.424	04-3480-00															0
Unnamed	19.388	31-0985-00															0
Tower	17.644	31-0924-00															0
Unnamed	17.609	04-4600-00															0
Rosy	17.546	31-0935-00															0
Unnamed	17.093	04-5280-00															0
Unnamed	16.65	04-0060-00															0
Unnamed	16.564	31-0899-00															0
One Loaf	16.136	31-0875-00															0
Unnamed	15.708	04-4820-00															0
Christenson	15.703	04-3950-00															0
Unnamed	15.537	31-1219-00															0
Unnamed	15.411	04-3490-00															0
Unnamed	15.057	31-0996-00															0
Unnamed	14.67	11-0301-00															0
Unnamed	14.617	31-1098-00															0
Unnamed	13.848	04-0820-00															0
Baumgartner	13.683	04-0210-00															0
Unnamed	13.19	04-0370-00															0
Unnamed	13.149	04-5200-00															0
Unnamed	13.089	11-0909-00															0
Unnamed	13.051	04-3570-00															0
Unnamed	12.776	31-1119-00															0
Unnamed	11.819	04-3610-00															0
Unnamed	11.67	04-3580-00															0
Unnamed	11.455	04-4830-00															0
Unnamed	11.169	04-3600-00															0
Unnamed	11.158	04-4530-00															0

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North Upper Twin	10.98	31-0933-00															0
Unnamed	10.637	31-0989-00															0
Minny	10.542	31-0927-00															0
Unnamed	10.221	11-0908-00															0
Unnamed	10.16	04-3650-00															0

Appendix F
Stream Prioritization

Appendix F
Stream Prioritization

AUID	Reach Name	Reach Description	Use Class	Reach Length	Trout Stream	Tributary to Trout Stream	Detrimental Landuse Forecasted	Exceptional Use	Close to WQ Standard	Comprehensive Score
07010101-645	Smith Creek	Smith Lk to Little Pokegama Lk	1B, 2A, 3B	1.65	Yes		Yes		Yes	6
07010101-659	Unnamed creek (Pokegama Creek)	Headwaters to Sherry Lk	1B, 2A, 3B	2.73	Yes		Yes		Yes	6
07010101-660	Schoolcraft River (Schoolcraft Creek)	Headwaters to Schoolcraft Lk	1B, 2A, 3B	1.76	Yes		Yes	Yes		6
07010101-751	Schoolcraft River	Frontenac Cr to Plantagenet Lk	2B, 3C	7.78			Yes		Yes	4
07010101-517	Little Mississippi River	Moose Lk to Grant Cr	2B, 3C	8.73			Yes		Yes	4
07010101-521	Vermillion River	Headwaters to Mississippi R	2B, 3C	15.59			Yes		Yes	4
07010101-923	Mississippi River	Headwaters to Unnamed cr	2B, 3C	29.57			Yes		Yes	4
07010101-526	Third River	Skimmerhorn Lk to Lk Winnibigoshish	2B, 3C	24.82			Yes		Yes	4
07010101-732	Unnamed creek	Headwaters to Pokegama Lk	2B, 3C	2.17			Yes		Yes	4
07010101-546	Grant Creek	Grant Lk outlet to Unnamed cr	2B, 3C	4.25			Yes		Yes	4
07010101-924	Mississippi River	Unnamed cr to Schoolcraft R	2B, 3C	28.6			Yes		Yes	4
07010101-627	Big Lake Creek	Lk Andrusia to Big Lk	2B, 3C	1.2					Yes	3
07010101-633	LaSalle Creek	T143 R35W S6, south line to Unnamed lk (29-0302-00)	1B, 2A, 3B	1.71	Yes		Yes			3
07010101-640	Cold Creek	T145 R33W S19, east line to Lk Plantagenet	1B, 2A, 3B	1.54	Yes		Yes			3
07010101-643	Unnamed creek (Siseebakwet Creek)	Headwaters to South Sugar Lk (31-0555-00)	1B, 2A, 3B	0.93	Yes		Yes			3
07010101-663	Sucker Creek	Gould Cr to Mississippi R	1B, 2A, 3B	2.39	Yes		Yes			3
07010101-696	Unnamed creek (Little Pokegama Creek)	Headwaters to Unnamed cr	1B, 2A, 3B	0.33	Yes		Yes			3
07010101-711	Unnamed creek (Schoolcraft River Tributary)	Headwaters to Schoolcraft R	1B, 2A, 3B	0.82	Yes		Yes			3
07010101-917	Unnamed creek (Matuska's Creek)	Headwaters to Smith Cr	1B, 2A, 3B	0.69	Yes		Yes			3
07010101-918	Unnamed creek (Smith Creek Tributary)	Headwaters to Smith Cr	1B, 2A, 3B	1.15	Yes		Yes			3
07010101-635	LaSalle Creek	Unnamed lk (29-0302-00) to T144 R35W S19, west line	1B, 2A, 3B	2.33	Yes		Yes			3
07010101-644	Smith Creek	Headwaters to Smith Lk	1B, 2A, 3B	6.23	Yes		Yes			3
07010101-656	Unnamed creek	Headwaters to Smith Cr	1B, 2A, 3B	1.05	Yes		Yes			3
07010101-664	Sucker Creek	Sucker Lk to Gould Cr	1B, 2A, 3B	1.15	Yes		Yes			3
07010101-919	Unnamed creek (Little Pokegama Creek)	Unnamed cr to Little Pokegama Lk	1B, 2A, 3B	1.44	Yes		Yes			3
07010101-636	Hennepin Creek	T144 R35W S21, south line to T145 R35W S34, east line	1B, 2A, 3B	5.59	Yes		Yes			3
07010101-700	Unnamed creek (Hennepin Creek Tributary)	T144 R35W S10, west line to Hennepin Cr	1B, 2A, 3B	0.11		Yes	Yes			2
07010101-714	Unnamed creek (Smith Creek Tributary)	Headwaters (Unnamed lk 31-0548-00) to Unnamed lk	1B, 2A, 3B	0.37		Yes	Yes			2
07010101-707	Unnamed creek	Headwaters to Unnamed cr	1B, 2A, 3B	0.23		Yes	Yes			2
07010101-708	Unnamed creek (Pokegama Creek Tributary)	Headwaters to Unnamed cr	1B, 2A, 3B	0.2		Yes	Yes			2
07010101-712	Unnamed creek (Smith Creek Tributary)	Headwaters to Smith Cr	1B, 2A, 3B	0.76		Yes	Yes			2
07010101-715	Unnamed creek (Smith Creek Tributary)	Unnamed lk to Smith Cr	1B, 2A, 3B	0.58		Yes	Yes			2
07010101-719	Unnamed creek (Sucker Creek Tributary)	Headwaters to Sucker Cr	1B, 2A, 3B	0.78		Yes	Yes			2
07010101-718	Unnamed creek (Sucker Creek Tributary)	Headwaters to Sucker Cr	1B, 2A, 3B	0.68		Yes	Yes			2
07010101-697	Unnamed creek (Little Pokegama Creek)	Headwaters to Unnamed cr	1B, 2A, 3B	0.53		Yes	Yes			2
07010101-701	Gould Creek	T144 R35W S32, south line to Sucker Cr	1B, 2A, 3B	1.1		Yes	Yes			2
07010101-713	Unnamed creek (Smith Creek Tributary)	Headwaters to Smith Cr	1B, 2A, 3B	0.54		Yes	Yes			2

AUID	Reach Name	Reach Description	Use Class	Reach Length	Trout Stream	Tributary to Trout Stream	Detrimental Landuse Forecasted	Exceptional Use	Close to WQ Standard	Comprehensive Score
07010101-709	Unnamed creek (Pokegama Creek Tributary)	Headwaters to Unnamed cr	1B, 2A, 3B	0.37		Yes	Yes			2
07010101-699	Unnamed creek (Cold Creek Tributary)	T145 R33W S19, south line to Cold Cr	1B, 2A, 3B	0.21		Yes	Yes			2
07010101-710	Unnamed creek (Pokegama Creek Tributary)	Headwaters to Unnamed cr	1B, 2A, 3B	0.9		Yes	Yes			2
07010101-717	Unnamed creek (Smith Creek Tributary)	T53 R26W S11, north line to Unnamed cr	1B, 2A, 3B	0.06		Yes	Yes			2
07010101-730	Schoolcraft River	Lk Marquette to Mississippi R	2B, 3C	0.74			Yes			1
07010101-727	Schoolcraft River (Lake Plantagenet)	Lk Plantagenet (29-0156-00)	2B, 3C	14.05			Yes			1
07010101-729	Schoolcraft River (Lake Marquette)	Lk Marquette (04-0142-00)	2B, 3C	3.54			Yes			1
07010101-752	Schoolcraft River	Schoolcraft Lk to Frontenac Cr	2B, 3C	19.49			Yes			1
07010101-661	Schoolcraft River (Schoolcraft Lake)	Schoolcraft Lk (29-0215-00)	2B, 3C	1.18			Yes			1
07010101-728	Schoolcraft River	Lk Plantagenet to Lk Marquette	2B, 3C	1.13			Yes			1
07010101-505	Deer River	Bay Lk to Mississippi R	2B, 3C	18.36			Yes			1
07010101-520	Deer Lake	Deer Lk (31-0719-00)	2B, 3C	5.25			Yes			1
07010101-530	Wolf Lake Artificial Path	Wolf Lk (04-0079-00)	2B, 3C	1.91			Yes			1
07010101-538	Little Mississippi River	Daniel Lk to Dahlberg Lk	2B, 3C	0.82			Yes			1
07010101-543	Little Mississippi River	Berg Lk to Moose Lk	2B, 3C	1.08			Yes			1
07010101-554	Gull River	Fagen Lk to Gull Lk	2B, 3C	2.77			Yes			1
07010101-574	Nicollet Creek	Headwaters to Lk Itasca	2B, 3C	1.29			Yes			1
07010101-614	Unnamed lake	Unnamed lk (31-0815-00)	2B, 3C	0.36			Yes			1
07010101-615	Unnamed creek	Unnamed lk (31-0815-00) to Ball Club Lk	2B, 3C	0.35			Yes			1
07010101-619	Island Lake Creek	Hansen Lk outlet to Deer R	2B, 3C	2.36			Yes			1
07010101-639	Rat Creek	Evergreen Lk to Frontenac Lk	2C	2.58			Yes			1
07010101-658	Hennepin Creek	Headwaters to T144 R35W S28, north line	2C	0.55			Yes			1
07010101-668	Unnamed creek	Headwaters to Lk Bemidji	2B, 3C	3.15			Yes			1
07010101-672	LaSalle Creek (Unnamed lake)	Unnamed lk (29-0302-00)	2B, 3C	0.31			Yes			1
07010101-685	Cut Foot Sioux Lake	Cut Foot Sioux Lk (31-0857-00)	2B, 3C	4.3			Yes			1
07010101-695	Unnamed creek	Decker Lk to Third R	2B, 3C	0.54			Yes			1
07010101-734	Deer River	Deer Lk to Bay Lk	2B, 3C	0.16			Yes			1
07010101-738	Unnamed creek	Headwaters to Duncan Lk	2B, 3C	5.94			Yes			1
07010101-740	Unnamed creek	Headwaters to Deer R	2B, 3C	3.63			Yes			1
07010101-750	Unnamed creek	Unnamed cr to Lk Bemidji	2B, 3C	1.94			Yes			1
07010101-903	Unnamed creek	Wetland to Mississippi R	2B, 3C	0.88			Yes			1
07010101-922	Unnamed creek (Little Bass Creek)	Headwaters to Lk Bemidji	2B, 3C	0.79			Yes			1
07010101-999	Unassessed	Unassessed	2B, 3C	718.87			Yes			1
07010102-999	Unassessed	Unassessed	2B, 3C	539.99			Yes			1
09020108-999	Unassessed	Unassessed	2B, 3C	1501.29			Yes			1
09030006-999	Unassessed	Unassessed	2B, 3C	879.94			Yes			1
07010101-525	Lake Winnibigoshish Artificial Path	Lk Winnibigoshish (11-0147-00)	2B, 3C	53.54			Yes			1

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07010101-531	Lake Bemidji Artifical Path	Lk Bemidji (04-0130-00)	2B, 3C	9.01			Yes			1
07010101-535	Little Mississippi River (Rice Lake)	Rice Lk (04-0286-00)	2B, 3C	1.52			Yes			1
07010101-537	Little Mississippi River (Daniel Lake)	Daniel Lk (15-0022-00)	2B, 3C	0.63			Yes			1
07010101-540	Little Mississippi River (Duncan Lake)	Duncan Lk (15-0024-00)	2B, 3C	0.37			Yes			1
07010101-544	Little Mississippi River (Moose Lake)	Moose Lk (04-0342-00)	2B, 3C	0.97			Yes			1
07010101-553	Gull River (Fagen Lake)	Fagen Lk (04-0060-00)	2B, 3C	0.38			Yes			1
07010101-612	Unnamed creek	Headwaters to Mississippi R	2B, 3C	1.46			Yes			1
07010101-616	Unnamed creek	Wetland to Ball Club Lk	2B, 3C	0.48			Yes			1
07010101-618	Island Lake Creek	Island Lk to Hansen Lk outlet	2B, 3C	1.56			Yes			1
07010101-626	Little Wolf Lake Outlet	Little Wolf Lk to Wolf Lk	2B, 3C	0.58			Yes			1
07010101-638	Alcohol Creek	Lk George to Schoolcraft R	2C	6.51			Yes			1
07010101-649	Pokegama Lake	Pokegama Lk (31-0532-00)	2B, 3C	30.88			Yes			1
07010101-657	Skunk Creek	Headwaters to Evergreen Lk	2C	2.02			Yes			1
07010101-665	Unnamed creek	Headwaters to Lk Plantagenet	2B, 3C	1.71			Yes			1
07010101-670	Grant Creek	Unnamed ditch to Unnamed cr	2B, 3C	2.64			Yes			1
07010101-675	LaSalle Creek (Big LaSalle Lake)	Big LaSalle Lk (15-0001-00)	2B, 3C	1.41			Yes			1
07010101-678	LaSalle Creek (LaSalle Lake)	LaSalle Lk (29-0309-00)	2B, 3C	2.47			Yes			1
07010101-684	Little Cut Foot Sioux Lake	Little Cut Foot Sioux Lk (31-0852-00)	2B, 3C	3.4			Yes			1
07010101-686	Smith Creek (Smith Lake)	Smith Lk (31-0547-00)	2B, 3C	0.32			Yes			1
07010101-690	Sugar Brook	Siseebakwet Lk to Unnamed lk (31-0553-00)	2B, 3C	0.48			Yes			1
07010101-702	Unnamed creek (Gould Creek)	Headwaters to Tamarack Lk	2C	0.32			Yes			1
07010101-716	Unnamed creek (Smith Creek Tributary)	Unnamed lk (31-1140-00)	2B, 3C	0.12			Yes			1
07010101-731	Unnamed creek	Cavanaugh Lk to Pokegama Lk	2B, 3C	0.33			Yes			1
07010101-733	Unnamed creek	Munzer Lk to Pokegama Lk	2B, 3C	0.57			Yes			1
07010101-737	Unnamed creek	Little Deer Lk to Deer Lk	2B, 3C	0.05			Yes			1
07010101-741	Fisherman's Brook	Headwaters to Ball Club Lk	2B, 3C	6.66			Yes			1
07010101-744	Two Mile Creek	Headwaters to Two Mile Lk	2B, 3C	0.58			Yes			1
07010101-745	Two Mile Creek (Two Mile Lake)	Two Mile Lk (31-0823-00)	2B, 3C	0.42			Yes			1
07010101-904	Unnamed creek	Wetland to Third R (Dixon Lk)	2B, 3C	1.07			Yes			1
07010103-707	Mississippi River	Cohasset Dam to Swan R	2Bg, 3C	43.27			Yes			1
07010101-523	Ball Club Lake	Ball Club Lk (31-0812-00)	2B, 3C	12.99			Yes			1
07010101-536	Little Mississippi River	Headwaters to Daniel Lk	2B, 3C	0.59			Yes			1
07010101-541	Little Mississippi River	Duncan Lk to Berg Lk	2B, 3C	0.62			Yes			1
07010101-551	Gull River	Erickson Lk to Nelson Lk outlet	2B, 3C	4.44			Yes			1
07010101-556	Gull River	Gull Lk to Turtle R	2B, 3C	0.33			Yes			1
07010101-567	North Turtle River	Carls Lk outlet to Unnamed cr	2B, 3C	2.17			Yes			1
07010101-573	Birch Creek	Lk Hattie outlet to Schoolcraft R	2B, 3C	5.04			Yes			1

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07010101-581	Moose Creek	Unnamed cr to Third R	2B, 3C	9.33			Yes			1
07010101-609	Simpson Creek	Headwaters to Little Cut Foot Sioux Lk	2B, 3C	3.99			Yes			1
07010101-611	Two Mile Creek	Two Mile Lk to Little Cut Foot Sioux Lk	2B, 3C	1.12			Yes			1
07010101-629	Cut Foot Sioux Creek	Little Cut Foot Sioux Lk to Cut Foot Sioux Lk (Bay)	2B, 3C	2.37			Yes			1
07010101-637	Hennepin Creek	T145 R35W S35, west line to Mississippi R	2C	8.06			Yes			1
07010101-647	Jay Gould Lake	Jay Gould Lk (31-0565-00)	2B, 3C	2.62			Yes			1
07010101-650	Frontenac Creek	Frontenac Lk to Unnamed lk (29-0497-00)	2C	0.61			Yes			1
07010101-674	LaSalle Creek	T144 R36W S24, east line to Big LaSalle Lk	2B, 3C	0.45			Yes			1
07010101-679	Evergreen Lake	Evergreen Lk (29-0227-00)	2B, 3C	1.63			Yes			1
07010101-682	Frontenac Creek	T144 R34W S3, north line to Schoolcraft R	2B, 3C	0.03			Yes			1
07010101-687	South Sugar Lake	South Sugar Lk (31-0555-00)	2B, 3C	0.51			Yes			1
07010101-692	Sugar Brook	Unnamed lk (31-0553-00) to Pokegama Lk	2B, 3C	2.04			Yes			1
07010101-703	Unnamed creek (Gould Creek)	Tamarack Lk to Ozawindib Lk	2C	0.11			Yes			1
07010101-736	Unnamed creek (Moose Creek)	Moose Lk (31-0722-00) to Bay Lk	2B, 3C	0.48			Yes			1
07010101-742	Unnamed ditch	Unnamed ditch to Unnamed ditch	2B, 3C	10.39			Yes			1
07010101-747	Unnamed ditch	Headwaters to T147 R35W S24, south line	2B, 3C	6.08			Yes			1
07010101-754	Mississippi River	Schoolcraft R thru Cass Lk (04-0030-00)	2Bg, 3C	32.85			Yes			1
07010101-906	Unnamed creek	Sioux Lk to Wetland	2B, 3C	0.07			Yes			1
07010102-606	Leech Lake River	Mud-Goose Lk Dam to Mississippi R	2B, 3C	3.71			Yes			1
07010103-999	Unassessed	Unassessed	2B, 3C	1127.76			Yes			1
07010101-510	Turtle River	Headwaters (Stray Horse Lk 04-0246-00) to Cass Lk	2B, 3C	53.95			Yes			1
07010101-522	Ball Club River	Headwaters (Ball Club Lk 31-0812-00) to Mississippi R	2B, 3C	1.93			Yes			1
07010101-534	Little Mississippi River	Grant Cr to Rice Lk	2B, 3C	0.07			Yes			1
07010101-539	Little Mississippi River (Dahlberg Lake)	Dahlberg Lk (15-0023-00)	2B, 3C	0.23			Yes			1
07010101-555	Gull River (Gull Lake)	Gull Lk (04-0064-00)	2B, 3C	1.09			Yes			1
07010101-610	Unnamed creek	Headwaters to Little Cut Foot Sioux Lk	2B, 3C	1.31			Yes			1
07010101-613	Unnamed creek (Little Ball Club Lake Outlet)	Little Ball Club Lk to Unnamed lk (31-0815-00)	2B, 3C	0.93			Yes			1
07010101-634	LaSalle Creek	Big LaSalle Lk to Middle LaSalle Lk	2C	0.55			Yes			1
07010101-646	Blackwater Lake Artifical Path	Blackwater Lk (31-0561-00)	2B, 3C	2.97			Yes			1
07010101-651	Frontenac Creek	Unnamed lk (29-0497-00) to T145 R34W S34, south line	2C	1.12			Yes			1
07010101-655	LaSalle Creek	Middle LaSalle Lk to T144 R35W S6, north line	2C	0.95			Yes			1
07010101-667	Grant Creek	Unnamed lk (04-0202-00) to Grant Lk outlet	2B, 3C	0.84			Yes			1
07010101-673	Lake Itasca	Lk Itasca (15-0016-00)	2B, 3C	6.52			Yes			1
07010101-681	Frontenac Creek (Unnamed lake)	Unnamed lk (29-0497-00)	2B, 3C	1.26			Yes			1
07010101-688	Unnamed creek	South Sugar Lk to Siseebakwet Lk	2B, 3C	0.05			Yes			1
07010101-691	Sugar Brook (Unnamed lake)	Unnamed lk (31-0553-00)	2B, 3C	0.5			Yes			1
07010101-705	Unnamed creek (Ozawindib Lake)	Ozawindib Lk (15-0005-00)	2B, 3C	1.78			Yes			1

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07010101-735	Deer River (Bay Lake)	Bay Lk (31-0723-00)	2B, 3C	0.27			Yes			1
07010101-743	Unnamed ditch	Unnamed ditch to Mississippi R	2B, 3C	0.55			Yes			1
07010101-749	Unnamed creek	Alice Lk to Unnamed cr	2B, 3C	1.66			Yes			1
07010101-542	Little Mississippi River (Berg Lake)	Berg Lk (15-0025-00)	2B, 3C	0.5			Yes			1
07010101-545	LaSalle Creek	Lasalle Lk to Mississippi R	2C	1			Yes			1
07010101-617	Unnamed creek	Headwaters to Vermillion R	2B, 3C	2.28			Yes			1
07010101-625	Midge Lake Outlet	Midge Lk to Wolf Lk	2B, 3C	1.27			Yes			1
07010101-632	LaSalle Creek	Headwaters to T143 R35W S7, north line	2C	0.85			Yes			1
07010101-671	Grant Creek (Unnamed lake)	Unnamed lk (04-0225-00)	2B, 3C	0.2			Yes			1
07010101-704	Unnamed creek (Tamarack Lake)	Tamarack Lk (15-0329-00)	2B, 3C	0.59			Yes			1
07010101-739	Unnamed creek	Headwaters to Unnamed ditch	2B, 3C	4.39			Yes			1
07010101-746	Unnamed creek	First R to Little Cut Foot Siou Lk	2B, 3C	0.95			Yes			1
07010101-748	Unnamed ditch	T147 R35W S25, north line to Grant Cr	2B, 3C	2.62			Yes			1
07010101-518	Little Mississippi River	Dahlberg Lk to Duncan Lk	2B, 3C	0.93			Yes			1
07010101-653	Unnamed creek	Wetland to Turtle R	2B, 3C	4.45			Yes			1
07010101-677	LaSalle Creek	T145 R35W S31, south line to LaSalle Lk	2C	0.49			Yes			1
07010101-706	Unnamed creek (Gould Creek)	Ozawindib Lk to T143 R36W S5, north line	2C	0.25			Yes			1
07010101-756	Mississippi River	Lk Winnibigoshish (11-0147-00) to Cohasset Dam	2Bg, 3C	57.19			Yes			1
07010101-552	Gull River	Nelson Lk outlet to Fagen Lk	2B, 3C	1.04			Yes			1
07010101-568	North Turtle River	Unnamed cr to Rice Pond outlet	2B, 3C	1.18			Yes			1
07010101-652	Unnamed creek (Dutchman Lake Outlet)	Dutchman Lk to North Turtle R	2B, 3C	3.28			Yes			1
07010101-680	Frontenac Lake	Frontenac Lk (29-0241-00)	2B, 3C	1.55			Yes			1
07010101-902	Unnamed creek	Wetland to Mississippi R	2B, 3C	0.98			Yes			1
07010101-921	Unnamed creek (Judicial Ditch 2)	to Lk Irving	2B, 3C	0.17			Yes			1
07010101-547	Grant Creek	Unnamed cr to Little Mississippi R	2B, 3C	1.57			Yes			1
07010101-631	Bear Creek	T145 R36W S31, south line to Mississippi R	2C	6.64			Yes			1
07010101-666	Grant Creek	Unnamed lk (04-0225-00) to Unnamed lk (04-0202-00)	2B, 3C	1.97			Yes			1
07010101-550	Unnamed creek (Meadow Lake Outlet)	Meadow Lk to Turtle R	2B, 3C	1.04			Yes			1
07010101-642	Blackwater Creek	Headwaters to Blackwater Lk/Mississippi R	2C	1.46			Yes			1
07010101-676	LaSalle Creek (Middle LaSalle Lake)	Middle LaSalle Lk (29-0298-00)	2B, 3C	0.42			Yes			1
07010101-587	Otter Creek	Little Dixon Lk to Dixon Lk	2B, 3C	0.82			Yes			1
07010101-721	Lake Irving Artificial Path	Lk Irving (04-0140-00)	2B, 3C	3.41			Yes			1
07010101-689	Siseebakwet Lake	Siseebakwet Lk (31-0554-00)	2B, 3C	2.75			Yes			1
07010101-533	Fox Creek	Headwaters to Pike Bay (Cass Lk)	2B, 3C	2.04						0
07010101-566	North Turtle River	Little Rabideau Lk to Carls Lk outlet	2B, 3C	0.48						0
07010101-569	North Turtle River	Rice Pond outlet to Little Rice Pond outlet	2B, 3C	3.83						0
07010101-582	Unnamed creek	Unnamed cr to Upper Twin Lk	2B, 3C	0.72						0

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07010101-585	Cottonwood Creek	Rosy Lk outlet to Little Dixon Lk	2B, 3C	2.16						0
07010101-589	Unnamed creek	Morph Lk to Island Lake Cr	2B, 3C	1.67						0
07010101-599	Pigeon River	Lower Pigeon Lk to T147 R28W S13, east line	2B, 3C	1.04						0
07010101-605	Farley Lake	Farley Lk (31-0902-00)	2B, 3C	0.54						0
07010101-607	Unnamed lake	Unnamed lk (31-0895-00)	2B, 3C	0.73						0
07010101-641	Kitchi Creek	Headwaters to Rice Lk outlet	2C	2.07						0
07010101-654	Sucker Creek	Popple Lk to Kitchi Cr	2B, 3C	2.74						0
07010101-683	Pike Bay	Pike Bay (11-0415-00)	2B, 3C	11.53						0
07010101-908	Unnamed creek	Wetland to Pimushe Lk	2B, 3C	1.21						0
07010101-548	North Turtle River	Pimushe Lk to Turtle R	2B, 3C	4.85						0
07010101-557	Everton Creek	Christenson Lk to Gilstad Lk	2C	5.11						0
07010101-559	Unnamed creek (Gilstad Lake)	Gilstad Lk (04-0024-00)	2B, 3C	0.61						0
07010101-563	North Turtle River (Rabideau Lake)	Rabideau Lk (04-0034-00)	2B, 3C	3.05						0
07010101-564	North Turtle River	Rabideau Lk to Little Rabideau Lk	2B, 3C	0.29						0
07010101-571	North Turtle River (Pimushe Lake)	Pimushe Lk (04-0032-00)	2B, 3C	4.04						0
07010101-572	Unnamed creek (Carls Lake Outlet)	Carls Lk to North Turtle R	2B, 3C	0.58						0
07010101-576	Kitchi Creek (Burns Lake)	Burns Lk (04-0001-00)	2B, 3C	0.71						0
07010101-584	Cottonwood Creek	Upper Twin Lk to Rosy Lk outlet	2B, 3C	0.75						0
07010101-586	Little Dixon Lake	Little Dixon Lk (31-0936-00)	2B, 3C	0.71						0
07010101-590	Castle Creek	Headwaters to Unnamed cr	2B, 3C	5.29						0
07010101-598	Unnamed creek (Lower Pigeon Lake)	Lower Pigeon Lk (31-0893-00)	2B, 3C	1.68						0
07010101-600	Pigeon River	Unnamed cr to Pigeon Dam Lk	2C	1.26						0
07010101-604	Unnamed creek	Wilderness Lk outlet to Farley Lk	2B, 3C	0.71						0
07010101-608	Unnamed creek	Unnamed lk (31-0895-00) to Lk Winnibigoshish	2B, 3C	0.05						0
07010101-624	Pike Bay Creek	Pike Bay to Cass Lk	2B, 3C	0.52						0
07010101-630	Raven Creek	Wetland to Lk Winnibigoshish	2B, 3C	4.54						0
07010101-694	Unnamed creek (Decker Lake)	Decker Lk (31-0934-00)	2B, 3C	0.37						0
07010101-900	Unnamed creek	Unnamed Wetland to Turtle River	2B, 3C	1.19						0
07010101-913	Unnamed creek	Wetland to Rabideau Lk	2B, 3C	0.68						0
07010101-558	Unnamed creek	Headwaters (Unnamed lk 04-0364-00) to Gilstad Lk	2B, 3C	1.79						0
07010101-562	North Turtle River	Little Gilstad Lk to Rabideau Lk	2B, 3C	3.86						0
07010101-583	Upper Twin Lake	Upper Twin Lk (31-0932-00)	2B, 3C	0.59						0
07010101-591	Castle Creek	Unnamed cr to Lk Winnibigoshish (Third River Flowage)	2B, 3C	0.25						0
07010101-594	Unnamed creek	Upper Pigeon Lk to Middle Pigeon Lk	2B, 3C	0.34						0
07010101-603	Unnamed creek	Headwaters to Wilderness Lk outlet	2B, 3C	0.93						0
07010101-622	Skimerhorn Creek (Unnamed lake)	Unnamed lk (04-0460-00)	2B, 3C	0.28						0
07010101-698	Pigeon River	Pigeon Dam Lk to Pigeon Dam	2B, 3C	0.25						0

AUID	Reach Name	Reach Description	Use Class	Reach Length	Trout Stream	Tributary to Trout Stream	Detrimental Landuse Forecasted	Exceptional Use	Close to WQ Standard	Comprehensive Score
07010101-901	Unnamed creek	Wetland to Turtle R	2B, 3C	1.02						0
07010101-527	Cass Lake Artificial Path	Cass Lk (04-0030-00)	2B, 3C	15.25						0
07010101-561	Unnamed creek (Little Gilstad Lake)	Little Gilstad Lk (04-0016-00)	2B, 3C	0.42						0
07010101-565	North Turtle River (Little Rabideau Lake)	Little Rabideau Lk (04-0359-00)	2B, 3C	0.58						0
07010101-578	Kitchi Creek	Sucker Cr to Kitchi Lk	2C	0.22						0
07010101-579	Skimerhorn Creek (Skimmerhorn Creek)	Unnamed lk (04-0460-00) to T149 R30W S36, east line	2C	2.51						0
07010101-588	Crane Creek	Headwaters to Third R	2B, 3C	1.78						0
07010101-592	Unnamed creek	Headwaters to Upper Pigeon Lk	2B, 3C	1.96						0
07010101-595	Unnamed creek (Middle Pigeon Lake)	Middle Pigeon Lk (31-0892-00)	2B, 3C	1.09						0
07010101-601	Pigeon River (Pigeon Dam Lake)	Pigeon Dam Lk (31-0894-00)	2B, 3C	1.28						0
07010101-620	Pigeon River	T147 R27W S18, west line to Unnamed cr	2C	0.66						0
07010101-623	Skimerhorn Creek (Skimmerhorn Creek)	T149 R29W S31, west line to Skimerhorn Lk	2B, 3C	0.46						0
07010101-628	Island Lake Creek	Wetland to Lk Winnibigoshish (Third River Flowage)	2B, 3C	3.07						0
07010101-755	Mississippi River	Cass Lk (04-0030-00) thru Lk Winnibigoshish (11-0417-00)	2Bg, 3C	25.94						0
07010101-915	Unnamed creek	Wetland to Third R	2B, 3C	0.86						0
07010101-920	Stony Point Brook	Wetland to Lk Winnibigoshish	2C	1.42						0
07010101-560	Unnamed creek	Gilstad Lk to Little Gilstad Lk	2B, 3C	0.09						0
07010101-580	Skimerhorn Creek (Skimerhorn Lake)	Skimerhorn Lk (31-0939-00)	2B, 3C	0.6						0
07010101-907	Unnamed creek	Wetland to North Turtle R	2B, 3C	0.73						0
07010101-549	Lydick Brook	Headwaters to Mississippi R	2B, 3C	4.14						0
07010101-577	Kitchi Creek	Burns Lk to Sucker Cr	2C	5.81						0
07010101-596	Unnamed creek	Middle Pigeon Lk to Lost Lk outlet	2B, 3C	0.28						0
07010101-529	Lake Andrusia Artificial Path	Lk Andrusia (04-0038-00)	2B, 3C	3.6						0
07010101-593	Unnamed creek (Upper Pigeon Lake)	Upper Pigeon Lk (31-0908-00)	2B, 3C	0.37						0
07010101-621	Skimerhorn Creek (Skimmerhorn Creek)	Headwaters to Unnamed lk (04-0460-00)	2C	1.31						0
07010101-575	Kitchi Creek	Rice Lk outlet to Burns Lk	2C	4.06						0
07010101-597	Unnamed creek	Lost Lk outlet to Lower Pigeon Lk	2B, 3C	0.41						0
07010101-914	Unnamed creek	Coleman Lk to Decker Lk	2B, 3C	0.66						0
07010101-570	North Turtle River	Little Rice Pond outlet to Pimushe Lk	2B, 3C	2.45						0
07010101-606	Farley Creek	Farley Lk to Unnamed lk (31-0895-00)	2C	4.53						0
07010101-602	Pigeon River	Pigeon Dam to Unnamed lk (31-0895-00)	2B, 3C	0.03						0

Appendix G

Point Source and Feedlot Information

HUC-12 Subwatershed	Point Source		Pollutant Reduction Needed Beyond Current Permit Conditions/Limits?
	Permit #	Type	
Headwaters Grant Creek	MNG490109	Municipal wastewater	[No]
Lake Bemidji	MNG490139	Municipal wastewater	[No]
Lake Bemidji	MNG250027	Municipal wastewater	[No]
Lake Bemidji	MN0022462	Municipal wastewater	[No]
Lake Bemidji	MNG490038	Municipal wastewater	[No]
Lake Bemidji	MNG790166	Municipal wastewater	[No]
Deer River	MN0051616	Municipal wastewater	[No]
Mississippi River	MN0001007701	Municipal wastewater	[No]
Headwaters Little Mississippi River	007-64379	Feedlot	[No]
Headwaters Little Mississippi River	029-62802	Feedlot	[No]
Headwaters Little Mississippi River	029-62165	Feedlot	[No]
Headwaters Little Mississippi River	029-64132	Feedlot	[No]
Headwaters Little Mississippi River	029-65028	Feedlot	[No]
Headwaters Little Mississippi River	029-65026	Feedlot	[No]
Headwaters Little Mississippi River	029-63061	Feedlot	[No]
Headwaters Little Mississippi River	029-60650	Feedlot	[No]
Headwaters Little Mississippi River	029-60070	Feedlot	[No]
Headwaters Little Mississippi River	029-62975	Feedlot	[No]
Headwaters Grant Creek	007-60990	Feedlot	[No]
Headwaters Grant Creek	007-63059	Feedlot	[No]
Headwaters Grant Creek	007-64126	Feedlot	[No]
Headwaters Grant Creek	007-62072	Feedlot	[No]
Headwaters Grant Creek	007-64252	Feedlot	[No]
Headwaters Grant Creek	007-64120	Feedlot	[No]
Headwaters Grant Creek	007-64114	Feedlot	[No]
Grant Creek	007-64419	Feedlot	[No]
Little Mississippi River	007-64110	Feedlot	[No]
Little Mississippi River	007-64090	Feedlot	[No]
Little Mississippi River	029-63017	Feedlot	[No]
Little Mississippi River	029-62565	Feedlot	[No]
Bear Creek	029-62144	Feedlot	[No]
LaSalle Lake-Mississippi River	007-63851	Feedlot	[No]
Hennepin Creek	057-62060	Feedlot	[No]
Hennepin Creek	057-61614	Feedlot	[No]
Hennepin Creek	057-63033	Feedlot	[No]
Bootleg Lake-Mississippi River	057-60986	Feedlot	[No]
Bootleg Lake-Mississippi River	007-64108	Feedlot	[No]
Bootleg Lake-Mississippi River	007-62004	Feedlot	[No]
Bootleg Lake-Mississippi River	007-63064	Feedlot	[No]
Bootleg Lake-Mississippi River	007-64814	Feedlot	[No]
Bootleg Lake-Mississippi River	007-64277	Feedlot	[No]
Bootleg Lake-Mississippi River	007-62990	Feedlot	[No]
Birch Creek	057-62580	Feedlot	[No]
Birch Creek	057-64958	Feedlot	[No]
Alcohol Creek	057-61623	Feedlot	[No]
Alcohol Creek	057-64012	Feedlot	[No]
Alcohol Creek	057-61598	Feedlot	[No]

Lower Schoolcraft River	057-61900	Feedlot	[No]
Lower Schoolcraft River	057-65038	Feedlot	[No]
Long Lake	007-62013	Feedlot	[No]
Long Lake	007-64806	Feedlot	[No]
Little Turtle Lake	007-61901	Feedlot	[No]
Little Turtle Lake	007-62477	Feedlot	[No]
Little Turtle Lake	007-61531	Feedlot	[No]
Little Turtle Lake	007-62040	Feedlot	[No]
Little Turtle Lake	007-62043	Feedlot	[No]
Little Turtle Lake	007-62030	Feedlot	[No]
Turtle River Lake	007-62082	Feedlot	[No]
Gull River	007-62909	Feedlot	[No]
Gull River	007-63029	Feedlot	[No]
Rabideau Lake-North Turtle River	007-62992	Feedlot	[No]
Rabideau Lake-North Turtle River	007-63038	Feedlot	[No]
Rabideau Lake-North Turtle River	007-63036	Feedlot	[No]
Rabideau Lake-North Turtle River	007-64784	Feedlot	[No]
Rabideau Lake-North Turtle River	007-63030	Feedlot	[No]
Rabideau Lake-North Turtle River	007-63599	Feedlot	[No]
Rabideau Lake-North Turtle River	007-63829	Feedlot	[No]
Rabideau Lake-North Turtle River	007-64246	Feedlot	[No]
Alice Lake	007-64103	Feedlot	[No]
Lake Bemidji	007-63787	Feedlot	[No]
Lake Bemidji	007-63956	Feedlot	[No]
Stump Lake-Mississippi River	007-63991	Feedlot	[No]
Wolf Lake-Mississippi River	007-64704	Feedlot	[No]
Wolf Lake-Mississippi River	007-61855	Feedlot	[No]
Wolf Lake-Mississippi River	021-120517	Feedlot	[No]
Decker Lake	007-63595	Feedlot	[No]
Decker Lake	007-63828	Feedlot	[No]
Skimerhorn Creek-Third River	007-64415	Feedlot	[No]
Deer Lake	061-64465	Feedlot	[No]
Deer River	061-61862	Feedlot	[No]
White Oak Lake-Mississippi River	061-65648	Feedlot	[No]
White Oak Lake-Mississippi River	061-65486	Feedlot	[No]
White Oak Lake-Mississippi River	061-64992	Feedlot	[No]
White Oak Lake-Mississippi River	061-65233	Feedlot	[No]
Leighton Lake-Mississippi River	061-65091	Feedlot	[No]
Pokegama Lake	061-65096	Feedlot	[No]
Pokegama Lake	061-64628	Feedlot	[No]
Pokegama Lake	061-114687	Feedlot	[No]
Mississippi River	061-64450	Feedlot	[No]
Gill Lake-Mississippi River	029-62151	Feedlot	[No]

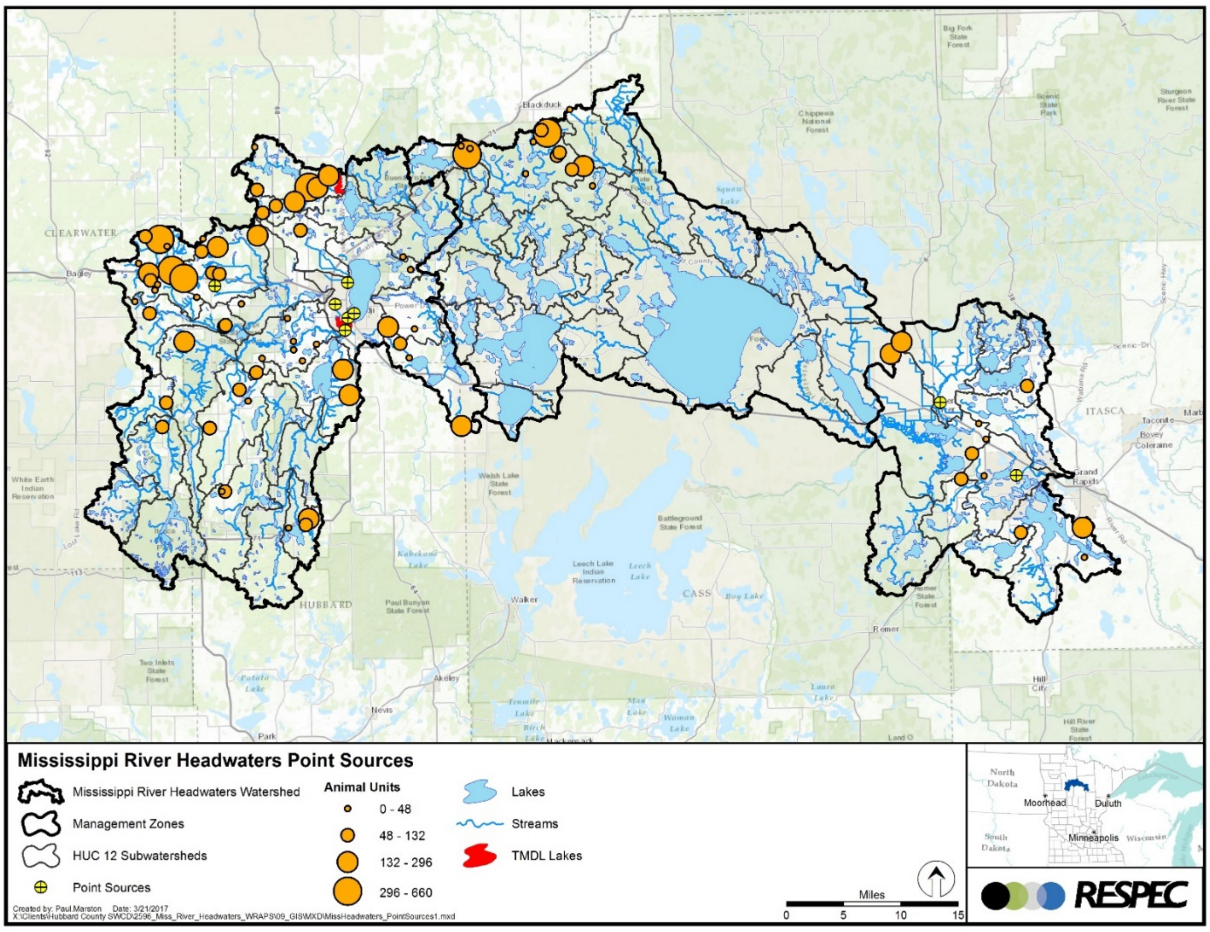

Figure 54: Mississippi River Headwaters Point Source and Feedlot Locations