Watershed health

July 2019

Mississippi River – Sartell Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

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List of acronyms

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

DNR Minnesota Department of Natural Resources

DOP Dissolved Orthophosphate

E Eutrophic

EPA U.S. Environmental Protection Agency

EQuIS Environmental Quality Information System

EXS Exceeds Criteria, Potential Severe Impairment

SUP Full Support

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

IMP Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WID Waterbody Identification Number

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The Mississippi River-Sartell Watershed (07010201) includes portions of Benton, Crow Wing, Mille Lacs, Morrison, Stearns, and Todd Counties in central Minnesota. The Mississippi River flows through the central portion of this watershed. Many tributary streams enter the Mississippi River along its course. The Mississippi River experiences one of its greatest drops in elevation in the Upper Mississippi River Basin within this watershed. From the community of Little Falls (just outside the watershed to the north) to Royalton, the river drops 6 ½ feet for every mile of river.

The Platte River located on the east side of the Mississippi River originates approximately five miles northeast of the town of Harding. It flows southwest collecting many smaller tributaries as it passes through the towns of Pierz and Hillman eventually flowing into the Mississippi four miles southwest of Royalton. On the west side of the Mississippi River the Watab River begins near the town of Avon and flows east collecting smaller tributaries before flowing into the Mississippi two miles east of Sartell. Similarly, Spunk Creek originates near Avon and flows northeast through a series of lakes, collecting tributaries along its way to the Mississippi River four miles northeast of Rice. Major communities located within the watershed include Lastrup, Pierz, Buckman, Royalton, Upsala, Bowlus, Rice, Holdingford, Avon, St. Joseph, and Sartell. The watershed consists of 879 total river miles, draining approximately 652,800 acres (1,020mi^2) and includes 43 named stream assessment units (WIDs). There are 232 lakes within the watershed covering a total of 13,319 acres.

The lakes are primarily situated in the northeastern and southwestern corners of the watershed. A diverse network of tributaries occur throughout the central region of the watershed. The excessively drained sand plain regions are some of the most intensively used lands within the watershed. Many of these areas are along the Mississippi River (MPCA, Mississippi River-Sartell Webpage).

The lakes and streams within the Mississippi River-Sartell Watershed provide habitat for aquatic life, riparian corridors for wildlife, and recreational opportunities such as fishing, swimming and canoeing. Today, land use in the watershed is roughly 35% grass/pasture/hay, 29% row crops, 19% forested, and 9% wetlands, and 3% rangeland respectively. Five percent of the watershed is developed land used for housing, business and industrial complexes, county roads and city streets, and less than 1% is open water (Figure 6).

In 2016, the Minnesota Pollution Control Agency (MPCA) initiated an intensive watershed monitoring (IWM) effort of the Mississippi River-Sartell Watershed's surface waters. Fifty-nine stream sites were sampled for biology at the outlets of various sized subwatersheds, which included the mainstem Platte River, Watab and Spunk Creeks, outlets of major tributaries, and the headwaters of smaller streams. As part of this effort, MPCA staff joined with the Morrison and Benton County Soil and Water Conservation Districts to complete stream water chemistry sampling. In 2017, a holistic approach was taken to assess all of the watershed's surface waterbodies for support or non-support of aquatic life, recreation, and fish consumption, where sufficient data was available.

The Mississippi River-Sartell Watershed has high quality lake basins, some of which have increasing water clarity trends over time. Three lake basins deemed impaired for aquatic recreation prior to this assessment effort have newer data showing poor recreational condition persists. Minnesota Department of Natural Resources (DNR) fish community data revealed 90% of lakes assessed within this watershed meet goals that support aquatic communities. Fish species sensitive to water pollution were observed in several lakes. Challenges lie ahead in maintaining the high water quality of the watersheds lakes, as these basins are highly developed and utilized for recreation. Strategies to protect the high water quality of many of the watersheds lakes should be developed for future generations.

Of the stream reaches monitored and assessed in this effort, 27% failed to meet aquatic life use criteria, while 70% of stream reaches failed aquatic recreation use criteria. High levels of bacteria are found in the majority of the assessed stream reaches. Efforts to address past recreational use impairments have been completed for some stream reaches. Five stream reaches, including Little Rock Creek had low dissolved oxygen, which can impact aquatic communities.

The main resource concerns in the watershed include (MPCA, Mississippi River-Sartell Webpage):

- Loss of shoreline buffers and habitat due to development.
- Introduction of large amounts of phosphorus, sediment, and bacteria to surface waters.
- Increased nutrient, contaminant, and sedimentation loading from stormwater runoff from development and other non-point sources.
- Loss of biodiversity due to competition from invasive species.
- Relatively high percentage of agricultural and urban/residential land uses within the riparian or sensitive areas of the watershed.
- Protecting drinking water supplies from bacteria impairments.

Introduction

Water is one of Minnesota's most abundant and precious resources. The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) which requires states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of water bodies that do not meet established standards. Such waters are referred to as "impaired waters" and the state must make appropriate plans to restore these waters, including the development of total maximum daily loads (TMDLs). A TMDL is a comprehensive study determining the assimilative capacity of a waterbody, identifying all pollution sources causing or contributing to impairment, and an estimation of the reductions needed to restore a water body so that it can once again support its designated use.

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment. To successfully prevent and address problems, decision makers need good information regarding the status of the resources, potential and actual threats, options for addressing the threats and data on the effectiveness of management actions. The MPCA's monitoring efforts are focused on providing that critical information. Overall, the MPCA is striving to provide information to assess, and ultimately, to restore or protect the integrity of Minnesota's waters.

The passage of Minnesota's Clean Water Legacy Act in 2006 provided a policy framework and the initial resources for state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. This work is implemented on an on-going basis with funding from the Clean Water Fund created by the passage of the Clean Water Land, and Legacy Amendment to the state constitution. To facilitate the best use of agency and local resources, the MPCA has developed a watershed monitoring strategy, which uses an effective and efficient integration of agency and local water monitoring programs to assess the condition of Minnesota's surface waters, and to allow for coordinated development and implementation of water quality restoration and improvement projects.

The strategy behind the watershed monitoring approach is to intensively monitor streams and lakes within a major watershed to determine the overall health of water resources, identify impaired waters, and to identify waters in need of additional protection. The benefit of the approach is the opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. The watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and non-point sources of pollution and further the CWA goal of protecting and restoring the quality of Minnesota's water resources.

This watershed-wide monitoring approach was implemented in the Mississippi River-Sartell Watershed beginning in the summer of 2016. This report provides a summary of all water quality assessment results in the Mississippi River-Sartell Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Minnesota's Water Quality Monitoring Strategy 2011 to 2021 https://www.pca.state.mn.us/sites/default/files/p-gen1-10.pdf

Watershed pollutant load monitoring

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term statewide river monitoring network initiated in 2007 and designed to obtain pollutant load information from 199 river monitoring sites throughout Minnesota. Monitoring sites span three ranges of scale:

Basin – major river main stem sites along the Mississippi, Minnesota, Rainy, Red, Des Moines, Cedar and St. Croix rivers

Major Watershed – tributaries draining to major rivers with an average drainage area of 1,350 square miles (8-digit HUC scale)

Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 square miles

The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads.

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale (Figure 1). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 80 major watersheds (HUC-8) within Minnesota. Using this approach, many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least one year within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, HUC-8, aggregated HUC-12 and HUC-14 (Figure 1). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the HUC-8 scale. The outlet of the major HUC-8 watershed (purple dot in Figure 2) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The aggregated HUC-12 is the next smaller subwatershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated HUC-12 outlet (green dots in Figure 2) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each aggregated HUC-12, smaller watersheds (HUC-14s, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated HUC-12 tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 2).

Figure 1. The intensive watershed monitoring design.

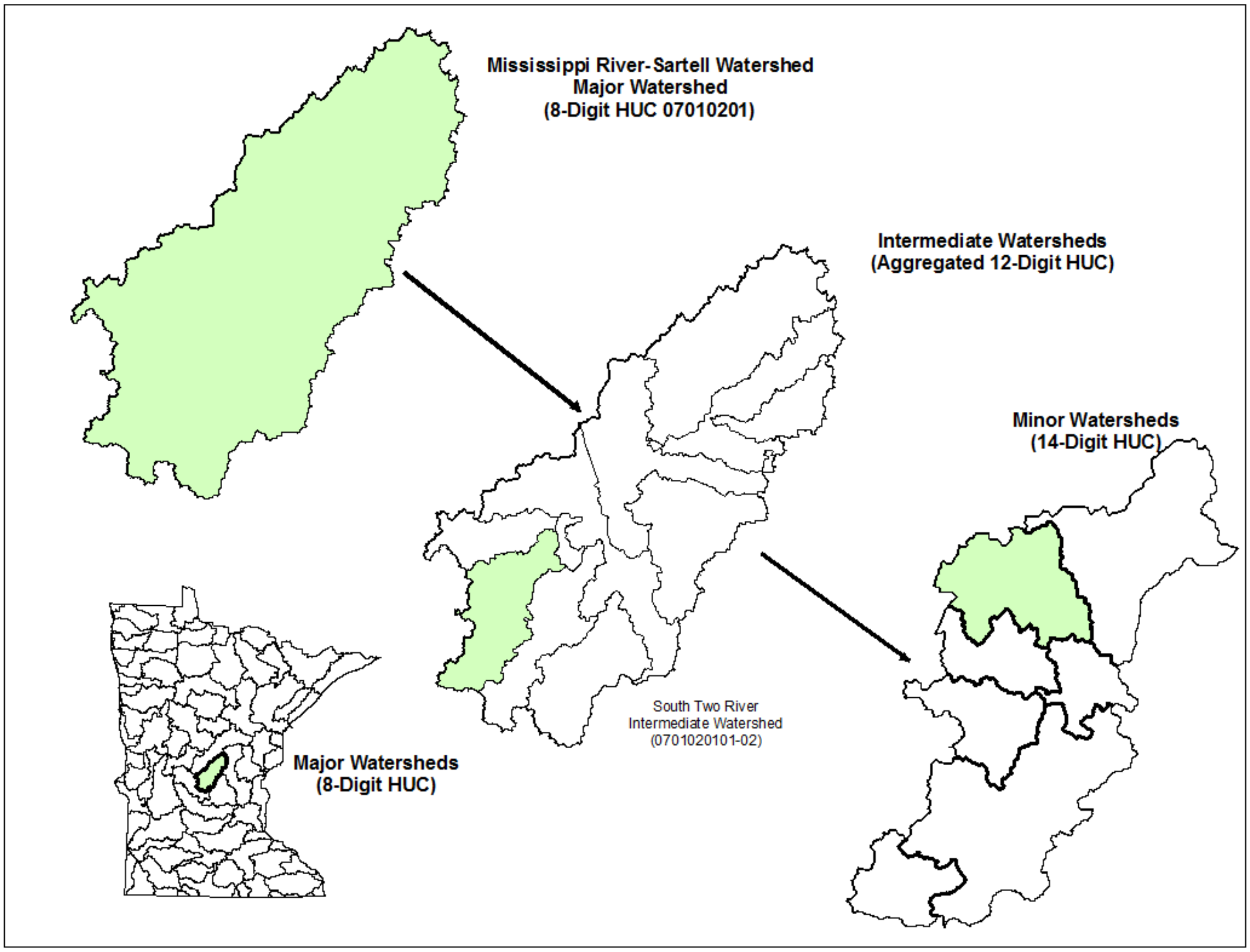
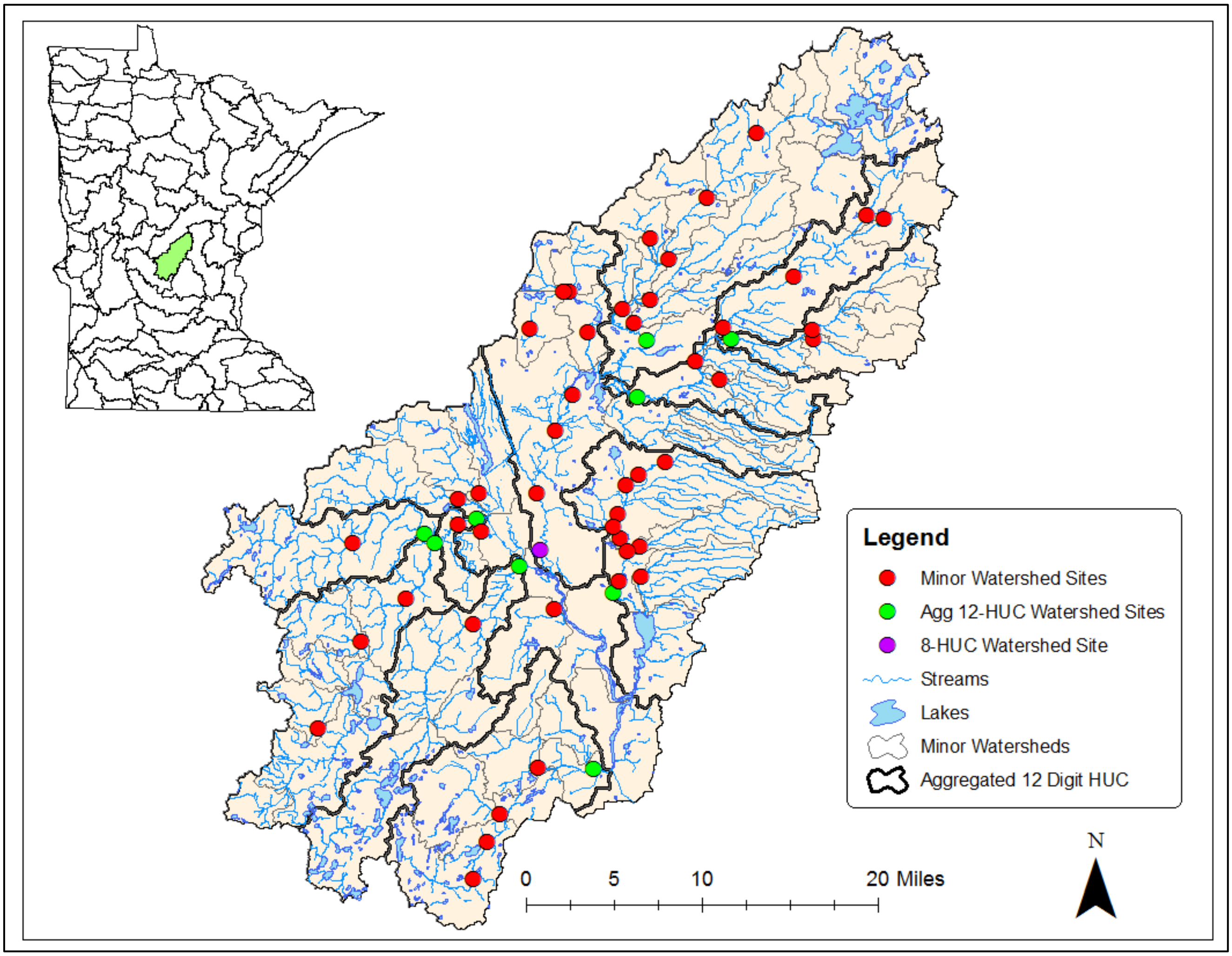


Figure 2. Intensive watershed monitoring sites for streams in the Mississippi River-Sartell Watershed.



Lake monitoring

Lakes most heavily used for recreation are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported and where applicable, where fish community health can be determined. Lakes are prioritized by size (greater than 100 acres), accessibility (can the public access the lakes), and presence of recreational use.

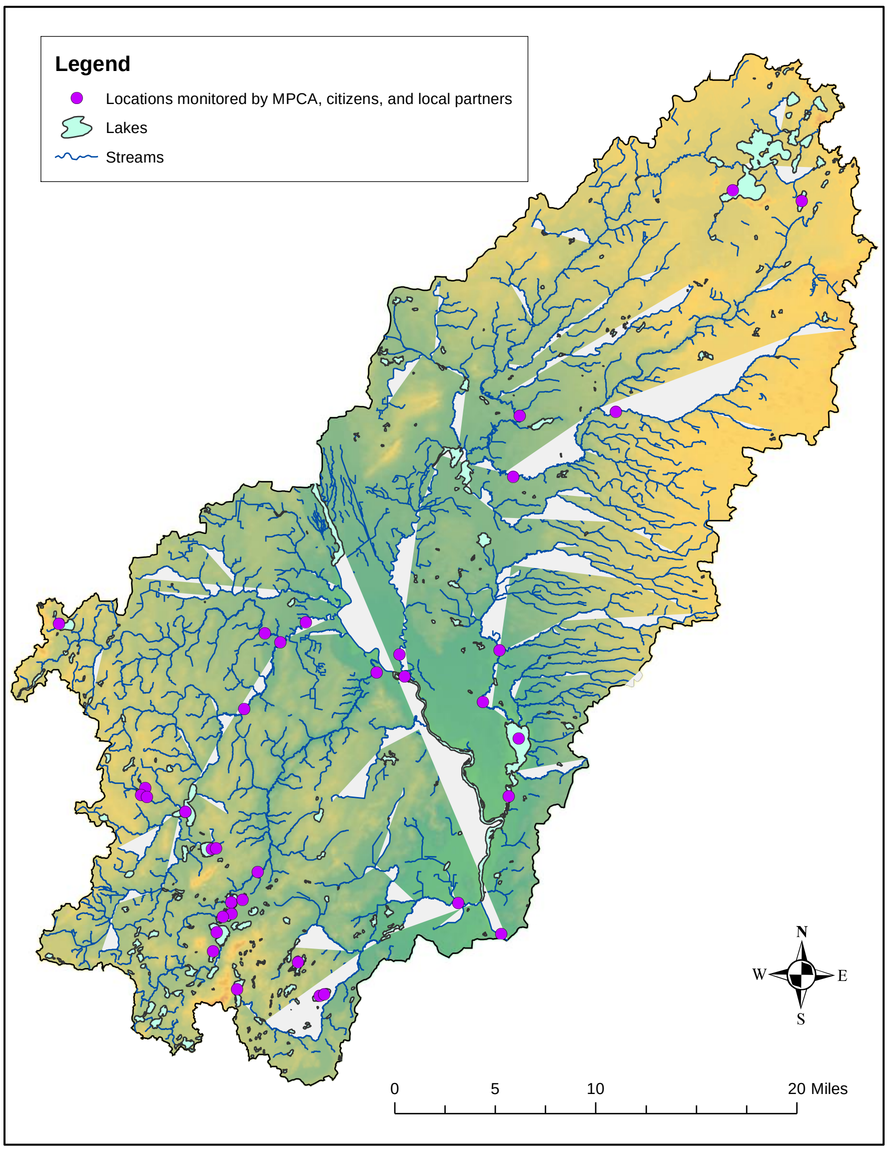
Specific locations for sites sampled as part of the intensive monitoring effort in the Mississippi River-Sartell Watershed are shown in Figure 2 and are listed in Appendices 2.1 and 2.2.

Citizen and local monitoring

Citizen and local monitoring is an important component of the watershed approach. The MPCA and its local partners jointly select the stream sites and lakes to be included in the intensive watershed monitoring process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments the ability to see how their efforts are used to inform water quality decisions and track how management efforts affect change. Many SWAG grantees invite citizen participation in their monitoring projects and their combined participation greatly expand our overall capacity to conduct sampling.

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 3 provides an illustration of the locations where citizen-monitoring data were used for assessment in the Mississippi River-Sartell Watershed.

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Mississippi River-Sartell Watershed.



Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment, methodologies see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012)*. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams and wetlands are protected for aquatic life and recreation where these uses are attainable. Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses.

Protection of aquatic recreation means the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of *Escherichia coli (E. coli)* bacteria in the water. To determine if a lake supports aquatic recreational activities its trophic status is evaluated, using total phosphorus, Secchi depth and chlorophyll-a as indicators. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this beneficial use. The concentrations of mercury and polychlorinated biphenyls (PCBs) in fish tissue are used to evaluate whether or not fish are safe to eat in a lake or stream and to issue recommendations regarding the frequency that fish from a particular water body can be safely consumed. For lakes, rivers and streams that are protected as a source of drinking water the MPCA primarily measures the concentration of nitrate in the water column to assess this designated use.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, macroinvertebrates, and plants. Biological monitoring, the sampling of aquatic organisms, is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI). This index is a scientifically validated combination of measurements of the biological community (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a site. The MPCA has developed stream IBIs for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. The MPCA also uses a lake fish IBI developed by the Minnesota Department of Natural Resources (DNR) to determine if lakes are meeting aquatic life use. Because the lakes, rivers, and streams in Minnesota are physically, chemically, and biologically diverse, IBI's are developed separately for different stream classes and lake class groups to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life. For streams, these include pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride, total suspended solids, pesticides, and river eutrophication. For lakes, pesticides and chlorides contribute to the overall aquatic life use assessment.

Protection for aquatic life uses in streams and rivers are divided into three tiers: Exceptional, General, and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that can be characterized as having an overall balanced distribution of the assemblages and with the ecosystem functions largely maintained through redundant attributes. Modified Use waters have been extensively altered through legacy physical modifications, which limit the ability of the biological communities to attain the General Use. Currently the Modified Use is only applied to streams with channels that have been directly altered by humans (e.g., maintained for drainage). These tiered aquatic life uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat (MPCA 2015). For additional information, see: http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/tiered-aquatic-life-use-talu-framework.html).

Table 1. Tiered aquatic life use standards.

Tiered aquatic life use	Acronym	Use class code	Description
Warm water General	WWg	2Bg	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the General Use biological criteria.
Warm water Modified	WWm	2Bm	Warm water Stream protected for aquatic life and recreation, physically altered watercourses (e.g., channelized streams) capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Modified Use biological criteria, but are incapable of meeting the General Use biological criteria as determined by a Use Attainability Analysis
Warm water Exceptional	WWe	2Be	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Exceptional Use biological criteria.
Coldwater General	CWg	2Ag	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of cold water aquatic organisms that meet or exceed the General Use biological criteria.

Tiered aquatic life use	Acronym	Use class code	Description
Coldwater Exceptional	CWe	2Ae	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of cold water aquatic organisms that meet or exceed the Exceptional Use biological criteria.

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, dissolved oxygen and toxic pollutants.

Assessment units

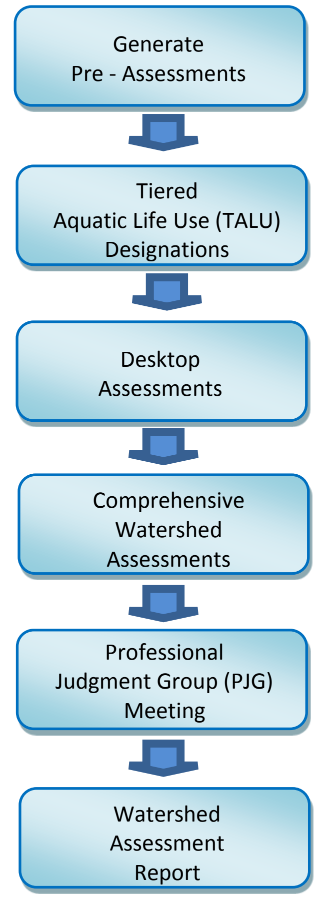
Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R. ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its WID), comprised of the USGS 8-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the DNR. The Protected Waters Inventory (PWI) provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the WID and are composed of an eight-digit number indicating county, lake and bay for each basin.

It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). Over the course of time it takes fish, particularly game fish, to grow to "catchable" size and accumulate unacceptable levels of pollutants, there is a good chance they have traveled a considerable distance. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach and thus often includes several assessment units.

Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 4.

Figure 4. Flowchart of aquatic life use assessment process.



The first step in the aquatic life assessment process is largely an automated process performed by logic programmed into a database application where all data from the 10 year assessment window is gathered; the results are referred to as 'Pre-Assessments'. Data filtered into the "Pre-Assessment" process is then reviewed to insure that data is valid and appropriate for assessment purposes. Tiered aquatic life use designations are determined before data is assessed based on the attainment of the applicable biological criteria and/or an assessment of the habitat. Stream reaches are assigned the highest aquatic life use attained by both biological assemblages on or after November 28, 1975. Streams that do not attain the Exceptional or General Use for both assemblages undergo a Use Attainability Analysis (UAA) to determine if a lower use is appropriate. A Modified Use can be proposed if the UAA demonstrates that the General Use is not attainable as a result of legal human activities (e.g., drainage maintenance, channel stabilization) which are limiting the biological assemblages through altered habitat. Decisions to propose a new use are made through UAA workgroups, which include watershed project managers and biology leads. The final approval to change a designated use is through formal rulemaking.

The next step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. Pre-assessments are then reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are conducted at the workstation of each reviewer (i.e., desktop) using computer applications to analyze the data for potential temporal or spatial trends as well as gain a better understanding of any extenuating circumstances that should be considered (e.g., flow, time/date of data collection, or habitat).

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2016) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04j.pdf for guidelines and factors considered when making such determinations.

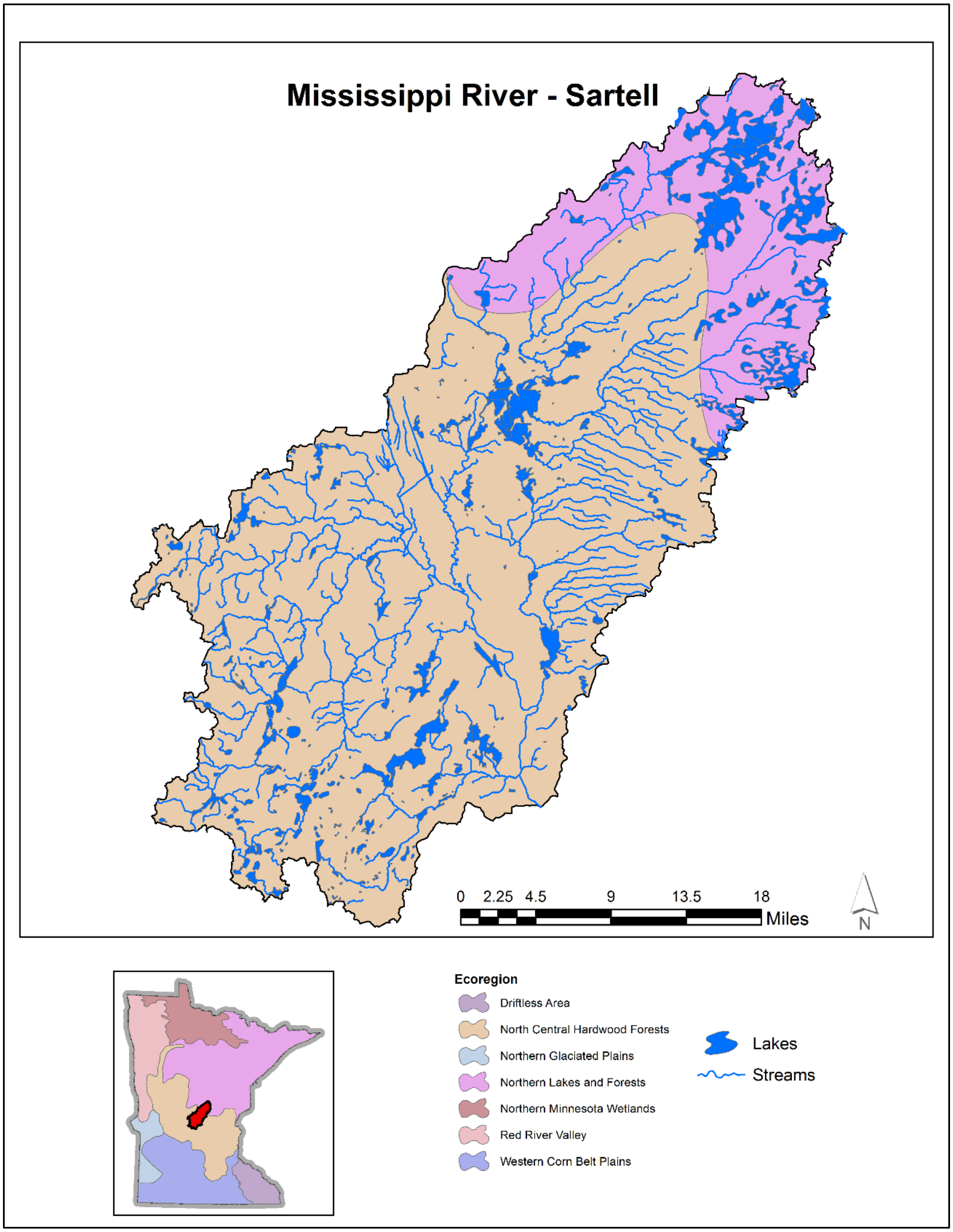
The last step in the assessment process is the Professional Judgment Group meeting. At this meeting, results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling events that may have been uncharacteristic due to annual climate or flow variation, local factors such as impoundments that do not represent the majority of conditions on the WID). Waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are also included in watershed monitoring and assessment reports.

Watershed overview

The Mississippi River-Sartell Watershed drains approximately 1,020 square miles in central Minnesota. The watershed includes parts of Crow Wing, Morrison, Mille Lacs, Todd, Stearns, and Benton counties. The Mississippi River flows through the central portion of this watershed and on its way collects water from several tributaries. The Mississippi River sees its greatest change in elevation within this watershed as it drops nearly 6 ½ feet for every mile of river. The Mississippi River main stem will not be covered in the results and discussion portion of this report; the river was monitored and assessed as part of a Large River Monitoring and Assessment strategy which was piloted on the Upper Mississippi River in 2013 (Large river monitoring | Minnesota Pollution Control Agency); conditions along this stretch of the Mississippi River were found to be supporting recreation and aquatic life uses.

The Mississippi River-Sartell Watershed lies within the southern portion of the Northern Lakes and Forests (NLF) ecoregion and northern portion of the North Central Hardwood Forests (NCHF) ecoregion Figure 5. The NLF ecoregion is dominated by nutrient-poor glacial soils, extensive sandy outwash plains, and broad lacustrine basins which a variety of coniferous and northern hardwood forests commonly grow. Most streams in this ecoregion are perennial, and commonly originate in lakes and wetlands. Most of the land in this ecoregion is forested, however, where there is agriculture, farming takes place in small fields often used for feed and grazing of beef and dairy cattle (Omernik, 1988). The NCHF ecoregion is transitional between the forested NLF and the more agricultural dominated ecoregions to the South. The ecoregion is comprised of mainly rolling glacial till plains, lacustrine basins, outwash plains, and rolling moraines. Lake clusters are prominent in the western half. Almost one-third of the land is cultivated to feed primarily dairy cattle. Poultry farms are concentrated in some areas. Typical irrigated crops found in this ecoregion are: potatoes, corn, and soybeans (Omernik, 1988).

Figure 5. The Mississippi River-Sartell Watershed lies within the North Central Hardwood Forests and Northern Lakes and Forests ecoregion of Central Minnesota.



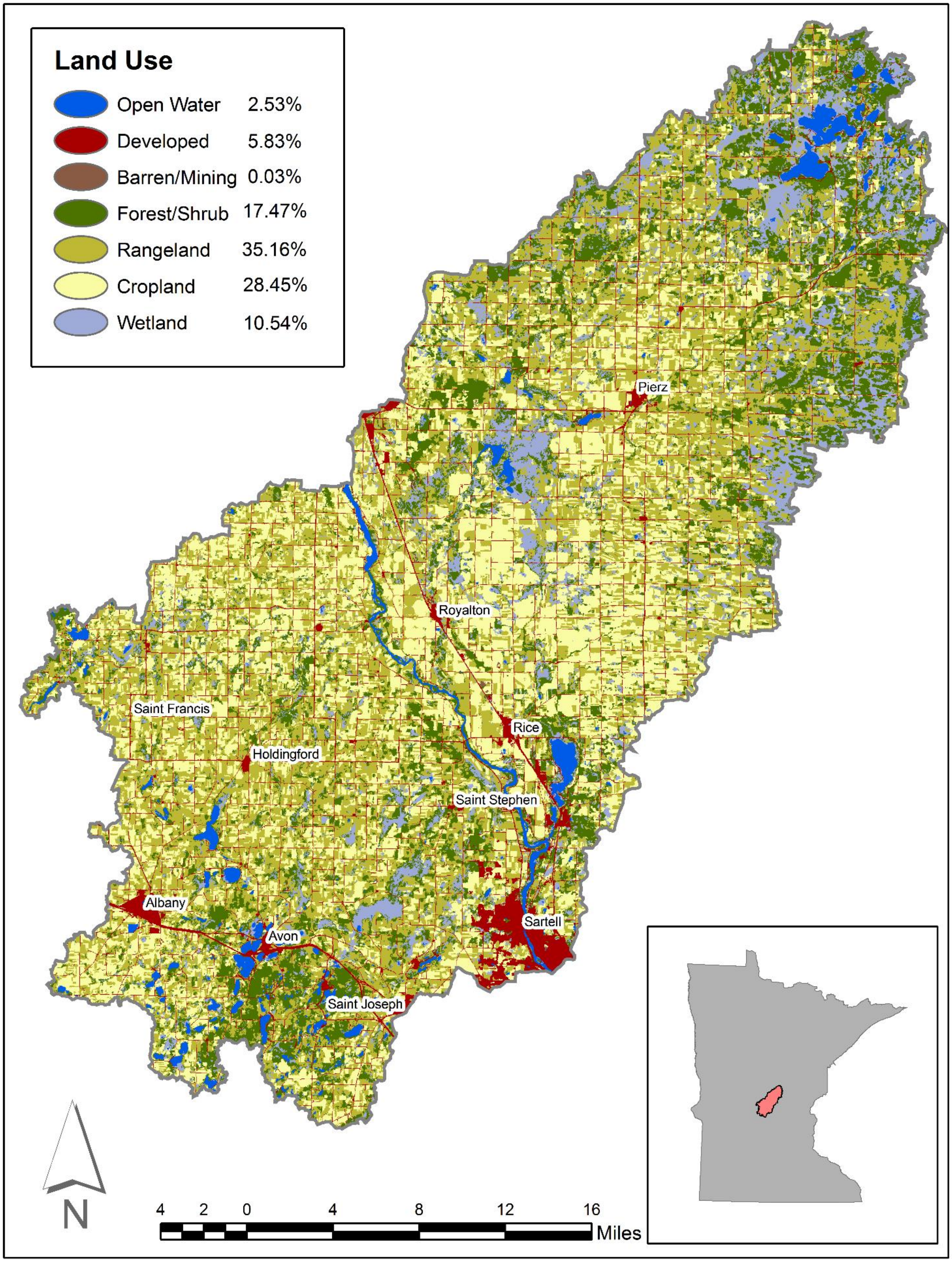
Land use summary

Historically the central Minnesota region was rich in resources such as fur and timber. The fur trade industry began during the mid-seventeenth century and continued to be the most prominent industry of the Upper Mississippi River Valley until the mid-1800s, when logging took over as the largest industry in Minnesota. The logging industry was instrumental in populating the state of Minnesota by providing jobs, raw materials for construction, and by creating markets for agriculture (Larson 2007). The expansion of the railroads used to haul lumber resources also aided in exposing areas of the Upper Mississippi River Valley to settlement. From 1860-1880 the population of Minnesota increased from 172,000 to 780,000 people (Larson 2007). The Mississippi River and its tributaries were an important resource used by the lumber industry for transporting logs and other goods. Businesses such as the Pine Tree Lumber Company and Hennepin Paper Company, which began their operations in 1890, took advantage of the waterpower of the Mississippi River (Morrison County Historical Society). By the early 1900s, majority of the white pine in the state had been harvested. Many of the larger sawmills in the state closed down forcing the men they employed to find a new occupation (Larson 2007). Lumber companies sold large amounts of the cut over land to farmers and other prospective settlers (Larson 2007).

Today land use in the Mississippi River – Sartell Watershed is primarily dominated by two forms of agriculture: rangeland (35.2%) and cropland (28.5%). Forest/shrub land covers 17.5% while wetlands make up 10.5% of the land. Developed land (5.8%) is most prominent in the southern portion of the watershed, particularly along Interstate 94 and Highway 10. According to the Benton County Soil and Water Conservation District (SWCD), the majority of the watershed is under private ownership (approximately 96%). Open Water (2.3%) is most prominent in the northeast portion and southwest portion of the watershed. Figure 6 shows all of the current land uses in the HUC-8.

Land use patterns in the watershed appear to be associated with differences in the water quality of lakes and streams. Water quality data on the lakes in the watershed reveals that most lakes have good water quality and transparency. However, Two Rivers and Little Rock Lakes were found to have high levels of nutrients that commonly result in algal blooms. The lakesheds of these two lake are dominated by primarily row crop agriculture. Monitoring of nutrients, such as phosphorus, and sediment in streams reflects the different land uses in the watershed. Lower levels of sediment in streams are found east of Highway 10; this is attributed to less intensive agricultural activities in this part of the watershed. Erosion of soils from the watershed and in the stream channel are typically the primary sources of sediment. Phosphorus in streams generally increases from North to South. This is indicative of more cropland and a higher density of livestock operations in the southern part of the watershed. Bacteria are also monitored throughout the watershed with high concentrations found in different parts of the watershed, which can be attributed to wastewater (treatment plants, pipes, and septic systems), livestock, wildlife, pets, and other natural sources. (Benton County SWCD)

Figure 6. Land use in the Mississippi River – Sartell Watershed.



Surface water hydrology

The Mississippi River-Sartell Watershed is a flow-through type watershed comprised of 11 intermediate sized subwatersheds (Aggregated HUC-12) totaling approximately 652,800 acres (1,020 square miles). There are 879 total river miles, and 232 lakes. The Mississippi River flows from Blanchard Dam through the central portion of the watershed to the Sartell Dam. The major tributaries to the Mississippi River that enter from the north inlcude the Platte and Skunk Rivers, and Little Rock Creek which flows south to Little Rock Lake, and then west to the Mississippi River. The North and South Two Rivers enter the Mississippi River from the south and flow northeast to form the Two River, which flows east to the Mississippi River. Spunk Creek and the Watab River also flow northeast to the Mississippi River. More detailed flow patterns for each tributary can be found in the aggregated HUC-12 subwatershed overviews.

Historically, a number of dams were built on area lakes and rivers to aid in log transportation, control water levels, and provide electricity to local towns. Today, a number of dams still exist within the watershed with different intended uses. There are two hydroelectric dams located on the Mississippi River; Blanchard Dam south of Little Falls and west of Royalton, and the Sartell Dam. There is a dam on the Skunk River in Pierz Park Campground that is used to create a pool for swimming. Three dams exist on the Platte River with two being near Platte and Sullivan Lakes. Further downstream near Crane Meadows National Wildlife Refuge, a dam used for flood control is located at the outlet of the Rice/Skunk wetland complex. In addition to dams, over half of the streams in the watershed have been altered (i.e. channelized) in some way. Figure 7 shows a map of percent altered streams by Huc-8 across the state. Figure 8 shows a closer breakdown of natural streams versus altered streams within the Mississippi River-Sartell major watershed.

Figure 7. Map of percent altered streams by major watershed (8-HUC).

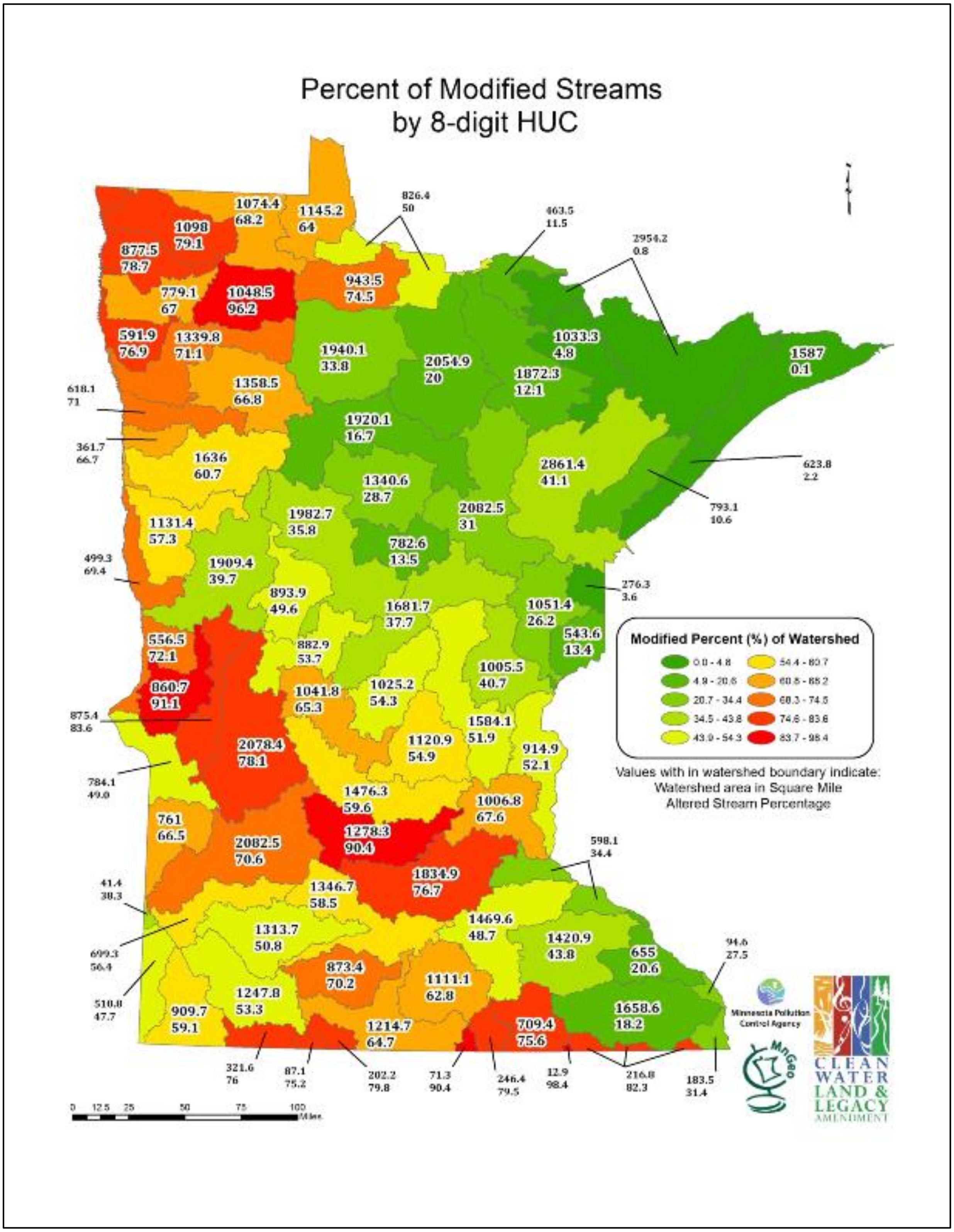
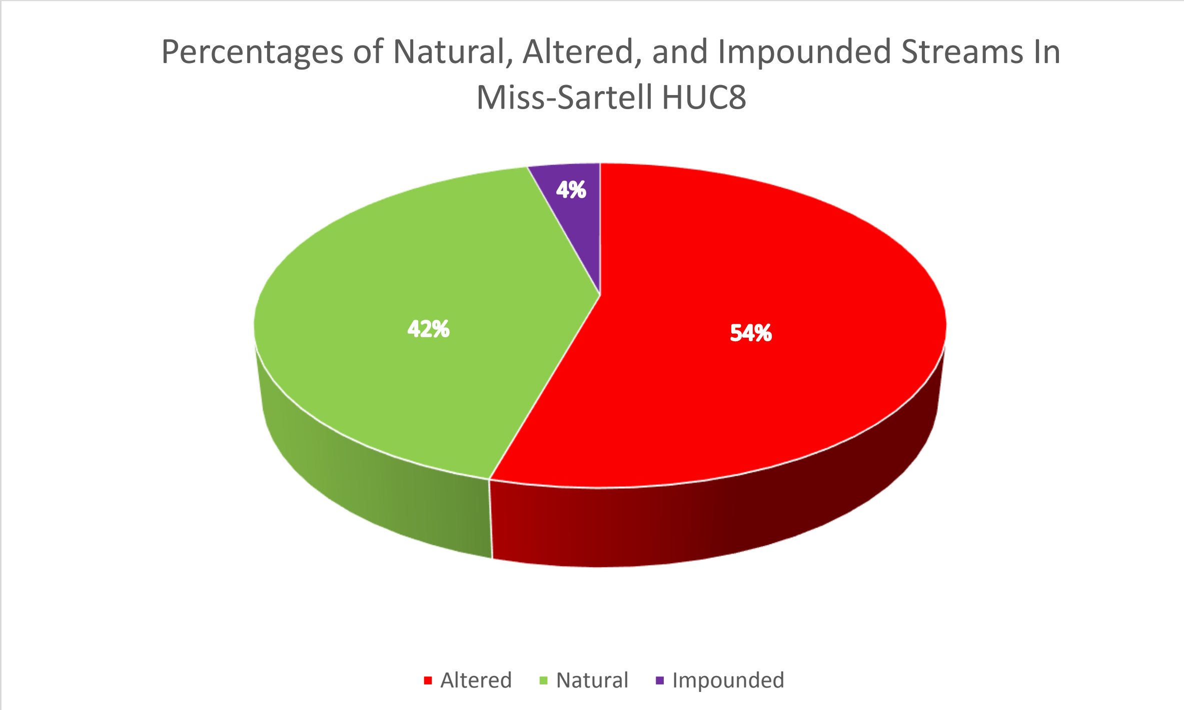


Figure 8. Comparison of natural to altered streams in the Mississippi River – Sartell Watershed (percentages derived from the Statewide Altered Water Course project).



Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota ranges from 2.2 to 9.4˚C (NOAA); the mean summer (June-August) temperature for the Mississippi River-Sartell Watershed is 19.4˚C and the mean winter (December-February) temperature is -10.0˚ C (DNR: Minnesota State Climatology Office, 2019a).

Precipitation is an important source of water input to a watershed. Figure 9 displays two representations of precipitation for calendar year 2016. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the southeastern portion of the state. According to this figure, the Mississippi River-Sartell Watershed area received 28 to 32 inches of precipitation in 2016. The display on the right shows the amount that precipitation levels departed from normal. The watershed area experienced precipitation that ranged from two to six inches above normal in 2016.

The Mississippi River-Sartell Watershed is located in the Central precipitation region. Figure 10 displays the areal average representation of precipitation in Central Minnesota for 20 and 100 years, top and bottom respectively. Though rainfall can vary in intensity and time of year, rainfall totals in the Central regions display no significant trends over the last 20 years. However, precipitation in this region does exhibit a significant rising trend over the past 100 years ($p<0.001$). This is a strong trend and matches similar trends throughout Minnesota.

Figure 9. Statewide precipitation total (*left*) and precipitation departure (*right*) during 2016 (Source: DNR State Climatology Office, 2019b)

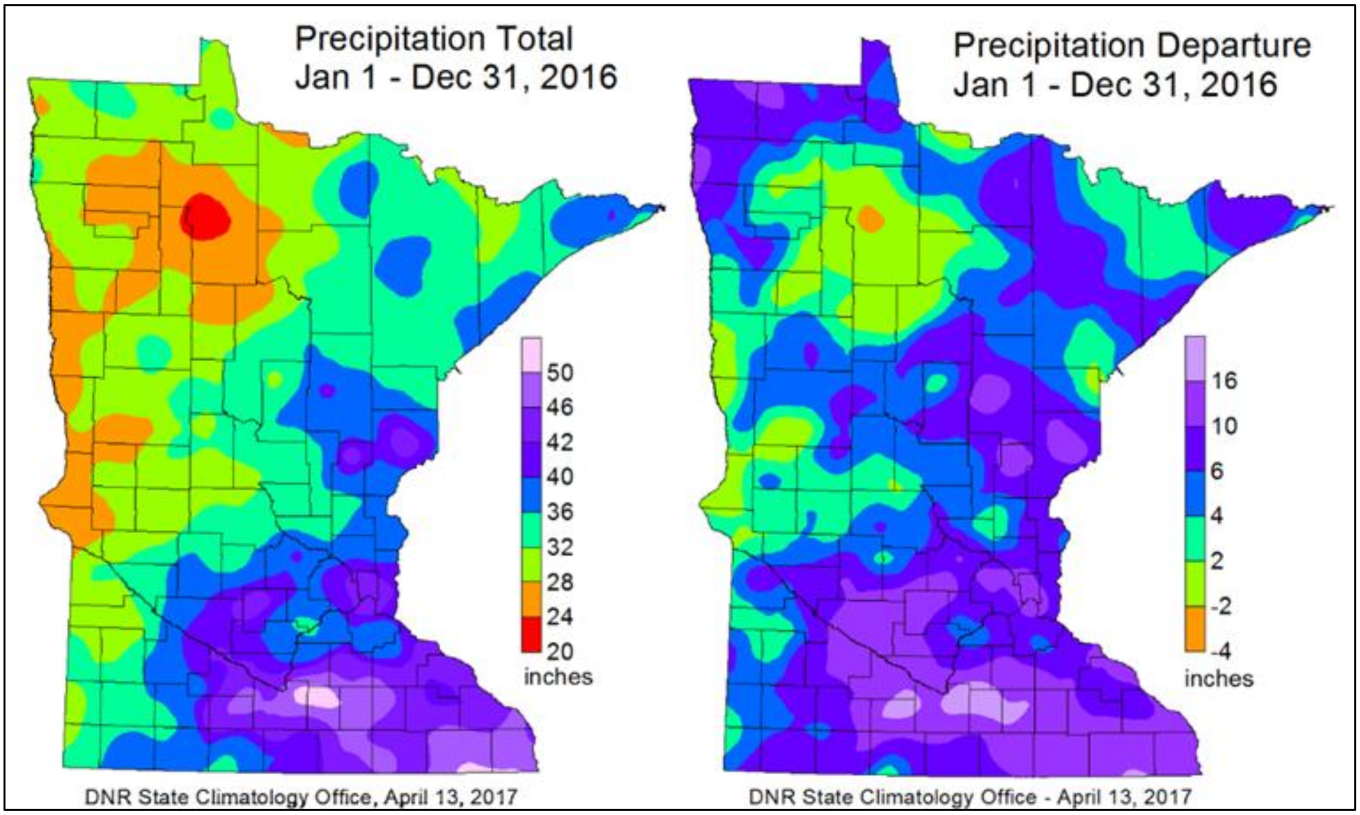
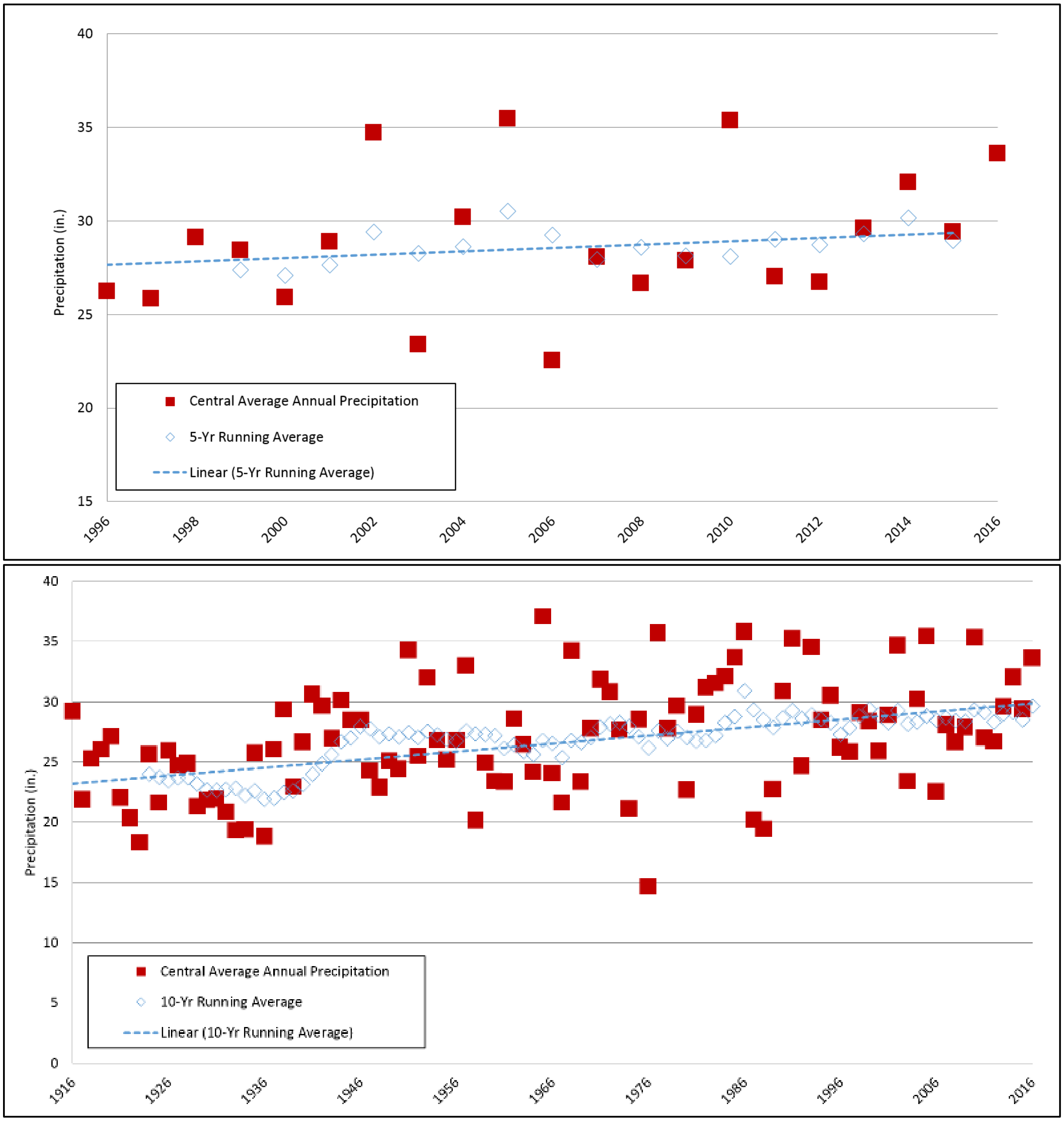


Figure 10. Precipitation trends in Central Minnesota from 1997-2016 (*top*) and 1917-2016 (*bottom*) (Source: WRCC, 2018).



Hydrogeology and groundwater quality

Hydrogeology

Hydrogeology is the study of the interaction, distribution and movement of groundwater through the rocks and soil of the earth. The geology of a region strongly influences the quantity of groundwater available, the quality of the water, the sensitivity of the water to pollution, and how quickly the water will be able to recharge and replenish the source aquifer. This branch of geology is important to understand as it indicates how to manage groundwater withdrawal and land use and can determine if mitigation is necessary.

Surficial and bedrock geology

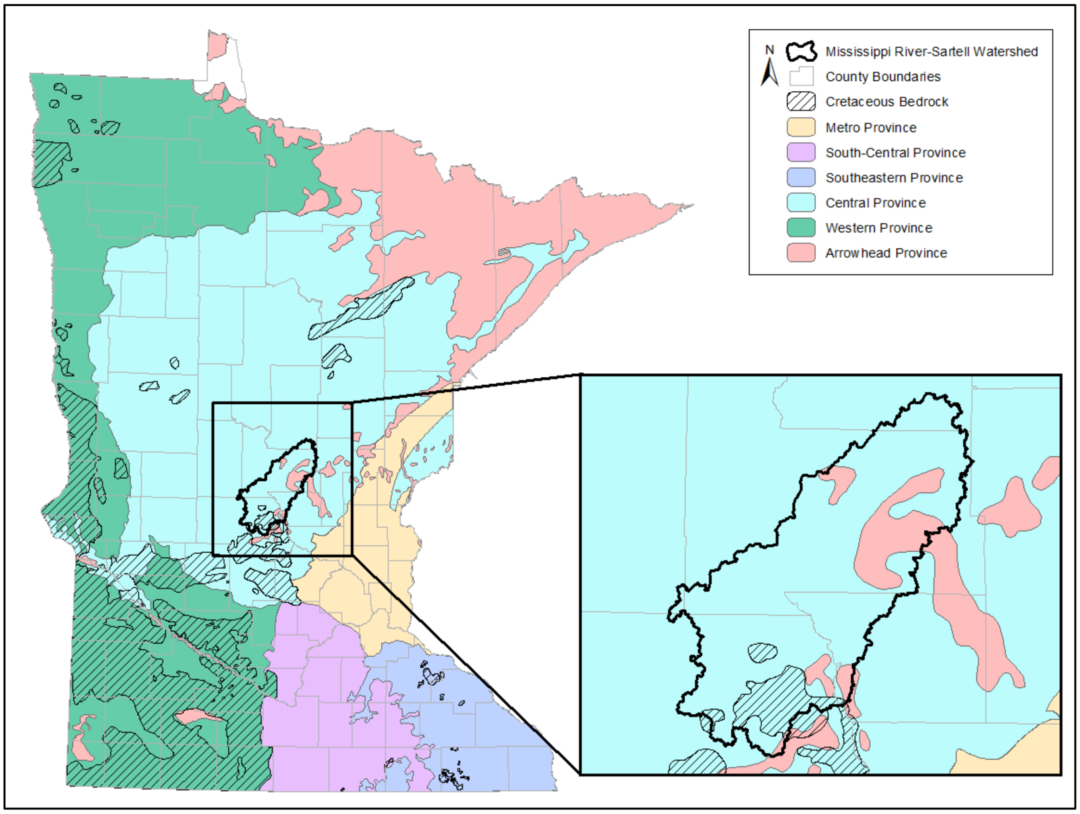
Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface in much of the Mississippi River-Sartell Watershed and is the parent material for the soils that have developed since glaciation. The depth to bedrock ranges from exposed at the surface to over 375 feet and is buried by deposits of the various ice lobes that reached this watershed during the last glacial period, as well as during previous glaciations in the last 2.58 million years. The deposits at the surface are associated with three ice lobes, the Des Moines, Rainy and Superior lobes, and post-glacial alterations to that sediment, including soil formation and peat accumulation. The geomorphology includes moraines (end, ground and stagnation), outwash, and terraces (Hobbs & Goebel, 1982).

Bedrock is the main mass of rocks that form the Earth, located underneath the surficial geology and can be seen in only a few places where weathering has exposed the bedrock. Precambrian bedrock lies under the extent of the Mississippi River-Sartell Watershed. The main terrane groups include the Little Falls Formation, East-Central Minnesota batholith, Hillman tonalite, Sartel gneiss, as well as mafic intrusions containing pyroxenite, peridotite, gabbro and lamprophyre scattered throughout the watershed (Jirsa et al., 2011). Additionally, Cretaceous bedrock associated with the Mesozioc era, is found in the lower section of this watershed, overlying the Precambrian bedrock. This formation is undifferentiated and includes conglomerate, sandstone, shale and mudstone. The rock types that are found in the uppermost bedrock include amphibolite, argillite, diorite, granodiorite, sandstone, and schist (Morey & Meints, 2000).

Aquifers

Groundwater aquifers are layers of water-bearing units that readily transmit water to wells and springs (USGS, 2016). As precipitation hits the surface, it infiltrates through the soil zone and into the void spaces within the geologic materials underneath the surface, saturating the material and becoming groundwater (Zhang, 1998). The geologic material determines the permeability and availability of water within the aquifer. This watershed is within Central Groundwater Provinces with some portions of the Arrowhead Province and Cretaceous bedrock present (Figure 11). The Arrowhead Province contains mostly exposed fractured igneous and metamorphic bedrock with a limited thin layer of glacial drift, while the Central Province has sand aquifers in thick sandy and clayey glacial drift (DNR, 2001). The Cretaceous bedrock are layers of sandstone that are interbedded with thick layers of shale, located between older bedrock and glacial drift, and are often utilized as local water sources (DNR, 2001). The general availability of groundwater for areas that are within the Arrowhead Province are very limited due to the hard fractured bedrock, while areas associated with the Central Province have good groundwater availability in the surficial sands, moderate availability in the buried sands, and limited within the bedrock (DNR, 2001; DNR, 2018a).

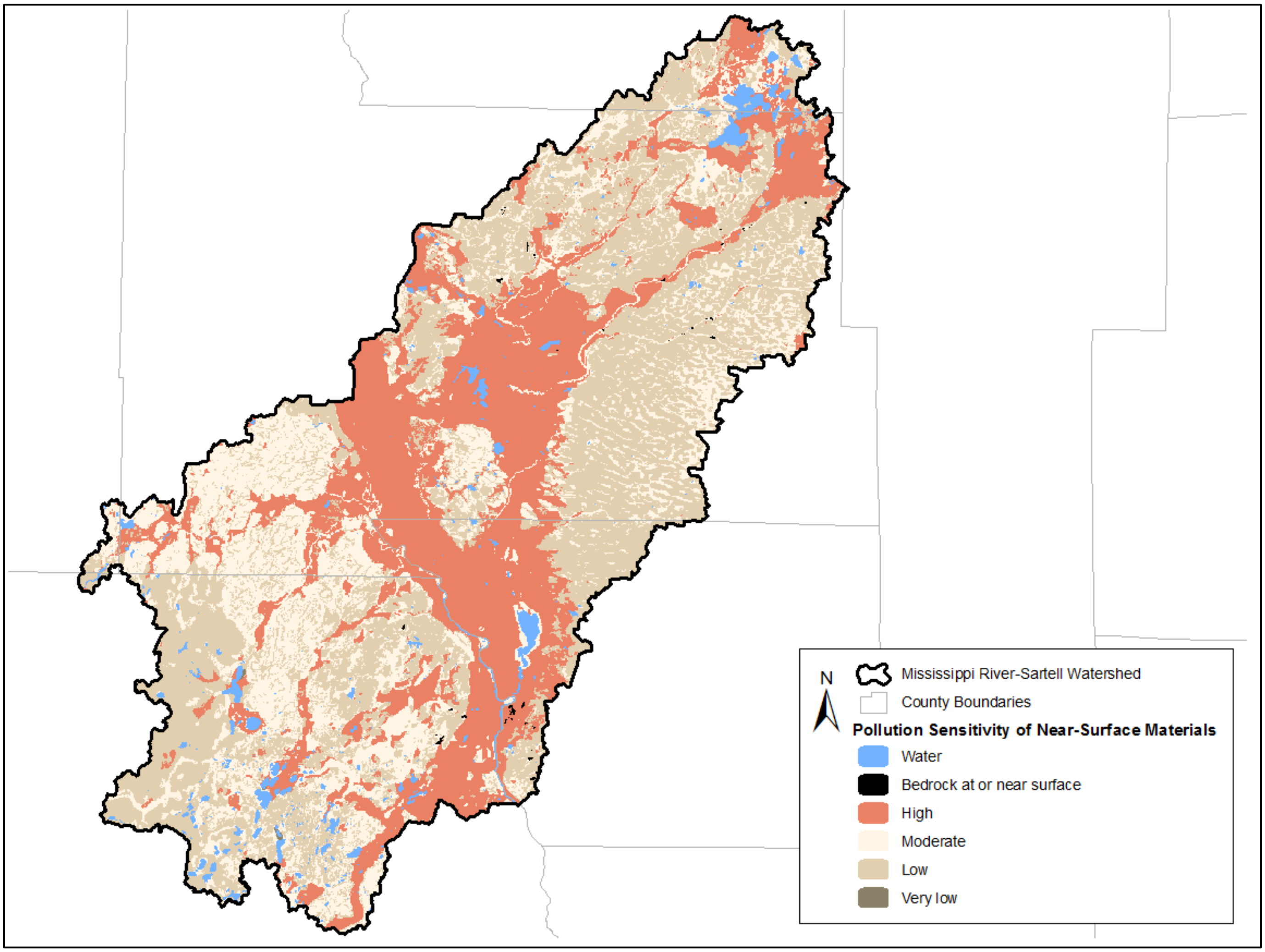
Figure 11. Groundwater Provinces within the Mississippi River-Sartell Watershed (GIS Source: DNR, 2001)



Groundwater pollution sensitivity

Bedrock aquifers are typically covered with thick till and are normally better protected from contaminant releases at the land surface. It is also less likely that withdrawals from wells would have a direct and significant impact on local surface water bodies. In contrast, surficial aquifers are typically more likely to 1) be vulnerable to contamination, 2) have direct hydrologic connections to local surface water, and 3) influence the quality and quantity of local surface water. A 2016 statewide evaluation of pollution sensitivity of near-surface materials completed by the DNR is utilized to estimate pollution vulnerability up to ten feet from the land surface. According to this data, the Mississippi River-Sartell Watershed is estimated to have primarily low to moderate with some high pollution sensitivity areas scattered throughout the watershed, most likely due to the presence of sand and gravel Quaternary geology (Figure 12) (DNR, 2016).

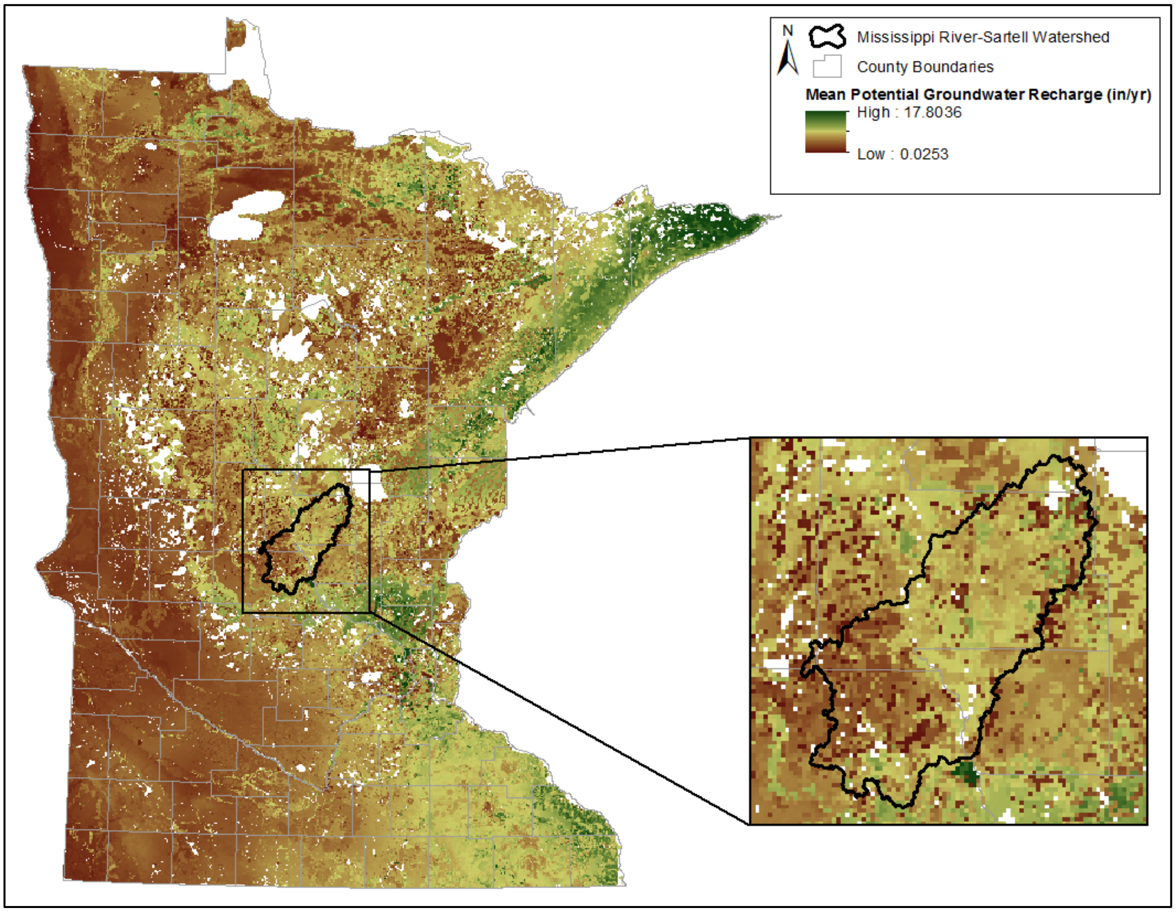
Figure 12. Pollution sensitivity of near-surface materials for the Mississippi River-Sartell Watershed (GIS Source: DNR, 2016)



Groundwater potential recharge

Groundwater recharge is one of the most important parameters in the calculation of water budgets, which are used in general hydrologic assessments, aquifer recharge studies, groundwater models, and water quality protection. Recharge is a highly variable parameter, both spatially and temporally, often limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock-surficial deposit interface (Figure 13). Typically, recharge rates in unconfined aquifers are estimated at 20% to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). For the Mississippi River-Sartell Watershed, the average annual potential recharge rate to surficial materials ranges from 0.07 to 9.56 inches per year, with an average of 5.18 inches per year. The statewide average potential recharge is estimated to be four inches per year with 85% of all recharge ranging from three to eight inches per year. When compared to the statewide average potential recharge, this watershed receives a slightly greater average potential recharge.

Figure 13. Average annual potential recharge rate to surficial materials in Mississippi River-Sartell Watershed (1996-2010) (GIS Source: USGS, 2015)



Groundwater quality

Approximately 75% of Minnesota's population receives their drinking water from groundwater, undoubtedly indicating that clean groundwater is essential to the health of its residents. The Minnesota Pollution Control Agency's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These ambient groundwater wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly.

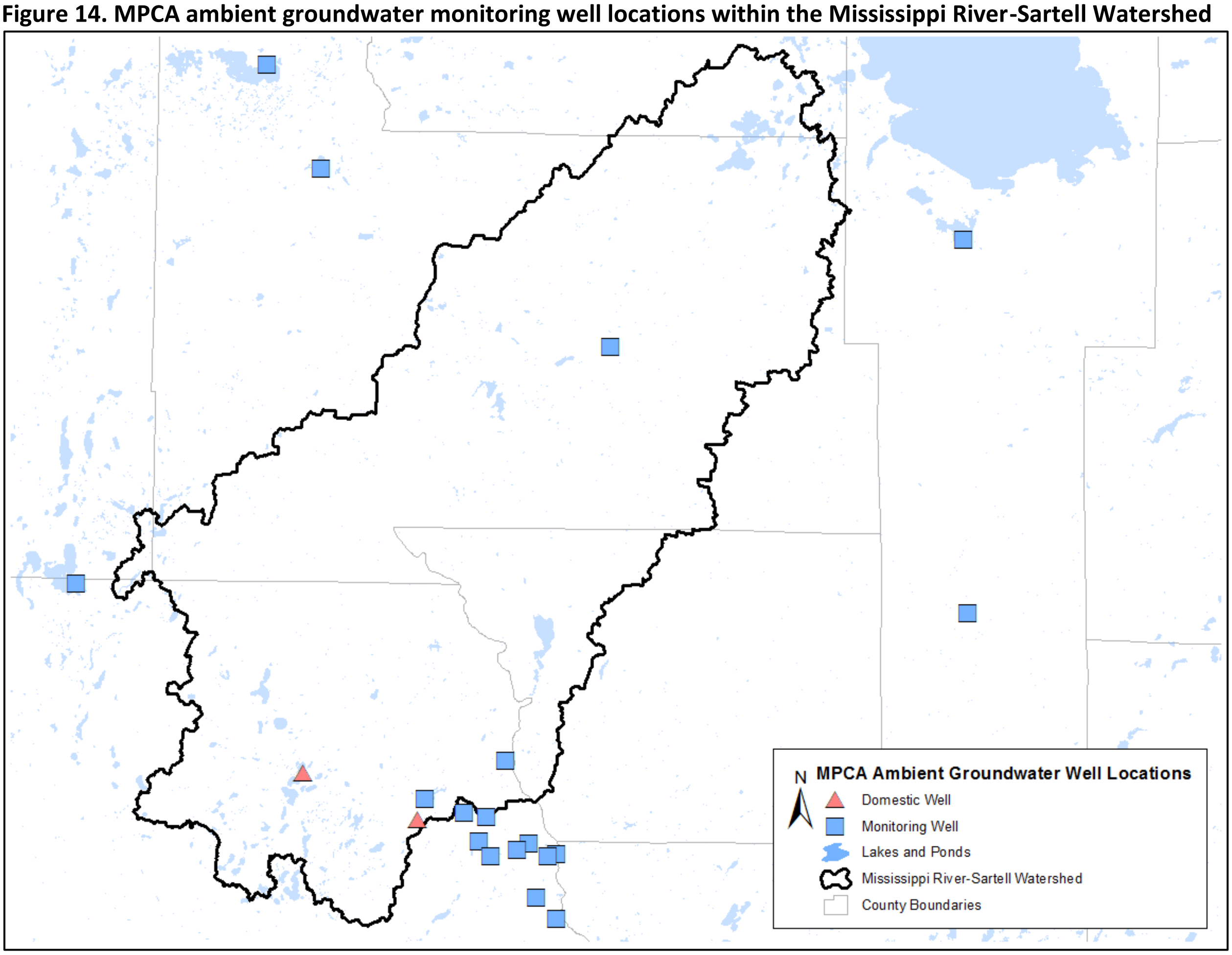
There are currently five MPCA Ambient Groundwater Monitoring wells (three monitoring, two domestic) within the Mississippi River-Sartell Watershed (Figure 14). Data collection for these wells ranges from 1997 to 2018. The most commonly detected analytes within this watershed were chloride, sodium, calcium, magnesium, sulfate, barium, strontium, potassium, and bromide. All of these analytes are naturally occurring and released into the groundwater as the mineral dissolves over time. Majority of the detections were below water quality standards set by MDH and USEPA. There were some exceedances of water quality standards identified in these wells. The most common exceedances found were iron (21.7%), inorganic nitrogen (nitrate and nitrite) (21.7%), and manganese (20.0%).

Iron has a secondary maximum contaminant level (SMCL) of 300 µg/L, where exceedances can lead to noticeable nuisance affects (taste, color, odor), but are not considered to be a threat to human health (USEPA, 2017). These effects may include rusty color, metallic taste, pipe clogging and staining clothes and appliances. Within this watershed, 36.9% of samples had detections of iron while 21.7% of samples exceeded the SMCL. Conventional treatments, such as coagulation, flocculation, filtration, aeration, and granular activated carbon filters, are effective ways of removing color and odor associated with secondary contaminants (USEPA, 2017).

Inorganic nitrogen included nitrate and nitrite that may contaminate water sources through excess fertilizer runoff, leakage from septic tanks and sewage, and erosion of natural deposits (USEPA, 2018). The maximum contaminant level (MCL) is 10 mg/L for nitrate and 1 mg/L for nitrite. For this analysis, 10 mg/L was used as the exceedance benchmark, since nitrate is the dominant form typically found in groundwater. Nitrate levels that exceed the MCL are considered dangerous for infants younger than six months due to the risk of methemoglobinemia (blue-baby syndrome), which could potentially be life threatening if untreated. Although detections of inorganic nitrogen occurred at 81.7% of all samples, there was only one monitoring well that had exceedances to the MCL. The well is not a source of drinking water.

Manganese has a Health Based Value (HBV) of 100 µg/L and was detected 32.0% and exceeded the HBV 20.0% of the time. Manganese is naturally occurring and commonly found in groundwater across the state. High concentrations of manganese give water a black to brown color, a bitter metallic taste, and may be unsafe for human consumption when concentrations are over the HBV, especially for infants. At low levels, manganese is considered beneficial, but high exposures can cause harm to the nervous system and issues with memory, attention and motor skills (MDH, 2019). If their drinking water exceeds the HBV, individuals are advised by the MDH to utilize a carbon filter or bottled water, especially with infants and nursing mothers (MDH, 2019).

Figure 14. MPCA ambient groundwater monitoring well locations within the Mississippi River-Sartell Watershed



Groundwater quantity

The DNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or one million gallons per year. Permit holders are required to track water use and report back to the DNR annually. The changes in withdrawal volume are a representation of water use and demand in the watershed and are taken into consideration when the DNR issues permits for water withdrawals. Other factors when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

The three largest permitted consumers of water in the state are (in order) power generation, public water supply (municipals), and irrigation (DNR, 2018b). According to the most recent DNR Permitting and Reporting System (MPARS), in 2016 the withdrawals within the Mississippi River-Sartell Watershed were primarily utilized for agricultural irrigation (76.4%). The remaining withdrawals include water supply (19.9%), special categories (1.9%), non-crop irrigation (1.3%), and industrial processing (0.5%). From 1997 to 2016, withdrawals associated with special categories have increased significantly, but both categories account for a very minor percentage of withdrawals within this watershed. Agricultural irrigation, non-crop irrigation, and water supply have also increased over the most recent 20 years. Withdrawals associated with industrial processing have decreased, but not statistically significant.

Figure 15 displays total high capacity withdrawal locations within the watershed with active permit status in 2016. During 1997 to 2016, groundwater withdrawals within this watershed exhibited a significant increasing withdrawal trend (Figure 16, top), while surface water withdrawals decreased drastically in 2012 (Figure 16, *bottom*).

Figure 15. Locations of active status permitted high capacity withdrawals in 2016 within the Mississippi River-Sartell Watershed

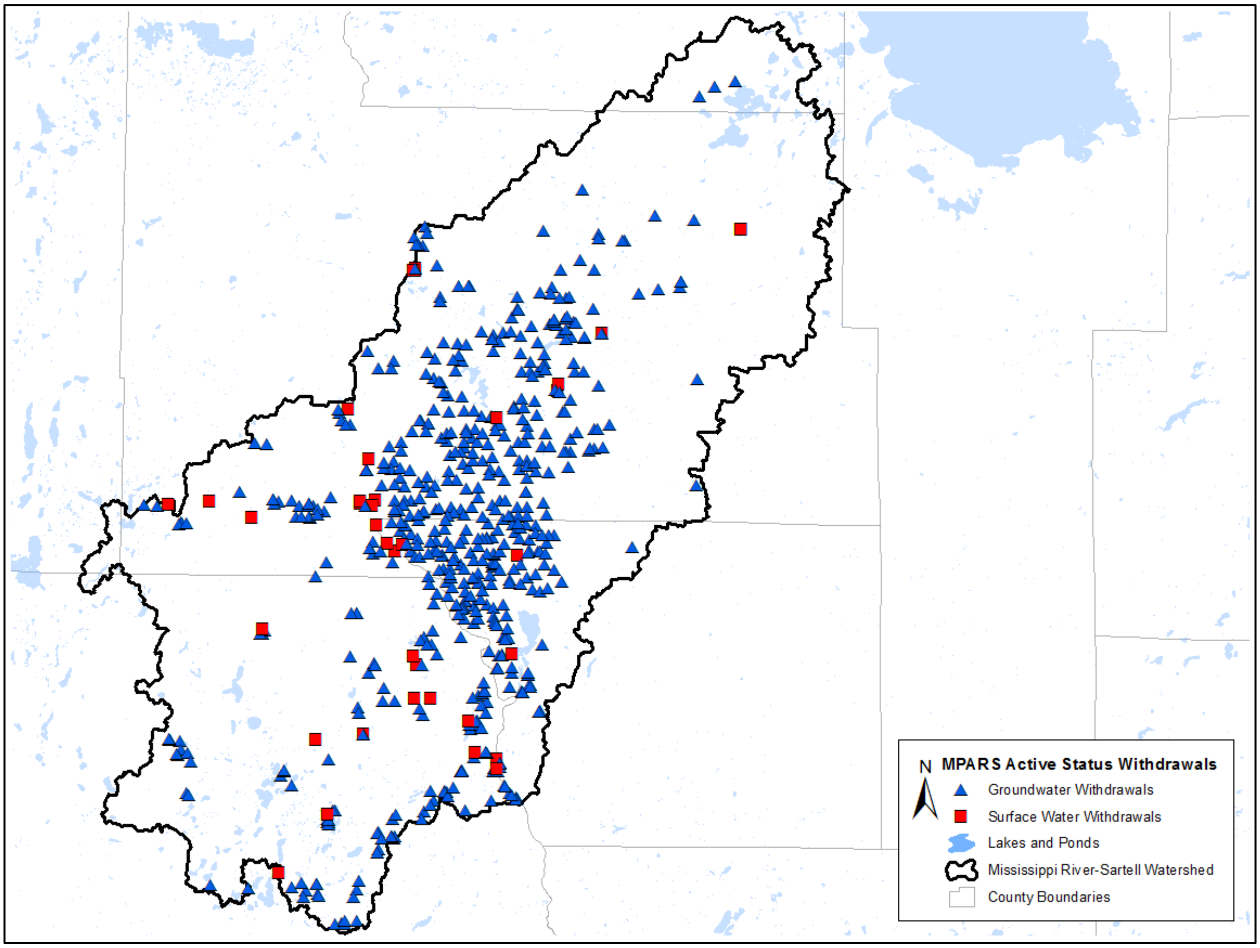
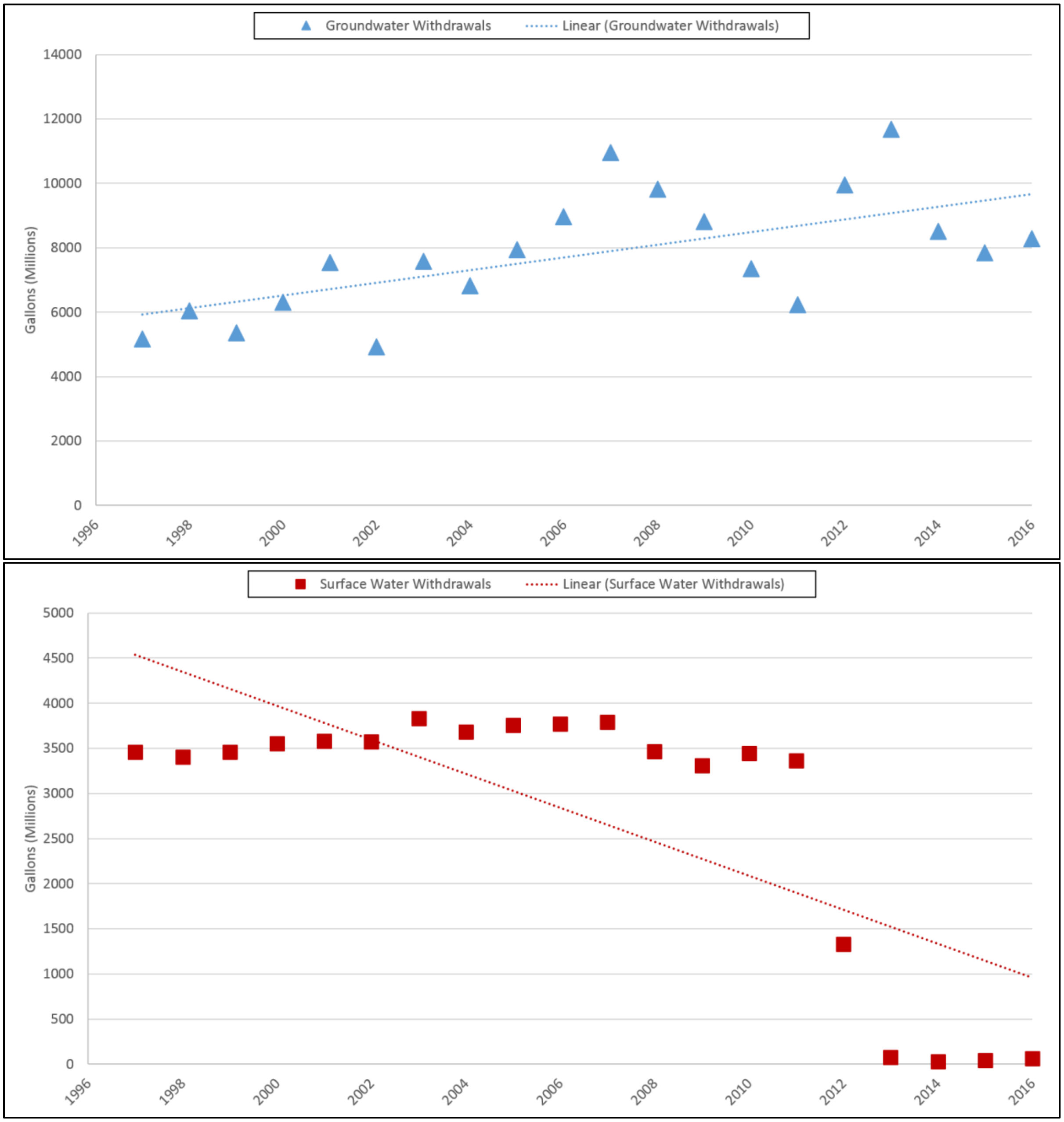


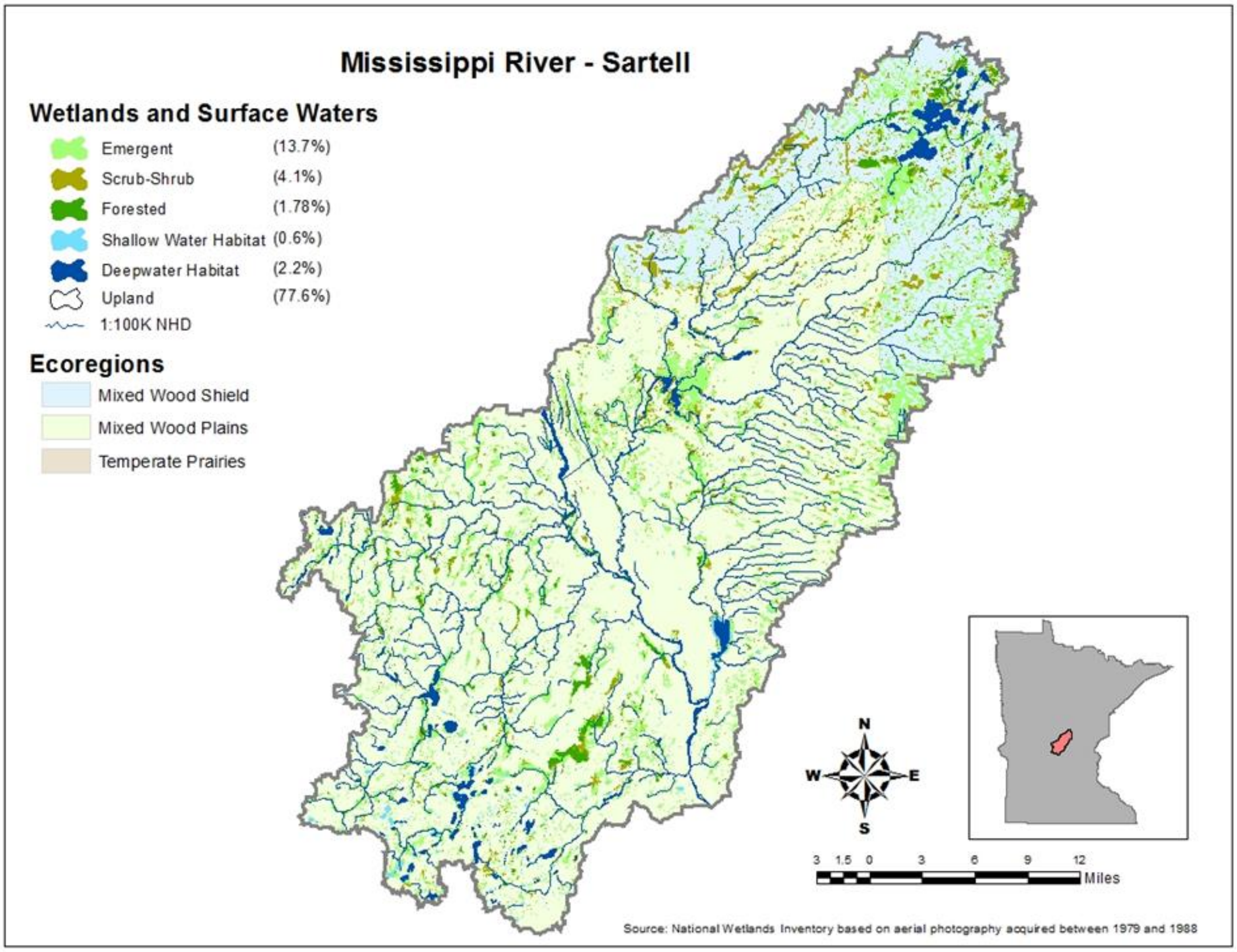
Figure 16. Total annual groundwater (top) and surface water (bottom) withdrawals in the Mississippi River-Sartell Watershed (1997-2016)



Wetlands

Wetlands are common in the Mississippi River-Sartell Watershed. There are 132,535 acres of wetland in the watershed according the National Wetlands Inventory (NWI), which is about 20% of the watershed (Figure 17). This coverage rate is approximately the same as the statewide coverage rate of 19% (Kloiber and Norris 2013, Bourdaghs et al. 2015). Emergent wetlands (wetlands dominated by grasses, sedges, and forbs) are the predominant wetland type—occupying approximately 14% of the watershed and comprising roughly two-thirds (68%) of the wetlands in the watershed.

Figure 17. Wetlands and surface water in the Mississippi River – Sartell watershed. Wetland data are from the National Wetlands Inventory.

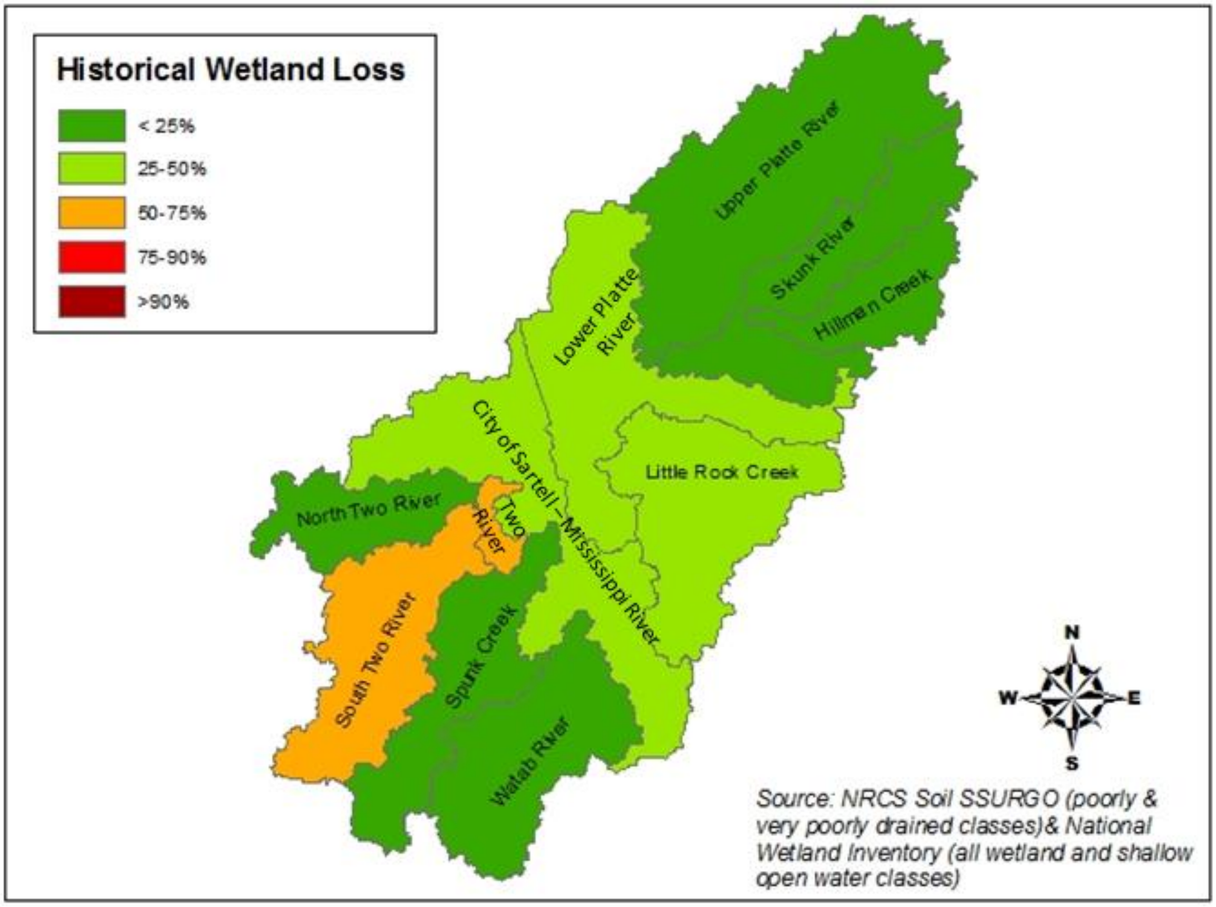


The Mississippi River-Sartell Watershed includes two major ecoregions (the Mixed Wood Shield or northern forest and the Mixed Wood Plains or former hardwood forest; Figure 17) and a variety of glacial landforms. These have led to the varying degrees of historical wetland drainage (Figure 18) and the varying hydrogeopmorphic (HGM) wetland patterns that are present today.

Prior to European settlement, wetlands were more prevalent within the watershed. Soil survey data was used to estimate historical wetland extent. Wetland loss estimates were then made by subtracting NWI totals (i.e., the best current estimate of wetland extent) from the poorly and very poorly drained soil map unit totals (i.e., the best historical estimate). Overall, it is estimated that the watershed has lost approximately 60,000 wetland acres.

Wetland losses also vary by sub-watershed (Figure 18) with historical wetlands generally being intact in the western and easternmost subwatersheds and relatively more losses in the central portion of the watershed. The easternmost subwatersheds lie mostly within the relatively cooler/wetter Mixed Wood Shield (i.e., northern forest) ecoregion (Figure 17) where the soils are typically not as productive for agriculture and there has been less wetland drainage. The central portion of the watershed is located in the Mixed Wood Plains ecoregion (i.e., hardwood forest) and is mostly comprised of flat glacial outwash landforms that can be effectively drained for agriculture (Figure 17). The westernmost sub-watersheds, while also within the Mixed Wood Plains ecoregion and agriculturally dominated, are comprised of moraine landforms that are dissected by glacial outwash valleys. The depressional wetlands that commonly form in topographic low points in moraine landforms can persist where the topography of the local landscape becomes too great for agriculture. Extensive wetlands typically form along the relatively flat glacial outwash valleys and often comprise the largest wetland extent in these types of sub-watersheds. In the North Two River, Spunk Creek, and Watab River subwatersheds, large wetland complexes within the outwash valleys for the most part remain intact and the subwatersheds overall have < 25% historical wetland losses. The South Two River Subwatershed, however, has experienced > 50% historical wetland loss, where it appears many larger wetland complexes have been effectively drained.

Figure 18. Historical wetland loss by subwatershed in the Mississippi River-Sartell Watershed.



The watershed also supports some notable wetland features. Wild rice populations have been documented on a number of lakes, ponds, and streams in the watershed. These documented populations mostly occur in three clusters in the vicinity of Platte Lake in the northeast, the Rice-Skunk Lake Wildlife Management Area in the central, and the Spunk Lake chain in the southwest portion of the watershed. Given how common wild rice is throughout this part of the state, there may be many more un-documented wild rice populations in the watershed. In addition, a calcareous fen—an uncommon type of wetland with alkaline (pH > 6.7) peat that can form where groundwater discharge is mineral-rich—is located in the watershed. Calcareous fens support a unique community of plant species (many are rare) and receive additional protections as state Outstanding Resource Value Waters (ORVW; Minn. R. ch. 7050; https://www.revisor.leg.state.mn.us/rules/?id=7050). The fen is protected as part of the St. Wendel Tamarack Bog Scientific and Natural Area.

Watershed-wide data collection methodology

Lake water sampling

MPCA sampled seven lakes in 2016 and 2017 to enhance the dataset for lake assessment of aquatic recreation. There are currently twelve volunteers enrolled in the MPCA's Citizen Lake Monitoring Program (CLMP) that are conducting lake monitoring within this 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 recreation use assessment requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth. Chloride, sulfate, and nitrates are sampled at a subset of waters that have been identified, as being impacted by chloride inputs, are designated wild rice waters, or have a designated drinking water use.

Stream water sampling

Ten water chemistry stations were sampled from May through September in 2016, and again June through August of 2017, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated HUC-12 subwatershed that was >40 square miles in area (purple circles and green circles/triangles in (Figure 2). (See Appendix 2.1 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study). The City of Sartell-Mississippi River aggregated HUC-12 subwatershed did not have a tributary with a drainage area large enough to meet the criteria discussed above, therefore there was no intensive water chemistry station within this subwatershed. The Mississippi River mainstem flows through this subwatershed, was monitored and assessed in the Mississippi River Report in 2013.

Stream flow methodology

MPCA and the DNR joint stream water quantity and quality monitoring data for dozens of sites across the state on major rivers, at the mouths of most of the state's major watersheds, and at the mouths of some aggregated HUC-12 subwatersheds are available at the DNR/MPCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Lake biological sampling

Twenty-two lakes were monitored for fish community health in the Mississippi River-Sartell Watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2018 assessment was collected in the last five years. Waterbody assessments to determine aquatic life use support were completed for 22 waterbody identification number (WIDs).

To measure the health of aquatic life at each lake, a fish IBI was calculated based on monitoring data collected in the lake. A fish classification framework was developed to account for natural variation in community structure, which is attributed to area, maximum depth, alkalinity, shoreline complexity, and geographic location. As a result, an IBI is available for four different groups of lake classes (Schupp Lake Classification, DNR). Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs). IBI scores higher than the impairment threshold and upper CI indicate that the lake supports aquatic life. Scores below the impairment threshold and lower CI indicate that the lake does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, plant surveys, and observations of local land use activities).

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Mississippi River-Sartell Watershed was completed during the summers of 2016 and 2017. A total of 41 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, 18 existing biological monitoring stations were revisited in 2016 and 2017. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2018 assessment was collected in 2016 and 2017. A total of 36 WIDs were sampled for biology with aquatic life use assessments conducted on 34 WIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long-term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, fish and macroinvertebrate IBIs were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into seven distinct warm water classes and two cold water classes, with each class having its own unique fish IBI and macroinvertebrate IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs) (For IBI classes, thresholds and CIs, see Appendix 3.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold and lower CI indicate that the stream reach does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, observations of local land use activities). For IBI results for each individual biological monitoring station, see Appendices 4.1 and 4.2.

Fish contaminants

Minnesota Department of Natural Resource (DNR) fisheries staff collect most of the fish for the Fish Contaminant Monitoring Program. In addition, MPCA's biomonitoring staff collect up to five piscivorous (top predator) fish and five forage fish near the HUC8 pour point, as part of the Intensive Watershed Monitoring. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish of each species are analyzed for polychlorinated biphenyls (PCBs).

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 60 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzed the samples for mercury and PCBs. If fish were tested for poly- and perfluoroalkyl substances (PFAS), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFAS. Of the measured PFAS, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.

From the fish contaminant analyses, MPCA determines which waters exceed impairment thresholds. The Impaired Waters List is prepared by the MPCA and submitted every even year to the EPA. MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs (and PFOS when tested) in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 mg/kg for PCBs (and 0.200 mg/kg for PFOS).

Monitoring of fish contaminants in the 1970s and 1980s showed high concentrations of PCBs were primarily a concern downstream of large urban areas in large rivers, such as the Mississippi River, and in Lake Superior. Therefore, PCBs are now tested where high concentrations in fish were measured in the past and the major watersheds are screened for PCBs in the watershed monitoring collections.

Before 2006, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory, the same as PCBs. With the adoption of a water quality standard for mercury in edible fish tissue, a waterbody has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90^{th} percentile) exceed 0.2 mg/kg of mercury. At least five fish samples of the same species are required to make this assessment and only the last 10 years of data are used for the assessment. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

Watershed pollutant load monitoring network

Intensive water quality sampling occurs at all WPLMN sites. Thirty-five samples per year are allocated for basin and major watershed sites and 25 samples per season (ice out through October 31) for subwatershed sites. Because concentrations typically rise with streamflow for many of the monitored pollutants, and because of the added influence elevated flows have on pollutant load estimates, sampling frequency is greatest during periods of moderate to high flow. All major snowmelt and rainfall events are sampled. Low flow periods are also sampled although sampling frequency is reduced, as pollutant concentrations are generally more stable when compared to periods of elevated flow.

Water sample results and daily average flow data are coupled in the $FLUX_{32}$ pollutant load model to estimate the transport (load) of nutrients and other water quality constituents past a sampling station over a given period of time. Loads and flow weighted mean concentrations (FWMCs) are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website.

Groundwater monitoring

The MPCA maintains an Ambient Groundwater Monitoring Network that monitors the aquifers that are most likely to be polluted with non-agricultural chemicals. This network primarily targets the shallow aquifers that underlie the urban parts of the state, due to the higher tendency of vulnerability to pollution. The MPCA's Ambient Groundwater Monitoring Network as of 2019, when this report was produced, consisted of approximately 270 wells that are primarily located in the sand and gravel and Prairie du Chien- Jordan aquifers.

Some wells in the MPCA's network are used to discern the effect of urban land use on groundwater quality and comprise an early warning network. Most wells in this early warning network contain water that was recently recharged into the groundwater, some even less than one year old. The wells in the early warning network are distributed among several different settings to determine the effect land use has on groundwater quality. These assessed land use settings are: 1) sewered residential, 2) residential areas that use subsurface sewage treatment systems (SSTS) for wastewater disposal, and 3) commercial or industrial, and 4) undeveloped. The data collected from the wells in the undeveloped areas provide a baseline to assess the extent of any pollution from all other land use settings.

Water samples from the MPCA's Ambient Groundwater Monitoring Network wells generally are collected annually by MPCA staff. This sampling frequency provides sufficient information to determine trends in groundwater quality. The water samples are analyzed to determine the concentrations of over 100 chemicals, including nitrate, chloride, and VOCs.

Information on groundwater monitoring methodology is taken from Kroening and Ferrey's report: The Condition of Minnesota's Groundwater, 2007-2011 (2013). To download ambient groundwater monitoring data, please refer to: https://www.pca.state.mn.us/water/groundwater-data

Wetland monitoring

The MPCA is actively developing methods and building capacity to conduct wetland quality monitoring and assessment. Our primary approach is biological monitoring—where changes in biological communities may be indicating a response to human-caused impacts. The MPCA has developed IBIs to monitor the macroinvertebrate condition of depressional wetlands that have open water and the Floristic Quality Assessment (FQA) to assess vegetation condition in all of Minnesota's wetland types. For more information about the wetland monitoring (including technical background reports and sampling procedures), please visit the MPCA Wetland monitoring and assessment webpage.

The MPCA currently does not monitor wetlands systematically by watershed. Alternatively, the overall status and trends of wetland quality in the state and by major ecoregion is being tracked through probabilistic monitoring. Probabilistic monitoring refers to the process of randomly selecting sites to monitor; from which, an unbiased estimate of the resource can be made. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

Individual aggregated HUC-12 subwatershed results

Aggregated HUC-12 subwatersheds

Assessment results for aquatic life and recreation use are presented for each aggregated HUC-12 subwatershed within the Mississippi River-Sartell. The primary objective is to portray all the full support and impairment listings within an aggregated HUC-12 subwatershed resulting from the complex and multi-step assessment and listing process. This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated HUC-12 subwatersheds contain the assessment results from the 2018 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2016 intensive watershed monitoring effort, but also considers available data from the last ten years.

The proceeding pages provide an account of each aggregated HUC-12 subwatershed. Each account includes a brief description of the aggregated HUC-12 subwatershed, and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, and b) lake aquatic life and recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the aggregated HUC-12 subwatershed. A brief description of each of the summary tables is provided below.

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the aggregated HUC-12 subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2018 assessment process (2020 U.S. Environmental Protection Agency [EPA] reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 4). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), dissolved oxygen, total suspended solids, chloride, pH, total phosphorus, chlorophyll-a, biochemical oxygen demand and un-ionized ammonia (NH3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A) or cool or warm water community (2B). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated HUC-12 subwatershed as well as in the Watershed-wide results and discussion section.

Lake assessments

A summary of lake water quality is provided in the aggregated HUC-12 subwatershed sections where available data exists. This includes aquatic recreation (phosphorus, chlorophyll-a, and Secchi) and aquatic life, where available (chloride and fish IBI). Similar to streams, parameter level and over all use decisions are included in the table.

Upper Platte River Aggregated HUC-12 HUC 0701020104-02

The Upper Platte River Subwatershed drains 180 square miles located in southern Crow Wing and eastern Morrison counties. Spanning from 10 miles northeast of Harding to five miles west of Pierz and Genola, this subwatershed is located in the northernmost portion of the watershed. The Platte River begins at the outlet of Platte and Sullivan Lakes and flows 37.7 miles to the southwest before flowing into Skunk Lake. Major tributaries, Big Mink and Little Mink creeks both flow in from the east and meet their individual confluences with the Platte River roughly five miles west of Pierz. Major lakes, Erskine, Platte, and Sullivan occur in the northeast and Pierz Lake in the southern portion of the subwatershed. Land cover is primarily rangeland (34.4%), forested (23.1%), and wetland (18.2%).

Table 2. Aquatic life and recreation assessments on stream reaches: Upper Platte River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-507 ***Platte River*** *Headwaters (Platte Lk 18-0088-00) to Skunk R*	03UM002, 10EM102, 16UM111, 16UM117, 16UM123	37.70	WWg	EXS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IMP	IMP
07010201-634 ***Unnamed Creek*** *Unnamed Cr to Platte R*	16UM112	3.03	WWg	EXS	MTS	IF	IF	IF	--	IF	IF	IF	IMP	--
07010201-645 ***Little Mink Creek*** *-94.119 46.014 to Platte R*	16UM105	5.50	WWg	MTS	EXS	IF	IF	IF	--	IF	IF	IF	IMP	--
07010201-646 ***Big Mink Creek*** *Headwaters to 235th Ave*	--	8.33	WWg	--	--	EXS	MTS	MTS	--	IF	--	IF	IF	IMP

07010201-647 ***Big Mink Creek*** *235th Ave to Platte R*	16UM107	1.46	WWg	MTS	EXS	--	--	--	--	--	--	--	IMP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: [ ] = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 3. Lake assessments: Upper Platte River Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Twenty Two	18-0008-00	164	--	Shallow Lake	NLF	--	--	--	--	IF	--	IF	--	IF
Erskine	18-0009-00	179	14	Shallow Lake	NLF	--	MTS	IF	--	MTS	IF	IF	SUP	IF
Bass	18-0011-00	44	--	Deep Lake	NLF	--	--	--	--	IF	--	--	--	IF
Bulldog	18-0014-00	146	34	Deep Lake	NLF	--	--	--	--	--	--	IF	--	IF
Rock	18-0016-00	201	22	Deep Lake	NLF	--	--	IF	--	MTS	EXS	IF	IF	IF
Platte	18-0088-00	1661	23	Deep Lake	NLF	D	MTS	--	--	EXS	EXS	EX	SUP	IMP
Unnamed	18-0422-00	12	--	Shallow Lake	NLF	--	--	--	--	IF		IF	--	IF
Peavy	49-0005-00	139	63	Deep Lake	NLF	NT	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Long	49-0015-00	118	35	Deep Lake	NLF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Sullivan	49-0016-00	1099	57	Deep Lake	NLF	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Round	49-0019-00	132	29	Deep Lake	NLF	NT	MTS	--	--	MTS	EXS	MTS	SUP	SUP
Pierz	49-0024-00	184	34	Deep Lake	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Summary

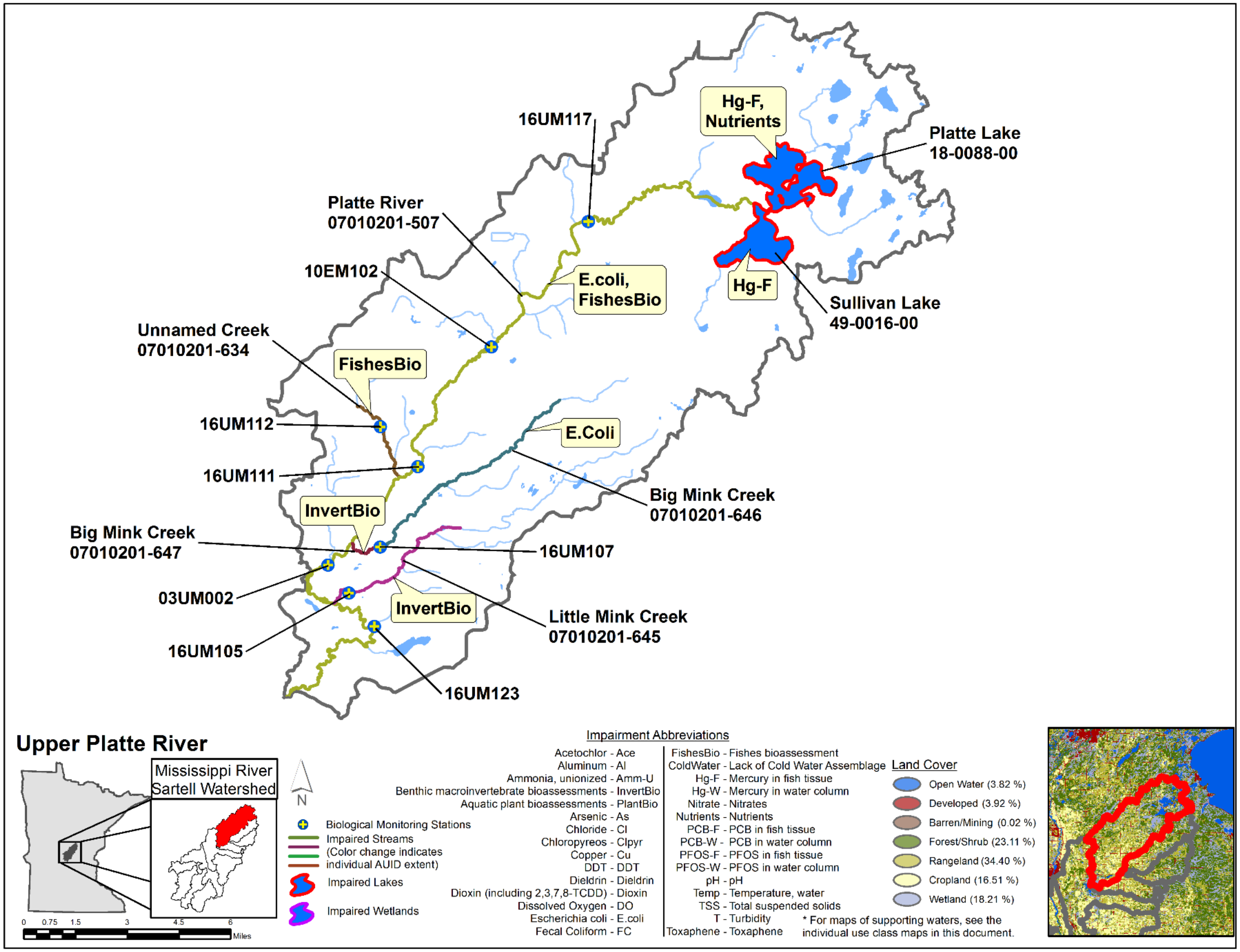
Five stream reaches (-507, -634, -645, -646, -647) were assessed in the Upper Platte River Subwatershed; five stations on the Platte River, one on an unnamed tributary to the Platte River, and one each on Big Mink and Little Mink Creeks. Biological communities in this subwatershed indicate there is stress in the system. In particular, the upper portions of the Platte River are located just downstream of a large low gradient section that may contribute to stressful low dissolved oxygen (DO) conditions. In addition, there is a low-head dam just downstream of 16UM117, which may inhibit fish passage. Sensitive species such as Hornyhead Chub, Rock Bass, Burbot, Longnose Dace, and Smallmouth Bass were abundant in this middle stretch of the upper Platte River (See Appendix 3.2). It is notable that no redhorse were observed at either of the uppermost stations despite both possessing suitable habitat. Macroinvertebrate assemblages in the Platte River show the river is in good health (See Appendix 3.3). Low dissolved oxygen levels may be limiting the macroinvertebrate communities in Big and Little Mink Creeks. In-stream habitat in the Upper Platte River Subwatershed as a whole is fair with the Platte River having good habitat (See Appendix 5).

Extensive water chemistry datasets available on the Platte River do not reveal any obvious chemical stressors to aquatic life use. Big Mink Creek is showing signs of low dissolved oxygen; the station was located directly downstream of a large wetland complex. To determine if conditions are still poor further downstream, stressor identification will complete further investigation. The Platte River and Big Mink Creek have poor recreational water quality with elevated bacteria concentrations.

Historical data from Platte Lake indicated poor recreational water quality during the initial assessment in 2010. The lake has a declining trend in water clarity, indicating worsening conditions over time. Historical inputs of nutrients, relatively shallow lake depth and internal nutrient cycling are likely key factors in continued poor recreational water quality on this headwater lake. Deeper lakes in the headwaters of this subwatershed are clearly in good recreational condition for public use. Long Lake (49-0015-00) has a declining trend in water clarity, despite meeting regional water quality goals, this lake would be a priority for protection efforts.

There were seven lakes assessed for aquatic life using the FIBI; Erskine, Platte, Peavy, Long, Sullivan, Round, and Pierz. All seven lakes had IBI scores ranging from 42 to 61, which met the standard for each individual lake type. Intolerant species (those requiring good quality water) found in these lakes included Rock Bass, Banded Killifish, Blackchin Shiner, Blacknose Shiner, and Iowa Darter. Logperch and Burbot were unique to Pierz Lake; both species are sensitive to degraded water quality. Mottled Sculpin, a sensitive bottom dwelling fish species were captured in a 2017 survey of Sullivan Lake. The tolerant species commonly captured in lakes within the subwatershed were Fathead Minnow, Black Bullhead, and Common Carp. Vegetation surveys on all seven lakes assessed for aquatic life use have healthy plant communities indicative of good water quality. Score your shore surveys completed by DNR staff are used to quantify shoreline health and human disturbance, those results for three lakes (Round, Erskine, and Peavy) indicated good nearshore habitat.

Figure 19. Currently listed impaired waters by parameter and land use characteristics in the Upper Platte River – 0701020104-02 Aggregated HUC-12.



Skunk River Aggregated HUC-12 HUC 0701020103-01

The Skunk River Subwatershed drains 91 square miles in eastern Morrison County. Spanning from 10 miles East of Harding to 7 miles northwest of Buckman. The Skunk River starts at a large wetland complex in the northern most portion of the watershed, before flowing southwest and eventually dumping into Skunk Lake near Crane Meadows National Wildlife Refuge. The land cover is primarily rangeland (35.6%), forest (22.5%), and cropland (21.7%).

Table 4. Aquatic life and recreation assessments on stream reaches: Skunk River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators:									Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication		
07010201-520 ***Skunk River*** *Headwaters (Skunk Lk 49-0007-00) to Hillman Cr*	16UM104, 16UM113, 16UM133	21.43	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--
07010201-521 ***Skunk River*** *Hillman Cr to Platte R*	16UM129, 16UM130	14.71	WWg	MTS	MTS	MTS	IF	IF	MTS	MTS	MTS	IF	SUP	IMP
07010201-633 ***Unnamed Creek*** *Unnamed Cr to Skunk R*	16UM114	3.43	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--
07010201-637 ***Unnamed Creek*** *Unnamed Cr to Skunk R*	16UM100	2.19	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--

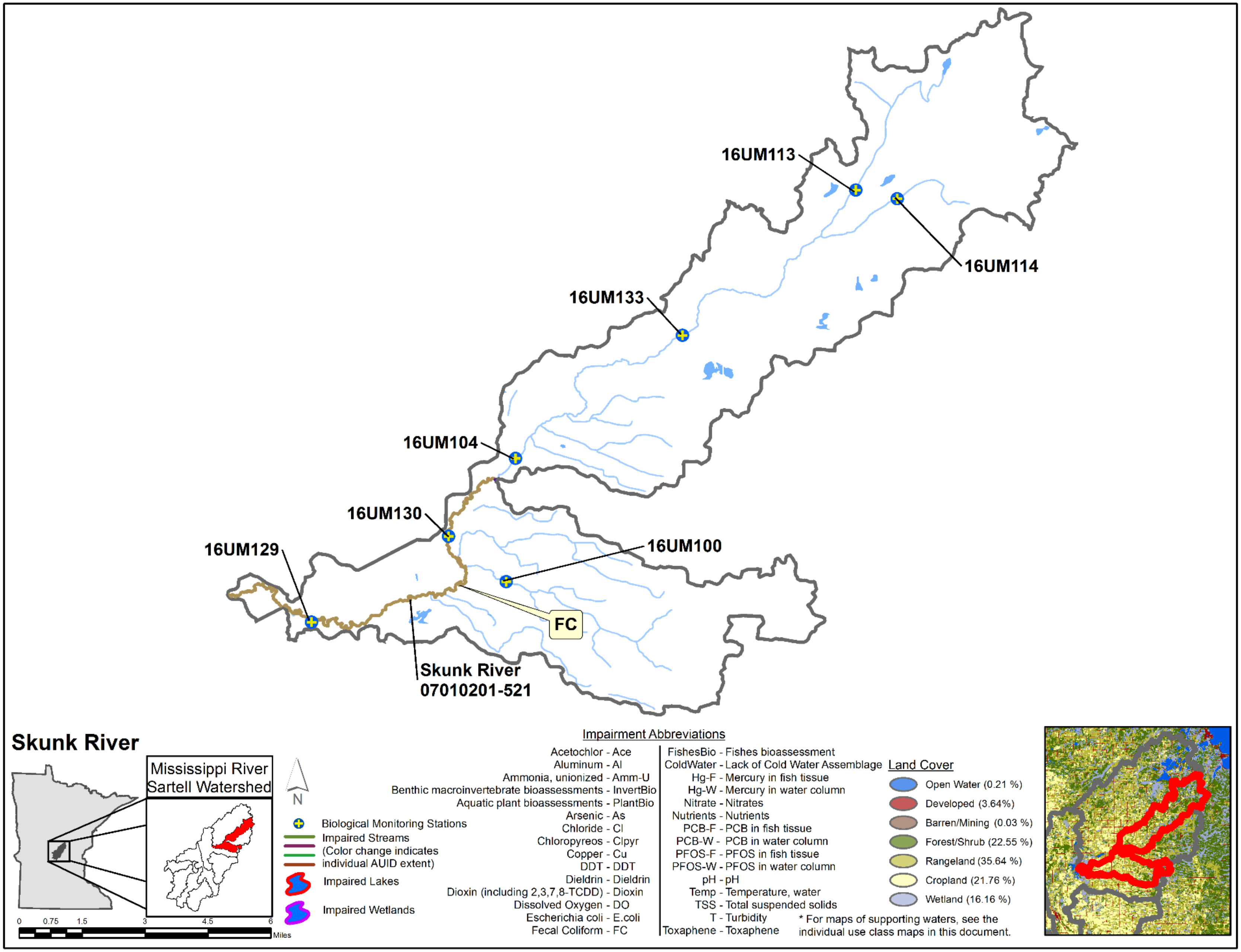
Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXS** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria)
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **IMP** = Non-Support, **SUP** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

Summary

Four stream reaches (-520, -521, -633, -637) were assessed in the Skunk River Subwatershed; five stations on the Skunk River and two stations on unnamed tributaries to the Skunk River. Habitat near the upstream portion of Skunk River appear to be impacted by wetlands and beaver activity, resulting in a FIBI score below the threshold at 16UM113. Conditions improve dramatically near the midpoint of the Skunk River with cool water fish species (Longnose Dace, Burbot, and Mottled Sculpin) present (See Appendix 5). The lowest station had the highest macroinvertebrate taxa richness in the entire watershed with 76 species sampled (See Appendix 4.2). In general, the Skunk River and its tributaries show support for aquatic life (See Appendix 3.2).

Water chemistry datasets available on the downstream reach of Skunk River clearly met all applicable water quality goals for aquatic life. Unusual precipitation patterns in July 2016 likely drove isolated exceedances in total suspended solids and Secchi tube data. Historical bacteria monitoring resulted in an aquatic recreation use impairment in 2008, newer data from 2016 and 2017 indicates poor recreational water quality still exists. There were no lakes assessed in this subwatershed.

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Skunk River – 0701020103-01 Aggregated HUC-12.



Hillman Creek Aggregated HUC-12 — HUC 0701020103-02

The Hillman Creek Subwatershed drains 46 square miles in eastern Morrison County. Spanning five miles northeast of Hillman to one mile east of Pierz, the subwatershed contains Hillman Creek as well as several unnamed tributaries to Hillman Creek. Hillman Creek starts one-half mile east of Kurtz Pond and flows southwest until its confluence with the Skunk River one mile East of Pierz. The land cover is primarily rangeland (35.4%), forest (35.3%), and wetlands (21.3%).

Table 5. Aquatic life and recreation assessments on stream reaches: Hillman Creek Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID / ***Reach name,*** / *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class***	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07010201-639 ***Hillman Creek*** *370th Ave to Skunk R*	16UM102, 16UM108	13.96	WWg	MTS	MTS	MTS	MTS	MTS	MTS	IF	MTS	IF	SUP	IMP
07010201-636 ***Unnamed Creek*** *Headwaters to Hillman Cr*	16UM103	4.40	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--

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

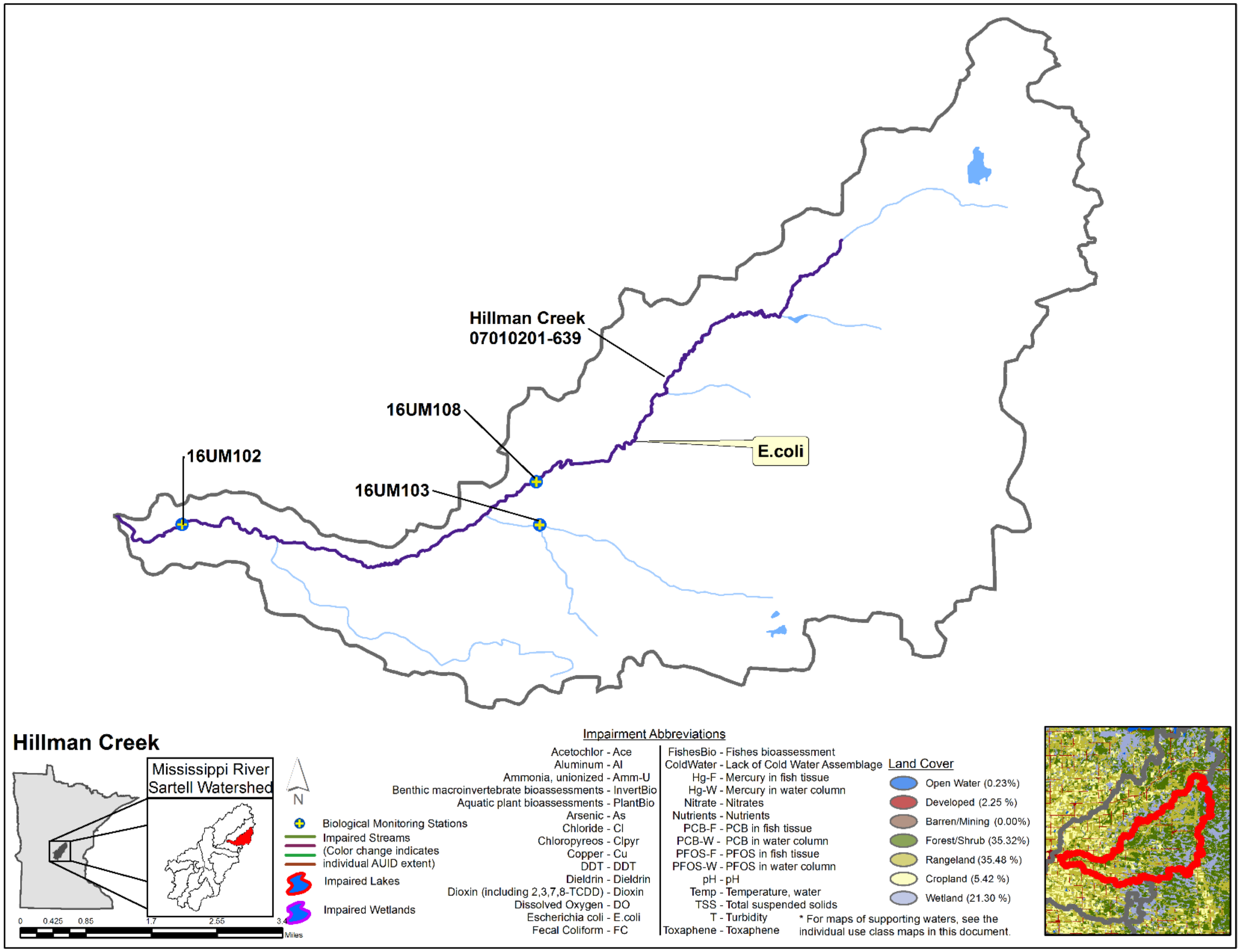
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

Two stream reaches (-639, -636) were assessed in the Hillman Creek Subwatershed; two stations on Hillman Creek (16UM108 and 16UM102) and one station on Unnamed Creek (16UM103). Both of the assessed stream reaches fully supported aquatic life. Fish samples collected at each of the stations all had FIBI scores well above the impairment threshold and are among the highest in the entire Mississippi River-Sartell Watershed (See Appendix 3.2). Macroinvertebrate samples collected at these stations also indicated full support for aquatic life (See Appendix 3.3). The habitat in Hillman Creek is good with coarse substrate and good channel development throughout (See Appendix 5). The habitat in Unnamed Creek (Trib. To Hillman Creek) is fair with minor areas of bank erosion, excess sediments in runs and pools, and an overall lack of productive macroinvertebrate habitats. Water chemistry data collected on the downstream reach of Hillman Creek met all applicable water quality goals for aquatic life. However, bacteria concentrations were high, indicating this reach does not support aquatic recreation. Further analysis will be required to address sources and reductions in bacteria concentrations. There were no lakes assessed in this subwatershed.

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Hillman Creek – 0701020103-02 Aggregated HUC-12.



Lower Platte River Aggregated HUC-12 — HUC 0701020104-01

The Lower Platte Subwatershed drains 130 square miles in east-central Morrison County. This subwatershed is located just east of Little Falls and stretches south of Royalton. The Platte River is the largest watercourse, flowing from north to south. Two major tributaries to the Platte River are Rice Creek, starting at Mud Lake and flowing south through Pelkey Lake, before flowing into Rice Lake; and Buckman Creek, which originates in a large wetland complex five miles east of Buckman and flows west into Skunk Lake. There are four major lakes over 50 acres in size: Mud, Pelkey, Rice, and Skunk. The land cover is primarily rangeland (33.2%), cropland (32.8%) and forest (15.8%).

Table 6. Aquatic life and recreation assessments on stream reaches: Lower Platte River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-545 ***Platte River*** Unnamed Cr (above RR bridge) to Mississippi R	03UM003, 03UM004, 16UM122	13.90	WWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	SUP	IF
07010201-546 ***Platte River*** Rice-Skunk Lakes Dam to Unnamed Cr (above RR bridge)	99UM048	3.88	WWg	MTS	--	IF	IF	IF	--	IF	IF	IF	SUP	--
07010201-618 ***Rice Creek*** Pelkey Lk to Rice Lk	16UM124	4.51	WWg	MTS	EXS	IF	IF	IF	--	IF	IF	IF	IMP	--
07010201-621 ***Unnamed Creek*** Unnamed Cr to Unnamed Cr	16UM110	0.46	WWm	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--
07010201-622 ***Unnamed Creek*** Unnamed Ditch to Unnamed Cr	10EM166	4.19	WWm	MTS	NA	IF	IF	IF	--	IF	--	IF	SUP	--

07010201-651 ***Unnamed Creek*** -94.26 46.016 to Unnamed Cr	16UM109 18UM109	0.59	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	IF	IMP	--

Abbreviations for Indicator Evaluations: MTS **= Meets Standard;** EXS **= Fails Standard;** IF **= Insufficient Information**
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 7. Lake assessments: Lower Platte River Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators: Fish IBI	Aquatic life indicators: Chloride	Aquatic life indicators: Pesticides ***	Aquatic recreation indicators: Total phosphorus	Aquatic recreation indicators: Chlorophyll-a	Aquatic recreation indicators: Secchi	Aquatic life use	Aquatic recreation use
Coon	49-0020-00	17	--	Shallow Lake	NCHF	--	--	--	--	IF	IF	IF	--	IF
Rice	49-0025-00	334	8	Shallow Lake	NCHF	--	--	--	--	EXS	MTS	IF	--	IF
Skunk	49-0026-00	364	2.3	Shallow Lake	NCHF	--	--	--	--	EXS	MTS	IF	--	IF
Pelkey	49-0030-00	103	7	Shallow Lake	NCHF	--	--	--	--	EXS	IF	IF	--	NA
Popple	49-0033-00	19	4	Shallow Lake	NCHF	--	--	--	--	IF	IF	IF	--	IF

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

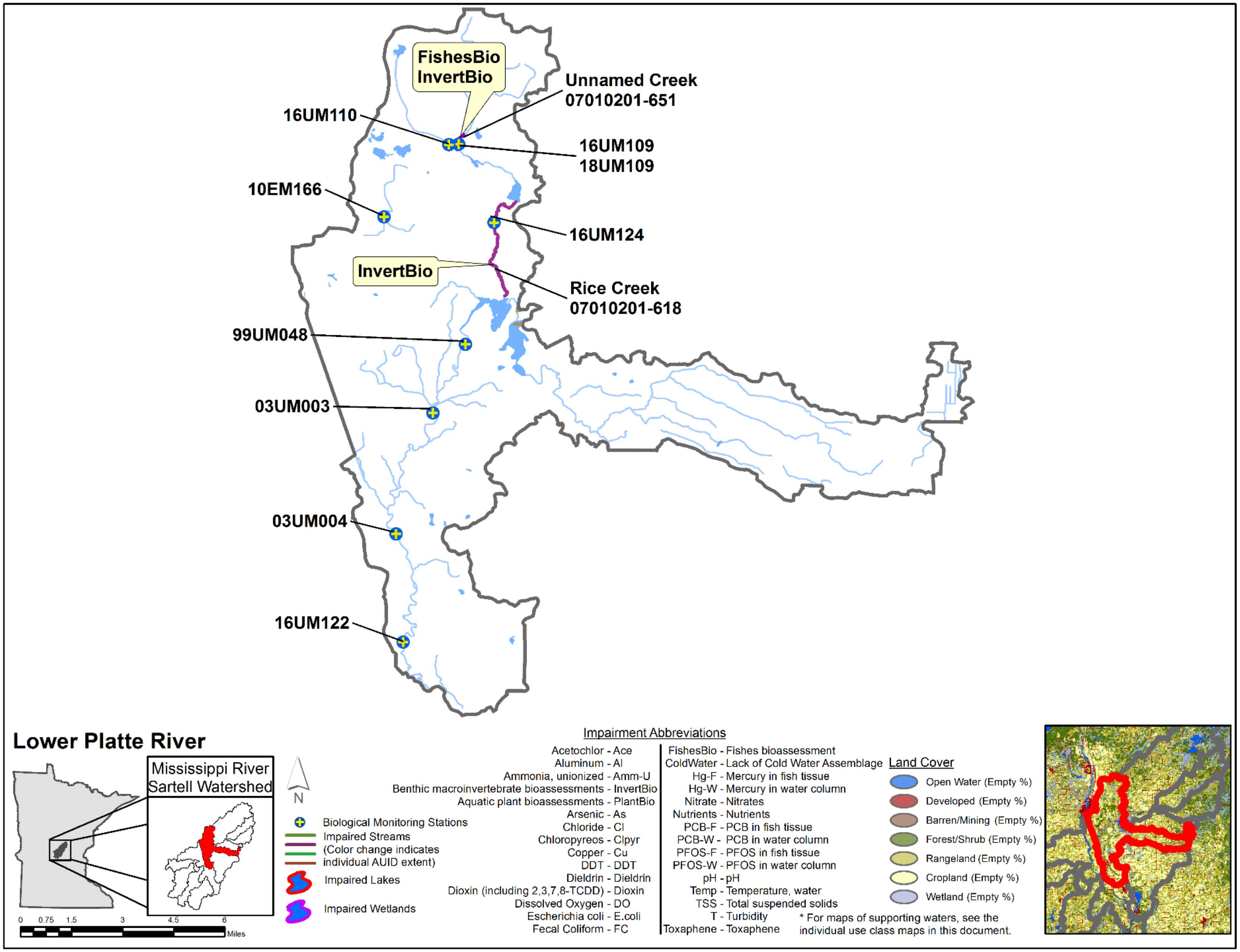
Summary

Eight stream reaches (-518, -535, -545, -546, -618, -621, -622, -651) were assessed in the Lower Platte River Subwatershed: three segments of the Platte River, one segment of Rice Creek, three unnamed tributaries, and one segment of Buckman Creek. Buckman Creek is a Limited Resource Value Water so the class 2 water quality standards do not apply to this segment. The Platte River (-545) supports the only exceptional biological community in the Mississippi River-Sartell Watershed with several sensitive fish and macroinvertebrate species present. Conditions appear to improve from upstream to downstream in this segment. The lower section of the Platte River directly downstream of the Rice-Skunk Lake complex, is currently listed as impaired for aquatic life based on a poor FIBI score from 1999. The initial sampling event was affected by well-above-normal flow levels, and recent data indicates that this reach of the Platte River now supports aquatic life. The aquatic life impairment will be corrected and removed. The biology in Rice Creek indicates a fish and macroinvertebrate community that is dominated by species tolerant to low DO common in wetland type systems (See Appendix 3.2 and 3.3). This, combined with poor habitat, are resulting in an aquatic life impairment. A small, unnamed tributary to Rice Creek with two sampling stations does not support fish or macroinvertebrate communities with in-stream habitat being barren sand with a very unstable bed (See Appendix 5).

Water chemistry condition in the lower reaches of the Platte River are similar to headwater reaches, all parameters are clearly meeting water quality goals. The majority of tributaries to the Lower Platte River have good water quality and support aquatic life. The lower reach of Rice Creek had limited dissolved oxygen data, but the available data suggests DO is low in this reach; more data would be needed to accurately assess conditions.

Shallow lakes on flow through streams systems make up the majority of lakes in this subwatershed. Some, such as Pelkey Lake, have low retention times and did not retain water long enough to be assessed as a lake. Other lakes have small datasets that are likely associated with shallow lake or wetland surveys. Elevated phosphorus is a common in these lakes. These shallow basins may not be viewed as ideal for traditional recreational use (e.g. swimming); however, maintaining good water quality is ideal to encourage native vegetation growth and diverse wildlife use for other recreational uses.

Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Lower Platte River – 0701020104-01 Aggregated HUC-12.



Little Rock Creek Aggregated HUC-12 HUC 0701020105-01

The Little Rock Creek Subwatershed drains nearly 110 square miles of southern Morrison and northern Benton counties. This subwatershed is located south of Buckman and east of the communities of Royalton and Rice. Major streams include: Little Rock Creek from its headwaters to Little Rock Lake, and Bunker Hill Creek from its headwaters to Little Rock Creek. The only major lake in this subwatershed is Little Rock Lake. The land cover in this subwatershed is primarily cropland (46.8%), rangeland (25.6%), and forest (11.8%).

Table 8. Aquatic life and recreation assessments on stream reaches: Little Rock Creek Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-511 ***Bunker Hill Creek*** T38 R30W S6, north line to Little Rock Cr	15UM210	4.69	CWg	EXS	EXS	MTS	MTS	IF	MTS	IF	MTS	IF	IMP	IF
07010201-512 ***Bunker Hill Creek*** Headwaters to T39 R30W S31, south line	--	9.57	WWg	--	--	IF	--	--	IF	IF	IF	IF	IF	--
07010201-539 ***Zuleger Creek*** Unnamed Cr to Unnamed Cr	16UM088	2.08	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	IF	IMP	--
07010201-541 ***Zuleger Creek*** Unnamed Cr to Little Rock Lk	--	1.79	WWg	--	--	IF	IF	IF	IF	IF	IF	IF	IF	IF
07010201-547 ***Little Rock Creek*** Headwaters to T39 R30W S27, north line	--	4.01	WWg	--	--	IF	--	--	IF	IF	IF	--	IF	--
07010201-550 ***Sucker Creek***	--	5.16	WWg	--	--	IF	IF	IF	IF	IF	IF	IF	IF	IF

Mayhew Cr to Little Rock Lk														
07010201-588 ***Unnamed creek (Little Rock Creek Tributary)*** T38 R31W S4, west line to Unnamed Cr	--	0.42	CWg	--	--	IF	--	--	IF	IF	IF	--	IF	--
07010201-608 ***Unnamed Creek*** Unnamed Cr to T39 R31W S28, east line	--	1.24	WWg	--	--	IF	--	--	IF	IF	IF	--	IF	--
07010201-652 ***Little Rock Creek*** T39 R30W S22, south line to T38 R31W S23, west line	99UM058	8.09	WWg	EXS	MTS	EXS	IF	MTS	IF	MTS	MTS	IF	IMP	--
07010201-653 ***Little Rock Creek*** T39 R31W S22, east line to T38 R31W S28, east line	03UM110, 07UM070, 07UM071, 07UM072, 07UM073, 75UM001, 82UM001, 92UM001	13.30	CWg	EXS	EXS	EXS	IF	IF	MTS	MTS	MTS	MTS	IMP	IMP

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

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 9. Lake assessments: Little Rock Creek Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Little Rock	05-0013-00	1293	19	Shallow Lake	NCHF	NT	--	MTS	--	EXS	EXS	EXS	NA	IMP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Ten stream reaches (-511, -512, -539, -541, -547, -550, -588, -608, -652, -653) were assessed in the Little Rock Creek Subwatershed: two sections of Bunker Hill and Zuleger creeks, three sections of Little Rock Creek, one section of Sucker Creek, and three unnamed creeks (See Appendix 3.2 and 3.3) . Little Rock Creek is data rich with nine biological monitoring stations scattered longitudinally, and significant water temperature data, which indicates temperatures increase from upstream to downstream. In general, the stream fails to support biological communities at least partially due to poor habitat conditions (See Appendix 3.2 and 3.3). Beginning upstream the habitat has unstable banks, excess sediment, and little to no coarse substrate. Because of these characteristics and a lack of cold water species, WID -652 from the headwaters to 230th Ave. is proposed to change from a designated coldwater stream to a designated warmwater stream. The habitat downstream of 230th Ave. has abundant coarse substrate, increased gradient, faster flow, and less sediment. Because of the improved habitat conditions, this section supports trout and is considered a designated cold water stream. Continuing downstream however, habitat again declines with characteristics much like the upper reaches coupled with slower flow and increased water temperature (See Appendix 5). This lower section of Little Rock Creek does support trout; however, the community is dominated by tolerant warmwater species. Comparison of historic maps with current hydrography suggests that what was once the headwaters of Bunker Hill Creek may now, in large part, drain to Little Rock Creek via ditching.

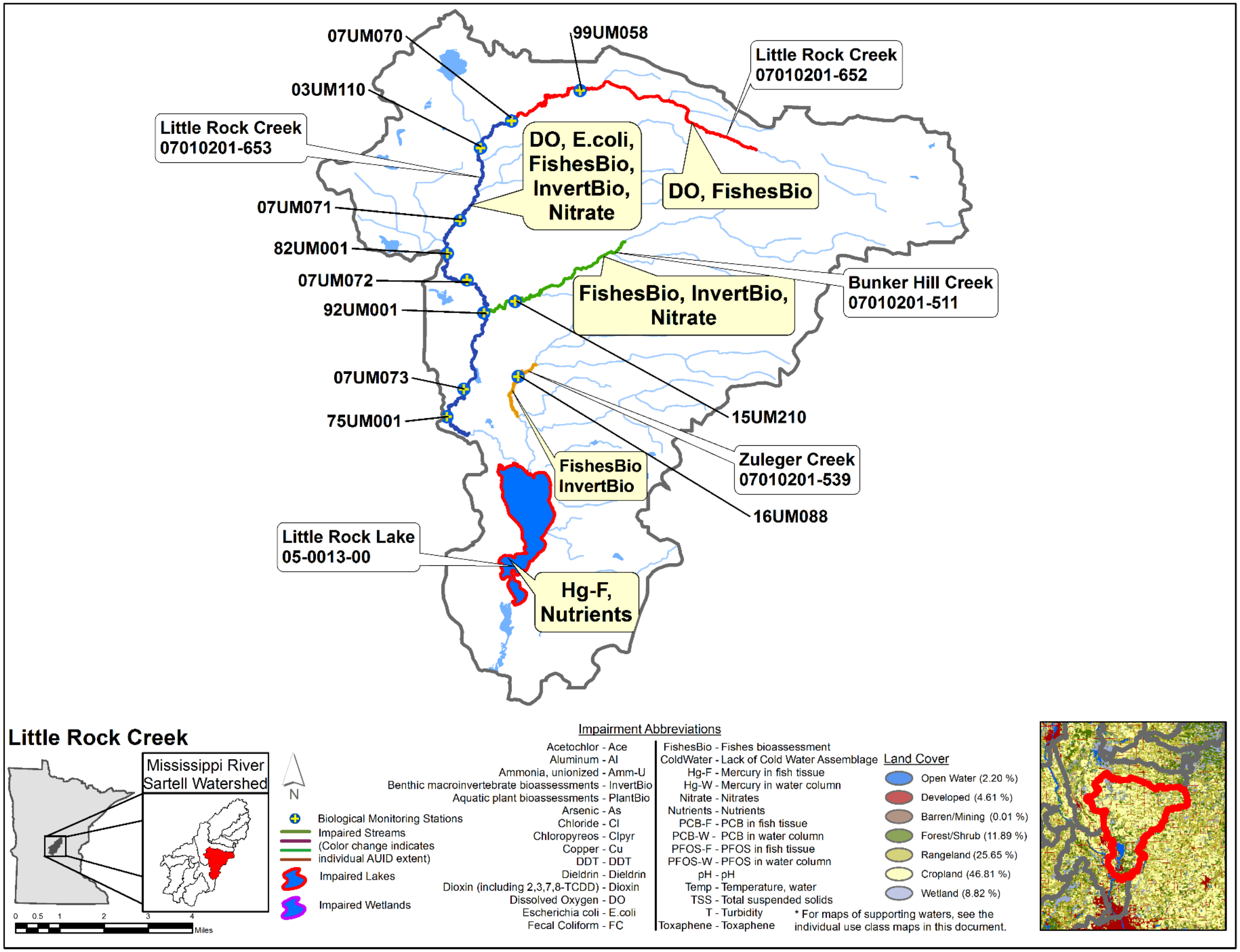
Historical data from Little Rock Creek triggered a DO impairment in 2010. Newer water chemistry data indicates low DO concentrations continue to impact aquatic life in Little Rock Creek. In addition, bacteria concentrations in Little Rock Creek are high suggesting poor recreational water quality. Further investigation is needed to pinpoint the contributing sources. Any further degradation of the stream could result in a loss of this unique central Minnesota trout fishery.

Extensive chemistry datasets exist for a number of tributaries to Little Rock Lake, many datasets indicating high concentrations of nutrients throughout the system. Bunker Hill Creek, a small coldwater tributary to Little Rock Creek also fails to support a coldwater aquatic life assemblage, even though in-stream habitat is generally good. Water temperature data shows conditions for trout are considered stressful roughly 40% of the summer months (May to September).

Little Rock Lake continues to display the impacts of historical nutrient loading and in-lake nutrient cycling. The flow through nature of the lake, large contributing watershed, open water fetch and shallow depth make ideal conditions for reoccurring nuisance algae blooms resulting in poor recreational opportunities for lake users. Local restoration efforts in progress will hopefully promote native vegetation growth, which can utilize the available nutrients and improve clarity by reducing nutrients available for suspended algae.

Extensive work has been completed in this subwatershed resulted in a TMDL being finished in 2015. This information can be found on the MPCA's website: https://www.pca.state.mn.us/sites/default/files/wq-iw8-09e.pdf.

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Little Rock Creek – 0701020105-01 Aggregated HUC-12.



City of Sartell – Mississippi River Aggregated HUC-12 HUC 0701020107-01

The City of Sartell-Mississippi River Subwatershed drains nearly 138 square miles of central Morrison, eastern Stearns, and western Benton Counties. This subwatershed stretches from just south of Little Falls all the way to Sartell, and has the most developed land in the entire watershed. This subwatershed contains the Mississippi River mainstem and several major tributaries such as: Little Two River, Hazel Creek, Hay Creek, and Stony. Zebulon Pike Lake, a reservoir created by Blanchard Dam, is the only lake located in this subwatershed. Land cover is primarily cropland (37.2%), rangeland (33.2%), forest (11%) and developed (10.2%).

Table 10. Aquatic life and recreation assessments on stream reaches: City of Sartell – Mississippi River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-516 ***Little Two River*** Headwaters to Mississippi R	16UM093	16.19	WWg	MTS	MTS	MTS	MTS	MTS	--	IF	IF	MTS	SUP	IMP
07010201-569 ***Hazel Creek*** Unnamed Ditch to Mississippi R	16UM092	2.55	WWg	EXS	MTS	IF	IF	IF	--	IF	IF	IF	IMP	--
07010201-630 ***Hay Creek*** Unnamed Cr to Mississippi R	16UM094	3.26	WWg	MTS	MTS	MTS	IF	MTS	--	IF	IF	IF	SUP	IMP
07010201-649 ***Stony Creek*** -94.31 45.728 to Mississippi R	16UM087	5.57	WWg	MTS	MTS	NA	MTS	MTS	MTS	MTS	IF	IF	SUP	IMP

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

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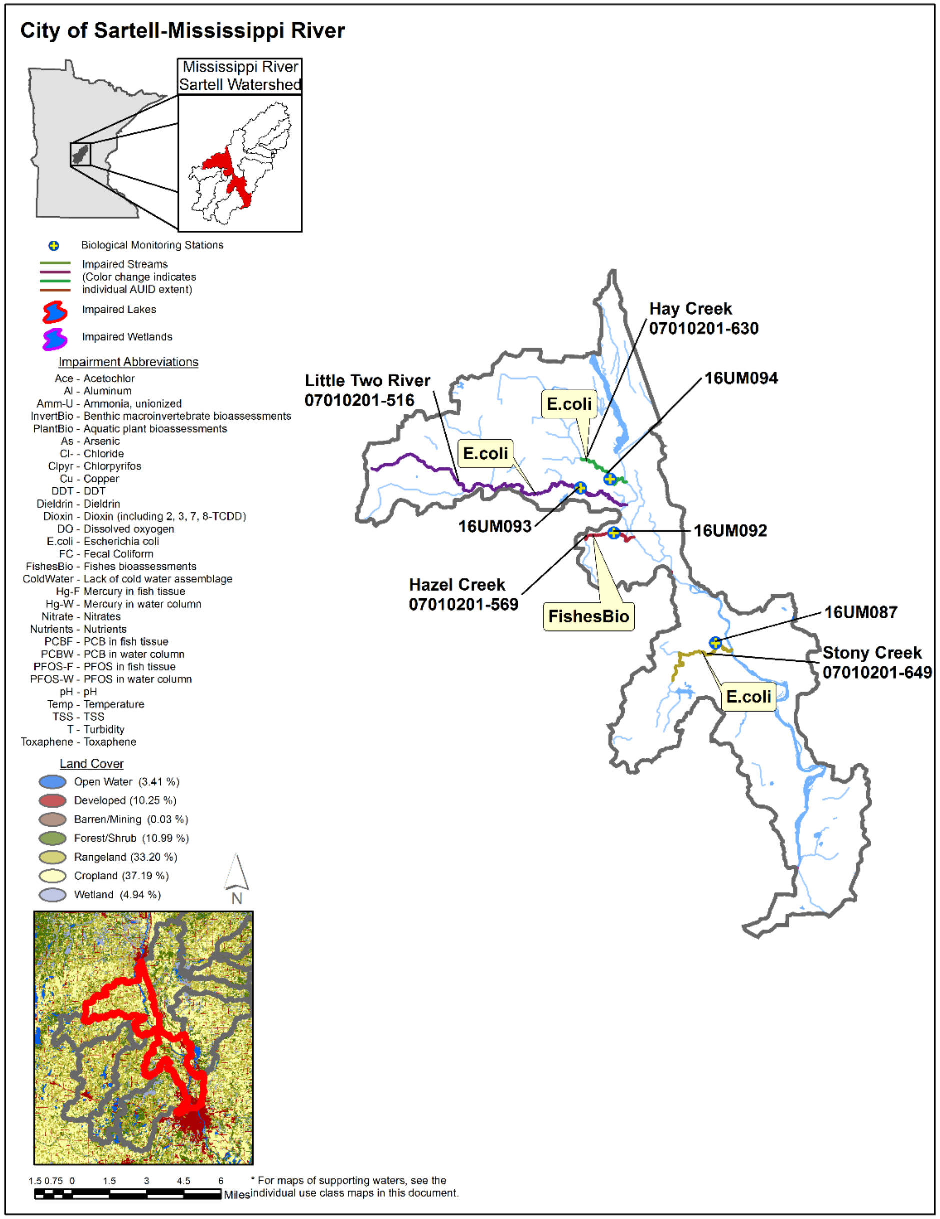
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

Four stream segments (-516, -569, -630, -and -649) were assessed in the City of Sartell Subwatershed: Little Two River, Hazel Creek, Hay Creek, and Stony Creek (See Appendix 3.2 and 3.3). The Little Two River supports fish and macroinvertebrate communities even though habitat throughout the stream is sand dominated with sparse cover and extensive bank erosion (See Appendix 5). Mottled Sculpin were captured in good numbers, indicating a cool/cold thermal regime. Hazel Creek has good habitat, but fails to support aquatic life with the fish community suggesting impairment. Hay Creek supports a healthy biological community with several sensitive cool water species (Mottled Sculpin, Longnose Dace, and Burbot). There are several sensitive macroinvertebrate taxa present within this stream as well, namely caddisflies, midges, and stoneflies with two coldwater taxa (Diamesa: chironomidae and Gammarus: amphipoda) also observed in low numbers. This represents the MPCA's fourth record of Diamesa in the Upper Mississippi River Basin (See Appendix 4.2). Although Stony Creek supports a healthy biological community, habitat conditions throughout this reach are only fair, because of extensive bank erosion, unstable substrates, and large lateral bars. There were no lakes with assessable data in this subwatershed. Water chemistry data is relatively sparse. The available data meets applicable criteria for aquatic life. Where available, sediment concentrations were generally low. Hay and Stony creeks did show elevated nutrients present; however, there was not an increase in eutrophication as a result (i.e. low levels of algae were present). Bacteria concentrations are consistent with poor recreational water quality in the three tributaries to the Mississippi River. Further investigation into sources will be necessary to address recreational water quality.

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the City of Sartell – Mississippi River – 0701020107-01 Aggregated HUC-12.



North Two River Aggregated HUC-12 — HUC 0701020101-03

The North Two River Subwatershed drains 49 square miles in southern Morrison and northern Stearns counties. This subwatershed flows from five miles west of Upsala to just west of the town of Bowlus where it meets up with the South Two River forming the Two River. The major river in this subwatershed is the North Two River; and the major lakes in this catchment are Cedar Lake and Mary Lake west of the town of Upsala. Land cover is primarily rangeland (41.0%), cropland (34.7%), and forest (11.7%).

Table 11. Aquatic life and recreation assessments on stream reaches: North Two River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class***	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07010201-524 ***North Two River*** Headwaters (Mary Lk 77-0019-00) to South Two R	16UM090, 16UM091	22.47	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	SUP	IMP

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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: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 12. Lake assessments: North Two River Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Cedar	49-0140-00	237	88	Deep Lake	NCHF	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Mary	77-0019-00	128	58	Deep Lake	NCHF	NT	MTS	IF	--	MTS	EXS	MTS	SUP	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

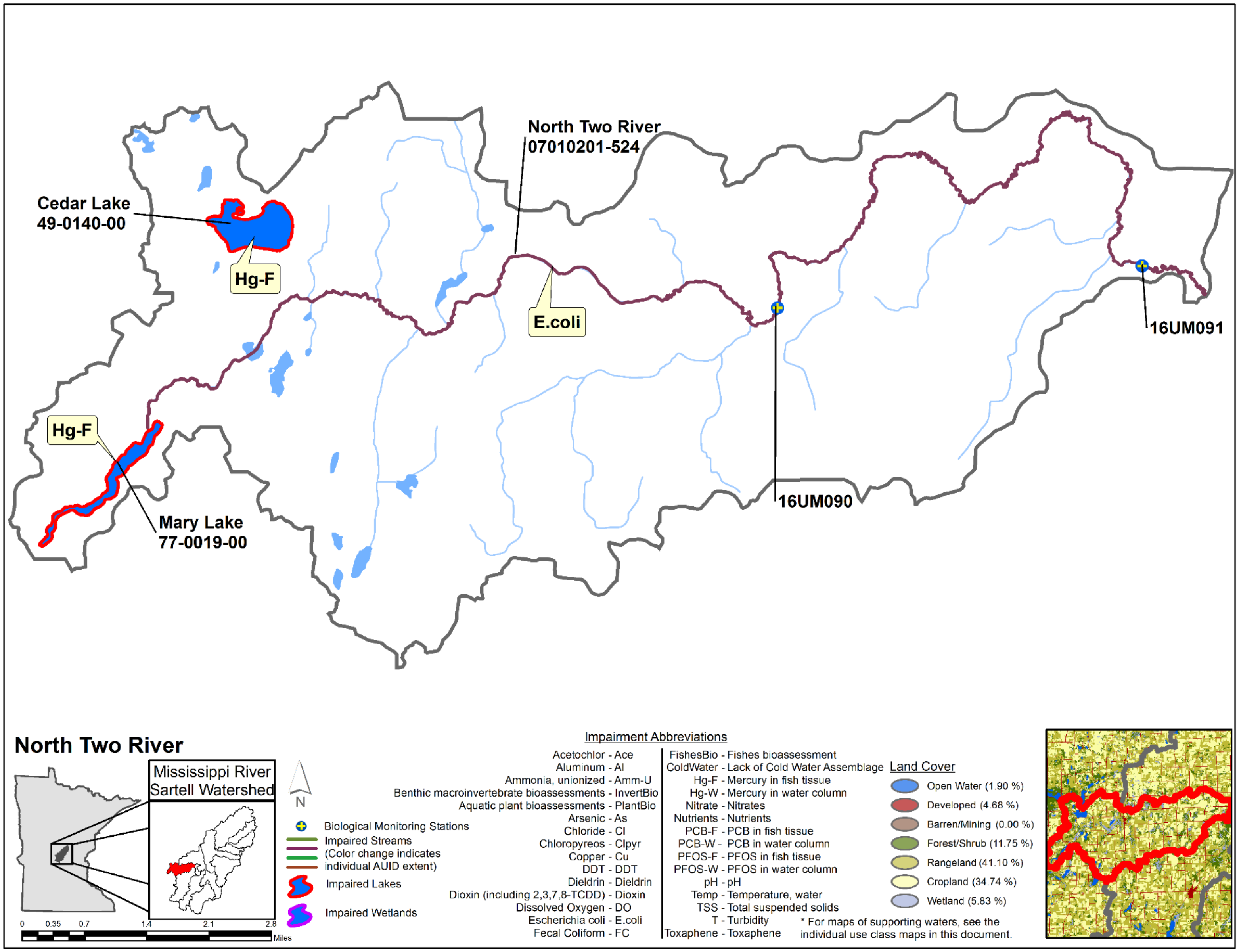
Summary

One stream segment (-524) was assessed in the North Two River Subwatershed (See Appendix 3.2 and 3.3). The North Two River supports a healthy biological community with both the fish and macroinvertebrate communities scoring above the upper confidence limit in their respective classes. Water chemistry data meet goals for aquatic life. Poor recreational water quality was found, based on elevated bacteria concentrations. Further investigation is needed to locate sources within the contributing watershed.

Two lakes (Cedar and Mary) were assessed. Cedar Lake is a regional highlight with excellent recreational water quality. Cedar Lake is part of the DNR's Sentinel Lake Program. As a result, long-term, intensive monitoring occurs on this lake. There is an improving trend of water clarity. Declining recreational water quality was observed in Lake Mary. The recent data from 2016 and 2017 show that algae is increasing and clarity is being reduced as a result. This lake should be considered a high priority for protection efforts.

There were two lakes assessed for aquatic life health using the FIBI; Cedar and Mary. Lake Mary had a 2017 IBI score of 53, meeting goals for this lake type. Four small bottom dwelling fish species requiring good quality water were collected; Tadpole Madtom, Least Darter, Johnny Darter and Iowa Darter. Vegetation and score your shore surveys conducted by DNR found healthy conditions for aquatic communities. Cedar Lake has IBI scores ranging from 76 to 85, all clearly meeting goals for lake type. Across all sampling efforts, seven different intolerant species requiring good water quality were found. Historical records indicate Cisco populations present prior to 2000, since then no individuals have been observed in DNR surveys. Cisco is an open water fish requiring well-oxygenated, cool water. As waters warm, ideal habitat for this species shrinks. Vegetation and score your shore surveys conducted by DNR reveal healthy plant and shoreline attributes.

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the North Two River – 0701020101-03 Aggregated HUC-12.



Two River Aggregated HUC-12 — HUC 0701020101-01

The Two River Subwatershed the smallest subwatershed draining just 9 square miles in southern Morrison and northern Stearns counties. The Two River mainstem begins at the confluence of the North Two and South Two Rivers and flowing 5.58 miles east to its confluence with the Mississippi River. There are no lakes or other significant streams in this subwatershed. The only town in this subwatershed is the community of Bowlus, which lies on the western edge of the subwatershed. The land cover is primarily rangeland (40.1%), cropland (37.5%), and forest (10.0%).

Table 13. Aquatic life and recreation assessments on stream reaches: Two River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class***	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07010201-523 ***Two River*** North & South Two R to Mississippi R	16UM118, 16UM128	5.58	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	SUP	IMP

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

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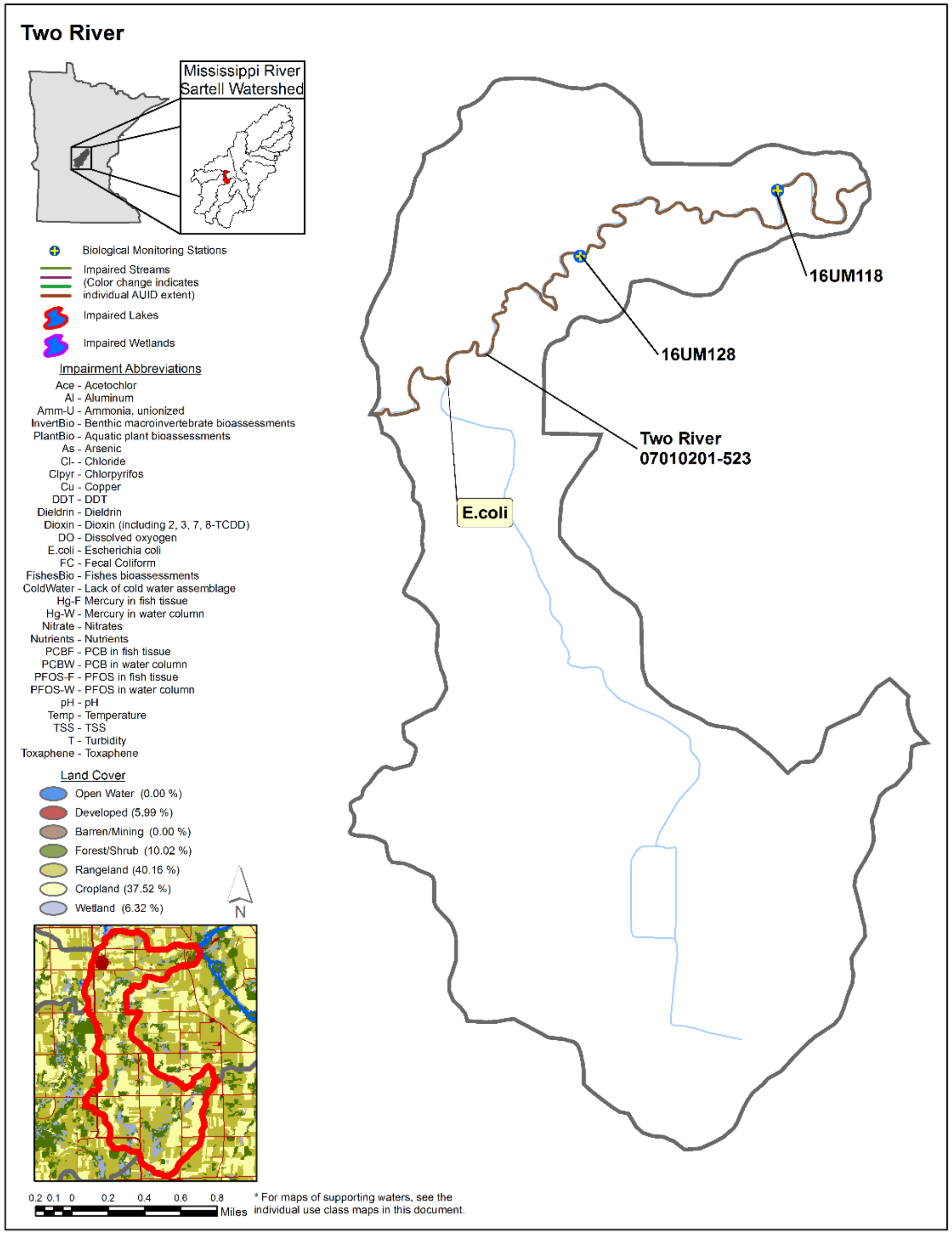
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

One stream segment (-523) was assessed in the Two River Subwatershed. The Two River supports healthy aquatic life. Sensitive insectivorous fish species needing clean coarse substrate were found in good numbers at both biological stations (See Appendix 3.2). There was a high number of macroinvertebrate species at the biological monitoring station, 16UM118 (73 species). This site harbored Micrasema rusticum and Neureclipsis, which are both sensitive caddisflies. Odonates are present at both stations and are good indicators, but most of these are ubiquitously distributed damselflies (See Appendix 4.2). In-stream habitat is very good with various substrate types, depth variability, good sinuosity, and good channel development (See Appendix 5).

Extensive water chemistry data was available on the downstream reach of Two Rivers, where all parameters are meeting goals for supporting healthy aquatic life. Aquatic recreation use was previously assessed in 2012, which showed elevated bacteria concentrations reflecting poor recreational water quality. Follow-up work has been completed to begin addressing this issue; however, newer data included in this assessment cycle indicate that elevated bacteria still persists. There were no lakes assessed in this subwatershed.

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Two River – 0701020101-01 Aggregated HUC-12.



South Two River Aggregated HUC-12 HUC 0701020101-02

The South Two River Subwatershed drains 96 square miles of northern Stearns and southern Morrison counties. The subwatershed spans from five miles southwest of Albany to just south of Bowlus before joining the North Two River to form Two River. Major waterbodies in this subwatershed include: South Two River, Krain Creek, Two Rivers Lake, Little Pine Lake, and Pelican Lake. The communities of Albany and Holdingford are located within this subwatershed. The land cover is primarily rangeland (42.8%), cropland (34.6%), forest (9.7%), and developed (6.9%).

Table 14. Aquatic life and recreation assessments on stream reaches: South Two River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia $-NH_3$	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-532 ***South Two River*** Schwinghammer Lk to Two River Lk	--	5.10	WWg	--	--	EXS	IF	MTS	MTS	MTS	--	IF	IMP	SUP
07010201-542 ***South Two River*** T125 R31W S21, south line to T125 R31W S23, east line	--	2.82	LRVW	--	--	MTS	--	--	--	MTS	--	--	--	IMP
07010201-580 ***Unnamed Creek*** Unnamed Cr to Two Rivers Lk	--	1.05	WWg	--	--	IF	MTS	IF	MTS	MTS	--	IF	IF	IMP
07010201-610 ***Unnamed Creek*** Pelican Lk to Little Mud Lk outlet	--	0.36	WWg	--	--	--	MTS	MTS	--	--	--	MTS	IF	IF
07010201-612 ***Unnamed Creek*** Unnamed Cr to Unnamed Cr	--	0.71	WWg	--	--	MTS	IF	IF	MTS	MTS	--	IF	IF	IMP

07010201-613 ***Krain Creek*** Unnamed Cr to Unnamed Cr	16UM086	2.56	WWg	MTS	MTS	MTS	IF	MTS	MTS	MTS	IF	IF	SUP	IMP
07010201-628 ***Unnamed Creek*** Headwaters to Pelican Lk	--	0.97	WWg	--	--	--	IF	MTS	--	--	--	IF	IF	IMP
07010201-632 ***Unnamed Creek*** Headwaters to Unnamed Cr	15EM008	3.92	WWm	NA	MTS	IF	IF	IF	--	IF	--	IF	SUP	--
07010201-643 ***South Two River*** River St to Two R	16UM127, 16UM131	12.73	WWg	EXS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	IMP	IMP

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

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*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 15. Lake assessments: South Two River Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Pelican	73-0118-00	332	40	Deep Lake	NCHF	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Pine	73-0136-00	103	--	Deep Lake	NCHF	I	IF	--	--	MTS	MTS	MTS	IF	SUP
Two Rivers	73-0138-00	584	60	Deep Lake	NCHF	NT	EXS	IF	--	EXS	EXS	MTS	IMP	IMP
North	73-0177-00	71	--	Shallow Lake	NCHF	--	--	--	--	IF	IF	IF	--	IF
Bear	73-0190-00	32	--	Deep Lake	NCHF	NT	--	--	--	IF	IF	MTS	--	IF
Fish	73-0191-00	37	--	Shallow Lake	NCHF	NT	--	--	--	--	--	MTS	--	IF
Gravel	73-0204-00	57	--	Deep Lake	NCHF	--	--	--	--	IF	--	--	--	IF
Unnamed	73-0330-00	17	--	Shallow Lake	NCHF	NT	--	--	--	--	--	MTS	--	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

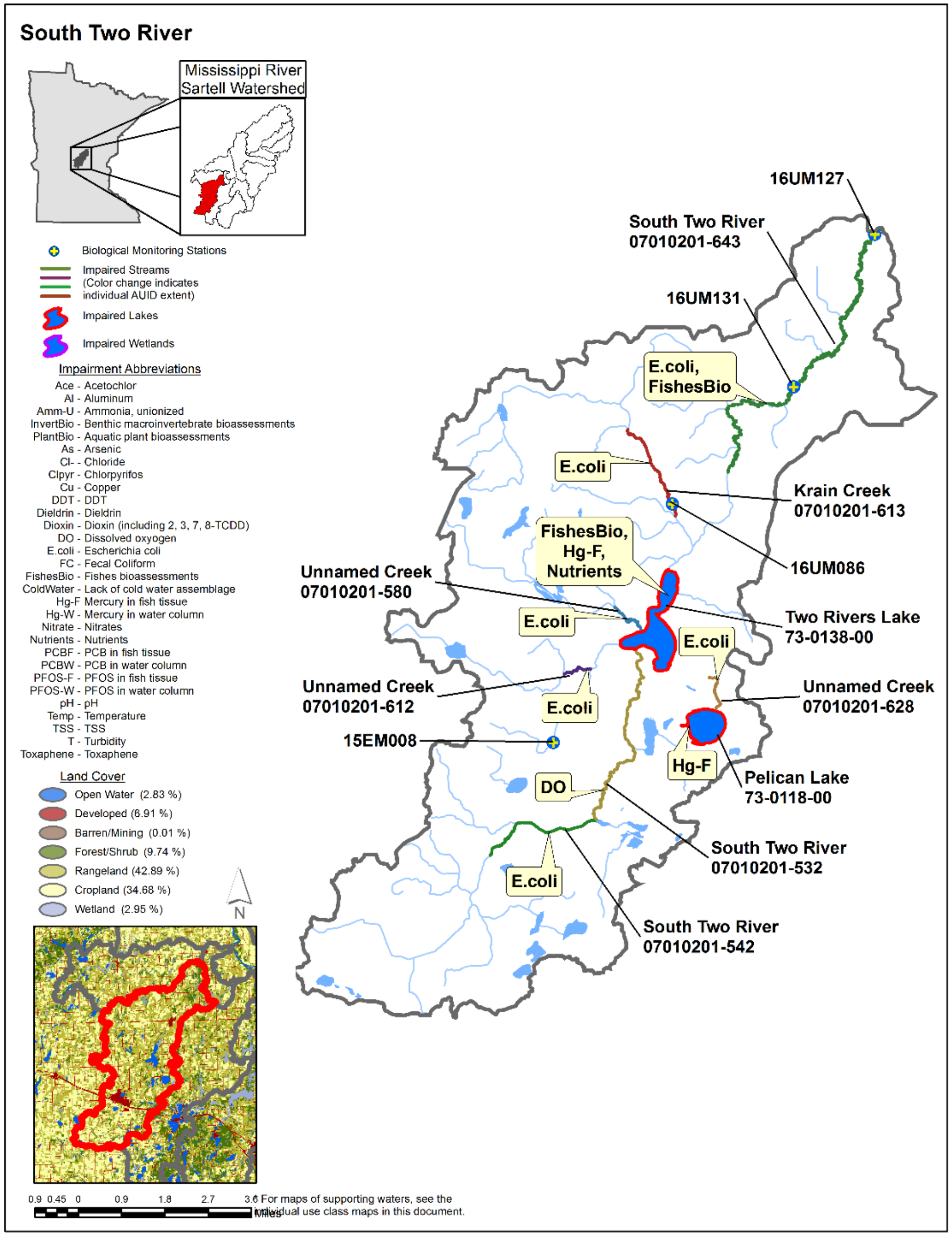
Nine stream sections were assessed in the South Two River Subwatershed: South Two River, Krain Creek, and unnamed tributaries (See Appendix 3.2 and 3.3). The mainstem of the South Two River does not support aquatic life. The headwaters consisting largely of channelized streams with areas of open pastures and little to no riparian protection. Habitat scores improve from upstream to downstream with middle sections reflecting a low gradient, low DO system, and the lower section having more flow, with a more stable, cleaner streambed (See Appendix 5). Krain Creek currently supports a good aquatic community; however, there were few sensitive fish species present. Further degradation in this intensively row-cropped subwatershed may contribute to a biological impairment. Blue Winged Olive (*Baetis tricaudatus),* a species of mayfly often found in coldwater streams throughout the Driftless and North Shore areas of Minnesota was sampled, indicating there maybe groundwater influences to the thermal regime.

Substantial water chemistry datasets are available for South Two River and smaller tributaries to Two Rivers Lake. Elevated nutrient concentrations were common; however, available data did not indicate that eutrophic conditions (excess algal or plant growth) were present as a result. Dissolved oxygen conditions were poor within the upstream reach of South Two Rivers and other smaller tributaries had limited DO data. Bacteria concentrations were consistently high on all reaches, indicating poor recreational suitability.

A past assessment conducted in 2010 of Two Rivers Lake found poor recreational quality. Recent data indicates conditions have not improved; further work will be needed to identify restorations techniques to improve recreational water quality. Pine and Pelican lakes are headwater lakes upstream of Two Rivers Lake benefitting from smaller drainage areas with less nutrient inputs and resulting in better recreational water quality. Both exhibit improving trends in water clarity, protection of these high quality basins will ensure good recreational opportunities for future generations.

There were two lakes assessed for aquatic life health using the FIBI; Two Rivers and Pelican. Two Rivers Lake has FIBI scores ranging from 22 to 31, both well below goals for its specific lake type. The IBI scores were negatively impacted by the presence of five species that are tolerant to pollution; Common Carp, Bigmouth Buffalo, Green Sunfish, Black Bullhead, and Fathead Minnow. Score your shore survey conducted by DNR indicate the shoreline is in average condition when compared to statewide averages. Aquatic plant communities are poor. Pelican had high FIBI scores (54, 57) indicative of good water quality for supporting aquatic life. Positive influences on the FIBI scores were the large amount of top predators in gill net catches, presence of four species sensitive to poor water quality and nine plant dwelling species. Plant communities surveyed were in healthy condition to support aquatic life. Score your shore survey revealed shoreline conditions are below statewide averages.

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the South Two River – 0701020101-02 Aggregated HUC-12.



Spunk Creek Aggregated HUC-12 — HUC 0701020102-01

The Spunk Creek Subwatershed drains 81 square miles in Stearns County. The subwatershed spans from 7.5 miles south of Albany and flows nearly 22 miles northeast to its confluence with the Mississippi River five miles southeast of Bowlus. The communities of Avon and Opole are located in the midsection of this subwatershed. Major streams in this subwatershed include: Spunk Creek, Spunk Branch, and several unnamed tributaries. Major lakes in this subwatershed include: Kreigle, Pitts, Minnie, Kalla, the Spunk chain of lakes, Ochotto, and Clear lakes as well as a few smaller lakes. The land cover is primarily rangeland (41.2%), cropland (26.9%), and forest (17.4%).

Table 16. Aquatic life and recreation assessments on stream reaches: Spunk Creek Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-525 ***Spunk Creek*** Lower Spunk Lk to Mississippi R	00UM040, 16UM126, 16UM132	23.59	WWg	MTS	MTS	MTS	IF	MTS	MTS	MTS	MTS	IF	SUP	IMP
07010201-561 ***Spunk Branch*** Kalla Lk to Upper Spunk Lk	--	1.67	WWg	--	--	NA	MTS	MTS	MTS	MTS	--	MTS	IF	IMP

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

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Table 17. Lake assessments: Spunk Creek Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Kreigle	73-0097-00	102	66	Deep Lake	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Pitts	73-0098-00	107	--	Shallow Lake	NCHF	--	--	--	--	MTS	IF	MTS	--	SUP
Minnie	73-0099-00	23	59	Deep Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Kalla	73-0100-00	105	48	Deep Lake	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Big Spunk	73-0117-00	392	33	Deep Lake	NCHF	NT	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Ochotto	73-0122-00	38	40	Deep Lake	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Lower Spunk	73-0123-00	173	28	Deep Lake	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Linneman	73-0127-00	107	--	Shallow Lake	NCHF	D	--	--	--	MTS	MTS	MTS	--	SUP
Middle Spunk	73-0128-00	228	78	Deep Lake	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Minnie	73-0129-00	52	--	Shallow Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Koop	73-0166-00	56	54	Deep Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Clear	73-0172-00	115	--	Deep Lake	NCHF	NT	EXS	IF	--	MTS	MTS	MTS	IMP	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
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Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

Summary

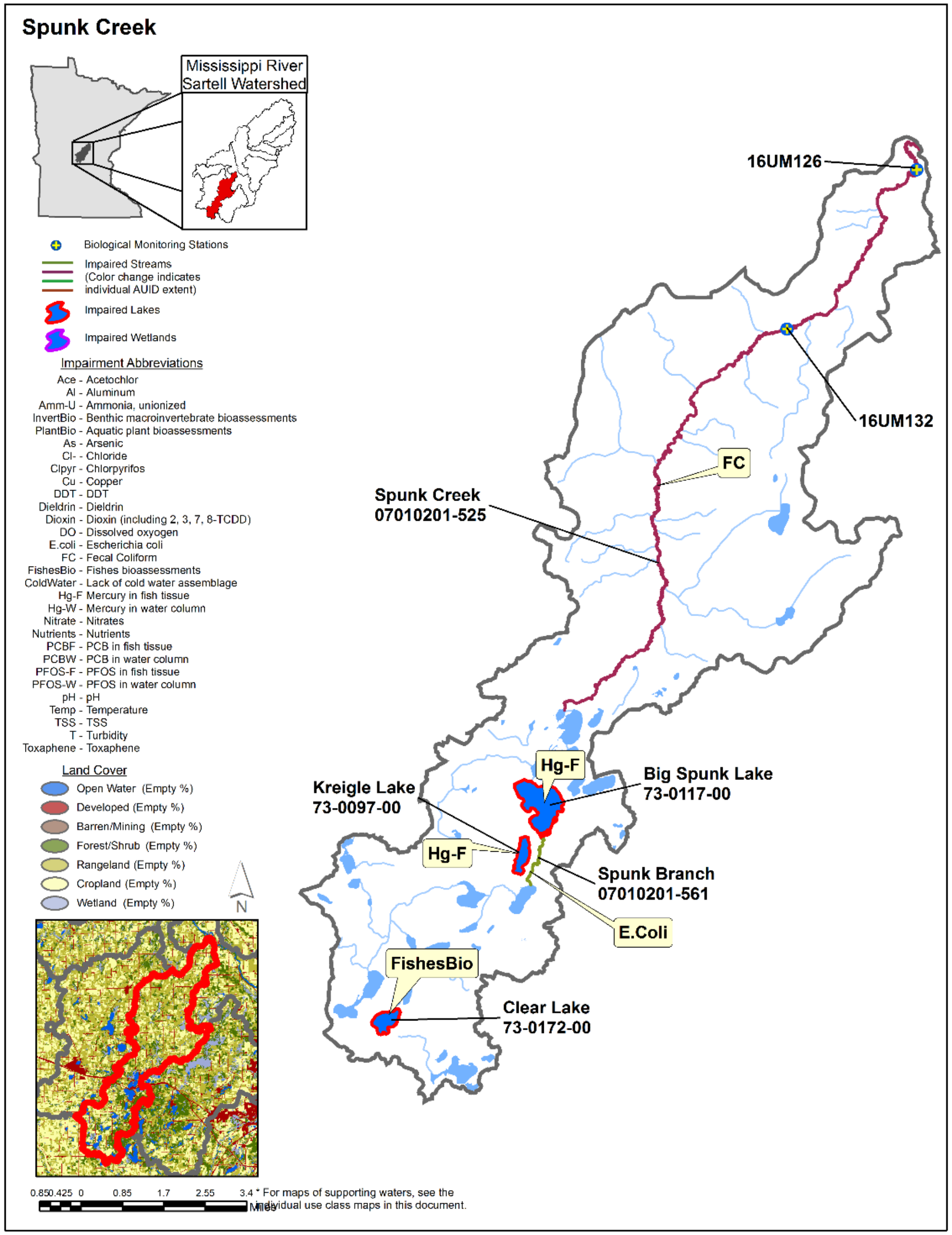
Two stream segments (-525, -561) were assessed in the Spunk Creek Subwatershed (See Appendix 3.2 and 3.3). Spunk Creek fully supports aquatic life, although conditions improve from upstream to downstream. Habitat in the upper sections reflect a lower gradient system with dense vegetation, fine substrates, and slower flow velocity. At the furthest downstream section, habitat is good with excellent channel development, coarse clean substrate, good cover, and fast flow (See Appendix 5).

Spunk Creek, downstream of Spunk Lake had good water quality, with low nutrient and sediment concentrations and supports aquatic life. Previous assessment of bacteria for aquatic recreation use indicated elevated bacteria concentrations on the lower portion of the creek. Implementation activities have been completed since the initial listing. However, the most recent assessment found elevated concentrations both upstream and downstream of the chain of lakes.

A number of headwater lakes in this subwatershed had sufficient datasets to assess for aquatic recreation. In general, all of these lakes met regional goals for good recreational water quality. Three of these lakes (Kalla, Lower Spunk, Middle Spunk) had improving water clarity trends detected over time. The clarity on these lakes is already clearly meeting goals. Protection strategies would be ideal for maintaining future water quality. Linneman Lake fully supports aquatic recreation although recently detected trend in declining water clarity could be a sign of a lake nearing the tipping point of poor water quality. Protection efforts to preserve current water quality should be considered for this resource. Continued citizen monitoring of area lakes is ideal for tracking clarity changes between larger monitoring efforts.

Three lakes were assessed as fully supporting for aquatic life health using the FIBI. FIBI scores from Big Spunk, Lower Spunk, Middle Spunk ranged from 50 to 73, easily meeting goals for each lake type. Positive influences on the FIBI scores were the presence of bottom dwelling species (Johnny Darter, Iowa Darter, Least Darter, and Tadpole Madtom), numbers of vegetative dwelling species and occurrence of species sensitive to poor water quality. Clear Lake did not support aquatic life based on three FIBI scores ranging from 16 to 30, none of which met goals for this lake type. The FIBI scores were negatively impacted by sheer amount of fish captured that are tolerant to water pollution, near absence of bottom dwelling species, and lack of fish that are sensitive to water pollution. Score your shore survey conducted by DNR indicates the shoreline is in above average condition when compared to the statewide average, while aquatic plant communities are representative of healthy conditions.

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Spunk Creek – 0701020102-01 Aggregated HUC-12.



Watab River Aggregated HUC-12 — HUC 0701020106-01

The Watab River Subwatershed drains 95 square miles in eastern Stearns County. This Subwatershed stretches from four miles south of Avon to the city of Sartell. Major streams include: North Fork Watab River, South Fork Watab River, Watab River, County Ditch 12, County Ditch 13, and County Ditch 16. Major lakes include: Watab, Lower Watab, Rossier, Sagtagan, Schuman, Big Watab, and a few others. The community of St. Joseph is located on the eastern border midway through the subwatershed. The lower portion is more urban than the rest of the subwatershed with the city of Sartell located at the pour point. Land cover is primarily rangeland (35.9%), forest (22.8%), cropland (19.4%), and developed (9.3%).

Table 18. Aquatic life and recreation assessments on stream reaches: Watab River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological Station ID	Reach length (miles)	Use class*	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07010201-528 ***Watab River*** Rossier Lk to Mississippi R	16UM125	7.64	WWg	EXS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IMP	IMP
07010201-529 ***Watab River, North Fork*** Headwaters (Stump Lk 73-0091-00) to S Fk Watab R	16UM082	5.79	WWg	MTS	MTS	MTS	MTS	IF	MTS	MTS	IF	MTS	SUP	IMP
07010201-537 ***County Ditch 12*** Unnamed Cr to Watab R	16UM083	6.16	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	MTS	SUP	IMP
07010201-554 ***Watab River, South Fork*** Little Watab Lk to Watab R	07UM101, 16UM081	10.31	WWg	EXS	MTS	MTS	MTS	MTS	MTS	MTS	IF	MTS	IMP	IMP
07010201-564 ***County Ditch 13*** Bakers Lk to Watab R	--	2.07	WWg	--	--	EXS	MTS	MTS	MTS	MTS	--	MTS	IMP	IMP
07010201-616 ***County Ditch 16*** Headwaters to Watab R	--	2.23	WWg	--	--	IF	IF	IF	MTS	MTS	--	MTS	IF	IMP

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

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 19. Lake assessments: Watab River Aggregated HUC-12.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Kraemer	73-0064-00	189	27	Deep Lake	NCHF	D	--	--	--	MTS	EXS	IF	IF	IF
Watab	73-0070-00	90	54	Deep Lake	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Lower Watab	73-0071-00	12		Shallow Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Rossier	73-0072-00	33	31	Deep Lake	NCHF	I	--	--	--	EXS	EXS	MTS	--	IF
Sagatagan	73-0092-00	194	40	Deep Lake	NCHF	NT	--	--	--	--	--	MTS	--	IF
Schuman	73-0096-00	21		Deep Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Schmid	73-0101-00	35	31	Deep Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Big Watab	73-0102-00	242	123	Deep Lake	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Island	73-0104-00	110		Deep Lake	NCHF	--	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Achman	73-0125-00	46	30	Shallow Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Anna	73-0126-00	68	27	Shallow Lake	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
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Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

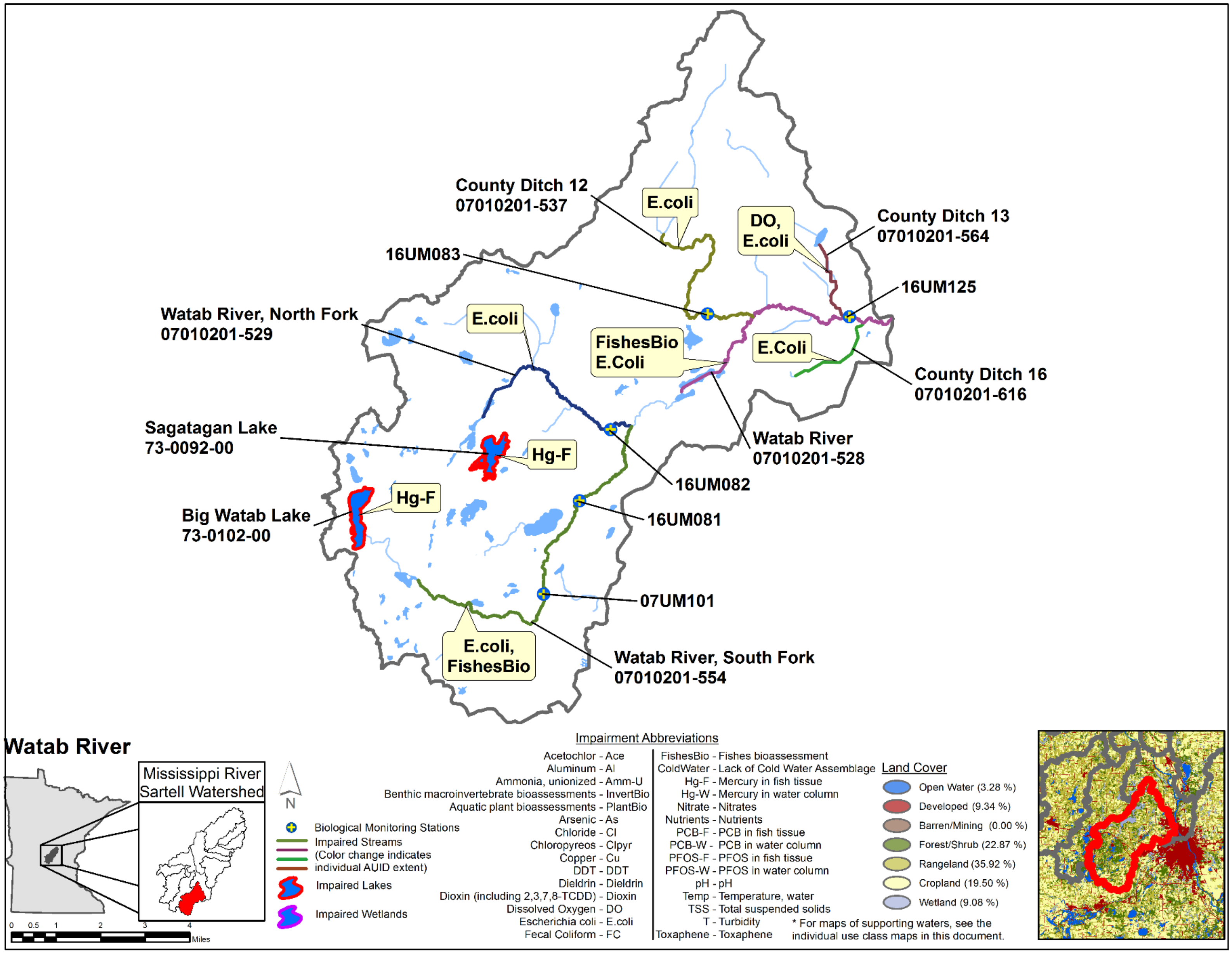
Six stream segments (-528, -529, -537, -554, -564, -616) were assessed in the Watab River Subwatershed (See Appendix 3.2 and 3.3). The North Fork Watab River and County Ditch 12 were the only two streams that supported aquatic life. The South Fork Watab River and Watab River will each receive new aquatic life impairments based upon poor fish assemblages. In-stream habitat is generally fair, but erosion and channel morphology issues were noted throughout the subwatershed (See Appendix 5).

Dissolved oxygen conditions in County Ditch 13 do not meet goals to support healthy aquatic communities, resulting in a new impairment. Further analysis will be needed to narrow down contributing sources to this aquatic stressor, much of the contributing watershed and adjacent riparian areas are heavily developed with urban land uses. Four stream reaches in this watershed have existing impairments for excess bacteria and new bacteria data on County Ditch 16 resulted in a new impairment.

A number of high quality lakes are located in the headwater region of this subwatershed. Big Watab Lake is clearly meeting regional recreation goals with good water quality. Rossier Lake had elevated nutrients and algae based on older data, but has an improving trend in water clarity. Kraemer Lake has elevated algae levels and a declining trend in water clarity; this lake is a high priority for protection efforts. In the cases of both Kraemer and Rossier, citizen monitored clarity data has provided a long term, more precise view of water quality conditions, which would not be possible without volunteer efforts. The data collected by the volunteer monitors is important to track water quality between larger monitoring efforts.

Fish IBI information was available on three lakes; Big Watab, Island and Kraemer. Big Watab and Island Lakes meet aquatic life use goals for their lake type based on the available IBI score. Both lakes scored positively based on the significant number of species intolerant to pollution (Banded Killifish, Blackchin Shiner, Blacknose Shiner, Iowa Darter, Least Darter, Pugnose Shiner, and Rock Bass) and lack of species tolerant to pollution observed during surveys. Brown Trout and Rainbow Trout create a unique two-story fishery in Big Watab Lake. Kraemer Lake had only one FIBI survey from 2007, preventing confident assessment of conditions for aquatic life.

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Watab River – 0701020106-01 Aggregated HUC-12.



Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Mississippi River-Sartell Watershed, grouped by sample type. Summaries are provided for lakes, streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption results, load monitoring data results, transparency trends, and remote sensed lake transparency. Waters identified as priorities for protection or restoration work were also identified. Additionally, groundwater and wetland monitoring results are included where applicable. Following the results are a series of graphics that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Mississippi River-Sartell Watershed.

Stream water quality

Of the stream reaches with assessment data available, 20 fully support aquatic life and one stream is fully supports aquatic recreation. Two stream reaches were classified as limited resource waters and assessed accordingly. In contrast, 36 stream reaches do not support aquatic life and/or recreation. Of those reaches, 16 do not support aquatic life and 21 do not support aquatic recreation.

Of the assessed streams reaches found to be not support aquatic life, ten were found to have an impaired fish assemblage, while six streams were found to have an impaired macroinvertebrate assemblage, in three instances a reach was listed for both fish and macroinvertebrate assemblage. Dissolved oxygen conditions triggered aquatic life use impairment on two reaches during this assessment effort, two reaches were previously listed impaired for aquatic life use based on dissolved oxygen data. Of the 21 aquatic recreation use impairments within the watershed, 16 are new during this assessment cycle.

Table 20. Assessment summary for stream water quality in the Mississippi River-Sartell Watershed.

			Supporting		Non-supporting			
Watershed	Area (acres)	Assessed WIDs	Aquatic life	Aquatic recreation	Aquatic life	Aquatic recreation	Insufficient data	Delistings
Mississippi River-Sartell	**656,115**	**50**	**20**	**1**	**16**	**24**	**27**	**0**
Upper Platte River	115,016	5	0	0	4	2	1	0
Lower Platte River	83,270	6	4	0	2	0	2	0
Little Rock Creek	70,041	10	0	0	4	1	10	0
North Two River	31,501	1	1	0	0	1	0	0
South Two River	61,504	9	2	1	2	6	5	0
Spunk Creek	51,968	2	1	0	0	2	1	0
Watab River	60,736	6	2	0	3	6	7	0
Skunk River	58,496	4	4	0	0	1	0	0
Hillman Creek	29,440	2	2	0	0	1	0	0
City of Sartell-Mississippi River	88,192	4	3	0	1	3	1	0
Two River	6,016	1	1	0	0	1	0	0

Lake water quality

Of the lakes >10 acres within the Mississippi River-Sartell Watershed, 53 had some type of assessment data available (Table 21). The availability of IBI data during this assessment cycle provided an opportunity to make complete aquatic life use assessments on 17 lakes. Twenty-eight lakes were found to support aquatic recreation, 15 were found to support aquatic life. Three lakes (Two Rivers, Little Rock, Platte) were listed impaired prior to this assessment cycle for aquatic recreation and the more recent data collected on these previously listed lakes confirm the initial impairments. No new lake impairments for aquatic recreation will be added during this assessment cycle. Fish IBI data triggered new aquatic life use impairments on Two Rivers and Clear Lakes. Insufficient data was available for aquatic life or aquatic recreation use assessments on 22 lakes.

Table 21. Assessment summary for lake water chemistry in the Mississippi River-Sartell River Watershed.

Watershed	Area (acres)	Lakes >10 acres	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	Insufficient data	# Delistings
Mississippi River-Sartell	**656115**	**53**	**15**	**28**	**2**	**3**	**22**	**0**
Upper Platte River	115016	12	7	5	0	1	7	0
Lower Platte River	83270	5	0	0	0	0	4	0
Little Rock Creek	70041	2	0	0	0	1	1	0
North Two River	31501	2	2	1	0	0	1	0
South Two River	61504	8	1	2	1	1	5	0
Spunk Creek	51968	12	3	12	1	0	0	0
Watab River	60736	11	2	8	0	0	4	0

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) have been analyzed in fish tissue samples collected from the Platte River and 13 lakes in the watershed. Samples were collected by DNR fisheries staff from 1990 to 2017 and MPCA biomonitoring staff collected fish from the Platte River in 2017.

Eleven of the 13 tested lakes are on the 2018 Impaired Waters Inventory (IWI) for mercury in fish tissue (Table 22). Ten of the lakes on the IWI qualified for inclusion in the Minnesota Statewide Mercury TMDL.

PCBs were tested in representative species from four lakes and the Platte River. All PCB concentrations were less than the reporting limits and were, therefore, well below the 0.2 ppm threshold for impairment.

Table 22 Fish contaminants: summary of fish length, mercury and PCBs by waterway-species-year

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
DOWID	Waterway	Species	Year	Anatomy[1]	Fish	Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
07010201-545, -546	**PLATTE RIVER**	Shorthead redhorse	2017	FILSK	5	5	17.0	14.5	18.3	0.275	0.108	0.366	5	0.025	0.025	Y
05-0013-00	**LITTLE ROCK***	Black crappie	2007	FILSK	17	1	7.8	7.8	7.8	0.045	0.045	0.045				
05-0013-00	**LITTLE ROCK***		2014	FILSK	7	1	7.6	7.6	7.6	0.054	0.054	0.054				
		Northern pike	1990	FILSK	6	2	23.9	22.5	25.3	0.076	0.061	0.091	2	0.01	0.01	Y
			2014	FILSK	4	4	20.6	19.0	23.9	0.229	0.106	0.426				
		Walleye	1990	FILSK	15	3	17.4	11.4	21.5	0.094	0.056	0.130	3	0.01	0.01	Y
			2014	FILSK	8	8	16.8	12.3	20.5	0.103	0.075	0.144				
		White crappie	1990	FILSK	10	1	7.9	7.9	7.9	0.330	0.330	0.330	1	0.01	0.01	Y
		White sucker	1990	FILSK	16	2	14.3	12.2	16.3	0.041	0.029	0.052	2	0.01	0.01	Y
			2014	FILSK	5	1	16.8	16.8	16.8	0.038	0.038	0.038				
18-0088-00	**PLATTE***	Black crappie	2003	FILSK	10	1	8.2	8.2	8.2	0.081	0.081	0.081				
		Bluegill sunfish	2003	FILSK	10	1	7.0	7.0	7.0	0.057	0.057	0.057				
		Northern pike	2003	FILSK	6	6	20.2	17.1	25.9	0.156	0.092	0.280				
49-0015-00	**LONG**	Bluegill sunfish	2017	FILSK	10	1	7.4	7.4	7.4	0.054	0.054	0.054				
		Northern pike	2017	FILSK	4	4	20.5	16.3	30.0	0.207	0.185	0.252				
49-0016-00	**SULLIVAN***	Black crappie	2009	FILSK	9	2	8.7	7.7	9.7	0.028	0.025	0.030				
		Bluegill sunfish	1993	FILSK	8	1	7.0	7.0	7.0	0.031	0.031	0.031				
			2009	FILSK	2	1	7.1	7.1	7.1	0.042	0.042	0.042				
		Northern pike	1993	FILSK	11	2	19.7	18.8	20.6	0.108	0.085	0.130				
			2009	FILSK	8	8	19.6	15.5	26.7	0.153	0.107	0.250				
		Walleye	1993	FILSK	10	3	17.1	13.7	20.1	0.173	0.110	0.230	1	0.01	0.01	Y
			2009	FILSK	8	8	16.3	11.8	21.5	0.211	0.089	0.472				
49-0024-00	**PIERZ**	Bluegill sunfish	1996	FILSK	10	1	6.6	6.6	6.6	0.040	0.040	0.040				
		Northern pike	1996	FILSK	7	2	20.1	17.6	22.6	0.095	0.050	0.140				
			2014	FILSK	4	4	22.2	16.5	30.3	0.141	0.064	0.296				
		Walleye	1996	FILSK	6	2	17.7	15.4	20.0	0.110	0.070	0.150	1	0.01	0.01	Y
			2014	FILSK	4	4	16.5	15.3	17.8	0.162	0.116	0.179				
		White sucker	1996	FILSK	4	1	16.3	16.3	16.3	0.020	0.020	0.020				
49-0140-00	**CEDAR***	Largemouth bass	2008	FILSK	5	5	12.8	10.8	14.4	0.419	0.248	0.556				
		Northern pike	2000	FILSK	15	15	25.3	18.1	32.2	0.492	0.300	0.780				
			2016	FILSK	15	15	21.5	16.5	27.7	0.577	0.307	1.071				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in) Mean	Min	Max	Mercury (mg/kg) Mean	Min	Max	PCBs (mg/kg) N	Mean	Max	< RL
		Pumpkinseed sunfish	2008	FILSK	5	1	6.2	6.2	6.2	0.087	0.087	0.087				
73-0092-00	**SAGATAGAN***	Northern pike	2000	FILSK	18	18	18.7	10.9	25.4	0.219	0.060	0.410				
		Yellow perch	2000	WHORG	2	2	6.2	5.4	6.9	0.065	0.060	0.070				
73-0097-00	**KREIGLE***	Northern pike	2000	FILSK	20	20	20.7	12.9	30.0	0.149	0.060	0.320				
			2010	FILSK	14	14	20.7	16.4	25.2	0.190	0.106	0.340				
73-0102-00	**BIG WATAB***	Black bullhead	2016	FILET	5	1	10.6	10.6	10.6	0.215	0.215	0.215				
		Black crappie	2016	FILSK	3	1	9.7	9.7	9.7	0.110	0.110	0.110				
		Bluegill sunfish	2016	FILSK	10	1	7.3	7.3	7.3	0.148	0.148	0.148				
		Largemouth bass	2016	FILSK	8	8	11.5	9.6	14.3	0.260	0.158	0.538				
		Northern pike	2016	FILSK	8	8	23.2	18.6	29.8	0.276	0.176	0.425				
		Yellow perch	2016	FILSK	4	1	8.1	8.1	8.1	0.124	0.124	0.124				
73-0117-00	**BIG SPUNK****	Black crappie	2016	FILSK	7	1	9.4	9.4	9.4	0.068	0.068	0.068				
		Bluegill sunfish	2016	FILSK	9	1	7.0	7.0	7.0	0.069	0.069	0.069				
		Common Carp	2016	FILSK	2	1	21.6	21.6	21.6	0.027	0.027	0.027				
		Largemouth bass	2016	FILSK	6	6	12.8	10.1	16.0	0.378	0.167	0.700				
		Northern pike	2016	FILSK	8	8	24.5	16.4	29.3	0.331	0.236	0.432				
		Walleye	2016	FILSK	6	6	22.0	17.8	26.9	0.628	0.313	1.050				
73-0117-00	**BIG SPUNK****	Yellow bullhead	2016	FILET	4	1	11.7	11.7	11.7	0.272	0.272	0.272				
73-0118-00	**PELICAN***	Bluegill sunfish	2010	FILSK	9	1	7.1	7.1	7.1	0.025	0.025	0.025				
		Northern pike	2010	FILSK	8	8	20.0	16.5	29.0	0.143	0.065	0.242				
		Walleye	2010	FILSK	8	8	15.7	12.3	22.5	0.117	0.069	0.257				
73-0138-00	**TWO RIVERS***	Black crappie	1993	FILSK	10	1	7.2	7.2	7.2	0.180	0.180	0.180				
73-0138-00	**TWO RIVERS***	Bluegill sunfish	2009	FILSK	10	1	7.3	7.3	7.3	0.155	0.155	0.155				
		Common Carp	2009	FILSK	3	1	23.5	23.5	23.5	0.172	0.172	0.172				
		Northern pike	1993	FILSK	9	4	25.9	18.7	33.4	0.375	0.270	0.480	1	0.01	0.01	Y
			2009	FILSK	4	4	21.6	16.3	29.3	0.172	0.119	0.296				
		Walleye	2009	FILSK	5	5	18.0	13.5	21.6	0.260	0.192	0.329				
		White sucker	1993	FILSK	8	1	17.4	17.4	17.4	0.062	0.062	0.062	1	0.01	0.01	Y
77-0019-00	**MARY***	Northern pike	2000	FILSK	18	18	21.0	16.6	30.1	0.344	0.180	0.590				
			2006	FILSK	10	10	27.3	22.1	34.1	0.527	0.262	0.801				
			2012	FILSK	12	12	22.4	16.9	30.6	0.323	0.193	0.416				
			2017	FILSK	12	12	22.5	17.2	28.9	0.221	0.168	0.330				
		Yellow perch	2000	WHORG	8	8	5.9	5.6	6.5	0.136	0.060	0.220				
			2006	WHORG	7	5	6.9	5.4	8.0	0.056	0.039	0.076				

* Impaired for mercury in fish tissue as of 2018 Draft Impaired Waters Inventory; categorized as EPA Category 4a for waters covered by the Statewide Mercury TMDL.

** Impaired for mercury in fish tissue as of 2018 Draft Impaired Waters Inventory; categorized as EPA Category 5 for waters needing a TMDL.

1 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; WHORG—whole organism.

Pollutant load monitoring

The WPLMN has three sites within the Mississippi River-Sartell Watershed as shown in Table 22. The Mississippi River at Royalton and Sartell are "basin" sites, which are monitored year round, while the Platte River site is a "subwatershed" site and monitored seasonally (ice out through October 31).

Table 22 WPLMN stream monitoring sites for the Mississippi River-Sartell Watershed

Site type	Stream name	USGS ID	DNR/MPCA ID	EQuIS ID
Basin	Mississippi River at Royalton, MN	05267000	E15001002	S000-150
Basin	Mississippi River at Sartell*	05270700	W15009003	S015-116
Subwatershed	Platte River near Royalton	05268000	H15030001	S001-930

*Water samples are collected at a different location than the USGS flow gaging station. The EQuIS ID and DNR/MPCA ID are the locations were the actual samples are collected.

Average annual FWMCs of TSS, TP, and NO_3+NO_2-N for major watershed and basin sites statewide are presented in Figure 30, with the Mississippi River-Sartell Watershed outlined. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that ends up in a river or stream; which is expressed in inches.

Excessive TSS, TP, and NO_3+NO_2-N in surface waters impacts aquatic life, vegetation growth, drinking water supplies, and recreation such as fishing and swimming. As a general rule, elevated levels of TSS and NO_3+NO_2-N are regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. High levels of NO_3+NO_2-N is a concern for drinking water which may be affected by surface water inputs throughout a watershed. The abundance of other surface waters throughout the watershed such as lakes, small streams, and ditches have a greater impact on NO_3+NO_2-N concentrations in the groundwater supply. Excess TP can be attributed to both non-point as well as point sources such as industrial or wastewater treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff. More information can be found at the WPLMN website.

When compared with other major watersheds throughout the state, Figure 30 shows the average annual TP and NO_3+NO_2-N FWMCs for the Mississippi River at Royalton and Sartell to be slightly higher than the neighboring watersheds to the north; however lower than the watersheds to the south and west. Similarly, TSS FWMCs are roughly equal to surrounding watersheds but significantly lower than watersheds found in the southern and/or western portions of Minnesota.

Substantial year-to-year variability in water quality occurs for most rivers and streams, including the Mississippi River. Variability can be attributed to snow and ice melt runoff, precipitation amounts, soil types, and/or land use among many others. Annual TSS, TP, and NO_3+NO_2-N FWMCs and loads for the Mississippi River at Royalton and Sartell are shown in Figure 31 and Figure 32, respectively.

Figure 30. 2007-2016 Average annual TSS, TP, and NO_3-NO_2-N flow weighted mean concentrations and runoff by major watershed.

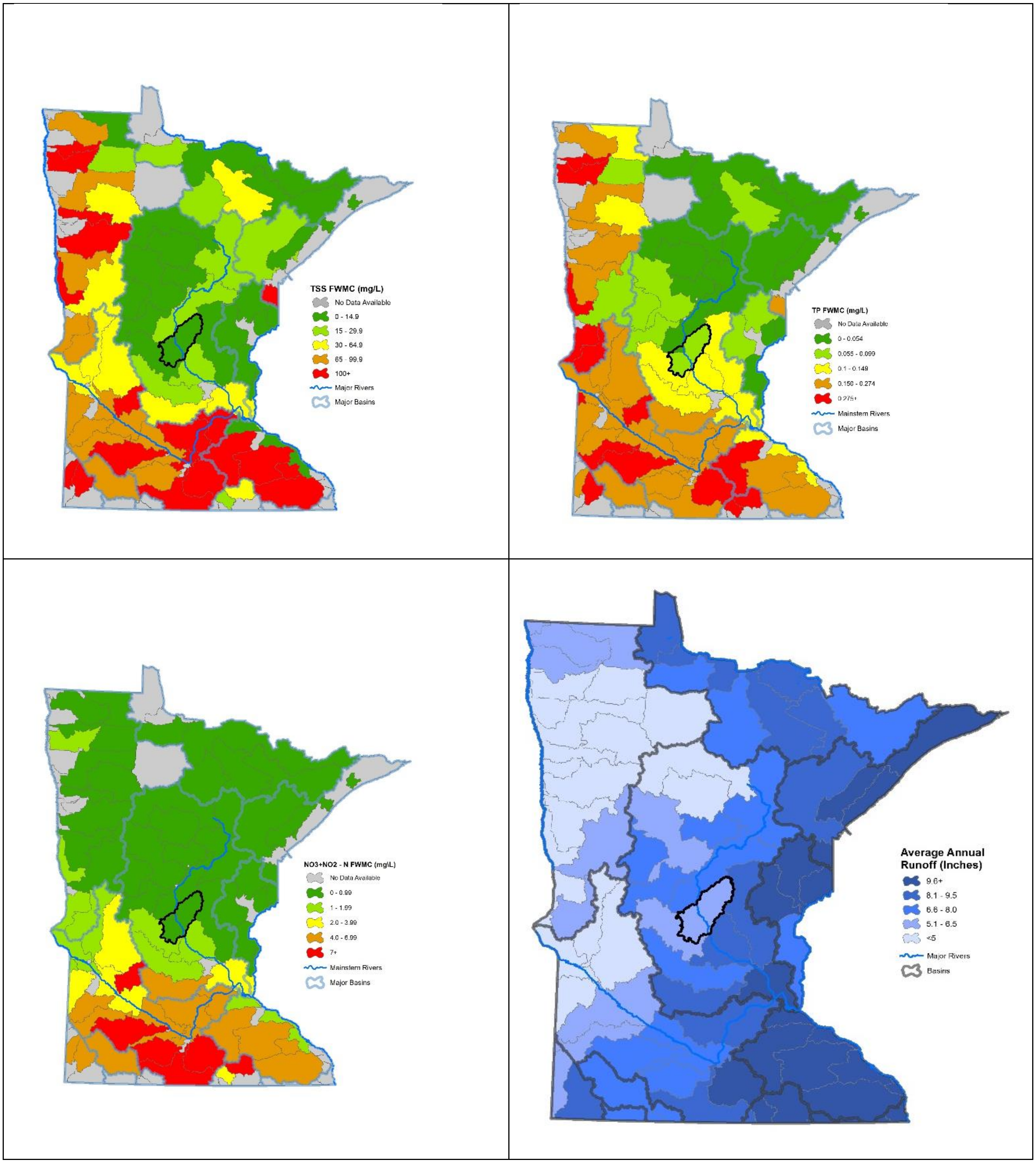
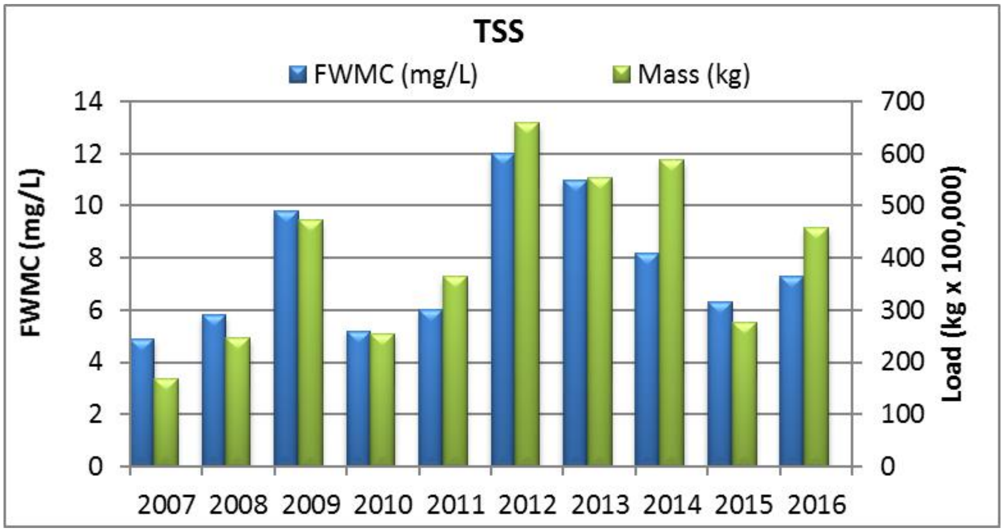
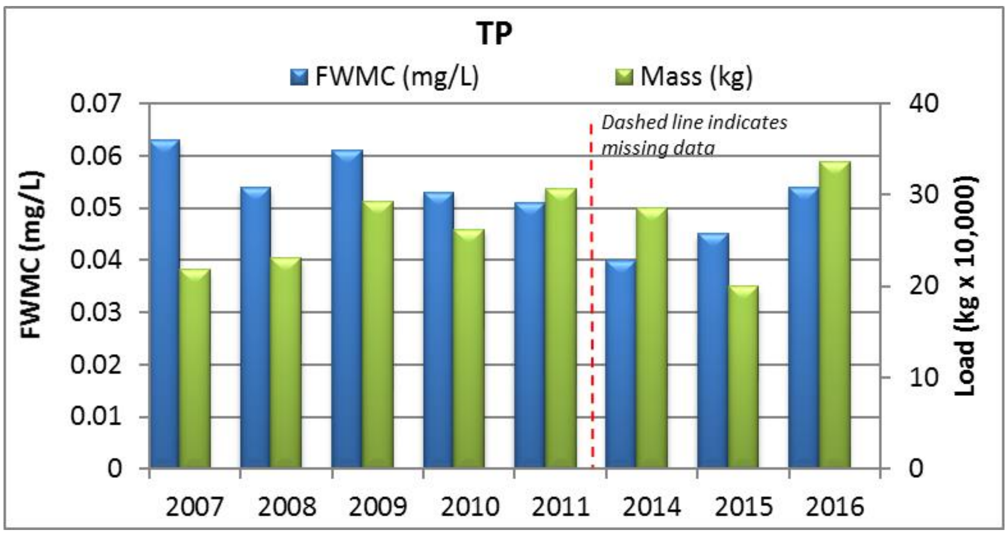


Figure 31. TSS, TP, and NO_3+NO_2-N Flow weighted mean concentrations and loads for the Mississippi River at Royalton, Minnesota, 2007-2016.





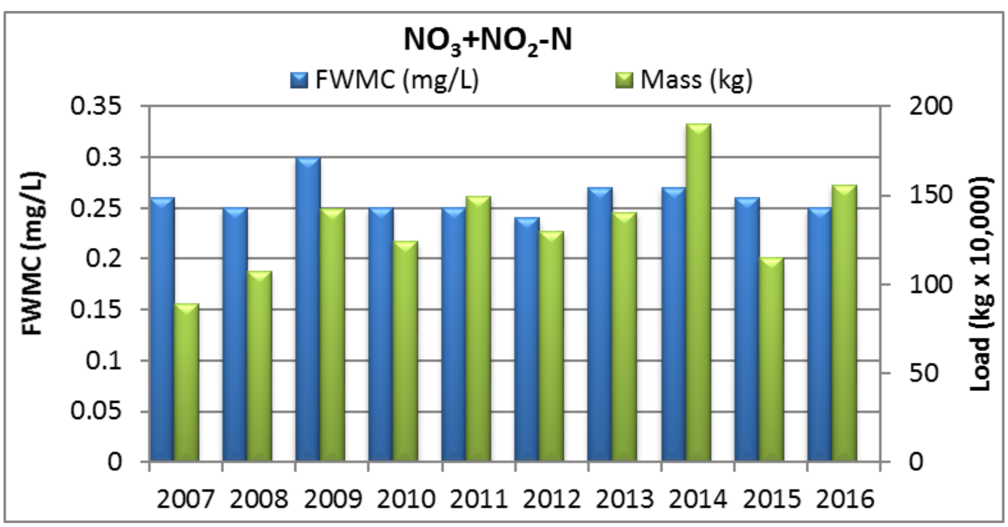
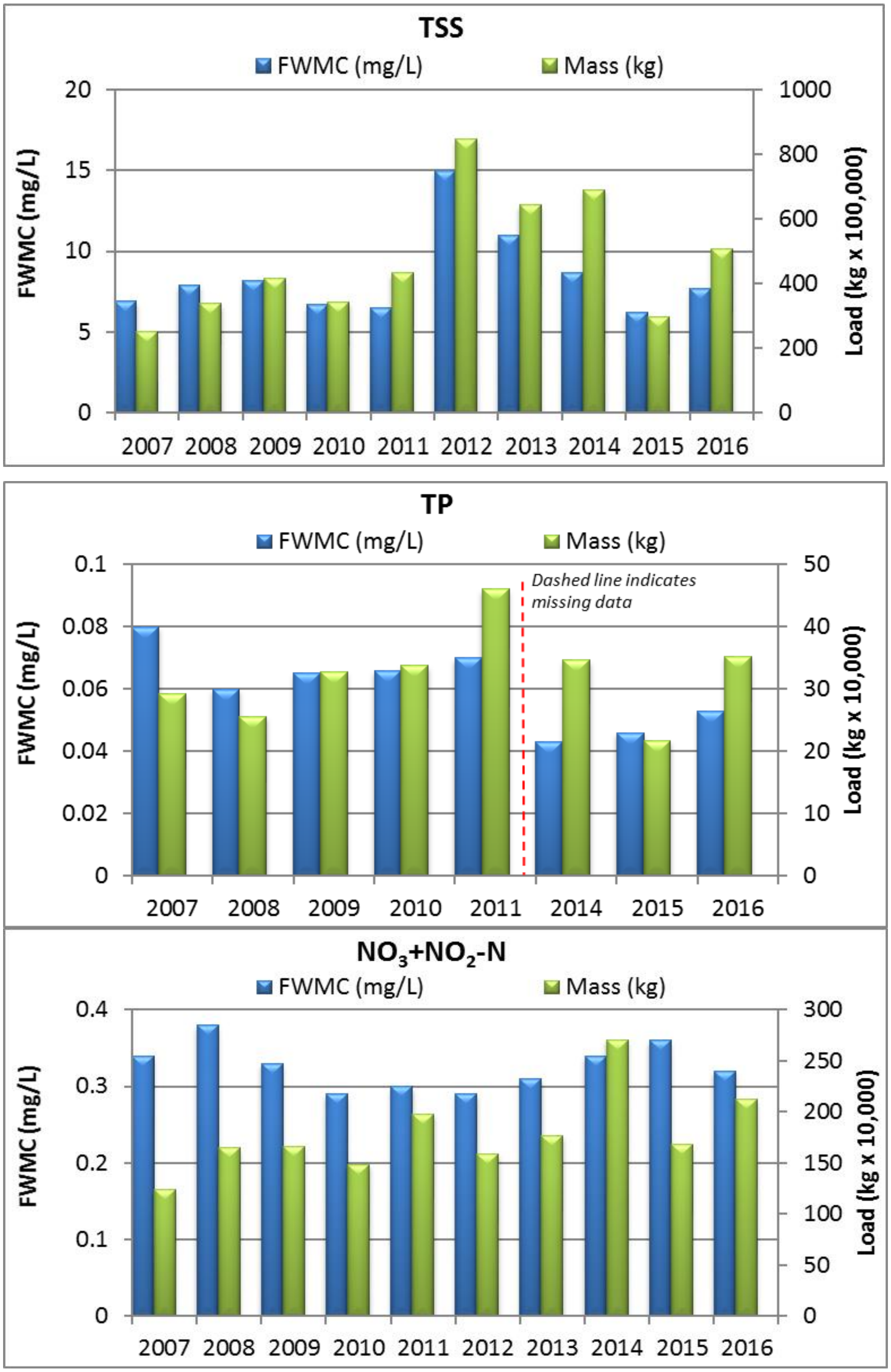


Figure 32. TSS, TP, and NO_3+NO_2-N flow weighted mean concentrations and loads for the Mississippi River at Sartell, Minnesota, 2007-2016.



Land-use changes, soil textures, and drainage practices all have an effect on the water quality found within the Mississippi River-Sartell Watershed. Unlike most other major watersheds in Minnesota, "flow through" watersheds, like those along the Mississippi River, where a river passes through rather than confined within defined watershed boundaries, are impacted not only by pollutants originating within the boundaries but also by those originating upstream. For example, the concentrations found at the Royalton and Sartell sites are not only affected by the water quality from within the Mississippi River-Sartell Watershed but also the three Mississippi River watersheds located upstream. In the charts below, concentrations at Royalton and Sartell are compared to the next WPLMN site upstream on the Mississippi River located near Aitkin.

NO_3+NO_2-N concentrations (Figure 33) roughly double from Aitkin to the Royalton site and continue to increase to the Sartell site. Although there are many ways for NO_3+NO_2-N to be transported, changes in land use types likely play a large role in the increases in concentrations. Agriculture landuse increases from 10% in the Mississippi River-Brainerd Watershed (where the Aitkin site is located) to 28% within the Missippi River-Sartell Watershed. In general, a correlation exists between increased agricultural production and higher NO_3+NO_2-N concentrations within surface waters. During intense rain events and/or field drainage, NO_3+NO_2-N is transported to surface waters through overland flow, field drain tiles, and/or water within the soil. It should be noted that although concentrations are increasing, they are significantly below the Minnesota drinking water standard (10 mg/L).

Similarly, TP concentrations continue an upward trend from the Mississippi River-Brainerd Watershed through the Mississippi River-Sartell Watershed. Two average concentrations are reported in Figure 34, average FWMC and average summer FWMC (June through September) when the statewide TP standard is in effect. Concentrations are just below the state standard (0.05 mg/L) within the Mississippi-Brainerd Watershed, however increase to a level slightly above the standard at the Royalton site where 43% of the annual samples (91/211) exceeded the standard and slightly higher still at the Sartell site where 57% of the annual samples exceeded the standard (114/199), respectively. However, seasonal average concentrations at both locations meet the phosphorus threshold and no corresponding eutrophication is observed. Like NO_3+NO_2-N, excess TP can be contributed by runoff from pastures and croplands, which are the largest source of nonpoint phosphorus on a statewide basis.

Figure 35 shows a dramatic decrease in TSS concentrations from the Mississippi River near Aitkin site to the Royaltion site with concentrations staying roughly equal at the Sartell site. Soil types are a large contributor to higher TSS concentrations near Aitkin, which are above the state standard (15 mg/L) causing a TSS impairment. Loamy soils (clay, silt, and sand) are more prevalent within the upper reaches of the Mississippi River-Brainerd Watershed but transition to more sand dominated soils in the lower reaches. Loamy soils are more easily detached and eroded when compared to the courser sediments (i.e. sand) which are more commonly found in the Mississippi River-Sartell Watershed. Less erodible soils help TSS concentrations decline to well below the state standard despite increased stream flow and volume, thus eliminating the impairment before reaching the Mississippi-River Sartell Watershed. Samples collected over the ten year period at the Royalton site showed only 7% of the TSS samples were over the state standard (19/274) versus 11% at the Sartell site (30/268), respectively.

Figure 33. Comparison of average NO_3+NO_2-N flow weighted mean concentrations for three stations on the Mississippi River, Minnesota, 2007-2016.

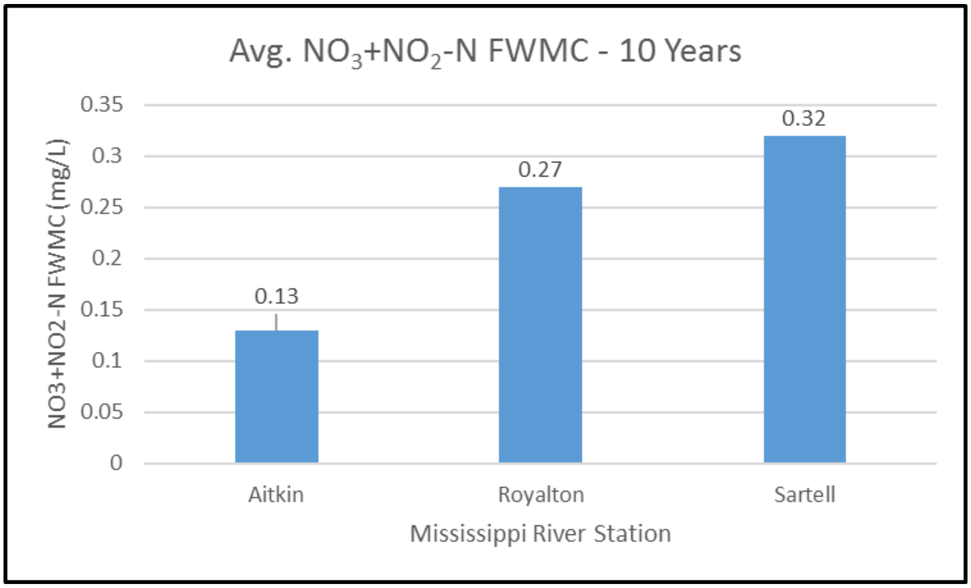


Figure 34.Comparison of average TP flow weighted mean concentrations for three stations on the Mississippi River, Minnesota, 2007-2011 and 2014-2016.

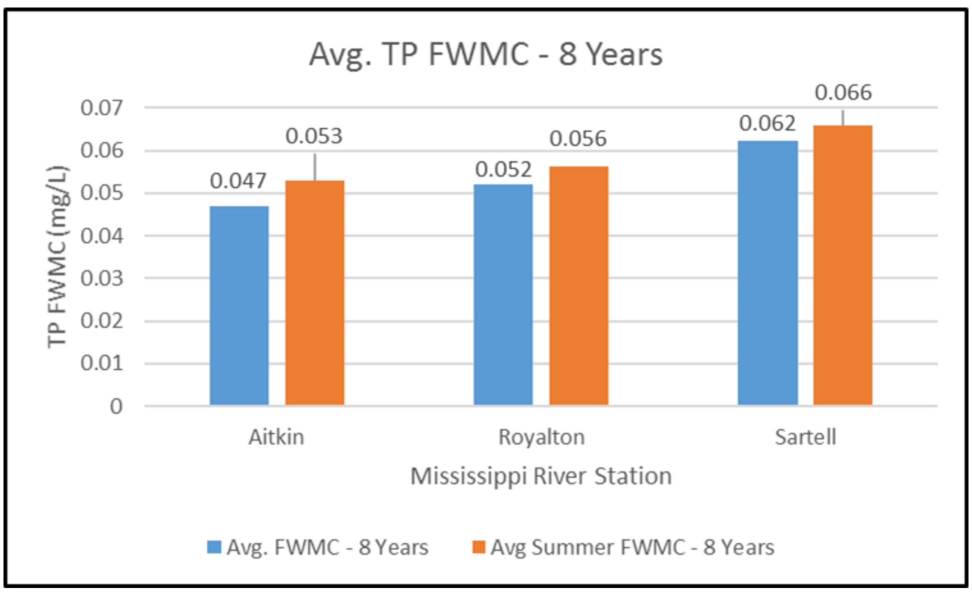
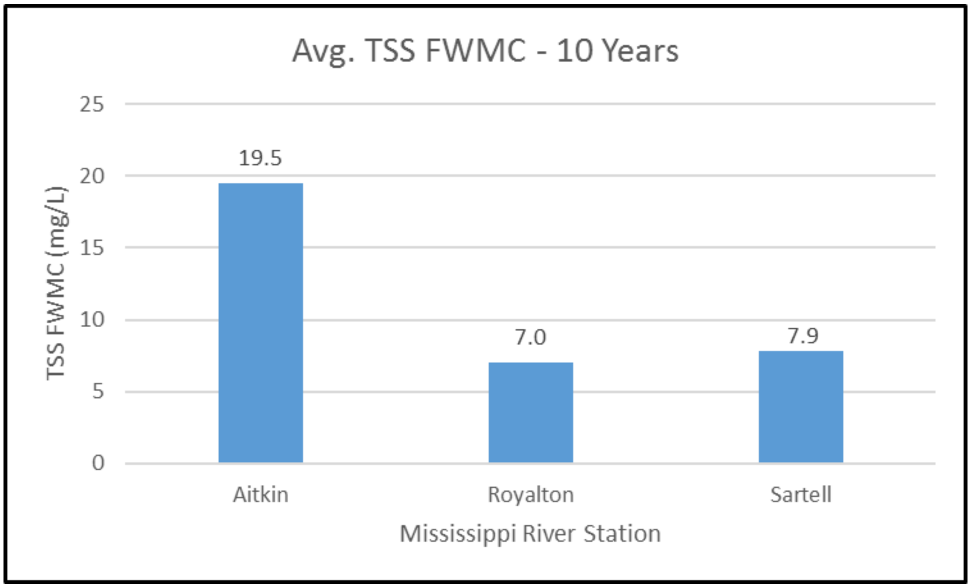


Figure 35. Comparison of average TSS flow weighted mean concentrations for three stations on the Mississippi River, Minnesota, 2007-2016.



The Platte River is a WPLMN subwatershed site within the Mississippi River-Sartell Watershed, with limited data available for 2015 and 2016. Figure 36 shows NO_3+NO_2-N FWMCs to be roughly 0.2 mg/L higher than those found within the Mississippi River at both basin sites. Similarly, TP concentrations (Figure 37) were also above the levels found within the Mississippi River mainstem. The Platte River, as well as other tributaries to the Mississippi River have watersheds with a higher percentage of agricultural lands. This is a likely reason that NO_3+NO_2-N and TP concentrations rise on the Mississippi River from upstream to downstream. Figure 38 displays TSS FWMCs, which are significantly lower than those measured at the Mississippi River near Aitkin site, but roughly in line with those measured at the Mississippi River in Royalton and Sartell, respectively.

Figure 36. Comparison of average NO_3+NO_2-N flow weighted mean concentrations and loads at the Platte River, Minnesota, 2015-2016.

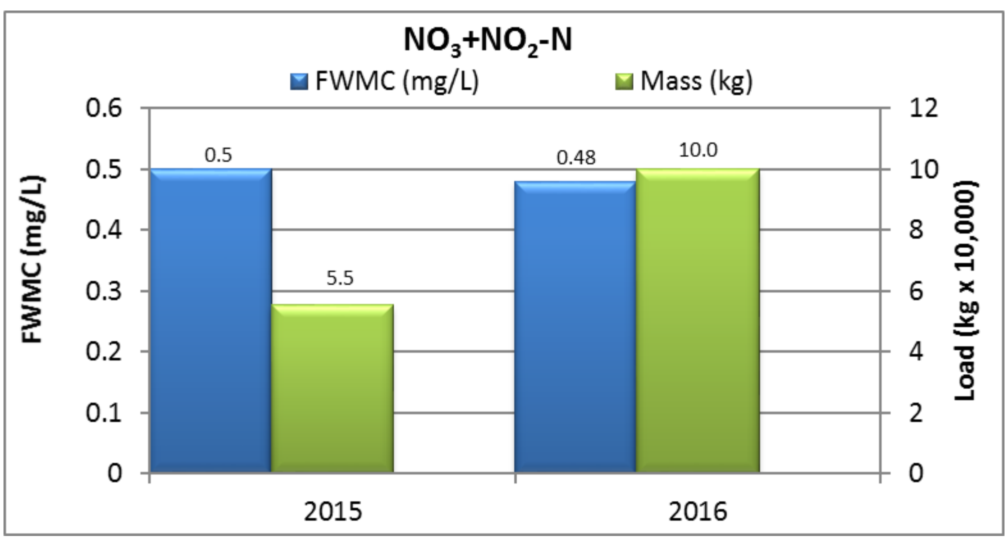


Figure 37. Comparison of average TP flow weighted mean concentrations and loads at the Platte River, Minnesota, 2015-2016.

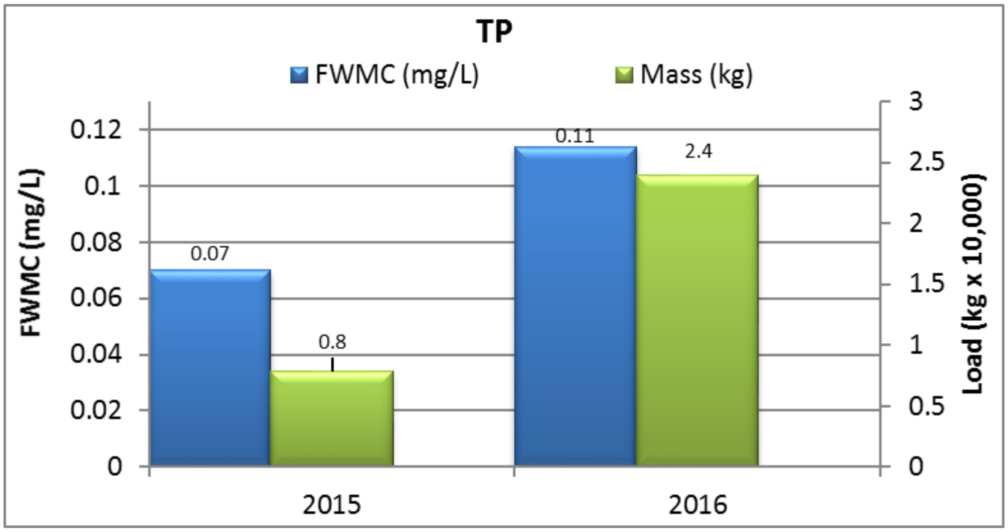
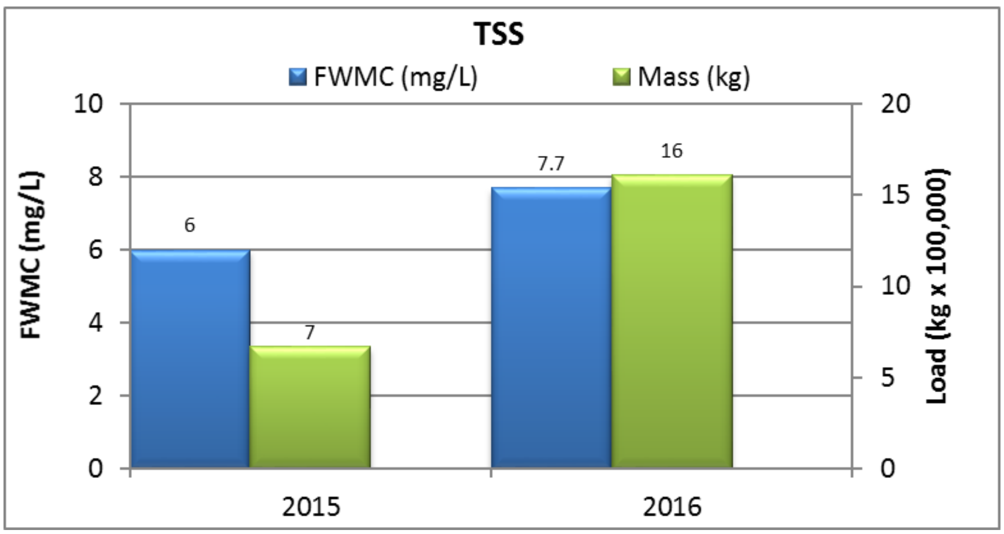


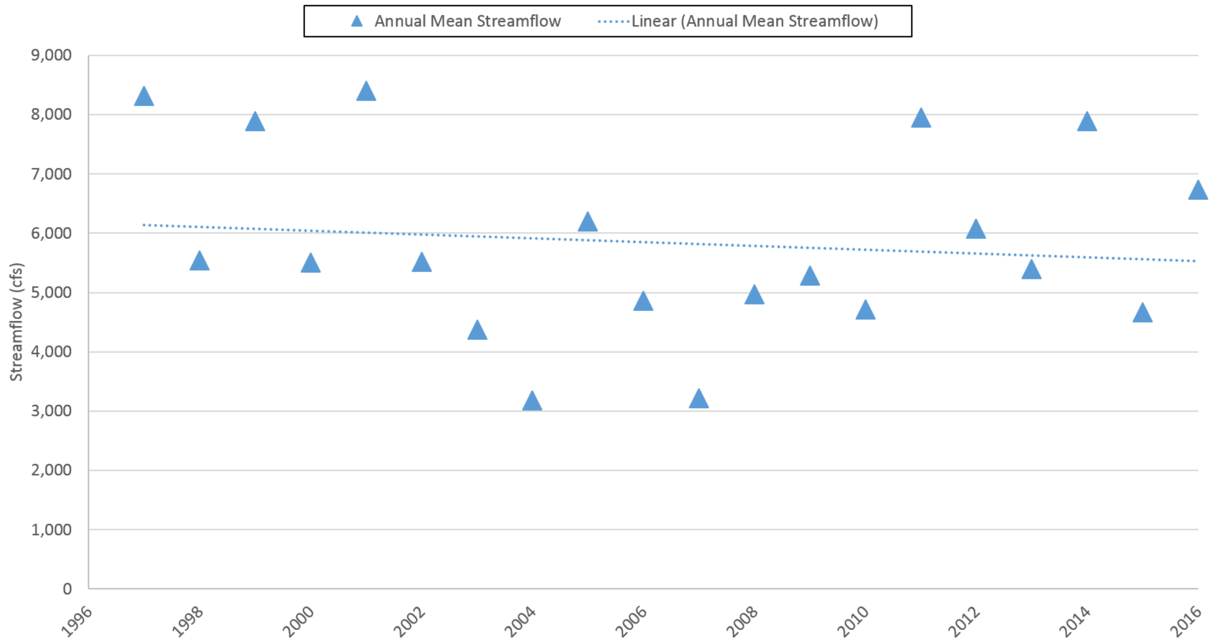
Figure 38. Comparison of average TSS flow weighted mean concentrations and loads at the Platte River, Minnesota, 2015-2016.

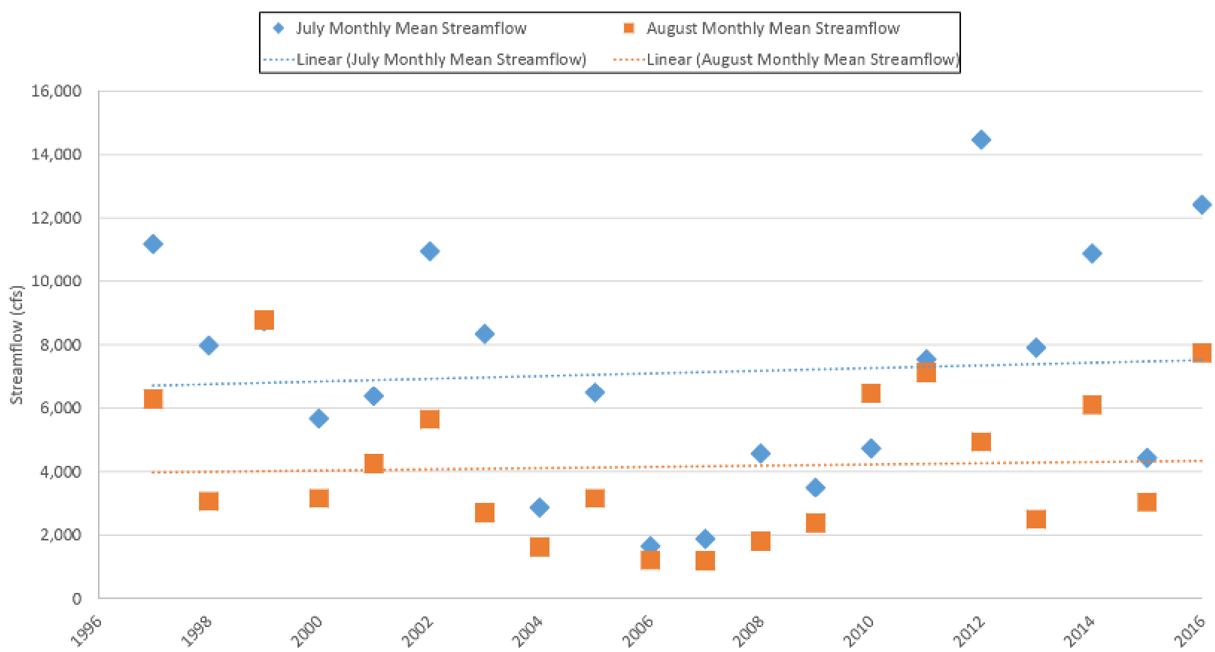


Stream flow

Stream flow data from the United States Geological Survey's real-time streamflow gaging stations for the Mississippi River at Royalton was analyzed for annual mean discharge and summer monthly mean discharge (July and August). Figure 39 (*top*) is a display of the annual mean discharge for the Mississippi River near Royalton, Minnesota for water years 1997 to 2016. The data shows that although streamflow appears to decrease slightly over time, there is no statistically significant trend. Figure 39 bottom displays July and August mean flows for the same time frame, for the same water body. Graphically, the data appears to be increasing in July and August, but neither with significance. By way of comparison at a state level, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends (Streitz, 2011).

Figure 39. Annual mean (*top)* and monthly mean (*bottom*) streamflow for the Mississippi River near Royalton, Minnesota (1997-2016) (Source: USGS, 2019)





Wetland condition

Wetland vegetation quality is high overall in Minnesota (Table 23). This is driven by the large share of wetlands located in Mixed Wood Shield (i.e., northern forest) ecoregion where development and resulting stressors are much less widespread (and wetland condition is largely intact) compared to the rest of the state. Wetlands in exceptional or good vegetation condition have few (if any) changes in their expected native species composition or abundance distribution. Wetland vegetation quality is largely degraded in the remainder of the state, where non-native invasive plant species (most notably reed canary grass and narrow leaf or hybrid cattail) have replaced native wetland plant communities over the majority of the remaining wetland extent (Bourdaghs et. al, 2015). High abundance of non-native invasive plant species is associated with a broad spectrum of wetland stressors and may also occur in the absence of stressors.

Table 23. Biological wetland condition statewide and by major ecoregions according to vegetation and macroinvertebrate indicators. Vegetation results are expressed by extent (i.e., percentage of wetland acres) and include virtually all wetland types (Bourdaghs et al. 2015). Macroinvertebrate results represent natural depressional wetlands (e.g., prairie potholes) that typically have open water and are expressed as the percentage of wetland basins (Genet 2015). Depressional wetland monitoring is focused in Mixed Wood Plains and Temperate Prairie ecoregions (as opposed to statewide) where it is a more prevalent type.

Vegetation Condition in All Wetlands

Condition Category	Statewide	Mixed Wood Shield	Mixed Wood Plains	Temperate Prairies
Exceptional	49%	64%	6%	7%
Good	18%	20%	12%	11%
Fair	23%	16%	42%	40%
Poor	10%		40%	42%

Macroinvertebrate Condition in Depressional Wetlands

Condition Category	Mixed Wood Plains + Temperate Prairies	Mixed Wood Plains	Temperate Prairies
Good	45%	46%	41%
Fair	33%	34%	30%
Poor	22%	20%	27%

The overall macroinvertebrate quality of natural depressional wetlands in the Mixed Wood Plains and Temperate Prairies ecoregions (where depressional wetlands are more prevalent) is moderate (Table 23). Approximately 41% - 46% of natural depressional wetland basins (man-made ponds were excluded from the results) are in good macroinvertebrate condition between the two ecoregions. Natural depressional wetlands have much higher rates of good macroinvertebrate condition compared to the rate of exceptional-good vegetation condition in this part of Minnesota.

Wetland quality in the Mississippi River-Sartell Watershed is expected to vary from northeast to southwest as the watershed transitions from the Mixed Wood Shield ecoregion to the Mixed Wood Plains ecoregion (Figure 17, Table 23). The large majority of wetlands in the Mixed Wood Shield portion of the watershed likely are supporting exceptional-good vegetation and wetlands with degraded vegetation condition are probably limited to localized impacts. The depressional wetlands that occur here (though relatively uncommon) would likely support good quality macroinvertebrate communities, as they are often located in steep topography moraine landforms that are undeveloped. Conversely, the large majority of wetlands in the Mixed Wood Plains portion of the watershed (which corresponds to widespread agricultural development) likely have degraded (fair-poor) vegetation condition. Wetlands with intact vegetation (such as the St. Wendel Tamarack Bog) will be more localized. Depressional wetlands are limited to the moraine landforms along the southwest margin in this part of the watershed and likely have variable good-fair-poor macroinvertebrate condition.

Figure 40. Stream Tiered Aquatic Life Use Designations in the Mississippi River-Sartell Watershed.

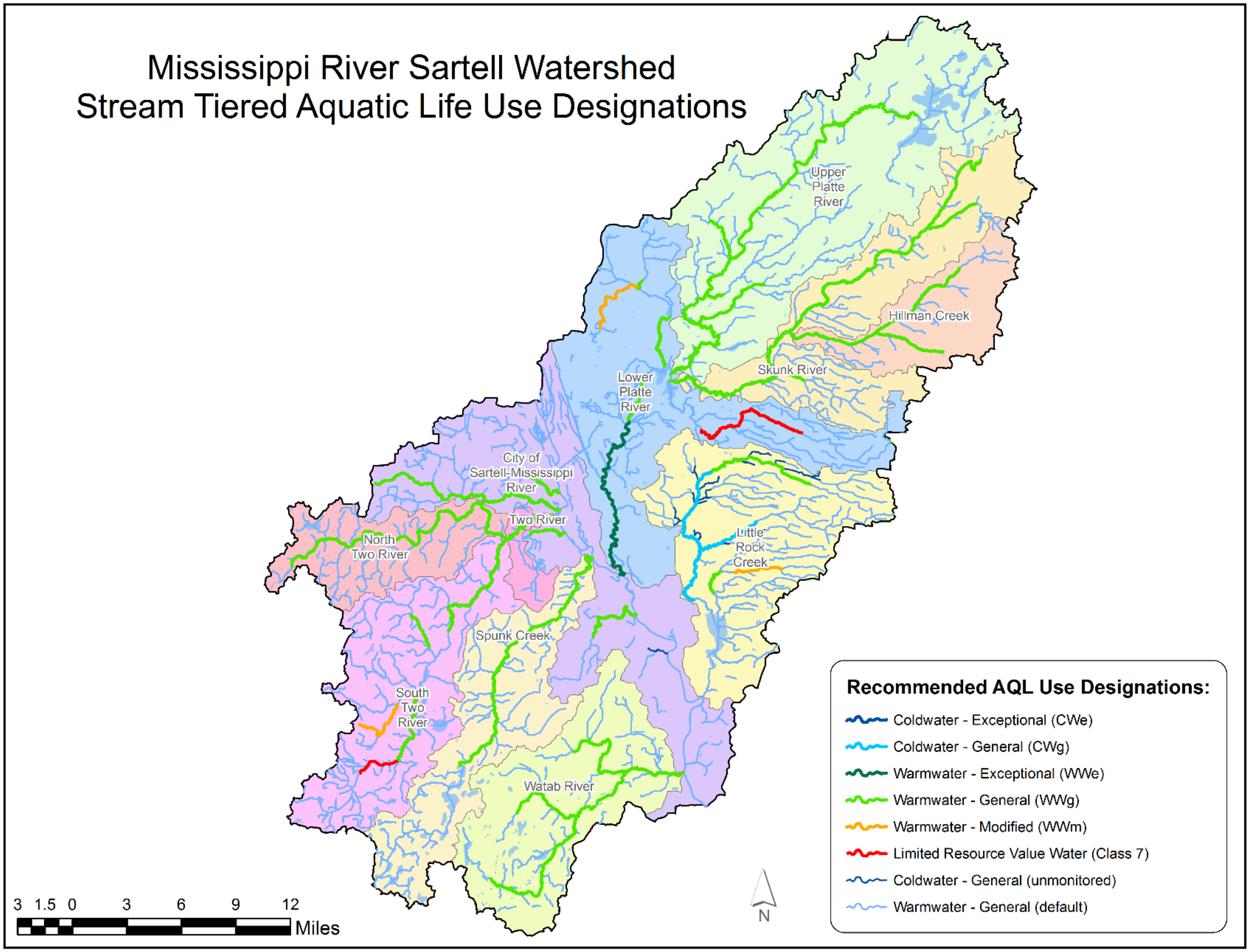


Figure 41. Fully supporting waters by designated use in the Mississippi River-Sartell River Watershed.

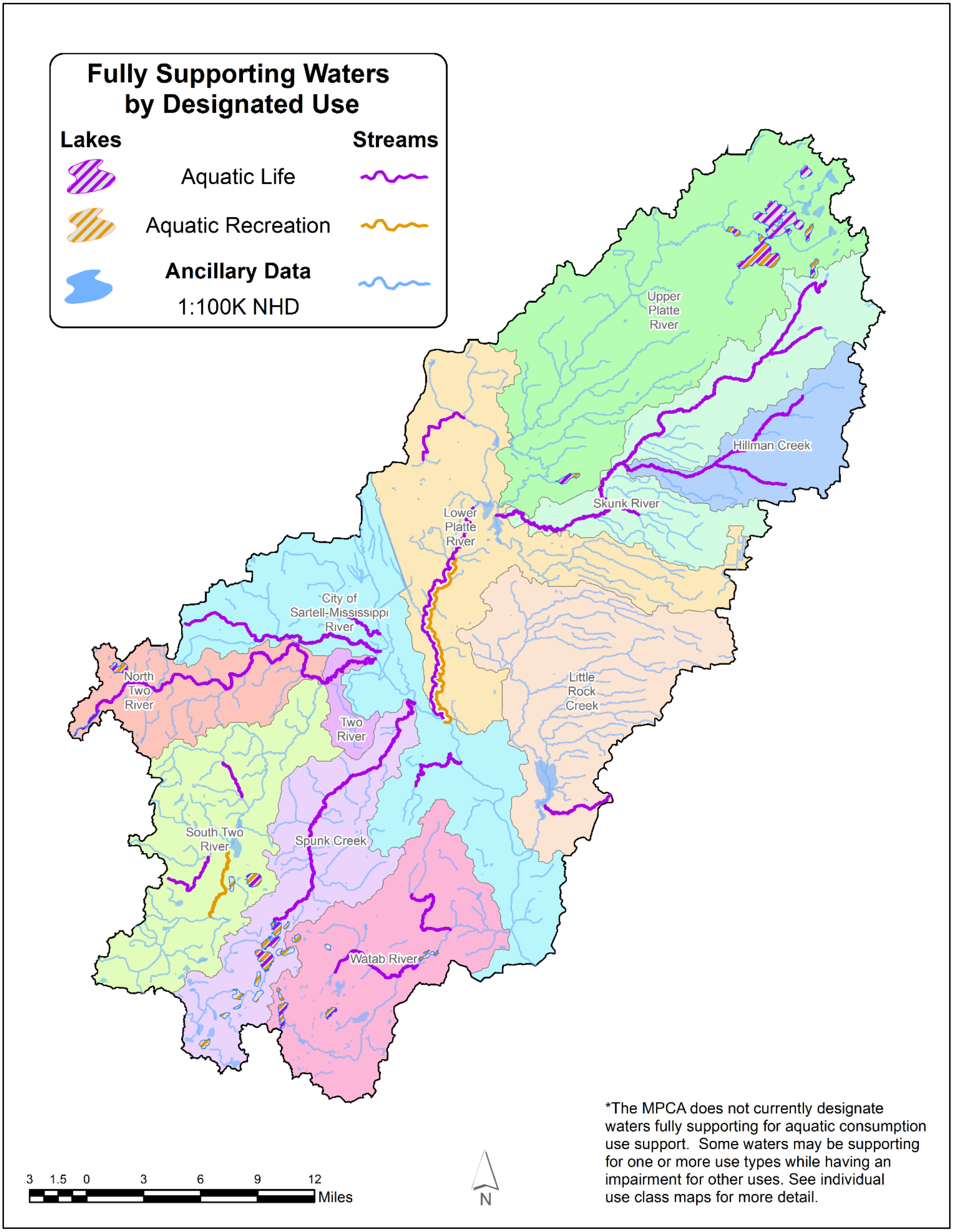


Figure 42. Impaired waters by designated use in the Mississippi River-Sartell River Watershed.

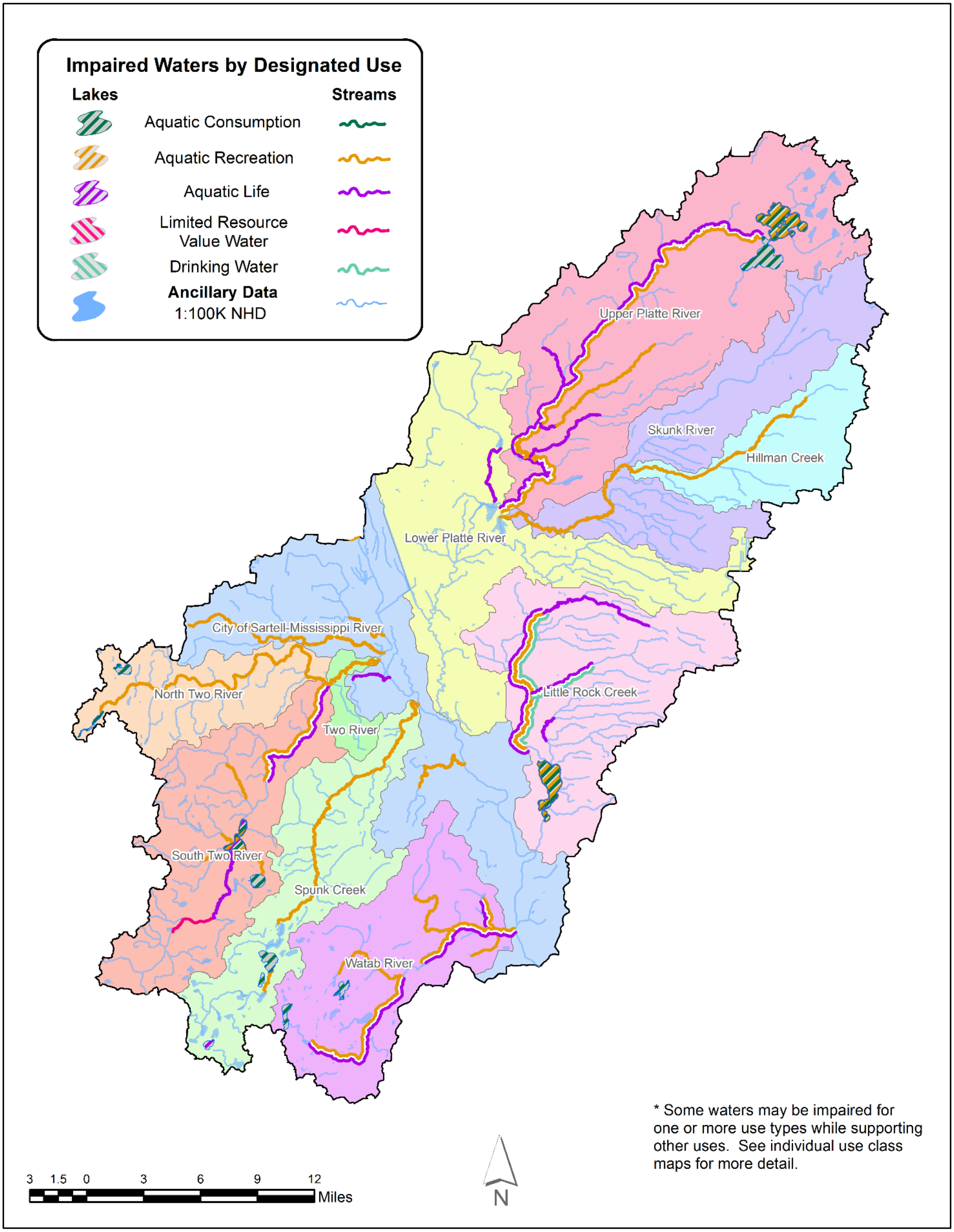


Figure 43. Aquatic consumption use support in the Mississippi River-Sartell River Watershed.

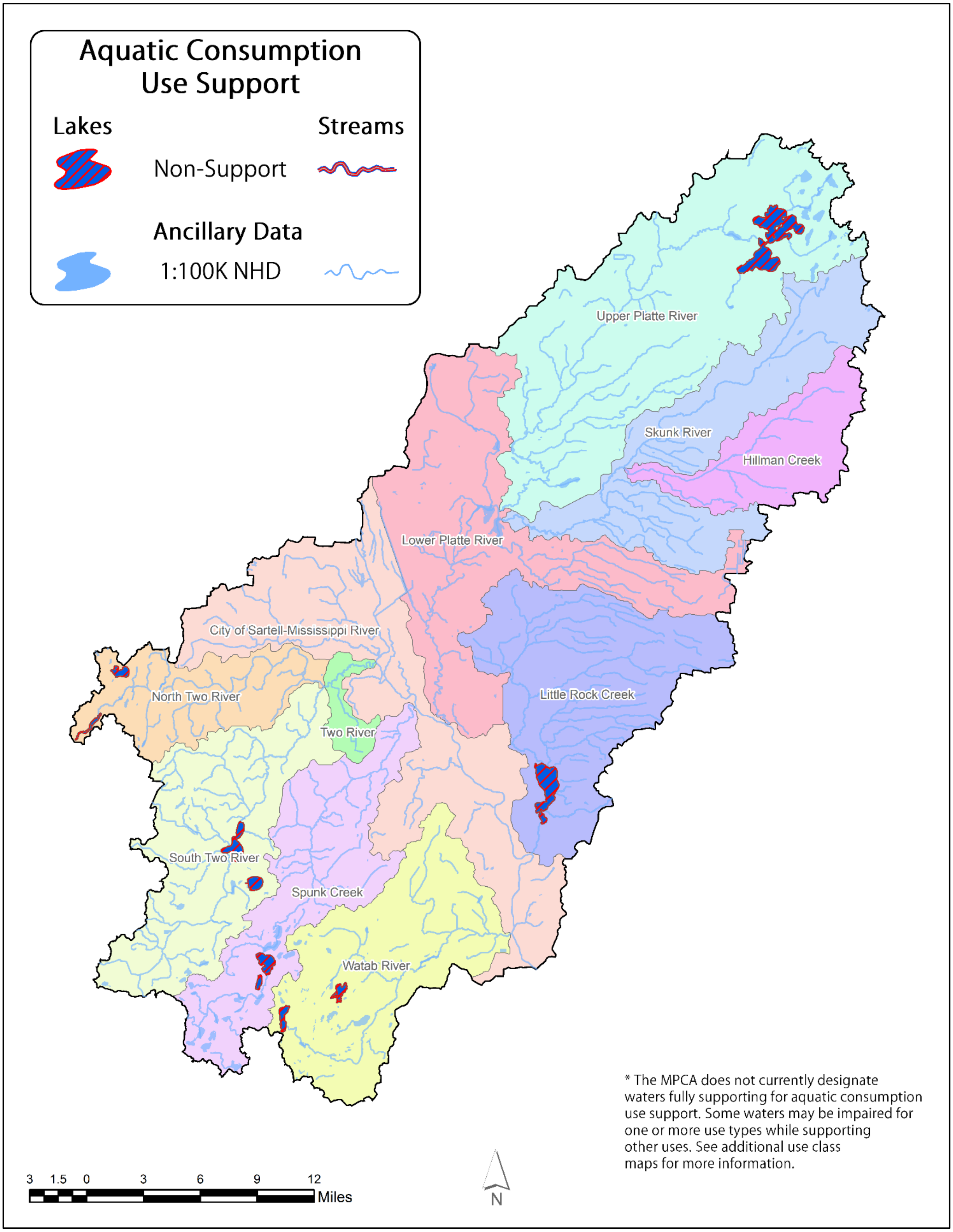


Figure 44. Aquatic life use support in the Mississippi River-Sartell River Watershed.

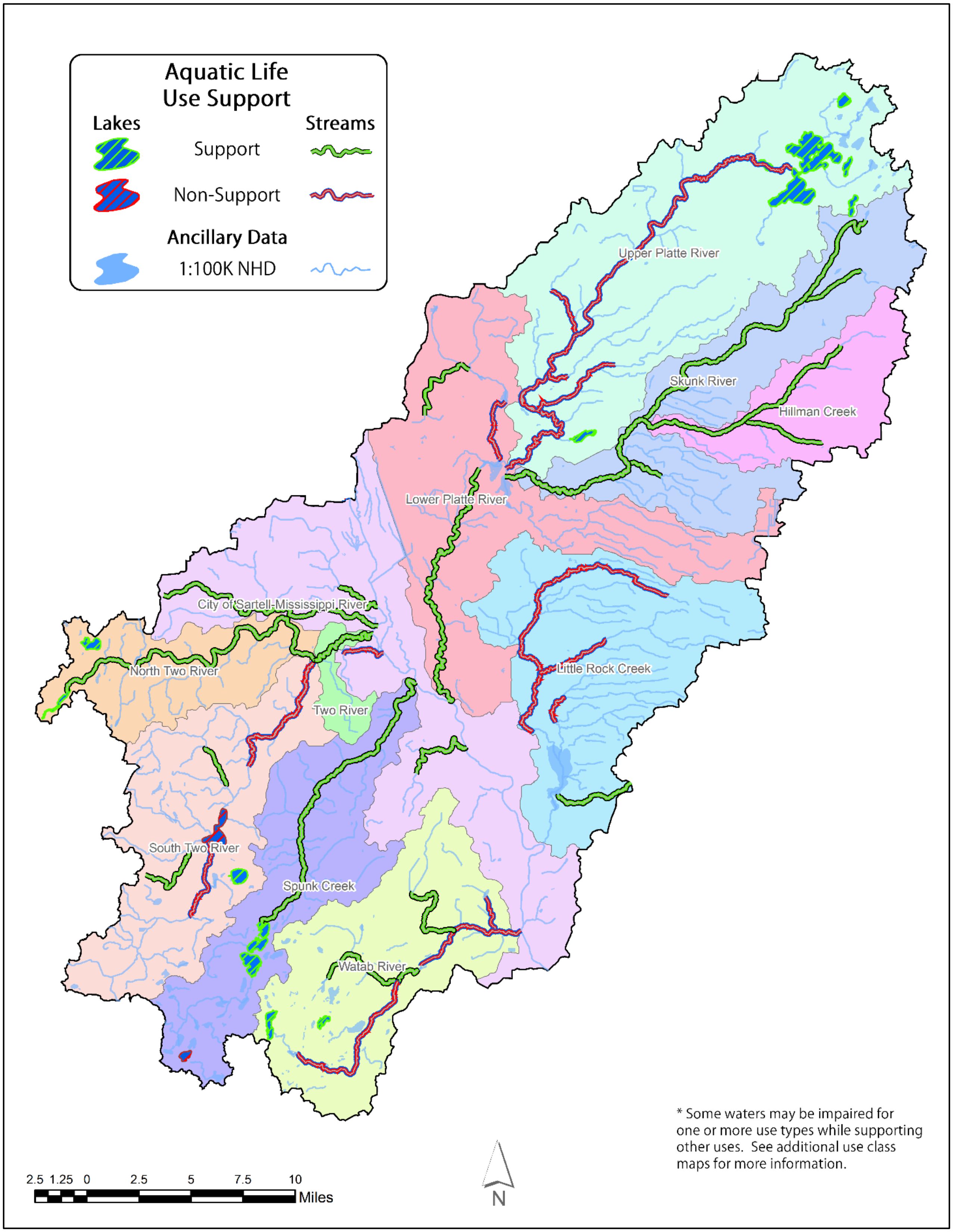
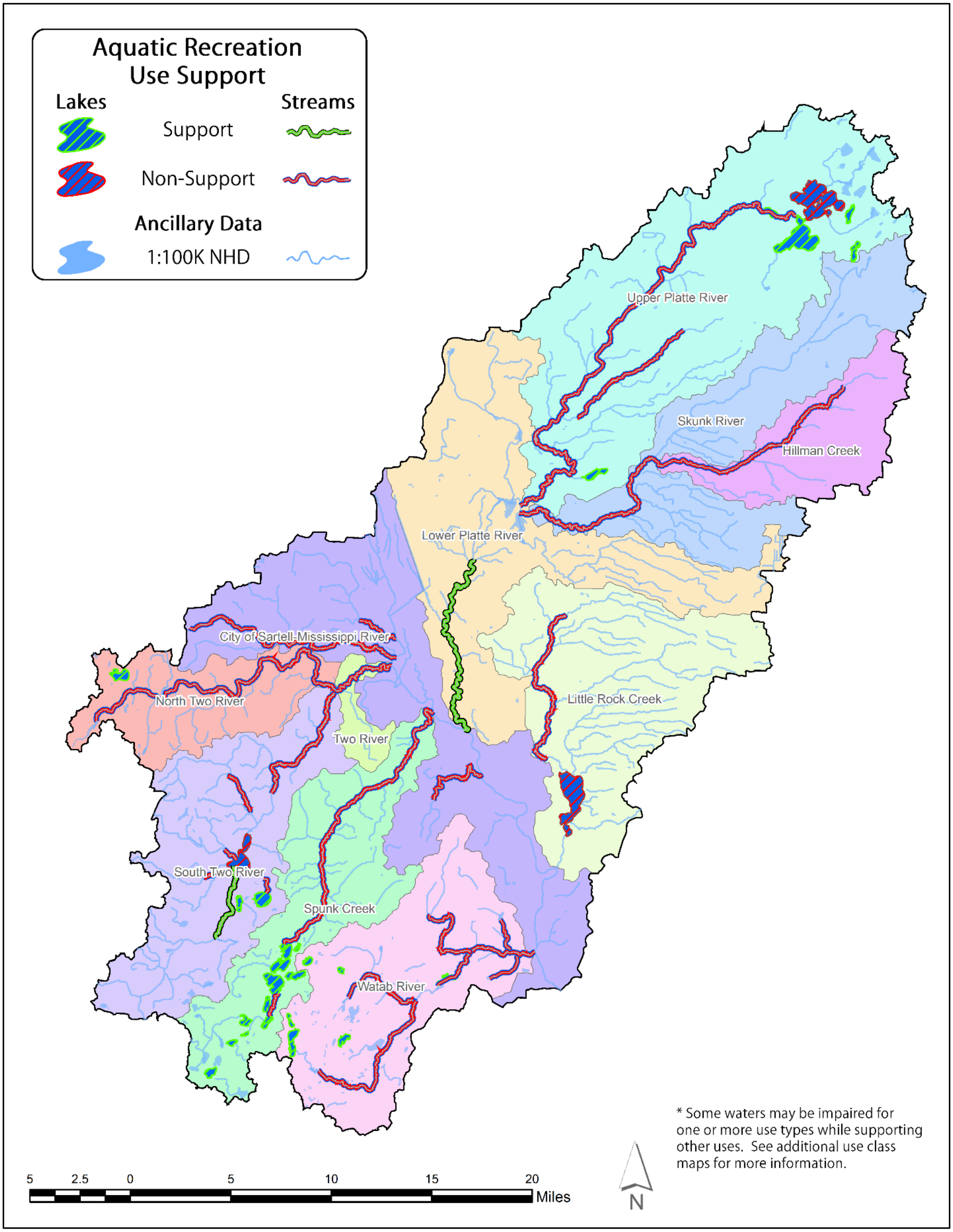


Figure 45. Aquatic recreation use support in the Mississippi River-Sartell River Watershed.



Transparency trends for the Mississippi River-Sartell Watershed

MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state and also incorporates any agency and partner data submitted to EQuIS.

The trends are calculated using a Seasonal Kendall statistical test for waters with a minimum of eight years of transparency data; Secchi disk measurements in lakes and Secchi Tube measurements in streams.

Citizen volunteer monitoring occurs at 5 streams and 14 lakes in the watershed. Recent data analysis indicated increasing water clarity trends on three different locations of two streams: Mississippi River near Royalton, Spunk Creek downstream of Spunk Lake. Improving trends in lake water clarity was detected on ten lakes; Cedar, Kalla, Sullivan, Pierz, Rossier, Big Watab, Pelican, Lower Spunk, Middle Spunk and Pine lakes. Four lakes had detected declining trends in water clarity; Platte, Long, Kraemer, and Linneman. Extensive datasets are required for developing accurate long-term trends in water quality datasets. Secchi clarity monitoring is a simple to collect, correlates well to nutrients and algae and provides the long-term datasets needed to build trend information. Continuing to build stronger citizen monitoring programs to collect these data will be ideal for tracking water quality changes over time.

Table 24. Water Clarity Trends.

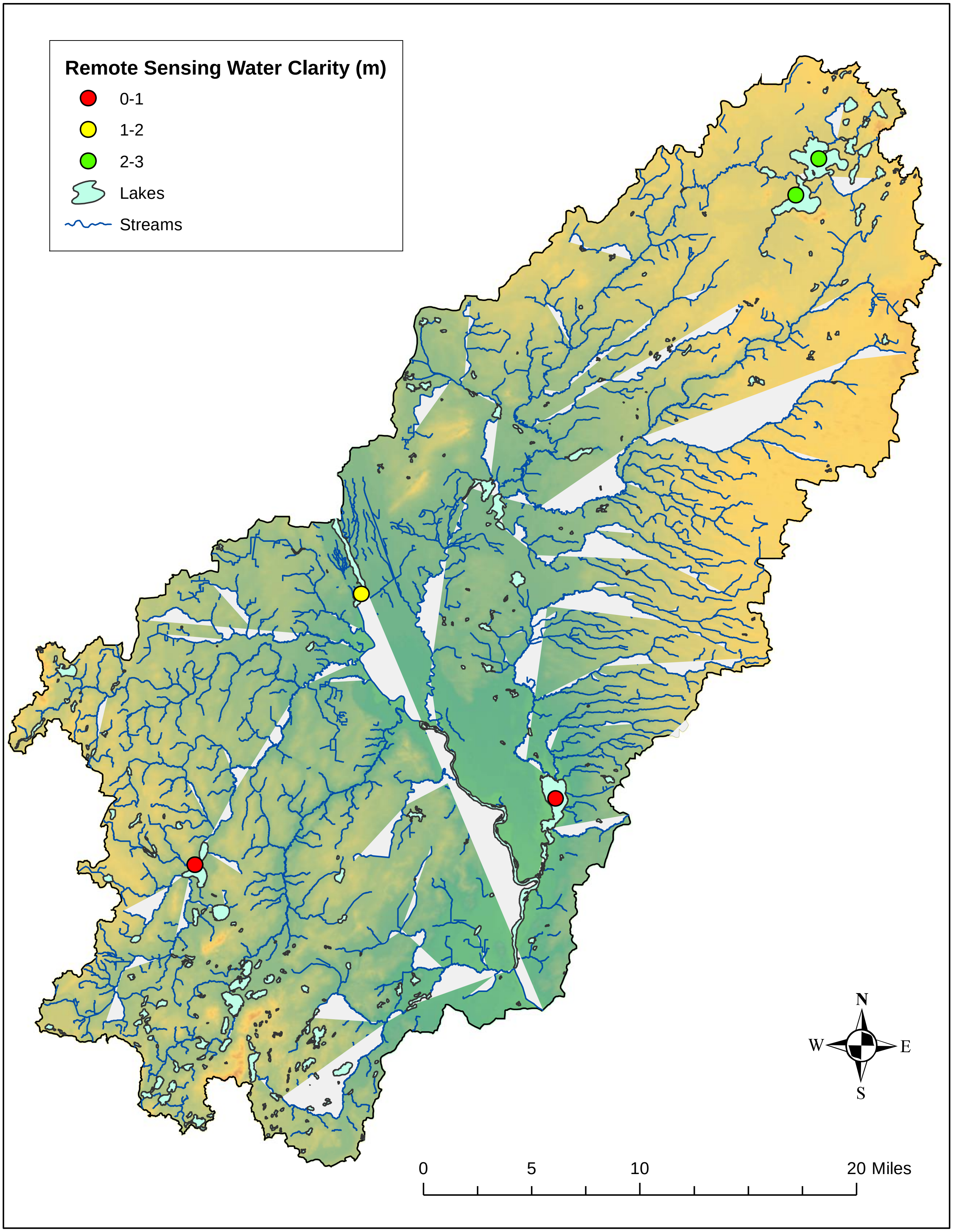
Mississippi River-Sartell HUC 07010201	Streams	Lakes
Number of sites w/increasing trend	3	10
Number of sites w/decreasing trend	0	4
Number of sites w/no trend	4	15

In June 2014, the MPCA published its final trend analysis of river monitoring data located statewide based on the historical Milestones Network. The network is a collection of 80 monitoring locations on rivers and streams across the state with good, long-term water quality data. The period of record is generally more than 30 years, through 2010, with monitoring at some sites going back to the 1950s. While the network of sites is not necessarily representative of Minnesota's rivers and streams as a whole, they do provide a valuable and widespread historical record for many of the state's waters. Starting in 2017, the MPCA will be switching to the Watershed Pollutant Load Monitoring Network for long-term trend analysis on rivers and streams. Data from this program has much more robust sampling and will cover over 100 sites across the state.

Remote sensing for lakes in the Mississippi River-Sartell Watershed

The University of Minnesota, in partnership with MPCA, conducts remote sensing of lake clarity. The information provides a snapshot of water transparency during late summer over a span of 30 years. Secchi disk transparency data is paired with satellite imagery to come up with estimates of water clarity across the state. While there are limitations to the data, such as cloud cover, vegetation, or stained water altering the estimated Secchi transparency, it does provide information to help prioritize monitoring and protection efforts on lakes which do not have water quality data.

Figure 46. Remotely sensed Secchi transparency on lakes in the Mississippi River-Sartell Watershed.



Priority Waters for Protection and Restoration in the Mississippi River-Sartell Watershed

The MPCA, DNR, and BWSR have developed methods to help identify waters that are high priority for protection and restoration activities. Protecting lakes and streams from degradation requires consideration of how human activities impact the lands draining to the water. In addition, helping to determine the risk for degradation allows for prioritization to occur; so limited resources can be directed to waters that would benefit most from implementation efforts.

The results of the analysis are provided to watershed project teams for use during WRAPS and One Watershed One Plan or other local water plan development. The results of the analysis are considered a preliminary sorting of possible protection priorities and should be followed by a discussion and evaluation with other resource agencies, project partners and stakeholders. Other factors that are typically considered during the protection prioritization process include: whether a water has an active lake or river association, is publically accessible, presence of wild rice, presence of invasive, rare or endangered species, as well as land use information and/or threats from proposed development. Opportunities to gain or enhance multiple natural resource benefits ("benefit stacking") is another consideration during the final protection analysis. Waterbodies identified during the assessment process as vulnerable to impairment are also included in the summary below.

The results for selected indicators and the risk priority ranking for each lake are shown in Appendix 6. Protection priority should be given to lakes that are particularly sensitive to an increase in phosphorus with a documented decline in water quality (measured by Secchi transparency), a comparatively high percentage of developed land use in the area, or monitored phosphorus concentrations close to the water quality standard. In the Mississippi River-Sartell Watershed, highest protection priority is suggested for fifteen lakes: Peavy, Kreigle, Ochotto, Cedar, Island, Big Watab, Achman, Pierz, Anna, Middle Spunk, Long, Pelican, Koop, Sagatagan and Kraemer. Pierz Lake was identified as priority for protection as fish community health was near the threshold and water quality was in decline. As mentioned above, all these lakes are currently meeting water quality standards.

The results for selected indicators and risk priority ranking for each stream are shown in Appendix 7. Stream protection is driven by how close the stream is to having an impaired biological community, density of roads and disturbed land use in the immediate and larger drainage area, and how much land is protected in the watershed. In Mississippi River-Sartell watershed, one Exceptional Use stream was identified as priority A, additionally thirteen General Use streams scored as priority A for protection. While these streams currently meet standards, work done to maintain current condition is important to prevent impairment in the future. Extensive work has been done in the Little Rock Creek Subwatershed to protect the creek for over withdrawals of groundwater. This has been highlighted by DNR with an action plan being started in 2016 and will continue through 2020.

Summaries and recommendations

Biological Summaries and Recommendations

Since 2008, 82 assessable fish visits were made to 59 biological monitoring stations in the Mississippi River – Sartell Watershed (See Appendix 3.2). Of these 82 assessable fish visits, 36 fish visits had FIBI scores above their respective use class threshold, while 46 visits had FIBI scores that fell below the threshold. Falling below the threshold does not necessarily mean impairment, as multiple lines of evidence are taken into account during the assessment process. Seventy-five species of fish have been documented within the Upper Mississippi River Basin. MPCA staff collected 48 species and 32,691 total fish from the tributaries to the Mississippi River in the Mississippi River-Sartell Watershed (See Appendix 4.1). The most commonly sampled species in the watershed was White Sucker, totaling 4,622 individuals at 56 of the 59 sites. White Suckers tolerate a wide range of water conditions, from pristine to polluted and temperatures ranging from cold to warm. Being a simple lithophilic spawner, they require clean, coarse substrate in moving waters for reproduction. Other species that were commonly captured (>75% of stations) include: Central Mudminnow, Common Shiner, Creek Chub, and Johnny Darter. In addition to White Sucker, these four species (19,955 individuals) comprise nearly two-thirds of the total fish caught.

The macroinvertebrate community of the Mississippi River-Sartell Watershed is generally diverse. Seventy-one assessable visits were made to 56 stations; 316 unique taxa were identified from these samples. Of these 71 visits, 53 were above the MIBI threshold and reflective of the good water quality of this watershed. Conversely, approximately 28% of visits (21 visits) were below the MIBI threshold, which may suggest stressed conditions (See Appendix 3.3). On average, 50 taxa were collected per visit, with 16UM129 (Skunk River) having the highest richness (76 species) in 2016. This station contained two of the 19 intolerant taxa found in the watershed. Ten of these 19 sensitive taxa were caddisflies, with the genera *Micrasema* and *Protoptila* being the most common. Additionally, eleven coldwater taxa were collected, although in low abundances. Eight stations on Little Rock Creek harbored notable taxa, including the scud *Gammarus*, the caddisfly *Lype diversa*, the midge *Chelifera*, and the stonefly *Isoperla*. The most abundant taxa collected in the watershed were *Polypedilum, Rheotanytarsus, Hyalella, Simulium,* and *Hydropsyche betteni*, which are all tolerant to disturbance and ubiquitously distributed throughout Minnesota (See Appendix 4.2).

Overall, the fish community of the Mississippi River-Sartell Watershed is in moderate health, but protection and restoration measures should be enacted to prevent further degradation. The macroinvertebrate community of the Mississippi River-Sartell Watershed is in good health, but protection and restoration measures should be enacted to prevent further degradation. There were no endangered, threatened, or species of special concern of neither fish nor macroinvertebrates collected during this study. Overall, biological communities found throughout the Mississippi River-Sartell Watershed are fair to good; however, fifteen stream segments failing to meet aquatic life standards (See Figure 42). The lower section of the Platte River from the railroad bridge just south of the Rice/Skunk complex to the Mississippi River had very good fish and macroinvertebrate communities, resulting in it being classified as an exceptional aquatic life use (see Figure 40). The Platte River along this reach also has exceptional habitat, and should be addressed by WRAPs to protect its natural riparian corridor.

The majority of the Mississippi River-Sartell watershed was characterized by flowing streams with riffle habitat; however, some lower gradient streams were also sampled. Minnesota Stream Habitat Assessment (MSHA) scores indicate habitat is on average fair across the watershed with some stations scoring very good and others scoring poor (See Appendix 5). Four stream reaches in the Little Rock

Creek, Watab River and South Two River subwatersheds are suffering from a pattern of poor DO conditions, negatively impacting aquatic life (see Figure 42). Further investigation will be needed to identify sources contributing to these conditions. Excess nutrients within the system could be a starting point for future follow-up on this issue. Reviewing past assessments and new impairments from this assessment cycle, it becomes clear one of the leading problems for streams in this watershed is poor recreational water quality due to bacterial contamination. One stream reach in the entire watershed meets goals for good recreational use, that is contrasted by 20 reaches not meeting recreation goals further driving home the point that future work will be needed to address this problem (see Figure 45). A number of TMDL studies have been conducted to address previous recreation use impairments, indicating a strong desire to troubleshoot poor recreational water quality. Improvements will hinge upon cooperation and compromise between local planners and citizens living on the landscape to devise a long-term plan that works for all parties.

Potential stressors found throughout the Mississippi River – Sartell include: habitat degradation due to livestock access to the stream and riparian corridors, stressful riparian land uses (i.e. erosion), dams and improperly installed culverts, which can create a loss of stream connectivity. Going forward, significant work should be done with landowners to reduce livestock access to streams and/or reduce erosion issues. Furthermore, existing dams should be evaluated to analyze their function and impacts on biological communities. In addition, where culvert issues exist corrective action should be considered to remedy any issues related to stream flow and/or and negative effects on biological communities.

Lake Summaries and Recommendations

The majority of lakes in this watershed have good water quality to support recreation and healthy aquatic communities. Increasing water clarity trends over time on nine lakes already meeting regional goals suggest that efforts already underway may be working to improve water quality. Lakes with high potential for aquatic recreation are typically deep. Deep lakes stratify in the summer months allowing nutrients to settle in to the bottom sediments, curbing dense summertime nuisance algae blooms that are fueled by excess nutrients near the surface. Shallower lakes tend to mix frequently throughout the open months based on wind prevalence and thermal differences. The mixing allows nutrients to cycle from bottom sediments back into the water column driving nuisance algal blooms that are associated with poor recreation water quality. If nuisance algal blooms are severe, water clarity may drop significantly and prevent sunlight from penetrating through the water column that inhibiting the growth native aquatic plants. Invasive plants (curly-leaf pondweed, Eurasian watermilfoil) can overtake native plant communities stressed from poor water quality transforming the natural nutrient cycle of the lake. In the case of Little Rock Lake, not only is it a shallow basin that mixes frequently, historical nutrient loading from the contributing watershed has supercharged the basin with nutrients. Local planners are taking an “outside the box” approach to improve water quality on Little Rock Lake. This approach involves a lake drawdown that hopes to establish vegetation growth, which should utilize some of the excess nutrients in the lake. on a small scale, local planners should identify ways to prevent lawn fertilizer, grass clippings, pet waste, and leaf litter from entering lakes and streams directly from the shoreline or during rain events through storm sewers. They should also consider planting native grasses, raingardens and vegetation along shorelines to reduce runoff and prevent erosion. These measures, when implemented broadly throughout a lakeshed can be successful in returning impaired lakes to acceptable conditions. These types of watershed improvement strategies combined with continued citizen monitoring can detect changes in water quality between larger monitoring efforts. Local advocacy to engage lakeshore owners and recreational lake users will continue to be paramount to bolster volunteer monitoring programs.

Watershed wide bacteria levels are elevated; continued work to reduce sources of pathogens in this watershed will be necessary to improve conditions. Overall, across the watershed, sediment concentrations were low; dissolved oxygen issues were noted in several subwatershed, which negatively impacted biological communities.

Groundwater Summary and Recommendations

Groundwater protection should be considered both for quantity and quality. Quantity is based on the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater withdrawals in the watershed have been increasing over the last 20 years, as well as increasing withdrawals for agricultural irrigation, non-crop irrigation and water supply. However, streamflow and groundwater elevation measured by DNR observation wells have also not exhibited any trends over time in this watershed. The average potential groundwater recharge rate is above the state average, which may contribute to steady groundwater levels. While fluctuations due to seasonal variations are normal, long-term changes in water levels should not be ignored.

Groundwater quality data from the MPCA Ambient Groundwater Monitoring Program indicated that although there were high percentages of analyte detections, the majority were within water quality standards. There were detections of 59 different contaminants and exceedances of eight of these contaminants. The majority of detections were from naturally occurring contaminants, while the most common exceedances were iron (SMCL), nitrate (MCL) and manganese (HBV). Furthermore, the pollution sensitivity of near-surface materials throughout the watershed should be considered. While many of the areas had low to moderate rankings, some areas had high vulnerability, correlating with sand and gravel quaternary geology. These areas may experience a possible risk of contamination due to high infiltration rates. While it may appear that this watershed does not exhibit a great risk, it is important to continue to monitor potentially harmful sites in order to inhibit possible water pollution.

Additional and continued monitoring will increase the understanding of the health of the watershed and its groundwater resources and aid in identifying the extent of the issues present and risk associated. Increased localized monitoring efforts will help accurately define the risks and extent of any issues within the watershed. Adoption of best management practices will benefit both surface and groundwater.

Literature cited

Benton County Soil and Water Conservation District, https://www.soilandwater.org/mississippi-river-sartell

Bourdaghs, M. and J. Genet, M. Gernes, and E. Peters. 2015. Status and Trends of Wetlands in Minnesota: Vegetation Quality Baseline. wq-bwm-1-09. Minnesota Pollution Control Agency, St. Paul, MN.

Genet, J. 2015. Status and Trends of Wetlands in Minnesota: Depressional Wetland Quality Assessment (2007-2012).

Kloiber, S.M. and Norris, D.J. 2013. Status and Trends of Wetlands in Minnesota: Wetland Quantity Trends from 2006 to 2011. Minnesota Department of Natural Resources. St. Paul, MN.

Kroening, S. and Ferrey, M. (2013), The Condition of Minnesota's Groundwater, 2007-2011. Document number: wq-am1-06. Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-am1-06.pdf

Jirsa, M.A., Boerboom, T. J., Chandler, V.W., Mossler, J. H., Runkel, A. C. and Setterholm, D. R. (2011), Geologic Map of Minnesota, Bedrock Geology, S-21. Minnesota Geological Survey. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://conservancy.umn.edu/handle/11299/101466

Midwest Regional Climate Center. Climate Summaries. Historical Climate Data. Precipitation Summary. Station: 210355 Austin 3 S, MN. 1971-2000 NCDC Normals. https://mrcc.illinois.edu/

Minnesota Department of Agriculture (MDA). 2010. 2010 Water Quality Monitoring Report. Pesticide and Fertilizer Management Division, Minnesota Department of Agriculture, St. Paul, Minnesota. https://www.mda.state.mn.us/node/2696

Minnesota Department of Health (2019), Manganese and Drinking Water. Retrieved from https://www.health.state.mn.us/communities/environment/water/contaminants/manganese.html

Minnesota Department of Natural Resources (2001), Figure1. Minnesota Ground Water Provinces. Retrieved from http://files.dnr.state.mn.us/natural_resources/water/groundwater/provinces/gwprov.pdf

Minnesota Department of Natural Resources (2016), Pollution Sensitivity of Near-Surface Materials. County Geologic Atlas Program. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://gisdata.mn.gov/dataset/geos-hydrogeology-atlas-hg02

Minnesota Department of Natural Resources (2018a), Groundwater Provinces. Retrieved from http://dnr.state.mn.us/groundwater/provinces/index.html

Minnesota Department of Natural Resources (2018b), Water use- Water Appropriations Permit Program. Retrieved from http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Minnesota Department of Natural Resources: State Climatology Office (2019a), Climate. Retrieved from http://www.dnr.state.mn.us/faq/mnfacts/climate.html

Minnesota Department of Natural Resources: State Climatology Office (2019b), Annual Precipitation Maps. Retrieved from https://www.dnr.state.mn.us/climate/historical/annual_precipitation_maps.html

Minnesota Pollution Control Agency (MPCA). 2007b. Minnesota Statewide Mercury Total Maximum Daily Load. Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (MPCA). 2008a. Watershed Approach to Condition Monitoring and Assessment. Appendix 5.2 *in* Biennial Report of the Clean Water Council. Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (MPCA). 2010a. Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity). http://www.pca.state.mn.us/index.php/view-document.html?gid=14922.

Minnesota Pollution Control Agency (MPCA). Guidance Manual for Assessing the Quality of Minnesota Surface Water for the Determination of Impairment: 305(b) Report and 303(d) List. Environmental Outcomes Division, Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (MPCA). 2010d. Minnesota Milestone River Monitoring Report. http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/streams-and-rivers/minnesota-milestone-river-monitoring-program.html.

Minnesota Pollution Control Agency (MPCA). 2010e. Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria. http://www.pca.state.mn.us/index.php/view-document.html?gid=6072.

Minnesota Pollution Control Agency (MPCA). 2015. Technical guidance for designating aquatic life uses in Minnesota streams and rivers. Minnesota Pollution Control Agency, St. Paul, MN (Available at: https://www.pca.state.mn.us/sites/default/files/wq-s6-34.pdf).

Minnesota Pollution Control Agency (MPCA). 2017. Incorporating Lake Protection Strategies into WRAPS Reports.

Morrison County Historical Society. History – Morrison County Historical Society

Minnesota Rules Chapter 7050. 2008. Standards for the Protection of the Quality and Purity of the Waters of the State. Revisor of Statutes and Minnesota Pollution Control Agency, St. Paul, Minnesota.

Morey, G.B., and Meints, J. (2000), Geologic Map of Minnesota, Bedrock Geology, S-20. Minnesota Geological Survey. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://mrdata.usgs.gov/geology/state/state.php?state=MN

National Oceanic and Atmospheric Administration: National Climatic Data Center (NOAA) (ND), Climate of Minnesota. Retrieved from https://www.ncdc.noaa.gov/climatenormals/clim60/states/Clim_MN_01.pdf

State Climatology Office - DNR Division of Ecological and Water Resources. 2010. http://climateapps.dnr.state.mn.us/index.htm

Streitz, A. (2011), Minnesota Pollution Control Agency. Retrieved from http://www.mgwa.org/newsletter/mgwa2011-4.pdf

United States Environmental Protection Agency (2017), National Primary Drinking Water Regulations. Retrieved from https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

United States Environmental Protection Agency (2018), National Primary Drinking Water Regulations. Retrieved from https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

United States Geological Survey (2007), Ground Water Recharge in Minnesota. Retrieved from http://pubs.usgs.gov/fs/2007/3002/pdf/SUP2007-3002_web.pdf

United States Geological Survey (2015), Mean Annual Potential Groundwater Recharge Rates from 1996-2010 for Minnesota. Methodology documented in Smith, E.A. and Westernbroek, S.M., 2015 Potential groundwater recharge for the state of Minnesota using the Soil-Water-Balance model, 1996-2010: U.S. Geological Survey Investigations Report 2015-5038. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://conservancy.umn.edu/handle/11299/60085

United States Geological Survey (2016), Aquifers and Groundwater. Retrieved from http://water.usgs.gov/edu/earthgwaquifer.html

United States Geological Survey (2018), USGS 05267000 Mississippi River near Royalton, MN. Retrieved from https://waterdata.usgs.gov/mn/nwis/inventory/?site_no=05267000

Western Regional Climate Center (WRCC) (2018), U.S.A. Divisional Climate Data. Retrieved from https://wrcc.dri.edu/spi/divplot1map.html

Zhang, H. (1998), Geologic Atlas of Stearns County, Minnesota: Hydrogeology of the Quaternary Water Table System. County Atlas Series, Atlas C-10, part B, Plate 8 of 10, Hydrogeology of the Quaternary Water-table System.

Appendix 1 – Water chemistry definitions

Dissolved oxygen (DO) - Oxygen dissolved in water required by aquatic life for metabolism. Dissolved oxygen enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. Dissolved oxygen is removed from the water when organisms metabolize or breathe. Low DO often occurs when organic matter or nutrient inputs are high, and light inputs are low.

Escherichia coli (E. coli) - A type of fecal coliform bacteria that comes from human and animal waste. *E. coli* levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of *E. coli*.

Nitrate plus Nitrite – Nitrogen - Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, these species can stimulate excessive levels of algae in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-nitrogen to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen (nitrate-N), with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however, concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

Orthophosphate - Orthophosphate (OP) is a water soluble form of phosphorus that is readily available to algae (bioavailable). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

pH - A measure of the level of acidity in water. Rainfall is naturally acidic, but fossil fuel combustion has made rain more acid. The acidity of rainfall is often reduced by other elements in the soil. As such, water running into streams is often neutralized to a level acceptable for most aquatic life. Only when neutralizing elements in soils are depleted, or if rain enters streams directly, does stream acidity increase.

Total Kjeldahl nitrogen (TKN) - The combination of organically bound nitrogen and ammonia in wastewater. TKN is usually much higher in untreated waste samples then in effluent samples.

Total phosphorus (TP) - Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Increasing the amount of phosphorus entering the system therefore increases the growth of aquatic plants and other organisms. Excessive levels of Phosphorous over stimulate aquatic growth and resulting in the progressive deterioration of water quality from overstimulation of nutrients, called eutrophication. Elevated levels of phosphorus can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries and toxins from cyanobacteria (blue green algae) which can affect human and animal health.

Total suspended solids (TSS) – TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity.

Higher turbidity results in less light penetration, which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

Unionized ammonia (NH3) - Ammonia is present in aquatic systems mainly as the dissociated ion $NH4^+$, which is rapidly taken up by phytoplankton and other aquatic plants for growth. Ammonia is an excretory product of aquatic animals. As it comes in contact with water, ammonia dissociates into $NH4^+$ ions and ^-OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 2.1 – Intensive watershed monitoring water chemistry stations in the Mississippi River – Sartell Watershed

EQuIS ID	Biological station ID	WID	Waterbody name	Location	Aggregated 12-digit HUC
S008-819	00UM030	07010201-535	Platte River	At Hwy 27, 3 mi. SW of Pierz	Upper Platte River
S002-954	16UM129	07010201-521	Skunk River	At CR 36, 4 mi. SW of Pierz	Skunk River
S008-820	16UM102	07010201-639	Hillman Creek	At 280th Ave., 1 mi. E of Pierz	Hillman Creek
S002-948	16UM126	07010201-525	Spunk Creek	At Great River Road, 3.5 mi. SW of Royalton	Spunk Creek
S001-331	16UM128	07010201-523	Two River	At 40th St., 1 mi. E of Bowlus	Two River
S000-423	16UM127	07010201-643	South Two River	At CR 21, 1 mi. S of Bowlus	South Two River
S008-821	16UM091	07010201-523	North Two River	At 110th Ave., 1 mi. SW of Bowlus	North Two River
S003-457	16UM125	07010201-528	Watab River	At 57th Ave, 0.3 MI W of Sartell	Watab River
S004-061	75UM001	07010201-549	Little Rock Creek	At CR 12, 1 mi. E of Rice	Little Rock Creek
S001-930	16UM122	07010201-545	Platte River	At CR 40, 2 mi. S of Royalton	Lower Platte River

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Mississippi River-Sartell Watershed

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07010201-634	16UM112	Trib. to Platte River	Upstream of CR 265, 5 mi. NW of Lastrup	Morrison	0701020104-02
07010201-645	16UM105	Little Mink Creek	Upstream of CR 255, 4 mi. W of Pierz	Morrison	0701020104-02
07010201-647	16UM107	Big Mink Creek	Downstream of CR 279, 3.5 mi. NW of Pierz	Morrison	0701020104-02
07010201-507	16UM117	Platte River	Downstream of CR 275, 4 mi. NE of Platte	Morrison	0701020104-02
07010201-507	10EM102	Platte River	Upstream of Hwy 25, 3. mi. SW of Harding	Morrison	0701020104-02
07010201-507	16UM111	Platte River	Downstream 193rd St, 4 mi. W of Lastrup	Morrison	0701020104-02
07010201-507	03UM002	Platte River	Upstream of CR 43, 4.75 mi. W of Pierz	Morrison	0701020104-02
07010201-507	16UM123	Platte River	Upstream of Hwy 27, 3 mi. SW of Pierz	Morrison	0701020104-02
07010201-520	16UM113	Skunk River	Upstream of 360th Ave, 4 mi. NW of Hillman.	Morrison	0701020103-01
07010201-633	16UM114	Trib. to Skunk River	Upstream of CR 8, 5 mi. N of Hillman	Morrison	0701020103-01
07010201-637	16UM100	Skunk Creek	Downstream of CR 241, 2 mi. SE of Pierz	Morrison	0701020103-01
07010201-520	16UM133	Skunk River	Upstream of 320th Ave, just north of 183rd St, 6 mi. NE of Pierz	Morrison	0701020103-01
07010201-520	16UM104	Skunk River	Upstream of CR 39, 1 mi. NE of Pierz	Morrison	0701020103-01
07010201-521	16UM130	Skunk River	Upstream of CR 38, 1 mi. S of Pierz	Morrison	0701020103-01
07010201-521	16UM129	Skunk River	Upstream of CR 36, 4 mi. SW of Pierz	Morrison	0701020103-01
07010201-636	16UM103	Trib. to Hillman Creek	Upstream of 330th Ave, 6 mi. E of Pierz	Morrison	0701020103-02
07010201-639	16UM108	Hillman Creek	Upstream of CR 39, SW of Hillman	Morrison	0701020103-02
07010201-639	16UM102	Hillman Creek	Upstream of 280th Ave, 1 mi. E of Pierz	Morrison	0701020103-02
07010201-622	10EM166	Unnamed creek	Upstream of 153rd St, 2 mi. E of Little Falls	Morrison	0701020104-01
07010201-518	16UM097	Buckman Creek	Downstream of 103rd St, 4 mi. S of Pierz	Morrison	0701020104-01

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07010201-651	18UM109	Trib. to Rice Creek	Upstream of 173rd St, 8 mi. NW of Pierz	Morrison	0701020104-01
07010201-651	16UM109	Trib. to Rice Creek	Downstream of 173rd St, 8 mi. NW of Pierz	Morrison	0701020104-01
07010201-621	16UM110	Trib. to Rice Creek	Downstream of CR 263, 8 mi. NW of Pierz	Morrison	0701020104-01
07010201-618	16UM124	Rice Creek	Upstream of Hwy 27, 5 mi. E of Little Falls	Morrison	0701020104-01
07010201-546	99UM048	Platte River	Upstream of Iris Rd (CR 35), 6 mi. SE of Little Falls	Morrison	0701020104-01
07010201-545	03UM003	Platte River	Upstream of CR 34, 4.5 mi. N of Royalton	Morrison	0701020104-01
07010201-545	03UM004	Platte River	Upstream of CR 27, 1 mi. N of Royalton	Morrison	0701020104-01
07010201-545	16UM122	Platte River	Upstream of CR 40, 2 mi. S of Royalton	Benton	0701020104-01
07010201-539	16UM088	Zuleger Creek	Downstream of CR 12, 2 mi. NE of Rice.	Benton	0701020105-01
07010201-652	99UM058	Little Rock Creek	~0.5 mi. W of 250th Ave, 0.3 mi. N of CR 238	Morrison	0701020105-01
07010201-653	07UM070	Little Rock Creek	Downstream of CR 36, 5.5 mi. NE of Royalton	Morrison	0701020105-01
07010201-511	15UM210	Bunker Hill Creek	Upstream of CR 56 (5th Ave NW), 3.5 mi. NE of Rice	Benton	0701020105-01
07010201-653	03UM110	Little Rock Creek	Upstream of Twp Rd 234, 5 mi. NE of Royalton	Morrison	0701020105-01
07010201-653	07UM071	Little Rock Creek	Downstream of Nature Rd (CR 26), 4 mi. E of Royalton	Morrison	0701020105-01
07010201-653	82UM001	Little Rock Creek	Adjacent to 15th Ave, 4 mi. SE of Royalton	Benton	0701020105-01
07010201-653	07UM072	Little Rock Creek	Upstream of 220th Ave, 3.5 mi. NE of Rice	Benton	0701020105-01
07010201-653	92UM001	Little Rock Creek	Downstream of CR 40, downstream of Bunker Hill Cr confluence w. LRC, 3 mi. N of Rice	Benton	0701020105-01
07010201-653	07UM073	Little Rock Creek	Downstream of 15th Ave, 1.5 mi. NE of Rice	Benton	0701020105-01
07010201-653	75UM001	Little Rock Creek	Upstream of CR12, 1 mi. N of Rice	Benton	0701020105-01
07010201-569	16UM092	Hazel Creek	Upstream of CR 25, 2 mi. SE of Bowlus	Morrison	0701020107-01
07010201-649	16UM087	Stony Creek	Downstream of CR 17, 3 mi. W of Rice	Stearns	0701020107-01
07010201-630	16UM094	Hay Creek	Upstream of CR 52, 2 mi. NE of Bowlus	Morrison	0701020107-01
07010201-516	16UM093	Little Two River	Upstream of 130th Ave, 1 mi. NE of Bowlus	Morrison	0701020107-01
07010201-524	16UM090	North Two River	Upstream of CR 21, 2.5 mi. W of Upsala	Morrison	0701020101-03

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07010201-524	16UM091	North Two River	Downstream of 110th Ave, 1 mi. SW of Bowlus	Morrison	0701020101-03
07010201-523	16UM128	Two River	Upstream of 40th St, 1 mi. E of Bowlus	Morrison	0701020101-01
07010201-523	16UM118	Two River	Upstream of Great River Rd, 2 mi. E of Bowlus	Morrison	0701020101-01
07010201-632	15EM008	Unnamed ditch	Downstream of CSAH 10, 1.5 mi. NE of Albany	Stearns	0701020101-02
07010201-613	16UM086	Krain Creek	Downstream of 190th Ave, 1 mi. W of Holdingford	Stearns	0701020101-02
07010201-542	16UM119	South Two River	Downstream of CR 156, 1 mi. S of Albany	Stearns	0701020101-02
07010201-643	16UM131	South Two River	Downstream of 165th Ave, 2 mi NE of Holdingford	Stearns	0701020101-02
07010201-643	16UM127	South Two River	Upstream of CR 21, 1 mi. SW of Bowlus	Morrison	0701020101-02
07010201-525	16UM132	Spunk Creek	Upstream of 125 Ave, 4.5 mi. E of Holdingford	Stearns	0701020102-01
07010201-525	16UM126	Spunk Creek	Downstream of Great River Rd, 3.5 mi. SW of Royalton	Morrison	0701020102-01
07010201-554	07UM101	Watab River, South Fork	Downstream of CR 160, 3 mi. SW of St. Joseph	Stearns	0701020106-01
07010201-537	16UM083	County Ditch 12	Upstream of CR 2, 4 mi. W of Sartell	Stearns	0701020106-01
07010201-529	16UM082	Watab River, North Fork	Upstream of CR 3, 1.5 mi. NW of St Joseph	Stearns	0701020106-01
07010201-554	16UM081	Watab River, South Fork	Upstream of CR 51, 1.5 mi. SW of St Joseph.	Stearns	0701020106-01
07010201-528	16UM125	Watab River	Downstream of 57th Ave (Pine Cone Rd), in Sartell	Stearns	0701020106-01

Appendix 3.1 – Minnesota statewide IBI thresholds and confidence limits

Class #	Class name	Use class	Exceptional use threshold	General use threshold	Modified use threshold	Confidence limit
Fish						
1	Southern Rivers	2B	71	49	NA	±11
2	Southern Streams	2B	66	50	35	±9
3	Southern Headwaters	2B	74	55	33	±7
10	Southern Coldwater	2A	82	50	NA	±9
4	Northern Rivers	2B	67	38	NA	±9
5	Northern Streams	2B	61	47	35	±9
6	Northern Headwaters	2B	68	42	23	±16
7	Low Gradient	2B	70	42	15	±10
11	Northern Coldwater	2A	60	35	NA	±10
Invertebrates						
1	Northern Forest Rivers	2B	77	49	NA	±10.8
2	Prairie Forest Rivers	2B	63	31	NA	±10.8
3	Northern Forest Streams RR	2B	82	53	NA	±12.6
4	Northern Forest Streams GP	2B	76	51	37	±13.6
5	Southern Streams RR	2B	62	37	24	±12.6
6	Southern Forest Streams GP	2B	66	43	30	±13.6
7	Prairie Streams GP	2B	69	41	22	±13.6
8	Northern Coldwater	2A	52	32	NA	±12.4
9	Southern Coldwater	2A	72	43	NA	±13.8

Appendix 3.2 – Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
HUC-12: 0701020104-02 (Upper Platte River)							
07010201-507	10EM102	Platte River	96.77685	5	47	44.89	6/15/2017
07010201-507	16UM111	Platte River	104.6118	5	47	68.05	7/5/2016
07010201-507	03UM002	Platte River	146.6433	5	47	49.38	7/6/2016
07010201-507	16UM123	Platte River	169.591	5	47	45.75	7/6/2016
07010201-507	16UM117	Platte River	72.74327	5	47	30.76	7/5/2016
07010201-507	16UM117	Platte River	72.74327	5	47	34.19	6/15/2017
07010201-507	10EM102	Platte River	96.77685	5	47	41.02	6/21/2010
07010201-507	10EM102	Platte River	96.77685	5	47	40.55	7/6/2010
07010201-507	10EM102	Platte River	96.77685	5	47	47.61	7/6/2015
07010201-634	16UM112	Unnamed creek	7.435285	6	42	24.68	6/27/2016
07010201-645	16UM105	Little Mink Creek	16.04197	6	42	44.18	6/23/2016
07010201-647	16UM107	Big Mink Creek	21.99624	6	42	61.80	6/27/2016
		Line					
HUC-12: 0701020103-01 (Skunk River)							
07010201-520	16UM113	Skunk River	8.82	7	42	37.28	6/28/2016
07010201-520	16UM133	Skunk River	37.71	6	42	82.24	6/27/2016
07010201-520	16UM104	Skunk River	53.55	5	47	48.15	6/30/2016
07010201-521	16UM130	Skunk River	103.04	5	47	58.65	6/30/2016
07010201-521	16UM129	Skunk River	133.83	5	47	55.99	8/8/2016
07010201-633	16UM114	Trib. to Skunk River	9.91	7	42	63.20	6/28/2016
07010201-637	16UM100	Skunk Creek	13.96	6	42	58.01	6/28/2016
HUC-12: 0701020103-02(Hillman Creek)							
07010201-636	16UM103	Unnamed creek	9.421202	7	42	60.27	6/27/2016

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07010201-639	16UM108	Hillman Creek	26.2829	6	42	66.02	6/27/2016
07010201-639	16UM102	Hillman Creek	45.3894	6	42	74.75	8/4/2016
HUC-12: 0701020104-01 (Lower Platte River)							
07010201-545	03UM003	Platte River	408.07	5	61*	58.63	6/20/2017
07010201-545	03UM004	Platte River	432.27	5	61*	73.96	7/7/2016
07010201-545	16UM122	Platte River	437.52	5	61*	87.71	6/20/2017
07010201-546	99UM048	Platte River	395.44	5	47	49.39	6/21/2017
07010201-618	16UM124	Rice Creek	31.66	7	42	48.30	8/4/2016
07010201-621	16UM110	Unnamed creek	15.24	7	15**	45.44	6/23/2016
07010201-622	10EM166	Unnamed creek	3.42	7	15**	36.35	6/16/2010
07010201-651	16UM109	Unnamed creek	10.49	6	42	29.69	6/23/2016
07010201-651	16UM109	Unnamed creek	10.49	6	42	16.92	7/26/2018
07010201-651	18UM109	Unnamed creek	10.48	6	42	29.32	7/24/2018
HUC-12: 0701020105-01 (Little Rock Creek)							
07010201-511	15UM210	Bunker Hill Creek	16.71	11	35	15.01	7/2/2015
07010201-511	15UM210	Bunker Hill Creek	16.71	11	35	16.06	6/29/2016
07010201-539	16UM088	Zuleger Creek	11.41	6	42	25.51	6/29/2016
07010201-652	99UM058	Little Rock Creek	12.08	6	42	21.80	7/25/2007
07010201-652	99UM058	Little Rock Creek	12.08	6	42	14.68	8/9/2007
07010201-652	99UM058	Little Rock Creek	12.08	6	42	15.67	6/30/2015
07010201-652	99UM058	Little Rock Creek	12.08	6	42	19.43	6/29/2016
07010201-653	07UM070	Little Rock Creek	13.80	11	35	11.15	7/25/2007
07010201-653	07UM070	Little Rock Creek	13.80	11	35	9.96	7/2/2008
07010201-653	07UM070	Little Rock Creek	13.80	11	35	4.67	6/30/2015
07010201-653	03UM110	Little Rock Creek	20.80	11	35	7.65	7/30/2008
07010201-653	03UM110	Little Rock Creek	20.80	11	35	20.42	7/2/2015

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
07010201-653	03UM110	Little Rock Creek	20.80	11	35	17.02	6/29/2016
07010201-653	07UM071	Little Rock Creek	35.07	11	35	41.63	7/24/2007
07010201-653	07UM071	Little Rock Creek	35.07	11	35	30.82	8/12/2008
07010201-653	07UM071	Little Rock Creek	35.07	11	35	31.14	7/30/2015
07010201-653	07UM071	Little Rock Creek	35.07	11	35	30.02	7/27/2016
07010201-653	82UM001	Little Rock Creek	42.18	11	35	20.73	8/12/2008
07010201-653	82UM001	Little Rock Creek	42.18	11	35	20.70	6/25/2015
07010201-653	82UM001	Little Rock Creek	42.18	11	35	38.40	7/27/2016
07010201-653	07UM072	Little Rock Creek	42.67	11	35	27.15	7/25/2007
07010201-653	07UM072	Little Rock Creek	42.67	11	35	24.67	8/13/2008
07010201-653	07UM072	Little Rock Creek	42.67	11	35	10.09	7/30/2015
07010201-653	07UM072	Little Rock Creek	42.67	11	35	28.23	7/27/2016
07010201-653	92UM001	Little Rock Creek	62.45	11	35	18.14	8/13/2008
07010201-653	92UM001	Little Rock Creek	62.45	11	35	28.06	6/24/2015
07010201-653	92UM001	Little Rock Creek	62.45	11	35	21.96	7/26/2016
07010201-653	07UM073	Little Rock Creek	66.12	11	35	38.07	7/24/2007
07010201-653	07UM073	Little Rock Creek	66.12	11	35	24.98	8/18/2008
07010201-653	07UM073	Little Rock Creek	66.12	11	35	35.50	6/24/2015
07010201-653	07UM073	Little Rock Creek	66.12	11	35	31.04	7/26/2016
07010201-653	75UM001	Little Rock Creek	67.26	11	35	14.51	8/19/2008
07010201-653	75UM001	Little Rock Creek	67.26	11	35	40.33	6/24/2015
07010201-653	75UM001	Little Rock Creek	67.26	11	35	31.65	7/6/2016
HUC-12: 0701020107-01 (City of Sartell – Mississippi River)							
07010201-516	16UM093	Little Two River	25.63	6	42	50.46	6/29/2016
07010201-569	16UM092	Hazel Creek	3.26	6	42	24.96	7/7/2016
07010201-569	16UM092	Hazel Creek	3.26	6	42	35.32	6/14/2017

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
07010201-630	16UM094	Hay Creek	17.36	6	42	58.89	6/29/2016
07010201-649	16UM087	Stony Creek	14.17	6	42	56.81	8/2/2016
HUC-12: 0701020101-03 (North Two River)							
07010201-524	16UM090	North Two River	33.18	6	42	58.62	6/28/2016
07010201-524	16UM091	North Two River	48.20	6	42	67.04	8/17/2016
HUC-12: 0701020101-01 (Two River)							
07010201-523	16UM128	Two River	153.24	5	47	44.28	6/28/2016
07010201-523	16UM118	Two River	154.61	5	47	55.06	6/29/2016
HUC-12: 0701020101-02 (South Two River)							
07010201-613	16UM086	Krain Creek	11.09	6	42	43.27	8/3/2016
07010201-632	15EM008	Unnamed creek	1.54	6	23*	0.00	6/15/2015
07010201-632	15EM008	Unnamed creek	1.54	6	23*	0.00	8/10/2015
07010201-643	16UM131	South Two River	86.03	5	47	37.68	6/28/2016
07010201-643	16UM127	South Two River	96.29	5	47	42.63	6/28/2016
HUC-12: 0701020102-01 (Spunk Creek)							
07010201-525	00UM040	Spunk Creek	32.65	7	42	23.23	6/29/2016
07010201-525	16UM132	Spunk Creek	70.57	5	47	48.93	6/29/2016
07010201-525	16UM126	Spunk Creek	80.87	5	47	53.53	6/29/2016
HUC-12: 0701020106-01 (Watab River)							
07010201-528	16UM125	Watab River	91.50	5	47	38.66	8/3/2016
07010201-529	16UM082	Watab River, North Fork	20.24	5	42	54.57	6/30/2016
07010201-537	16UM083	County Ditch 12	19.73	6	42	70.67	8/2/2016
07010201-554	07UM101	Watab River, South Fork	14.20	6	42	39.90	6/18/2007
07010201-554	07UM101	Watab River, South Fork	14.20	6	42	28.49	8/16/2016
07010201-554	16UM081	Watab River, South Fork	25.70	6	42	29.65	6/30/2016
*Exceptional Use Threshold applied							
** Modified Use Threshold applied							

Appendix 3.3 – Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
HUC-12: 0701020104-02 (Upper Platte River)							
07010201-507	16UM117	Platte River	72.74	3	53	45.39	8/7/2017
07010201-507	10EM102	Platte River	96.78	4	51	75.27	9/8/2011
07010201-507	10EM102	Platte River	96.78	4	51	71.17	8/25/2015
07010201-507	16UM111	Platte River	104.61	3	53	69.98	8/7/2017
07010201-507	03UM002	Platte River	146.64	3	53	72.14	8/7/2017
07010201-507	16UM123	Platte River	169.59	4	51	89.91	8/7/2017
07010201-634	16UM112	Unnamed creek	7.44	3	53	47.60	9/7/2016
07010201-645	16UM105	Little Mink Creek	16.04	6	43	22.88	9/1/2016
07010201-645	16UM105	Little Mink Creek	16.04	6	43	42.52	8/8/2017
07010201-647	16UM107	Big Mink Creek	22.00	5	37	33.03	9/1/2016
07010201-647	16UM107	Big Mink Creek	22.00	5	37	29.53	9/13/2017
HUC-12: 0701020103-01 (Skunk River)							
07010201-520	16UM133	Skunk River	37.71	3	53	69.94	9/6/2016
07010201-520	16UM104	Skunk River	53.55	5	37	64.38	9/6/2016
07010201-521	16UM130	Skunk River	103.04	5	37	73.62	9/1/2016
07010201-521	16UM130	Skunk River	103.04	5	37	76.18	9/27/2016
07010201-521	16UM129	Skunk River	133.83	5	37	71.05	9/1/2016
07010201-633	16UM114	Unnamed creek	9.91	4	51	72.49	8/8/2017
07010201-637	16UM100	Unnamed creek	13.96	5	37	56.41	9/1/2016
HUC-12: 0701020103-02 (Hillman Creek)							
07010201-636	16UM103	Unnamed creek	9.42	4	51	53.60	9/7/2016
07010201-639	16UM108	Hillman Creek	26.28	3	53	55.56	8/22/2016
07010201-639	16UM102	Hillman Creek	45.39	3	53	66.77	9/6/2016
HUC-12: 0701020104-01 (Lower Platte River)							
07010201-545	03UM003	Platte River	408.07	7	69*	85.79	8/2/2017
07010201-545	03UM004	Platte River	432.27	5	69*	85.05	8/2/2017

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi2	Invert class	Threshold	MIBI	Visit date
07010201-545	16UM122	Platte River	437.52	5	69*	70.81	8/2/2017
07010201-618	16UM124	Rice Creek	31.66	6	43	21.00	9/14/2016
07010201-621	16UM110	Unnamed creek	15.24	6	30**	35.51	9/1/2016
07010201-622	10EM166	Unnamed creek	3.42	6	30**	7.36	9/8/2010
07010201-651	16UM109	Unnamed creek	10.49	5	37	29.37	9/1/2016
07010201-651	16UM109	Unnamed creek	10.49	5	37	41.08	8/7/2018
07010201-651	18UM109	Unnamed creek	10.48	5	37	36.1	8/7/2018
HUC-12: 0701020105-01 (Little Rock Creek)							
07010201-511	15UM210	Bunker Hill Creek	16.71	8	32	30.43	8/25/2015
07010201-511	15UM210	Bunker Hill Creek	16.71	8	32	13.07	8/30/2016
07010201-539	16UM088	Zuleger Creek	11.41	5	37	35.38	8/30/2016
07010201-652	99UM058	Little Rock Creek	12.08	5	37	48.52	8/13/2015
07010201-652	99UM058	Little Rock Creek	12.08	5	37	39.44	8/30/2016
07010201-653	07UM070	Little Rock Creek	13.80	9	43	8.89	8/13/2015
07010201-653	03UM110	Little Rock Creek	20.80	9	43	26.83	8/13/2015
07010201-653	03UM110	Little Rock Creek	20.80	9	43	28.06	8/30/2016
07010201-653	07UM071	Little Rock Creek	35.07	9	43	64.25	8/13/2015
07010201-653	07UM071	Little Rock Creek	35.07	9	43	63.88	8/30/2016
07010201-653	82UM001	Little Rock Creek	42.18	9	43	63.71	8/13/2015
07010201-653	82UM001	Little Rock Creek	42.18	9	43	61.28	8/30/2016
07010201-653	07UM072	Little Rock Creek	42.67	9	43	36.70	8/7/2007
07010201-653	07UM072	Little Rock Creek	42.67	9	43	55.97	8/25/2015
07010201-653	07UM072	Little Rock Creek	42.67	9	43	71.21	8/31/2016
07010201-653	92UM001	Little Rock Creek	62.45	9	43	26.07	8/25/2015
07010201-653	92UM001	Little Rock Creek	62.45	9	43	59.61	9/14/2016
07010201-653	07UM073	Little Rock Creek	66.12	9	43	30.83	8/7/2007
07010201-653	07UM073	Little Rock Creek	66.12	9	43	30.35	8/25/2015
07010201-653	07UM073	Little Rock Creek	66.12	9	43	27.19	8/10/2016
07010201-653	75UM001	Little Rock Creek	67.26	9	43	35.02	8/25/2015
07010201-653	75UM001	Little Rock Creek	67.26	9	43	54.02	8/10/2016

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
HUC-12: 0701020107-01 (City Of Sartell – Mississippi River)							
07010201-516	16UM093	Little Two River	25.63	5	37	50.51	8/10/2016
07010201-569	16UM092	Hazel Creek	3.26	5	37	40.44	8/10/2016
07010201-630	16UM094	Hay Creek	17.36	5	37	59.86	8/17/2016
07010201-649	16UM087	Stony Creek	14.17	5	37	56.30	8/9/2016
HUC-12: 0701020101-03 (North Two River)							
07010201-524	16UM090	North Two River	33.18	5	37	48.66	8/17/2016
07010201-524	16UM091	North Two River	48.20	5	37	69.88	8/16/2016
HUC-12: 0701020101-01 (Two River)							
07010201-523	16UM128	Two River	153.24	5	37	58.93	8/16/2016
07010201-523	16UM118	Two River	154.61	5	37	65.84	8/17/2016
HUC-12: 0701020101-01 (South Two River)							
07010201-613	16UM086	Krain Creek	11.09	5	37	62.33	8/17/2016
07010201-632	15EM008	Unnamed creek	1.54	5	24**	34.26	8/25/2015
07010201-643	16UM131	South Two River	86.03	6	43	57.44	8/18/2016
07010201-643	16UM127	South Two River	96.29	5	37	48.32	8/16/2016
HUC-12: 0701020102-01 (Spunk Creek)							
07010201-525	16UM132	Spunk Creek	70.57	5	37	43.31	8/31/2016
07010201-525	16UM126	Spunk Creek	80.87	5	37	55.86	8/31/2016
HUC-12: 0701020106-01 (Watab River)							
07010201-528	16UM125	Watab River	91.50	6	43	54.30	8/9/2016
07010201-529	16UM082	Watab River, North Fork	20.24	5	37	41.03	8/9/2016
07010201-537	16UM083	County Ditch 12	19.73	5	37	44.51	8/9/2016
07010201-554	07UM101	Watab River, South Fork	14.20	5	37	51.76	8/8/2016
07010201-554	16UM081	Watab River, South Fork	25.70	6	43	48.22	8/18/2016
*Exceptional Use Threshold applied							
** Modified Use Threshold applied							

Appendix 4.1 – Fish species found during biological monitoring surveys

CommonName	Quantity of Individuals Collected	Quantity of Stations Where Present
bigmouth shiner	255	15
black bullhead	71	19
black crappie	17	10
blacknose dace	2799	37
blacknose shiner	14	3
blackside darter	5	1
bluegill	361	24
bluntnose minnow	202	21
bowfin	2	1
brassy minnow	156	8
brook silverside	7	1
brook stickleback	1148	31
brook trout	1	1
brown bullhead	6	2
brown trout	142	7
burbot	281	21
central mudminnow	2700	55
central stoneroller	243	14
common carp	1	1
common shiner	6048	46
creek chub	2687	53
fathead minnow	539	32
finescale dace	1	1
Gen: Notropis	1	1
Gen: redhorses	18	2
golden shiner	14	4
green sunfish	92	14
hornyhead chub	1292	29
hybrid sunfish	39	4
Iowa darter	12	5
johnny darter	3898	51
largemouth bass	270	23
logperch	417	23
longnose dace	740	23
mottled sculpin	117	7
northern pike	256	34
northern redbelly dace	826	15
pumpkinseed	66	12
rock bass	463	24
shorthead redhorse	71	9

CommonName	Quantity of Individuals Collected	Quantity of Stations Where Present
silver redhorse	5	1
smallmouth bass	745	22
spotfin shiner	50	7
spottail shiner	5	1
tadpole madtom	252	22
walleye	35	13
white sucker	4622	56
yellow bullhead	16	7
yellow perch	683	21

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ablabesmyia	36	137
Acari	44	239
Acentrella parvula	11	39
Acerpenna	17	76
Acerpenna pygmaea	12	206
Acroneuria	13	28
Acroneuria lycorias	1	1
Aeshna	6	9
Aeshna umbrosa	7	11
Aeshnidae	3	6
Agabinae	1	1
Agarodes distinctus	1	1
Agnetina	3	4
Agraylea	1	1
Amphipoda	6	15
Anacaena	2	2
Anafroptilum	2	2
Anax junius	6	6
Ancyronyx variegatus	11	50
Anisoptera	1	2
Anopheles	9	17
Antocha	10	18
Aquarius	1	3
Argia	4	6
Atherix	18	141
Atrichopogon	2	10
Baetidae	10	37
Baetis	32	192
Baetis brunneicolor	22	378
Baetis flavistriga	33	184
Baetis intercalaris	11	78
Baetis tricaudatus	1	3
Baetisca	5	63
Baetisca laurentina	1	1
Basiaeschna janata	1	1
Belostoma	1	1
Belostoma flumineum	24	34
Berosus	3	3
Bezzia/Palpomyia	1	2

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Boyeria	3	4
Boyeria vinosa	9	23
Brachycentrus	2	4
Brachycentrus numerosus	6	225
Brillia	29	116
Caecidotea	7	96
Caenis	6	13
Caenis diminuta	31	614
Caenis hilaris	7	13
Callibaetis	1	1
Calopterygidae	20	79
Calopteryx	20	67
Calopteryx aequabilis	25	100
Calopteryx maculata	5	10
Cambaridae	5	5
Cambarus	3	3
Campeloma	1	1
Cardiocladius	1	1
Ceraclea	20	70
Ceratopogonidae	3	6
Ceratopogoninae	15	21
Ceratopsyche	20	98
Ceratopsyche alhedra	5	21
Ceratopsyche bronta	8	28
Ceratopsyche morosa	8	80
Ceratopsyche slossonae	13	108
Ceratopsyche sparna	10	145
Ceratopsyche vexa	1	1
Chelifera	1	4
Cheumatopsyche	46	708
Chimarra	6	14
Chironomini	14	25
Chironomus	13	191
Chrysops	1	1
Cladopelma	1	1
Cladotanytarsus	14	26
Clinotanypus	1	1
Coenagrionidae	26	124
Conchapelopia	7	10
Corduliidae	2	2
Corixidae	9	40
Corynoneura	11	37
Crambidae	2	10

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Crangonyx	2	6
Cricotopus	42	344
Cryptochironomus	11	15
Cryptotendipes	2	3
Culicidae	6	8
Deronectes griseostriatus	1	1
Diamesa	1	1
Dicranota	10	35
Dicrotendipes	22	126
Dineutus	5	6
Dixella	7	17
Dixidae	2	2
Dubiraphia	50	453
Dytiscidae	1	1
Elmidae	1	1
Empididae	14	22
Endochironomus	5	7
Ephemera	3	8
Ephemerella	1	1
Ephoron album	1	1
Ephydridae	16	26
Epitheca canis	1	1
Erioptera	1	1
Eukiefferiella	3	22
Eurylophella	2	4
Ferrissia	36	299
Forcipomyia	2	5
Forcipomyiinae	1	2
Fossaria	1	1
Gammarus	10	131
Gastropoda	1	1
Gerridae	2	2
Glossosomatidae	5	11
Glyptotendipes	5	5
Gomphidae	2	2
Gomphus	1	1
Gyraulus	12	40
Gyrinus	7	12
Haliplus	11	37
Helichus	12	35
Helicopsyche	1	3
Helicopsyche borealis	30	312
Helicopsychidae	1	2

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Helisoma anceps	1	1
Helius	1	1
Helopelopia	1	1
Hemerodromia	27	83
Heptagenia	2	3
Heptageniidae	22	103
Hetaerina	1	4
Hetaerina titia	1	1
Heterocloeon	1	1
Hexagenia	1	1
Hexatoma	2	2
Hirudinea	19	40
Hyalella	37	1071
Hydatophylax argus	5	9
Hydraena	5	7
Hydrobiidae	21	283
Hydrophilidae	3	3
Hydropsyche	21	226
Hydropsyche betteni	37	843
Hydropsyche placoda	1	2
Hydropsyche simulans	1	5
Hydropsychidae	31	329
Hydroptila	24	83
Hydroptilidae	10	25
Hygrotus	1	1
Ischnura	1	4
Isonychia	6	10
Isoperla	3	4
Iswaeon	27	339
Labiobaetis	2	6
Labiobaetis dardanus	4	5
Labiobaetis frondalis	8	35
Labiobaetis propinquus	22	162
Labrundinia	28	87
Larsia	3	6
Lepidostoma	9	40
Leptoceridae	12	21
Leptophlebiidae	23	189
Leucrocuta	12	33
Libellulidae	1	2
Limnephilidae	20	114
Limnophila	3	3
Limnophyes	14	21

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Limonia	1	1
Limoniinae	1	2
Liodessus	8	54
Lopescladius	1	1
Lymnaeidae	9	17
Lype diversa	3	10
Maccaffertium	25	219
Maccaffertium exiguum	2	6
Maccaffertium mediopunctatum	7	18
Maccaffertium terminatum	1	4
Maccaffertium vicarium	13	46
Macronychus	2	17
Macronychus glabratus	30	529
Mayatrichia ayama	1	6
Mesovelia	2	2
Micrasema	2	12
Micrasema rusticum	17	168
Micropsectra	26	275
Microtendipes	42	203
Microvelia	2	2
Mystacides	2	6
Nanocladius	8	9
Natarsia	1	3
Nectopsyche	3	5
Nectopsyche diarina	6	13
Nectopsyche exquisita	3	18
Nemata	17	23
Nematoda	1	1
Nemotaulius hostilis	1	1
Neophylax	1	2
Neophylax concinnus	1	67
Neophylax fuscus	13	112
Neophylax oligius	1	5
Neoplasta	8	18
Neoplea striola	19	42
Neoporus	3	4
Neureclipsis	9	32
Nigronia	1	1
Nilotanypus	10	14
Nilothauma	3	4
Notonecta	2	2
Nyctiophylax	7	8

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ochrotrichia	1	1
Odontomyia	4	4
Odontomyia /Hedriodiscus	1	1
Oecetis	2	3
Oecetis avara	13	49
Oecetis furva	2	3
Oecetis persimilis	1	1
Oecetis testacea	19	78
Oligochaeta	43	287
Ophiogomphus	3	3
Ophiogomphus rupinsulensis	1	1
Optioservus	39	462
Orconectes	25	28
Ormosia	1	1
Orthocladiinae	15	24
Orthocladius	9	16
Orthocladius (Symposiocladius)	12	53
Oxyethira	3	91
Parachironomus	2	5
Paracladopelma	1	1
Paracloeodes minutus	1	2
Paracricotopus	1	1
Paragnetina media	14	23
Parakiefferiella	13	40
Paralauterborniella	1	1
Parametriocnemus	25	238
Parapoynx	9	61
Paratanytarsus	29	238
Paratendipes	13	20
Peltodytes	2	2
Pentaneura	14	33
Perlesta	1	2
Perlidae	3	3
Phaenopsectra	31	108
Phryganeidae	1	3
Physa	3	21
Physella	41	291
Physidae	4	9
Pisidiidae	45	279
Planorbella	5	5
Planorbidae	3	3
Planorbula armigera	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Plauditus	4	5
Polycentropodidae	6	12
Polycentropus	6	6
Polypedilum	54	1858
Potthastia	2	2
Procladius	11	24
Procloeon	14	45
Promenetus exacuous	1	1
Prostoma	1	1
Protoptila	11	75
Psectrocladius	2	2
Pseudochironomus	1	7
Pseudocloeon propinquum	1	4
Pseudosuccinea columella	1	1
Psychomyia	1	3
Psychomyia flavida	5	26
Pteronarcys	5	5
Ptilostomis	17	32
Pycnopsyche	25	210
Ranatra	1	1
Rhagovelia	1	1
Rheocricotopus	25	61
Rheotanytarsus	51	1263
Roederiodes	1	1
Saetheria	3	4
Scirtes	2	2
Scirtidae	3	4
Sialis	7	13
Sigara	2	2
Simulium	48	995
Somatochlora minor	1	1
Sperchopsis tessellata	1	1
Sperchopsis tessellata	1	2
Sphaerium	1	1
Stagnicola	5	8
Stempellinella	30	67
Stenacron	26	203
Stenelmis	41	417
Stenochironomus	28	86
Stenonema femoratum	2	2
Stictochironomus	7	9
Sublettea coffmani	2	2
Sympetrum costiferum	1	2

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Synorthocladius	2	2
Syrphidae	1	1
Tabanidae	6	11
Tanypodinae	19	36
Tanypus	1	1
Tanytarsini	28	71
Tanytarsus	46	391
Teloganopsis deficiens	5	57
Telopelopia okoboji	2	2
Thienemanniella	40	108
Thienemannimyia Gr.	48	356
Tipula	21	57
Tipulidae	1	1
Trepaxonemata	21	147
Triaenodes	17	53
Tribelos	6	12
Trichocorixa	1	1
Trichoptera	2	2
Tricorythodes	21	172
Tropisternus	1	1
Turbellaria	3	5
Tvetenia	25	103
Uenoidae	12	166
Valvata	2	19
Veliidae	1	1
Xenochironomus xenolabis	8	14
Xylotopus par	5	5
Zavrelimyia	16	35

*

Appendix 5 – Minnesota Stream Habitat Assessment results

Habitat information documented during each fish sampling visit is provided. This table convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the aggregated HUC-12 subwatershed.

# Visits	Biological station ID	Reach name	Land use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish cover (0-17)	Channel morph.	MSHA score (0-100)	MSHA rating
2	03UM002	Platte River	2.5	10	20.52	16.5	26	75.53	Good
5	10EM102	Platte River	2.95	9.2	13.2	11	14.6	50.95	Fair
3	16UM105	Little Mink Creek	1.33	10.17	14	11.67	11.67	48.83	Fair
3	16UM107	Big Mink Creek	1.58	9	17.8	13.67	16.33	58.38	Fair
2	16UM111	Platte River	2.5	12.5	23.3	16.5	24	78.8	Good
2	16UM112	Unnamed Creek	2.88	11	19.7	13.5	23	70.07	Good
3	16UM117	Platte River	3	9.67	22.48	16.33	25	76.48	Good
2	16UM123	Platte River	2.13	8.75	14.97	14	16	55.85	Fair
Average Habitat Results: *Upper Platte River-0701020104-02*			2.36	10.04	18.25	14.15	19.58	64.36	Fair
2	16UM100	Unnamed Creek (Skunk creccCreek)	1.00	9.50	20.70	14.00	26.00	71.20	Good
2	16UM104	Skunk River	1.25	10.25	19.00	13.00	24.50	68.00	Good
1	16UM113	Skunk River	5.00	11.00	8.00	12.00	10.00	46.00	Fair
2	16UM114	Unnamed Creek (Trib. To Skunk River)	3.75	11.50	7.00	13.00	8.50	43.75	Poor
2	16UM129	Skunk River	2.50	8.25	15.53	13.00	19.00	58.27	Fair
3	16UM130	Skunk River	2.33	8.83	16.32	12.00	16.67	56.15	Fair
2	16UM133	Skunk River	2.50	12.00	20.97	16.00	26.00	77.48	Good
Average Habitat Results: *Skunk River-0701020103-01*			2.62	10.19	15.36	13.29	18.67	60.12	Fair
2	16UM102	Hillman Creek	2.00	12.00	22.95	12.50	20.50	69.95	Good
2	16UM103	Unnamed Creek (Trib. To Hillman Creek)	3.38	10.75	12.90	12.00	10.00	49.02	Fair

2	16UM108	Hillman Creek	2.50	9.00	20.32	14.00	21.50	67.33	Good
Average Habitat Results: *Hillman Creek- 0701020103-02*			2.63	10.58	18.72	12.83	17.33	62.10	Fair
2	03UM003	Platte River	2.5	10.75	20.38	15	19	67.62	Good
4	03UM004	Platte River	2.19	9.38	21.46	16.5	24.5	74.02	Good
1	10EM166	Unnamed Creek	3	11	8	5	4	31	Poor
2	16UM097	Buckman Creek	0	8.25	18.57	12.5	21.5	60.83	Fair
4	16UM109	Unnamed Creek (Trib. To Rice Creek)	3	10.13	11.61	12	16.75	53.49	Fair
2	16UM110	Unnamed Creek (Trib. To Rice Creek)	3.25	11	5.5	11.5	7.5	38.75	Poor
2	16UM122	Platte River	3.75	9.75	23	14	26	76.5	Good
2	16UM124	Rice Creek	2.5	9.25	9.5	12.5	7.5	41.25	Poor
2	18UM109	Unnamed Creek (Trib. To Rice Creek)	2	7.25	11.8	12	15.5	48.55	Fair
1	99UM048	Platte River	3.75	11	14	14	12	54.75	Fair
Average Habitat Results: *Lower Platte River- 0701020104-01*			2.59	9.78	14.38	12.50	15.43	54.68	Fair
5	03UM110	Little Rock Creek	3.5	12.8	11.11	11.6	18.8	57.81	Fair
4	07UM070	Little Rock Creek	0	10.38	11.75	14	16.25	52.38	Fair
6	07UM071	Little Rock Creek	1.25	11.58	18.65	14.83	26	72.32	Good
6	07UM072	Little Rock Creek	2.5	13.33	14.28	11.17	18	59.27	Fair
6	07UM073	Little Rock Creek	3.17	10	15.88	11.17	16.5	56.71	Fair
4	15UM210	Bunker Hill Creek	3.13	9.63	18.85	14	21.25	66.85	Good
2	16UM088	Zuleger Creek	2.5	10.75	9.95	7	15	45.2	Fair
5	75UM001	Little Rock Creek	3.5	11.3	14.66	9	16.4	54.86	Fair
5	82UM001	Little Rock Creek	2.5	12.4	18.78	14	26.4	74.08	Good
5	92UM001	Little Rock Creek	3.5	11.5	13.04	13.2	18.4	59.64	Fair
6	99UM058	Little Rock Creek	3.33	12.33	13.68	9.33	13.83	52.51	Fair
Average Habitat Results: *Little Rock Creek- 0701020105-01*			2.63	11.45	14.60	11.75	18.80	59.24	Fair
2	16UM087	Stony Creek	1.88	10.75	14	7	13	46.63	Fair
3	16UM092	Hazel Creek	1.92	11.83	20.75	10.33	20.67	65.5	Fair

2	16UM093	Little Two River	2.5	10	11.05	9.5	17.5	50.55	Fair
2	16UM094	Hay Creek	4.5	12.5	19.05	11.5	24	71.55	Good
Average Habitat Results: ***City of Sartell – Mississippi River- 0701020107-01***			2.70	11.27	16.21	9.58	18.79	58.56	Fair
2	16UM090	North Two River	1.25	9.75	22.7	13	19.5	66.2	Good
2	16UM091	North Two River	2.5	11.5	21.55	15	27	77.55	Good
Average Habitat Results: ***North Two River- 0701020101-03***			1.88	10.63	22.13	14.00	23.25	71.88	Good
2	16UM118	Two River	2.5	10.5	19.65	15	24.5	72.15	Good
2	16UM128	Two River	1.25	8	18.55	15.5	24.5	67.8	Good
Average Habitat Results: ***Two River- 0701020101-01***			1.88	9.25	19.10	15.25	24.50	69.98	Good
3	15EM008	Unnamed Creek (Unnamed Ditch)	2.5	9.67	18.95	10.33	10.67	52.12	Fair
2	16UM086	Krain Creek	2	10	20.25	14	22	68.25	Good
2	16UM119	South Two River	0	1	12.68	11.5	13.5	38.67	Poor
2	16UM127	South Two River	2.5	10.75	14.58	14	20.5	62.32	Fair
2	16UM131	South Two River	2.5	8.25	10.5	14.5	13.5	49.25	Fair
Average Habitat Results: ***South Two River- 0701020101-02***			1.90	7.93	15.39	12.87	16.03	54.12	Fair
2	16UM126	Spunk Creek	2.5	10.25	17.88	17	25.5	73.13	Good
2	16UM132	Spunk Creek	1.25	9.5	16.05	14	17.5	58.3	Fair
Average Habitat Results: ***Spunk Creek- 0701020102-01***			1.88	9.88	16.97	15.50	21.50	65.72	Fair
3	07UM101	Watab River, South Fork	0.5	9.33	18.55	11	18.33	57.72	Fair
2	16UM081	Watab River, South Fork	2.75	9.5	10.2	16	14	52.45	Fair
2	16UM082	Watab River, North Fork	4.13	9.5	12.8	14	18	58.42	Fair
2	16UM083	County Ditch 12	1.25	8.5	18.5	13	9.5	50.75	Fair
2	16UM125	Watab River	1.5	8.25	16.1	13.5	15.5	54.85	Fair

Average Habitat Results: *Watab River- 0701020106-01*	2.03	9.02	15.23	13.50	15.07	54.84	Fair

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Appendix 6 – Lake protection and prioritization results

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% load reduction goal	Priority
49-0005-00	Peavy	10.5	Insufficient data	6%	2	A
49-0015-00	Long	19.5	No evidence of trend	21%	5	A
49-0024-00	Pierz	18.5	No evidence of trend	55%	9	A
49-0140-00	Cedar	14.8	Improving trend	37%	6	A
73-0064-00	Kraemer	33.6	Declining trend	12%	11	A
73-0092-00	Sagatagan	31.3	No evidence of trend	15%	6	A
73-0097-00	Kreigle	10.9	No evidence of trend	16%	1	A
73-0102-00	Big Watab	15.1	Improving trend	13%	7	A
73-0104-00	Island	14.8	Insufficient data	17%	1	A
73-0118-00	Pelican	22.8	Improving trend	33%	9	A
73-0122-00	Ochotto	12.6	No evidence of trend	81%	0	A
73-0125-00	Achman	17.5	Insufficient data	25%	1	A
73-0126-00	Anna	18.7	Insufficient data	59%	1	A
73-0128-00	Middle Spunk	19.0	Improving trend	65%	46	A
73-0166-00	Koop	26.1	Insufficient data	60%	3	A
18-0008-00	Twenty Two	34.0	Insufficient data	3%	14	B
49-0016-00	Sullivan	18.8	Improving trend	9%	156	B
73-0098-00	Pitts	46.9	Insufficient data	37%	48	B
73-0099-00	Minnie	16.3	Insufficient data	38%	1	B
73-0117-00	Big Spunk	24.0	No evidence of trend	25%	52	B
73-0123-00	Lower Spunk	21.4	Improving trend	24%	45	B
73-0127-00	Linneman	21.5	Insufficient data	22%	3	B
73-0172-00	Clear	35.9	Insufficient data	47%	17	B
77-0019-00	Mary	37.7	Insufficient data	33%	9	B

18-0009-00	Erskine	26.1	Insufficient data	4%	7	C
18-0016-00	Rock	25.4	Insufficient data	6%	27	C
49-0019-00	Round	28.7	No evidence of trend	8%	161	C
49-0025-00	Rice	91.5	Insufficient data	19%	1,399	C
49-0026-00	Skunk	165.3	Insufficient data	6%	1,298	C
49-0030-00	Pelkey	105.3	Insufficient data	26%	182	C
49-0033-00	Popple	71.0	Insufficient data	29%	6	C
73-0070-00	Watab	44.7	No evidence of trend	47%	157	C
73-0072-00	Rossier	80.5	No evidence of trend	29%	234	C
73-0100-00	Kalla	26.9	Insufficient data	13%	40	C
73-0101-00	Schmid	15.4	Insufficient data	6%	1	C
73-0136-00	Pine	39.5	Improving trend	24%	22	C

Appendix 7 – Stream protection and prioritization results

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
07010201-545	Platte River	Exceptional	warm	neither	high	high	med/low	A
07010201-613	Krain Creek	General	warm	one	high	high	low	A
07010201-523	Two River	General	warm	one	high	high	med/low	A
07010201-529	Watab River, North Fork	General	warm	one	med/high	high	low	A
07010201-546	Platte River	General	warm	one	high	high	med/low	A
07010201-525	Spunk Creek	General	warm	one	med/high	high	med/low	A
07010201-524	North Two River	General	warm	neither	high	high	low	A
07010201-537	County Ditch 12	General	warm	neither	high	high	low	A
07010201-636	Unnamed creek	General	warm	one	med/high	medium	low	A
07010201-649	Stony Creek	General	warm	neither	high	high	low	A
07010201-521	Skunk River	General	warm	neither	high	med/high	low	A
07010201-630	Hay Creek	General	warm	neither	high	high	med/low	A
07010201-637	Unnamed creek	General	warm	neither	high	med/high	low	A
07010201-632	Unnamed creek	Modified	warm	one	med/high	high	low	A
07010201-622	Unnamed creek	Modified	warm	one	med/high	high	med/low	A
07010201-621	Unnamed creek	Modified	warm	neither	high	high	med/low	A
07010201-516	Little Two River	General	warm	neither	med/high	high	med/low	B
07010201-520	Skunk River	General	warm	neither	med/high	med/high	low	B
07010201-639	Hillman Creek	General	warm	neither	med/high	med/high	low	B
07010201-633	Unnamed creek	General	warm	neither	medium	medium	low	B