Sauk River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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Executive Summary

The Sauk River Watershed (070102020) lies in the heart of rural central Minnesota, encompassing a complex system of integrated lakes and streams, comprising 374 lakes and 79 named stream assessment units (AUID's). Since European settlement in the 1860s the Sauk has undergone dramatic land use modification; including the plowing of its native prairies, harvesting of its hardwood forests, draining of its wetlands and modifications to its natural stream courses. Today, 77 percent of its landscape is utilized for agricultural production. The watershed's wealth of surface waters is a valuable resource for aquatic recreation and its health is essential to resident aquatic life.

In 2008 the Minnesota Pollution Control Agency (MPCA) undertook an intensive watershed monitoring effort of the Sauk River Watershed's surface waters. Fifty-four sites were sampled for biology at the pour points of variable sized sub-watersheds within the Sauk River watershed. These locations included the mouth of the Sauk River, the outlet of its major tributaries and the pour points of headwater tributaries. As part of this effort MPCA also joined with the Sauk River Watershed District (SRWD) who completed stream water chemistry sampling at the pour points of the Sauk River's nine major subwatersheds. In 2010, a holistic approach was taken to assess all of the watershed's surface waterbodies for aquatic life, recreation and consumption use support, where data was available; 39 streams and 44 lakes were assessed in this effort. (Not all lake and stream AUIDs were able to be assessed due to insufficient data, modified channel condition or their status as limited resources waters.)

Thirteen of the watershed's assessed lakes are fully supporting for aquatic recreation. Thirty-one lakes are non-supporting for aquatic recreation and nine are non-supporting for aquatic consumption. Lake water quality in the Sauk River Watershed in modest to poor; nutrient eutrophication is a common concern across the watershed's 374 lakes.

Eight stream AUIDs are fully supporting for aquatic life, while 11 are fully supporting for aquatic recreation. Twenty-four stream AUIDs are non-supporting for aquatic recreation throughout the watershed; twenty-three are non-supporting for aquatic life use. Aquatic consumption impairments span the entire length of the Sauk River. Aquatic biological impairments are isolated to specific reaches on the mainstem Sauk River but are widely dispersed across assessable tributary streams. Channelized streams throughout the watershed are generally in poor biological condition. Three mainstem impairments occur downstream of large stretches of riverine lakes, impaired for nutrients. Water chemistry impairments involving low dissolved oxygen and high bacteria concentrations are common across the watershed's tributaries.

Despite past improvements to point source discharges and conservation efforts taken to improve water quality, both point and non-point sources of pollution continue to impact surface water quality in the watershed. Land use modification and hydrologic alteration including groundwater withdrawal may be contributing factors to the observed poor water quality conditions. While some regions have shown more resilience than others, additional monitoring and protection strategies are needed to improve conditions and attain water quality standards.

I. 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) requiring 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 take appropriate actions to restore these waters, including the development of Total Maximum Daily Loads (TMDL). A TMDL is a comprehensive study identifying all pollution sources causing or contributing to impairment and the reductions needed to restore a water body so that it can 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.

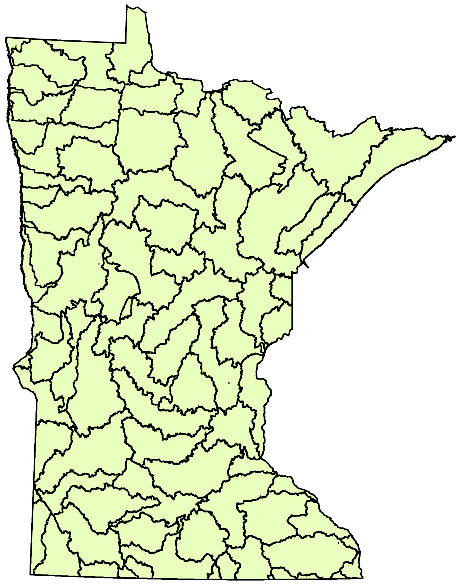
The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and the initial resources to state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. Funding from the Clean Water Fund from the constitutional amendment passed by voters in 2008 allowed for a continuation of this work. In response, the MPCA has developed a watershed monitoring strategy that promotes an effective and efficient integration of water monitoring activities. This monitoring provides a more comprehensive assessment of water quality and expedites the restoration and protection process. The monitoring strategy goal is to assess the condition of Minnesota's surface waters via a 10-year cycle while providing an opportunity to more fully integrate MPCA water resource management efforts in cooperation with local government and stakeholders. This ultimately allows for coordinated development and implementation of water quality restoration and improvement projects.

The rationale behind the watershed monitoring approach is to intensively monitor the streams and lakes within a major watershed to identify impaired waters and to identify waters in need of additional protection efforts. The watershed approach provides the opportunity to address most, if not all, of the impairments through a coordinated TMDL process at the watershed scale, rather than the reach by reach and parameter by parameter approach historically employed. The watershed approach was initiated in the Sauk River Watershed in the summer of 2008. This report provides a summary of all water quality assessment results in the Sauk River watershed and incorporates all data available for the assessment process including watershed monitoring by volunteers monitoring and local government units including the Sauk River Watershed District.

II. 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 81 major watersheds (Figure 1). The primary feature of the watershed approach is that it provides a unifying focus on the water resources within a watershed as the starting point for water quality assessment, planning, and result measures. 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 and protection strategies. The following descriptions provide details on each of the four principal monitoring components of the watershed approach. For additional information see: *Watershed Approach to Condition Monitoring and Assessment* (MPCA 2008a) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Figure 1. Major watersheds within Minnesota (8-Digit HUC)



Load monitoring network

The Major Watershed Load Monitoring Program (MWLMP) is designed to measure and compare regional differences and long-term trends in water quality of Minnesota's major rivers. Initiated in 2007 and funded by Minnesota's Clean Water Fund, the MWLMP's multi-agency monitoring approach combines stream flow data from the United States Geological Survey (USGS) and Minnesota Department of Natural Resources (DNR) flow gauging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations and MPCA staff to compute annual pollutant loads. When fully implemented, the MWLMP will monitor and compute pollutant loads at 82 stream sites across Minnesota.

Pollutant sources affecting rivers can be quite variable from one watershed to the next depending on land use, climate, soils, slopes and other factors. Elevated levels of total suspended solids (TSS) and nitrate plus nitrite-nitrogen (nitrate-N) are generally regarded as "non-point" source derived pollutants originating from many smaller diffuse sources such as agricultural or urban runoff, or air deposition. Excess total phosphorus and dissolved orthophosphate can be attributed to natural, "non-point", and "point" or end of pipe sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

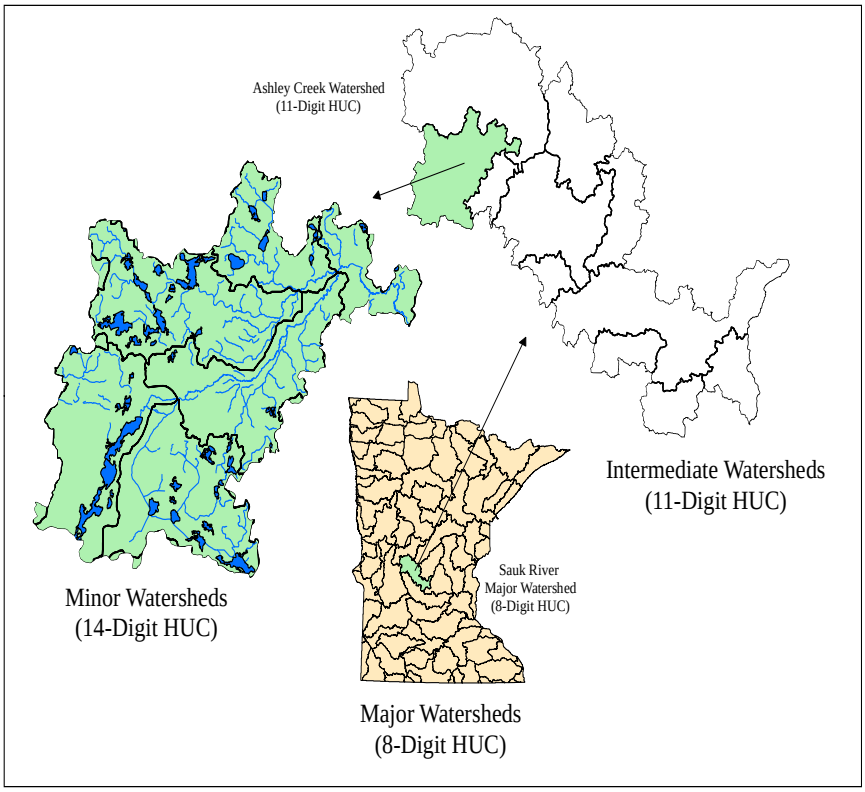
Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as: canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations will typically be much higher during rain events prior to canopy development rather than after post-canopy events where less surface runoff and more foliage interception and soil infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, groundwater and drain tile flow. These pathways influence the type and levels of pollutants transported in runoff.

In addition to providing comparative and trend information, data that is collected and generated by the MWLMP will also be used to assist in developing Total Maximum Daily Load (TMDL) for watershed models as well as watershed protection and restoration plans. It will also be used to put the intensive watershed monitoring data into a longer-term context.

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale (Figure 2). The foundation of this comprehensive approach is the 81 major watersheds within Minnesota. Sampling occurs in each major watershed once every 10 years. In this approach, intermediate-sized (approx. 11-digit HUC) and "minor" (14-digit HUC) watersheds are sampled along with the major watershed outlet to provide a complete assessment of water quality. Monitoring sites are selected at or near a road crossing closest to the outlet or "pour point" of each stream. This approach provides an assessment of conditions of rivers and streams at multiple scales within each watershed without monitoring every single stream reach.

Figure 2. The intensive watershed monitoring design



The outlet of the major watershed (8 digit HUC) is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use-support. Each intermediate watershed (11 digit HUC) pour point is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use-support. Watersheds at this scale generally consist of major tributary streams with drainage areas ranging from 75 to 150 square miles. Lastly, most minor watersheds (14 digit HUC) (typically 10-20 square miles) are sampled for biology to assess for aquatic life use-support. Chemistry monitoring is performed by MPCA staff and by local partners funded by Surface Water Assessment Grants (SWAGs) while biological monitoring is performed by MPCA staff.

The second step of the intensive watershed monitoring effort consists of follow-up monitoring at all intermediate watersheds determined to have impaired waters. This follow-up monitoring is designed to collect the information needed to initiate the stressor identification process in order to identify the source(s) and cause(s) of impairment that is required for TMDL development and implementation.

Lake monitoring

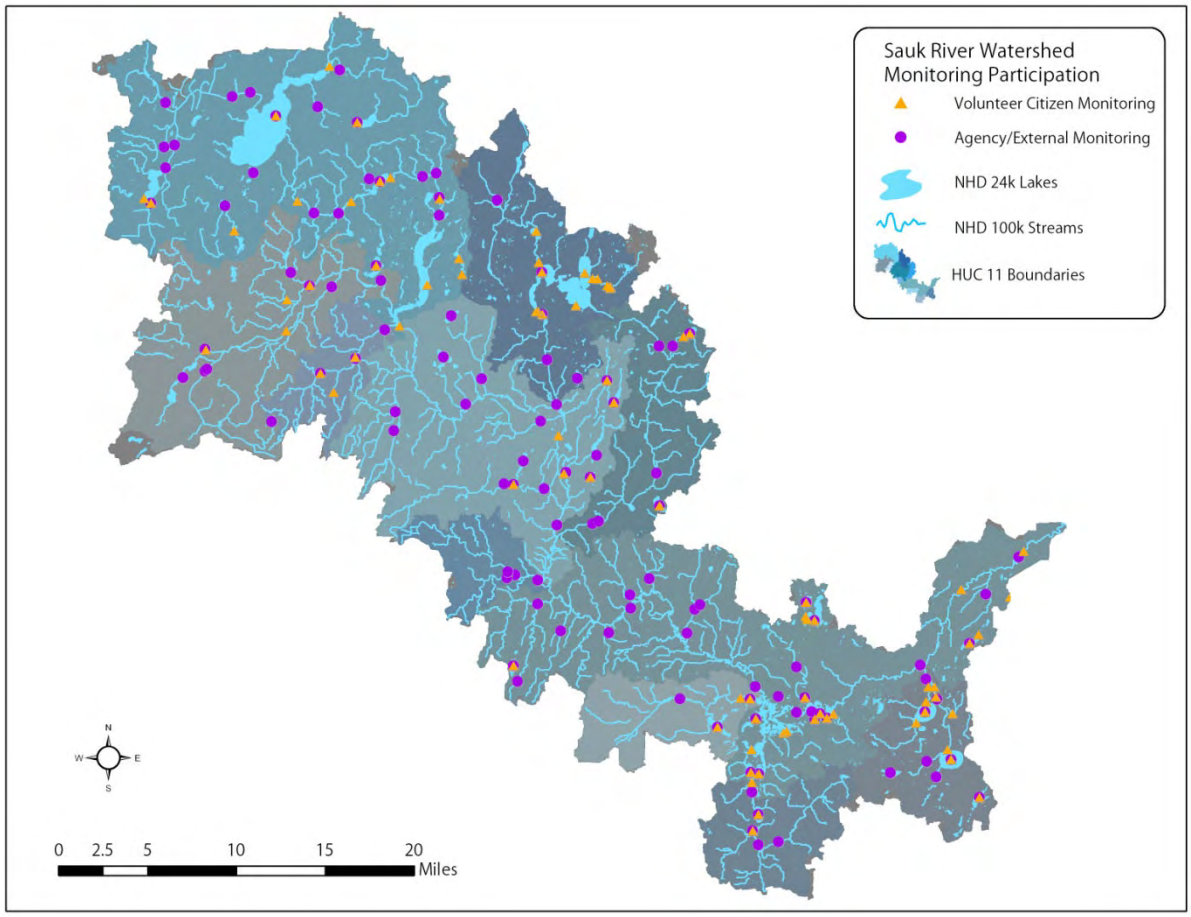
The MPCA conducts and supports lake monitoring for a variety of objectives. Lake condition monitoring activities are focused on assessing the recreational use-support of lakes and identifying trends over time. The MPCA also assesses lakes for aquatic consumption use-support, based on fish-tissue and water-column concentrations of toxic pollutants. Lake monitoring was added to the watershed monitoring framework in 2009, so while there is some data available, not all of the lakes in the Sauk River Watershed currently have enough information for assessment. The MPCA conducts its own lake monitoring and also funds monitoring by local groups such as counties, SWCDs, watershed districts, nonprofits and educational institutions via SWAGs. Many SWAG grantees invite citizen participation in their monitoring projects. These local partners and citizens greatly expand MPCA's overall capacity to conduct lake monitoring.

Even when pooling MPCA and local resources, we are not able to monitor all lakes in Minnesota.

The primary focus of MPCA monitoring is lakes $\geq$500 acres in size ("large lakes"). These resources typically have public access points; they generally provide the greatest aquatic recreational opportunity to Minnesota's citizens; and these lakes collectively represent 72 percent of the total lake area (greater than 10 acres) within Minnesota. Though our primary focus is on monitoring and assessing larger lakes, we are also committed to directly monitoring, or supporting the monitoring of small lakes between 100-499 acres for assessment purposes.

The annual SWAG Request for proposals identifies the major watersheds that are scheduled for upcoming intensive monitoring and small lakes that have not been assessed. SWAG grantees conduct detailed sampling efforts following the same established monitoring protocols and quality assurance procedures used by the MPCA. All of the lake and stream monitoring data from SWAG projects are combined with the MPCA's monitoring data to assess the condition of Minnesota lakes and streams.

Figure 3. Citizen, local and MPCA lake and stream monitoring locations in the Sauk River Watershed



Citizen and local monitoring

Citizen monitoring is an important component of the watershed monitoring approach. The MPCA coordinates two programs aimed at encouraging citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network has been established at watershed pour points, sustained citizen monitoring can provide the long-term picture needed to help evaluate current status and trends. The advance identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites, so that water quality data are available for the years before and after the intensive monitoring effort. This citizen-collected data helps agency staff interpret the results from the intensive monitoring effort, which only occurs once every ten years. It also allows interested parties to track any water quality changes that occur in the years between the intensive monitoring events. Coordinating with volunteers to focus monitoring efforts where it will be most effective for Clean Water Legacy planning and tracking purposes helps local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change. Figure 3 provides an illustration of the locations where citizen monitoring data are being used for assessment in the Sauk River Watershed.

III. Assessment Methodology

The Clean Water Act 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. 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 methodology 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).

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by Minnesota Water Quality Standards (Minnesota Rules Chapter 7050 2008) (https://www.revisor.leg.state.mn.us/rules/?id=7050). 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. Protection of aquatic life means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms, including fish and invertebrates. Protection of recreation means the maintenance of conditions suitable for swimming and other forms of water recreation. Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this use.

Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Ideally, if the standard is not exceeded, the use will be protected. However, nature is very complex and variable therefore the MPCA uses a variety of tools to fully assess designated uses. Assessment methodologies often differ by parameter and designated use. Furthermore, pollutant concentrations may be expressed in different ways such as chronic value, maximum value, final acute value, magnitude, duration and frequency.

Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses. Interpretations of narrative criteria for aquatic life support in streams are based on multi-metric biological indices including the Fish Index of Biological Integrity (F-IBI), which evaluates the health of the fish community, and the Macroinvertebrate Index of Biological Integrity (M-IBI), which evaluates the health of the aquatic invertebrate community. Biological monitoring is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of pollutants and stressors over time.

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 reach may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minnesota Rules, Chapter 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 reach is identified by a unique waterbody identifier (known as its AUID), comprised of the USGS eight digit hydrologic unit code plus a three character code that is unique within each HUC. Lake and wetland identifiers are assigned by the MDNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs, and wetlands. These identification numbers serve as the AUID 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 status

Conceptually, the process for determining use attainment status of a waterbody is similar for each designated use: comparison of monitoring data to established water quality standards. However, the complexity of that process and the amount of information required to make accurate assessments varies between uses. In part, the level of complexity in the assessment process depends on the strength of the dose-response relationship; i.e., if chemical B exceeds water quality criterion X, how often is beneficial use Y truly not being attained. For beneficial uses related to human health, such as drinking water, the relationship is well understood and thus the assessment process is a relatively simple interpretation of 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 in the Sauk River watershed is outlined below and in Figure 4.

The first step in the aquatic life assessment process is a comparison of the monitoring data to standards. This is largely an automated process performed by logic programmed into a database application and the results are referred to as ‘Pre-Assessments’. 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 attenuating circumstances that should be considered (e.g., flow, time/date of data collection, 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 2012) for the guidelines and factors to consider when making such determinations.

Any new impairment determination (i.e., waterbody not attaining its beneficial use) is reviewed using GIS to determine if greater than 50 percent of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use framework. For additional information see: Tiered Aquatic Life Use (TALU) Framework (http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/the-tiered-aquatic-life-use-talu framework.html?menuid=&redirect=1). The last step in the assessment processis the Professional Judgement Group or PJG 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 have a vested interest in the outcomes of the assessment process. Information obtained during this meeting may be used to revise previous use attainment decisions. The result of this meeting is a compilation of the assessed waters which will be included in the watershed assessment report. 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.

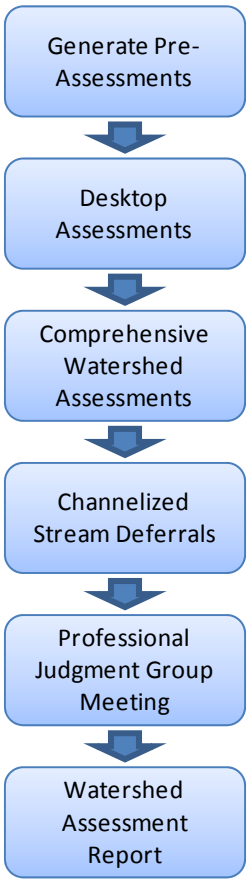
Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local government and volunteers. The data must meet rigorous quality-assurance protocols before being used. The MPCA stores surface monitoring data in USEPA's STORET system and all monitoring data required or paid for by MPCA is entered into EQuIS, MPCA's front end data portal to STORET. Projects funded by MPCA include Clean Water Act 319 projects, Clean Water Partnership (CWP) projects, SWAG projects and more recently, TMDL projects. Many local projects not funded by MPCA choose to submit their data to the MPCA in STORET-ready format so that it may be utilized in the assessment process. Prior to each biennial assessment cycle, the MPCA publishes a "Call for Data" in the State Register and contacts partner organizations directly to request their monitoring data.

Period of record

The MPCA uses data collected over the most recent 10 year period for all water quality assessments. Generally, the most recent data from the 10-year assessment period is reviewed first when assessing toxic pollutants, eutrophication and fish contaminants. Also, the more recent data for all pollutant categories may be given more weight during the comprehensive watershed assessment or professional judgment group meetings. The goal is to use data from the 10 year period that best represents the current water quality conditions. Using data over a 10 year period provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data for the entire period is not required to make an assessment.

Figure 4. Flowchart of aquatic life use assessment process



IV. Watershed Overview

From its source at Lake Osakis, the Sauk River travels southeast 90 miles to its confluence with the Mississippi River in St. Cloud, draining 1042.5 square miles. The watershed encompasses portions of Todd, Douglas and Meeker Counties but predominately occupies a significant area of Stearns County

Figure 5). The Sauk River Watershed lies in the central portion of Minnesota's North Central Hardwood Forest (NCHF) Ecoregion (Omernik, 1988). The NCHF is dominated by glacial sediments deposited by the Des Moines Lobe of the Wisconsin Glaciation approximately 12,000 years ago. Glacial till and drift dominate the landscape with outwash deposits in much of the river valley (Figure 6). Soils are classified as Mollisols and Alfisols. Outwash deposits are predominately sand and gravel. Till and drift contain high clay and silt fractions.

Figure 5. The Sauk River Watershed within the North Central hardwoods forest ecoregion of central Minnesota

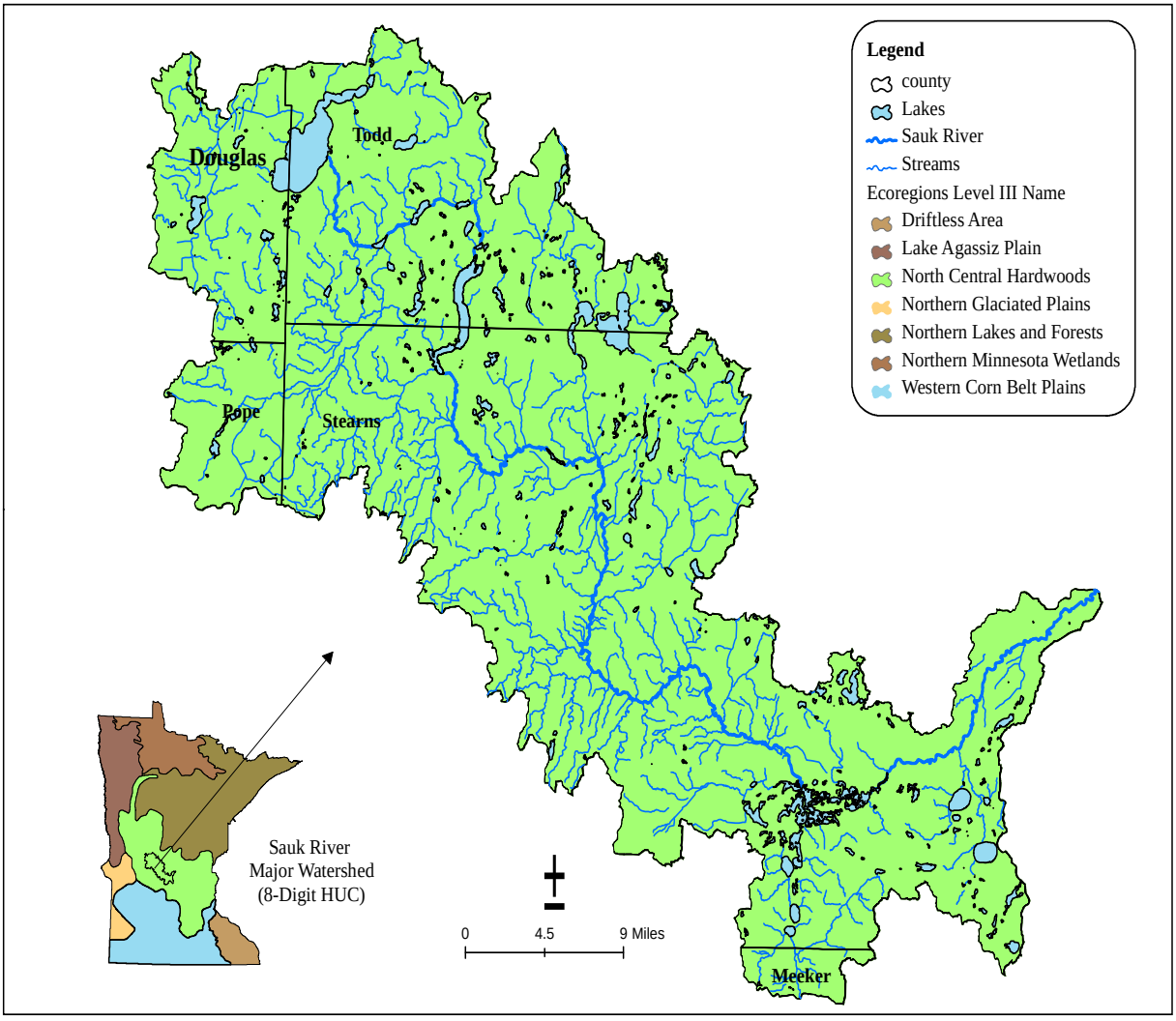
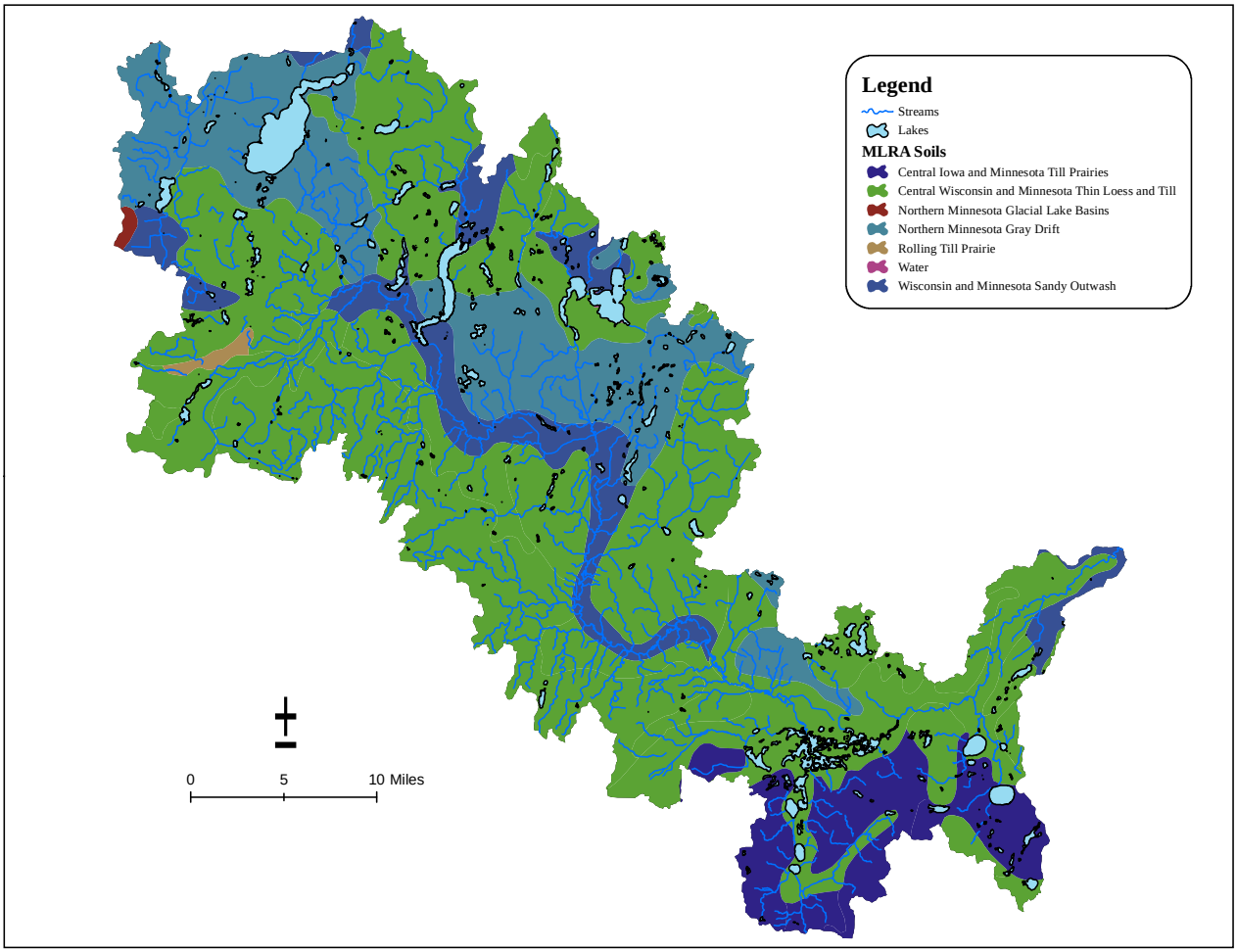


Figure 6. Glacial deposits in the Sauk River Watershed



Land use summary

Throughout the western two thirds of the watershed the Sauk River divides part of the major transition from prairie to hardwood forests in central Minnesota. Many of the Sauk River's tributaries emerge from wetlands and lakes. The river's riparian zones remain intact on many stretches of the Sauk River and range from patches of riverine forests to cattail marshes and groves of hardwood forest (MNDNR 2010).

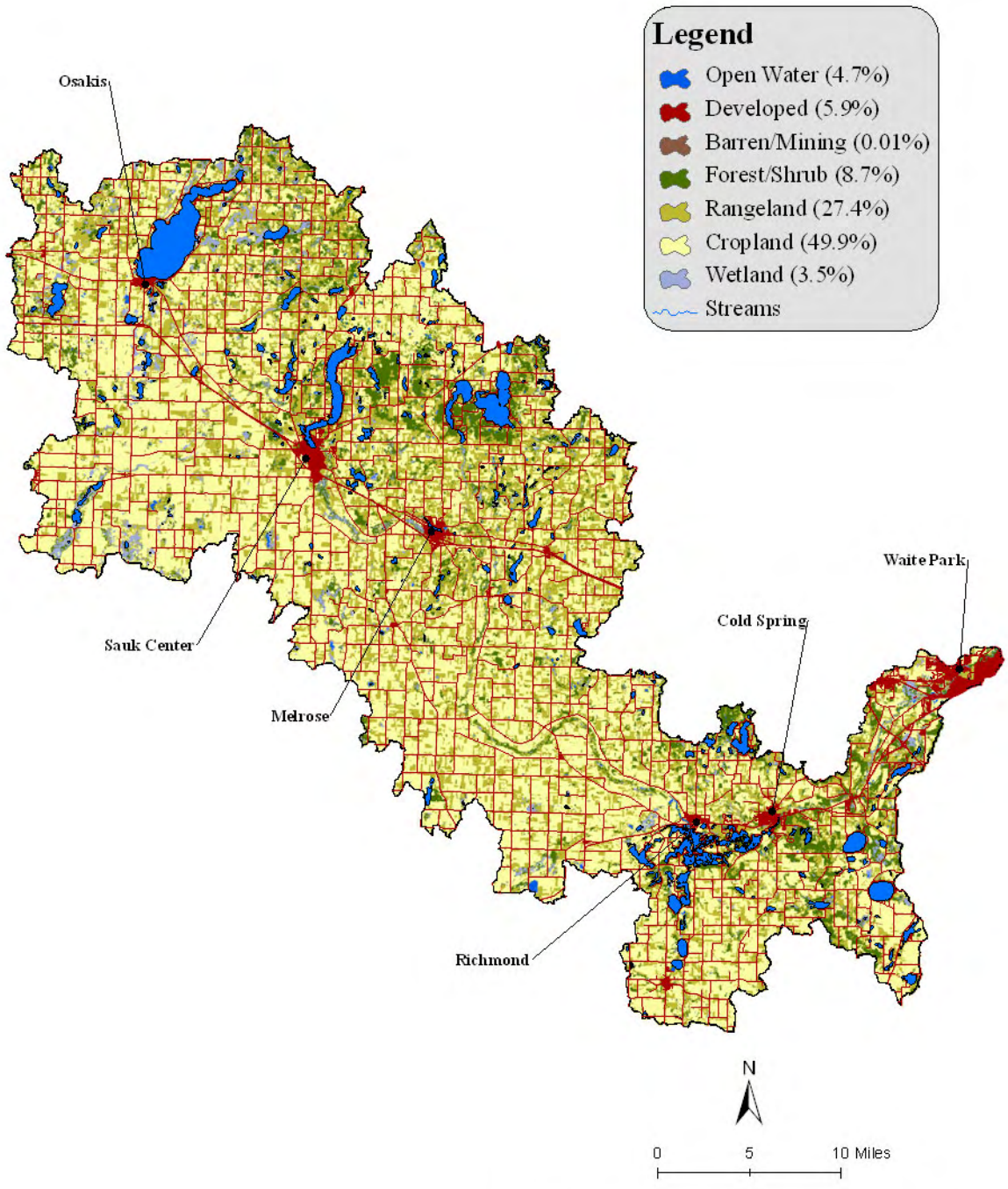
Prior to western settlement, tall grasslands, prairie potholes and scattered oak savanna extended over much of the southwestern portion of the watershed. The Sauk River served as a natural fire break, allowing for an extensive oak savanna and closed canopy hardwood forest to burgeon on the Sauk River's eastern shores (MNDNR 2010). Western expansion came to the Sauk River in the late 1850s; the agriculture, logging and granite industry flourished. "The Sauk River provided a corridor for the passage of wood to the rapidly developing St. Cloud area" (MNDNR 2010). In thirty years, half of all arable farmland in the watershed had been tilled; in 1900 the rate increased twenty five percent (Olsen, 2002). The draining of area wetlands and straightening of Sauk River tributaries occurred shortly thereafter allowing for nearly all remaining arable land to be employed in agricultural production by 1920 (Nelson, 2010 and Olsen, 2002).

Today land cover in the watershed is distributed as follows: 49.9 percent cropland, 27.4 percent rangeland, 8.7 percent forest/shrub, 5.9 percent developed, 4.7 percent open water, 3.5 percent wetland and 0.01 percent barren/mining (Figure 7).

Ninety seven percent of the watershed's acreage is privately owned. Farmland stretches over the countryside, comprising more than 77 percent of the watershed's landscape. Sixty-five percent of agricultural producers in the Sauk earn their living entirely off the land. Area farms range in size from the small family farm to operations exceeding 1000 acres in size; 86 percent are less than 500 acres in size (NRCS, 2007). In 2007, Stearns County was the state leader in dairy production, ranked second in poultry and egg sales and third in beef sales (USDA 2007). Four thousand one hundred fifty nine permitted feedlots are present in the watershed. Cropland is predominately planted in corn, soybeans and forage crops for livestock (USDA 2007).

57,092 people reside within the Sauk River Watershed; equating to roughly six people per square mile. The largest population centers are located along the I-94 corridor (dividing the watershed in two from the NW to the SE), including the western St. Cloud metropolitan area and the communities of St. Joseph, Sauk Centre, Osakis and Melrose. On State Hwy 23, the small communities of Richmond and Cold Spring serve as gateway communities for recreational opportunities on the Sauk River's Horseshoe Chain of Lakes.

Figure 7. Landuse in the Sauk River Watershed



Source of landuse: National Land-Cover Dataset (2001)

Surface water hydrology

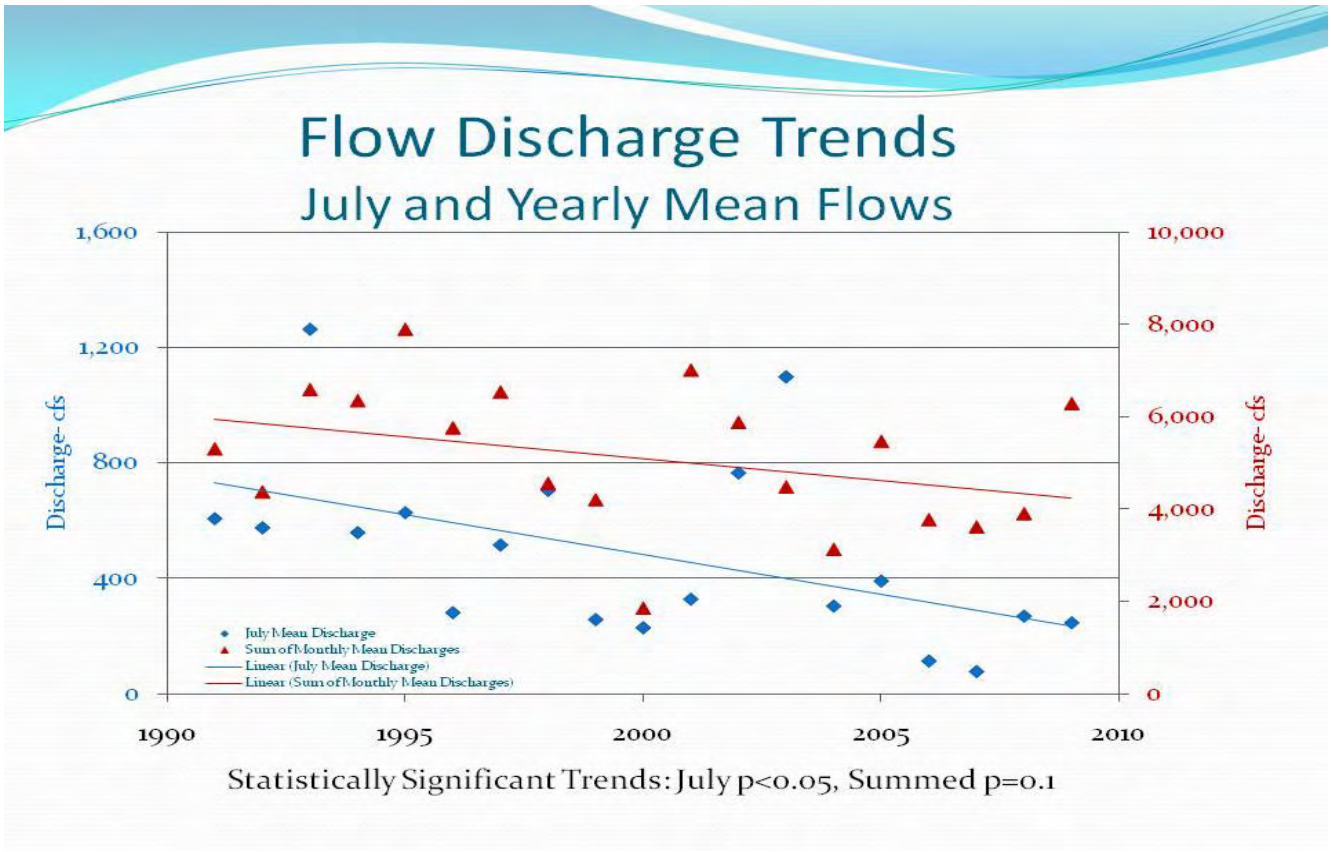
The Sauk River originates from the outlet of Lake Osakis in the southeastern corner of Todd County and continues its course flowing across Stearns County. Gradually meandering in a southeasterly direction, the river traverses the communities of Sauk Centre and Melrose before merging with the Sauk Horseshoe Chain of Lakes in Richmond. In Cold Spring, the river turns northeast passing through the western metropolitan edge of St. Cloud and discharges into the Mississippi River just upstream of Sauk Rapids. Throughout its course, the river drops 340 feet with an overall mean gradient of 3.4 feet per mile (Waters, 1977).

Several impoundments restrict the natural flow of river. Historically, dams in the watershed were constructed for timber milling and power generation; some, including the Cold Spring Dam, have stood for more than 150 years. Today, most dams serve to maintain stable water levels on the river; two of the largest are located in Sauk Centre and Melrose. Several remnants of low-head dams also persist, creating many of the riverine lakes observed in the Sauk River Watershed.

The watershed is lake-rich, holding 370 established lakes greater than 10 acres in size. Several major tributaries feed into the Sauk including Ashley, Hoboken, Adley, Getchell, Stony, Kolling and Mill Creeks. The Sauk's 11 HUC-11 subwatersheds are comprised of 77 minor watersheds.

Data from USGS stream gauging station 05270500, located on the Sauk River near St. Cloud, shows a decreasing trend in summer discharge, ($p = 0.1$); while July average flows have a decreasing flow trend, $p < 0.05$ (Figure 8). The summer flow statistics in the Sauk River Watershed are similar to the declining summer flow pattern observed for a majority of randomly selected rivers from across the state, as analyzed by the groundwater – surface water interaction team. Given the flat precipitation trend over the same period (Figure 10), this raises the possibility of a groundwater-surface water interaction similar to that observed at Little Rock Creek and the North Fork Crow River.

Figure 8. Flow discharge trends in the Sauk River: July



Climate and precipitation

Precipitation is the source of almost all water inputs to a watershed. Precipitation in the watershed ranges from 25 to 29 inches each year. Evaporation estimates are between 36 to 37 inches annually (Minnesota State Climatologists Office, 1999). The Oct. 2007-Sept. 2008 water year precipitation summary shows conditions were near normal to slightly drier than normal (Figure 9).

Figure 9. State wide precipitation levels during the 2007 water year

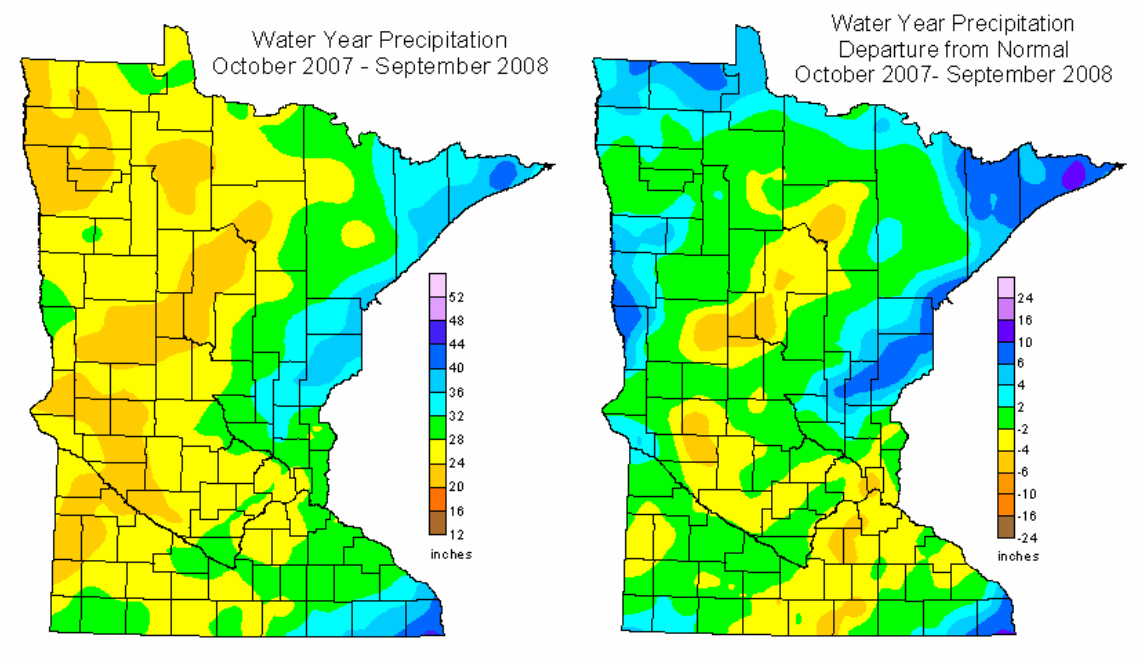
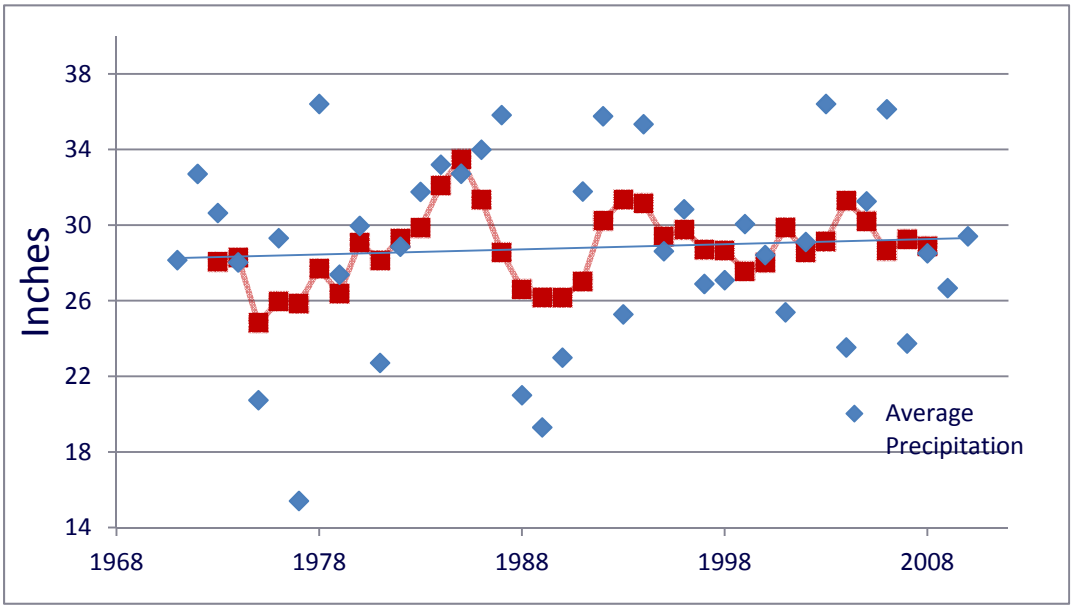


Figure 10 shows an areal average representation of precipitation in Central Minnesota. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center Link: http://www.wrcc.dri.edu/spi/divplot1map.html. Rainfall in the Central region has a statistically insignificant rising trend over the last 40 years. This contrasts with a state-wide spatial average showing a statistically significant rising trend. Though rainfall can vary in intensity and time of year, it appears that precipitation has not changed dramatically over the past 40 years in this area.

Figure 10. Precipitation trends in central Minnesota: average precipitation with five year running average (red line)

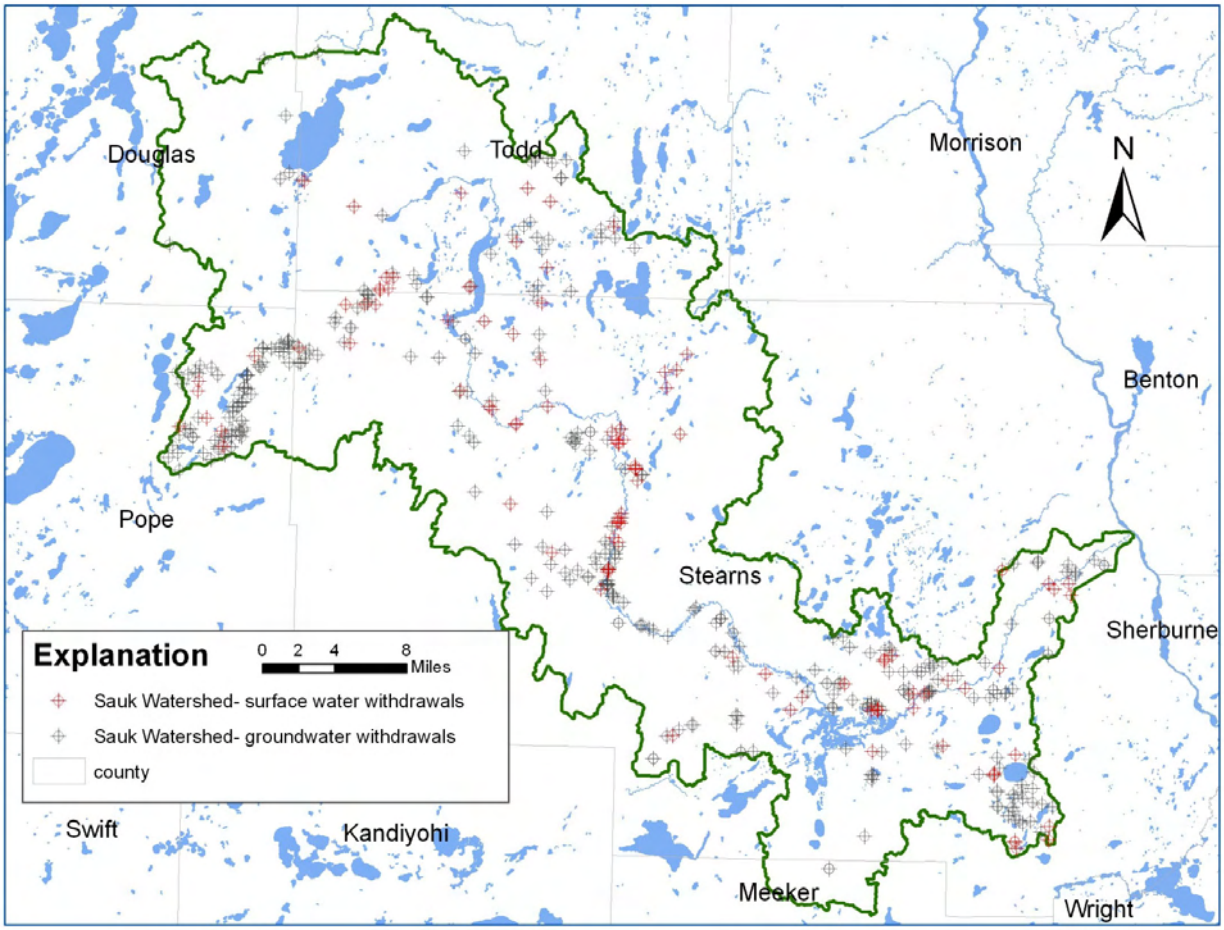


Surficial and groundwater withdrawals

Currently the Minnesota Department of Natural Resources (MNDNR) permits 377 groundwater withdrawals and 104 surface water withdrawals in the Sauk River Watershed. The Department of Natural Resources permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or one million gallons/year. Permit holders are required to track water use and report back to the DNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html.

Figure 11 shows the distribution of water withdrawals in the watershed. Groundwater withdrawals generally are found where: there are sufficient groundwater supplies to pump and where sandy soil allows for the necessary infiltration of the water. Surficial aquifers meet both requirements, and as a result are often intensively farmed.

Figure 11. Groundwater withdrawals in the Sauk River Watershed

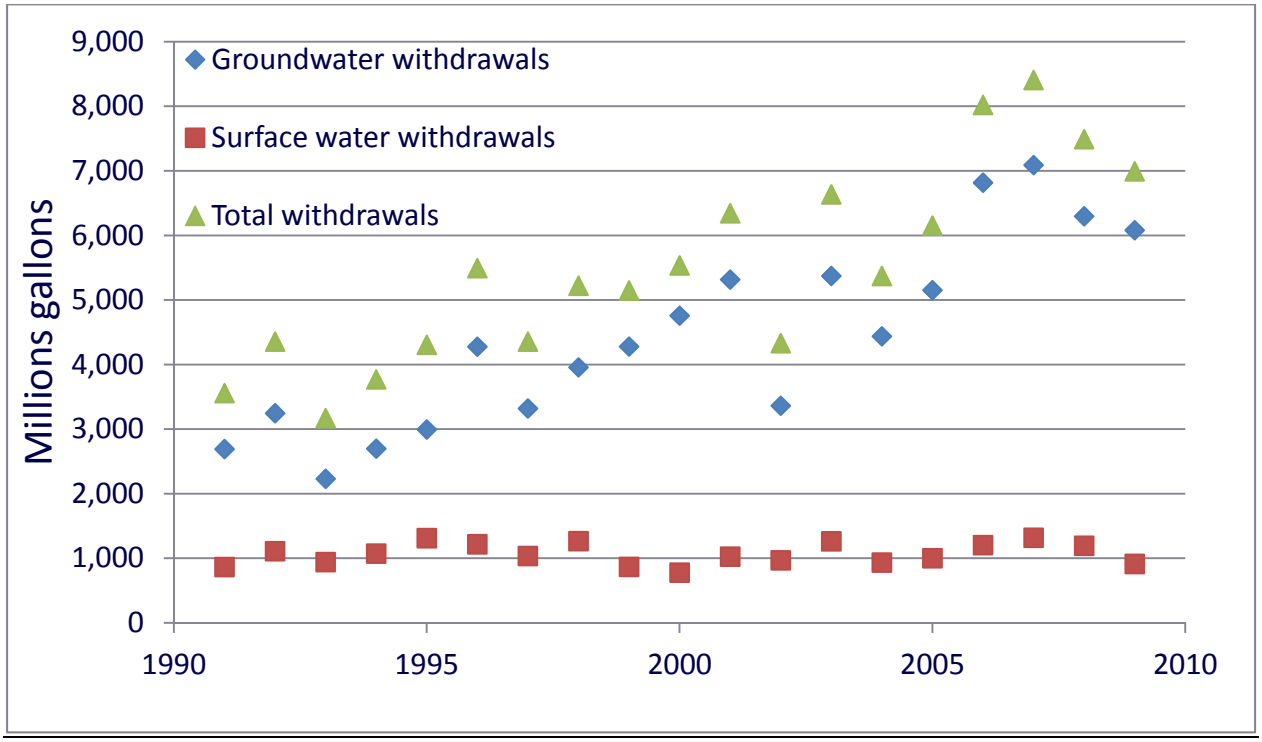


Combining surface water and groundwater withdrawals together (Figure 12) produces a statistically significant (P= 0.001) increasing trend in water withdrawals in the area around the Sauk River Watershed. This completes the same pattern seen at Little Rock Creek and North Fork of the Crow River: rising (if not statistically significant) regional precipitation trend, statistically significant decreasing summer flow trends and statistically significant increasing water withdrawal trends.

Based on the priority system set up for groundwater investigations of watersheds, the Sauk River Watershed is given a high probability of exhibiting significant groundwater-surface water interactions and should therefore be considered as a candidate for further investigation.

Additional information concerning surficial geological information for the Sauk River Watershed can be found in the Stearns County Geologic Atlas: http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/steacga.html.

Figure 12. Flow discharge trends for July and annual totals in the Sauk River Watershed



V. Watershed-Wide Data Collection Methodology

Load monitoring

A load monitoring station is located on the Sauk River in Sauk Rapids just upstream of its discharge into the Mississippi River. Intensive water quality sampling occurs year round at this site. Twenty to thirty-five grab samples are collected per site per year with sampling frequency greatest during periods of moderate to high flow. Frequent sampling during major runoff events is required to capture the largest pollutant loads and to accurately characterize shifting concentration/flow dynamics. Low flow periods are also sampled and are well represented. This biased sampling methodology generally results in samples being well distributed over the entire range of flows.

Water chemistry and discharge data are input into the "Flux32" load estimation program to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs include: annual pollutant loads, defined as the amount (mass) of a pollutant passing a stream location over a defined period of time, and flow weighted mean concentrations (FWMC's). Flow weighted means concentrations are computed by dividing the pollutant load by the total seasonal flow volume. Annual pollutant loads and flow weighted means are calculated for total suspended solids (TSS), total phosphorus (TP), orthophosphate (OP), Total Kjeldahl Nitrogen (TKN) and nitrate plus nitrite nitrogen (nitrate-N).

Stream water sampling

Nine water chemistry stations were sampled from May thru September in 2008 and again June thru August of 2009 to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards in the 11 HUC subwatersheds (green circles and triangles in Figure 13). A Surface Water Assessment Grant (SWAG) was awarded to the Sauk River Watershed District to complete the monitoring. Following the IWM design, sampling locations were established near the pour points of the intermediate 11-HUC watersheds. The Sauk River Watershed district has actively sampled the watershed for nearly 25 years and as such has compiled an extensive data set; the additional data collected for this project filled in existing data gaps needed for a complete watershed assessment. Due to the small drainage area of the Hoboken and Stony Creek subwatersheds (11-HUC) intensive chemistry collection stations were not placed at their pour points. Instead, the MPCA will assess the condition of these small watersheds using existing data collected by the SRWD. See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study.

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Sauk River Watershed was completed during the summer of 2008. A total of 54 sites were established across the watershed and sampled. These sites were located near the pour points of most minor HUC-14 watersheds, selected following the sampling design. In addition, four existing biological monitoring stations within the watershed were revisited in 2008. These monitoring stations were initially established as part of a random Upper Mississippi River Basin wide survey in 2000 or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last ten years contributed to the watershed assessments, the majority of data utilized for the 2010 assessment was collected in 2008. A total of 51 AUIDs were sampled for biology in the Sauk River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 23 AUID's. Waterbody assessments were not conducted for 26AUID's because criteria for channelized (26 AUIDs) and coldwater streams had not been developed prior to the assessments (two AUIDs). Nonetheless, the 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 the biological communities at each biological monitoring station an Index of Biological Integrity (IBI) was used, specifically the Fish Index of Biological Integrity (F-IBI) and the Macroinvertebrate Index of Biological Integrity (M-IBI). A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure. For both the F-IBI and the M-IBI, Minnesota's streams and rivers were divided into seven distinct classes, with each class having its own unique IBI. The classification factors used to produce the seven classes were drainage area, gradient, water temperature and geographic region of the state. Fish and macroinvertebrate communities occurring at sites within each class are more similar to each other than those occurring in other classes. These classification factors are unaffected by human disturbance to ensure that the framework reflects natural variability and that the resulting IBI's reflect human-induced impacts to the waterbody. IBI development was stratified by class, with a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals identified for each. IBI scores higher than the impairment threshold indicate that the stream reach supports its aquatic life use, contrarily; scores below the impairment threshold indicate that the stream reach does not support its aquatic life use. Confidence limits around the impairment threshold help to ascertain where additional information may

be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, land use activities, etc. For individual biological monitoring station IBI scores, thresholds and confidence intervals for all biological monitoring sites within the watershed refer to Appendix 4.

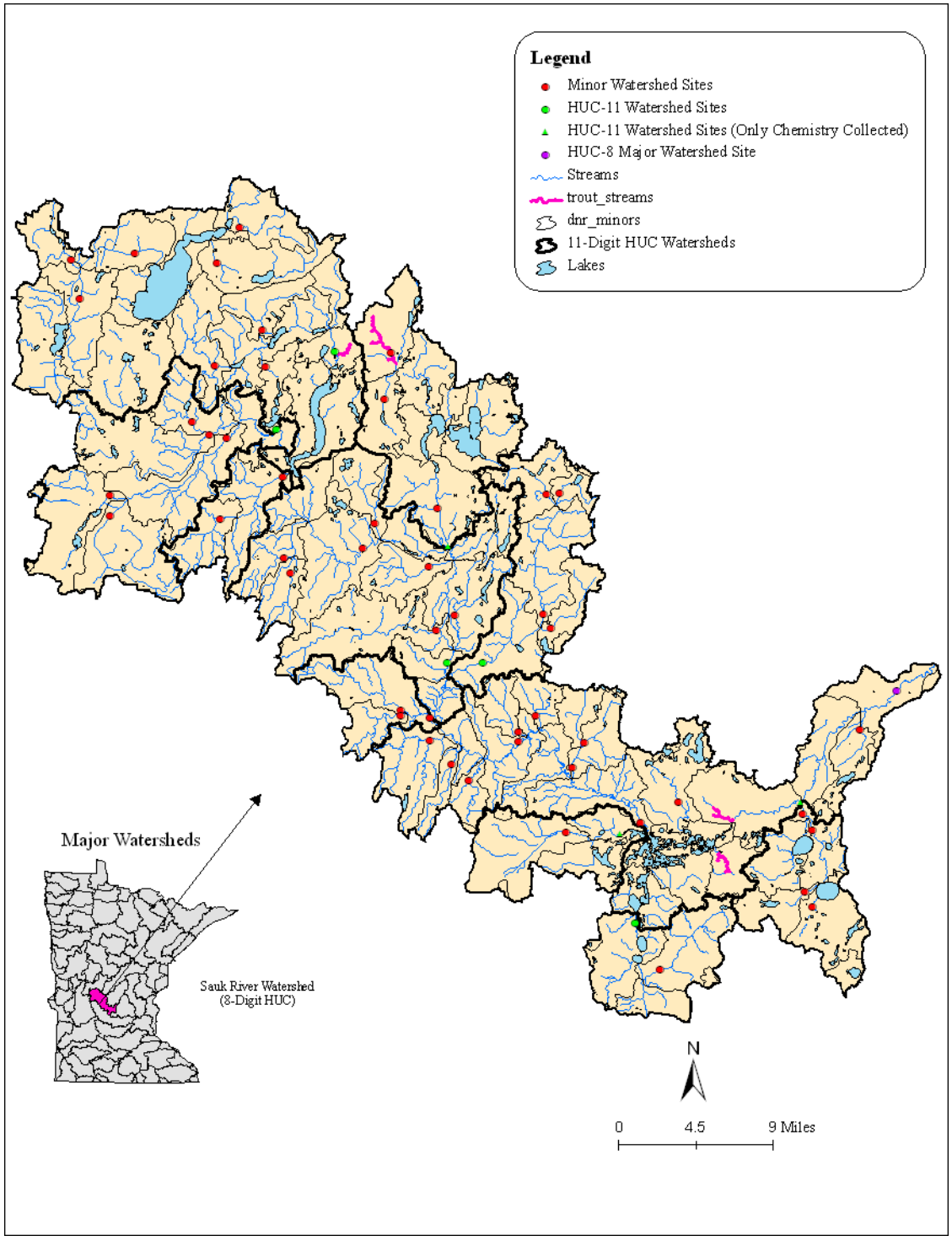
Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Sauk River in 1995, 2006 and 2008. Since 1991, mercury samples from fish were collected in 10 lakes within the Sauk River watershed. PCBs were tested in the Sauk River, below the Cold Spring dam and in six lakes within the watershed. Common carp, smallmouth bass, walleye and white sucker were collected in rivers by the MPCA biomonitoring unit and a wide array of game and rough fish were collected in lakes by the MDNR. Captured fish were wrapped in aluminum foil and frozen until they were thawed prior to being scaled, filleted and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue.

Prior to 2006, mercury fish tissue concentrations were assessed for water quality impairment based on the Minnesota Department of Health's fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if ten percent of the fish samples (measured as the 90^{th} percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples are required per species to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters Inventory includes waterways that were assessed as impaired prior to 2006 as well as more recently.

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These studies identified that high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. This implied that it was not necessary to continue widespread frequent monitoring of smaller river systems as is done with mercury. Impairment assessment for PCBs in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs, the MPCA considers the lake or river impaired. The threshold concentration for impairment is 0.22 mg/kg PCBs and more restrictive advice is recommended for consumption (one meal per month).

Figure 13. Intensive watershed monitoring stations in the Sauk River Watershed



Lake water sampling

Lakes were not targeted during the Intensive Watershed Monitoring efforts that took place in 2008 and 2009. However, extensive monitoring of lakes has occurred in the Sauk River watershed in the past. Some areas such as the Horseshoe Chain of Lakes (Sauk River Chain of Lakes) have a particularly robust monitoring history. Lake water chemistry and Secchi data used in this report was taken from the MPCA's STORET database. This data was collected by both MPCA staff and local partners including: Stearns County Soil and Water Conservation District, Sauk River Watershed District, MPCA and CLMP volunteers. Volunteers enrolled in the MPCA's Citizens Lake Monitoring Program (CLMP) have completed a majority of the lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a ten year period for Phosphorus, Chlorophyll-a and Secchi depth.

VI. Individual Watershed Results

HUC-11 watershed units

Assessment results are presented for each HUC-11 watershed unit within the Sauk River Watershed, enabling the assessment of all surface waters at one time and the ability to develop comprehensive TMDL studies on a watershed wide basis rather than the reach by reach and parameter by parameter approach that has been historically employed. This scale provides a robust assessment of water quality condition in the 11-digit watershed unit and is a practical size for the development and implementation of effective TMDLs and protection strategies. The primary objective of this monitoring strategy is to portray all the impairments within a watershed resulting from the complex and multi-step assessment and listing process. The graphics presented for each of the HUC-11 watershed units contain the assessment results from the most recent 2011 assessment cycle as well as any impairment listings carried forward from previous assessment cycles. Discussion of assessment results will focus primarily on the 2008 intensive watershed monitoring effort but will also consider all available data from the last ten years.

Given all of the potential sources of data and differing assessment methodologies for assessing indicators and designated uses it is not feasible to provide results or summary tables for every monitoring station by parameter. However, in the proceeding pages an individual account of each 11 HUC subwatershed is provided. Within each account, readers are given a brief description of the subwatershed, a stream assessment table where an overall assessment result is provided for each AUID by each assessable parameter and designated use (i.e. aquatic life and aquatic recreation), a non assessed channelized AUID table describing the quality of these AUIDs, a stream habitat results table, a pour point water chemistry results table, a table describing lake water chemistry, and a narrative summary relating the unique components of the assessment and highlighting interesting findings in the results.

Stream assessment

This table provides a summary of all assessable AUIDs by parameter within the watershed (where sufficient information was available to make an assessment). The tables denote the use support status of each individual water chemistry and biological parameter, as well as an overall use support

assessment for aquatic life and aquatic recreation for each assessable AUID. The assessment for aquatic life is derived from analyzing biological data, DO, turbidity, chloride, pH and NH3 to determine use status, while the assessment for aquatic recreation in streams is solely based on E. coli concentrations. Immediately following the AUID specific use support results, the location of any assessed biological monitoring sites are listed. Water chemistry station locations are not provided because information collected at specific locations within each AUID are combined for the purposes of conducting waterbody assessments. Some AUIDs within the subwatershed do not have sufficient information for assessment and are not included in this table. Following the stream assessment table is a table describing a narrative biological condition of stations that could not be assessed due to their occurrence on channelized AUIDs and is not an assessment for aquatic life for these systems. For more information regarding chemistry parameters monitored in these studies refer to Appendix 1. A complete listing of all AUIDs within the watershed may be found in Appendix 3.

Stream habitat results

These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) surveys that are conducted during each fish sampling visit. The MSHA provides information on available fish habitat, land use and buffers along the immediate site reach, providing clues for impacts such as siltation or eutrophication which may lead to unhealthy fish and macroinvertebrate communities. The MSHA score is comprised of numerous scoring categories including land use, riparian zone, instream zone (substrate, embeddedness, cover types and amounts) and channel morphology (depth variability, sinuosity, stability, channel development, velocity), which are summed for a total possible score of 100 points. Total scores for each category and a summation of the total MSHA score are included with a narrative rating of good, fair or poor, indicating the overall condition of the 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 for each scoring category for that particular subwatershed.

Pour point water chemistry results

These summary tables display the water chemistry results for the intensive watershed station representing the pour point of the HUC-11 watershed. This data along with other data collected within the 10 year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed and includes those parameters most closely related to the standards or expectations used for determining the assessments (i.e. supporting aquatic life and aquatic recreational use). While not all of the water chemistry parameters of interest have developed water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of water quality parameters in streams that provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. For comparative purposes, water chemistry results for the Sauk River Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long term dataset of least impacted streams.

Lake water chemistry

These summary tables display lake water chemistry results for all lakes where assessment quality data is present. Basic morphometry data, trophic status, trophic status indicators, trend data (based on volunteer monitoring statistics) and the assessment status is provided where available. A complete listing of all lakes within the watershed including those without sufficient data for assessments may be found in the MPCA Sauk River Watershed Lakes Report: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/lakes/lake-water-quality/lake-water-quality.html.

Upper Sauk River Watershed Unit HUC 07010202010

The Upper Sauk River Watershed Unit is the largest subwatershed within the Sauk River system, draining 226 square miles and encompassing portions of Douglas, Todd and Stearns counties. The watershed begins as a series of channelized streams draining Smith Lake and the farmland West of Lake Osakis. The Sauk River's headwaters emerge at the mouth of the southeast outlet of the lake and continue northeast in a valley of rolling hills through a series of small lakes: Guernsey, Little Sauk, Juergens and Cedar, which are protected by an intact riparian zone. Downstream the river widens into Sauk Lake, a reservoir impounded by a 22 foot dam in Sauk Center. Ashley and Hoboken Creeks converge with the lake at its southwestern shore, upstream of the dam. Agricultural land use dominates the watershed, 41.6 percent is planted in crops while 29.1 percent is utilized as pasture. The pour point of the watershed unit is collocated with SRWD's station: Sauk River 1-6, located on the Sauk River upstream of Sauk Lake; it is represented by MPCA biological station 08UM039.

Stream assessment

Table 1. Aquatic life and recreation assessments on assessed AUIDs in the Upper Sauk 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-904 **Unnamed Creek** *Stevens Lk to Faille Lk*	--	--	--	**--**	**NS**	--	FS	--	--	**NA**	**FS**
07010202-552 ***Crooked Lake Ditch,*** *Unnamed Cr to Lk Osakis*	00UM072*	Upstream of C.R. 85, 4 mi. N. of Osakis	FS*	**NS***	NA	FS	FS	--	--	**NS***	**NS**
07010202-592 ***Unnamed Creek,*** *Headwaters to Sauk R*	00UM028	Upstream of CR 97 NW of Little Sauk	**NS**	FS	--	--	--	--	--	**NS**	NA
07012020-666 ***Trib. to Little Sauk Lake,*** *Unnamed Cr to Sauk Lk*	08UM041	Upstream of CR 4, 7 mi. E of Osakis	**NS**	**NS**	--	--	--	--	--	**NS**	NA
07012020-667 ***Sauk River,*** *Headwaters to Guernsey Lk*	08UM040	Upstream of 151st Ave, 4 mi. SE of Osakis	FS	FS	FS	FS	FS	FS	FS	**FS**	IF
07010202-669 ***Sauk River,*** *Guernsey Lk to Little Sauk Lk*			--	--	IF	FS	FS	FS	FS	**FS**	**FS**
07010202-671 ***Sauk River,*** *Little Sauk Lk to Juergens Lk*			--	--	IF	FS	FS	FS	FS	**FS**	**FS**
07010202-673 ***Sauk River,*** *Juergens Lk to Sauk Lk*	08UM039	Upstream of Cedar Lake Rd, 7 mi. N of Sauk Centre	**NS**	FS	**NS**	FS	FS	FS	FS	**NS**	**FS**

Abbreviations:

F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

* Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized streams until after the adoption of Tiered Aquatic Life Uses, see Appendix 4.2 for thresholds for the Upper Mississippi Basin IBI.

Table 2. Non-assessed biological stations on channelized AUIDs in the Upper Sauk 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
AUID not assigned **Trib. to Fairfield Creek** **Headwaters of Fairfield Cr**	99UM054	4.5 mi. W of Osakis, ~1.0 mi. N of Hwy 27	Poor	--
07010202-586 **Fairfield Creek** *Smith Lk outlet to Unnamed Cr*	07UM077	Downstream of Hidden Dr, 3.5 mi. W of Osakis	Fair	--
07010202-584 **Fairfield Creek** *Unnamed Cr to Crooked Lk Ditch*	08UM048	Upstream of Hope Rd, 2 mi. E of Nelson	Fair	--
07010202-637 **Trib to Crooked Lake Ditch** *Unnamed Cr to Fairfield Cr*	08UM047	Upstream of CR 73, 2.5 mi. NE of Nelson	Poor	Poor
07010202-581 **Crooked Lake Ditch** *Unnamed Ditch to Unnamed Cr*	07UM076	Downstream of Ottertail Trl NE, 4 mi. N of Osakis	Poor (3)	Poor (2)
07010202-638 **Trib. to Little Lake Osakis** *Unnamed Lk to Little Lk Osakis*	08UM046	Downstream of 161st Ave, 7 mi. NE of Osakis	Poor	Poor
07010202-589 **Boss Creek** *Baugh Cr to Pitt Lk*	07UM078	Upstream of CR 37, 5.5 mi. NE of Osakis	Poor (3)	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 3. Minnesota Stream Habitat Assessment (MSHA) for the Upper Sauk 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	07UM077	Fairfield Creek	0	9.5	17.4	11	3	40.9	Poor
1	08UM048	Fairfield Creek	1.5	6	9	12	10	38.5	Poor
1	08UM047	Trib. to Crooked Lake Ditch	0	6.5	16	7	7	36.5	Poor
3	07UM076	Crooked Lake Ditch	0	8	15.7	12	11.7	47.3	Fair
1	00UM072	Crooked Lake Ditch	0	10.5	17.9	11	13	52.4	Fair
1	08UM046	Trib. to Little Lake Osakis	0	11	17.4	12	26	66.4	Good
3	07UM078	Boss Creek	2.2	12	11.1	13	11.7	50.0	Fair
1	08UM040	Sauk River	0	10	20.7	9	26	65.7	Fair
1	08UM041	Trib. to Little Sauk Lake	5	13	18.6	16	25	77.6	Good
1	00UM028	Trib. to Sauk River	3.3	12	11.1	7	26	59.4	Fair
2	08UM039	Sauk River	1.3	9.8	19.5	12.5	26.5	69.5	Good
Average Habitat Results: *Upper Sauk 11 HUC Watershed*			1.2	9.8	15.9	11.1	16..9	54.9	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)

Table 4. Pour point water chemistry results for the Upper Sauk 11 HUC

Station location:	Sauk River at Cedar Lake Rd, 7 mi. N of Sauk Centre											
Storet ID:	S003-888											
Station #:	08UM039											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	C	cm
# Samples	10	6	10	10	9	10	10	10	9	10	10	10
Minimum	5.26	<1.00	.002	<0.02	1.37	7.84	0.01	<1.00	<1.00	416	12.8	35.7
Maximum	14.14	48	0.01	0.20	2.43	8.66	0.14	29	21	451	27.1	100 +
Mean[1]	8.83	8.8	0.006	0.08	1.68	8.25	0.04	8.02	7.28	436	19.6	82.8
Median	8.91	17	0.05	0.05	1.54	8.27	0.03	5.5	7	436	18.4	90.9
WQ standard[2]	5.0	126/1260	0 .04			6.5 - 9.0		100				20
# WQ exceedances[3]	0/10	0/6	0/10			0/10		0/10				0/10
NCHF 75th Percentile[4]			0.2	0.12			0.17	5.6		310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Upper Sauk 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 5. Lake water aquatic recreation assessments for the Upper Sauk 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Osakis	77-0215-00	6341	E	55	67	17	NT	54	27.9	2.3	**NS**
SAUK (N BAY)	77-0150-02	2137	E		61	18		54.4	35.3	1.8	**NS**
SAUK (SW BAY)	77-0150-01	2137	H		18	7		115.8	59.6	1.1	**NS**
Smith	21-0016-00	648	E	47	36	14	NT	48.5	31.8	1.5	**NS**
Maple	77-0181-00	376	E	41	21		NT	81.3	45.7	1.8	**NS**
Fairy	77-0154-00	324	M	47	36			21.4	7.9	3.3	**FS**
Little Sauk	77-0164-00	294	E	60	29	11		54.7	47	1.1	**NS**
Clifford	21-0003-00	164	H					308.2	20.4	0.8	**NS**
LONG (MAIN)	77-0149-01	141	M		36					3.8	IF
Guernsey	77-0182-00	132	E	94	19	7		69.7	45.3	0.9	**NS**
Juergens	77-0163-00	117	E	76		9		79.8	44.7	1.3	**NS**
Little Osakis	77-0201-00	112	M	34						3.5	IF
Faille	77-0195-00	58	H	100				173.5	28.2	1.1	**NS**
Mud	77-0151-00	47	E	100				67.1	11.1	1.7	IF
LONG (S BAY)	77-0149-02	35	M		20					3.4	IF

Abbreviations:

↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O – Oligotrophic

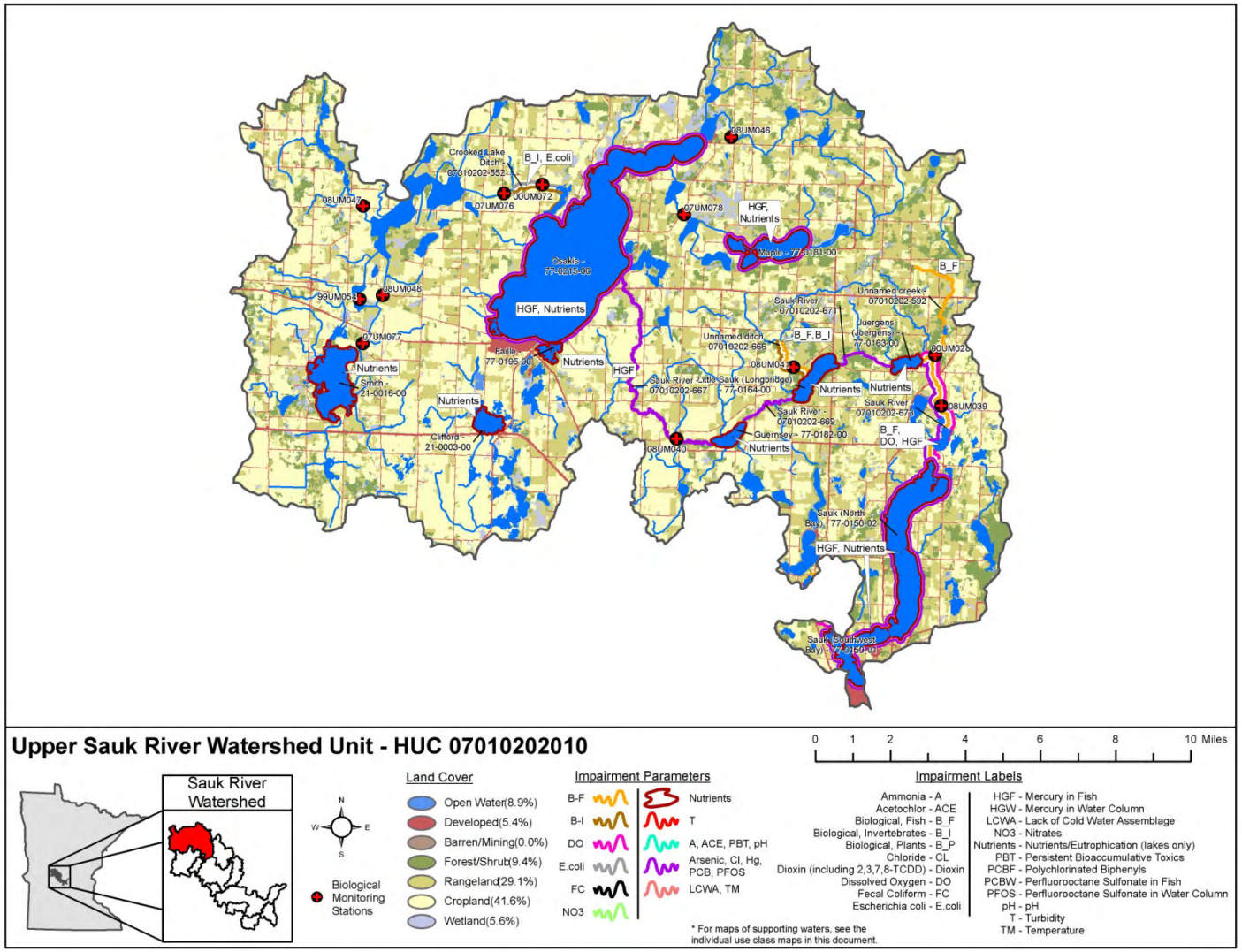
FS – Full Support
NS – Non-Support
IF – Insufficient Information
ARUS – Aquatic Recreational Use Support

Summary

The headwaters of Lake Osakis are predominately low gradient in nature. Lake Osakis is fed by several channelized streams, of poor habitat quality and biological integrity, draining nutrient impaired lakes. Impaired for both dissolved oxygen, E. Coli and MIBI, Crooked Lake Ditch (JD 2) enters Lake Osakis at its western shores. The ditch has shown little improvement in biological condition or habitat in recent surveys. In 2003, sediment retention ponds were constructed near the outlet of Crooked Lake Ditch to reduce TSS readings in Osakis. After periodic cleanings and the completion of an enhancement project, 2006/2007 SRWD results show signs of TSS reduction. A water quality improvement project beginning in 2011 to restore the integrity of Crooked Lake may improve downstream conditions of both Crooked Lake Ditch and Lake Osakis (Chuck Johnson, personal communication).

The Sauk River emanates from nutrient rich Lake Osakis. The river's fish community degrades moving downstream, dropping just below standards at the pour point site. Downstream there are several impaired riverine lakes including: Gurnsey, Little Sauk, Jurgens and Sauk Lake. Here the river is also impaired for turbidity. Interestingly, macroinvertebrate and habitat quality slightly improve moving downstream in the watershed. Fairy Lake, just West of Sauk Lake, is in particularly good condition considering other impaired lakes in the watershed. It's TSI indicators are well below CHF standards. Most upstream reaches in Upper Sauk's headwaters have not been sufficiently monitored to determine their use support status and may warrant further monitoring.

Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Upper Sauk River Watershed Unit



Ashley Creek Watershed Unit HUC 07010202020

The Ashley Creek Watershed Unit is located in the northwestern corner of Stearns County and lies just beyond the border of Douglas, Pope and Todd counties. Draining from Westport Lake, Ashley Creek flows northeast through the village of Westport and a series of wetland complexes before crossing I-94. From I-94 the stream gradient increases before discharging into Sauk Lake. The basin has 28 established lakes, of which only 12 are greater than 10 acres. Many of the shallow lakes in the Ashley Creek watershed are also classified as wetlands. Sixty six percent of the watersheds nearly 113 square miles is annually planted in row crop; combined with rangeland, 81 percent of the watershed is vested in agricultural production. The pour point of Ashley Creek is collocated with SRWD station: Ashley 11 on Ashley Creek represented by MPCA biological station 08UM038.

Stream assessment

Table 6. Aquatic life and recreation assessments on assessed AUIDs in the Ashley Creek 11 HUC

AUID	Biological Station ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-503 Ashley Creek, *Headwaters to Sauk Lk*	08UM038 08UM042	Downstream of CR 11, 6 mi. NW of Westport Upstream of CR 92, 4.5 mi. NW of Sauk Centre	**NS**	**NS**	**NS**	FS	FS	FS	FS	**NS**	**NS**
07010202-521 County Ditch 6 *Unnamed Cr to Ashley Cr*	00UM073*	Upstream of C.R. 33, 11 mi. W. of Sauk Centre	**NS***	**NS***	--	--	--	--	--	**NS**	--

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

* Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized **s**treams until after the adoption of Tiered Aquatic Life Uses.

Table 7. Non-assessed biological stations on channelized AUIDs in the Ashley Creek 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-503 **Ashley Creek** *Headwaters to Sauk Lk*	08UM050	Upstream of Twp Rd 130, 1 mi. NW of Westport	Poor	--
07010202-521 **County Ditch 6** *Unnamed Cr to Ashley Cr*	07UM083	Downstream of CR 33, 4 mi. E of Villard	Poor (3)	Poor
07010202-640 **Unnamed Ditch to Silver Creek** *West Union Lk outlet to Unnamed Cr*	08UM043	Upstream of CR 91, 1 mi. SE of West Union	Poor (2)	Fair
07010202-613 **Silver Creek,** *Unnamed Cr to Silver Cr*	08UM045	Upstream of CR 182, 2 mi. SE of West Union	Poor (2)	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 8. Minnesota Stream Habitat Assessment (MSHA) for the Ashley Creek 11 HUC

			Land Use	Riparian	Substrate	Fish Cover	Channel Morph.	MSHA Score	MSHA
Visits	Site ID	Stream Name	(0-5)	(0-15)	(0-27)	(0-17)	(0-36)	(0-100)	Rating
1	08UM050	Ashley Creek	0	12.5	13.2	13	18	56.7	Fair
1	00UM073	County Ditch 6	0	9.5	10	13	13	45.5	Fair
2	07UM083	County Ditch 6	0	10.3	12.5	12	9	43.8	Poor
1	08UM042	Ashley Creek	0	4	21	7	31	63	Fair
2	08UM043	Unnamed Ditch to Silver Creek	0	9.3	15.7	11.5	18.5	54	Fair
1	08UM045	Trib. to Silver Creek	0	9.5	16.1	14	26	65.6	Fair
2	08UM038	Ashley Creek	5	13	21	13	32	84	Good
Average Habitat Results: Ashley Creek 11 HUC Watershed			0.7	9.7	15.6	11.9	21.1	58.9	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)

Table 9. Pour point stream water chemistry for the Ashley Creek 11 HUC

Station location:	Ashley Creek at 415th Ave, 2 mi. N of Sauk Centre											
Storet ID:	S004-625											
Station #:	08UM038											
Parameter	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/L		mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	Deg C	cm
# Samples	10	6	10	10	9	10	10	10	6	10	10	10
Minimum	4.12	3	0.001	1.66	0.56	7.62	0.01	<1.00	3	580	12.2	70.5
Maximum	10.21	252	0.008	3.44	1.92	8.04	0.29	18	252	657	22.4	100 +
Mean[1]	8.25	25.5	0.003	2.38	1.32	7.91	0.09	7	60.2	623	16.7	91.2
Median	8.68	24.5	0.002	2.45	1.36	7.94	0.04	6	24.5	633	17.5	98.8
WQ standard[2]	5.0	126/1260	0.04			6.5 - 9.0		100				20
# WQ exceedances[3]	1/10	1/6	0/10			0/10		0/10				0/10
NCHF 75th Percentile[4]			0.2	0.12			0.17	5.6		310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Ashley Creed 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to Assess the AUID.**

Table 10. Lake water aquatic recreation assessment for the Ashley Creek 11 HUC

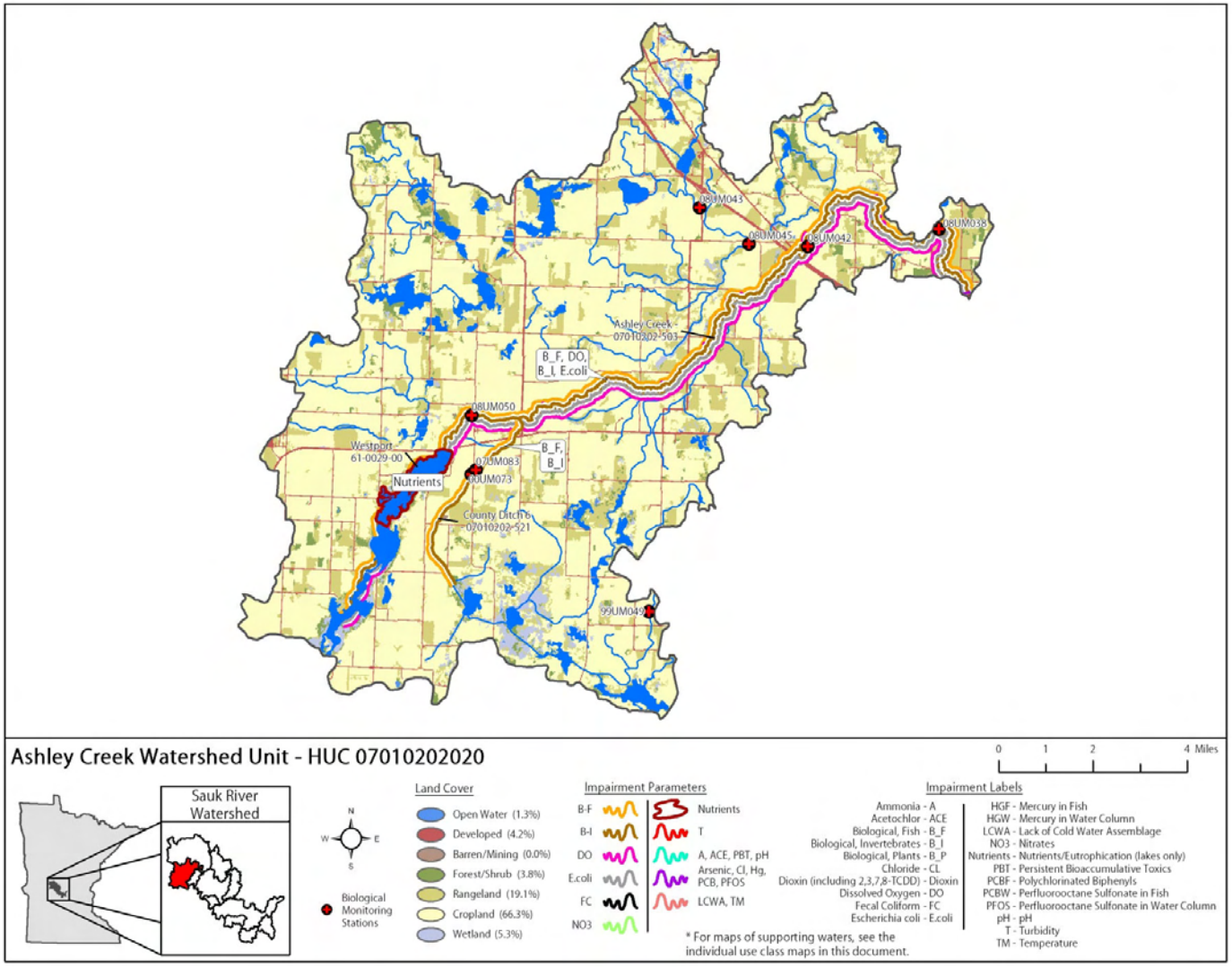
Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Westport	61-0029-00	199	E		13	IF	NT	78	47	1	**NS**

Abbreviations: ↘ -- Decreasing/Declining Trend; ↗ -- Increasing/Improving Trends; **NT** – No Trend; **H** – Hypereutrophic; E –Eutrophic; **M** – Mesotrophic; **O** – Oligotrophic; **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information; **ARUS** – Aquatic Recreational Use Support

Summary

Westport Lake, the source of Ashley Creek, is a shallow, excessively fertile lake, with frequent winter fish kills. Placed on the impaired waters list in 2010, its TMDL is scheduled for completion in 2016. Below Westport Lake, Ashley Creek's low gradient nature coincides with poor habitat, low dissolved oxygen and biological conditions observed upstream in the watershed. County Ditch 6 feeds into Ashley Creek downstream of Westport. Historical fish and macroinvertebrate impairments circa 2000 show no improvement from biological and stream habitat monitoring completed in 2007 and 2008. Fish communities improve moving downstream on Ashley Creek coinciding with an increase in stream gradient and exceptional habitat conditions observed downstream. However, biological communities reside on the cusp of impairment and tolerant taxa dominate the local fish population. Silver Creek, a tributary in the downstream reach of Ashley, was assessed as non-support for aquatic life. Westport Lake's nutrient impairment, along with upstream low gradient conditions may be factors that contribute to the present aquatic life impairments observed in the watershed. Additional monitoring is recommended for dissolved oxygen in order to better define the impairment.

Figure 15. Currently listed impaired waters by parameter and land use characteristics in the Ashley Creek Watershed Unit



Hoboken Creek Watershed Unit HUC 07010202030

The Hoboken Creek Watershed Unit is the second smallest watershed in the Sauk River drainage, confined to 28 square miles in Stearns County. Historically channelized around the turn of the twentieth century, the creek flows between agricultural fields on a six mile journey northeast to Sauk Center; here it joins Sauk Lake. Twenty four of the watershed's 28 acres are tied to agricultural production; 66 percent of its area is cultivated. Due to its small drainage, MPCA did not establish a stream water chemistry station at the pour point of Hoboken Creek, represented by MPCA biological station 08UM037. This station is collocated with a SRWD site on Hoboken Creek; chemistry data provided below is courtesy of SRWD where monitoring occurred using identical methods to monitoring conducted at other water chemistry stations in this study.

Stream assessment

Table 11. Aquatic life and recreation assessment on assessed AUIDs in the Hoboken Creek 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-522 Hoboken Creek *Headwaters to Sauk Lk*	--	--	**--**	**--**	IF	FS	FS	FS	--	**IF**	**FS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

Table 12. Non-assessed biological station on channelized AUIDs in the Hoboken Creek 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-624 **Trib to Hoboken Creek** *Unnamed Cr to Hoboken Cr*	08UM036	Upstream of CR 183, 5 mi. SW of Sauk Centre	Poor	Fair
07010202-522 **Hoboken Creek** *Headwaters to Sauk Lk*	00UM037	South of Hwy 28	Poor	Fair
07010202-522 **Hobboken Creek** *Headwaters to Sauk Lk*	08UM037	Upstream of CR 72 in Sauk Centre	Poor (3)	Fair (2)

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 13. Minnesota Stream Habitat Assessment (MSHA) for Hoboken Creek 11 HUC

			Land Use	Riparian	Substrate	Fish Cover	Channel Morph.	MSHA Score	MSHA
Visits	**Site ID**	**Stream Name**	**(0-5)**	**(0-15)**	**(0-27)**	**(0-17)**	**(0-36)**	**(0-100)**	**Rating**
2	08UM036	Trib. to Hoboken Creek	0	9.5	17.5	9.5	24	60.5	Fair
3	00UM037	Hoboken Creek	1.3	12.2	15.9	13.7	20.7	63.7	Fair
2	08UM037	Hoboken Creek	4.3	14.5	20.6	9.5	31.5	80.3	Good
Average Habitat Results: *Hoboken Creek 11 HUC Watershed*			1.9	12.1	18	10.9	25.4	68.2	Good

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)

Table 14. Pour point water chemistry results for Hoboken Creek 11 HUC

Station location:	Hoboken Creek at CR 72 in Sauk Centre											
Storet ID:	S002-654											
Station #:	08UM037											
Parameter	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp	T-tube
Units	mg/l		mg/l	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	Deg	cm
# Samples	11	7	0	0	0	0	11	11	0	0	11	0
Minimum	6.26	16					0.03	<1.00			10.3	
Maximum	13.52	216					0.20	12			21.6	
Mean[1]	9.66	45.87					0.08	3.64			15.69	
Median	9.38	56					0.09	1			16.2	
WQ standard[2]	5.0	126/1260	0.04			6.5 – 9.0		100				20
# WQ exceedances[3]	0/11	1/7						0/11				
NCHF 75th Percentile[4]			0.2	0.12			0.17	310			24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

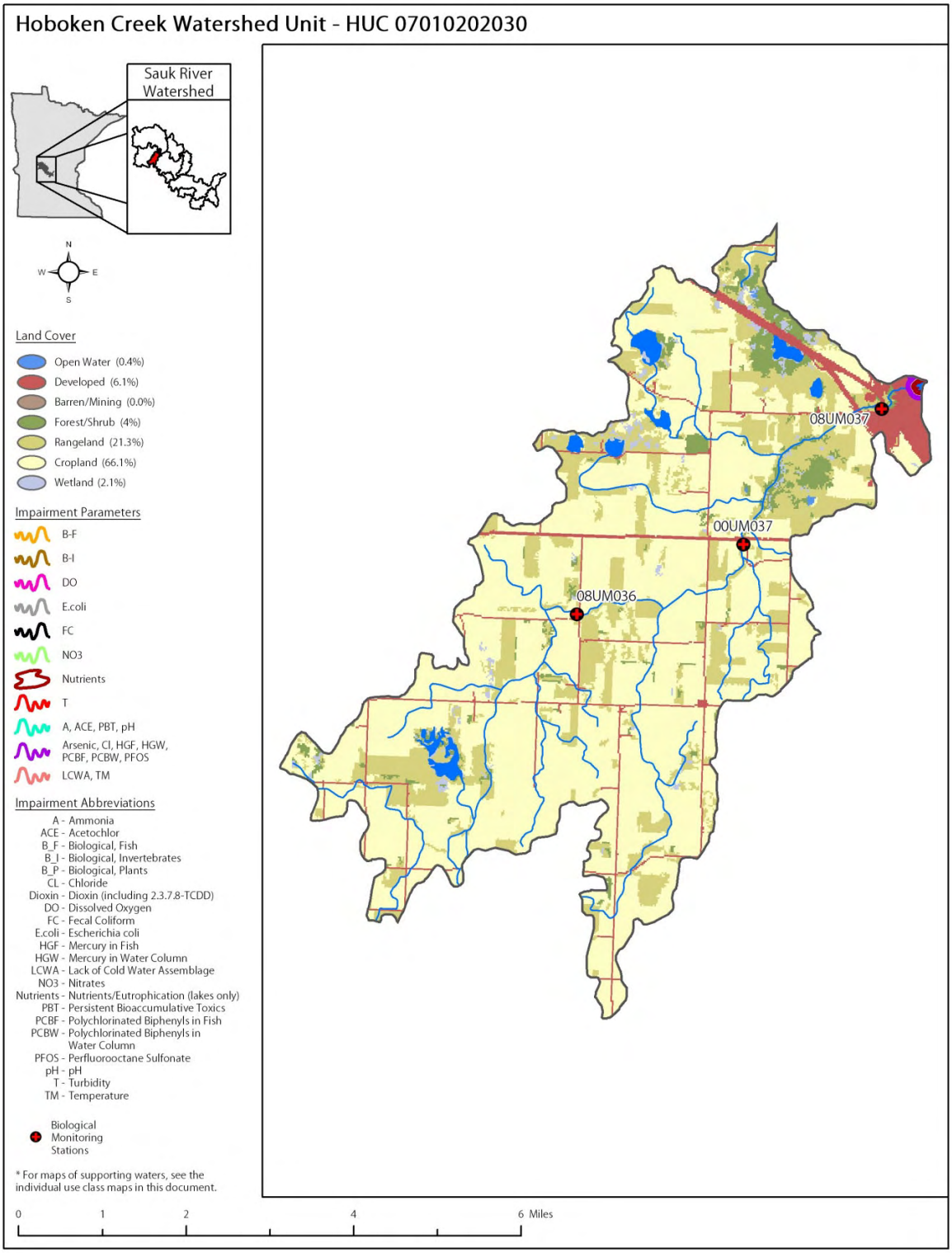
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected by the SRWD at the pour point of Hoboken Creek. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Hoboken Creek has been heavily channelized in the upper half of the watershed but retains moderate gradient throughout most of its reach. Exceedances in both quantity and concentration for TP and nitrogen are exceptionally high in comparison to ecoregion norms. Fish communities fare poorly in the watershed while macroinvertebrate communities perform in the fair range, scoring just below the impairment threshold for natural streams. Habitat scores increase moving downstream in the watershed. The Hoboken subwatershed has five established lakes, none have assessment level data. One unnamed lake within the watershed has remote sensing data (Lindon 2010).

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Hoboken Creek Watershed Unit



Middle Sauk River Watershed Unit HUC 07010202040

The Middle Sauk River Watershed Unit is a flow through system that extends across 149 square miles of Stearns County. The Sauk River continues in a southerly direction upon leaving Sauk Centre, slowly meandering through a corridor of agricultural fields and wetland depressions, including the 400-acre Sauk River Wildlife Management Area. In Melrose the Sauk widens, dropping 20 feet over the 'Mill Dam,' a historical presence since 1867. The river gains the drainage of Adley Creek and abruptly turns south, flowing through a 300 acre Wildlife Management Area before advancing past the outskirts of New Munich. Getchell Creek then discharges into the Sauk, followed by Stony Creek before the river continues its course into the Lower Sauk 11 HUC. Sixty one lakes are found across the watershed; however, Kings and Uhlenkolts, located on the eastern boundaries of the watershed, are the only lakes greater than 200 acres. Farms stretch across the watershed's agrarian landscape, encompassing 74.4 mi^2 of row crops and 46 mi^2 of rangeland. Numerous protection and improvement projects have been implemented in the Middle Sauk including: the "Middle Sauk River Rehabilitation Project" and "Restoring Water Resources of the Sauk River Chain of Lakes". The pour point of the Middle Sauk was collocated with SRWD station 'Sauk River 31' on the Sauk River and is represented by MPCA biological station 08UM025.

Stream assessment

Table 15.Aquatic Life and Recreation Assessments on Assessed AUIDs in the Middle Sauk 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-507 **Sauk River** *Sauk Lk to Melrose Dam*	08UM033	Upstream of Hwy 4, 2.5 mi. W of Melrose	**NS**	FS	IF	FS	FS	--	--	**NS**	**FS**
07010202-506 **Sauk River** *Melrose Dam to Adley Cr*	00UM038	Upstream of CR 168, in Melrose	**NS (2)**	**NS**	--	--	--	--	--	**NS**	**NA**
07010202-505 **Sauk River** *Adley Cr to Getchell Cr*	08UM027 08UM025	Munich Upstream of CR 30 in New Munich Downstream of CR 31, 3 mi. S of New	FS	**NS**	IF	FS	FS	FS	FS	**NS**	**NS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment
NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

Table 16. Non-assessed biological stations on channelized AUIDs in the Middle Sauk 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-647 **Trib to Unnamed Creek** *Unnamed Cr to Unnamed Lk*	08UM034	Upstream of CR 28, 5 mi. S of Sauk Centre	Poor	Fair
07010202-643 **Trib to Unnamed Creek** *Unnamed Cr to Unnamed Cr*	08UM035	Upstream of CR 187, 4 mi. S of Sauk Centre	Poor	Poor
07010202-653 **Trib to Sauk River** *Unnamed Cr to Sauk R*	08UM032	Downstream of 400th St, 2.5 mi. NW of Melrose	Good	Fair
07010202-654 **Trib to Sauk River** *Unnamed Cr to Sauk R*	08UM030	Downstream of Kraft Dr, .5 mi. SE of Melrose	Poor	Fair
07010202-540 **County Ditch 44** *Headwaters to Sauk R*	07UM075	Upstream of Overton Rd, 3 mi. S of Melrose	Fair	Good
07010202-540 **County Ditch 44** *Headwaters to Sauk R*	08UM026	Upstream of Overdale Rd, 1 mi. SW of New Munich	Fair	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 17. Minnesota Stream Habitat Assessment (MSHA) for the Middle Sauk 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	08UM034	Trib. to Unnamed creek	0	8	3.5	12.5	11.5	35.5	Poor
1	08UM035	Trib. to Unnamed creek	0	8.5	17.8	11	14	51.3	Fair
1	08UM033	Sauk River	4	9.5	9	7	26	55.5	Fair
1	08UM032	Trib. to Sauk River	2.3	13	18	12	33	78.3	Good
2	00UM038	Sauk River	2.5	10.5	16.2	7	16.5	52.7	Fair
1	08UM030	Trib. to Sauk River	0	12	18.8	6	28	64.8	Fair
2	08UM027	Sauk River	2.5	8.8	18.9	12.5	27	69.7	Good
1	07UM075	County Ditch 44	0	12	18.2	12	20	62.2	Fair
1	08UM026	Trib. to Sauk River	1.5	12	15.1	14	18	60.6	Fair
1	08UM025	Sauk River	5	11	15	14	28	73	Good
Average Habitat Results: *Middle Sauk 11 HUC Watershed*			1.8	10.5	15.1	10.8	22.2	60.4	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)

Table 18. Pour point water chemistry results for the Middle Sauk 11 HUC

Station location:	Sauk River at CR 31 3 mi. S of New Munich											
Storet ID:	S000-284											
Station #:	08UM025											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/L		mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	C	cm
# Samples	11	7	9	11	11	9	11	11	7	9	11	9
Minimum	6.90	7	0.003	1.10	1.03	8.04	0.05	<1.00	7	476	12.3	25.4
Maximum	11.16	540	0.12	2.59	2.82	8.63	0.18	36	540	665	25	96
Mean[1]	9.03	34.3	0..02	1.65	1.95	8.20	0.10	14.56	98.6	560	20.3	49.5
Median	8.46	31	0.004	1.38	2.01	8.15	0.09	16.67	31	561	21.1	38.8
WQ standard[2]	5.00	126/1260	0.04			6.5 - 9.0		100				20
# WQ exceedances[3]	0/10	1/7	1/9			0/10		0/10				0/9
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Middle Sauk 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 19. Lake water aquatic recreation assessments for the Middle Sauk 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Uhlenkolts	73-0208-00	240	H					244	80	0	**NS**
Kings	73-0233-00	201	E	24	44	23		33	12	3	FS
Cedar	73-0255-00	187	E		5			40	6	1	FS
McCormic	73-0273-00	186	E	100	12			93	57	2	**NS**
Black Oak	73-0241-00	100	H	94				101	31	1	IF
Maria	73-0215-00	99	H	60	45	13	↗	114	18	1	**NS**
Long	73-0231-00	82	M	39		20		21	8	2	FS
Ellering	73-0244-00	36	E	49				70	29	2	IF

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend

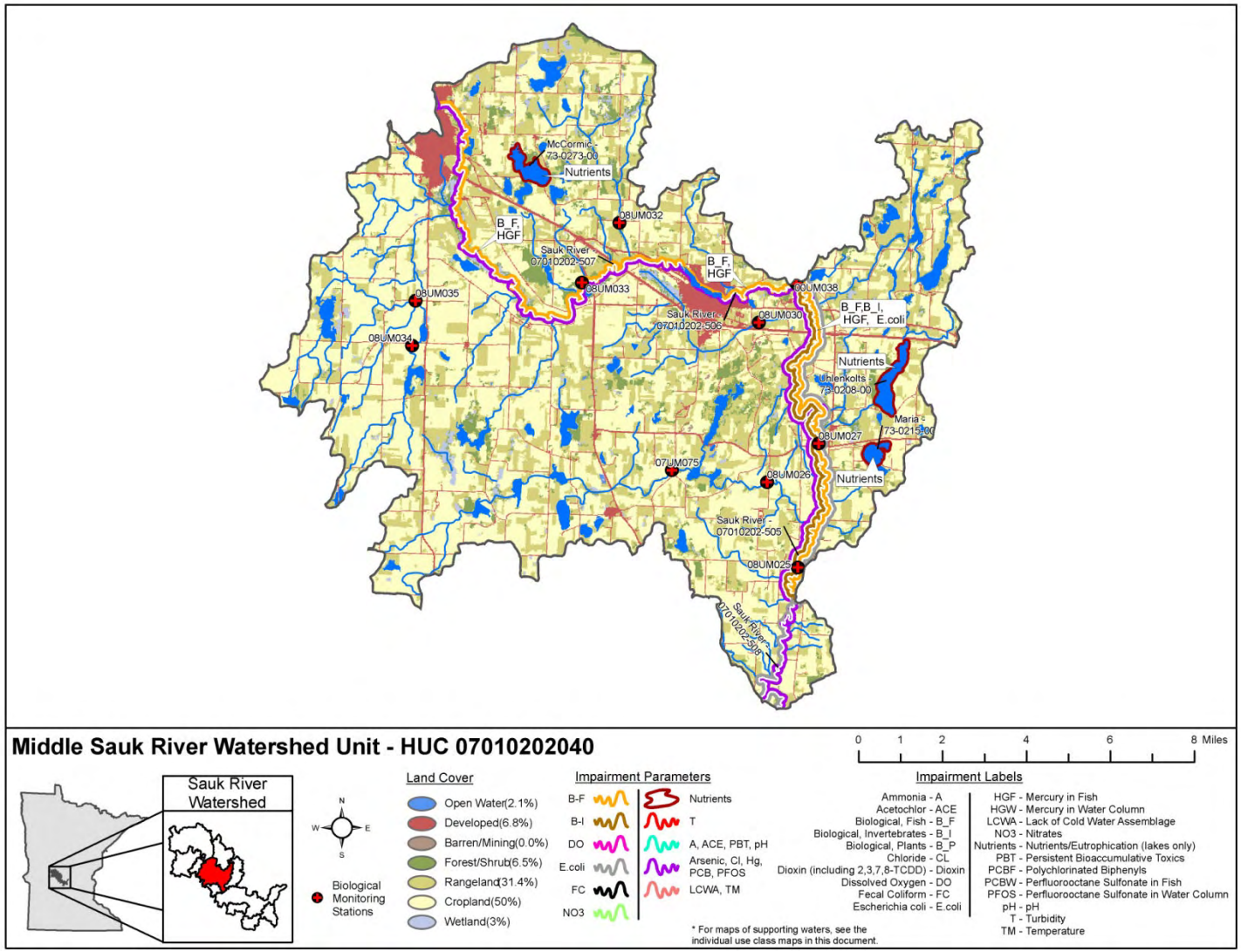
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic

FS – Full Support
NS – Non-Support
I**F** – Insufficient Information

Summary

The Sauk River (07010202-507) leaves nutrient-rich Sauk Lake and receives the effluent of the Sauk Centre WWTP downstream of Sauk Centre. Habitat and fish IBI's are poor in the upstream reaches of this watershed but improve somewhat further downstream. The low gradient characteristics of this stretch, combined with excessive nutrient concentrations from Sauk Lake, may be factors that contribute to the poor conditions found in this AUID. The Melrose WWTP discharges to the Sauk River (07010202-505) in Melrose. MIBI quality exceeds impairment thresholds above the Adley Creek confluence but degrades below it. Excessive nutrients from Uhlenkolts Lake may be contributing to the poor biological quality of this stretch of the Sauk River. Adley Creek's E. Coli impairment may contribute to the E. Coli impairment observed on the Sauk River downstream of the confluence. A majority of the watershed's lakes are riverine in nature, serving as the headwaters for several small unnamed tributaries to the Sauk River whose biota are generally performing poorly. The quality of the aquatic communities on channelized tributaries to the Sauk River tends to improve further downstream in the watershed. Additional chemistry monitoring on tributary streams to the Sauk River may provide insight into poor biological conditions observed in these smaller tributary systems and the Sauk River itself.

Figure 17. Currently listed impaired waters by parameter and land use characteristics in the Middle Sauk River Watershed Unit



Adley and Prairie Creeks Watershed Unit HUC 07010202050

The Adley and Prairie Creek Watershed Unit encompasses 89 mi^2 of Stearns and Todd counties. The headwaters in the northern reaches of the watershed and are lake rich, holding 47 lakes of which 28 are greater than 10 acres. Trout Creek (Round Prairie Creek), a system fed by natural springs, flows by Ward Springs and into Little Birch Lake. Trout Creek was stocked with Brook Trout by the MDNR from 1949 to 1975, since 1975 the stream has supported a self sustaining population (MDNR, 2004). At the Southern outlet of Little Birch Lake Adley Creek emerges heading south past stands of hardwood forest, and following a series of wetland complexes before emptying into the Sauk River two miles East of Melrose. At 68 percent, the watershed has the smallest percentage of agricultural land use in all of the 11 HUC subwatersheds in the Sauk River drainage. The pour point monitoring site of the watershed unit was collocated with the SRWD's monitoring station on Adley Creek. It is not associated with a biological station due to its close proximity to the Sauk River.

Stream assessment

Table 20. Aquatic life and recreation assessments on assessed AUIDs in the Adley and Prairie Creek 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-570 **Trout Creek** *Headwaters to Prairie Creek*	08UM052*	Upstream of Clayhill Rd, 8 mi. NW of Sauk Centre	NA*	NA*	--	--	--	--	--	NA*	--
07010202-535 **Fish Creek** *Goose Lk to Big Birch Lk*	--	--	--	--	IF	FS	FS	--	--	**FS**	IF
07010202-527 **Adley Creek** *Sylvia Lk to Sauk R*	--	--	NA	NA	IF	FS	FS	FS	FS	**FS**	**NS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

*** Assessment deferred during 2010 assessments due to coldwater thermal regime and the lack of appropriate assessment tools for coldwater streams.**

Table 21. Non-assessed biological stations on channelized AUIDs in the Adley and Prairie Creek 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-527 **Adley Creek** *Sylvia Lk to Sauk R*	08UM031	Upstream of CR 169, 3 mi. NE of Melrose	Poor	Good

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 22. Minnesota Stream Habitat Assessment (MSHA) for the Adley and Prairie Creek 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	08UM052	Trout Creek (Round Prairie Creek)	2	11.3	17.9	14.5	26.5	72.2	Good
1	08UM031	Adley Creek	2.5	10	15	13	19	59.5	Fair
Average Habitat Results: *Adley and Prairie Creek 11 HUC Watershed*			2.3	10.7	16.5	13.8	22.8	65.8	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)

Table 23. Pour point water chemistry results for the Adley and Prairie Creek 11 HUC

Station location:	Adley Creek at CR 176, 8.5 mi. SW of Albany											
Storet ID:	S000-369											
Station #:	None (WC ONLY)											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/L		mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	C	cm
# Samples	11	7	10	10	10	10	11	11	9	10	11	11
Minimum	7.85	6	0.001	0.35	0.80	7.96	<.005	<1.00	<1.00	418	8.4	65.9
Maximum	13.80	1296	0.009	2.56	2.86	8.61	0.10	15	17	493	25.1	100 +
Mean[1]	10.16	146	0.005	0.97	1.53	8.22	0.04	6.11	6	444	20	87.8
Median	10.20	360	0.005	0.64	1.23	8.16	0.04	5	4	429	23	91.5 +
WQ standard[2]	5.00	126/1260	.04			6.5 - 9.0		100				20
# WQ exceedances[3]	0/11	4/7	0/10			0/10		0/11				0/11
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Adley Creek 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 24. Lake water aquatic recreation assessments for the Adley and Prairie Creek 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Little Birch	77-0089-00	829	M	33	89	29	↗	22	7	3	FS
Cedar	73-0226-00	93	M	78	36	7		22	6	2	IF
Sylvia	73-0249-00	86	M	28	56	26	NT	17	6	3	FS

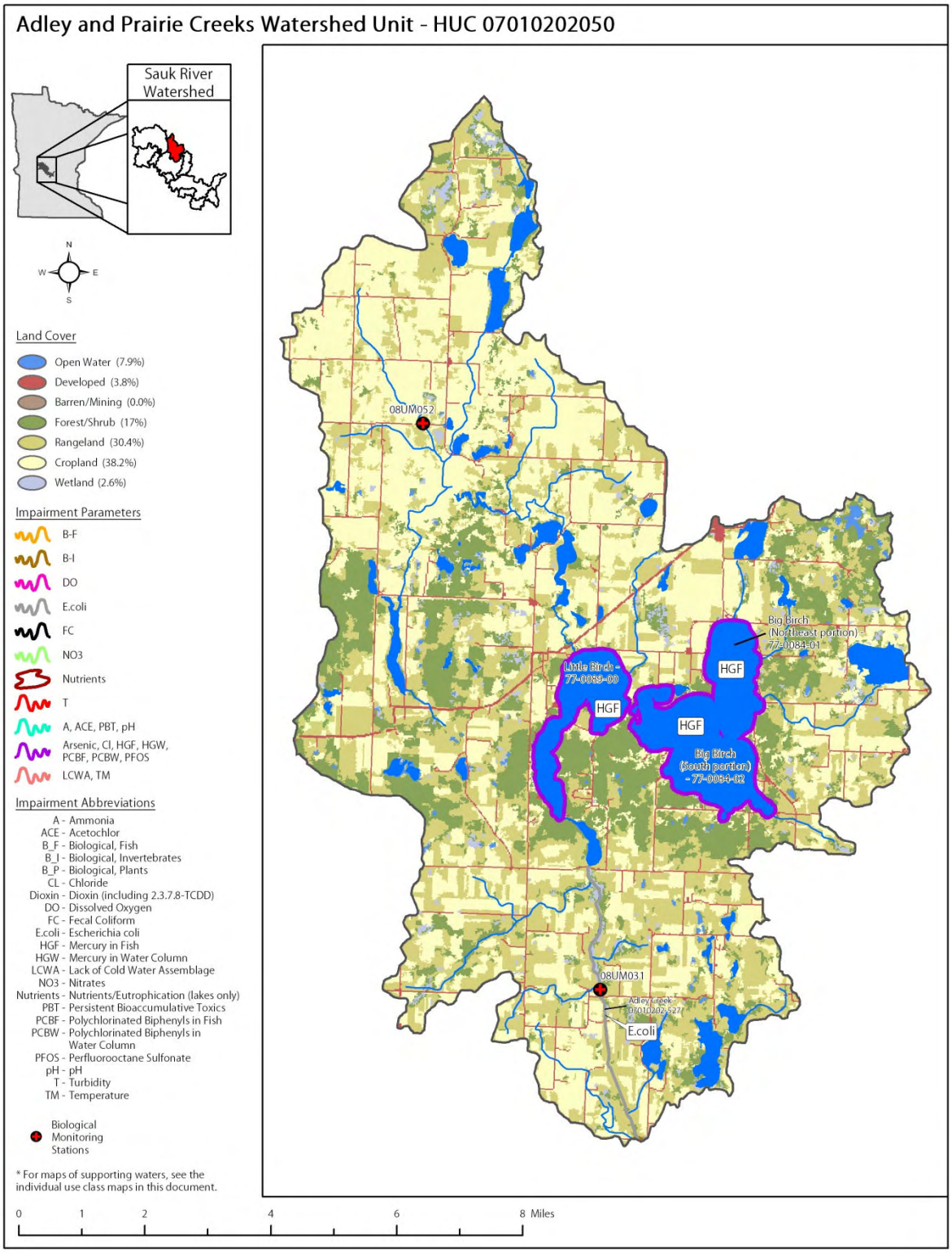
Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Summary

Historical channelization on Adley Creek along with the low gradient character and riparian wetlands along its upstream reaches likely equate to its mediocre stream habitat quality. Despite the remarkably high diversity observed in the fish community in Adley Creek, it is dominated by an abundance of tolerant taxa, resulting in an overall poor fish IBI score. In contrast, MIBI scores are exceptional. Nearly all stream water chemistry collection in the watershed has occurred at the outlet of Adley Creek. More investigation is needed further upstream in the watershed to better understand the E. Coli impairment.

The abundance of forested acreage in the watershed is potentially benefiting the lake quality in Cedar, Silvia and Little Birch lakes. That in combination with the excellent condition of the macroinvertebrate community, the high diversity seen in the fish community and the presence of a self sustaining brook trout population in Trout Creek, all warrant protection measures to maintain the current level of resource quality in the watershed.

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Adley and Prairie Creeks Watershed Unit



Getchell Creek Watershed Unit HUC 07010202060

The Getchell Creek Watershed Unit is in central Stearns County, possessing the greatest concentration of rangeland in all of the Sauk River Watershed's subwatersheds, 40 percent of its total area. In combination with cropland, nearly 87 percent of the watershed's area is utilized for agricultural production. The watershed has 16 lakes of which eight are over 10 acres. Getchell's headwaters begin approximately five miles north of Freeport in a region of shallow lakes and depressional wetlands. Getchell Creek flows south through a relatively flat landscape; it crosses I-94, gradually veering west before draining into the Sauk River southeast of New Munich. The creek is channelized almost along its entire course; first dug in 1907, it has since been maintained by local landowners periodically and is again scheduled for maintenance in the near future (Nelson, 2011). The pour point monitoring site of the Getchell Creek Watershed is collocated with SRWD station #5 on Getchell Creek and is represented by MPCA biological station 00UM039. Eleven lakes of moderate to small size are present in the watershed and are examined in greater detail in the MPCA report Assessment Report of Selected Lakes within the Sauk River Watershed (Lindon, 2010).

Stream assessment

Table 25. Aquatic life and recreation assessments on assessed AUIDs in the Getchell Creek 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-615 **Unnamed creek** *Unnamed Cr to Getchell Cr*	--	--	NA	NA	NA	FS	FS	--	--	**FS**	**NS**
07010202-562 **Getchell Creek (County Ditch 2)** *Unnamed Cr to Sauk R*	00UM039*	Downstream of CR 176, 8.5 mi. SW of Albany	FS*	NS*	NA	FS	FS	FS	FS	**NS**	**NS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

* Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized streams until after the adoption of Tiered Aquatic Life Uses.

Table 26. Non-assessed biological stations on channelized AUIDs in the Getchell Creek 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-615 **Getchell Creek** *Unnamed Cr to Getchell Cr*	08UM028	Upstream of CR 17, 4.5 mi. NE of Freeport	Poor	Fair
07010202-561 **Getchell Creek** *St Anna Lk to Unnamed Cr*	08UM029	Downstream of CR 17, 5 mi. NE of Freeport	Poor	Fair
07010202-562 **Getchell Creek** *Unnamed Cr to Sauk R*	08UM044	Downstream of 350th St, 4 mi. W of Albany	Poor	Fair
07010202-562 **Getchell Creek** *Unnamed Cr to Sauk R*	07UM086	Upstream of Oakland Rd, 3 mi. S of New Munich	Poor	Good
07010202-562 **Getchell Creek** *Unnamed Cr to Sauk R*	00UM039	Downstream of CR 176, 8.5 mi. SW of Albany	Fair (2)	Poor (2)

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 27. Minnesota Stream Habitat Assessment (MSHA) for the Getchell Creek 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	08UM028	Unnamed creek	3	11.5	3	10	12	39.5	Poor
1	08UM029	Getchell Creek	1	9	4.2	12	13	39.2	Poor
1	08UM044	Getchell Creek	0	11.5	14	15	13	53.5	Fair
1	07UM086	Getchell Creek	0	10.5	19	12	32	73.5	Good
2	00UM039	Getchell Creek	0	9	19.0	14.5	20.5	63.0	Fair
Average Habitat Results: *Getchell Creek 11 HUC Watershed*			0.8	10.3	11.8	12.7	18.1	53.7	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)

Table 28. Pour point water chemistry results for the Getchell Creek 11 HUC

Station location:	Getchell Creek at CR 176, 8.5 mi. SW of Albany											
Storet ID:	S003-289											
Station #:	00UM039											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/L		mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	C	cm
# Samples	10	7	10	11	10	10	11	11	11	9	11	11
Minimum	3.07	4	0.001	0.04	1.79	7.69	0.10	<1.00	<1.00	571	11.9	71.5
Maximum	10.58	60	0.393	2.59	4.11	8.56	0.80	27.37	20	718	23.4	100 +
Mean[1]	6.74	20.59	0..075	0.75	2.61	8.08	0.44	8.03	6	585	19.23	81.5
Median	6.84	31	0.007	0.22	2.45	8.13	0.47	5	4	589	19.7	95.7 +
WQ standard[2]	5.00	126/1260	0.04			6.5 - 9.0		100				20
# WQ exceedances[3]	3/10	0/7	2/10			0/10		0/11				0/11
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Getchell Creek 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 29. Lake water aquatic recreation assessments for the Getchell Creek 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Sand	73-0199-00	210	H	100	12	7	↗	153	78	1	**NS**
St. Anna	73-0183-00	118	E	26	105		NT	81	15	2	IF

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

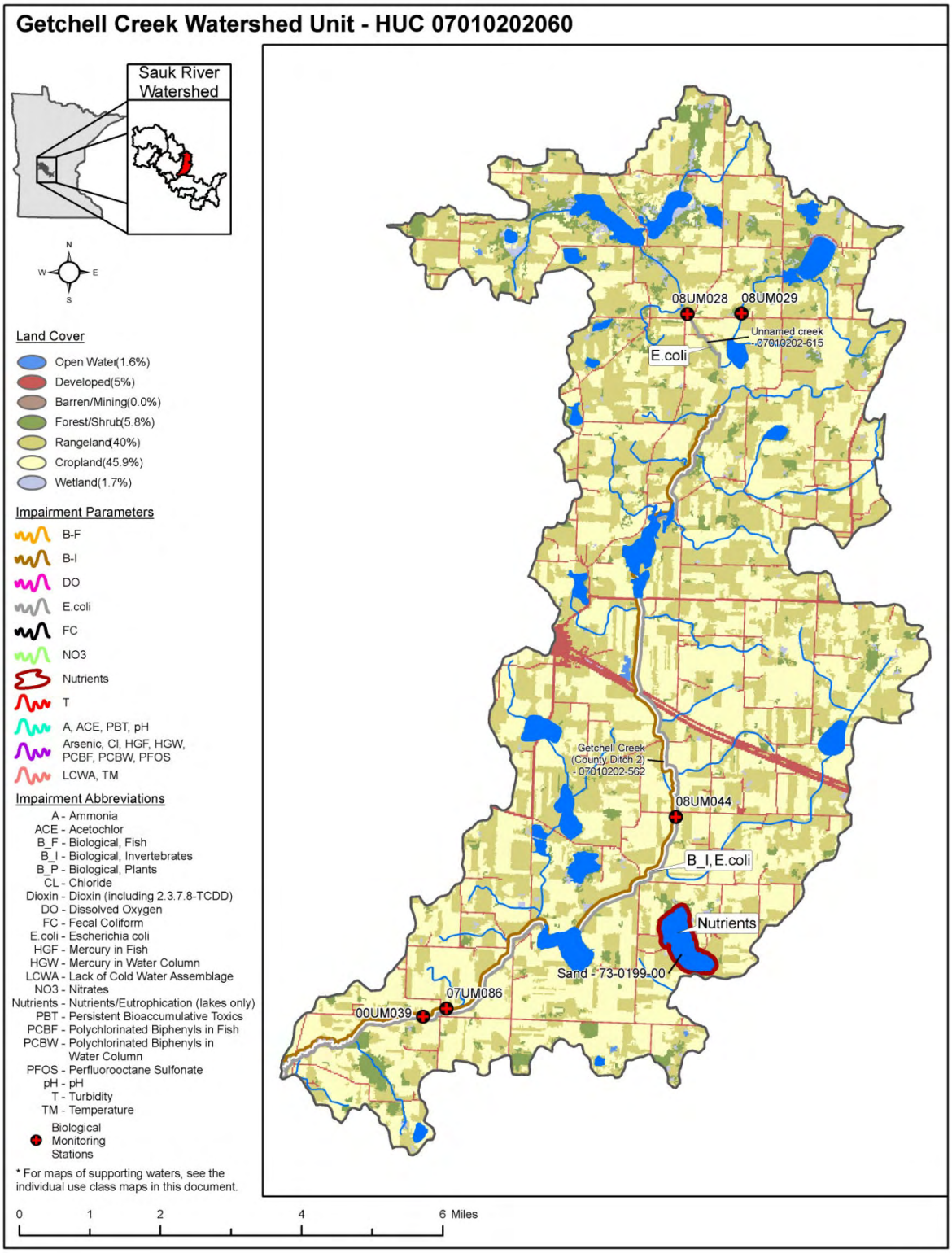
Summary

Fish community quality substantially improves longitudinally moving downstream in Getchell Creek, coinciding with similar improvements seen in stream habitat. When comparing FIBI results from 2000 to 2008, noticeable improvements have occurred; however, results remain below good thresholds. In contrast, MIBI scores show a reverse response and may potentially be responding to the dissolved oxygen impairment identified during the 2010 assessment cycle.

Both Sand and St. Anna lakes have uncharacteristically high nutrient levels when considering their overall watershed size and lake depth. More data is needed to better understand the conditions observed in these lakes.

The historic channelization and upcoming ditch maintenance planned in Getchell Creek in 2011, along with the creek's present water quality impairment status, pose significant challenges to making strides in water quality improvements in the watershed.

Figure 19. Currently listed impaired waters by parameter and land use characteristics in the Getchell Creek Watershed Unit



Stony Creek Watershed Unit HUC 07010202070

The smallest subwatershed within the Sauk River system, a catchment of just under 26 mi^2, Stony Creek Watershed Unit was once home to a productive self sustaining brook trout population. Stony Creek's trout stream designation was removed in 1977; recent attempts to reestablish a population by the MDNR have proven unsuccessful. Stony Creek emerges in rural Stearns County near Elrosa; its course runs SE alongside furrowed fields, flowing through a straightened channel for a majority of its upstream reach. Ninety percent of the watershed's land use classified as agricultural; Stony possesses the largest concentration of cropland of any one subwatershed in the Sauk drainage at 67 percent. Just north of Spring Hill the creek regains its natural sinuosity and increases gradient before discharging into the Sauk River. Due to its small size, MPCA did not establish a stream water chemistry station (for this project) at the pour point of Stony Creek, represented by MPCA biological station 08UM022. This station is however collocated with SRWD station '#3 Stony Creek'. Chemistry data provided below is from the SRWD's results when data was collected under similar circumstances and using identical methods to samples collected at other water chemistry stations in this study.

Stream assessment

Table 30. Aquatic life and recreation assessments on assessed AUIDs in the Stony Creek 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-541 **Stony Creek** *Headwaters to Sauk R*	08UM022*	Upstream of 325th Ave, 2 mi. NE of Spring Hill	**NA***	**NA***	IF	FS	FS	--	--	IF*	**NS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

* Assessment deferred during 2010 Assessments due to coldwater thermal regime and the lack of appropriate assessment tools for coldwater streams.

Table 31. Non-assessed biological stations on channelized AUIDs in the Stony Creek 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-541 **Stony Creek** *Headwaters to Sauk R*	08UM024	Upstream of 343rd Ave, 1.5 mi. N of Spring Hill	NA*	NA*
07010202-655 **Trib to Stony Creek** *Unnamed Cr to Stony Cr*	08UM023	Upstream of 343rd Ave, 1 mi. N of Spring Hill	Poor	Good

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 32. Minnesota Stream Habitat Assessment (MSHA) for the Stony Creek 11 HUC

			Land Use	Riparian	Substrate	Fish Cover	Channel Morph.	MSHA Score	MSHA
Visits	**Site ID**	**Stream Name**	**(0-5)**	**(0-15)**	**(0-27)**	**(0-17)**	**(0-36)**	**(0-100)**	**Rating**
2	08UM024	Stony Creek	0	11	21.5	12.5	27.5	72.5	Good
1	08UM023	Trib. to Stony Creek	0	13	17.9	12	33	75.9	Good
1	08UM022	Stony Creek	0	4	16.4	7	21	48.4	Fair
Average Habitat Results: *Stony Creek 11 HUC Watershed*			0	9.3	18.6	10.5	27.2	65.6	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)

Table 33. Pour point water chemistry results for the Stony Creek 11 HUC

Station location:	Stony Creek at 325th Ave, 2 mi. NE of Spring Hill											
Storet ID:	S000-497											
Station #:	08UM022											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/L	mg/L		mg/L	mg/L	mg/L	uS/cm	Deg C	cm
# Samples	11	7	0	0	0	0	11	11	0	0	11	0
Minimum	9.17	21					0.03	<1.00			9.3	
Maximum	15.57	1584					0.37	165.62			22	
Mean[1]	11.59	350.6					0.15	25.33			17.1	
Median	11.62	396					0.12	5			18.01	
WQ standard[2]	5.00	126/1260	0.04			6.5 – 9.0		100				20
# WQ exceedances[3]	0/11	6/7						1/11				
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	214	

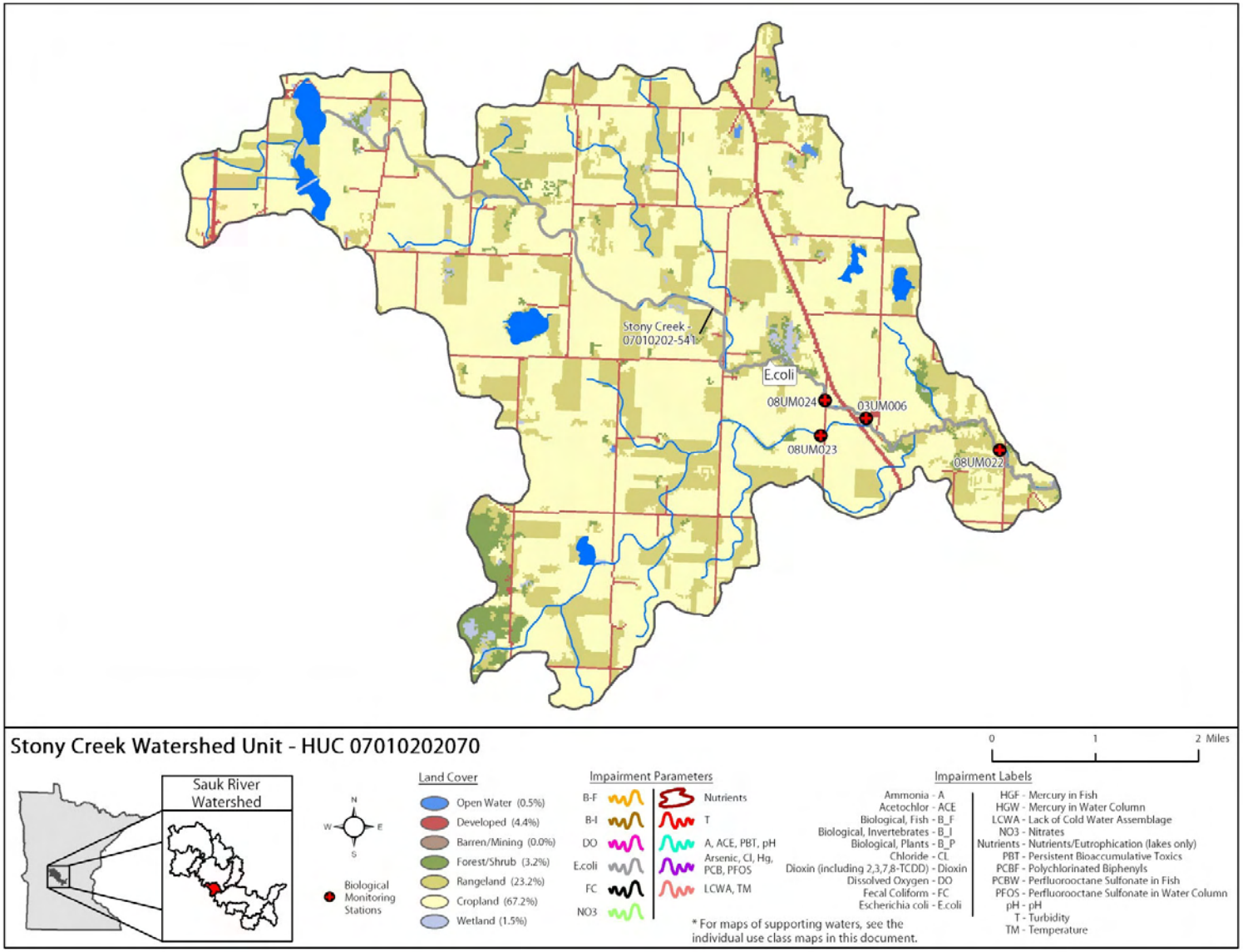
[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected by the SRWD at the pour point of Stony Creek. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

The results from 2008 surveys suggest Stony Creek is a degraded trout stream. Assessments of the biology on the main stem of Stony Creek were deferred in 2010 due to the potential of the stream possessing a cold water thermal regime, past accounts of the presence of a productive brook trout population and its historical designation as a coldwater fishery. Generally stream habitat conditions are excellent in the watershed. Isolated habitat concerns, occurring downstream in the watershed, are likely related to bank instability issues which have potential for improvement. There is a need to understand limiting factors inhibiting the brook trout population including thermal regime. Additional temperature loggers should be deployed throughout the reach to better understand the extent of the streams coldwater potential. Five lakes are located within the watershed and two are greater than 10 acres; there is currently no lake assessment level data in the watershed.

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Stony Creek Watershed Unit



Lower Sauk River Watershed Unit HUC 07010202080

Stretching 215 square miles across Stearns County, the Lower Sauk River Watershed Unit is the second largest subwatershed within the Sauk River system. Seventy nine lakes are within the watersheds boundaries. Upon leaving Middle Sauk Watershed, the Sauk River continues south and east past farmland, receiving the outflow of Getchell and Stony Creeks. In Richmond, the river widens losing velocity as it enters the Sauk River Horseshoe Chain of Lakes. The chain spans 2,224 acres, creating “more than 80 miles of continuous shoreline” while only flowing eight river miles. The extended shoreline has allowed for extensive lakeshore development and recreation opportunities for area residents. The Sauk River returns to its riverine nature after falling over the historic Cold Spring Dam. This portion of the watershed includes county parks and the Cold Spring Heron Colony Scenic and Natural Area. Mill Creek tributary joins the Sauk in aptly named Rockville, a river segment strewn with massive boulders. Gradient builds during the Sauk’s final decent to the Mississippi River, where the Sauk’s gradient reaches Class I to Class II level rapids. The pour point of this watershed unit is co-located with SRWD’s station: SR 4. This site is also the Sauk River Watershed’s fish contaminants monitoring station and is represented by MPCA biological station 08UM001.

Stream assessment

Table 34. Aquatic life and recreation assessments on assessed AUIDs in the Lower Sauk 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-598 **Trib to Sauk River** *Unnamed Ditch to Unnamed Cr*	08UM021	Downstream of 325th Ave, 2 mi. SE of Spring Hill	**FS**	**NS**	--	--	--	--	--	**NS**	NA
07010202-662 **Unnamed Creek** *Unnamed Cr to Sauk R*	08UM017	Downstream of 273rd Ave, 1.5 mi. NW of St. Martin	**NS**	FS	**--**	--	--	--	--	**NS**	NA
07010202-508 **Sauk River** *Getchell Cr to State Hwy 23*	08UM009 08UM018	Upstream of CR 111 W of Richmond Upstream of CR 12, 8 mi. SW of Albany	FS	FS	IF	FS	FS	--	--	**FS**	**NS**
07010202-660 **Trib. To Sauk River** *Unnamed Cr to Sauk R*	08UM016	Downstream of 290th St, 6 mi. SW of Albany	**NS**	**NS**	--	--	--	--	--	**NS**	NA
07010202-554 **Trib. to Sauk River** *Unnamed Cr to Unnamed Cr*	99UM064 *	W of Farming, 0.2 mi. N of Hwy 42, 1.6 mi. E of Hwy 10	FS*	**NS***	--	--	--	--	--	**NS**	**--**
07010202-556 **Unnamed Creek** *Unnamed Cr to Sauk R*	08UM012	Downstream of 260th St, 5 mi. NW of Richmond	**NS**	**NS**	--	--	--	--	--	**NS**	NA
07010202-663 **Trib to Unnamed Creek** *Unnamed Cr to Unnamed Cr*	08UM008	Upstream of Glenwood Rd, 1 mi. NE of Richmond	NA	**NS**	--	--	--	--	--	**NS**	NA
07010202-565 **Unnamed Creek (Kinzer Creek)** *Unnamed Lk to Knaus Lk*	--		--	**--**	**NS**	FS	FS	--	--	**NS**	**FS**
07010202-517 **Sauk River** *Knaus Lk to Cold Spring Dam*	--	--	--	--	IF	FS	FS	--	--	IF	**FS**
07010202-567 **Unnamed creek (Cold Spring Cr)** *T123 R30W S15, west line to Sauk R*	--	--	--	--	IF	--	FS	--	--	IF	**NS**
07010202-616 **Unnamed Creek** *Unnamed Cr to Schneider Lk*	--	--	--	--	**NS**	FS	FS	--	--	**NS**	IF
07010202-520 **Sauk River** *Cold Spring WWTP to Mill Cr*	08UM003	Upstream of Mill St N in Rockville	**NS**	**NS**	--	FS	FS	--	--	**NS**	**FS**
07010202-542 **Unnamed creek** *Unnamed Cr to Sauk R*	--	--	--	--	IF	**NS**	FS	--	--	IF	**NS**
07010202-501 **Sauk River** *Mill Cr to Mississippi R*	08UM001	Upstream of CR 4 in Waite Park	FS	FS	IF	**NS****	FS**	FS	FS	**NS**	**NS****

Abbreviations:

F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

*** Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized streams until after the adoption of Tiered Aquatic Life Uses.**

****Will be submitted to EPA for delisting in 2012, still show up as impaired on 2010 impaired waters list.**

Table 35. Non-assessed biological stations on channelized AUIDs in the Lower Sauk 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-659 Unnamed ditch Headwaters to T123 R33W S15, E line	08UM053	Downstream of CR 19, 0.5 mi. SW of Lake Henry	Poor	--
07010202-656 Trib to Sauk River Headwaters to Unnamed Cr	08UM020	Downstream of 260th St, 3.5 mi. SE of Spring Hill	Poor	--
07010202-661 Trib to Unnamed Creek Unnamed Cr to Unnamed Cr	08UM013	Upstream of CR 41, 6 mi. NW of Richmond	Fair	Poor
07010202-571* County Ditch 17 County Ditch 17 to Sauk R	08UM002*	Upstream of Hwy 23, 1.5 mi. SW of Waite Park	Poor	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).
*Class 7 AUID.

Table 36. Minnesota Stream Habitat Assessment (MSHA) for Lower Sauk 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	08UM053	Unnamed ditch	0	8	3	12	4	27	Poor
2	08UM021	Trib. to Sauk River	0	12	17.6	12.5	28	70.1	Good
1	08UM020	Trib. to Sauk River	1.5	14	17.6	11	25	69.1	Good
1	08UM018	Sauk River	5	11	17.6	13	19	65.6	Fair
1	08UM017	Trib. to Sauk River	1.8	14	16.8	14	25	71.6	Good
1	08UM016	Trib. to Sauk River	0	13.5	21.0	12	26	72.5	Good
1	08UM013	Trib. to Unnamed Creek	0	11	17.3	12	18	58.3	Fair
1	99UM064	Trib. to Sauk River	2.5	11	13.8	11	26	64.3	Fair
1	08UM012	Trib. to Sauk River	0	10.5	12	9	21	52.5	Fair
1	08UM009	Sauk River	1.3	13	9	11	23	57.3	Fair
1	08UM008	Trib. to Unnamed creek	2.5	14	20.7	10	20	67.2	Good
1	08UM003	Sauk River	5	11	15.6	15	23	69.6	Good
1	08UM002	County Ditch 17	2.5	12.5	20.3	13	25	73.3	Good
1	08UM001	Sauk River	0	8	18	7	18	51	Fair
Average Habitat Results: Lower Sauk 11 HUC Watershed			1.6	12	16.7	11.6	21.5	62.1	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)

Table 37. Pour point water chemistry results for the Lower Sauk 11 HUC

Station location:	Sauk River at 8th St N in Waite Park											
Storet ID:	S000-503											
Station #:	08UM001											
Parameter	D.O.	E. Coli	NH_3	NO_2 + NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	Deg C	cm
# Samples	11	6	11	11	11	11	11	11	10	11	11	11
Minimum	5.87	2	0.002	0.37	1.23	8.03	0.05	<1.00	<1.00	412	12.5	28.1
Maximum	11.30	144	0.02	1.48	2.06	8.66	0.21	28	14	572	24.2	100 +
Mean[1]	8.46	21.1	0.006	0.92	1.55	8.36	0.13	7.64	5.75	480	19.8	81.1
Median	8.38	44	0.005	1.04	1.43	8.37	0.14	4	5	486	22.1	93.2
WQ standard[2]	5.00	126/1260	0.04			6.5 - 9.0		100				20
# WQ exceedances[3]	0/11	1/6	0/11			0/11		0/11				0/11
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Lower Sauk 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 38. Lake water aquatic recreation assessments for the Lower Sauk 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Horseshoe	73-0157-00	596	H	50	57	14	NT	103	62	1	NS
Big Fish	73-0106-00	541	E	36	70	26	↗	47		5	FS
Long	73-0139-00	467	H	66	34	10	↗	97	62	1	NS
Cedar Island (Main Bay)	73-0133-01	420	E		18	15	↗	82	46	1	NS
Knaus	73-0086-00	309	H		23	6	NT	165	74	1	NS
North Brown's	73-0147-00	309	H	40	39	18	↘	121	41	2	NS
Pleasant	73-0051-00	219	E	49	33	13		55	7	3	FS
Great Northern	73-0083-00	210	H		14	6	NT	155	77	1	NS
Henry	73-0237-00	160	H		5			671	41	1	NS
Cedar Island (Koetter Lk)	73-0133-03	160	H	66	75	4	↗	157	79	1	NS
Long	73-0107-00	150	M	56	46		↗			3	IF
Bolting	73-0088-00	110	H		30	13	↗	128	56	1	NS
Zumwalde	73-0089-00	100	H	91	18	6	↗	156	65	1	NS
Krays	73-0087-00	81	H		31	7	NT	163	76	1	NS
Schneider	73-0082-00	59	E		52	20	NT	68	35	2	NS
Thein	73-0132-00	36	M					18	9	4	IF

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Summary

Lake water quality in the Lower Sauk Watershed is generally poor with many eutrophic and hypereutrophic lakes. A TMDL study is currently underway to address existing nutrient sources in the Horseshoe chain of lakes, Pleasant, Henry and Big Fish Lakes.

Impairments for biology on the main stem river in the subwatershed are isolated to the mid section of the river, below the Sauk Horseshoe Chain of Lakes and the outflow of wastewater discharge from the Cold Spring WWTP and Gold' N Plump Poultry (MN0047261) (07010202-520). Despite the biological impairments, stream habitat performs higher here than other main stem Sauk River sites in this subwatershed and assessed chemical parameters do not exceed water chemistry standards within the reach. In the 1980's and 1990's strides were made to reduce nutrient loading from major point source contributors throughout the watershed including municipal wastewater discharge. However, sufficient assessment information is still lacking for the assessment of dissolved oxygen, pH and NH3 in this AUID. Further monitoring of both water chemistry and biological indicators would be beneficial to understand the extent of impairment and whether or not the unassessed chemical parameters are influencing stream biology.

Several new biological impairments were identified on unnamed tributaries to the Sauk River as a result of intensive watershed monitoring completed in 2008. Additional monitoring of these streams is recommended to better understand stressors impacting these small systems.

Contrarily, a review of a newer and more comprehensive dataset for the Sauk River (07010202-501) was conducted after the draft 2010 TMDL list was prepared and sent to EPA. The review resulted in a delisting of turbidity and bacteria for this AUID. These parameters will still appear on the 2010 TMDL list. However, when the 2012 draft TMDL list is submitted to EPA these impairments will be removed from the list pending EPA review and approval.

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the upper half of the Lower Sauk River Watershed

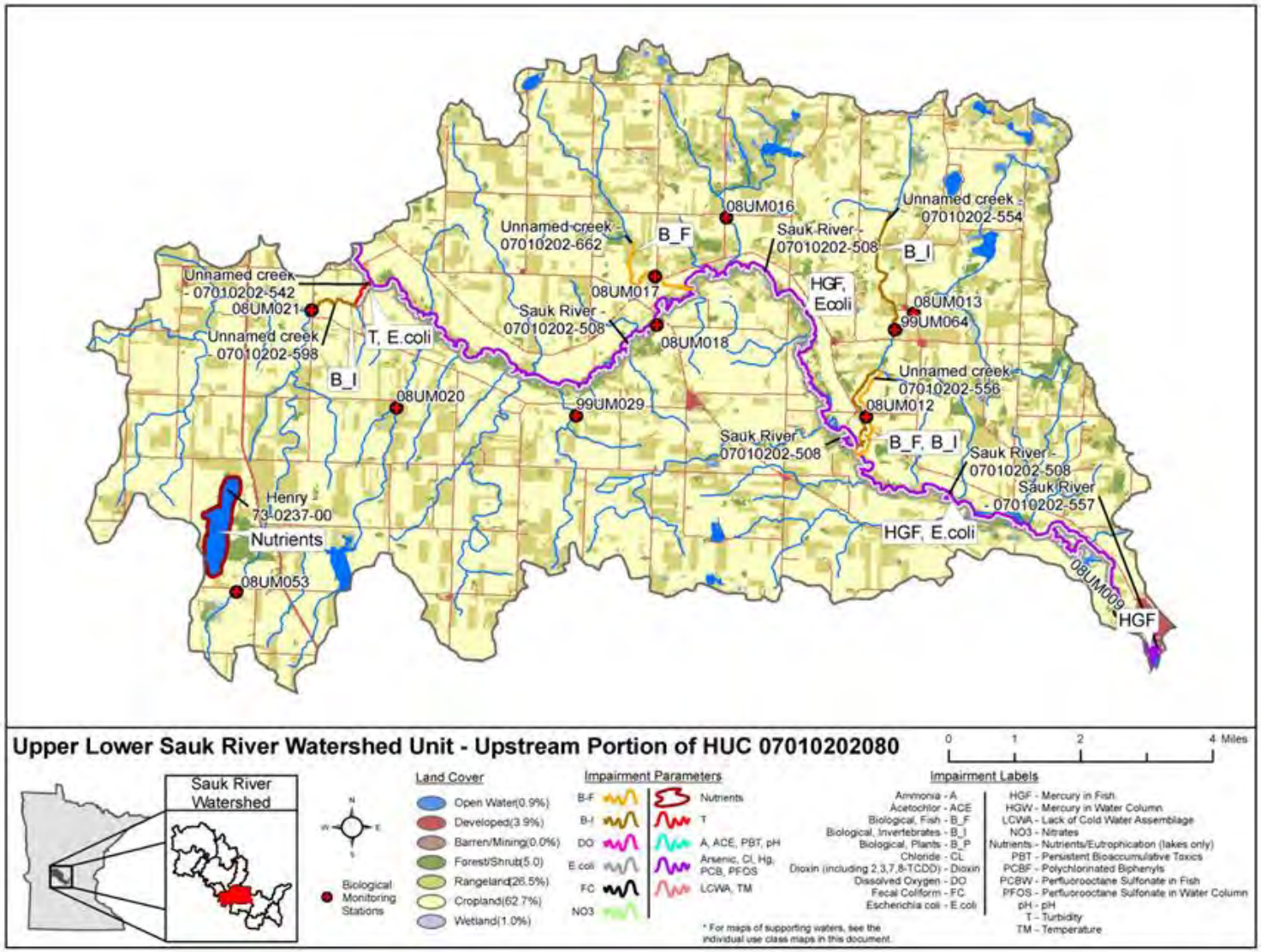


Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Horseshoe Chain of Lakes in the Lower Sauk River Watershed Unit

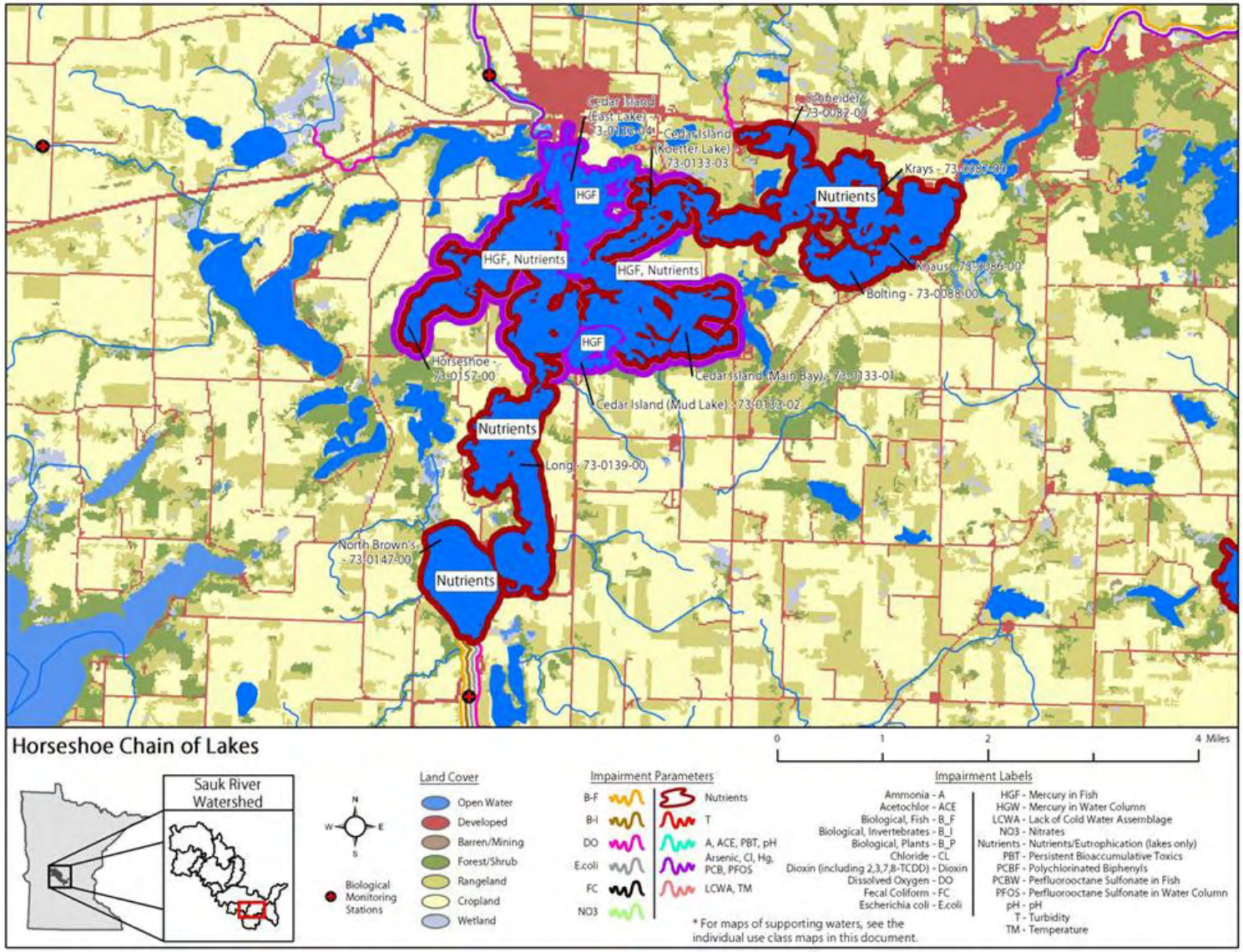
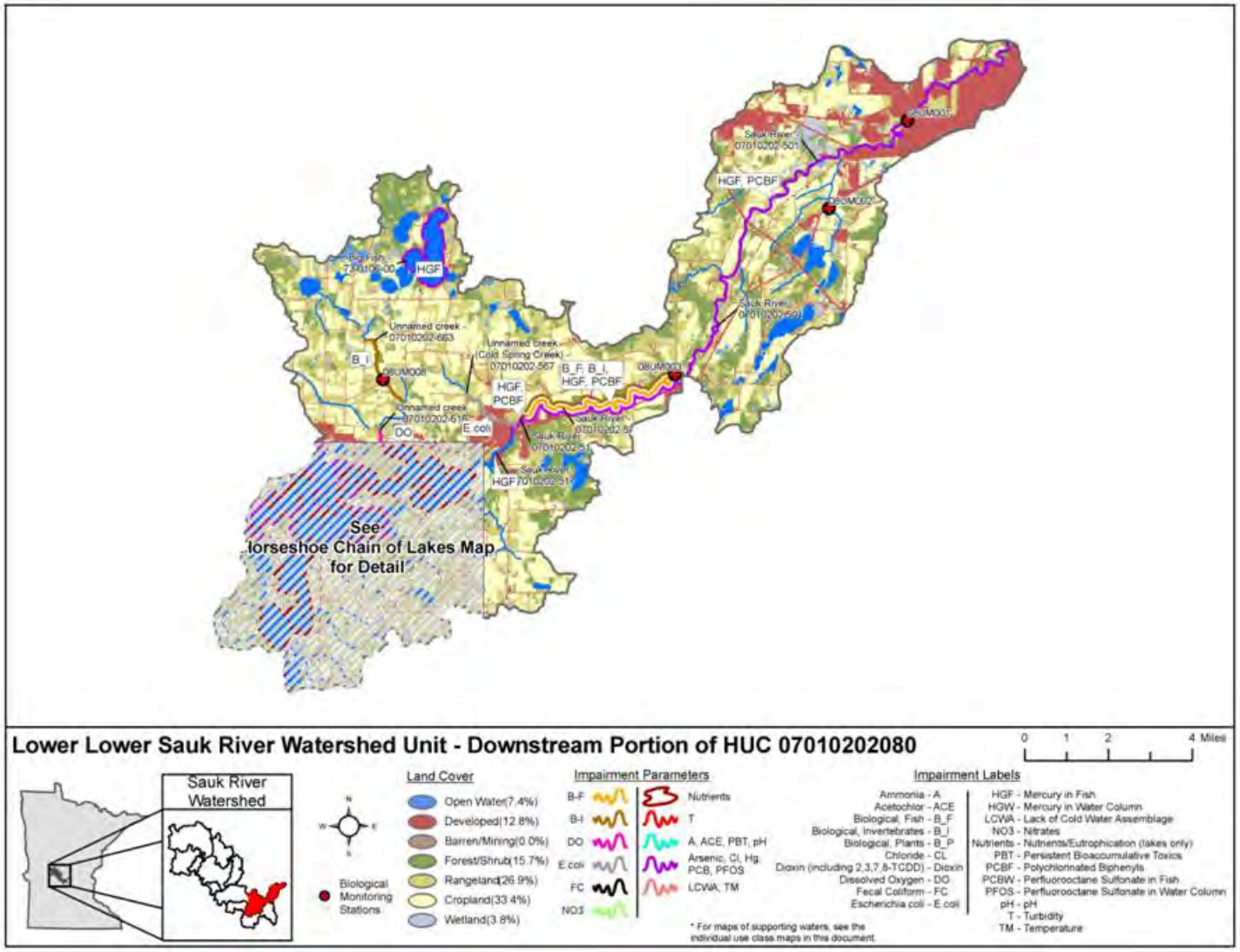


Figure 23. Currently listed impaired waters by parameter and land use characteristics in the lower half of the Lower Sauk River Watershed Unit



Roscoe Watershed Unit HUC 07010202090

Spanning 39 mi^2, the Roscoe Watershed Unit serves as the drainage for the outlying agrarian community of Roscoe in Stearns County. Sixty three percent of its land use is dedicated for crop production while 19 percent is held as rangeland. Kolling Creek starts southwest of Roscoe. This stretch is heavily channelized as it flows east past row crops and hayfields. A few miles past Roscoe the creek regains its natural sinuosity and an intact riparian buffer. The creek also loses gradient as it travels through a long series of wetland depressions before converging with Becker Lake, the westerly most lake in the Sauk Horseshoe Chain of Lakes. The watershed's nine lakes are located near its eastern boundaries, only two are greater than 200 acres. The pour point monitoring site of the watershed unit was collocated with the SRWD's monitoring station on Kolling Creek. It is not associated with a biological station due to its close proximity to Becker Lake.

Stream assessment

Table 39. Aquatic life and recreation Assessments on assessed AUIDs in the Roscoe 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-575 Kolling Creek Unnamed Cr to Becker Lk	--	--	--	--	**NS**	**FS**	**FS**	**FS**	**NA**	**NS**	**FS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

Table 40. Non-assessed biological stations on channelized AUIDs in the Roscoe 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-626 Trib. to Kolling Creek Unnamed Cr to Kolling Cr	**07UM096**	**Upstream of 246th Ave, 1 mi. NE of Roscoe**	**Poor (3)**	**Fair (2)**

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 41. Minnesota Stream Habitat Assessment (MSHA) for the Roscoe 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
3	07UM096	Trib. to Kolling Creek	1.3	7.3	16.7	12.3	17.7	55.4	Fair
Average Habitat Results: Pearl 11 HUC Watershed			1.3	7.3	16.7	12.3	17.7	55.4	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)

Table 42. Pour point water chemistry results for the Roscoe 11 HUC

Station location:	**Kolling Creek at CR 43, 2 mi. SE of Richmond**											
Storet ID:	**S000-917**											
Station #:	**None (WC Only)**											
Parameter	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l			mg/l	mg/l		uS/cm	C	cm
# Samples	11	7	10	10	9	10	11	11	10	10	11	10
Minimum	3.98	<1	0.001	<0.016	<0.7	7.44	<0.005	<1.00	<1.00	425	11.6	100+
Maximum	11.36	65	0.003	1.32	1.96	7.94	0.07	13	12	605	25.8	100+
Mean[1]	6.47	8.15	0.002	0.48	1.22	7.62	0.03	2.27	3.7	513.1	19	100+
Median	5.25	11	0.001	0.27	1.17	7.58	0.03	<1.00	3	268	19.4	100+
WQ standard[2]	5.00	126/1260	0.04			6.5 - 9.0		100				20
# WQ exceedances[3]	5/11	0/7	0/10	3/10		0/10		0/11				0/10
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	0/10

[1]Geometric mean of all samples is provided for *E. coli*.

[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25

[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

**Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Roscoe 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 43. Lake water aquatic recreation assessments for the Roscoe 11 HUC

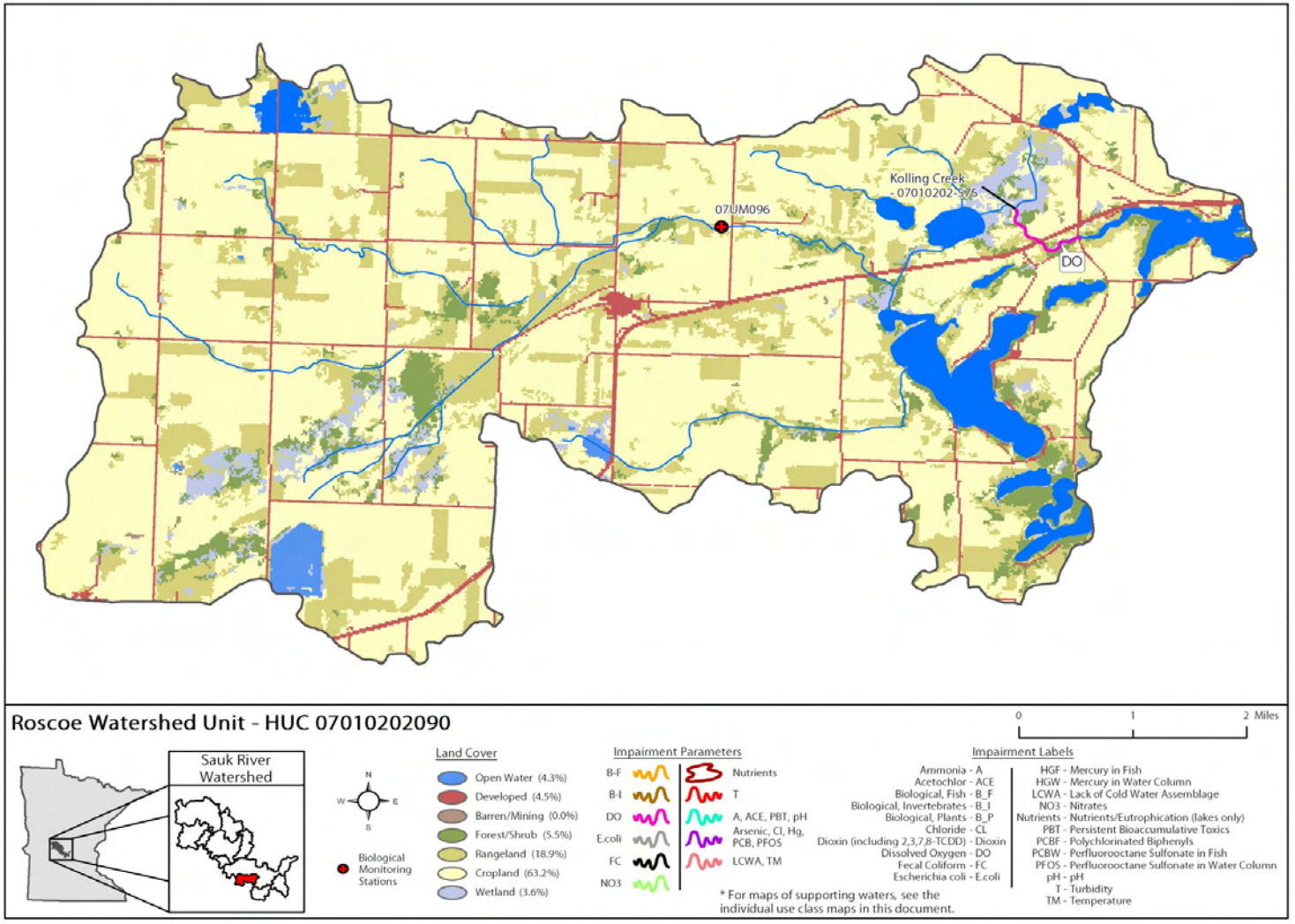
Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Big	73-0159-00	415	E	56	42	13	↗	29	13	2	FS
Becker	73-0156-00	251	E	97	20	2	↘	57	8	1	FS

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Summary

The stream biology in the Roscoe watershed is generally fair to poor, showing slight improvement in surveys conducted from 2007 to 2008. Big Lake, a riverine lake draining to Kolling Creek, has shown improvements in water quality since the 1970's (Lindon, 2010). The abundance of wetlands in the watershed, along with its low gradient nature, likely reduce dissolved oxygen levels in Kolling Creek's downstream reaches before its confluence with Becker Lake. Becker Lake, assessed as supporting for lake chemistry, occasionally has rapid increases in phosphorus and chlorophyll-a which may be a result of its small volume and large drainage area. More research is needed to investigate the cause and extent of the DO impairment on Kolling Creek.

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Roscoe Watershed Unit



Eden Valley Watershed Unit 07010202100

The Eden Valley Watershed Unit drains 43 mi^2 of rural Meeker and Stearns counties. Agricultural interests utilize nearly 90 percent of the watershed's land for cultivation and rangeland. The watershed's headwaters consist of small channelized streams and a Class 7 stream that empties into Vails and then Eden lakes. Historically, the Eden Valley wastewater treatment plant discharged effluent to this tributary, resulting in the stream's Class 7 designation. Currently effluent from treatment ponds is spray irrigated on agricultural fields on the southern borders of Vail's Lake (Greg VanEckhout, personal communication). Eden Lake drains north to Browns Lake, the southernmost basin in the Sauk River Horseshoe Chain of Lakes. The pour point of Eden Valley is served by biological station 08UM010 on the unnamed tributary connecting Eden and Browns Lakes.

Stream assessment

Table 44. Aquatic life and recreation assessments on assessed AUIDs in the Eden Valley 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-545 **Trib. to Brown's Lake** **Headwaters to Browns Lk**	08UM010	Upstream of CR 21, 2.5 mi. N of Eden Valley	NS	NS	NS	FS	FS	FS	FS	NS	NS

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
-- = No Data
NS = Non-Support

Table 45. Non-assessed biological stations on channelized AUIDs in the Eden Valley 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-648 **Trib to Vails Lake** *Unnamed Cr to Unnamed Cr*	08UM011	Upstream of 193rd Ave, 2 mi. E of Eden Valley	Poor	--
07010202-550* **Unnamed Ditch** *Unnamed Cr to Vails Lake*	08UM057	Downstream of CR 164, 1 mi. E of Eden Valley	Fair	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).
*Class 7 AUID.

Table 46. Minnesota Stream Habitat Assessment (MSHA) for the Eden Valley 11 HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	08UM011	Trib. to Vails Lake	3.3	9	9.3	12	4	37.6	Poor
1	08UM057	Unnamed ditch	0	12.5	20.4	12	32	76.9	Good
1	08UM010	Trib. to Browns Lake	1.3	10.5	17.9	12	21	62.7	Fair
Average Habitat Results: *Eden Valley 11 HUC Watershed*			0.7	10.7	15.9	12	19	59.1	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)

Table 47. Pour point water chemistry results for the Eden Valley 11 HUC

Station location:	Trib. To Browns Lake at CR 21, 2.5 mi. N of Eden Valley											
Storet ID:	S004-918											
Station #:	08UM010											
Parameter	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	C	cm
# Samples	8	5	8	8	8	8	8	8	7	8	8	8
Minimum	1.64	<1	0.0007	<.016	0.55	7.50	0.01	<1	<1	475	9.2	100 +
Maximum	9.68	65	0.008	1.34	2.53	8.33	0.22	10	5	568	28.2	100 +
Mean1	4.44	12.8	0.003	0.54	1.44	7.75	0.11	2.63	2.5	540	19	100 +
Median	4.01	32	0.002	0.46	1.49	7.70	0.12	1.5	3	553	19.6	100 +
WQ standard2	5.00	126/1260	0 .04			6.5 - 9.0		100				20
# WQ exceedances3	6/8	0/5	0/8			0/8		0/8				0/8
NCHF 75th Percentile4			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.

[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25

[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Eden Valley 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID**

Table 48. Lake water aquatic recreation assessments for the Eden Valley 11 HUC

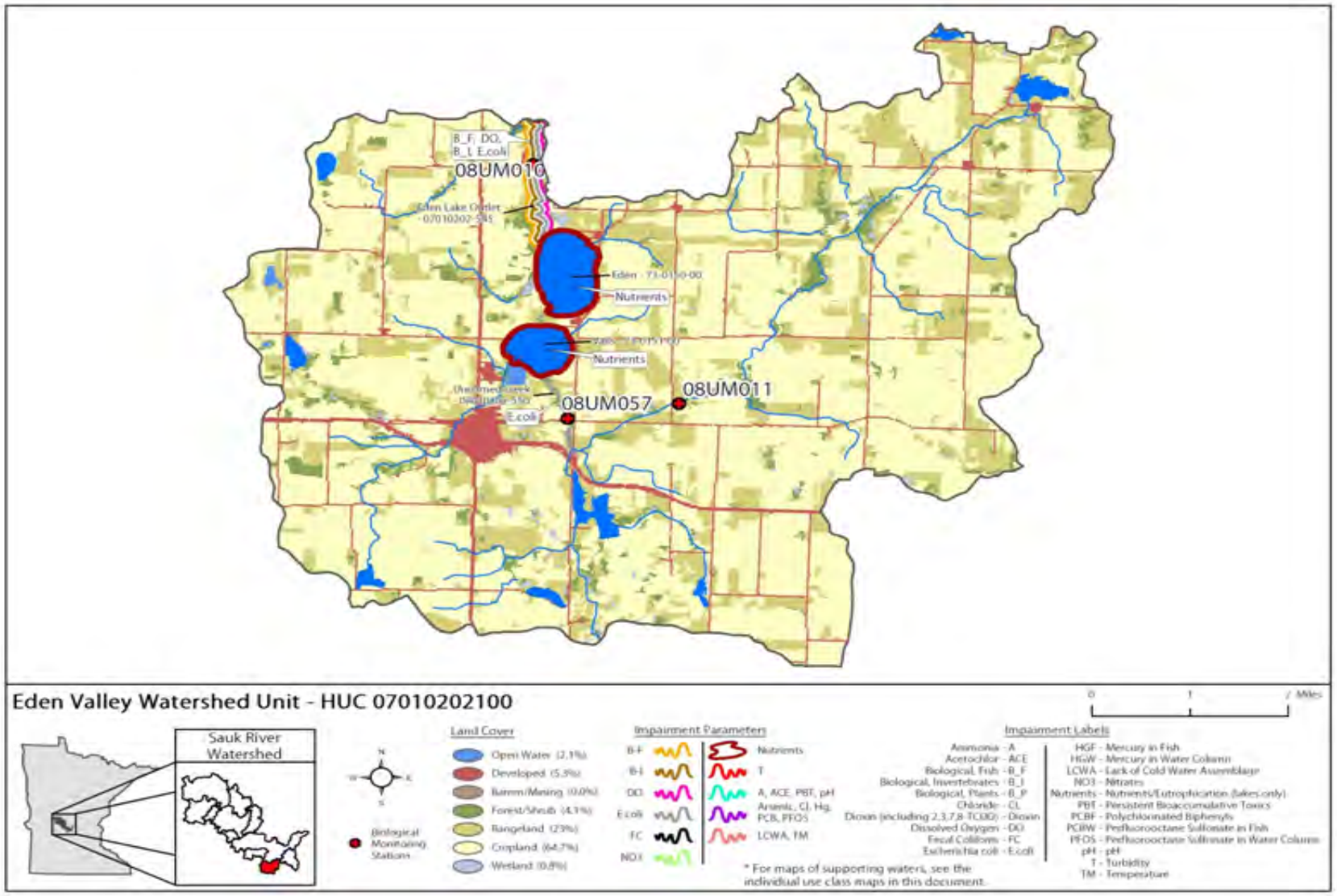
Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Eden	73-0150-00	260	H	47	77	19	NT	98	36	2	**NS**
Vails	73-0151-00	150	H	84	129	9	NT	192	63	1	**NS**

Abbreviations: ↘ -- Decreasing/Declining Trend; ↗ -- Increasing/Improving Trends; **NT** – No Trend; **H** – Hypereutrophic; **E** –Eutrophic; **M** – Mesotrophic; **O** – Oligotrophic; **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information

Summary

Channelization in the headwaters of the watershed and nutrient impairments flowing out of both Vails and Eden lakes equate to generally poor water quality conditions found across the watershed. The low gradient character and riparian wetlands of the tributary to North Brown's Lake may contribute to the DO impairment observed during 2008 and 2009 monitoring. Stream habitat in the lower half of the watershed is substantially better than may be expected considering present land use and the pervasive water quality problems.

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Eden Valley Watershed Unit



Pearl Lake Watershed Unit HUC 07010202110

The Pearl Lake Watershed Unit is fairly water rich considering its small size of 48.3 mi^2, holding 31 lakes and the tributary of Mill Creek. The watershed drains southeastern Stearns County in a northeasterly direction through agricultural land intermixed with forested regions. The watershed is equal only to the Adley and Prairie Creek Watershed Units in its percentage of forested land. Mill Creek originates in Goodner's Lake, flowing past Marty Lake and into Pearl Lake. From the Pearl Lake's outlet, the tributary increases gradient and flows north through a large expanse of intact hardwood forest. Mill Creek descends 13 feet over the dam in Rockville before joining the Sauk River. The pour point monitoring site in this watershed unit was co-located with a SRWD monitoring station, located below the dam on Mill Creek; however, this station is not associated with a biological site due to its close proximity to the Sauk River.

Stream assessment

Table 49. Aquatic life and recreation assessments on assessed AUIDs in the Pearl Lake 11 HUC

AUID	Site ID	Biological Sampling Location	F-IBI	M-IBI	DO	T	Cl	pH	NH_3	Aq. Life	Aq. Rec.
07010202-674 Mill Creek *Headwaters to Pearl Lk*	08UM006	Upstream of CR 48 in Marty	NS	NS	IF	FS	FS	--	--	**NS**	**NS**
07010202-665 Unnamed Ditch *Headwaters to Pearl Lk*	--	--	NA	--	IF	FS	FS	--	--	IF	**NS**
07010202-676 Mill Creek *Pearl Lk to Sauk R*	08UM004 08UM005	Downstream of Mill St, .5 mi. SE of Rockville Upstream of Agate Beach Rd, 2 mi. SE of Rockville	FS	FS	IF	FS	FS	FS	FS	**FS**	**NS**

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment
NA = Not Assessed
IF = Insufficient Information
NS = Non-Support
FS = Fully Support
-- = No Data

Table 50. Non-assessed biological stations on channelized AUIDs in the Pearl Lake 11 HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010202-665 **Trib to Pearl Lake** *Headwaters to Pearl Lk*	08UM007	Upstream of CR 147, 1 mi. S of Marty	Poor	--

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 51. Minnesota Stream Habitat Assessment (MSHA) for the Pearl Lake 11 HUC

			Land Use	Riparian	Substrate	Fish Cover	Channel Morph.	MSHA Score	MSHA
Visits	**Site ID**	**Stream Name**	**(0-5)**	**(0-15)**	**(0-27)**	**(0-17)**	**(0-36)**	**(0-100)**	**Rating**
1	08UM004	Mill Creek	1.5	11.5	18	13	20	64	Fair
1	08UM007	Trib. to Pearl Lake	0	11	3	13	13	40	Poor
2	08UM005	Mill Creek	4.8	14	23.3	15	27.5	84.5	Good
1	08UM006	Mill Creek	2.5	13	7	12	26	60.5	Fair
Average Habitat Results: *Pearl 11 HUC Watershed*			2.2	12.4	12.8	13.3	21.6	62.3	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)

Table 52. Pour point eater chemistry results from the Pearl Lake 11 HUC

Station location:	Mill Creek at Broadway Ave in Rockville											
Storet ID:	S000-444											
Station #:	N/A (WC ONLY)											
Parameter	D.O.	E. Coli	NH_3	NO_2+NO_3	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	C	cm
# Samples	10	6	10	10	10	10	10	10	10	10	10	10
Minimum	6.98	8	0.001	<0.016	0.47	7.93	0.01	<1.0	<1.00	308	10.2	68.5
Maximum	11.30	127	0.007	0.98	2.02	8.42	0.24	8	11	460	28.6	100+
Mean[1]	8.84	50.41	0.004	0.42	1.27	8.24	0.09	3.96	5.15	398	19.3	93.9
Median	8.55	69.5	0.004	0.26	1.17	8.27	0.09	3.5	3.5	408	20.7	100+
WQ standard[2]	5.00	126/1260	0 .04			6.5-9.0		100				20
# WQ exceedances[3]	0/10	1/6	0/10			0/10		0/10				0/10
NCHF 75th Percentile[4]			0.2	0.12			0.17			310	24	

[1]Geometric mean of all samples is provided for *E. coli*.

[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25

[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Pearl Lake 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 53. Lake water aquatic recreation assessments for the Peal Lake 11 HUC

Name	DOW#	Area	Trophic Status	% Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	ARUS
Pearl	73-0037	751	E	70	17	10	NT	40	16	2	**NS**
Grand	73-0055	649	E	36	30	19	↗	31	11	2	FS
School Section	73-0035	193	E	100	12	8	NT	37	9	3	FS
Goodners	73-0076	190	E	65	23	8		70	21	2	**NS**
Carnelian	73-0038	186	M	39	32	14		15	5	5	FS
Rausch	73-0057	71	H							0	IF

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E –Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

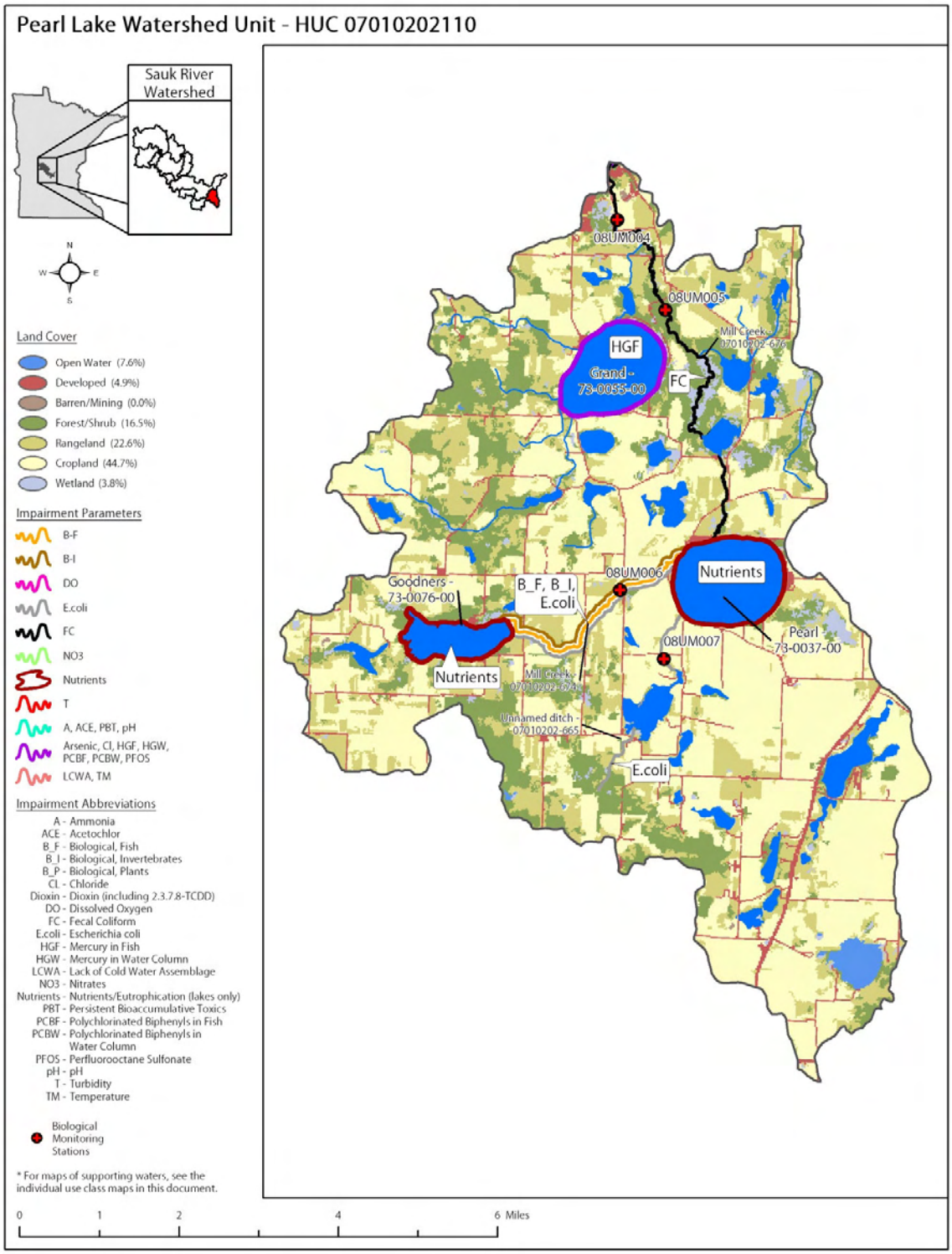
Summary

Water quality concerns in the headwaters of the Pearl Lake Watershed may be negatively impacting the biology in the upstream reaches of Mill Creek. Goodner's Lake, Mill Creek's source, is impaired for nutrients. Low gradient features in the upper watershed may contribute to the low dissolved oxygen concentrations observed in the creek. Before turning north the stream passes through impaired Pearl Lake. Pearl may potentially act as a sink for many of the water chemistry concerns in the upper reaches of the watershed.

Downstream of the lake a dramatic change occurs; gradient increases and aquatic biota thrive, exceeding upper confidence limits in both fish and macroinvertebrate IBIs. Here we find the best performing biological communities in the entire Sauk River watershed; which are in agreement with the high quality of stream habitat observed in Mill Creek. However, Mill Creek was listed in 2006 for a bacteria impairment. In 2004, 125,000 gallons of manure spilled into Mill Creek in Rockville before entering the Sauk River. E. coli monitoring conducted over the past few year's shows only two exceedances from 29 samples collected, suggesting that bacteria levels have improved in recent years.

With one of the highest percentages of forested land use remaining in the Sauk River Watershed, the relatively good water quality conditions observed on Grand, School Section and Carnelian lakes, along with the superior biology observed in its downstream reaches, the Pearl Lake Watershed is a prime candidate for watershed protection measures.

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Pearl Lake Watershed Unit



VII. Watershed-Wide Results and Discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Sauk River, grouped by sampling type. Summaries are provided for aquatic life and recreation uses in streams and lakes throughout the watershed, for aquatic consumption results at select river and lake locations along the watershed and for load monitoring data results near the mouth of the river.

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 Sauk River Watershed.

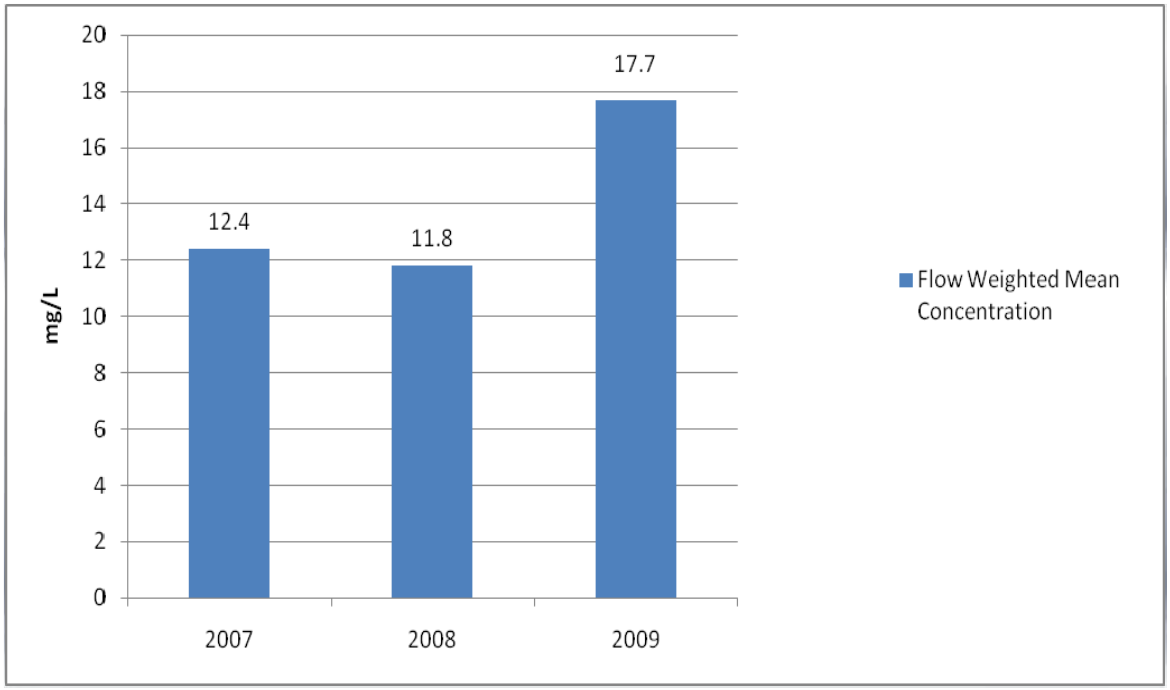
Load monitoring

Loads were calculated for the Sauk River using flow data from the USGS gage at Waite Park and chemistry from the MPCA station just upstream of the discharge point into the Mississippi River. Loads were calculated for the years 2007 through 2009. Chemistry data for 2007 does not include the winter months. The 2008 and 2009 data is year-round.

Total suspended solids

Currently, the State of Minnesota does not have a river standard for TSS but does have one for turbidity. Because turbidity is an optical measure and not a measure of mass, TSS "surrogate" standards for turbidity were developed for ecoregions of the state and are applicable to water quality data collected within each respective ecoregion. Total suspended solids concentrations in the Sauk River of 100 mg/L or greater are considered out of compliance with the turbidity standard of 25 Nephelometric Turbidity Units (NTU's). TSS flow weighted mean concentrations (FWMC'S) (Figure 27) and loads (Table 54) do not show a clear trend.

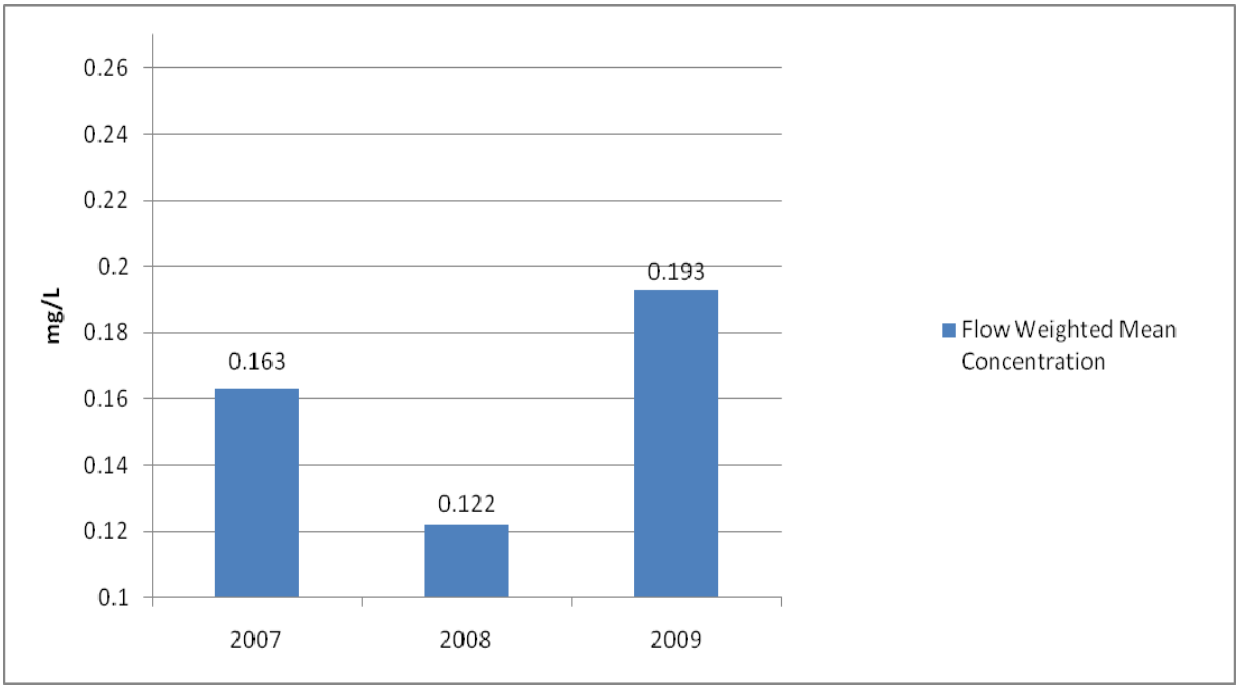
Figure 27. Total Suspended Solids (TSS) flow weighted mean concentrations for the Sauk River



Total phosphorus

Total phosphorus standards for Minnesota's rivers are currently in the "draft phase." Many years of water quality data from throughout Minnesota combined with previous analyses of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique standards. The Sauk River's load monitoring station is located within the south RNR which has a TP draft standard of 0.100 mg/L. All TP FWMC's exceed the draft standard, ranging from 0.122 mg/L to 0.193 mg/L (Figure 28). However, these proposed standards apply to concentrations, not to FWMC's.

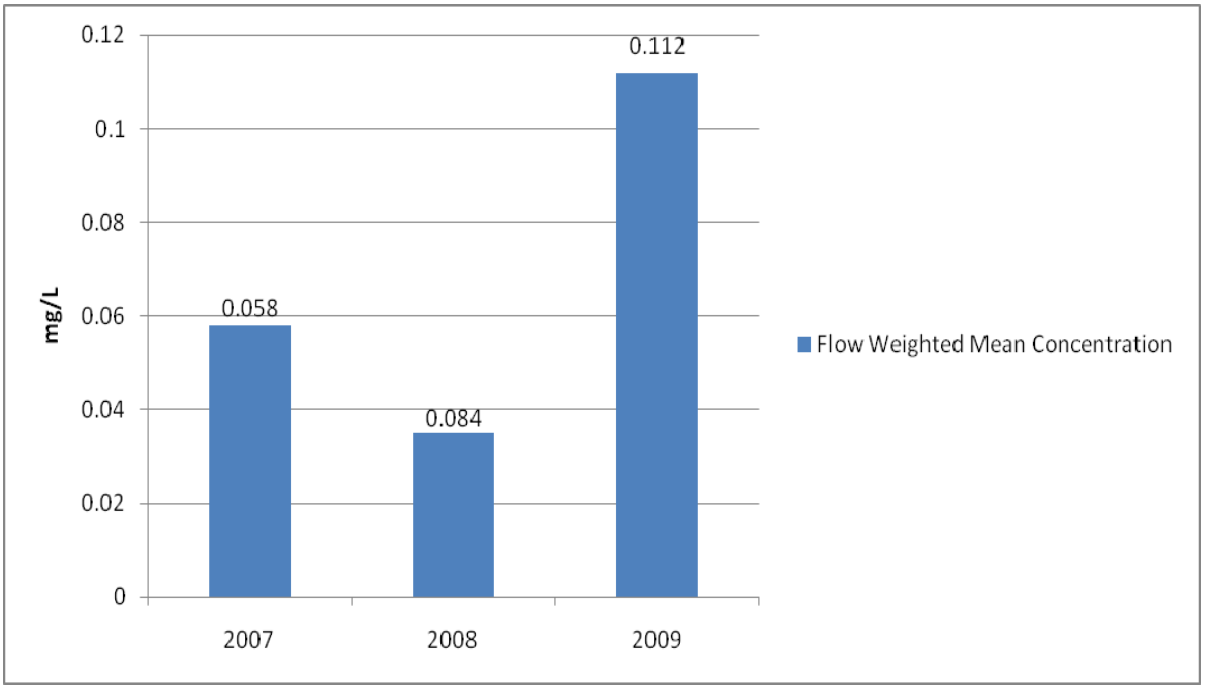
Figure 28. Total Phosphorous (TP) Flow Weighted Mean Concentrations for the Sauk River



Dissolved orthophosphate

Computation of OP to TP ratios from 2007 to 2009 show approximately 30 percent to 70 percent of TP is in the OP form.

Figure 29. Orthophosphate (OP) flow weighted mean concentrations for the Sauk River

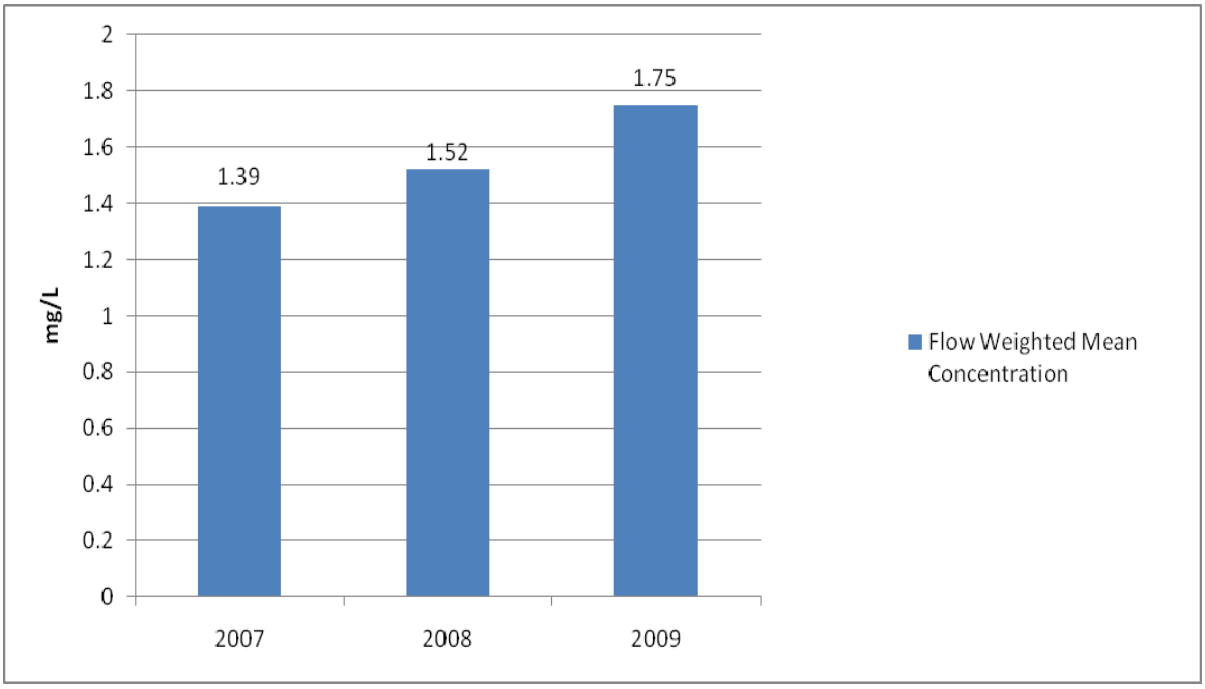


Nitrate plus nitrite - nitrogen

Currently nitrate-N standards are absent for Minnesota Rivers but are in the MPCA's "development phase," with a scheduled adoption deadline of May 2011. However, Minnesota does have a drinking water standard for nitrate-N. Elevated nitrate-N levels in the Mississippi basin contribute to hypoxia (low levels of dissolved oxygen) in the Gulf of Mexico. This occurs by nitrate-N stimulating the growth of algae which, through death and decay, consume large amounts of dissolved oxygen and thereby affect aquatic life.

Observation of FWMC's of nitrate-N within the Sauk River show concentrations well below the 10 mg/L drinking water standard (Figure 30). Calculations of the Sauk River's nitrate-N loads do not show a clear trend from 2007-2009 (Table 54).

Figure 30. Nitrate + nitrite (Nitrate-N) flow weighted mean concentrations for the Sauk River



Flow weighted mean concentrations (FWMC's) were calculated and compared for years 2007-2009. Results from 2007 – 2009 indicate that during years when high intensity rain events provide the greatest proportion of total annual runoff (Figure 31), concentrations of TSS and TP tend to be higher with OP and nitrate-N concentrations tending to be lower. During years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, OP, and nitrate-N levels may be elevated.

Figure 31. 2007-2009 Hydrograph and inches of runoff per year for the open water season of 2007, 2008 and 2009

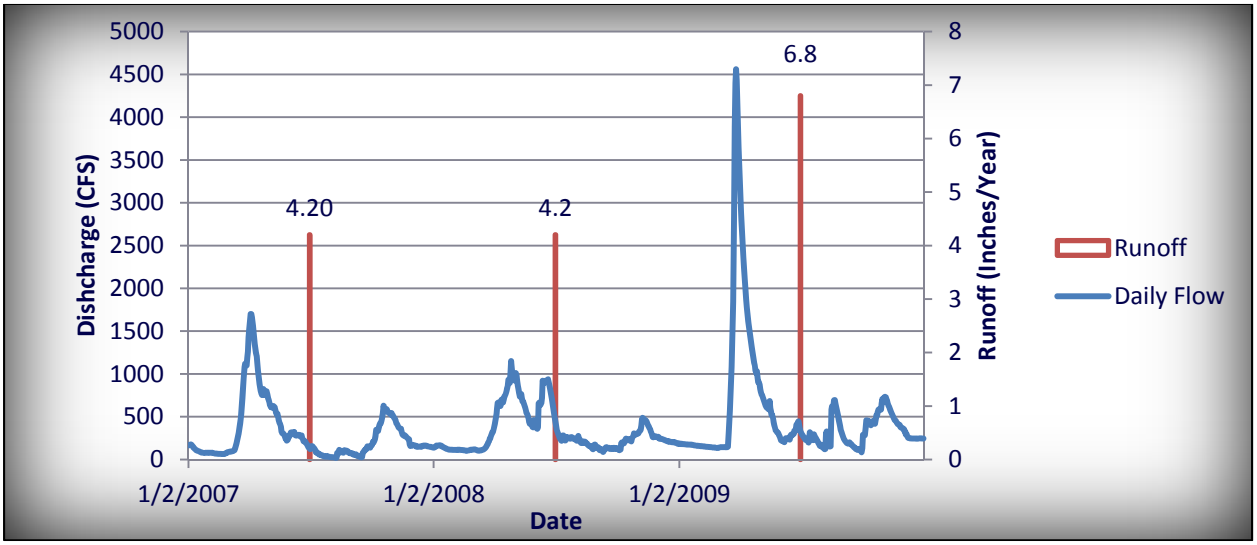


Table 54. Annual Loads for 2008 and 2009 and open water season loads for 2007 by parameter calculated for the Sauk River

	2007	2008	2009
Parameter	Mass (kg)	Mass (kg)	Mass (kg)
Total Suspended Solids	13,653,000	13,333,000	13,201,000
Total Phosphorus	48,000	36,000	64,000
Ortho Phosphorus	36,000	15,000	40,000
Nitrate + Nitrite Nitrogen	263,000	314,000	330,000

Stream water quality

Thirty nine of the 84 stream AUIDs were assessed (Table 55). Of the assessed streams, only eight streams were considered to be fully supporting of aquatic life and 11 of aquatic recreation. Three AUIDs were not assessed due to their classification as limited resource waters. Twenty six AUIDS were not assessed for aquatic biology because greater than 50 percent of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID. Two AUIDs were not assessed for aquatic biology due to their coldwater thermal regimes and the lack of appropriate assessment tools to assess the sites during the 2010 assessment cycle. One AUID will be delisted for an aquatic life and recreation impairment in 2012 pending EPA approval.

Throughout the watersheds 30 AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, 23 are non-supporting for aquatic life and 24 are non-supporting for aquatic recreation. Aquatic biological impairments on the mainstem river are isolated downstream of nutrient impaired riverine lake complexes but are scattered across its upper, middle and lower reaches. Other biological impairments on main stem tributaries are isolated to natural streams that can be assessed (Ashley Creek, the headwaters of Mill Creek and the outlet of the Eden Valley subwatershed) and impairments listed during 2006 assessments on channelized reaches (Getchell Creek and Crooked Lake Ditch). Several small unnamed tributaries feeding the main stem river have also been added to the impaired waters list during the watershed's 2010 assessment. A mainstem impairment for turbidity is isolated to the Sauk River's upstream reach, below Juergens Lake and upstream of Sauk Lake. Water chemistry impairments involving low dissolved oxygen impact four of the Sauk River's major tributaries, including: Ashley, Getchell and Kolling (Roscoe) Creeks and the outlet of the Eden Valley watershed. High bacteria concentrations are a common concern across the watershed affecting the upper reaches in Ashley Creek and an area stretching from Adley Creek to its discharge to the Sauk River and downstream to the Sauk Rivers confluence with the Horseshoe Chain of Lakes and the Eden Valley and Mill Creek subwatersheds. Nutrient (total phosphorus and total Kjeldahl nitrogen) concentrations are generally meeting ecoregion expectations.

Table 55. Assessment summary for stream water chemistry in the Sauk River Watershed

			Supporting		Non-support		
Waterbody	**Area (acres)**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**
Sauk River HUC 8	**667,212**	**39**	**8**	**11**	**23**	**24**	**50**
Upper Sauk	144,337	8	3	3	4	1	14
Ashley Creek	72,152	2	0	0	2	1	5
Hoboken Creek	18,155	1	0	1	0	0	1
Middle Sauk	95,181	3	0	1	3	1	6
Adley and Prairie Creeks	57,134	2	2	0	0	1	5
Getchell Creek	42,616	2	0	0	2	2	1
Stony Creek	16,467	1	0	0	0	1	1
Roscoe	25,241	1	0	1	1	0	1
Eden Valley	27,561	1	0	0	1	1	1
Pearl Lake	30,891	3	1	1	1	3	3
Lower Sauk	137,477	14	2	4	9	3	9

Lake water quality

Understanding the dynamics of how water travels through the Sauk River and its tributaries is critical to understanding the water quality of the watershed's lakes. In general the lake water quality in the Sauk River Watershed in modest to poor; 70 percent of assessed lakes are designated as non-support for aquatic recreation. Non-supporting lakes include Little Sauk, Horseshoe and Knaus lakes as well as the shallow, elongated, riverine lakes in the upper portions of the watershed. These lakes types offer little wind protection which allows for resuspension of sediments due to mixing. Good water quality conditions were seen in Pleasant, Kings and Little Birch lakes. A deep basin, the presence of several upstream lakes, or heavily forested catchments may be factors contributing to the superior conditions observed in these lakes. Numerous monitoring, assessment and improvement projects are currently underway in the watershed aimed at improving lake quality, with a predominate focus on reducing phosphorous contributions from non-point sources in the watershed. Bringing the watershed's lakes into compliance with water quality standards is an immense task when considering the scale and complexity of the problem.

No general trends or patterns were seen in lake quality longitudinally through the watershed. CLMP water quality trends analysis indicate improving conditions in 16 lakes with only three lakes showing declining trends in water clarity.

Table 56. Assessment summary for lake water chemistry in the Sauk River Watershed

Waterbody	Area (acres)	Total Lakes	Protected Lakes	Lakes >10 Acres	Lake <10 Acres	Full Support	Non-support	Insufficient Data
Sauk River HUC 8	**667,212**	***374**	***168**	***38**	***128**	**13**	**31**	**11**
Upper Sauk	144,337	85	40	9	31	1	10	4
Ashley Creek	72,152	28	17	7	10		1	
Hoboken Creek	18,155	5	4	1	3			
Middle Sauk	95,181	61	20	3	17	3	3	2
Adley and Prairie Creeks	57,134	47	22	3	19	2		1
Getchell Creek	42,616	16	8	8	0		1	1
Stony Creek	16,467	5	4	2	2			
Roscoe	25,241	9	4	1	3	2		
Eden Valley	27,561	8	3	0	3		2	
Pearl Lake	30,891	31	12	1	11	3	2	1
Lower Sauk	137,477	79	34	3	29	2	12	2

Fish contaminant results

Mercury

Mercury data was available for 12 fish species in the Sauk River watershed. Median mercury concentrations in the river fish ranged from 0.09 to 0.38 mg/kg; in lakes, the medians ranged from 0.01 to 0.47 mg/kg. As is typically seen in Minnesota lakes, walleye and northern pike had the highest mercury concentrations. The highest mercury concentration, 0.80 mg/kg, was in a walleye from Sauk River, above the Melrose dam. As a benchmark for the mercury concentrations, summary statistics are shown for years 2000 to 2008 from the Minnesota Fish Contaminant Program database (Table 58). Walleye and northern pike have very similar ranges of mercury concentrations, with the statewide mean mercury concentrations of 0.34 mg/kg and 0.36 mg/kg, respectively. Most of the high mercury concentrations in sport fish were from northern Minnesota lakes due to the watershed and water chemistry characteristics of the northern waters.

The 2010 Impaired Water Inventory includes nine of the 10 lakes in the watershed with mercury tissue data. Pearl Lake (73-0037) was not in the inventory because the only species tested from the lake, bluegill sunfish, had a 90th percentile of 0.131 mg/kg (well below the 0.2 mg/kg threshold for impairment. The 90th percentiles for the other nine lakes were between 0.2 to 0.57 mg/kg, which qualifies for inclusion in the Minnesota Statewide Mercury TMDL (http://www.pca.state.mn.us/water/tmdl/tmdl-mercuryplan.html). Therefore, these lakes have a completed TMDL. The Sauk River, above the Melrose dam, had 90th percentiles for northern pike and walleye that exceeded 0.57 mg/kg and, therefore, a TMDL is still required.

The goal for the statewide mercury TMDL is for the 90th percentile of mercury concentrations in top predator species to be less than 0.2 mg/kg. Implementation of the mercury TMDL is focused primarily on reducing mercury emissions to the atmosphere, because wastewater point source discharges are less than one percent of the total mercury load to the state. Descriptive statistics for fish total length and mercury concentrations are summarized by waterway and species in Table 57.

Table 57. Descriptive statistics of mercury concentrations by waterway and species

			Length (in)				Hg (mg/kg)				
Waterway	**Lake ID**	**Species**	**N**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Median**	**90th pctl**
Sauk River - Above Melrose Dam		Bluegill sunfish	1	6.5	6.5	6.5	0.089	0.089	0.089	0.089	NA
		Carp	3	19.1	31.1	24.3	0.115	0.152	0.135	0.138	0.152
		Northern Pike	5	14.0	22.0	18.6	0.217	0.643	0.405	0.377	0.643
		Walleye	8	11.5	21.2	15.4	0.255	0.802	0.401	0.342	0.709
Sauk River - Cold Spring Dam to Mississippi River		Carp	3	10.8	26.1	20.0	0.019	0.140	0.100	0.140	0.140
		Smallmouth Bass	2	8.7	14.1	11.4	0.050	0.091	0.071	0.071	0.091
		Walleye	2	11.7	15.5	13.6	0.075	0.160	0.118	0.118	0.160
		Smallmouth Bass	6	12.2	17.9	14.8	0.181	0.213	0.199	0.201	0.213
		White Sucker	3	14.5	16.3	15.5	0.083	0.167	0.125	0.125	0.167
Pearl	73-0037-00	Bluegill sunfish	8	6.2	7.8	7.1	0.037	0.144	0.076	0.072	0.131
Grand	73-0055-00	Bluegill sunfish	1	6.7	6.7	6.7	0.015	0.015	0.015	0.015	NA
		Northern pike	10	16.2	31.9	21.5	0.023	0.100	0.051	0.036	0.095
		Walleye	10	15.3	27.3	20.5	0.033	0.460	0.118	0.083	0.290
		Yellow bullhead	1	10.7	10.7	10.7	0.030	0.030	0.030	0.030	NA
Big Fish	73-0106-00	Bluegill sunfish	1	6.0	6.0	6.0	0.060	0.060	0.060	0.060	NA
		Northern pike	4	17.8	30.0	24.1	0.140	0.280	0.228	0.245	0.280
		White sucker	1	19.2	19.2	19.2	0.044	0.044	0.044	0.044	NA
Cedar Island	73-0133-00	Black crappie	1	7.7	7.7	7.7	0.074	0.074	0.074	0.074	NA
		Carp	1	24.9	24.9	24.9	0.188	0.188	0.188	0.188	NA
		Channel catfish	5	17.4	22.3	19.6	0.062	0.216	0.106	0.083	0.216
		Northern pike	5	21.1	28.9	25.2	0.151	0.230	0.187	0.184	0.230
		Walleye	4	18.5	24.9	21.3	0.236	0.382	0.284	0.259	0.382
Horseshoe	73-0157-00	Black crappie	1	8.2	8.2	8.2	0.072	0.072	0.072	0.072	NA
		Channel catfish	5	15.8	23.3	20.0	0.067	0.196	0.142	0.151	0.196
		Northern pike	5	16.2	34.3	25.3	0.110	0.250	0.180	0.160	0.250
		White sucker	1	20.0	20.0	20.0	0.170	0.170	0.170	0.170	NA
Big Birch	77-0084-00	Black crappie	1	10.0	10.0	10.0	0.080	0.080	0.080	0.080	NA
		Carp	1	17.5	17.5	17.5	0.036	0.036	0.036	0.036	NA
		Cisco	1	16.7	16.7	16.7	0.130	0.130	0.130	0.130	NA
		Largemouth bass	1	10.9	10.9	10.9	0.230	0.230	0.230	0.230	NA
		Northern pike	4	14.5	27.4	20.6	0.140	0.400	0.258	0.245	0.400

		Shorthead redhorse	1	17.2	17.2	17.2	0.037	0.037	0.037	0.037	NA
		Walleye	3	13.1	21.4	17.3	0.220	0.310	0.277	0.300	0.310
		White sucker	2	16.3	20.3	18.3	0.023	0.074	0.049	0.049	0.074
		Yellow perch	1	7.0	7.0	7.0	0.110	0.110	0.110	0.110	NA
Little Birch	77-0089-00	Bluegill sunfish	1	6.8	6.8	6.8	0.089	0.089	0.089	0.089	NA
		Cisco	1	17.3	17.3	17.3	0.281	0.281	0.281	0.281	NA
		Northern pike	6	19.4	28.1	22.2	0.253	0.483	0.363	0.370	0.479
		Walleye	5	17.5	21.0	19.6	0.415	0.519	0.475	0.466	0.519
Sauk	77-0150-00	Bluegill sunfish	1	6.9	6.9	6.9	0.010	0.010	0.010	0.010	NA
		Largemouth bass	9	7.4	15.1	12.5	0.010	0.360	0.097	0.035	0.290
		Northern pike	22	17.9	32.1	22.0	0.050	0.341	0.134	0.124	0.187
		Yellow perch	2	5.4	5.7	5.6	0.031	0.035	0.033	0.033	0.035
Maple	77-0181-00	Bluegill sunfish	1	7.8	7.8	7.8	0.084	0.084	0.084	0.084	NA
		Black crappie	1	9.8	9.8	9.8	0.157	0.157	0.157	0.157	NA
		Northern pike	6	19.8	24.2	22.0	0.203	0.270	0.244	0.258	0.270
Osakis	77-0215-00	Bluegill sunfish	1	8.1	8.1	8.1	0.110	0.110	0.110	0.110	NA
		Walleye	3	14.3	23.3	18.8	0.200	0.570	0.390	0.400	0.570
		White sucker	1	18.3	18.3	18.3	0.160	0.160	0.160	0.160	NA

NA - not available

Note: some of the species with N = 1 are composites of multiple fish in one sample, but 90th percentiles cannot be calculated

Table 58. Mercury concentrations of ten most abundant species in the Minnesota Fish Contaminant database from 2000-2008, sorted from highest to lowest mercury concentration

Species		Mercury Concentration (mg/kg - ww)					Total Fish Length (in)		
Common Name	Scientific Name	N	90th pctl	Min	Max	Mean	Min	Max	Mean
Walleye	*Sander vitreus*	2525	0.72	0.02	2.63	0.34	6.8	29.7	17.1
Northern Pike	*Esox lucius*	5293	0.71	0.01	2.95	0.36	7.5	45.5	22.2
Channel Catfish	*Ictalurus punctatus*	325	0.53	0.01	1.19	0.22	10	36	19.9
Smallmouth Bass	*Micropterus dolomieu*	528	0.46	0.02	1.24	0.25	1.2	20.3	12.9
Largemouth Bass	*Micropterus salmoides*	518	0.41	0.01	1.39	0.22	5.3	18.9	12.9
Common Carp	*Cyprinus carpio carpio*	359	0.31	0.01	0.70	0.16	4.5	35.9	21.8
Black Crappie	*Pomoxis nigromaculatus*	278	0.26	0.01	0.62	0.12	4.0	16.1	8.7
White Sucker	*Catostomus commersonii*	161	0.26	0.01	0.53	0.12	4.4	21.1	16.0
Yellow Perch	*Perca flavescens*	596	0.20	0.01	0.84	0.10	1.5	12.6	7.0
Bluegill Sunfish	*Lepomis macrochirus*	353	0.17	0.01	0.40	0.09	2.6	9.6	6.9

Polychlorinated Biphenyls (PCBs)

Fish were tested for PCBs in the Sauk River in 1995 and 2008 (Table). PCB concentrations were at or below the reporting limits in smallmouth bass, walleye and white sucker. Carp collected in 1995 were analyzed as three composite samples, ranging from two to eight fish per sample. The regular arithmetic mean for the three samples is equal to the threshold for impairment (0.22 mg/kg), whereas, a weighted average (each concentration weighted in proportion to the number of fish in the sample) was 0.28 mg/kg. Consequently, it is reasonable to conclude that the Sauk River is impaired for PCBs in fish tissue because of the carp concentration. Because the sample was collected in 1995, PCBs in carp above the Melrose dam should be tested as soon as feasible to determine if the reach continues to be impaired for PCBs. The Impaired Waters Inventory lists the lower reach of the Sauk River—Cold Spring dam to the Mississippi River—as impaired for PCBs in fish tissue; however, the PCB data that would have caused the impairment assessment were collected in 1978 and 1983. The 2008 testing of smallmouth bass and white sucker showed PCBs were below the reporting limit. PCBs should be tested again in carp from the lower reach as well to determine if the reach should be delisted from the Impaired Waters Inventory for PCBs.

Six of the lakes in the Sauk River watershed were tested for PCBs (Table). All of the lakes had concentrations of PCBs below the reporting limit, except for a two-fish composite of cisco from Big Birch Lake (77-0084), which was only slightly above the reporting limit (0.017 mg/kg). Therefore, no lakes are impaired for PCBs in fish tissue.

Table 59. Summary of the total PCBs concentrations by waterway and species: (a) Sauk River and (b) Sauk River Watershed lakes

Waterway	Lake ID	Species	PCBs (mg/kg)		
			N	Max	Mean
Sauk River - Cold Spring Dam to Mississippi River		Carp	3	0.42	0.22*
		Smallmouth bass	2	0.02	< 0.025
		Walleye	2	0.03	0.02
		White sucker	1	<0.025	< 0.025
Grand	73-0055-00	Walleye	1	< 0.01	< 0.01
Big Fish	73-0106-00	Northern pike	3	< 0.01	< 0.01
		White sucker	1	< 0.01	< 0.01
Cedar Island	73-0133-00	Carp	1	< 0.01	< 0.01
		Channel catfish	2	< 0.01	< 0.01
Horseshoe	73-0157-00	Channel catfish	1	< 0.01	< 0.01
		Northern pike	1	< 0.01	< 0.01
Big Birch	77-0084-00	Carp	1	< 0.01	< 0.01
		Cisco	1	0.017	0.017
		Northern pike	2	< 0.01	< 0.01
		Shorthead redhorse	1	< 0.01	< 0.01
		Walleye	2	< 0.01	< 0.01
		White sucker	1	< 0.01	< 0.01
Osakis	77-0215-00	Walleye	1	< 0.01	< 0.01

* Uniform average is 0.22 of 3 composite samples; average weighted by fish per composite is 0.28 mg/kg

Trends

Water Chemistry data were analyzed for trends for the long term period of record (1953-present) and near term period of record (1995-present). There were significant decreases in total phosphorus and significant increases in nitrite/nitrates and chlorides during the long term period of record. No trends were observed during the short term period of record. Citizen volunteer monitoring of stream and lakes occurs throughout the watershed. Water clarity has improved in 50 percent of the monitored stream sites and 45 percent of the monitored lakes.

Table 60. Trends in the Sauk River Watershed

Sauk River HUC 07010202	Total	Biochemical					
Period of Record: 1953 - present	Suspended	Oxygen	Total	Nitrite/	Unionized		
Site: S000-017 (SA-0)	Solids	Demand	Phosphorus	Nitrate	Ammonia	Chloride	pH
Overall Trend	**no trend**	**no trend**	**decrease**	**increase**	**no trend**	**increase**	**no trend**
avg. annual change			**-1.3%**	**4.4%**		**5.6%**	
(range: lower limit			(-1.7%)	(2.0%)		(3.8%)	
upper limit)			(-1.0%)	(7.7%)		(7.8%)	
total change			**-41%**	**439%**		**752%**	
(range: lower limit			(-50%)	(118%)		(329%)	
upper limit)			(-32%)	(1676%)		(1751%)	
(p-value)			0.00	0.00		0.00	
1995 - 2009 trend	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**

A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data. Ranges for annual and total changes are 90 percent confidence intervals.

Water clarity trends at citizen-monitoring sites

Sauk HUC 07010202	CSMP	CLMP
number of sites w/ increasing trend	3	16
number of sites w/ decreasing trend	0	3
number of sites w/ no trend	6	16

Figure 32. Fully supporting waters by designated use in the Sauk River Watershed

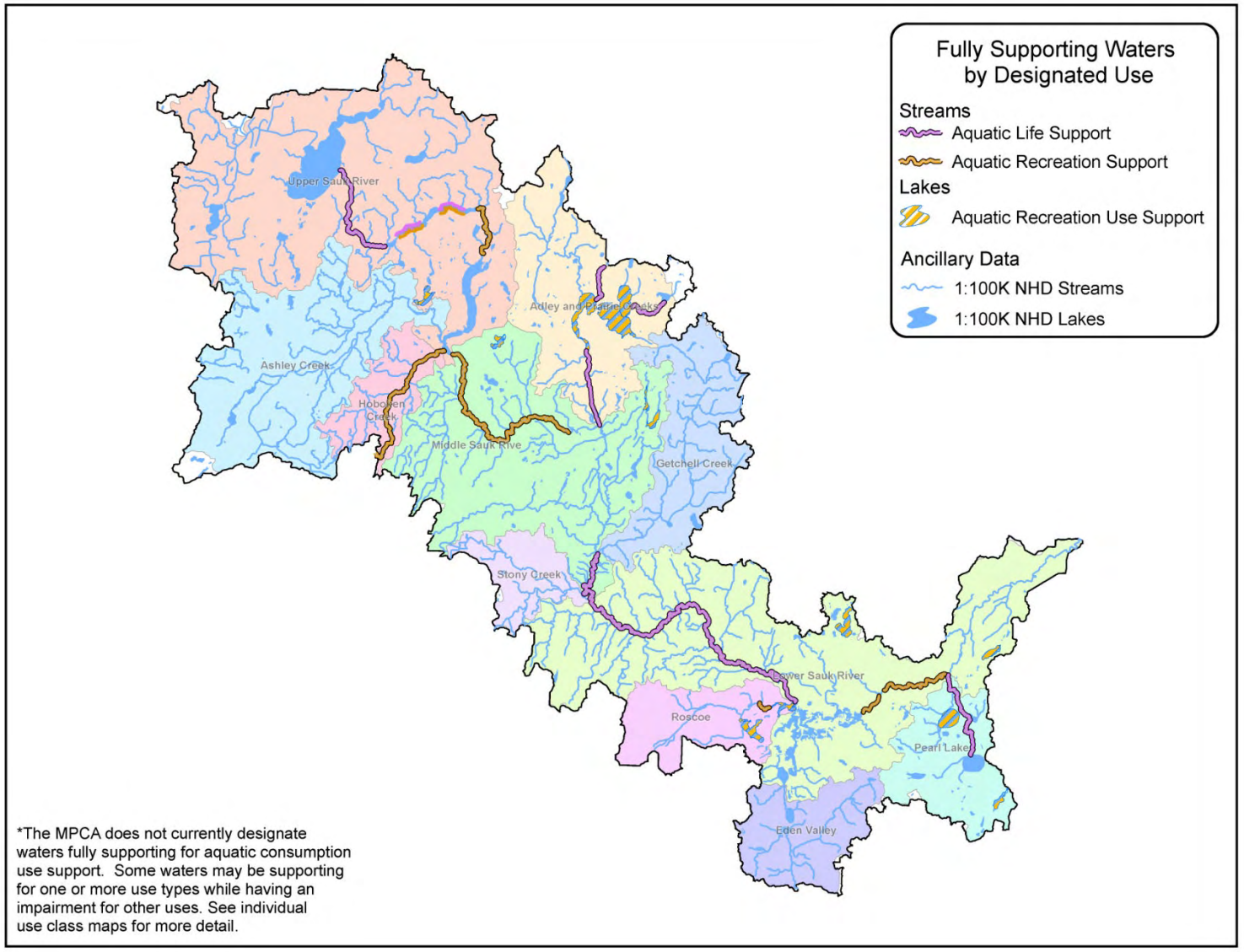


Figure 33. Impaired waters by designated use in the Sauk River Watershed

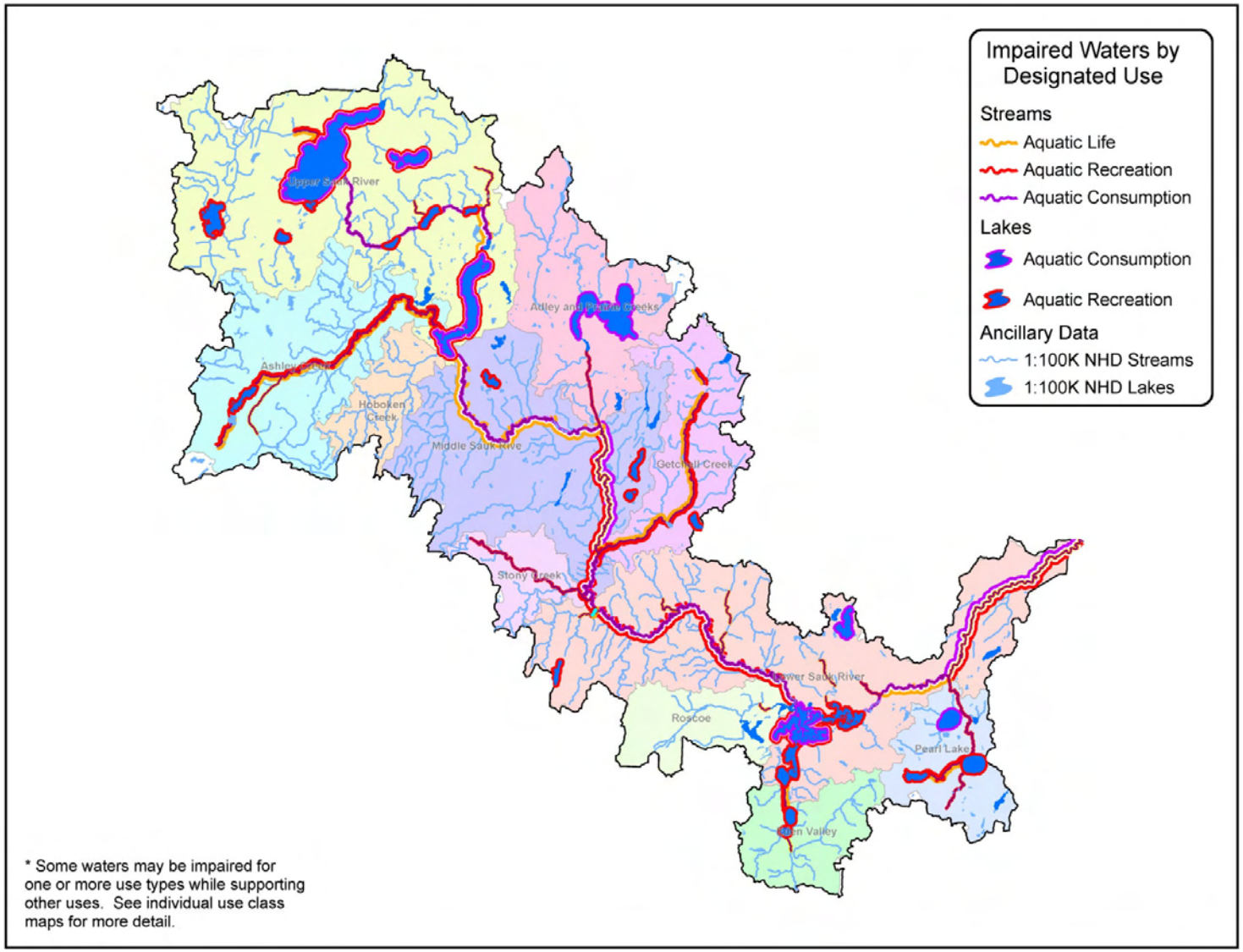


Figure 34. Aquatic consumption use support in the Sauk River Watershed

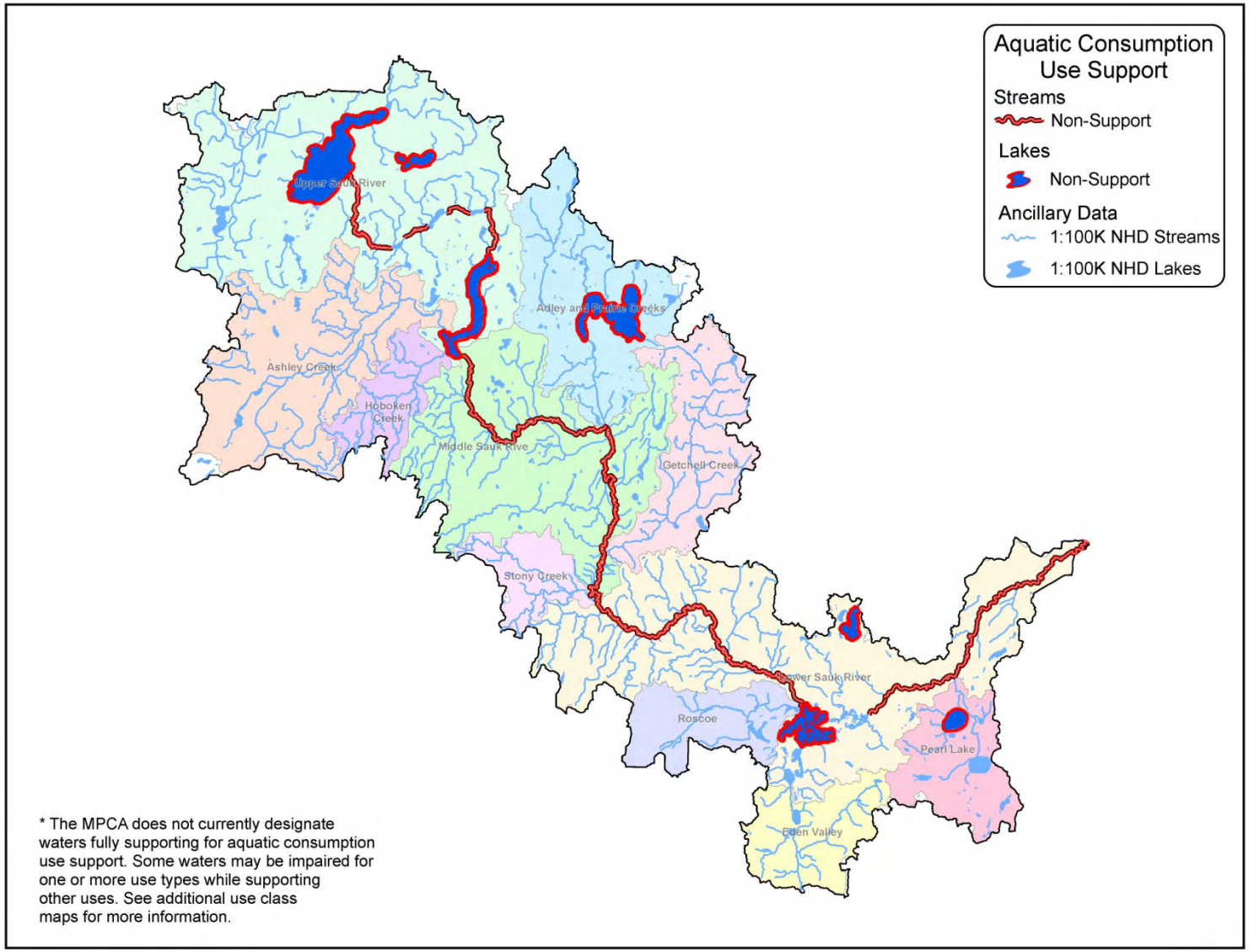


Figure 35. Aquatic life use support in the Sauk River Watershed

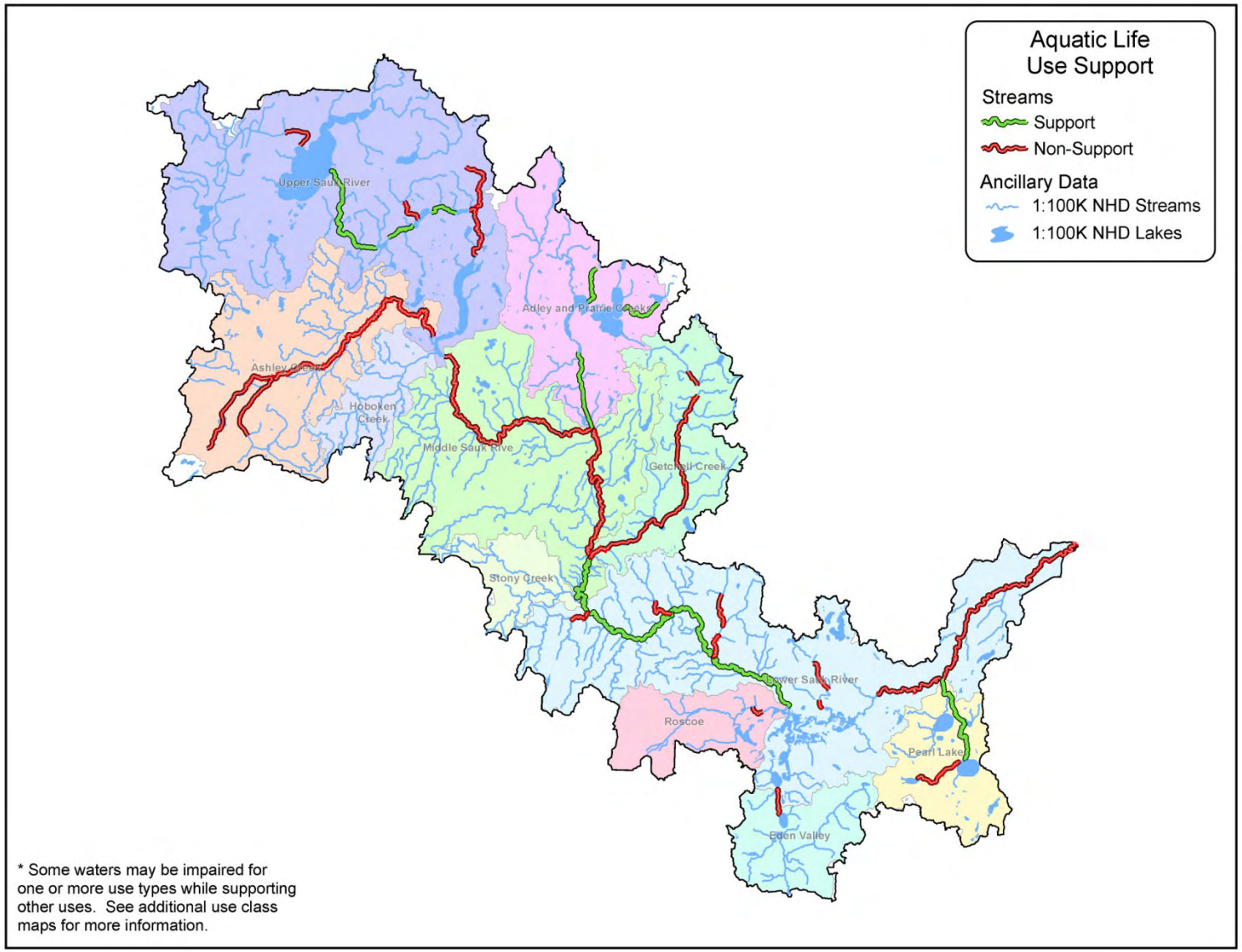
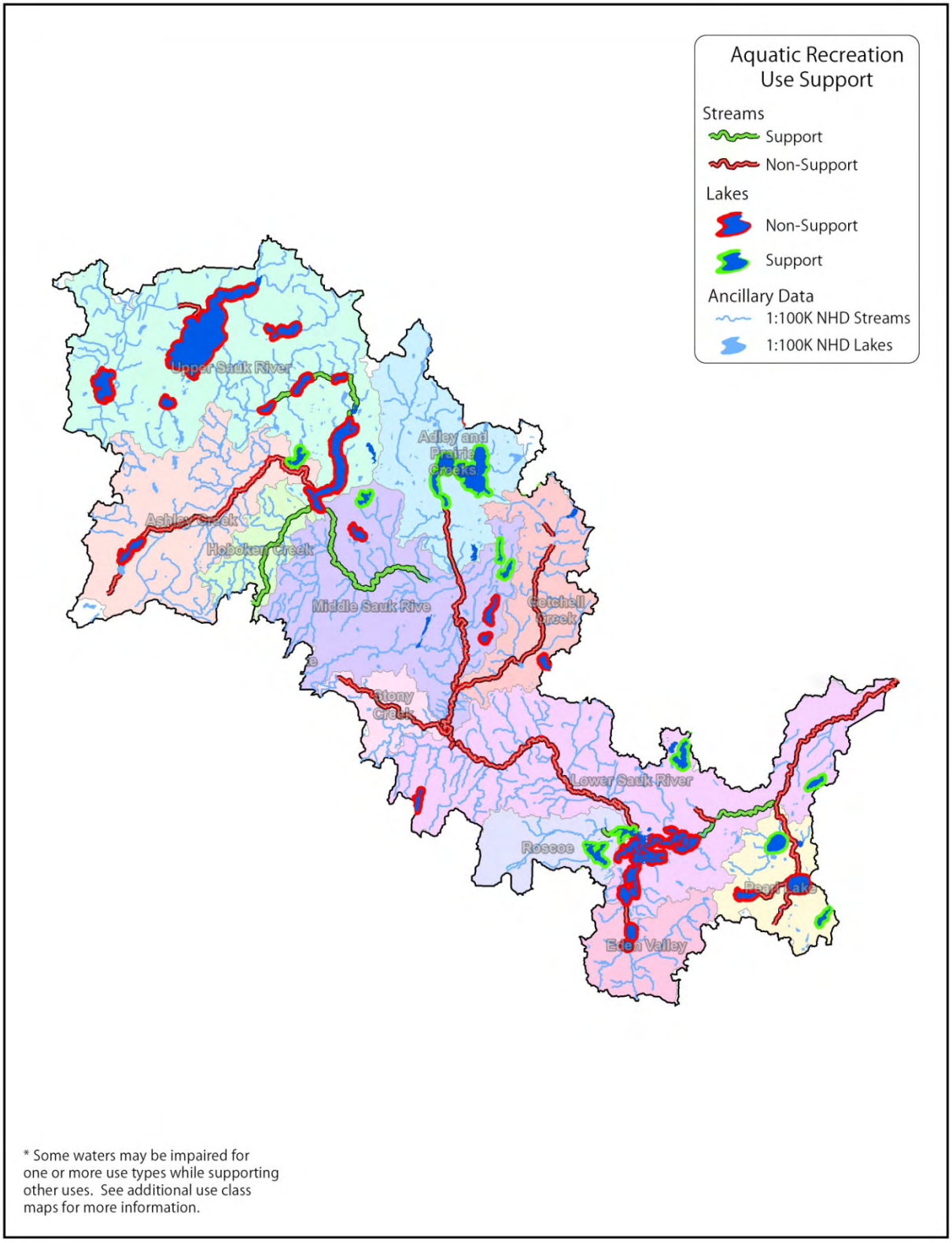


Figure 36. Aquatic recreation use support in the Sauk River Watershed



VIII. Summaries and Recommendations

While improvements have been made to the water quality of the Sauk River watershed over the last thirty years with regards to point source discharges; many of its waterbodies struggle to attain water quality standards. In order to see measureable improvements in water quality, measures must be taken to address both point and non-point source pollution across the watershed.

Additional monitoring should include investigating the extent of existing and new impairments and the effects of BMP implementation. Studies to identify the potential of dam retrofitting or removal to improve stream connectivity, and to examine the effects of groundwater withdrawal in the watershed in areas where there is a strong interaction between surficial and groundwater would be beneficial. Continued lake monitoring should target the 330 lakes where insufficient or no assessment level data is present. More targeted stream chemistry monitoring is needed in areas where sufficient data for assessment is lacking and to determine the extent and stressors of known impairments.

Measures should be taken to work with landowners in the watershed to target BMPs and improve conditions in feedlots along riparian corridors where they will most benefit water quality improvements. Protection strategies should be developed to protect remaining forested areas and natural landscapes such as the Pearl Lake subwatershed. Protection efforts are also needed for the high quality lakes and aquatic biological diversity in the Adley Creek subwatershed, and the high quality of aquatic biology in the downstream reaches of Mill Creek.

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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 waste water 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.

Specific Conductance - The amount of ionic material dissolved in water. Specific conductance is influenced by the conductivity of rainwater, evaporation and by road salt and fertilizer application.

Temperature - Water temperature in streams varies over the course of the day similar to diurnal air temperature variation. Daily maximum temperature is typically several hours after noon, and the minimum is near sunrise. Water temperature also varies by season as doe's air temperature.

Total Kjehldahl 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.

Total Suspended Volatile Solids (TSVS) - Volatile solids are solids lost during ignition (heating to 500 degrees C.) They provide an approximation of the amount of organic matter that was present in the water sample. ‘‘Fixed solids’’ is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called ‘‘volatile solids.’’

Unnionized 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 - Intensive watershed monitoring stations in the Sauk River Watershed

Biological Station ID	STORET ID	Waterbody Name	Location	11-digit HUC
08UM039	S003-888	Sauk River	Upstream of Cedar Lake Rd, 7 mi. N of Sauk Centre	7010202010
08UM038	S004-625	Ashley Creek	Downstream of 415th Ave, 2 mi. N of Sauk Centre	7010202020
08UM037	S002-654	Hoboken Creek	At CR 72 in Sauk Centre	7010202030
08UM025	S000-284	Sauk River	Downstream of CR 31, 3 mi. S of New Munich	7010202040
NONE	S000-369	Adley Creek	Downstream of CR176, 8.5 mi. SW of Albany	7010202050
00UM039	S003-289	Getchell Creek	Downstream of CR 176, 8.5 mi. SW of Albany	7010202060
08UM022	S000-497	Stony Creek	At 325th Ave, 2 mi. NE of Spring Hill	7010202070
08UM001	S000-503	Sauk River	Upstream of 8th St N in Waite Park	7010202080
NONE	S000-917	Kolling Creek	At Cr 43, 2 mi. SE of Richmond	7010202090
08UM010	S004-918	Trib. to Browns Lake	Upstream of CR 21, 2.5 mi. N of Eden Valley	7010202100
NONE	S000-444	Mill Creek	Upstream of Broadway Ave in Rockville	7010202110

Appendix 3 - AUID table of results (by parameter and beneficial use)

				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS												ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	**Stream Segment Name**	**Segment Description**	**NHD Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Consumption**		**Fish**	**Macroinvertebrates**	**Acetochlor**	**Alachlor**	**Atrazine**	**Chloride**	**Bacteria (Aquatic Recreation)**	**Metolachlor**	**Dissolved Oxygen**	**pH**	**Turbidity**	**Un-ionized ammonia**		**Oxygen Demand (BOD)**	**Nitrite/Nitrate**	**Total Phosphorous**	**Suspended Solids**
HUC 11: 07010202010 (Upper Sauk River)																									
07010202-552	Crooked Lake Ditch	*Unnamed Cr to Lk Osakis*	2.3	2B	NS	NS	NA		+	-				+	-		-		+				IF	IF	
07010202-592	Unnamed Creek	*Headwaters to Sauk R*	4.06	2B	NS	NA	NA		-	+															
07012020-666	Trib. to Little Sauk Lake	*Unnamed Cr to Sauk Lk*	1.79	2B	NS	NA	NA		-	-															
07012020-667	Sauk River	*Headwaters to Guernsey Lk*	9.69	2B	FS	IF	NS		+	+				+	IF		+	+	+	+			-	+	+
07010202-669	Sauk River	*Guernsey Lk to Little Sauk Lk*	2.02	2B	FS	FS	NS							+	+		IF	+	+	+			-		+
07010202-671	Sauk River	*Little Sauk Lk to Juergens Lk*	1.8	2B	FS	FS	NS							+	+		IF	+	+	+			-		+
07010202-673	Sauk River	*Juergens Lk to Sauk Lk*	4.42	2B	NS	FS	NS		-	+				+	+		-	+	+	+			-	+	+
07010202-586	Fairfield Creek	*Smith Lk outlet to Unnamed Cr*	2.08	2B	NA	NA	NA		NA																
07010202-584	Fairfield Creek	*Unnamed Cr to Crooked Lk Ditch*	2.34	2B	NA	NA	NA		NA																
07010202-637	Trib to Crooked Lake Ditch	*Unnamed Cr to Fairfield Cr*	1.68	2B	NA	NA	NA		NA	NA															
07010202-581	Crooked Lake Ditch	*Unnamed Ditch to Unnamed Cr*	1.7	2B	NA	NA	NA		NA	NA															
07010202-638	Trib. to Little Lake Osakis	*Unnamed Lk to Little Lk Osakis*	3.68	2B	IF	NA	NA		NA	NA															
07010202-589	Boss Creek	*Baugh Cr to Pitt Lk*	1.04	2B	IF	NA	NA		NA	NA				+										-	
07010202-585	Unnamed Creek	*Unnamed Cr to Fairfield Cr*	0.8	2B	NA	NA	NA																		
07010202-591	Unnamed Creek	*Little Lk Osakis to Lk Osakis*	0.17	2B	NA	IF	NA							+	IF										

07010202-611	Unnamed Creek	*Unnamed Cr to Sauk Lk*	0.12	2B	NA	IF	NA									IF														
07010202-905	Unnamed Creek	*Unnamed Cr to Lk Osakis*	0.1	2B	NA	IF	NA								+	IF														
07010202-906	Unnamed Creek	*Unnamed Cr to Lk Osakis*	0.28	2B	NA	IF	NA									IF														
07010202-904	Unnamed Creek	*Stevens Lk to Faille Lk*	0.41	2B	NA	FS	NA								+	+		-							-	-				
07010202-909	Unnamed Creek	*Clifford Lk to Unnamed Cr*	1.49	2B	NA	NA	NA								+					+					-	-				
07010202-910	Unnamed Creek	*Unnamed Cr to Smith Lk*	0.31	2B	NA	NA	NA													+										
07010202-564	Unnamed Creek	*Herberger Lk to Gulden Lk*	0.6	2B	NA	NA	NA													-										
HUC 11: 07010202020 (Ashley Creek Watershed)																															
07010202-503	Ashley Creek	*Headwaters to Sauk Lk*	25.73	2B	NS	NS	NA		-	+								-	+	+	+				-					
07010202-613	Silver Creek	*Unnamed Cr to Silver Cr*	1.91	2B	IF	IF	NA		NA	NA						IF			+	+										
07010202-578	Silver Creek	*Unnamed Cr to Ashley Cr*	1.85	2B	IF	IF	NA								+	IF		IF		+					-	-				
07010202-521	County Ditch 6	*Unnamed Cr to Ashley Cr*	4.43	2B	NS	NA	NA		NA	NA																				
07010202-640	Unnamed Ditch to Silver Creek	*West Union Lk outlet to Unnamed Cr*	0.75	2B	NA	NA	NA		NA	NA																				
07010202-614	Unnamed Creek	*Unnamed Cr to Unnamed Cr*	0.87	2B	IF	IF	NA									IF			+	+										
HUC 11: 07010202030 (Hoboken Creek Watershed)																															
07010202-522	Hoboken Creek	*Headwaters to Sauk Lk*	10.51	2B	IF	FS	NA								+	+		IF	+	+					+	-				
07010202-624	Trib to Hoboken Creek	*Unnamed Cr to Hoboken Cr*	1.67	2B	IF	IF	NA		NA	NA						IF			+	+										
HUC 11: 07010202040 (Middle Sauk River Watershed)																															
07010202-507	Sauk River	*Sauk Lk to Melrose Dam*	16.38	2B	NS	FS	NS		-						+	+		IF		+							+			
07010202-540	County Ditch 44	*Headwaters to Sauk R*	15.57	2B	IF	IF	NA		NA	NA					+	IF					+									
07010202-506	Sauk River	*Melrose Dam to Adley Cr*	2.66	2B	NS	NA	NS		-	-																				
07010202-505	Sauk River	*Adley Cr to Getchell Cr*	12.97	2B	NS	NS	NS		-	-					+	-		IF	+	+	+				-	-				
07010202-647	Trib to Unnamed Creek	*Unnamed Cr to Unnamed Lk*	2.26	2B	NA	NA	NA		NA	NA																				

07010202-643	Trib to Unnamed Creek	*Unnamed Cr to Unnamed Cr*	1.23	2B	NA	NA	NA		NA	NA																			
07010202-653	Trib to Sauk River	*Unnamed Cr to Sauk R*	1.96	2B	NA	NA	NA		NA	NA																			
07010202-654	Trib to Sauk River	*Unnamed Cr to Sauk R*	3.11	2B	NA	NA	NA		NA	NA																			
07010202-903	Unnamed Creek	*Unnamed Lk to Lk Maria*	0.11	2B	NA	NA	NA																						
HUC 11: 07010202050 (Adley and Prairie Creeks)																													
07010202-535	Fish Creek	*Goose Lk to Big Birch Lk*	2.91	2B	FS	IF	NA				+	+	+	+	IF	+	IF		+				-	+					
07010202-570	Trout Creek	*Headwaters to Prairie Cr*	6.8	2A	NA	NA			NA	NA																			
07010202-527	Adley Creek	*Sylvia Lk to Sauk R*	4.8	2B	FS	NS	NA		NA	NA				+	-		IF	+	+	+			-	+					
07010202-529	Unnamed Creek	*Little Birch Lk to Sylvia Lk*	0.19	2B	NA	NA	NA												+										
07010202-531	Unnamed Creek	*Big Birch Lk to Little Birch Lk*	0.26	2B	NA	NA	NA							+					+					+					
07010202-533	Unnamed Creek	*Headwaters to Big Birch Lk*	1.07	2B	IF	NA	NA							+										+					
07010202-593	Unnamed Creek	*Hennessy Lk to Little Birch Lk*	1.85	2B	IF	IF	NA							+	IF		IF		+										
07010202-901	Unnamed Creek	*Unnamed Ditch to Fish Cr*	0.41	2B	IF	NA	NA												+										
HUC 11: 07010202060 (Getchell Creek Watershed)																													
07010202-615	Unnamed creek	*Unnamed Cr to Getchell Cr*	1.09	2B	NS	NS	NA		NA	NA				+	-				+										
07010202-562	Getchell Creek (County Ditch 2)	*Unnamed Cr to Sauk R*	16.11	2B	NS	NS	NA		+	-				+	-			+	+	+			-	-					
07010202-561	Getchell Creek	*St Anna Lk to Unnamed Cr*	2.29	2B	NA	NA	NA		NA	NA																			
HUC 11: 07010202070 (Stony Creek Watershed)																													
07010202-541	Stony Creek	*Headwaters to Sauk R*	11.12	2A	IF	NS	NA		NA	NA				+	-		IF		+				-	-					

07010202-655	Trib to Stony Creek	*Unnamed Cr to Stony Cr*	1.53	2B	NA	NA	NA		NA	NA																	
HUC 11: 0701002080 (Lower Sauk River Watershed)																											
07010202-598	Trib to Sauk River	*Unnamed Ditch to Unnamed Cr*	1	2B	NS	NA	NA		+	-																	
07010202-662	Unnamed Creek	*Unnamed Cr to Sauk R*	2.07	2B	NS	NA	NA		-	+																	
07010202-508	Sauk River	*Getchell Cr to State Hwy 23*	32.45	2B	FS	NS	NS		+	+				+	-		IF		+				-	-		
07010202-556	Unnamed Creek	*Unnamed Cr to Sauk R*	2.11	2B	NS	NA	NA		-	-																	
07010202-663	Trib to Unnamed Creek	*Unnamed Cr to Unnamed Cr*	2.34	2B	NS	NA	NA		NA	-																	
07010202-517	Sauk River	*Knaus Lk to Cold Spring Dam*	1.62	2B	IF	FS	NS							+	+		IF		+				-	-		
07010202-567	Unnamed Creek (Cold Spring Cr)	*T123 R30W S15, west line to Sauk R*	1.71	2B	IF	NS	NA							+	-		IF									
07010202-616	Unnamed Creek	*Unnamed Cr to Schneider Lk*	0.55	2B	NS	IF	NA							+	IF		-		+							
07010202-554	Trib. to Sauk River	*Unnamed Cr. To Unnamed Cr.*	6.1	2B	NS	NA	NA		+	-																	
07010202-520	Sauk River	*Cold Spring WWTP to Mill Cr*	5.6	2B	NS	FS	NS		-	-				+	+				+							
07010202-542	Unnamed creek	*Unnamed Cr to Sauk R*	0.55	2B	IF	NS	NA							+	-		IF		-				-	-		
07010202-501	Sauk River	*Mill Cr to Mississippi R*	16.18	2B	FS	NS	NS		+	+	+	+	+	+	+	+	IF	+	-	+		-	-	-		
07010202-659	Unnamed ditch	*Headwaters to T123 R33W S15, E line*	1.95	7	NA	NA	NA		NA																		
07010202-656	Trib to Sauk River	*Headwaters to Unnamed Cr*	1.27	2B	NA	NA	NA		NA																		
07010202-660	Unnamed creek	*Unnamed Cr to Sauk R*	1.22	2B	NS	NA	NA		-	-																	
07010202-661	Unnamed creek	*Unnamed Cr to Unnamed cr*	1.16	2B	NA	NA	NA		NA	NA																	
07010202-610	Unnamed creek	*Browns Lk to Long Lk*	1.6	2B	IF	IF	NA							+	-				+							
07010202-911	Unnamed ditch	*Unnamed Ditch to Long Lk*	0.13	2B	NA	NA	NA							+													

07010202-565	Unnamed creek (Kinzer Cr)	*Unnamed Lk to Knaus Lk*	0.64	2B	NA	FS	NA							+	+		-		+								
07010202-571	County Ditch 17	*T124 R29W S25, south line to Sauk R*	3.01	7	NA	NA	NA																				
07010202-657	Unnamed Creek	*Unnamed Cr to Unnamed Cr*	4.18	2B	NA	NA	NA																				
07010202-684	Unnamed Ditch	*Headwaters to Long Lk*	0.13	2B	IF	NA	NA							+													
HUC 11: 07010202090 (Roscoe Watershed)																												
07010202-575	Kolling Creek	*Unnamed Cr to Becker Lk*	0.94	2B	NS	FS	NA							+	+		-	+	+							-		
07010202-626	Trib. to Kolling Creek	*Unnamed Cr to Kolling Cr*	3.23	2B	NA	NA	NA		NA	NA																	
11 HUC: 07010202100 (Eden Valley Watershed)																												
07010202-545	Trib. to Brown's Lake	*Headwaters to Browns Lk*	1.88	2B	NS	NS	NA		-	-				+	-		-	+	+	+							
07010202-648	Trib to Vails Lake	*Unnamed Cr to Unnamed Cr*	1.9	2B	NA	NA	NA		NA																		
07010202-550	Unnamed Creek	*Unnamed Cr to Vails (Mud) Lk*	1.49	7	NA	NA	NA		NA	NA				+	-		IF										
07010202-650	Unnamed Creek	*Headwaters to Unnamed Cr*	1.76	2B	IF	IF	NA							+	IF												
07010202-651	Unnamed Creek	*Unnamed Cr to Unnamed Cr*	0.29	2B	IF	IF	NA							+	IF												
11 HUC: 07010202110 (Pearl Lake Watershed)																												
07010202-674	Mill Creek	*Headwaters to Pearl Lk*	3.68	2B	NS	NS	NA		-	-				+	-		IF		+								
07010202-665	Unnamed Ditch	*Headwaters to Pearl Lk*	3.11	2B	IF	NS	NA		NA					+	-		IF		+								
07010202-676	Mill Creek	*Pearl Lk to Sauk R*	7.49	2B	FS	NS	NA		+	+				+	-		IF	+	+	+		+	-	+			
07010202-537	Mill Creek	*Headwaters to Sauk R*	11.09	2B	NA	NA	NA							+	-		IF	+	+	+		+	-	+			
07010202-560	Unnamed Creek	*Grand Lk to Mill Cr*	1.41	2B	NA	IF	NA								IF												

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets Standards or Ecoregion Norms (+); Exceeds Standards or Ecoregion Norms (-); Channelized streams were not assessed for aquatic life

Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B	39	±11	50	28
2	Southern Streams	2B	45	±9	54	36
3	Southern Headwaters	2B	51	±7	58	44
4	Northern Rivers	2B	35	±9	44	26
5	Northern Streams	2B	50	±9	59	41
6	Northern Headwaters	2B	40	±16	56	24
7	Low Gradient	2B	40	±10	50	30
Invertebrates						
1	Northern Forest Rivers	2B	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B	52.4	±13.6	66	38.8
5	Southern Streams RR	2B	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B	38.3	±13.6	51.9	24.7

Appendix 4.2 - Upper Mississippi River IBI thresholds and confidence limits

	Use Class	Drainage Area	Invertebrate Class	Threshold	CI	Upper	Lower
Fish							
	2B	5 mi^2 -> 34 mi^2	--	46	±13.5	59.5	32.5
	2B	35mi^2 -> 199 mi^2	--	46	±13.5	59.5	32.5
	2B	200 mi^2 ->	--	61	±13.5	74.5	47.5
Invertebrates							
	2B	0 mi^2 -> 39 mi^2	GP	54.005	±14.9	68.905	39.505
	2B	40 mi^2 ->	GP	57.66	±14.9	72.56	72.56
	2B	0 mi^2 -> 499 mi^2	RR	52.556	±14.9	67.456	67.456

Appendix 4.3 - Biological monitoring results - fish IBI

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 11: 07010202010 (Upper Sauk River)							
07010202-552	00UM072	Crooked Lake Ditch	56.8	--	46*	51*	24-Aug-00
07010202-502	08UM040	Sauk River	149.9	5	50	57	01-Jul-08
07010202-666	08UM041	Trib to Little Sauk Lake	9.4	6	40	0	25-Jun-08
07010202-592	00UM028	Trib. to Sauk River	5.8	6	40	0	07-Jul-00
07010202-673	08UM039	Sauk River	189.0	5	50	49	01-Jul-08
07010202-673	08UM039	Sauk River	189.0	5	50	38	22-Jul-08
HUC 11: 07010202020 (Ashley Creek Watershed)							
07010202-503	08UM042	Ashley Creek	68.9	5	48	37	30-Jun-08
07010202-503	08UM038	Ashley Creek	123.1	5	48	37	01-Jul-08

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
07010202-521	00UM073	County Ditch 6	21.8	--	46*	39*	24-Aug-00
07010202-613	08UM045	Silver Creek	25.4	6	40	32	16-Jul-08
HUC 11: 07010202030 (Hoboken Creek Watershed)							
NONE							
HUC 11: 07010202040 (Middle Sauk River Watershed)							
07010202-507	08UM033	Sauk River	418.8	5	48	18	20-Aug-08
07010202-506	00UM038	Sauk River	438.6	5	48	24	27-Jun-00
07010202-506	00UM038	Sauk River	438.6	5	48	29	16-Aug-00
07010202-505	08UM027	Sauk River	569.8	4	35	32	02-Jul-08
07010202-505	08UM027	Sauk River	569.8	4	35	30	21-Aug-08
07010202-505	08UM025	Sauk River	601.8	4	35	34	08-Jul-08
HUC 11: 07010202050 (Adley and Prairie Creeks)							
NONE							
HUC 11: 07010202060 (Getchell Creek Watershed)							
07010202-562	00UM039	Getchell Creek (CD 2)	60.9	--	46*	66*	27-Jun-00
HUC 11: 07010202070 (Stony Creek Watershed)							
NONE							
HUC 11: 07010202080 (Lower Sauk River Watershed)							
07010202-598	08UM021	Trib to Sauk River	15.9	6	40	48	17-Jul-08
07010202-598	08UM021	Trib to Sauk River	15.9	6	40	45	14-Aug-08
07010202-508	08UM018	Sauk River	747.6	4	35	39	20-Aug-08
07010202-662	08UM017	Trib to Sauk River	6.4	6	40	34	15-Jul-08
07010202-660	08UM016	Trib to Sauk River	5.9	6	40	29	15-Jul-08
07010202-554	99UM064	Trib. to Sauk River	6.1	--	46*	48*	30-Jun-99
07010202-556	08UM012	Trib to Sauk River	15.6	6	40	29	15-Jul-08
07010202-508	08UM009	Sauk River	805.6	4	35	41	18-Sep-08
07010202-520	08UM003	Sauk River	959.4	4	35	26	05-Sep-08

07010202-501	08UM001	Sauk River	1037.9	4	35	50	19-Aug-08
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Fish Class**	**Threshold**	**FIBI**	**Visit Date**
HUC 11: 07010202090 (Roscoe Watershed)							
NONE							
11 HUC: 07010202100 (Eden Valley Watershed)							
07010202-545	08UM010	Trib to Browns Lake	40.0	7	40	25	09-Jul-08
11 HUC: 07010202110 (Pearl Lake Watershed)							
07010202-674	08UM006	Mill Creek	8.4	6	40	11	24-Jul-08
07010202-676	08UM005	Mill Creek	32.8	6	40	62	09-Jul-08
07010202-676	08UM004	Mill Creek	47.6	6	40	62	10-Jul-08

* Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized streams until after the adoption of Tiered Aquatic Life Uses.

Appendix 4.4 - Biological monitoring results - macroinvertebrate IBI

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 11: 07010202010 (Upper Sauk River)							
07010202-552	00UM072	Crooked Lake Ditch	56.8	GP*	57.66*	46*	14-Sep-00
07010202-667	08UM040	Sauk River	149.9	5	35.9	37	12-Aug-08
07010202-592	00UM028	Unnamed creek	5.8	6	46.8	50	18-Sep-00
07010202-673	08UM039	Sauk River	189.0	6	46.8	50	12-Aug-08
HUC 11: 07010202020 (Ashley Creek Watershed)							
07010202-521	00UM073	County Ditch 6	21.8	GP*	54.005*	17*	19-Sep-00
07010202-503	08UM042	Ashley Creek	68.9	5	35.9	30	12-Aug-08
07010202-503	08UM038	Ashley Creek	123.1	5	35.9	34	12-Aug-08
07010202-613	08UM045	Silver Creek	24.4	5	35.9	21	26-Aug-08
HUC 11: 07010202030 (Hoboken Creek Watershed)							

None							
HUC 11: 07010202040 (Middle Sauk River Watershed)							
07010202-507	08UM033	Sauk River	418.8	5	35.9	40	26-Aug-08
07010202-506	00UM038	Sauk River	438.6	7	38.3	46	18-Sep-00
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Invert Class**	**Threshold**	**MIBI**	**Visit Date**
07010202-506	00UM038	Sauk River	438.6	7	38.3	54	13-Oct-00
07010202-505	08UM027	Sauk River	569.8	2	30.7	29	12-Aug-08
07010202-505	08UM025	Sauk River	601.8	2	30.7	33	11-Aug-08
HUC 11: 07010202050 (Adley and Prairie Creeks)							
NONE							
HUC 11: 07010202060 (Getchell Creek Watershed)							
07010202-562	00UM039	Getchell Creek (CD 2)	60.9	RR*	52.556*	29*	18-Sep-00
HUC 11: 07010202070 (Stony Creek Watershed)							
NONE							
HUC 11: 0701002080 (Lower Sauk River Watershed)							
07010202-598	08UM021	Unnamed creek	15.9	7	38.3	24	26-Aug-08
07010202-508	08UM018	Sauk River	747.6	2	30.7	36	26-Aug-08
07010202-662	08UM017	Unnamed creek	6.4	5	35.9	43	26-Aug-08
07010202-660	08UM016	Unnamed creek	5.9	5	35.9	34	13-Aug-08
07010202-554	99UM064	Unnamed creek	6.1	RR*	52.556*	37*	09-Sep-99
07010202-556	08UM012	Unnamed creek	15.6	6	46.8	30	13-Aug-08
07010202-663	08UM008	Unnamed creek	12.8	5	35.9	34	14-Aug-08
07010202-520	08UM003	Sauk River	959.4	2	30.7	30	11-Sep-08
07010202-501	08UM001	Sauk River	1037.9	2	30.7	39	11-Sep-08
HUC 11: 07010202090 (Roscoe Watershed)							
NONE							
11 HUC: 07010202100 (Eden Valley Watershed)							

07010202-545	08UM010	Eden Lake Outlet	40.0	5	35.9	23	28-Aug-08
11 HUC: 07010202110 (Pearl Lake Watershed)							
07010202-674	08UM006	Mill Creek	8.4	6	46.8	38	11-Sep-08
07010202-676	08UM005	Mill Creek	32.8	5	35.9	51	14-Aug-08
07010202-676	08UM004	Mill Creek	47.6	5	35.9	52	13-Aug-08

* Channelized site assessed for biology in 2006, utilizing Upper Mississippi Basin IBI prior to the adoption of policy decisions to defer assessments on channelized streams until after the adoption of Tiered Aquatic Life Uses.

Appendix 5.1 - Good/Fair/Poor thresholds for biological stations on non-assessed channelized AUIDs

Ratings of **Good** for channelized streams are based on Minnesota's general use threshold for aquatic life (Appendix 4.1). Stations with IBIs that score above this general use threshold would be given a rating of **Good**. The **Fair** rating is calculated as a 15 point drop from the general use threshold. Stations with IBI scores below the general use threshold, but above the **Fair** threshold would be given a rating of **Fair**. Stations scoring below the Fair threshold would be considered **Poor**.

Class #	Class Name	Good	Fair	Poor
Fish				
1	Southern Rivers	>38	38-24	<24
2	Southern Streams	>44	44-30	<30
3	Southern Headwaters	>50	50-36	<36
4	Northern Rivers	>34	34-20	<20
5	Northern Streams	>49	49-35	<35
6	Northern Headwaters	>39	39-25	<25
7	Low Gradient Streams	>39	39-25	<25
Invertebrates				
1	Northern Forest Rivers	>51	52-36	<36
2	Prairie Forest Rivers	>31	31-16	<16
3	Northern Forest Streams RR	>50	50-35	<35
4	Northern Forest Streams GP	>52	52-37	<37
5	Southern Streams RR	>36	36-21	<21
6	Southern Forest Streams GP	>47	47-32	<32
7	Prairie Streams GP	>38	38-23	<23

Appendix 5.2 - Channelized stream AUID IBI score FISH

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: 07010202010 (Upper Sauk River)									
07010202-XXX	99UM054	Trib. to Fairfield Creek	0.19	7	100 - 40	39 - 25	24 - 0	0	8-Jul-99
07010202-586	07UM077	Fairfield Creek	24.3	7	100 - 40	39 - 25	24 - 0	0	20-Jun-07
07010202-584	08UM048	Fairfield Creek	28.2	6	100 - 40	39 - 25	24 - 0	0	28-Jul-08
07010202-637	08UM047	Trib to Crooked Lake Ditch	8.9	6	100 - 40	39 - 25	24 - 0	0	21-Jul-08
07010202-581	07UM076	Crooked Lake Ditch	55.4	5	100 - 50	49 - 35	34 - 0	39	20-Jun-07
07010202-581	07UM076	Crooked Lake Ditch	55.4	5	100 - 50	49 - 35	34 - 0	26	24-Jun-08
07010202-581	07UM076	Crooked Lake Ditch	55.4	5	100 - 50	49 - 35	34 - 0	31	28-Jul-08
07010202-638	08UM046	Trib to Little Lake Osakis	7.7	6	100 - 40	39 - 25	24 - 0	12	16-Jul-08
07010202-589	07UM078	Boss Creek	15.7	7	100 - 40	39 - 25	24 - 0	0	20-Jun-07
07010202-589	07UM078	Boss Creek	15.7	7	100 - 40	39 - 25	24 - 0	0	24-Jun-08
07010202-589	07UM078	Boss Creek	15.7	7	100 - 40	39 - 25	24 - 0	0	28-Jul-08
HUC 11: 07010202020 (Ashley Creek Watershed)									
07010202-503	08UM050	Ashley Creek	24.7	7	100 - 40	39 - 25	24 - 0	29	05-Sep-08
07010202-521	07UM083	County Ditch 6	21.9	6	100 - 40	39 - 25	24 - 0	12	19-Jun-07
07010202-521	07UM083	County Ditch 6	21.9	6	100 - 40	39 - 25	24 - 0	16	21-Aug-07
07010202-521	07UM083	County Ditch 6	21.9	6	100 - 40	39 - 25	24 - 0	0	16-Jul-08
07010202-640	08UM043	Unnamed Ditch to Silver Creek	8.5	6	100 - 40	39 - 25	24 - 0	35	25-Jun-08
07010202-640	08UM043	Unnamed Ditch to Silver Creek	8.5	6	100 - 40	39 - 25	24 - 0	0	23-Jul-08
HUC 11: 07010202030 (Hoboken Creek Watershed)									
07010202-624	08UM036	Trib to Hoboken Creek	9.0	6	100 - 40	39 - 25	24 - 0	20	23-Jul-08
07010202-522	00UM037	Hobboken Creek	17.1	6	100 - 40	39 - 25	24 - 0	15	27-Jun-00
07010202-522	00UM037	Hobboken Creek	17.1	6	100 - 40	39 - 25	24 - 0	31	19-Jun-07

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
07010202-522	00UM037	Hobboken Creek	17.1	6	100 - 40	39 - 25	24 - 0	21	31-Jul-07
HUC 11: 07010202040 (Middle Sauk River Watershed)									
07010202-647	08UM034	Trib to Unnamed creek	5.1	6	100 - 40	39 - 25	24 - 0	17	24-Jul-08
07010202-643	08UM035	Trib to Unnamed creek	6.5	6	100 - 40	39 - 25	24 - 0	9	21-Jul-08
07010202-653	08UM032	Trib to Sauk River	9.1	6	100 - 40	39 - 25	24 - 0	44	24-Jun-08
07010202-654	08UM030	Trib to Sauk River	9.8	6	100 - 40	39 - 25	24 - 0	7	24-Jul-08
07010202-540	07UM075	County Ditch 44	20.2	6	100 - 40	39 - 25	24 - 0	39	19-Jun-07
07010202-540	08UM026	County Ditch 44	25.4	7	100 - 40	39 - 25	24 - 0	31	17-Jun-08
HUC 11: 07010202050 (Adley and Prairie Creeks)									
07010202-527	08UM031	Adley Creek	83.8	5	100 - 50	49 - 35	34 - 0	33	07-Jul-08
HUC 11: 07010202060 (Getchell Creek Watershed)									
07010202-615	08UM028	Unnamed creek	11.7	7	100 - 40	39 - 25	24 - 0	22	24-Jun-08
07010202-561	08UM029	Getchell Creek	4.2	6	100 - 40	39 - 25	24 - 0	0	30-Jul-08
07010202-562	08UM044	Getchell Creek	37.8	6	100 - 40	39 - 25	24 - 0	16	08-Jul-08
07010202-562	07UM086	Getchell Creek	60.6	5	100 - 50	49 - 35	34 - 0	25	18-Jun-07
07010202-562	00UM039	Getchell Creek	60.9	5	100 - 50	49 - 35	34 - 0	39	27-Jun-00
07010202-562	00UM039	Getchell Creek	60.9	5	100 - 50	49 - 35	34 - 0	47	08-Jul-08
HUC 11: 07010202070 (Stony Creek Watershed)									
07010202-655	08UM023	Trib to Stony Creek	7.8	6	100 - 40	39 - 25	24 - 0	9	26-Jun-08
HUC 11: 0701002080 (Lower Sauk River Watershed)									
07010202-659	08UM053	Unnamed ditch	1.8	6	100 - 40	39 - 25	24 - 0	0	30-Jul-08
07010202-656	08UM020	Trib to Sauk River	4.6	6	100 - 40	39 - 25	24 - 0	8	25-Jun-08
07010202-661	08UM013	Trib. to Unnamed Creek	7.2	6	100 - 40	39 - 25	24 - 0	30	14-Jul-08
07010202-571	08UM002	County Ditch 17	6.75	6	100 - 40	39 - 25	24 - 0	0	14-Jul-08
07010202-553	99UM029	Trib. to Sauk River	2.7	6	100 - 40	39 - 25	24 - 0	6	08-Jul-99

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: 07010202090 (Roscoe Watershed)									
07010202-626	07UM096	Trib. to Kolling Creek	20.2	6	100 - 40	39 - 25	24 - 0	18	21-Jun-07
07010202-626	07UM096	Trib. to Kolling Creek	20.2	6	100 - 40	39 - 25	24 - 0	20	31-Jul-07
07010202-626	07UM096	Trib. to Kolling Creek	20.2	6	100 - 40	39 - 25	24 - 0	33	15-Jul-08
11 HUC: 07010202100 (Eden Valley Watershed)									
07010202-648	08UM011	Trib to Vails Lake	16.9	6	100 - 40	39 - 25	24 - 0	0	14-Jul-08
07010202-550	08UM057	Unnamed Ditch	26.7	6	100 - 40	39 - 25	24 - 0	33	30-Jul-08
11 HUC: 07010202110 (Pearl Lake Watershed)									
07010202-665	08UM007	Trib to Pearl Lake	2.9	6	100 - 40	39 - 25	24 - 0	0	24-Jul-08

Appendix 5.3 - Channelized stream AUID IBI score macroinvertbrate

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 07010202010 (Upper Sauk River)									
07010202-637	08UM047	Crooked Lake Ditch	8.9	6	100 - 48	47 - 32	31 - 0	9	25-Aug-08
07010202-581	07UM076	Crooked Lake Ditch	55.4	6	100 - 48	47 - 32	31 - 0	19	06-Aug-07
07010202-581	07UM076	Crooked Lake Ditch	55.4	6	100 - 48	47 - 32	31 - 0	32	25-Aug-08
07010202-638	08UM046	Unnamed Creek	7.7	5	100 - 37	36 - 21	20 - 0	16	25-Aug-08
07010202-589	07UM078	Boss Creek	15.7	6	100 - 48	47 - 32	31 - 0	9	25-Aug-08
HUC 11: 07010202020 (Ashley Creek Watershed)									
07010202-521	07UM083	County Ditch 6	21.9	7	100 - 39	38 - 23	22 - 0	18	06-Aug-07
07010202-640	08UM043	Silver Creek	8.5	7	100 - 39	38 - 23	22 - 0	18	26-Aug-08

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 07010202030 (Hoboken Creek Watershed)									
07010202-624	08UM036	Unnamed Creek	9.0	7	100 - 39	38 - 23	22 - 0	35	12-Aug-08
07010202-522	00UM037	Hoboken Creek	17.1	7	100 - 39	38 - 23	22 - 0	36	19-Sep-00
07010202-522	00UM037	Hoboken Creek	17.1	7	100 - 39	38 - 23	22 - 0	28	13-Oct-00
HUC 11: 07010202040 (Middle Sauk River Watershed)									
07010202-647	08UM034	Unnamed Creek	5.1	7	100 - 39	38 - 23	22 - 0	23	12-Aug-08
07010202-643	08UM035	Unnamed Creek	6.5	5	100 - 37	36 - 21	20 - 0	19	12-Aug-08
07010202-653	08UM032	Unnamed Creek	9.1	5	100 - 37	36 - 21	20 - 0	26	14-Aug-08
07010202-654	08UM030	Unnamed Creek	9.8	7	100 - 39	38 - 23	22 - 0	16	12-Aug-08
07010202-540	07UM075	County Ditch 44	20.2	5	100 - 37	36 - 21	20 - 0	40	06-Aug-07
07010202-540	08UM026	County Ditch 44	25.4	7	100 - 37	36 - 21	20 - 0	36	11-Aug-08
HUC 11: 07010202050 (Adley and Prairie Creeks)									
07010202-527	08UM031	Adley Creek	83.8	6	100 - 48	47 - 32	31 - 0	59	12-Aug-08
HUC 11: 07010202060 (Getchell Creek Watershed)									
07010202-615	08UM028	Unnamed Creek	11.7	6	100 - 48	47 - 32	31 - 0	13	14-Aug-08
07010202-561	08UM029	Getchell Creek	4.2	6	100 - 48	47 - 32	31 - 0	25	11-Sep-08
07010202-562	08UM044	Getchell Creek (CD 2)	37.8	6	100 - 48	47 - 32	31 - 0	18	13-Aug-08
07010202-562	00UM039	Getchell Creek (CD 2)	60.9	5	100 - 37	36 - 21	20 - 0	27	26-Aug-08
07010202-562	00UM039	Getchell Creek (CD 2)	60.9	5	100 - 37	36 - 21	20 - 0	18	26-Aug-08

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 07010202070 (Stony Creek Watershed)									
07010202-655	08UM023	Unnamed Creek	7.8	7	100 - 39	38 - 23	22 - 0	39	12-Aug-08
HUC 11: 0701002080 (Lower Sauk River Watershed)									
07010202-661	08UM013	Trib. to Unnamed Creek	7.2	6	100 - 48	47 - 32	31 - 0	25	13-Aug-08
07010202-571	08UM002	County Ditch 17	6.8	5	100 - 37	36 - 21	20 - 0	25	14-Aug-08
HUC 11: 07010202090 (Roscoe Watershed)									
07010202-626	07UM096	Unnamed Creek	20.2	7	100 - 39	38 - 23	22 - 0	36	08-Aug-07
07010202-626	07UM096	Unnamed Creek	20.2	7	100 - 39	38 - 23	22 - 0	28	28-Aug-08
11 HUC: 07010202100 (Eden Valley Watershed)									
07010202-550	08UM057	Unnamed Ditch	26.7	5	100 - 37	36 - 21	20 - 0	30	28-Aug-08
11 HUC: 07010202110 (Pearl Lake Watershed)									
NONE									

Appendix 6.1 - Minnesota's ecoregion–based lake eutrophication standards

Ecoregion	TP µg/L	Chl-a µg/L	Secchi meters
NLF – Lake Trout (Class 2A)	< 12	< 3	> 4.8
NLF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NLF – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
NCHF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NCHF – Aquatic Rec. Use (Class 2B)	< 40	< 14	> 1.4
NCHF – Aquatic Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
WCBP & NGP – Aquatic Rec. Use (Class 2B)	< 65	< 22	> 0.9
WCBP & NGP – Aquatic Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7