St. Louis River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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Table of Contents

Tables

Figures

Executive Summary

The St. Louis River watershed is one of the largest watersheds in northern Minnesota and the largest contributing watershed to Lake Superior. Located in a heavily forested region of northeastern Minnesota, the watershed covers an area of 3,584 square miles. The vast majority of the watershed is within the Northern Lakes and Forests (NLF) ecoregion. As the ecoregion name implies, surface waters are abundant with 353 lakes and 97 streams segments, or assessment units (AUIDs) throughout the watershed.

From its source at Seven Beaver Lake, the St. Louis River flows 201 miles to its confluence with Lake Superior. Beginning as a low gradient stream, the river receives water from a number of major tributaries which include the Whiteface River, Swan River and Floodwood River. Following the Thompson Dam in Thompson, Minnesota the St. Louis River picks up significant gradient before emptying into Lake Superior at Duluth.

The lower 15 miles of the St. Louis River estuary has been impacted by heavy industry since the late 1800's; although water quality has improved since the Western Lake Superior Sanitary District began treating industrial and domestic effluent in 1979, contaminated sediments persist, and the International Joint Commission lists the estuary as an Area of Concern (AOC) (Lindgren, et. al., 2006).

In 2009, the Minnesota Pollution Control Agency (MPCA) began an intensive watershed monitoring effort of the St. Louis River watershed's surface waters. Of the 97 AUIDs in the watershed, 75 had assessable data for aquatic life and 35 had sufficient information to assess aquatic recreation (not all lake and stream AUIDs were able to be assessed due to insufficient data, modified channel condition, locations on tribal lands or their status as limited resources waters)(Appendix 8). Of the biological sites sampled and used for assessment, 29 were established in previous years. As part of this effort, the MPCA also joined with local partners to complete stream water chemistry sampling at the outlets of the St. Louis River's 22 major sub-watersheds (11-digit HUC). In addition to biology and water chemistry sampling in streams, 25 lakes were sampled and assessed to determine their suitability to support aquatic recreation.

Of the assessable stream segments in the St. Louis River watershed, 47 stream AUIDs fully support aquatic life, while 20 fully support aquatic recreation. The remaining sites did not meet their respective standards and were deemed impaired for either aquatic life or aquatic recreation or both. Biological impairments occur throughout the St. Louis River watershed in all stream types from the main stem St. Louis River to its tributaries, and most often are localized impairments associated with habitat loss from poor land use management practices. The IBI scores for channelized waterways throughout the watershed showed mixed results from good to poor, and the results were strongly related to more intensive land use practices. Water chemistry impairments were generally concentrated in the Swan River and St. Louis Bay watersheds where high levels of turbidity, total phosphorus and bacteria were found. Potential pollution sources in these areas include urban stormwater runoff, altered hydrology, mine tailings drainage, treated domestic wastewater from range cities, and agriculture (pasture). Aquatic consumption impairments span the entire length of the St. Louis River with mercury posing the biggest concern. Twenty four AUIDs along the St. Louis River and all but four lakes with sufficient data within the watershed are considered impaired for mercury. The Whiteface River is the only tributary to the St. Louis River that was sampled for mercury. All three AUIDs along the Whiteface are also impaired for mercury. Additionally, the lower 10 AUIDs within the St. Louis River watershed are impaired for aquatic consumption due to high levels of polychlorinated biphenyls (PCBs).

Of the assessable 25 lakes in the St. Louis River watershed, 18 fully support aquatic recreation. Many of the impaired lakes tend to be shallow and drain large, wetland dominated watersheds; or they have a range of anthropogenic impacts in their headwaters- such as treated domestic wastewater discharges, or iron mining, which collectively are factors in their relatively poor water quality.

Overall, the results from the intensive watershed monitoring and assessment process reveal that the St. Louis River watershed's surface water quality is somewhat variable. Large areas of forest and wetlands that still exist are helping to sustain areas of exceptional water quality. However, historic and current landuse changes throughout the watershed have proven to be damaging to the many lakes, rivers and streams within the St. Louis River watershed.

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 (TMDLs). 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) of 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 (CWF) created by the passage of the Clean Water, Land, and Legacy Amendment to the state constitution allows a continuation of this work. In response, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of water monitoring programs to provide a more comprehensive assessment of water quality and expedite the restoration and protection process. This has permitted the MPCA to establish a goal to assess the condition of Minnesota's surface waters via a 10-year cycle, and provides an opportunity to more fully integrate MPCA water resource management efforts in cooperation with local government and stakeholders to allow 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 determine the overall health of water resources, identify impaired waters, and to identify waters in need of additional protection efforts. The monitoring strategy was implemented in the St. Louis River watershed beginning in the summer of 2009. This report provides a summary of all water quality assessment results in the St. Louis River watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units. Consequently, there is an opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. A watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and non-point sources of pollution, and further the CWA goal of protecting, restoring, and preserving the quality of Minnesota's water resources.

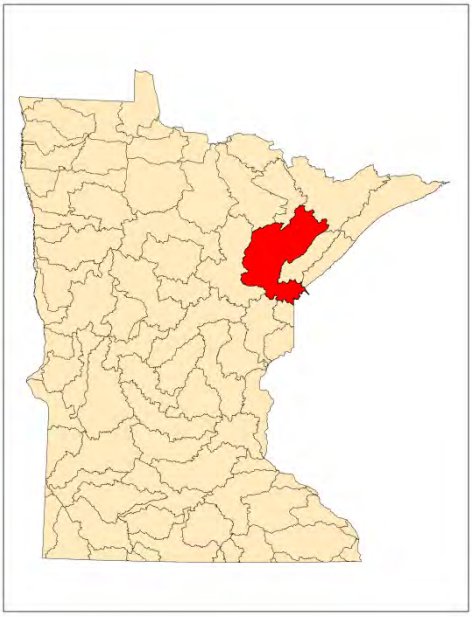

Figure 1. Major watersheds in Minnesota (8-Digit HUC). St. Louis River highlighted.

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, implementation, 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 paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: *Watershed Approach to Condition M Monitoring and Assessment* (MPCA 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Load monitoring network

Funded with appropriations from Minnesota's Clean Water Fund, the Major Watershed Load Monitoring Program (MWLMP) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers, including the Red, Rainy, St. Croix, Mississippi, Minnesota, and the outlets of major tributaries (8 digit HUC scale) draining to these rivers. Since the program's inception in 2007 the MWLMP has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MDNR) flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and MWLMP staff to compute annual pollutant loads at 79 river monitoring sites across Minnesota. Data will also be used to assist with: TMDL studies and implementation plans; watershed modeling efforts; and watershed research projects.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other factors. However, as a general rule, 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 diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP) can be attributed to both "non-point" as well as "point" and end of pipe sources such as industrial or wastewater treatment plants. Major non-point sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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, for example, will typically be much higher following high intensity rain events prior to canopy development rather than after low intensity post-canopy events where less surface runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in flow weighted mean concentrations (FWMCs) and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated.

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. 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 (Figure 2).

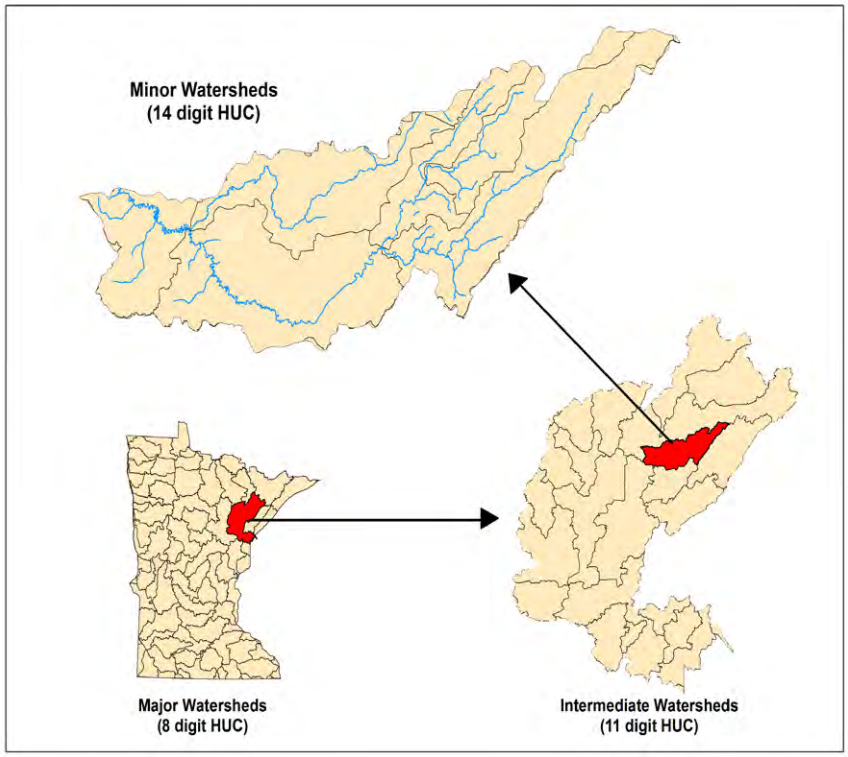

Figure 2. The intensive watershed monitoring design

Monitoring sites are selected at or near a road crossing closest to the mouth or "outlet" of each stream where possible. This approach provides an assessment of conditions of rivers and streams at multiple scales within each watershed without monitoring every single stream reach.

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) outlet 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 (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). 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 needed 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 brought into the watershed monitoring framework in 2009. The MPCA conducts its own lake monitoring and also funds monitoring by local groups such as counties, Soil Water Conservation Districts, 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.

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 that has been established at watershed outlets, 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 too, 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 volunteer citizen and agency/external monitoring data are being used for assessment in the St. Louis River watershed.

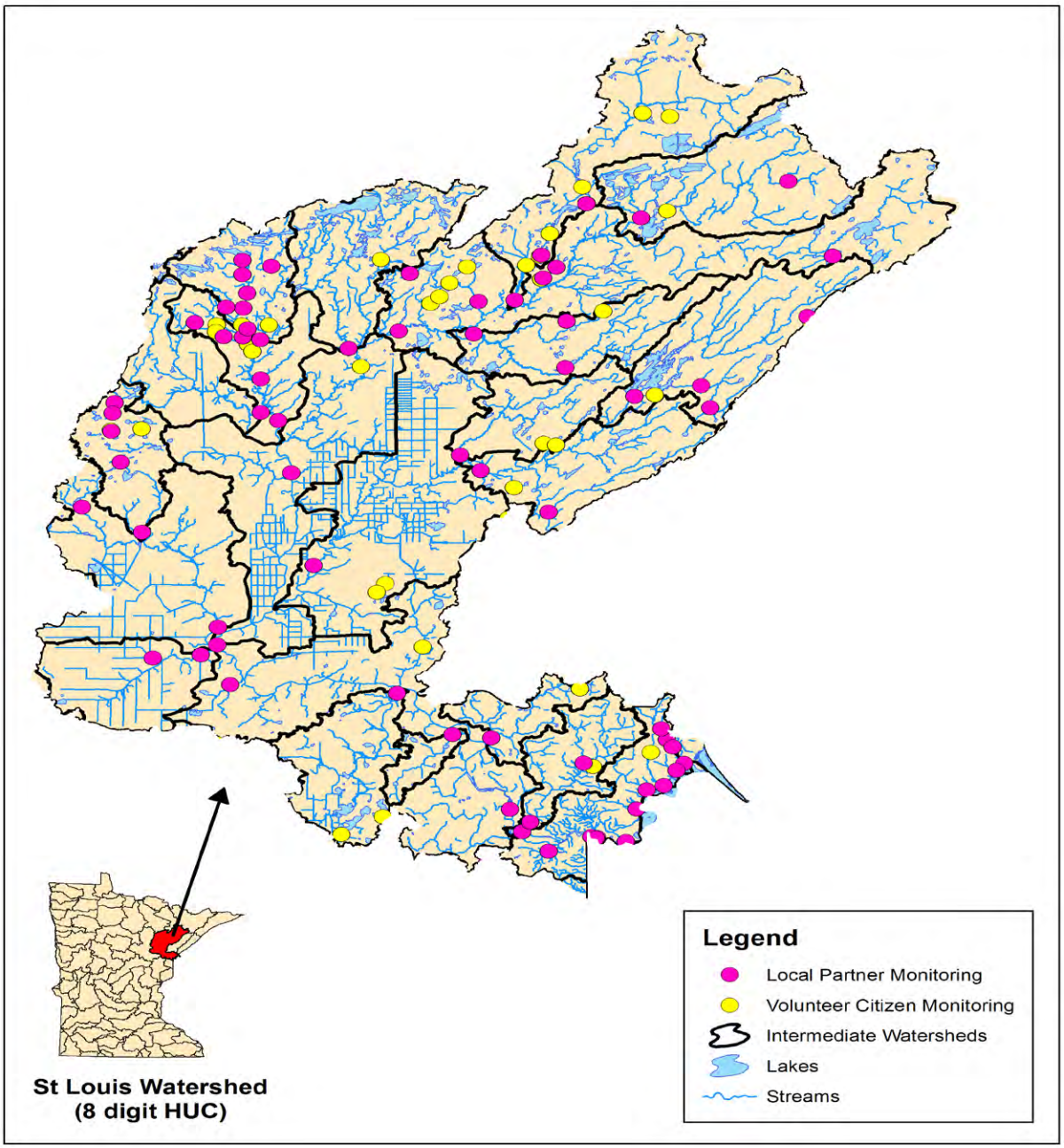

Figure 3. Monitoring locations of local groups, citizens, and the MPCA monitoring staff in the St. Louis River Watershed

III. Assessment Methodology

The Clean Water Act requires states to report, every two years, on the condition of the waters of the state. 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 in a review of water quality data to assess the condition of waterbodies. The goal of this effort is to use the best data and best science 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 2010) (http://www.pca.state.mn.us/index.php/download-document.html?gid=8601).

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters is measured. It is the water quality standards that are used to determine the impairment status (i.e. use attainment status) of a waterbody. 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 R. 7050 2008) (https://www.revisor.mn.gov/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). Waterbodies that are in attainment are said to be supporting their designated beneficial use(s) whereas waterbodies out of attainment are considered non-supporting. 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 macroinvertebrates. 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, and the MPCA uses a variety of tools to fully assess designated uses. Assessment methodologies often differ by parameter and designated use, and consider multiple factors of the pollutants concentration; 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 macroinvertebrate 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, ch. 7050), or when there is a significant morphological feature such as a dam or lake within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale High Resolution National Hydrologic Dataset (NHD) to define and index stream, lake, and wetland assessment units. Each river 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.

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 St. Louis 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 "desktop assessments" are conducted 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 2010) for the guidelines and factors to consider when making such determinations.

New impairments (i.e., waterbodies not attaining their beneficial uses), are reviewed using Geographic Information System to determine if greater than 50 percent of the assessment unit is channelized. With

the exception of toxics and bacteria, the MPCA is deferring new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use 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.) The last step in the assessment process is the Professional Judgement Group (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.

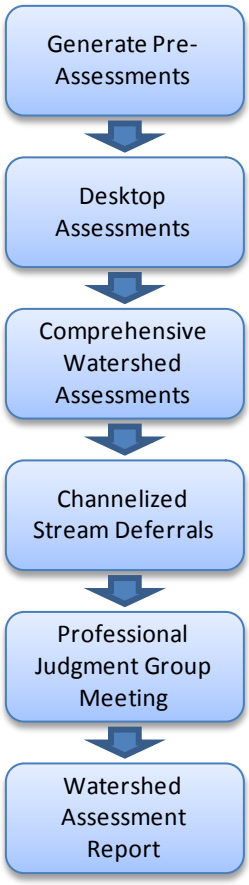

Figure 4. Flowchart of aquatic life use assessment process

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. All monitoring data required or paid for by MPCA is entered into STORET. STORET is currently being replaced by EQuIS. Projects funded by MPCA include CWA Section 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.

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 by members 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 are not required to make an assessment.

IV. Watershed Overview

Physical setting

From its source at Seven Beaver Lake, the St. Louis River flows 201 miles to its confluence with Lake Superior. The watershed is located in northeastern Minnesota, and a small portion in northwestern Wisconsin, but lies completely within the Northern Lakes and Forests (NLF) ecoregion (Omernik 1988). The St. Louis River HUC-8 watershed covers 2,926 square miles (NRCS, 2007), and for the most part lies in St. Louis County, Minnesota. As the river flows to Lake Superior it forms a 12,000 acre freshwater estuary which supports the shipping ports of Duluth, Minnesota and Superior, Wisconsin. The lower 15 miles of the St. Louis River estuary has been impacted by heavy industry since the late 1800's. Although water quality has improved since the Western Lake Superior Sanitary District began treating industrial and domestic effluent in 1979, contaminated sediments persist, and the International Joint Commission lists the estuary as an Area of Concern (AOC) (Lindgren, et. al., 2006).

Other major cities within the watershed include Cloquet, Floodwood, and a number of cities on the Mesabi Iron Range including Hibbing, Chisholm, Eveleth, Mountain Iron, Virginia, Gilbert, Biwabik, Aurora, Hoyt Lake and Babbitt.

Many of the 145,000 people that live within the watershed boundaries reside in the far southeastern area of the watershed in the cities of Duluth, Minnesota and Superior, Wisconsin. The Mesabi Iron Range contains the majority of the cities within the watershed, with populations generally less than 5,000. Outside of these two areas, much of the St. Louis watershed tends to be sparsely populated, with large tracts of lands consisting of little or no development. The headwaters of the watershed are within the public lands of the Superior National Forest.

There are two major tributaries to the St. Louis watershed as it flows to Lake Superior. The Whiteface River flows from the Whiteface Reservoir and enters the St. Louis River six miles north-east of Floodwood. At the point of entry the Whiteface River contributes one half of the St. Louis Rivers flow, and its water is softer and considerably darker than the St. Louis (Waters 1977). The Cloquet River flows from Cloquet Lake and enters the St. Louis River one mile east of Brookston. At the point of entry the Cloquet River contributes one third of the St. Louis Rivers flow (Waters 1977). The Cloquet River is an important tributary to the lower reaches of the St Louis River, but it is considered a separate major (8 digit HUC) and will not be included in this report.

Land use summary

Historically, the St. Louis River watershed was a diverse area dominated by mature coniferous forests. Low lying woods dominated the headwaters which transitioned to wetlands and bogs in the middle sections of the watershed. Soil Rich in iron ore are located in the headwaters, which make the land a valuable resource. The downstream portion flows through mixed stands of deciduous and coniferous forest. The river eventually enters a beautiful gorge at Jay Cooke State Park where it picks up considerable gradient before finally entering a 12,000 acre estuary at its confluence with Lake Superior (Waters 1977).

The St. Louis watershed was once covered with large stands of old growth white pines. With rivers including the Embarrass, Whiteface and St. Louis to transport logs, the lumber industry greatly impacted the forests from the late 1800's to 1925, when the last river log drive was made. Before railroads were built to Duluth, Cloquet prospered as the leading sawmill town in the region. The St. Louis River was a slow flowing river, perfect for large spring river drives, until picking up velocity at the gorge downstream of Cloquet. Once the railroads were built, Duluth became an important sawmill town as its lumber was the last western source of pine that could be easily transported to the large markets on the east coast. To this day Cloquet remains an important town for the lumber industry, but now relies heavily on Aspen, Birch, Spruce, Fir and Jack Pine (Waters 1977).

Historically and currently, another important land use component lies in the Mesabi Iron Range at the headwaters of the St. Louis watershed. Starting in 1892, the first mine was established on the Mesabi Range in the current city of Mountain Iron. Once mined, the ore was taken by rail to Silver Bay or Duluth where it was transported by boat to the steel mills of the Great Lakes States.

According to the 2001 National Land Cover Dataset (Figure 5) 87.8 percent of the land is undeveloped in the St. Louis watershed. Land use in the watershed is categorized by 60.9 percent forested or shrub, 24 percent wetland, 2.9 percent open water, 6.7 percent range land, 3.5 percent developed and 1.6 percent mines.

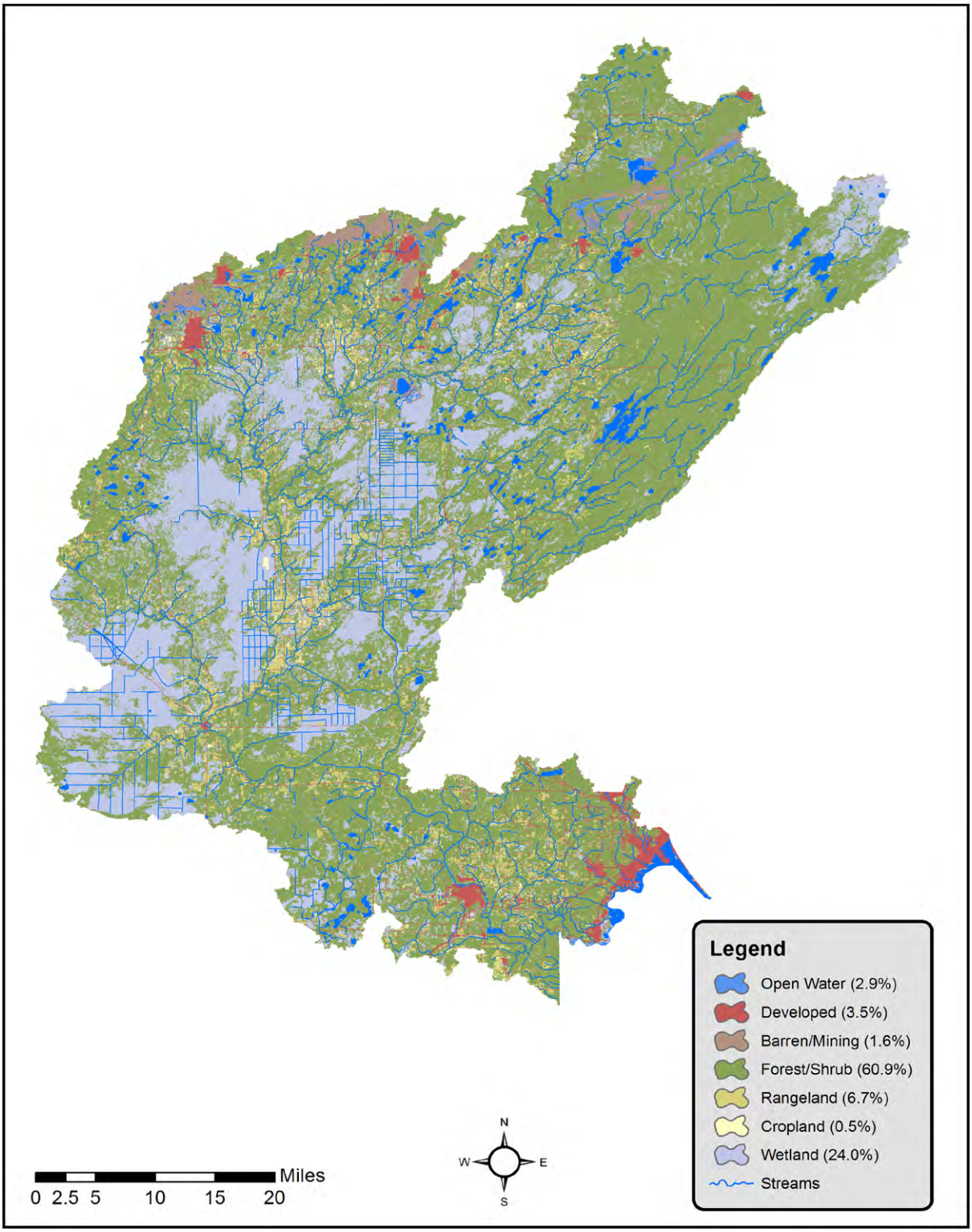

Figure 5. St. Louis Watershed 2001 land use

Surface water hydrology

One of the most geologically significant changes made to the St. Louis River Watershed surface water hydrology was the impact of glaciers sculpting the landscape as recent as 10,000 years ago. The most influential glaciers in this region include the Superior Lobe and St. Louis Sublobe of the Des Moines. These two lobes created most of the stream and river pathways seen today. (Waters 1977).

The St. Louis River originates from the outlet of Seven Beaver Lake in the Superior National Forest, 14 miles east of Hoyt Lakes. From its source the river flows west/south-west along the southern edge of the Mesabi Range, to the confluence with the Swan River 15 miles south of Hibbing. After the confluence with the Swan River, the St. Louis heads south to the town of Floodwood. From Floodwood the St. Louis River flows east until meeting with Lake Superior.

Starting at an elevation of 1669 feet at Seven Beaver Lake, the St. Louis River drops 1067 feet on its journey to Lake Superior where the elevation is 602 feet. Gradient within the river is highly variable ranging from 0.6 to 34.5 feet per mile (DNR 2006), with an average of 5.3 feet per mile over the rivers 201 mile course.

The long term stream USGS' flow monitoring station on the St. Louis River is immediately downstream of the Scanlon Dam, in Scanlon. The record started in 1908 and remains current to this day. The average daily flow at the Scanlon Dam is 2364 cubic feet per second (cfs) (USGS 2010). The peak flow reached approximately 45,000 cfs on June 21, 2012 and the minimum flow was 88 cfs on August 24, 1977 (USGS).

Historically, nearly 100 dams were constructed in the St. Louis watershed to aid in log transportation and sawmill operation (Waters 1977). Currently, there are 37 dams recognized by the MDNR Division of Waters (Figure 6). There are five dams using the St. Louis River's steep gradient in the lower reaches to produce electricity. From upstream to downstream they are: Knife Falls Dam; Cloquet Dam; Scanlon Dam; Thomson Dam; and Fond du Lac Dam. The Knife Falls Dam is located just north of Cloquet. This dam was built in 1921 and currently has 18 feet of drop to produce 2.4 megawatts of electricity. Downstream lies the Cloquet Dam. The Cloquet Dam was built in the town of Cloquet in 1899. It was originally built to provide water and power to run the Sappi paper mill. It is no longer used to run the paper mill, and has been turned into a hydroelectric dam that produces 6.5 megawatts of electricity with 40 feet of drop. The Scanlon Dam was built in 1922 in Scanlon to produce electricity for the town. It now produces 1.6 megawatts of electricity from 21 feet of drop. This dam does not have a large storage pool, so at low water levels there is little if any electricity produced. The Thomson Dam forms the Thomson Reservoir, but the power generation comes from a remote power house that is three miles from the main dam. The Thomson Dam can produce 69.6 megawatts of electricity. The Fond du Lac Dam is the last hydroelectric dam before the St. Louis River enters Lake Superior. Built in 1924, this dam currently resides within Jay Cooke State Park. The dam was built at the site of a waterfall and now has 78 feet of drop to produce 12 megawatts of electricity (MDNR 2011).

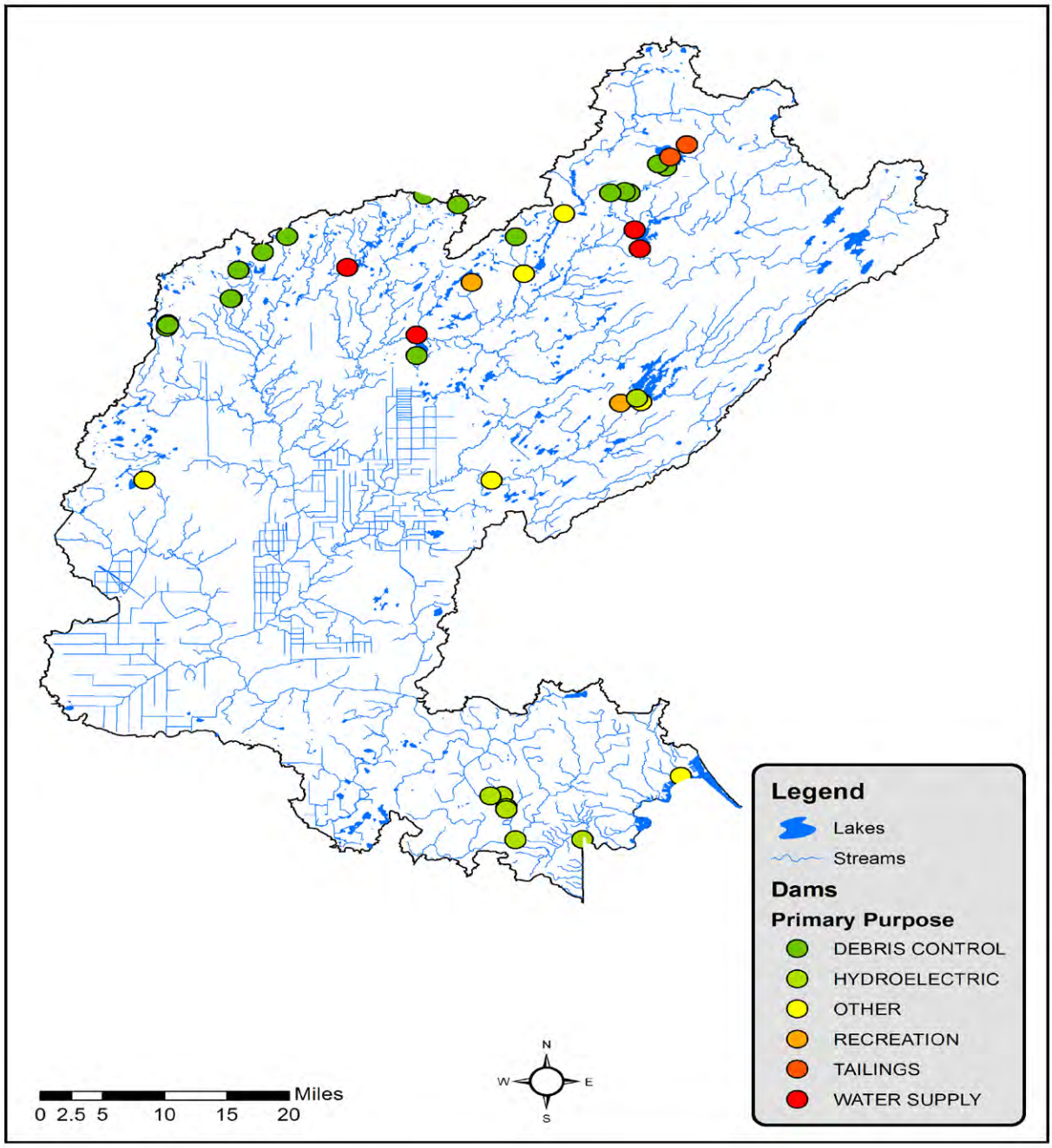

Figure 6. Dams within the St. Louis Watershed

Climate and precipitation

Annual precipitation levels in the watershed generally range from 27 to 31 inches (Minnesota State Climatologists Office, 2011). During the October 2008-September 2009 water year, which encompasses the time span in which the majority of the data were collected in the watershed, the precipitation levels were normal to slightly lower than normal (Figure 7).

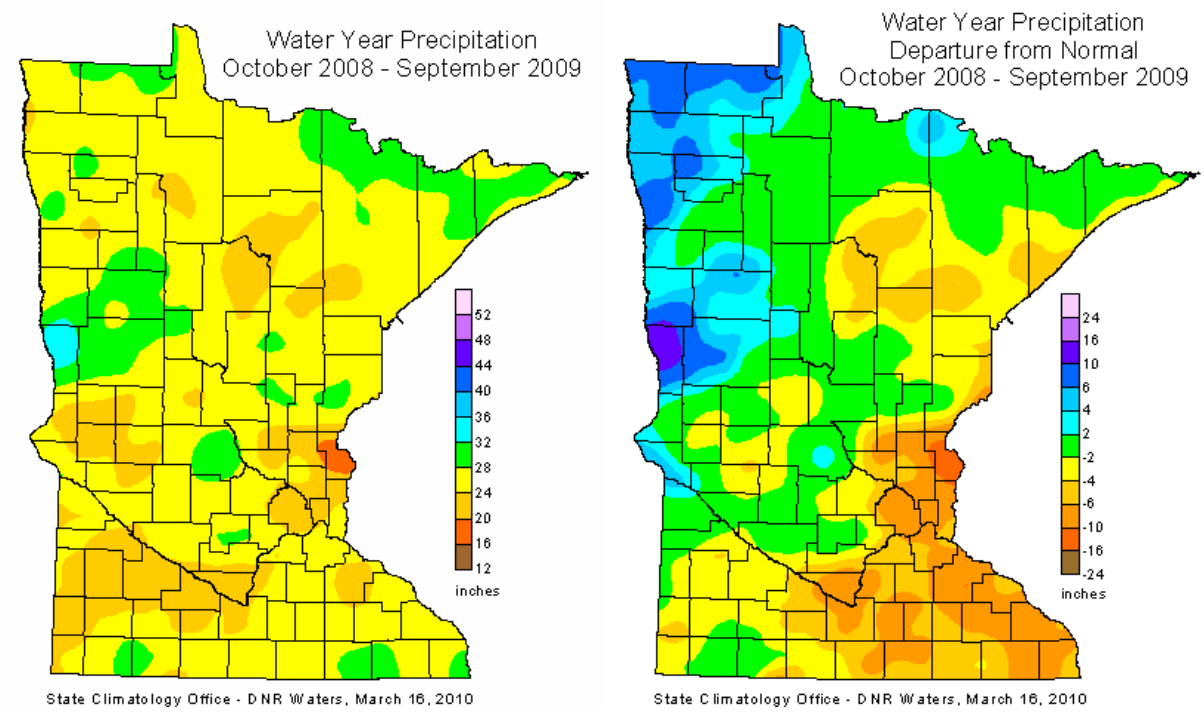

Figure 7. State-wide precipitation levels during the 2009 water year

V. Watershed wide Data Collection Methodology

Load monitoring

The St. Louis River is monitored in Scanlon below the Scanlon dam. 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; watershed yield, which describes amount of pollutant delivered per acre; and flow weighted mean concentrations, which are computed by dividing the pollutant load by the total seasonal flow volume. These are calculated for total suspended solids (TSS), total phosphorus (TP), orthophosphate (OP), Total Kjeldahl Nitrogen (TKN) and nitrate plus nitrite nitrogen (nitrate-N).

Intensive water quality sampling occurs year round at all MWLM sites. Thirty to thirty-five mid-stream grab samples are collected per site per year with sampling frequency greatest during periods of moderate to high flow (Figure 8). Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

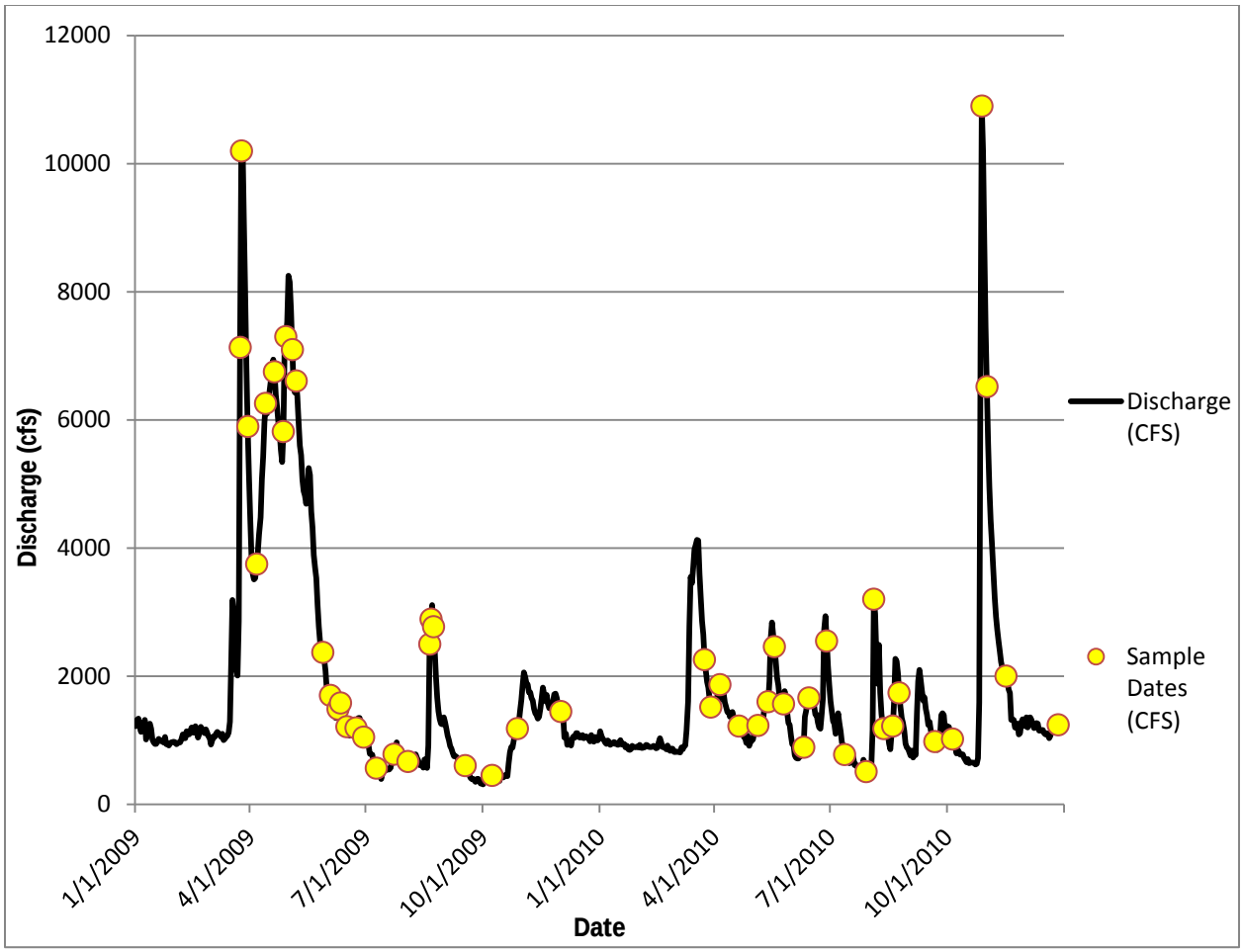

Figure 8. Hydrograph for the St. Louis River 2009-2010

Stream water sampling

A total of 23 water chemistry monitoring stations were sampled in the summer of 2009 and 2010 throughout the St. Louis River Watershed. These water chemistry sites were located near the outlets of most intermediate (HUC-11) watersheds, per the MPCA's watershed monitoring approach. This work was completed primarily by local partners, including the University of Minnesota Duluth/NRRI, N. St. Louis County SWCD, Hibbing Community College, the St. Louis River Alliance, and Fond Du Lac Tribal and Community College. Monitoring sites ranged from small tributaries such as Mud Hen and Dempsey Creeks to the St Louis River at the Highway 23 Bridge in Duluth – the watershed's 'de facto' outlet.

Stream biological sampling

The biological monitoring component of intensive watershed monitoring in the St. Louis River watershed was completed during the summer of 2009. A total of 116 biological monitoring stations were sampled within the watershed (Table 9), 29 of which had been established in previous years. These sites were located near the outlets of most HUC-11 & HUC-14 watersheds, selected following the sampling design. While data from the last ten years contributed to the watershed assessments, the majority of data utilized for this assessment was collected in 2009. A total of 97 stream assessment units (AUIDs) were sampled for biology in the St. Louis River watershed, and aquatic life assessments were conducted for 78 of these units. In anticipation of transitioning to a Tiered Aquatic Life Use (TALU) framework, biological monitoring data was not assessed on channelized stream segments due to their potential to qualify for a

'modified' aquatic life use classification and its associated water quality criteria. Nonetheless, the biological information that was not used in the assessment process will be used in the stressor identification process, and will also be used to investigate trends in water quality condition in subsequent reporting cycles.

To measure the health of the biological communities at each assessable biological monitoring station, Indices of Biological Integrity (IBI) were used, specifically the Fish Index of Biological Integrity (F-IBI) and the Macroinvertebrate Index of Biological Integrity (M-IBI). The F-IBI and M-IBI partitions streams into nine distinct classes to account for natural, physical, and biological differences associated with different regions of the state, drainage area, gradient, and water temperature (Appendix 4). Fish and macroinvertebrate communities within each class are more similar to each other than those occurring in other classes. By partitioning, or accounting for the natural variation in streams, any changes in IBI scores within a class should reflect real change due to human-induced impacts. Each class specific IBI has a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals. IBI scores higher than the upper confidence limit reflect good biological condition, while scores below the lower confidence limit reflect poor biological condition. 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, refer to Appendix 4-7.

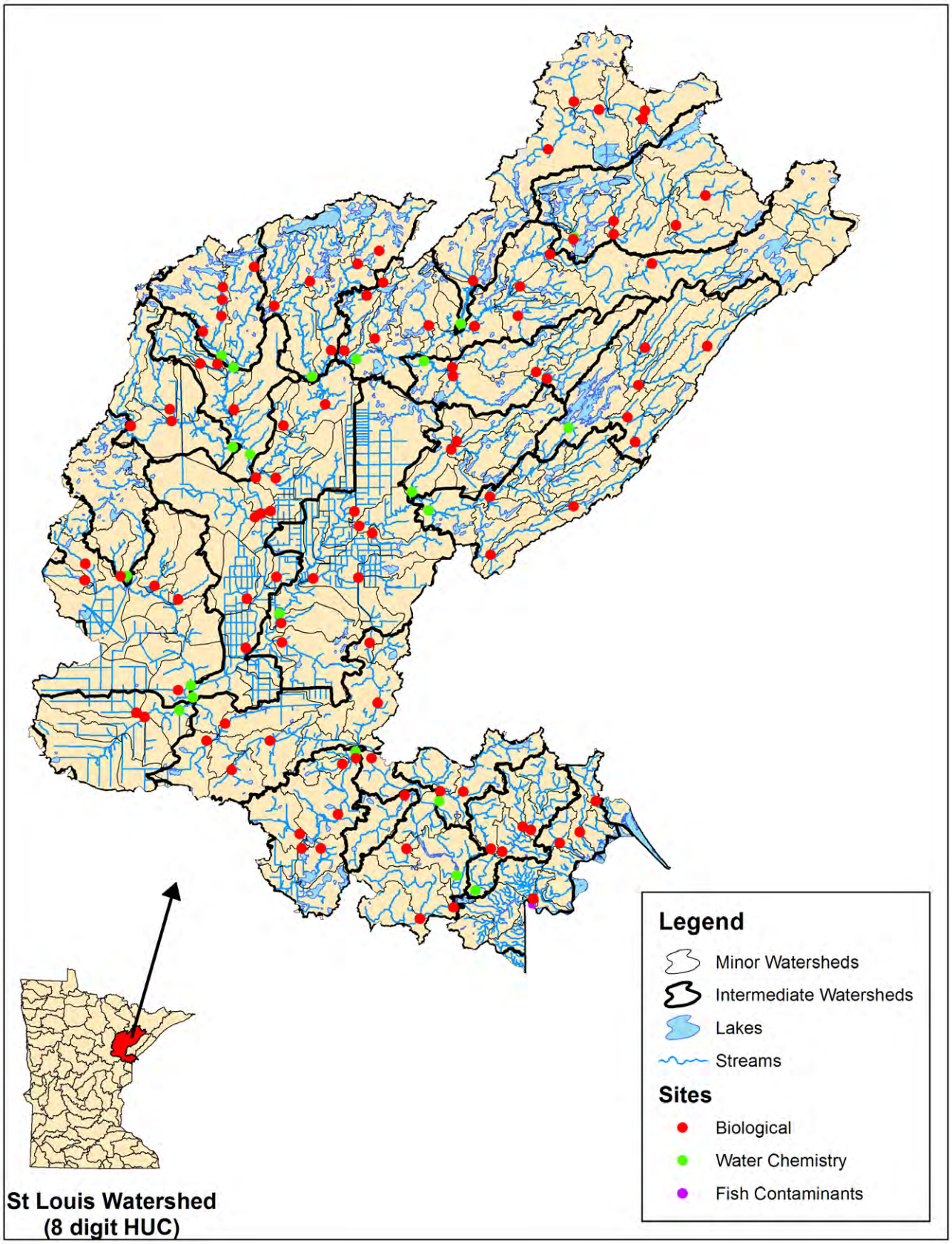

Figure 9. Intensive watershed monitoring stream stations in the St. Louis River Watershed

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the St. Louis and Whiteface rivers, as well as 43 lakes in the watershed. MPCA biomonitoring staff collected fish from the St. Louis River in 2009. All other fish were collected by MDNR Fisheries staff.

In addition, fish from 4 lake/reservoirs and the St. Louis River Estuary were tested for perfluorochemicals (PFCs) from 2007 to 2010. PFCs became a contaminant of emerging concern in 2004 when high concentrations were measured in fish from the Mississippi River. Extensive statewide monitoring of lakes and rivers for PFCs in fish was continued through 2010. More focused monitoring for PFCs will continue in known contaminated waters, such as the Mississippi River, several lakes in the Twin Cities Metropolitan Area, and the Fish Lake Flowage near Duluth.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. For mercury or PCBs analyses, homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue. For PFCs, whole fish were shipped to AXYS Analytical Services Ltd in Sidney, British Columbia, Canada. AXYS did the fish measurements and processing before analyzing the tissue samples for 13 PFCs. The PFC that primarily bioaccumulates in fish and is a known health concern for human consumption is perfluorooctane sulfonate (PFOS).

The MPCA has included waters impaired for mercury in fish on the 303d Impaired Waters List since 1998. Impairment assessment for PCBs and PFCs 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 or PFCs, the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is 0.22 mg/Kg for PCBs and 0.200 mg/Kg for PFOS.

Prior to 2006, mercury fish tissue concentrations were assessed for water quality impairment based on the Minnesota Department of Health's fish consumption advisory. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if 10 percent of the fish samples (measured as the 90th percentile) exceeded 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.

In the 1970s and 1980s, PCBs were the primary contaminant of concern in fish tissue. PCBs in fish have not been monitored as intensively as mercury in the last three decades. 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. Consequently, it was not necessary to continue widespread frequent monitoring of smaller river systems, as is done with mercury. Limited monitoring of PCBs has continued in watershed monitoring. The two largest fish of the fish species collected at the watershed outlets are analyzed for PCBs.

Lake water sampling

The distribution of lakes within the St. Louis River Watershed is highly variable. Northern HUC-11 sub-watersheds, such as the Upper St. Louis and Embarrass River watersheds are lake rich. Several sub-watersheds in the eastern and Southern portion of the basin, such as East Savanna and Midway Rivers have very few lake resources. Most of the lakes within the Stony Brook and Simian Creek Watersheds are within and managed by the Fond du Lac Reservation, and will not be discussed in detail in this report.

Although the St. Louis River watershed has a fair number of lakes overall (352 greater than 10 acres), there are relatively few large lakes (those greater than 500 acres). Whiteface Reservoir, managed by Minnesota Power as a hydro power storage reservoir, is the largest at 3,592 acres. Other large and notable lakes include Seven Beaver, Big, West Two Rivers Reservoir, and Colby Lake.
Lake assessment monitoring within the watershed was done primarily in 2009-2010 by a mix of MPCA staff, Surface Water Assessment Grantees such as the University of Minnesota Duluth, and citizen volunteers There are a total of 25 lakes with assessment-level data within the St. Louis River watershed. Morphometric data for these lakes, and aquatic recreational use assessments are summarized in Appendix 11. Observed phosphorus, chlorophyll-a and Secchi transparency data, as well as modeled water quality conditions using the MINLEAP model (Wilson and Walker, 1989) are summarized in Appendix 12. The Fond Du Lac Reservation has done a considerable amount of monitoring of tribal lake resources. For further information, see http://www.fdlrez.com/newnr/environ/waterlakestream.htm.

VI. Individual HUC-11 Watershed Results

Assessment results are presented for each HUC-11 watershed unit within the St. Louis 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 had been typically employed historically. This scale provides a robust assessment of water quality condition in the 11-digit watershed unit and is a practical size for the development, management and implementation of effective TMDL's 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 2009 intensive watershed monitoring effort but will also consider all available data from the last 10 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 HUC-11 subwatershed is provided. Within each account, readers are given a brief description of the watershed along with a series of tables including a 1) 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), 2) non-assessable AUID table where a general indication of condition is provided for channelized streams (where applicable), 3) a stream habitat results table, 4) an outlet water chemistry Results table, 5) a table describing lake water chemistry (where applicable) and finally, a narrative that summarizes the unique components of the assessment and highlights noteworthy 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 ammonia (-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 as 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 water chemistry parameters monitored in these studies refer to Appendix 2. 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. Where multiple visits occur at the same station, the relative 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. A qualitative habitat rating was then assigned to each station: Good ≥ 66, Fair 45-65, or Poor ≤ 44.

Outlet water chemistry results

These summary tables display the water chemistry results for the intensive watershed station representing the outlet of the HUC-11 watershed. This data can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. While not all of the water chemistry parameters of interest have developed water quality standards, (McCollor and Heiskary, 1993) have developed ecoregion expectations for a number of water quality parameters in streams. These ecoregion expectations provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. The ecoregion expectations were based on the 75th percentile from a long term dataset of least impacted streams.

Lake water chemistry

This section provides a summary table including all lakes possessing sufficient data for aquatic recreation use assessments.

HUC-11 and HUC-8 figures

The figures presented for each of the following HUC-11 watershed units contain the assessment results from the most recent assessment cycle as well as any impairment listings carried forward from previous assessment cycles. Following the results by HUC-11 watershed, are a series of figures that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire St. Louis River major watershed (HUC-8).

Upper St. Louis Watershed Unit HUC 04010201015

The Upper St. Louis River watershed, located in east-central St. Louis County, encompasses an area of 294.8 square miles. This watershed is the headwaters of the St. Louis River, which originates at Seven Beaver Lake. After flowing out of Seven Beaver Lake the St. Louis River travels 74.3 miles to its confluence with Elbow Creek, 1.5 miles south-west of Forbes. The watershed is largely undeveloped and consists predominantly of forest/shrub and wetland land cover. Much of the headwaters are within the Superior National Forest. Limited development and farming occur in the western half of the watershed, with the north western part of the watershed falling on portions of the Mesabi Range, and south western portion containing land used for hay and livestock. The cities of Aurora, Gilbert, Eveleth and Iron Junction fall on the northern border of the watershed.

The Upper St. Louis River is highly variable in gradient, with the upper half of this watershed having much steeper gradients than the lower half. In the section from Seven Beavers Lake to the confluence of the Partridge River, the river drops almost 300 feet in 34.4 miles. From the Partridge River to the confluence with Elbow Creek, the river only drops 80 feet in 39.9 miles. Named tributaries to the St. Louis River within this watershed include the Partridge River, Embarrass River, Ely Creek, Mud Hen Creek and Elbow Creek. The water chemistry monitoring for this watershed is station 09LS080 on the St. Louis River at the County State Aid Highway 7 Bridge just south of the town of Forbes.

Stream assessment

Table 1. Aquatic life and recreation assessments on assessed AUIDs in the Upper St. Louis River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-511 **St Louis River** *Embarrass R to East Two R*	20.98	2B	09LS080	Downstream of CR 7, 1 mi. S of Forbes	MTS	MTS	IF	MTS	MTS	MTS	MTS	-	MTS	FS	FS
04010201-644 **St Louis River** *T58 R13W S35, east line to Partridge R*	26.46	2B	97LS080	Just west off CSAH 110 bridge; 6 mi. SE of Hoyt Lakes	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-526 **St Louis River** *Partridge R to Embarrass R*	23.09	2B	09LS085 09LS088	Upstream of CR 95, 7 mi. SE of Gilbert Upstream Hwy 100, 2 mi. S of Aurora	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Table 1 (continued)

04010201-570 **Elbow Creek** *Unnamed Ditch to St Louis R*	5.55	2B	09LS081	Upstream of CR 16, 0.5 mi. W of Forbes	MTS	EXP	-	-	-	-	-	-	-	NS	NA
04010201-518 **Elbow Creek** *T57 R18WS12, north line to Elbow Lk*	3.55	2B	09LS082	Downstream of 18th Ave, 2 mi. SE of Eveleth	EXS	EXS	-	-	-	-	MTS	-	IF	NS	IF
04010201-A26 **Ely Creek** *Headwaters (Ely 69-0660-00) to Unnamed Cr*	4.12	2B	09LS084	Upstream CR 95, 2.5 mi. S of Sparta	EXP	MTS	-	-	-	-	MTS	MTS	IF	NS	IF

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

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

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-A39 **Unnamed Creek** *North Twin Lk to St Louis R*	09LS087	Upstream of TR 6627, 5 mi. SE of Biwabik	Fair	Good
04010201-521 **Elbow Creek** *Headwaters to T57 R18W S1, south line*	98LS016	N side of CSAH 101 in SE Eveleth	Fair	Poor
04010201-594 **Unnamed Creek** *Unnamed Cr to Pot Lk outlet*	98LS017	Just upstream of CSAH 4 at CSAH 111, 8 mi. S of Biwabik	Fair	Fair
04010201-A25 **Long Lake Creek** *Unnamed Cr to St Louis R*	09LS083	Upstream of CR 310, 1 mi. N of Peary	Good	Poor

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 3. Minnesota Stream Habitat Assessment (MSHA) for the Upper St. Louis River 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	09LS080	St Louis River	5	12	22	14	33	86	Good
1	09LS081	Elbow Creek	5	10	19	12	31	77	Good
1	09LS082	Elbow Creek	5	11	3	12	11	42	Poor
1	09LS083	Long Lake Creek	5	11	9	12	19	56	Fair
1	09LS084	Ely Creek	3	11	7	16	21	58	Fair
1	09LS085	St Louis River	5	9	13	15	27	69	Good
1	09LS087	Trib. to St Louis River	5	12	9	7	13	46	Fair
1	09LS088	St Louis River	4	12	25	14	31	87	Good
1	97LS080	St Louis River	5	13	21	12	31	82	Good
2	98LS016	Elbow Creek	1	9	15	12	26	63	Fair
3	98LS017	Trib. to St Louis River	4	11	15	9	22	61	Fair
Average Habitat Results: *Upper St Louis River 11 HUC Watershed*			4	11	15	12	24	66	Good

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)

Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)

Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 4. Outlet water chemistry results for the Upper St. Louis River 11-HUC

Station location:	Saint Louis River Downstream of CR 7, 1 mi. S of Forbes
Storet ID:	S000-119
Station #:	09LS080

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	20	19	27	28	20	16	4	15	28	29
Min	1.6	2.8	65	6.7	0.009	0.47	1.5	6	7.3	131
Max	7.2	21.8	120	10.4	0.035	0.96	3.1	79	8.3	444
Mean[1]	3.0	6.5	101	9.0	0.021	0.66	2.2	28	7.9	284
Median	2.5	5.0	100	9.1	0.020	0.63	2.0	30	7.9	283
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/19	0/27	0/28	0/20		0/4	0/15	0/28	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

1Geometric mean of all samples is provided for *E. coli* or fecal coliform.

2Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).

3Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW EPA 822 B-01-015. 2001

[4] Combined data from 3 turbidity methods, each with slightly different standard methods

[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

****Data found in the table above was compiled using the results from data collected in 2008 and 2009 at the outlet monitoring station. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 5. Lake Morphometric and assessment data for the Upper St. Louis River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Lost	69-0611-00	44	13.2	6.1	16	FS
South Twin	69-0420-00	45	14.4	10.6	43	FS
Bass	69-0553-00	59	10.5	7.6	35	FS
Butterball	69-0044-00	177	1.8	1.5	100	FS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

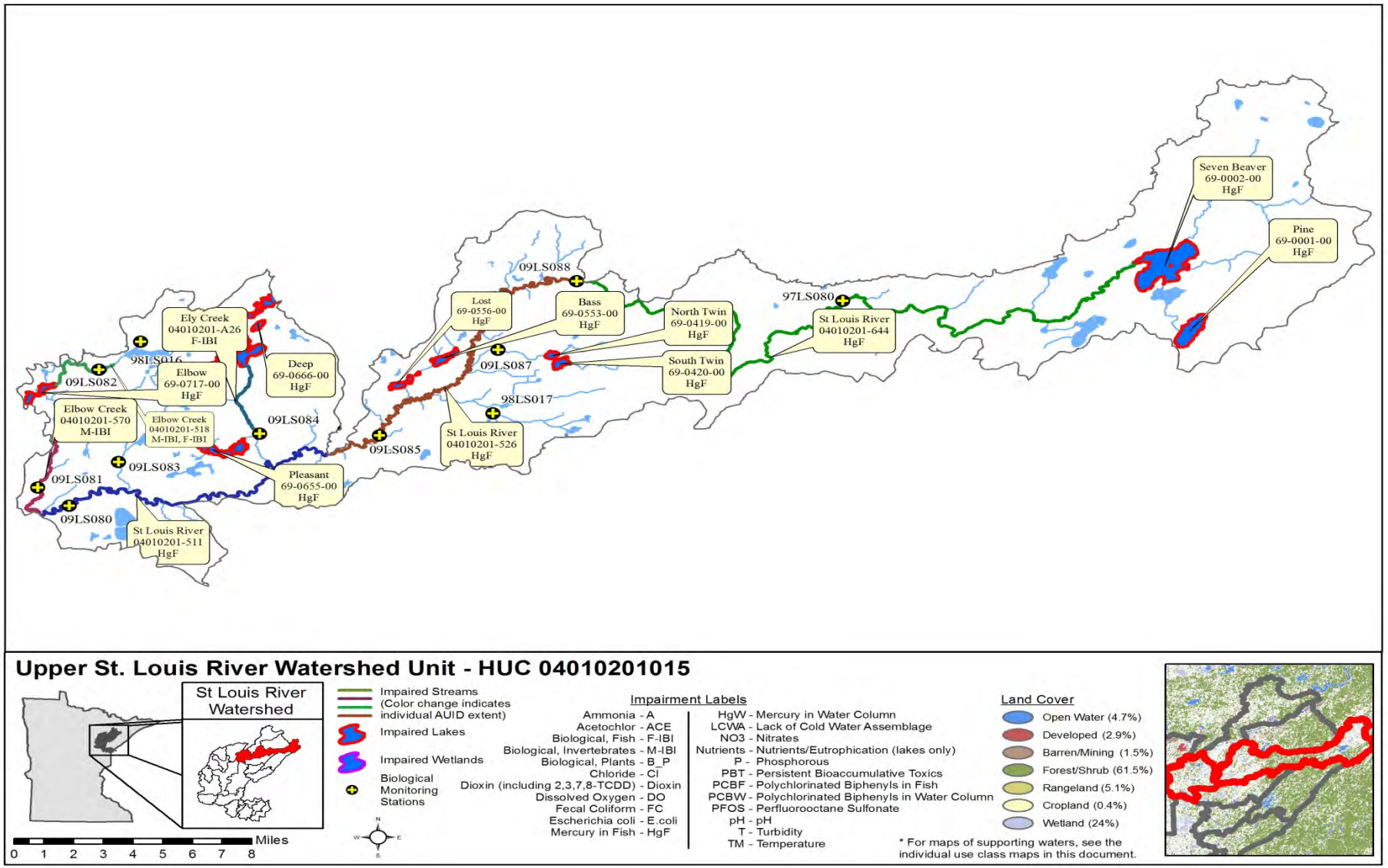

Figure 10. Currently Listed Impaired Waters by parameter and land use in the St. Louis River Watershed Unit

Summary

The Upper St. Louis watershed is a complex system consisting of both natural and channelized streams. Seven biological stations across six AUIDs were sampled and assessed for aquatic life. In addition, four channelized sites were not assessed and showed mixed F-IBI and M-IBI results ranging from good to poor (Table 2). There is considerable variation between the results in this watershed which appear to relate to habitat differences between sites. Tributaries in the southwest portion of the watershed are surrounded by small areas of development. This developed land tends to decrease along the tributaries as they flow closer to the main stem of the St. Louis River. Stations 09LS082 on Elbow Creek and 09LS084 on Ely Creek have poor MSHA substrate scores. Fine sediments like silt, sand and clay dominate these reaches which is potentially limiting the habitat for sensitive fish and invertebrates. Along the main stem St. Louis River there tends to be a natural forest riparian buffer that in return has provided fish cover that includes coarse substrates and stable channel morphology. In general, the main stem St. Louis River stations scored higher on MSHA and received better F-IBI and M-IBI scores than tributary streams (Table 3).

The chemistry data collected at the stream monitoring site near Forbes indicates that this watershed has excellent water quality. Water quality standards were not exceeded for any parameter. Concentrations of sediment, turbidity, nutrients, and bacteria were low and reflective of the forests and wetlands which dominate the land cover. Data indicate full support for both aquatic life and aquatic recreational uses.

Like the streams, water chemistry in lakes of this subwatershed also appears to be good. This watershed contains 65 lakes greater than 10 acres; notable lakes include Ely and Seven Beaver. A total of four lakes have assessment level data. All four monitored lakes in the watershed- Butterball (69-0044), South Twin (69-0420), Bass (69-0553), and Lost (69-0556) are supporting recreational use for warm water lakes in the NLF ecoregion. TP and chlorophyll-a concentrations are within expected ranges given the forest and wetland dominated landscape.

Partridge River Watershed Unit HUC 04010201020

The Partridge River watershed Unit, located in east-central St. Louis County, encompasses an area of 161.8 square miles. The Partridge River starts at the Peter Mitchel Pit area of the Mesabi Range and travels 40 miles to its confluence with the St. Louis River, 2.5 miles south of Aurora. The watershed is largely undeveloped and consists predominantly of forest cover (79.4 percent) managed by the Superior National Forest. Areas of the northern and western portions of the watershed fall within active mining of the Mesabi Range (7.8 percent), and a portion of the area include mine pits associated with the mining activity (6.1 percent). The city of Hoyt Lakes is the only town entirely within the watershed, but the northern edge of Aurora is also within the watershed boundaries.

From the Partridge River to its confluence with the St. Louis, the river drops 220 feet in 40 miles. Named tributaries to the Partridge River include the South Branch Partridge River, Colvin Creek, Wyman Creek, Second Creek and First Creek. The water chemistry monitoring for this watershed is station 09LS102 on the Partridge River at the County State Aid Highway 110 Bridge, two miles west of the town of Hoyt Lakes.

Stream assessments

Table 6. Aquatic life and recreation assessments on assessed AUIDs in the Partridge River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-552 **Partridge River** *Headwaters to St Louis R*	36.99	2B	09LS102 09LS105 09LS114	Downstream of CR 110, 2 mi. E of Aurora Downstream of CR 565, in Hoyt Lakes Downstream of CR 110, 2 mi. E of Aurora	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	FS	FS
04010201-942 **Wyman Creek** *Headwaters to Colby Lk*	10	2A	81LS008	Upstream of CR 666, in Wyman	EXP	MTS	-	-	-	-	-	-	-	NS	NA
04010201-946 **Colvin Creek** *Cranberry Cr to Partridge R*	5.14	2B	09LS106	Upstream of FR 420, 2.5 mi. N of Skibo	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-587 **Unnamed Creek** *Unnamed Cr to Unnamed Cr*	2.51	2B	97LS077	Just E off CR 680 bridge, 10 mi. NE of Hoyt Lakes	MTS	MTS	-	-	-	-	MTS	-	IF	FS	IF

Table 6 (Continued)

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 7. Minnesota Stream Habitat Assessment (MSHA) for the Partridge River 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	09LS102	Partridge River	5	13	19	12	20	69	Good
1	09LS105	Partridge River	5	12	26	14	27	84	Good
1	09LS106	Colvin Creek	5	11	18	8	20	62	Fair
1	09LS114	Partridge River	5	10	23	13	25	76	Good
1	81LS008	Wyman Creek	5	14	26	15	30	90	Good
2	97LS077	Partridge River, South Branch	5	13	23	14	27	81	Good
Average Habitat Results: *Partridge River 11 HUC Watershed*			5	12	22	13	25	77	Good

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 8. Outlet water chemistry results for the Partridge River 11-HUC

Station location:	Partridge River Downstream of CR 110, 2 mi. E. of Aurora
Storet ID:	S005-752
Station #:	09LS102

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	19	18	10	10	0	15	19	19
Min	1.6	2.7	76	6.8	0.005	0.49		10	7.3	91
Max	3.5	8.3	120	9.0	0.021	0.77		160	8.3	1184
Mean[1]	2.3	4.4	112	7.9	0.012	0.65		45	7.7	471
Median	2.1	4.0	120	7.8	0.012	0.66		45	7.7	444
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/25	0/19	0/18	0/10			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14

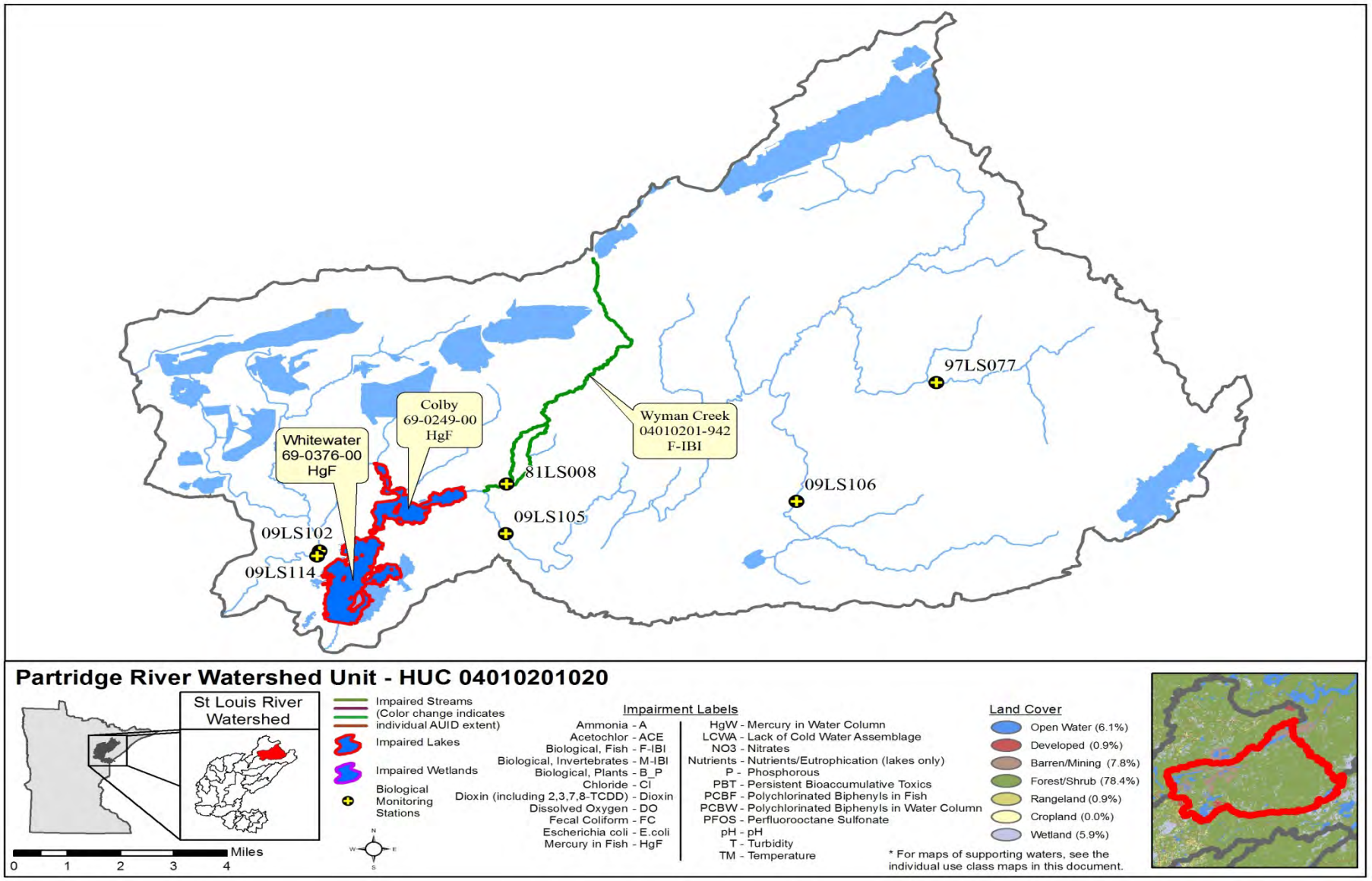

Figure 11. Currently Listed Impaired Waters by parameter and land use in the Partridge River Watershed Unit

Summary

In general, biological communities within the Partridge River watershed produced favorable IBI scores above their respected thresholds. One exception was one fish visit on Wyman Creek (81LS008) which is located on the south end of AUID 04010201-942. The coldwater IBI score for this site was heavily influenced by the presence of two tolerant warm water species (black bullhead and yellow perch) which drove the IBI score down. Historically, brook trout have been reported by the MDNR at this site but none were sampled in 2009 during the MPCA's biological monitoring visit. The headwaters of this watershed are heavily influenced by mining activities, and other than the mining activities there appear to be very few stressors related to human disturbance. Although habitat is robust throughout the sampling reach, habitat greatly reduces moving upstream towards the headwaters of Wyman Creek. The habitat alterations in the headwaters are possibly contributing to increased water temperatures which are affecting the downstream portions of the AUID. Although there is not conclusive evidence behind this reasoning, data in this watershed shows the five stations not directly influenced by mine drainage produced strong IBI scores above the upper confidence limits for their respective thresholds. Due to these results, additional monitoring is recommended to determine the source of this biological impairment.

Water chemistry data near Hoyt Lakes indicated excellent water quality for this watershed. Water quality standards were not exceeded for any parameter. Concentrations of sediment, turbidity, nutrients, and bacteria were low and reflective of the forests and wetlands which dominate the land cover. During low flow conditions in September, 2009 high values of specific conductivity (>1000 us/cm) were documented. Other parameters were within normal ranges at this time, and conductivity concentrations returned to normal for all samples collected in 2010. In summary, water quality data indicate full support for both aquatic life and aquatic recreational uses. However, a further investigation into the source and chemical constituents that are leading to the high conductivity values during low flow periods is warranted.

This watershed contains 10 lakes greater than 10 acres; notable lakes include Colby and Whitewater. Much of this watershed is within Superior National Forest. No lakes have assessment level data for aquatic recreation.

Embarrass River Watershed Unit HUC 04010201030

The Embarrass River watershed, located in east-central St. Louis County, encompasses an area of 180.8 square miles and contains the entire Embarrass River. The Embarrass River starts two miles south-west of Babbitt, and travels primarily southwesterly 50.7 miles to its confluence with St Louis River, 6.5 miles south-east of Gilbert. The watershed is largely undeveloped and consists predominantly of forest/shrub land cover (78.4 percent). About five percent of the watershed is used for agriculture, primarily pastureland. Portions of the watershed fall on active mining on the Mesabi Range (2.8 percent), but not as much as surrounding watersheds. The river flows through several on-channel lakes in the lower portion of the watershed, such as Sabin, Wynne, Embarrass, Esquagama, and Cedar Island. The cities of Babbitt, Biwabik, Belgrade and McKinney are within the watershed boundaries.

From the headwater of the Embarrass River to the confluence with the St Louis River, the river drops 55 feet in 81.8 miles. Named tributaries within this watershed include Spring Mine Creek, Camp Eight Creek and Bear Creek. The water chemistry monitoring for this watershed is station 09LS095 on the Embarrass River at the County State Aid Highway 95 Bridge, seven miles south-east of the town of Gilbert.

Stream assessments

Table 9. Aquatic life and recreation assessments on assessed AUIDs in the Embarrass River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-577 **Embarrass River** *Embarrass Lk to St Louis R*	14.53	2B	09LS095	Upstream of CR 95, 6.5 mi. of SE Gilbert	MTS	MTS	-	MTS	MTS	-	MTS	-	MTS	FS	FS
04010201-579 **Embarrass River** *Headwaters to Embarrass Lk*	34.02	2B	97LS005 09LS100 10EM045	.5mi. E off SH 135 bridge. 3 mi. SW of Embarrass Upstream of CR 620, 5 mi. SW of Babbit Downstream of Mattson Rd, 3.5 mi. E of Embarrass	EXP	MTS	-	MTS	-	-	-	-	-	NS	NA
04010201-583 **Unnamed Creek** *Headwaters to Embarrass R*	4.01	2B	98LS011	Just upstream of CR 392 bridge, 5 mi SW of Biwabik	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-A40 **Bear Creek** *Unnamed Cr to Embarrass R*	4.32	2B	09LS098	Upstream of CR 21, 1.5 mi. N of Embarrass	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-A42 **Spring Mine Creek** *Ridge Cr to Embarrass R*	1.96	2B	09LS101	Upstream of CR 615, 4.5 mi. SW of Babbitt	EXP	EXP	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 10. Minnesota Stream Habitat Assessment (MSHA) for the Embarrass River 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	09LS095	Embarrass River	5	13	15	12	24	69	Good
1	09LS098	Bear Creek	5	10	13	15	25	68	Good
1	09LS100	Embarrass River	4	11	7	8	13	42	Poor
2	09LS101	Spring Mine Creek	5	11	8	11	19	53	Fair
2	10EM045	Embarrass River	5	9	9	14	19	55	Fair
1	97LS005	Embarrass River	3	9	15	15	24	65	Fair
2	98LS011	Trib. to Embarrass River	4	9	12	8	13	45	Fair
Average Habitat Results: *Embarrass River 11 HUC Watershed*			4	10	11	12	20	57	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)

Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)

Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 11. Outlet water chemistry results for the Embarrass River 11-HUC

Station location:	Embarrass River Upstream of CR 95, 3 mi. NE of Makinen
Storet ID:	S005-751
Station #:	09LS095

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	Cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	19	18	10	10	0	15	18	19
Min	1.1	1.4	79	7.0	0.011	0.47		13	7.0	184
Max	4.0	3.8	120	9.6	0.024	0.64		90	8.2	329
Mean[1]	2.4	2.8	111	8.6	0.015	0.56		48	7.9	262
Median	2.1	2.9	120	8.4	0.014	0.56		50	8.0	270
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/19	0/18	0/10			0/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 12. Lake Morphometric and assessment data for the Embarrass River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Sabin (Embarrass Mine)	69-0429-00	63	141	60	8	FS
Esquagama	69-0565-00	191	27	15	19	FS
Embarrass	69-0496-00	182	4.5	3	92	FS

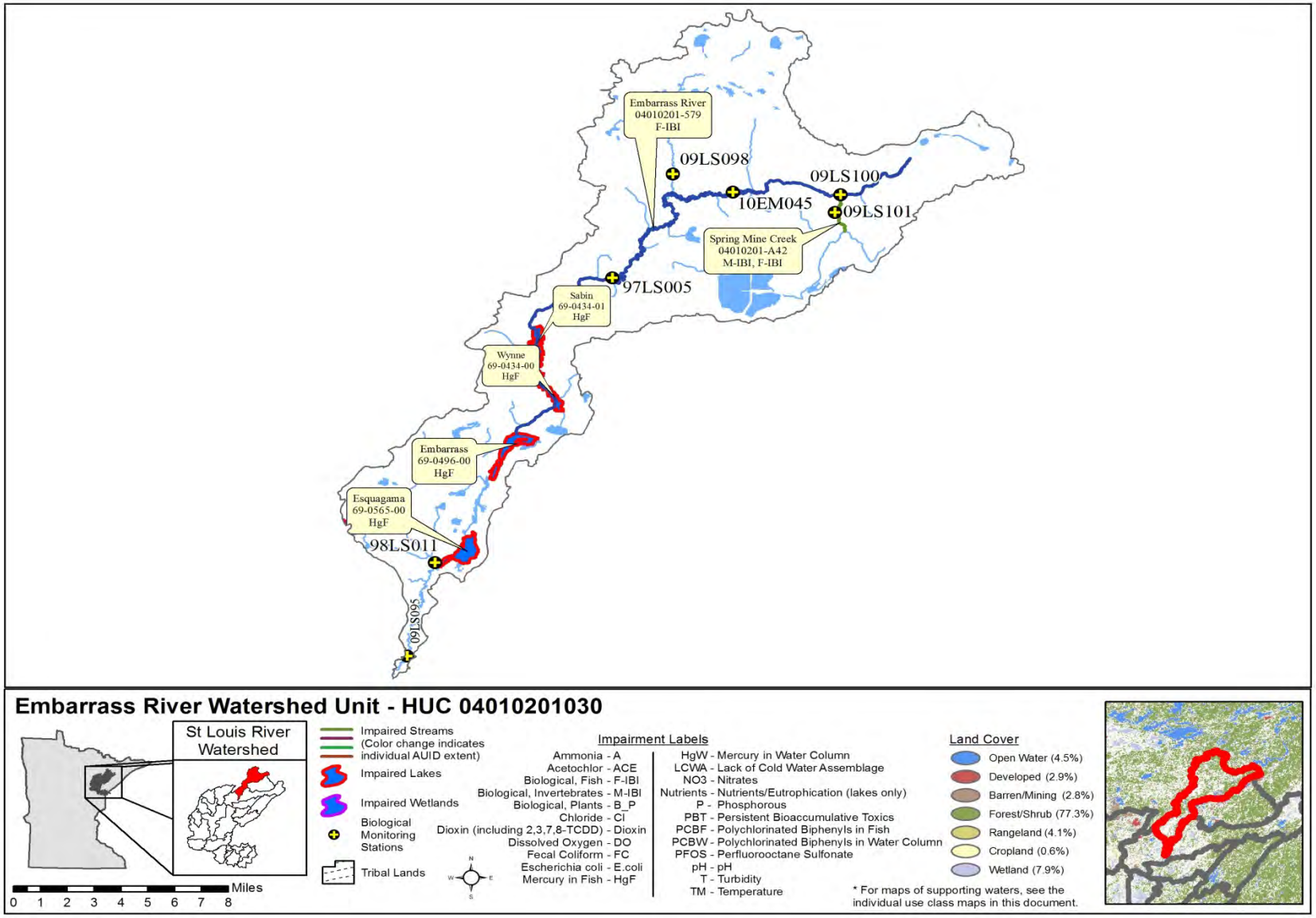

Figure 12. Currently Listed Impaired Waters by parameter and land use in the Embarrass River Watershed Unit

Summary

Seven biological stations along five AUIDs were sampled and assessed for aquatic life in the Embarrass River watershed, three of which had strong F-IBI and M-IBI scores above their respective thresholds, indicating healthy biological communities. The remaining 2 AUIDs had aquatic life impairments. AUID 04010201-579 had three biological stations which all scored poor on F-IBI. Biological communities seemed to be non-robust with low taxa richness and species diversity, even for a low productive, low gradient system like this. The influence of peat mining in the upstream portion of the watershed is a possible contributor to these impairments. The other impairment was found at station 09LS101 on Spring Mine Creek (AUID 04010201-A42), which was sampled for biology and failed to meet both F-IBI and M-IBI thresholds.

A strong longitudinal relationship exists when comparing conductivity values from upstream to downstream in this watershed. Station 09LS101 on Spring Mine Creek is the furthest upstream tributary to the Embarrass River in the watershed and has a conductivity value of 1205 umhos@25C, which is extremely high for streams in this region. Conductivity values immediately downstream of Spring Mine Creek on the Embarrass River are high but tend to decrease the further downstream you go so that by the lowest station (09LS095) conductivity values are close to normal ranges (average 260 umhos@25C). Conductivity values from two stations that are uninfluenced by the drainage of Spring Mine Creek are within normal ranges. For example, Bear Creek has the lowest conductivity value in the Embarrass River watershed at 92.1 umhos@25C. Also, the Embarrass River upstream of the Spring Mine Creek (09LS101) confluence has a conductivity value of 126.7. Although this station failed to meet its F-IBI threshold, the impairment is likely related to its very poor habitat (Table 10). Like conductivity, habitat scores also tend to improve further downstream in the Embarrass River. MSHA scores range from 42 at the most upstream site (09LS100) to 69 at 09LS095, the furthest downstream site. While high conductivity values are most likely not directly linked to the poor biological monitoring results (i.e. high conductivity is not the stressor), it is possible that high conductivity in general may be associated with other pollutants of concern emanating from Spring Mine Creek. Additional monitoring is recommended to determine the source of these biological impairments although both habitat and water chemistry concerns in the upper reaches appear to be likely factors.

Stream water quality data collected at the Highway 95 bridge indicates good water quality. The Embarrass River flows through several lakes upstream of the monitoring station, with Lake Cedar Island Lake being only six river miles upstream from the outlet. The lakes are likely retaining phosphorus, resulting in quite low concentrations (0.015 mg/L) at the downstream monitoring station. Sediment, turbidity, and bacteria concentrations are also low and meeting standards or ecoregion expectations. Water quality data indicate full support for both aquatic life and aquatic recreational uses.

This watershed contains 42 lakes greater than 10 acres; notable lakes include Embarrass and Sabin. A total of three lakes have assessment level data. All three monitored lakes in the watershed-Embarrass Mine Pit (69-0429), Esquagama (69-0565), and Embarrass (69-0496) – are supporting recreational use for lakes in the NLF ecoregion. For Esquagama and Embarrass, TP and chlorophyll-a concentrations are within the expected range given the forest and wetland dominated landscape in the upstream Embarrass River. Embarrass Mine Pit is a unique body of water, with excellent water quality.

Mud Hen Creek Watershed Unit HUC 04010201040

The Mud Hen Creek watershed, located in central St. Louis County, encompasses an area of 99.3 square miles. Mud Hen Creek starts at Loon Lake, nine miles south of Aurora. The river then travels 36.4 miles to its confluence with St Louis River, eight miles south of Gilbert. The watershed is largely undeveloped and consists predominantly of forest/shrub land cover (68.5 percent). There is a large area of wetlands in this watershed (16.7 percent), and 20 lakes (3.1 percent of the watershed area). It also has a relatively high amount of pastureland, with 8.5 percent of the total land area used for range. There are no incorporated cities located in the Mud Hen Creek watershed.

From the headwater of Mud Hen Creek at Loon Lake to the confluence with the St Louis River, Mud Hen creek drops 70 feet in 36.4 miles. Named tributaries within the Mud Hen Creek watershed include Water Hen Creek and South Branch Water Hen Creek. The water chemistry monitoring for this watershed is station 09LS090 on Mud Hen Creek at the County State Aid Highway 16 Bridge, seven miles south of Gilbert.

Stream assessments

Table 13. Aquatic life and recreation assessments on assessed AUIDs in the Mud Hen Creek 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-A28 **Mud Hen Creek** *Unnamed Cr to St Louis R*	5.83	2B	09LS090	Downstream of CR 16, 3 mi. N of Central Lakes	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	IF	FS	IF
04010201-A30 **Mud Hen Creek** *Unnamed Cr to Water Hen Cr*	8.97	2B	09LS091	Upstream of CR 93, 3 mi. NE of Central Lakes	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-A31 **Water Hen Creek** *Unnamed Cr to Mud Hen Cr*	4.03	2B	09LS092	Upstream of CR 93, 3 mi. NE of Central Lakes	MTS	EXP	-	-	-	-	-	-	-	NS	NA

Table 13 (Continued)

04010201-A35 **Water Hen Creek** *Unnamed Cr to S Br Water Hen Cr*	3.21	2B	09LS094	Downstream of CR 340, 2.5 mi. E of Makinen	MTS	EXS	-	-	-	-	-	-	-	NS	NA
04010201-A36 **Water Hen Creek, South Branch** *Unnamed Cr to Water Hen Cr*	4.42	2B	09LS093	Upstream of CR 4, 2.5 mi. E of Makinen	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 14. Minnesota Stream Habitat Assessment (MSHA) for the Mud Hen 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	09LS090	Mud Hen Creek	4	10	9	14	16	53	Fair
1	09LS091	Mud Hen Creek	5	11	19	13	22	70	Good
1	09LS092	Water Hen River	5	11	16	14	23	69	Good
1	09LS093	Water Hen Creek, South Branch	5	9	17	12	22	65	Fair
1	09LS094	Water Hen Creek	4	8	16	12	25	66	Fair
Average Habitat Results: *Mud Hen Creek 11 HUC Watershed*			5	10	15	13	22	64	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 15. Outlet water chemistry results for the Mud Hen Creek 11-HUC

Station location:	Mud Hen Creek at CR 16, 3 mi. N. of Central Lakes									
Storet ID:	S005-750									
Station #:	09LS090									
Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	19	18	10	10	0	15	18	19
Min	1.4	2.3	49	5.3	0.024	0.69		26	7.0	75
Max	6.8	6.6	120	8.9	0.049	1.60		1300	8.1	198
Mean[1]	3.5	4.2	86	6.7	0.038	1.00		107	7.4	136
Median	3.3	3.6	86	6.8	0.040	1.01		107	7.4	127
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/19	0/18	0/10			1/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947.

Table 16. Lake Morphometric and assessment data for the Mud Hen Creek HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Coe	69-0562-00	21	6.6	4.6	82	FS
Section Fourteen	69-0550-00	54	8.1	2.5	78	FS
Mud Hen	69-0494-00	64	2.4	1.8	100	NS
Loon	69-0426-00	105	25.5	10.6	24	FS
Long	69-0495-00	151	4.2	2.1	100	NS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

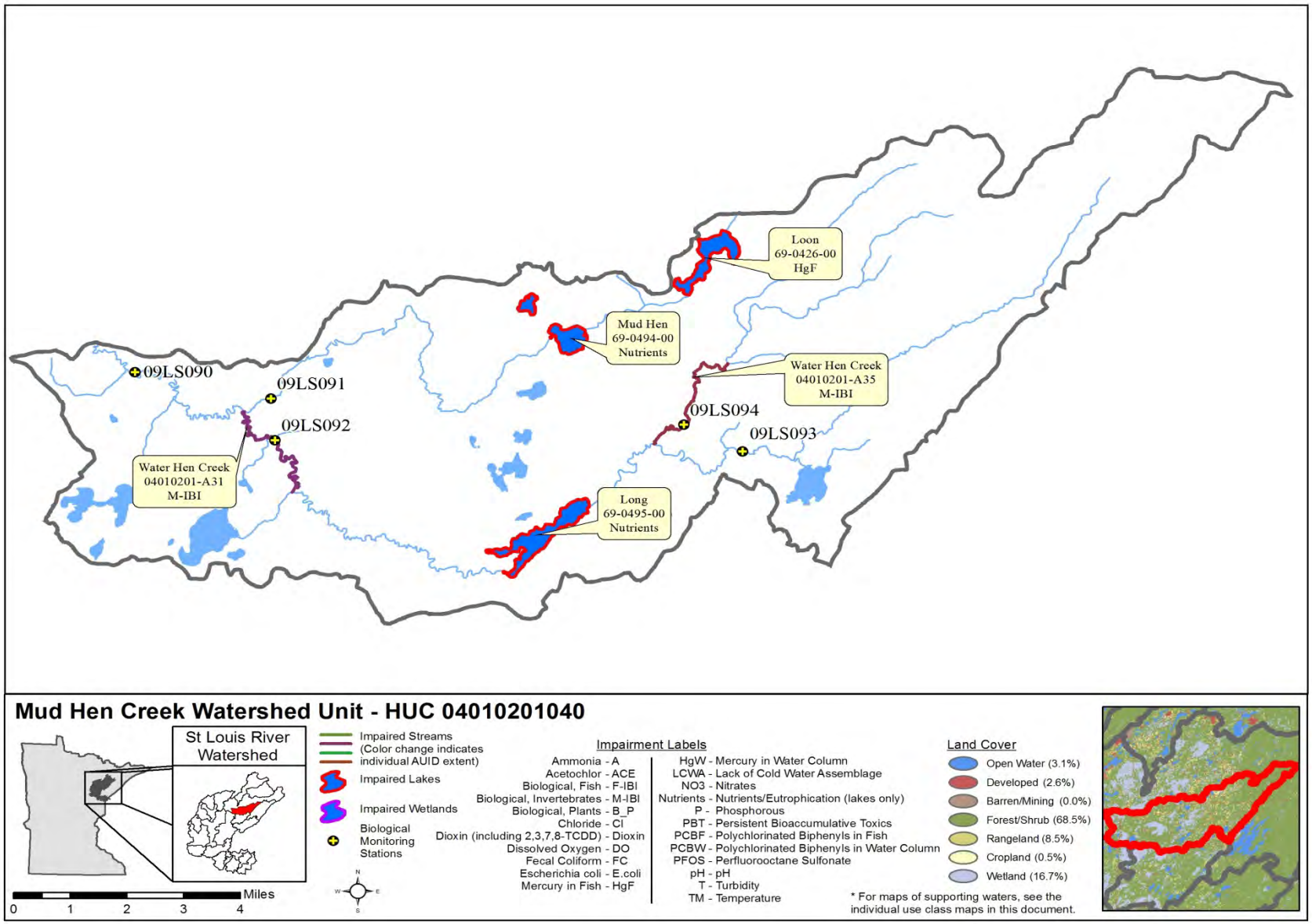

Figure 13. Currently Listed Impaired Waters by parameter and land use in the Mud Hen Creek Watershed Unit

Summary

Six AUIDs were sampled and assessed for support of aquatic life in the Mud Hen Creek watershed. F-IBI scores for all sites within this watershed scored above their respective thresholds, indicating healthy fish communities. Two sites (09LS092, 09LS094) scored below their thresholds for M-IBI and had aquatic life impairments. In general, there was no correlation found between habitat and IBI results. This is contradictory to the watershed as a whole where generally stations with low M-IBI scores usually had poor habitat. Sites in the Mud Hen Creek Watershed with the lowest M-IBI scores had fair to good MSHA scores leaving habitat as a poor indicator of determining the source of impairments in this watershed. Streams in this watershed are low gradient and tend to lack riffle habitats and coarse substrates. Generally, invertebrate communities in systems that lack flow and suitable coarse substrates may perform poorly. The Water Hen Creek (09LS092) impairment potentially stems from natural factors such as a lack of suitable habitat and flow for intolerant invertebrate species. However, station 09LS094 on Water Hen Creek displays a noticeable potential stressor. A mowed riparian buffer on the left bank of the site could be contributing to the impairment. The buffer alteration is potentially creating light bank erosion and producing silt accumulation over coarse substrates that could have previously held intolerant invertebrate species.

Water chemistry data indicate good water quality, and all standards or ecoregion expectations were met. Nutrient concentrations were slightly higher in the Mud Hen Creek watershed than in other upstream watersheds, likely influenced by the area's riparian wetlands and natural bog-staining from the numerous lakes. Bacteria concentrations generally were low; however one baseflow sample exceeded the standard. No follow up monitoring is recommended at this time.

This watershed contains 19 lakes greater than 10 acres; notable lakes include Long and Loon. A total of five lakes have assessment level data. Of the five monitored lakes in the Mud Hen Creek subwatershed, the three with small drainage areas in the headwaters of the watershed, Loon (69-0426), Section 14 (69-0550), and Coe (69-0562), are supporting recreational use for lakes in the NLF ecoregion. The two lakes with flowage hydrology that drain large wetland dominated watersheds, Mud Hen (69-0494) and Long Lakes (69-0495), are not meeting recreational use standards.

Two Rivers Watershed Unit HUC 04010201050

The Two Rivers watershed, located in central St. Louis County, encompasses an area of 133.4 square miles. Two Rivers is made up of the East Two River and the West Two River, separate tributaries to the St. Louis River. East Two River starts on the west side of Virginia, and flows 44.5 miles to its confluence with the St Louis River, three miles north-west of Zim. West Two River starts at the West Two River Reservoir and flows 29 miles to its confluence with the St. Louis River, 3.5 miles north-west of Zim. The majority of the watershed is forested land cover (54.5 percent). There is extensive mining in the headwaters of the Two Rivers watershed covering 11.1 percent of the watershed area. In the southern end of the watershed there is a fair amount of pasture, with 10.9 percent of the land considered range. The watershed has a fair amount of lakes, including 39 at least 10 acres in size. Cites within this watershed include of Franklin, Virginia, Mountain Iron, Leonidas, Kinney and portions of Buhl.

Named tributaries within the Two Rivers watershed include East Two River, West Two River, East Branch West Two River and Manganika Creek. The water chemistry monitoring for this watershed is station 09LS073 on West Two River at County State Aid Highway 25 Bridge, 4.5 miles north-west of Zim.

Stream assessments

Table 17. Aquatic life and recreation assessments on assessed AUIDs in the Two Rivers 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-534 **West Two River** *McQuade Lk outlet to St Louis R*	14.55	2B	09LS073	Upstream of CR 25, 3 mi. S of Cherry	MTS	MTS	MTS	MTS	MTS	IF	MTS	-	MTS	FS	FS
04010201-535 **West Two River** *West Two R Reservoir to McQuade Lk outlet*	5.55	2B	09LS075	Upstream of CR 137, 1.5 mi. E of Sherwood	MTS	EXS	-	-	-	-	-	-	-	NS	NA
04010201-548 **Unnamed Branch** *Manganika Lk to East Two R*	0.9	2B	09LS078	Upstream of CR 7, 1 mi. W of Largo	EXS	EXS	-	-	-	-	-	-	-	NS	NA
04010201-551 **Unnamed Creek** *Unnamed Cr to McQuade Lk*	7.51	2B	09LS074	Upstream of CR 592, 1 mi. S of Scott	MTS	EXP	-	-	-	-	-	-	-	NS	NA
04010201-555 **East Two River** *Unnamed branch to St Louis R*	19.62	2B	09LS076	Upstream of CR 16, 4 mi. S of Kirk	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Table 17 (Continued)

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 18. Non-assessed biological stations on channelized AUIDs in the Two Rivers 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-635 **Manganika Creek** *T58 R17W S19, north line to Manganika Lk*	98LS015	0.3 mi. S of CR 657 in SW Virginia	Poor	Poor

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 19. Minnesota Stream Habitat Assessment (MSHA) for the Two Rivers 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	09LS073	West Two River	5	11	20	15	29	80	Good
1	09LS074	Trib. to McQuade Lake	3	8	20	12	22	64	Fair
1	09LS075	West Two River	5	11	12	13	20	61	Fair
1	09LS076	East Two River	4	12	17	16	33	83	Good
1	09LS078	Trib. to East Two Rivers	5	11	10	12	17	55	Fair
2	98LS015	Trib. to Manganika Lake	3	13	7	10	11	43	Poor
Average Habitat Results: *Two Rivers 11 HUC Watershed*			4	11	14	13	22	64	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)

Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)

Poor: MSHA score below the median of the most disturbed sites (<44)

Table 20. Outlet water chemistry results for the Two Rivers 11-HUC

Station location:	West Two River Upstream of CR 25, 3 mi. S. of Cherry
Storet ID:	S004-601
Station #:	09LS073

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	20	19	9	9	0	14	20	20
Min	3.9	5.4	43	7.4	0.014	0.50		8	7.8	341
Max	18.0	13.1	120	11.9	0.055	1.06		196	8.4	615
Mean[1]	7.9	8.0	83	9.3	0.027	0.65		58	8.1	496
Median	6.2	7.7	87	9.3	0.025	0.56		69	8.1	505
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/20	0/19	0/9			0/14	0/20	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947.

Table 21. Lake Morphometric and assessment data for the Two Rivers HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth(m)	Littoral Area	Aquatic Recreation Use Support[4]
McQuade	69-0775-00	70	6.3	4.6	96	NS
Manganika	69-0726-00	71	7.2	3	88	NS
West Two Rivers Reservoir	69-0994-00	294	8.2	3.6	70	NS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

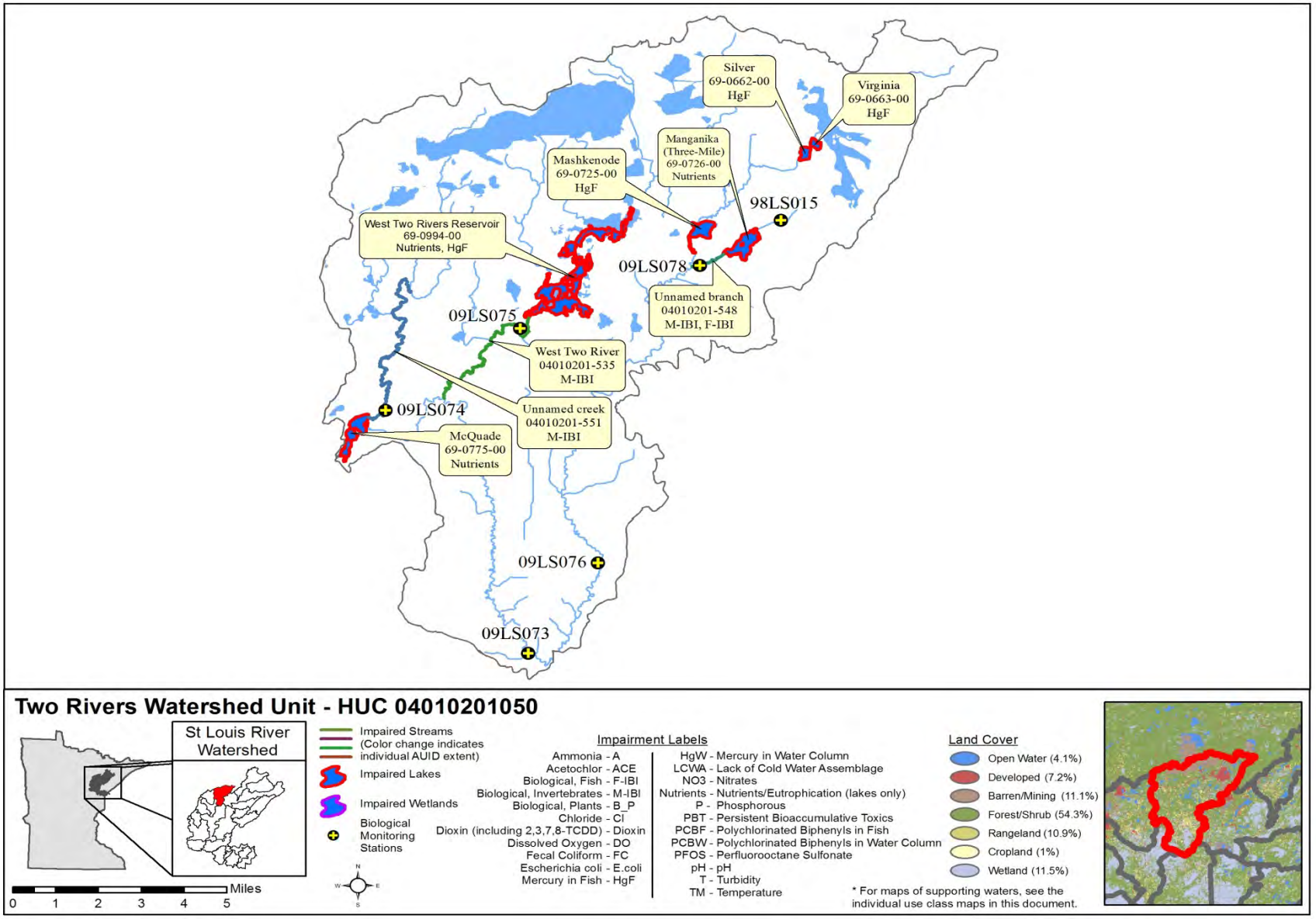

Figure 14. Currently Listed Impaired Waters by parameter and land use in the Two Rivers Watershed Unit

Summary

Assessments for aquatic life were completed on five of the six AUIDs in the Two Rivers watershed, two of which fully support aquatic life. Station 98LS015 on Manganika Creek (AUID 04010201-635) is listed as a class seven stream and therefore was not assessed for aquatic life. Both F-IBI and M-IBI results were poor. The remaining three AUIDs failed to meet their threshold for M-IBI and were deemed not supporting aquatic life. A correlation exists between the low IBI scores and poor habitat. Sites with poor aquatic communities tended to have substrates that were dominated by silt and clay which in return produced minimal habitat for intolerant species. Headwater reaches in this watershed performed poorly. The upper portions of the watershed have been compromised by mining and other development. The most downstream sites located in the southern portion of the watershed are more removed from the influence of the headwater impacts and meet goals for aquatic life and aquatic recreation. The longitudinal differences in stream quality are also apparent in the water chemistry results. Conductivity values in the northern and central portions of this watershed were generally over 1000 umhos@25 C which is extremely high for this region. As the watershed progresses downstream through a rather undeveloped landscape, values tend to decrease to 500-700 umhos@25. Additional monitoring is recommended to further explain these impairments.

Data collected from West Two River at the Highway 25 station indicate generally good water quality. Nutrients, sediment, and bacteria levels are low, and samples are meeting standards. Mean conductivity values exceeding the NLF ecoregion expectations; this may be an artifact of urban or mining landuse upstream. There are approximately 20 permitted discharge points in the headwaters of the watershed, most originating from mining facilities or cities.

This watershed contains 43 lakes greater than 10 acres; notable lakes include West Two Rivers Reservoir and McQuade. A total of three lakes have assessment level data. The three monitored lakes in the watershed, Manganika (69-0726), McQuade (69-0775), and West Two Rivers Reservoir (69-0994), are all not meeting recreational use standards for lakes within the NLF ecoregion. These lakes have large watersheds and a range of urban / anthropogenic impacts in their headwaters, such as iron mining or they receive treated domestic wastewater discharges - which collectively are factors in their poor water quality.

Middle St. Louis River Watershed Unit HUC 04010201060

The Middle St. Louis watershed, located in west-central St. Louis County, encompasses an area of 225.5 square miles. As the name implies this watershed contains the middle section of the St. Louis River from the confluence with Elbow Creek, down to the confluence of the Floodwood River. The watershed is largely undeveloped and consists predominantly of wetlands (50.8 percent) and forest land cover (36.3 percent). Historically, many of these wetlands were ditched in the attempt to drain the land for agricultural use. Much of this was unsuccessful and currently just 9.7 percent of the watershed is considered range. The cities of Meadowlands and Floodwood lie just outside of the watershed boundary, but both communities have a fair amount of their population within the watershed.

This section of the St. Louis River the river drops 65 feet in 50.9 miles. Named tributaries to the St. Louis River within this watershed include Stony Creek, Sand Creek, and Skunk Creek. Many other HUC-11 watersheds meet with the St. Louis River in this reach including East and West Two Rivers, East Swan River and the Whiteface River. The water chemistry monitoring site for this watershed is station 97LS090 on the St. Louis River at the County State Aid Highway 8 Bridge, just east of Floodwood.

Stream assessments

Table 22. Aquatic life and recreation assessments on assessed AUIDs in the Middle St. Louis River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-508 **St Louis River** *Whiteface R to Floodwood R*	6.92	2B	97LS090	Just N of CR 8 bridge on E edge of Floodwood	MTS	EXP	-	MTS	MTS	-	MTS	-	MTS	NS	FS
04010201-510 **St Louis River** *West Two R to Swan R*	22..57	2B	09LS038 09LS109	Downstream of CR 27, 2 mi. W of Zim Upstream of Lindstrom Rd, 3.5 mi N of Toivola	MTS	MTS	-	MTS	-	-	-	-	-	FS	NA
04010201-525 **St Louis River** *Swan R to Whiteface R*	18.45	2B	09LS030 09LS034	Downstream of CR 29, 6.5 mi. NE of Floodwood Downstream of CR 53, 0.5 mi. E of Toivola	MTS	MTS	-	-	-	-	MTS	-	IF	FS	IF
04010201-607 **Sand Creek** *Unnamed Cr to St Louis R*	2.28	2B	09LS033	Upstream of CR 743, 0.5 mi. S of Toivola	EXP	MTS	-	-	-	-	-	-	-	NS	NA

Table 22 (Continued)

04010201-963 **Stony Creek** *Unnamed Cr to Unnamed Cr*	5.49	2B	09LS036	Upstream of CR 83, 3 mi. N of Toivola	EXS	EXS	-	-	-	-	-	-	-	NS	NA
04010201-A17 **Unnamed Creek** *Unnamed Ditch to St Louis R*	2.14	2B	09LS035	Upstream of CR 52, 6.5 mi. N of Meadowlands	MTS	EXS	-	-	-	-	-	-	-	NS	NA
04010201-A18 **Skunk Creek** *Unnamed Cr to St Louis R*	1.78	2B	09LS031	Upstream of CR 196, 2 mi. W of Meadowlands	EXS	EXS	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 23. Non-assessed biological stations on channelized AUIDs in the Middle St. Louis River 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-A19 **Unnamed Creek** *Unnamed Cr to St Louis R*	09LS032	Upstream CR 740, 2 mi. NW of Meadowlands	Poor	Fair
04010201-A20 **Unnamed Creek** *Unnamed Cr to St Louis R*	09LS037	Upstream of CR 434, 1.5 mi. NW of Casco	Good	Fair

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 24. Minnesota Stream Habitat Assessment (MSHA) for the Middle St. Louis River 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	09LS030	St Louis River	5	9	21	12	25	72	Good
1	09LS031	Skunk Creek	5	9	7	12	10	42	Poor
1	09LS032	Trib. to St Louis River	4	9	12	8	17	50	Fair
1	09LS033	Sand Creek	4	13	7	12	25	61	Fair
1	09LS034	St Louis River	5	9	17	13	15	59	Fair
1	09LS035	Trib. to St Louis River	5	15	9	13	22	64	Fair
1	09LS036	Stony Creek	5	14	12	7	15	53	Fair
1	09LS037	Trib. to St Louis River	5	14	9	6	13	47	Fair
1	09LS038	St Louis River	5	11	20	14	26	76	Good
1	09LS109	St Louis River	5	10	20	13	26	74	Good
2	97LS090	St Louis River	2	9	21	12	25	69	Good
Average Habitat Results: *Middle St Louis River 11 HUC Watershed*			5	11	14	11	20	61	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 25. Outlet water chemistry results for the Middle St. Louis River 11-HUC

Station location:	St. Louis River Upstream of CR 8 in Floodwood
Storet ID:	S005-303
Station #:	97LS090

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100ml	SU	uS/cm
# samples	9	9	17	18	9	9	0	15	18	18
Min	3.0	3.5	22	6.0	0.015	0.69		4	7.2	147
Max	11.6	11.4	120	9.6	0.039	1.23		140	8.1	406
Mean[1]	5.9	5.9	66	7.6	0.027	0.81		20	7.7	266
Median	4.6	5.2	72	7.4	0.027	0.71		20	7.7	256
WQ standard		25	20	5.0	0.055		<10	126/1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/17	0/18	0/9			0/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947.

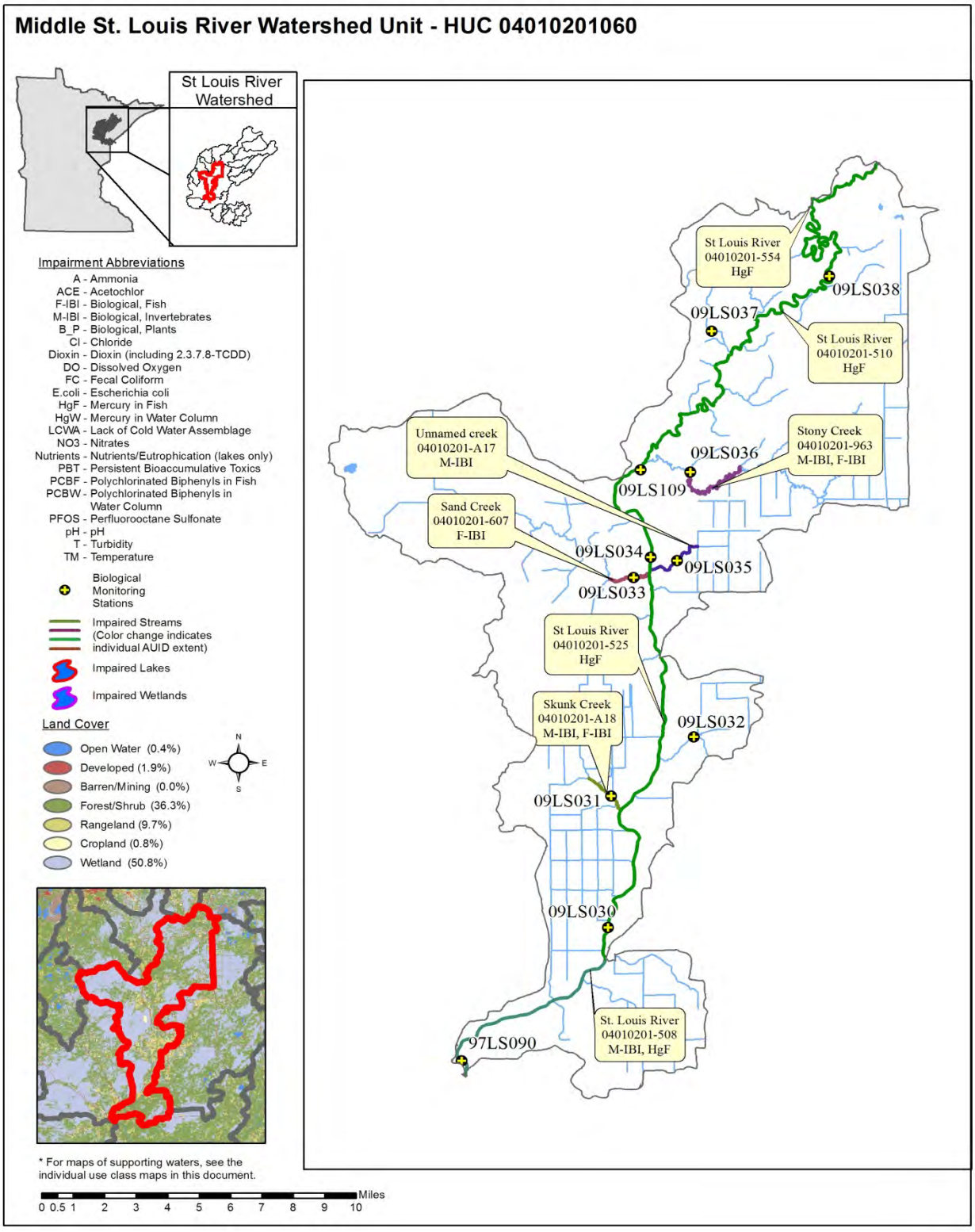

Figure 15. Currently Listed Impaired Waters by parameter and land use in the Middle St. Louis River Watershed Unit

Summary

A total of 12 biological monitoring stations along 10 AUIDs were reviewed in the Middle St. Louis River watershed. Biological communities showed great variability in relation to site location. This variation is an indication of the diverse landscape in the watershed that consists of 50.8 percent wetland, 36.3 percent forest, and the remainder being used for range. Although seven of the AUIDs were assessed for aquatic life, only two showed full support. Four of the remaining seven AUIDs showed new impairments for poor biological communities and are not meeting their respective IBI thresholds. The majority of these impairments are grouped in the central to southern portion of the watershed on tributaries to the St. Louis River. Areas of range land and wetland drainage dominate the central portion of the watershed and may be contributing subpar biological habitat results. There is a relationship between the low IBI scores and the MSHA substrate scores. Four of the five sites that are not supporting aquatic life show substrate scores <12 (Table 24). Moderate to high bank erosion was present at most of these stations and is a probable cause for the limited habitat and unstable channel geomorphology. In contrast, three of four sites (09LS030, 09LS038, 09LS109) from the two fully supporting AUIDs have substrate scores >20, and for the most part have stable banks with a wooded riparian zone. In addition, three sites were channelized and deemed non assessable at this time. These sites produced mixed results for F-IBI and M-IBI ranging from good to poor but follow the same spatial habitat patterns as the assessed AUIDs.

Data at the chemistry monitoring station on the St. Louis River indicate good water quality. Sediment, nutrient, and bacteria levels are low and all samples were meeting water quality standards. As expected, concentrations in this reach of the St. Louis River are very similar to those in the upstream contributing watersheds. Since large tracks of this watershed are undeveloped, no further monitoring is recommended at this time. This watershed contains three lakes greater than 10 acres, none with assessment level data.

Upper East Swan Watershed Unit HUC 04010201070

The Upper East Swan watershed, located in west-central St. Louis County, encompasses an area of 76.6 square miles. The river is made up of two principal tributaries – Penobscott and Barber Creeks. Barber Creek (East Swan River) starts on the east edge of Chisholm and travels 16.1 miles to its confluence with Dempsey Creek. Dempsey Creek starts at Sixmile Lake and flows 15.8 miles to its confluence with Barber Creek (East Swan River). The north-western part of the watershed is largely developed (8.6 percent) either in towns or mining activity (9.6 percent). Land use in the central and southern parts of the watershed is characterized by forests (50.3 percent) and wetlands (14.3 percent). The cities of Buhl, Chisholm, and the north end of Hibbing lie within the Upper East Swan watershed.

From the Headwaters to the confluence with Dempsey Creek the river drops 160 feet in 16.1 miles. Named tributaries to the Upper East Swan watershed include Dempsey Creek, Buhl Creek, Barber Creek, Carey Creek and Penobscot Creek. The water chemistry monitoring for this watershed was done at two stations as they each drain equal drainage areas. Station 09LS068 was on Dempsey Creek at Newton Road, 6 miles southeast of Hibbing. Station 89LS026 was on Barber Creek (East Swan River) at Swimmerton Road, 5 miles southeast of Hibbing.

Stream assessments

Table 26. Aquatic life and recreation assessments on assessed AUIDs in the Upper East Swan 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-569 **Barber Creek (East Swan River)** *T57 R20WS28, east line to Dempsey Cr*	6.53	2B †	89LS026	Upstream of Swinnerton Rd, 3 mi. E of Riley	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	EX	FS	NS
04010201-582 **Dempsey Creek** *Six Mile Lk to T56 R20WS12, west line*	15.55	2B	09LS068	Upstream of Newton Rd, 2 mi. N of Onega	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	EX	FS	NS
04010201-641 **Barber Creek (East Swan River)** *T57 R20WS2, north line to T57 R20WS27, west line*	7.54	2B	09LS071 09LS112	Upstream of Dupoint Rd, 2 mi. E of Hibbing Upstream of Spudville Rd, 3.5 mi SE of Chisolm	MTS	MTS	EXP	MTS	-	MTS	MTS	-	EX	FS	NS
04010201-580 **Buhl Creek** *T58 R19WS30, east line to Six Mile Lk*	2.2	2B	-	-	-	-	-	-	-	-	-	-	EX	IF	NS

Table 26 (Continued)

04010201-936 **Penobscot Creek** *T57 R20W S28, north line to East Swan R*	2	2A	-	-	-	-	MTS	EXP	-	MTS	MTS	-	EX	IF	NS
04010201-A23 **Unnamed Creek** *Headwaters to Barber Cr*	2.81	2B	-	-	-	-	-	-	-	-	-	-	MTS	NA	FS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 27. Non-assessed biological stations on channelized AUIDs in the Upper East Swan 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-553 **Penobscot Creek** *Headwaters to T57 R20W S21, south line*	09LS070	Upstream of Hwy 37, 1 mi. E of Hibbing	Poor	Poor

Table 28. Minnesota Stream Habitat Assessment (MSHA) for the Upper East Swan 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	09LS068	Dempsey Creek	5	10	12	12	17	56	Fair
1	09LS070	Penobscot Creek	5	8	17	8	17	55	Fair
1	09LS071	Barber Creek (East Swan River)	5	8	8	6	14	41	Poor
1	09LS112	Barber Creek	5	11	10	15	19	60	Fair
1	89LS026	Barber Creek	5	8	20	8	20	61	Fair
2	98LS012	Barber Creek	5	14	13	12	20	63	Fair
Average Habitat Results: *Upper East Swan River 11 HUC Watershed*			5	10	13	10	18	56	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 29. Outlet water chemistry results for the Upper East Swan River 11-HUC (Barber Creek)

Station location:	Barber Creek (East Swan River) Upstream of Swinnerton Rd. 3 mi. E of Riley
Storet ID:	S000-596
Station #:	89LS026 **(Coldwater)**

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	50	70	58	59	50	50	0	37	60	60
Min	1.0	1.1	14	6.2	0.011	0.04		15	6.4	138
Max	42.0	53.9	120	19.6	0.134	1.49		2420	8.8	684
Mean[1]	12.5	12.5	66	10.4	0.056	0.79		275	8.0	520
Median	8.7	8.2	60	10.1	0.052	0.76		258	8.1	559
WQ standard		10	20	7.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		18/70	2/58	3/59	21/50			5/37	1/60	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 30. Outlet water chemistry results for the Upper East Swan River 11-HUC (Dempsy Creek)

Station location:	Dempsy Creek Upstream of Newton Rd., 2 mi. N. of Onega
Storet ID:	S000-597
Station #:	09LS068

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	48	68	53	54	48	48	0	33	55	55
Min	1.0	1.8	19	4.0	0.005	0.41		4	4.9	20
Max	53.0	30.1	120	16.3	0.165	2.19		1986	8.4	409
Mean[1]	9.2	9.7	70	9.1	0.068	0.92		92	7.7	261
Median	6.0	7.3	70	8.8	0.054	0.79		96	7.7	251
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		1/68	1/53	1/54	23/48			1/33	1/55	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

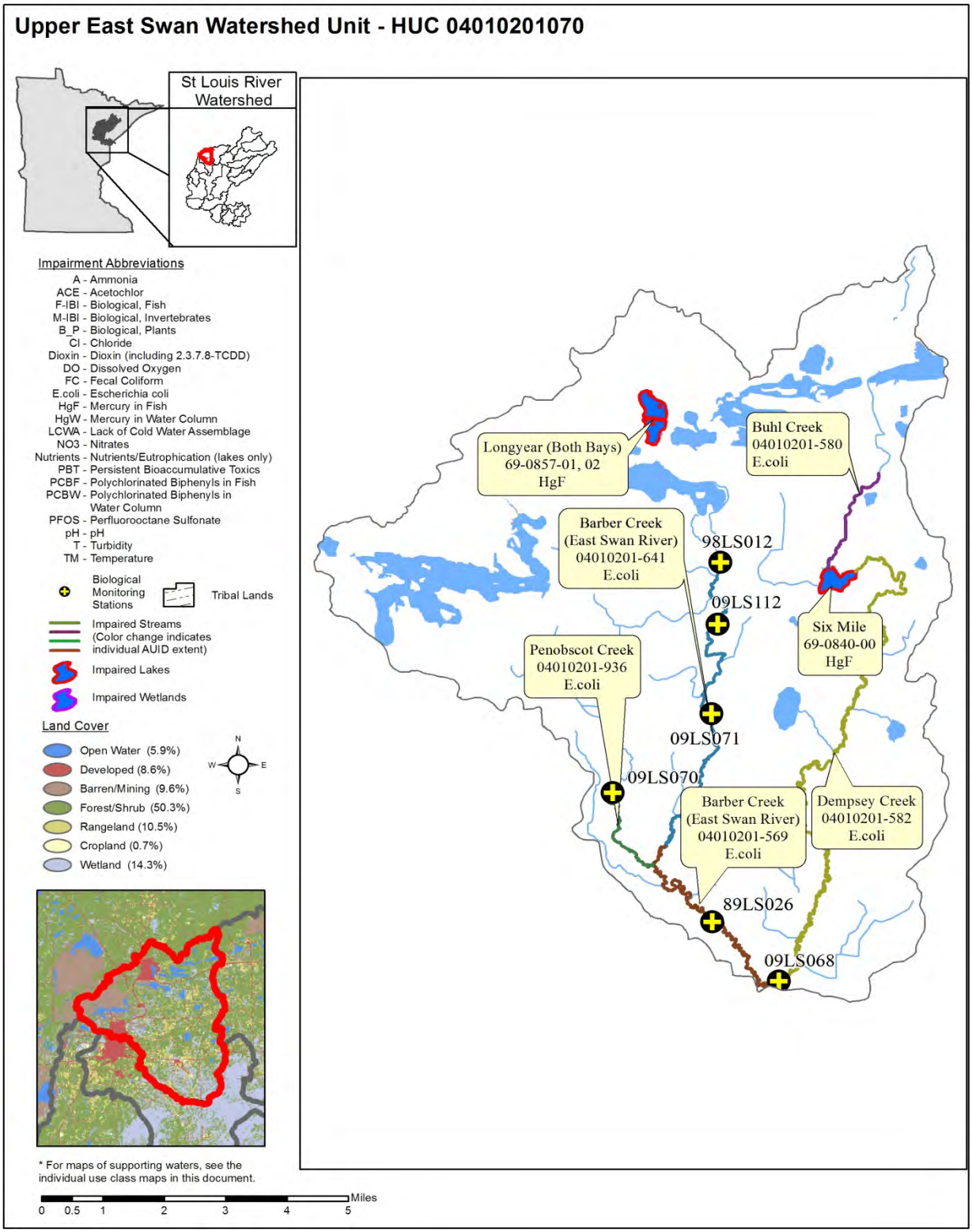

Figure 16. Currently listed impaired waters by parameter and land use in the Upper East Swan River Watershed Unit

Summary

Assessments for aquatic life were completed on three AUIDs in the Upper East Swan watershed. Both F-IBI and M-IBI results were good which indicates excellent aquatic life. Barber creek is currently classified as a coldwater stream by the MDNR. However, after a review by the MPCA and MDNR, it was determined that Barber Creek should be assessed as a warmwater stream to better reflect its current and historical potential. The MDNR has not managed Barber Creek for trout and both current and historical data suggest the aquatic community is, and has always been, more indicative of a warmwater stream habitat (it was sampled once in both 1989 and 2009 with no trout observed). Two AUIDs were sampled for biology and not assessed. Station 98LS012 on the upper portion of Barber Creek (AUID 04010201-520) met all water quality parameters but is currently listed as a Class 7 limited resource value and therefore not assessable for aquatic life. Station 09LS070 on Penobscot Creek (AUID 04010201-533) was not assessed because of channelization and scored poor for both fish and invertebrates. In addition, water chemistry samples at all biological stations in this watershed show levels of elevated bacteria above the current standards. As a result, these stations were deemed not supporting aquatic recreation. With the headwaters of this watershed largely developed, the high levels of bacteria could stem from urban storm water runoff.

Water quality data at the Barber Creek Swimmerton Road site indicate some water quality impairments in the E. Swan River watershed. A total of 18 samples exceeded the 10 NTU turbidity standard, a 25 percent exceedance rate. Similarly, bacteria data also suggest impairment. Some samples greatly exceeded the maximum standard of 1260 counts / 100 mL. A majority of TSS and phosphorus samples exceeded NLF Ecoregion expectations. Several small streams upstream of the Swimmerton Road station were sampled by a Surface Water Assessment Grantee, and were also found to be impaired for aquatic recreation due to high levels of E. Coli bacteria. These streams included Buhl Creek, Upper Barber Creek, and E. Swan Creek.

Monitoring was also conducted on the other Sub watershed within the E. Swan - Dempsey Creek upstream of Newton Road. Data from this site indicate slightly improved water quality, however some impairments were found. The geometric mean of the E. coli samples still exceeded the standard, indicating an impaired condition. Average TSS and turbidity values were lower in Dempsey Creek compared to Barber, but nutrient concentrations were slightly higher. The most downstream reach of the E. Swan River is impaired for turbidity, based on data collected in this reach and several sites upstream within the watershed.

This watershed contains 33 lakes greater than 10 acres; notable lakes include Carey and Longyear. No lakes have assessment level data.

In summary, the East Swan Watershed is a complicated system with many potential sources of pollution – urban stormwater runoff, altered hydrology and mining, treated domestic wastewater from Iron Range cities, agriculture (pasture), and unstable stream morphology. Additional monitoring is recommended, and will be conducted as part of future impaired waters investigations.

West Swan Watershed Unit HUC 04010201080

The West Swan River watershed located in west-central St. Louis, County encompasses an area of 78.1 square miles. The West Swan River starts at Kelly Lake, three miles west of Hibbing, and travels 41.6 miles to its confluence with East Swan River, four miles south of the town of Little Swan. The watershed is largely undeveloped and consists predominantly of forest/shrub land cover (61.2 percent), with a large portion in wetland (25.9 percent). Areas of the northern part of the watershed fall on active mining areas on the Mesabi Range (9.6 percent). A small amount of land in the southern end of the watershed is used as range (6.8 percent). There are no cities within the West Swan River watershed.

From the West Swan River to its confluence with the St. Louis, the river drops 235 feet in 41.6 miles. There are no named tributaries to the West Swan River. The water chemistry monitoring for this watershed is station 98NF115 on the West Swan River at the County Road 927 Bridge, three miles south of the town of Little Swan.

Stream assessments

Table 31. Aquatic life and recreation assessments on assessed AUIDs in the West Swan 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-559			98NF115	Downstream of CR 927 bridge 6mi. N of Toivola											
West Swan River	26.05	2C	09LS066	Upstream of CR 442, 3 mi. E of Silica	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	FS	FS
T55 R21WS4, north line to T55 R20WS14, east line			09LS067	Upstream of Hwy 73, 0.5 mi. N of Silica											

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 32. Minnesota Stream Habitat Assessment (MSHA) for the West Swan River 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	09LS066	West Swan River	5	10	9	7	20	51	Fair
1	09LS067	West Swan River	5	15	21	15	33	89	Good
3	98NF115	West Swan River	4	12	15	10	20	62	Fair
Average Habitat Results: *West Swan River 11 HUC Watershed*			5	12	15	11	24	67	Good

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 33. Outlet water chemistry results for the West Swan River 11-HUC

Station location:	West Swan River Upstream of CR927, 3 mi. S. of Little Swan
Storet ID:	S005-757
Station #:	98NF115

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	19	18	10	10	0	15	19	19
Min	3.1	4.8	39	5.8	0.025	0.57		11	7.1	25
Max	15.0	10.2	102	9.5	0.040	1.14		130	8.2	354
Mean[1]	6.1	6.6	67	7.5	0.032	0.81		46	7.6	161
Median	5.5	6.4	66	7.3	0.031	0.82		45	7.6	152
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/19	0/18	0/10			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 34. Lake Morphometric and assessment data for the West Swan River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Little Island	31-0022-00	42	13.5	6.8	46	FS
Helen	31-0023-00	66	9	6.1	52	FS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

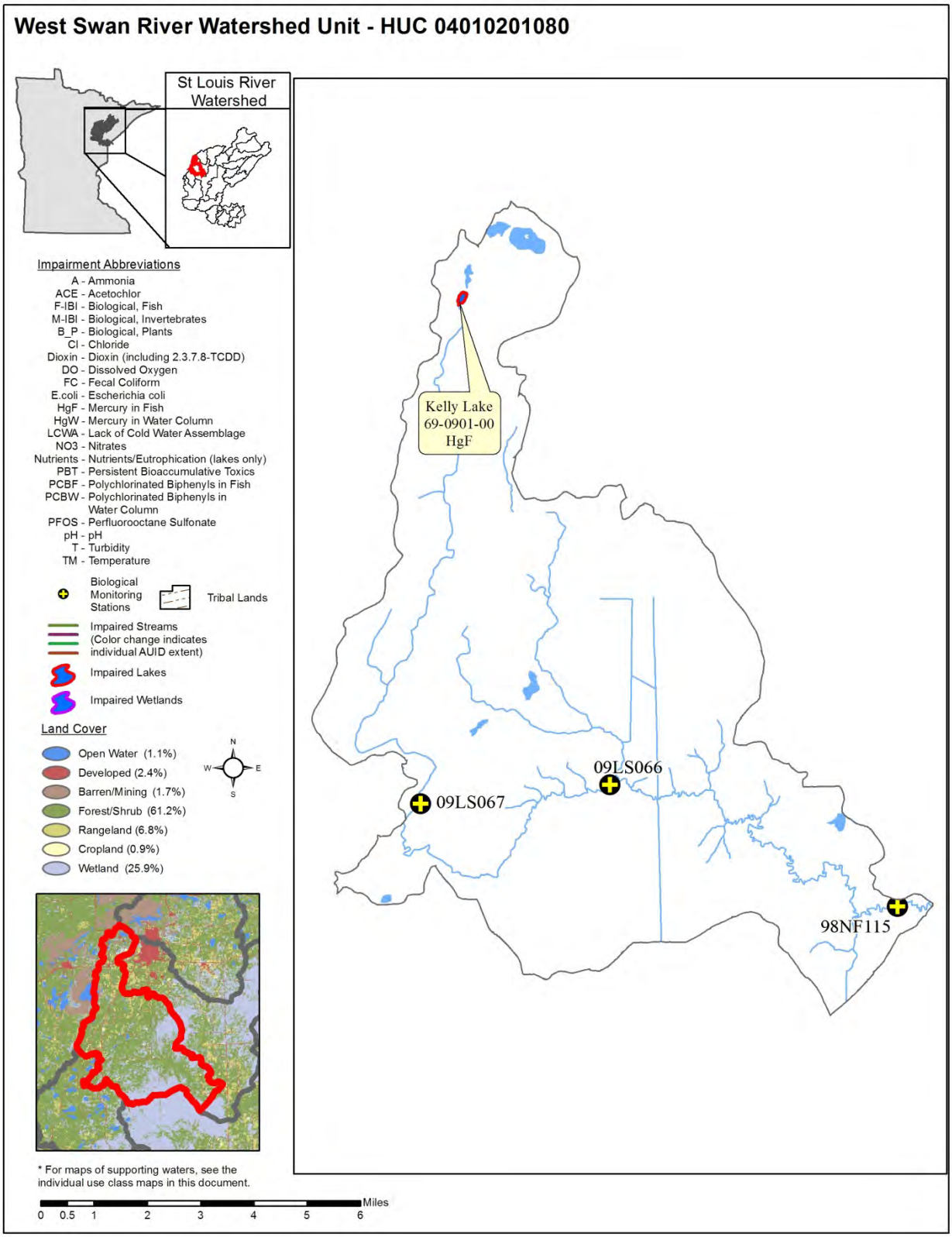

Figure 17. Currently Listed Impaired Waters by parameter and land use in the West Swan River Watershed Unit

Summary

Three biological stations were sampled along this 41 mile reach of the West Swan River. Biological indicators appear to be adequate and supporting aquatic life. IBI scores for all three stations are well above their respective minimum desired thresholds. As previously mentioned, the landscape is largely undeveloped with over 87 percent dominated by forest and wetland. There is an excellent riparian buffer throughout the watershed, leading to stable channel morphology (Table 31) and the presence of several sensitive fish (longnose dace, mottled sculpin, and burbot) and invertebrate species. Additionally, a positive temporal trend is noticed for F-IBI at 98NF115. This station was sampled three times for fish, once in 1998 and twice in 2009. F-IBI scores have shown a consistent increase over time with the F-IBI score rising seven points from 1998-2009.

Water Chemistry data collected from the West Swan River at the County Road. 927 Bridge indicates excellent water quality. Sediment, nutrient, and bacteria levels were low and reflective of the forests and wetlands which dominate the landscape. Unlike other watersheds whose headwaters are influenced by mining activities, average conductivity values in the West Swan River are generally within expected ranges for northern Minnesota streams. No water chemistry samples exceeded water quality standards, and average values were close to NLF ecoregion expectations.

This watershed contains seven lakes greater than 10 acres; notable lakes include Harriet and Helen. Two lakes have assessment level data, Little Island (31-0022) and Helen (31-0023). Both were assessed as fully supporting of recreational use.

Lower East Swan Watershed Unit HUC 04010201090

The Lower East Swan watershed, located in west-central St. Louis County, encompasses an area of 75.1 square miles. The Lower East Swan watershed starts at the confluence of Penobscot Creek and Barber Creek (East Swan River). The East Swan River travels 19.1 miles to its confluence with the Lower West Swan River, forming the Swan River. Following the confluence, the Swan River then flows 5.1 miles to its confluence with the St. Louis River. The watershed is largely undeveloped and consists predominantly of forested land cover (41.1 percent) and wetlands (41 percent). Areas in the northern portion of the watershed are developed around Hibbing (7.1 percent) and 9.9 percent of the watershed is in range land use, primarily in the south end of the watershed. Hibbing is the only city within the Lower East Swan watershed.

From the headwaters of the watershed to its confluence with the St. Louis River, the Lower East Swan River drops 40 feet in 24.2 miles. Named tributaries to the East Swan River within this watershed include Little Swan Creek and East Swan Creek. The Upper East Swan watershed and West Swan River watershed also drain into this watershed. Water chemistry monitoring for this watershed was conducted at station 09LS061 on the Swan River at the County Road 750 Bridge, 2.5 miles south of the town of Little Swan. This site is located approximately 2.5 river miles upstream from the St. Louis River and is downstream from the confluences of both the East and West Swan Rivers. This station is designated by the MDNR as a coldwater stream.

Stream assessments

Table 35. Aquatic life and recreation assessments on assessed AUIDs in the Lower East Swan 11-HUC

AUID *Reach Name* *Reach* *Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-542 **Unnamed creek** *Unnamed Cr to T56 R20W S9, east line*	4.15	2B	09LS063	Upstream of Koivu Rd, 2 mi. E of Riley	MTS	MTS	EXP	MTS	-	MTS	-	-	EX	FS	NS
04010201-557 **Swan River** *Confluence of East and West Swan R to St Louis R*	5.12	2B †	09LS061	Upstream of CR 750, 2.5 mi. S of Little Swan	EXS	MTS	-	MTS	MTS	MTS	MTS	-	MTS	NS	FS
04010201-888 **Unnamed Creek (East Swan Creek)** *T56 R20W S5, north line to East Swan R*	4.63	2A	09LS064	Upstream of Koivu Rd, 2.5 mi. E of Riley	MTS	EXP	MTS	MTS	MTS	MTS	MTS	-	EX	NS	NS

Table 35 (Continued)

04010201-891 **Unnamed Creek (Little Swan Creek)** *Headwaters to East Swan R*	6.29	2A	09LS062	Upstream of CR 444, 8.5 mi. SE of Hibbing	EXP	NA	-	-	-	-	-	-	MTS	NS	FS
04010201-558 **East Swan River** *Barber Cr to Swan R*	19.13	2B †	-	-	-	-	-	EXS	MTS	-	-	-	-	NS	NA
04010201-A22 **Unnamed Creek** *Unnamed Cr to Unnamed Cr*	-	-	-	-	-	-	-	-	-	-	-	-	EX	NA	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 36. Minnesota Stream Habitat Assessment (MSHA) for the Lower East Swan River 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	09LS061	Swan River	4	14	18	10	17	62	Fair
1	09LS062	Little Swan Creek	2	6	9	11	9	37	Poor
1	09LS063	Trib. to East Swan Creek	5	12	9	11	20	57	Fair
1	09LS064	East Swan Creek	4	10	12	11	14	51	Fair
Average Habitat Results: *Lower East Swan River 11 HUC Watershed*			4	10	12	11	15	52	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 37. Outlet water chemistry results for the Lower East Swan River 11-HUC

Station location:	Swan River Upstream of CR 750, 2.5 mi. S. of Little Swan
Storet ID:	S005-770
Station #:	09LS061 (Coldwater)

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	19	18
Min	5.2	6.0	13	6.0	0.033	1.00		12	7.1	133
Max	28.0	18.2	71	10.3	0.069	2.16		670	8.3	586
Mean[1]	11.1	10.3	42	7.9	0.049	1.37		69	7.8	346
Median	9.1	9.5	41	7.9	0.047	1.22		73	7.9	340
WQ standard		25	20	5	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	2/18	0/18	3/10			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

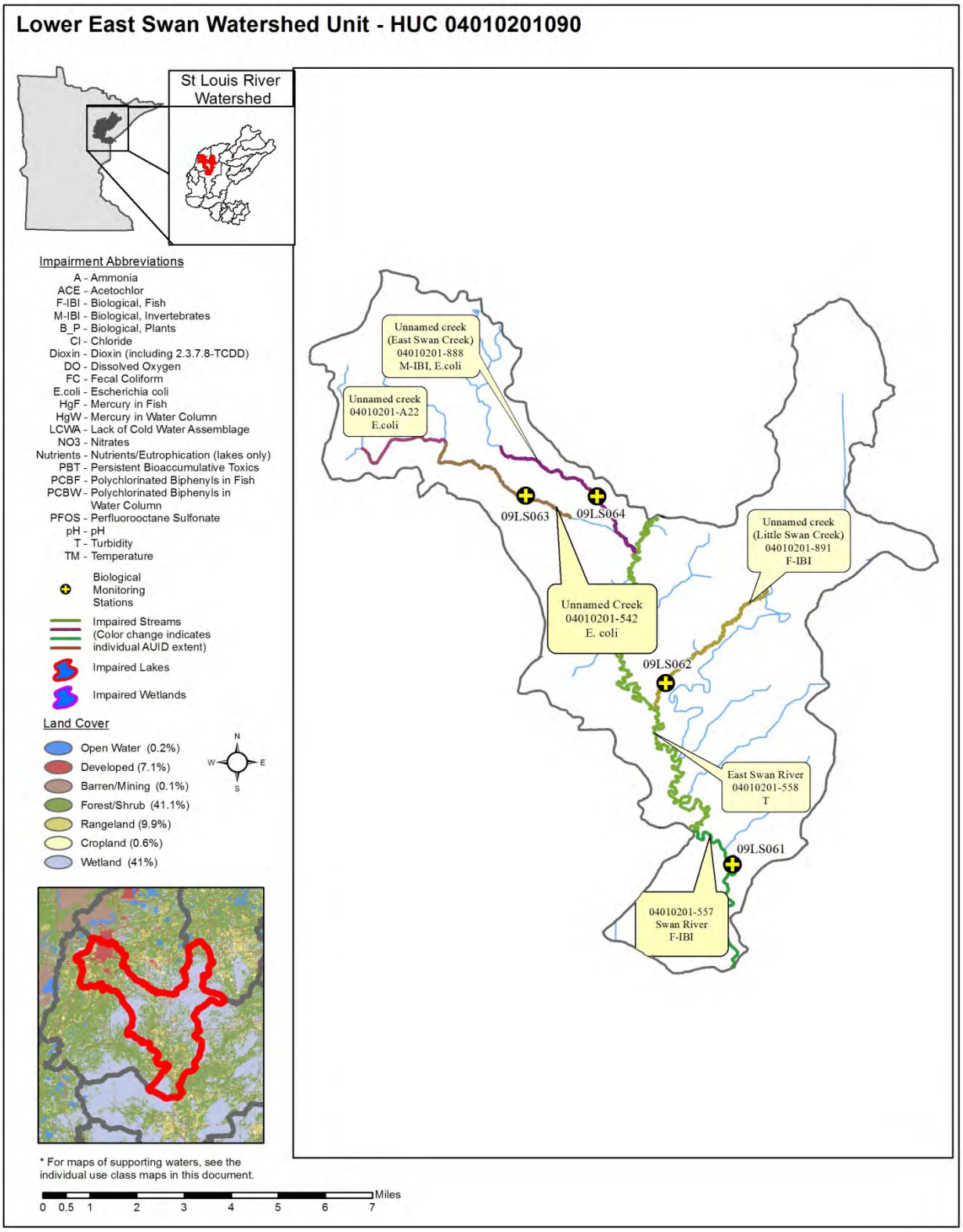

Figure 18. Currently Listed Impaired Waters by parameter and land use in the Lower East Swan Watershed Unit

Summary

The East Swan River, from Barber Creek to the Swan River, as well as a number of its tributaries designated as coldwater streams (Class 2A) were assessed as warmwater streams (Class 2B). The MDNR classifies this stream as marginal trout water, which typically lack suitable habitat and water quality for reproduction and year round survival. The East Swan River was stocked with brook trout in the mid-1960s, but this effort was unsuccessful in establishing a reproducing population. Historical and recent fish and macroinvertebrate data compiled by the MPCA indicate that the streams fauna are more indicative of a warmwater stream community.

Four stations along four AUIDs had biological data for assessment in the Lower East Swan watershed. Only an unnamed tributary to East Swan River (09LS063 on AUID 04010201-542) fully supported aquatic life. As previously mentioned, this watershed is largely undeveloped consisting of 82 percent forest and wetland. However, logging has taken place in the headwaters of the watershed, specifically upstream of 09LS062.

Longitudinally, F-IBI scores tend to decrease in a downstream direction. In contrast, M-IBI scores tend to increase; the cause of this is unknown. Additional impairments within this watershed include E-coli at the tributary to East Swan Creek (09LS063 on AUID 04010201-542) and East Swan Creek (09LS064 on AUID 04010201-888) which could be stemming from localized pollution sources. Further work to investigate the potential impact of logging and other point or non-point impacts is needed to understand the causal factors that have led to aquatic life impairments in this watershed.

As expected water quality at this watersheds outlet integrates conditions in both the East and West Swan Rivers. As discussed previously, water quality is better in the West Swan River Watershed. With the streams reclassification from coldwater to warmwater and the resulting change in the turbidity standard from 10 NTU to 25 NTU, no turbidity samples exceeded the 25 NTU standards. This reach of the Swan River is meeting standards for bacteria, with zero exceedances in 19 samples, perhaps this reach was influenced by dilution from the West Swan River. Other parameters, such as DO and pH, indicate that water quality standards are being met. There are no lakes within the Lower East Swan watershed unit.

Upper Whiteface River Watershed Unit HUC 04010201100

The Upper Whiteface River watershed, located in east-central St. Louis County, encompasses an area of 144.4 square miles. The Whiteface River starts at the outlet of the Whiteface Reservoir, a man-made reservoir formed at the confluence of the North and South Branches of the Whiteface River. Undeveloped land dominates this watersheds landscape which includes forest (87.1 percent), lakes (6.1 percent), and wetlands (4.3 percent). There are no cities within the Upper Whiteface River watershed.

From the headwaters of the North Branch Whiteface River at Mud Lake to the Whiteface Reservoir, the North Branch drops 230 feet in 26.8 miles. From the headwaters of the South Branch Whiteface River to the Whiteface Reservoir, the South Branch drops 140 feet in 18.7 miles. From the Whiteface Reservoir outlet to the end of this watershed, the Whiteface River drops 90 feet in 5.9 miles of river. Named tributaries within this watershed include the South Branch Whiteface River, North Branch Whiteface River, Jenkins Creek, Reno Creek, Porcupine Creek, Shiver Creek, Bum Creek, Wallow Creek, and Tynjala Creek. The water chemistry monitoring for this watershed is station 09LS056 on the Whiteface River at the County State Aid Highway 4 Bridge, two miles southeast of Markham.

Stream assessments

Table 38. Aquatic life and recreation assessments on assessed AUIDs in the Upper Whiteface River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-529 **Whiteface River** *Whiteface Reservoir to Bug Cr*	18	2B	09LS056	Upstream of CR 4, 2 mi. S of Markham	MTS	MTS	-	MTS	MTS	MTS	MTS	-	MTS	FS	FS
04010201-549 **Whiteface River, North Branch** *Headwaters to Whiteface Reservoir*	26.78	2B	09LS059 09LS060	Upstream of Camp 26 Rd, 4 mi. SW of Fairbanks Upstream of CR 16, in Fairbanks	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Table 38 (Continued)

04010201-600 **Whiteface River, South Branch,** *Unnamed Cr to Unnamed Cr*	2.66	2B	97LS019	Just W of FR 118 off of CHAH 16. 15 mi. E of Melrude	MTS	MTS	-	-	-	-	MTS	-	-	FS	IF
04010201-766 **Whiteface River, South Branch** *Ryan Cr to Unnamed Cr*	4.45	2B	09LS057	Upstream of NE Grade Rd, 4 mi. SE of Markham	MTS	MTS	-	-	-	-	MTS	-	-	FS	IF
04010201-A37 **Shiver Creek** *Headwaters to Little Shiver Cr*	8.67	2B	09LS058	Upstream of CR 16, 4 mi. W of Fairbanks	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data

Table 39. Minnesota Stream Habitat Assessment (MSHA) for the Upper Whiteface River 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	09LS056	Whiteface River	5	10	19	12	25	71	Good
1	09LS057	Whiteface River, South Branch	5	10	8	7	18	48	Fair
1	09LS058	Shiver Creek	4	12	20	12	31	78	Good
1	09LS059	Whiteface River, North Branch	5	11	19	12	23	70	Good
1	09LS060	Whiteface River, North Branch	5	11	12	15	22	65	Fair
2	97LS019	Whiteface River, South Branch	5	12	22	15	29	82	Good
Average Habitat Results: *Upper Whiteface River 11 HUC Watershed*			5	11	17	12	25	69	Good

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 40. Outlet water chemistry results for the Upper Whiteface River 11-HUC

Station location:	Whiteface River Upstream of CR 4, 2 mi. S. of Markham									
Storet ID:	S005-768									
Station #:	09LS056									
Parameter	TSS	Turb.[4]	T-tube	D.O.	TP [5]	TKN	Chloro-phyll-a [5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	14	20	19
Min	1.3	2.0	72	7.4	0.015	0.69		3	6.9	48
Max	3.2	6.1	120	10.5	0.037	0.84		64	8.4	89
Mean[1]	2.4	3.6	105	8.7	0.023	0.75		12	7.5	67
Median	2.7	3.8	102	8.5	0.022	0.74		9	7.5	65
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	0/18	0/10			0/14	0/20	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 41. Lake morphometric and assessment data for the Upper Whiteface River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Cadotte	69-0114-00	119	5.4	3	71	FS
Whiteface Reservoir	69-0375-00	1454	9.9	3.6	62	FS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

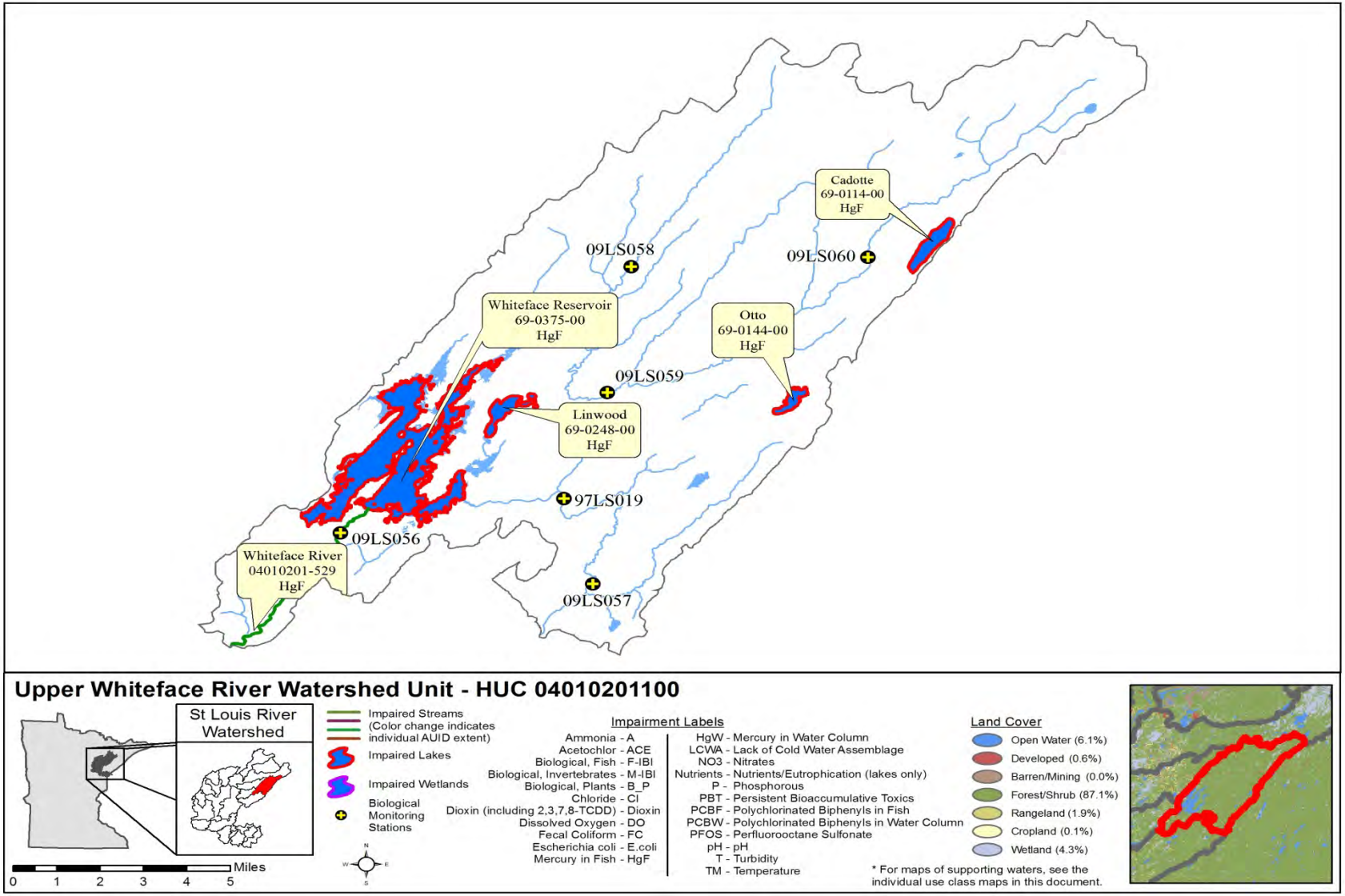

Figure 19. Currently Listed Impaired Waters by parameter and land use in the Two Rivers Watershed Unit

Summary

Biological communities within the Upper Whiteface River watershed all produced F-IBI and M-IBI scores within their respective thresholds and all but one was above the upper confidence interval. All six biological stations produced MSHA scores of fair or better, with four of them scoring high. These habitat and IBI scores are likely linked to the largely undeveloped landscape, which consists of a combination 97 percent forest, wetland or open water.

The water chemistry sampling site is located about one mile downstream from the outlet of the Whiteface Reservoir, so water chemistry indicators largely reflect conditions in the Whiteface Reservoir. Nutrient, turbidity, and sediment concentrations are low, likely due to the Reservoir retaining suspended sediment and algae. No samples exceeded water quality standards, and average values were close to NLF ecoregion expectations. Conductivity values were much lower than the NLF ecoregion range, reflecting the soft water in Whiteface Reservoir. Bacteria concentrations were very low as well. No additional monitoring is recommended at this time.

This watershed contains seven lakes greater than 10 acres; a notable lake within this watershed is the Whiteface Reservoir. The two monitored lakes in the Upper Whiteface River subwatershed- Whiteface Reservoir (69-0375) and Cadotte Lake (69-0114), are meeting recreational use standards for lakes within the NLF ecoregion. Both drain forested watersheds, one very large (Whiteface Reservoir) and one very small (Cadotte). Water clarity is naturally low in Whiteface reservoir, due to runoff from the surrounding forests and wetlands.

Middle Whiteface River Watershed Unit HUC 04010201110

The Middle Whiteface River watershed, located in central St. Louis County, encompasses an area of 113.9 square miles. The watershed starts at the confluence of the Whiteface River with Gimlet Creek (Comstock Lakes' outlet) and flows 22.7 miles to the confluence of the Whiteface and Paleface Rivers. The watershed is largely undeveloped and consists predominantly of forest cover (82.3 percent) and wetlands (8.7 percent). Much of the forested land is public and managed by the St. Louis County Land Department. Scattered throughout the watershed are areas used as range or pasture (5.3 percent). There are 14 lakes in the watershed and several are developed with seasonal properties. No cities are present within the Middle Whiteface River watershed.

From the watershed border to the confluence with the Paleface River, the Whiteface River drops 70 feet in 22.7 miles. Named tributaries include Bug Creek, Palo Creek, and Gimlet Creek. The water chemistry monitoring site for this watershed is the station 09LS051 on the Whiteface River at the County State Aid Highway 52 Bridge, one mile east of the town of Cotton.

Stream assessments

Table 42. Aquatic life and recreation assessments on assessed AUIDs in the Middle Whiteface River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-528 **Whiteface River** *Bug Cr to Paleface R*	10.7	2B	09LS051	Upstream of CR 52, 1 mi. E of Cotton	MTS	MTS	-	MTS	MTS		MTS	-	MTS	FS	FS
04010201-529 **Whiteface River** *Whiteface Reservoir to Bug Cr*	18	2B	97LS081	Just S. of CSAH 52 bridge. 12 miles SE of Gilbert	MTS	MTS	-	MTS	MTS	MTS	MTS	-	MTS	FS	FS
04010201-545 **Bug Creek** *Headwaters to Whiteface R*	26.88	2B	09LS052 99NF016	Upstream of CR 15, in Shaw 2.4 miles S of CR 547, 5.8 miles W of Hwy 4, 0.5 mi. NE of	MTS	MTS	-	-	-	-	MTS	-	IF	FS	IF

Table 42 (Continued)

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 43. Minnesota Stream Habitat Assessment (MSHA) for the Middle Whiteface River 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	09LS051	Whiteface River	4	9	20	12	16	60	Fair
1	09LS052	Bug Creek	5	11	12	12	18	58	Fair
3	97LS081	Whiteface River	5	11	21	11	31	79	Good
1	99NF016	Bug Creek	5	11	15	13	23	67	Good
Average Habitat Results: *Middle Whiteface River 11 HUC Watershed*			5	10	17	12	22	66	Good

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites(45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 44. Outlet water chemistry results for the Middle Whiteface River 11-HUC

Station location:	Whiteface River Upstream of CR 52, 1 mi. E. of Cotton
Storet ID:	S005-765
Station #:	09LS051

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	18	19
Min	2.1	2.8	53	6.9	0.018	0.59		22	7.0	59
Max	6.8	4.3	120	10.2	0.032	1.23		220	8.0	179
Mean[1]	3.3	3.6	102	8.4	0.025	0.79		48	7.6	105
Median	2.9	3.6	105	8.4	0.023	0.71		44	7.6	102
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	0/18	0/10			0/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 45. Lake morphometric and assessment data for the Middle Whiteface River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	

						Aquatic Recreation Use Support[4]
Strand	69-0529-00	127	4.8	23	99	NS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

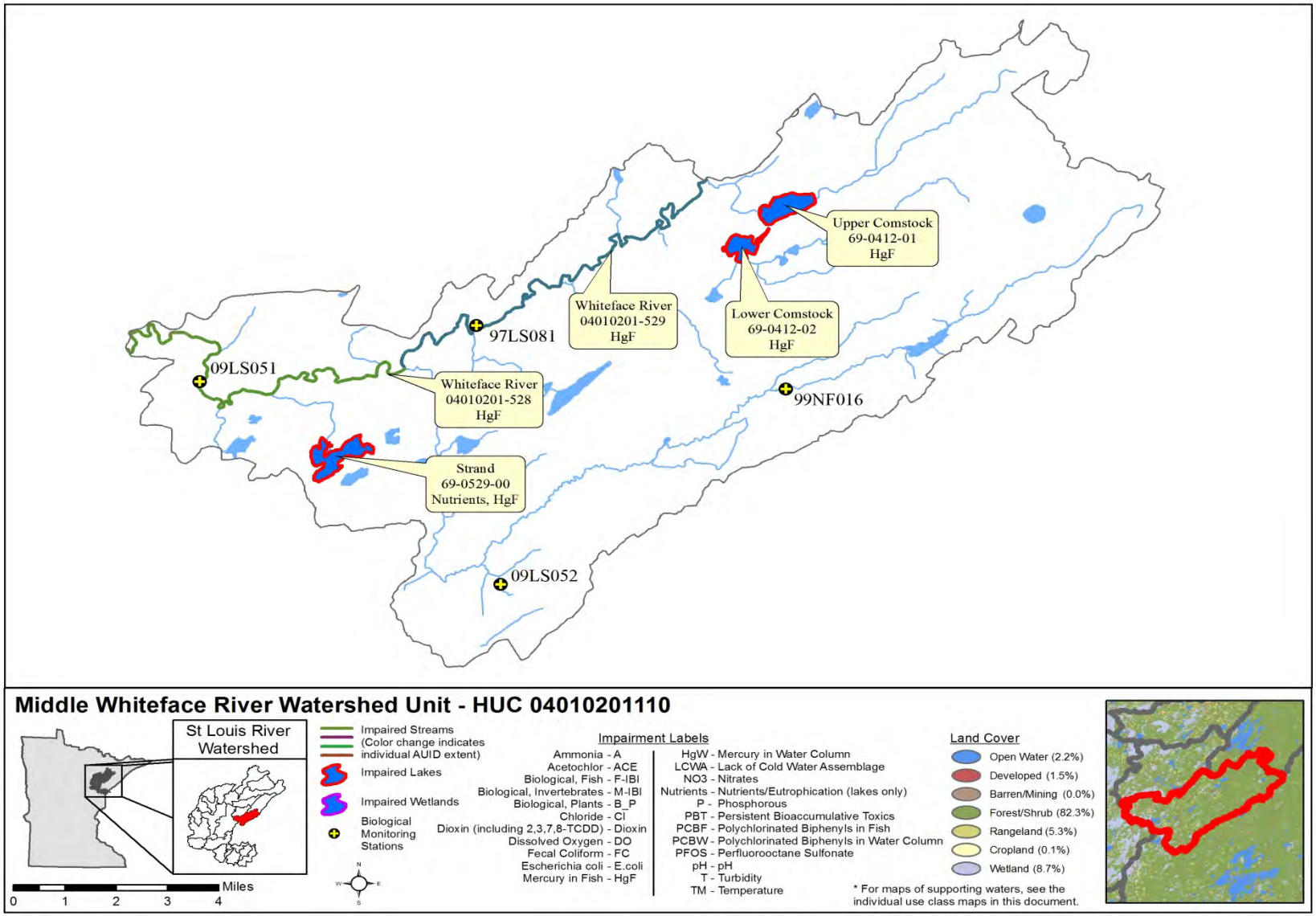

Figure 20. Currently listed impaired waters by parameter and land use in the Middle Whiteface River Watershed Unit

Summary

The Middle Whiteface River watershed has three assessable AUIDs, all of which fully support aquatic life. All F-IBI and M-IBI are well above their upper confidence limits. With 91 percent of the land cover being forest or wetland, the predominantly undisturbed landscape is likely contributing to the robust biological communities in these streams. A diverse fish and invertebrate community is commonly observed when extensive habitat is present, which is true for all sites within this watershed.

Data collected at the Highway 52 Bridge indicate the Middle Whiteface River has excellent water quality. Nutrient, sediment, turbidity, and bacteria levels are low, and reflective of the forests and wetlands that dominate the landscape (>90 percent of the landcover). No samples exceeded water quality standards and further monitoring is not recommended at this time.

This watershed contains 14 lakes greater than 10 acres; notable lakes include Comstock and Strand. One lake, Strand (69-0529), has assessment level data, and was determined to be impaired due to excessive nutrients. Strand Lake is a productive shallow lake, draining a relatively large, wetland dominated landscape.

Paleface River Watershed Unit HUC 04010201120

The Paleface River watershed, located in east-central St. Louis County, encompasses an area of 73.2 square miles. The Paleface River headwaters are approximately one mile west of Markham. The river travels 26 miles to its confluence with the Whiteface River, 1.5 miles northwest of Cotton. The watershed is largely undeveloped and consists predominantly of forest cover (64.3 percent) and wetlands (25.3 percent). Some of the land use is range or pasture (5.4 percent) and 22 lakes make up the remaining 3.6 percent of the watershed area. Melrude is the only community within the Paleface River watershed.

From the headwaters of the Paleface River to its confluence with the Whiteface River the gradient drops 140 feet in 26 miles. Named tributaries to the Paleface River include Bobcat Creek and Paleface Creek. The water chemistry monitoring station for this watershed is on the Paleface River (09LS048) at the County Road 563 Bridge, two miles north of Cotton.

Stream assessments

Table 46. Aquatic life and recreation assessments on assessed AUIDs in the Paleface River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-550			10EM185	Downstream of CR 351, 2 mi. W of Markham											
Paleface River	25.99	2B	09LS048	Upstream of Moberg Rd, 13.5 mi. NE of Meadowlands	MTS	MTS	IF	MTS	MTS	MTS	MTS	-	IF	FS	IF
Headwaters to Whiteface R			09LS050	Upstream of CR 322, 2.5 mi. SE of Central Lakes											
04010201-A24															
Paleface Creek	4.34	2B	09LS049	Upstream of Twp Rd 6630, in Melrude	EXP	EXS	-	-	-	-	-	-	-	NS	NA
Unnamed Cr to Paleface R															

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R.7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 47. Minnesota Stream Habitat Assessment (MSHA) for the Paleface River 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	09LS048	Paleface River	3	9	18	11	25	65	Fair
2	09LS049	Paleface Creek	5	10	13	10	12	49	Fair
1	09LS050	Paleface River	5	11	16	13	20	65	Fair
Average Habitat Results: *Paleface River 11 HUC Watershed*			4	10	15	11	19	59	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites(45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 48. Outlet water chemistry results for the Paleface River 11-HUC

Station location:	Paleface River Upstream of Moberg Rd., 13.5 mi. NE of Meadowlands
Storet ID:	S005-764
Station #:	09LS048

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	18	19
Min	3.6	4.5	43	4.6	0.030	0.89		33	6.9	65
Max	7.2	10.1	103	9.3	0.072	1.47		326	7.9	181
Mean[1]	4.7	6.8	66	7.5	0.049	1.08		93	7.4	116
Median	4.3	6.5	63	7.5	0.046	1.04		82	7.4	112
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	1/18	3/10			0/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 49. Lake morphometric and assessment data for the Paleface River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Dinham	69-0544-00	81	7.5	3.7	63	NS

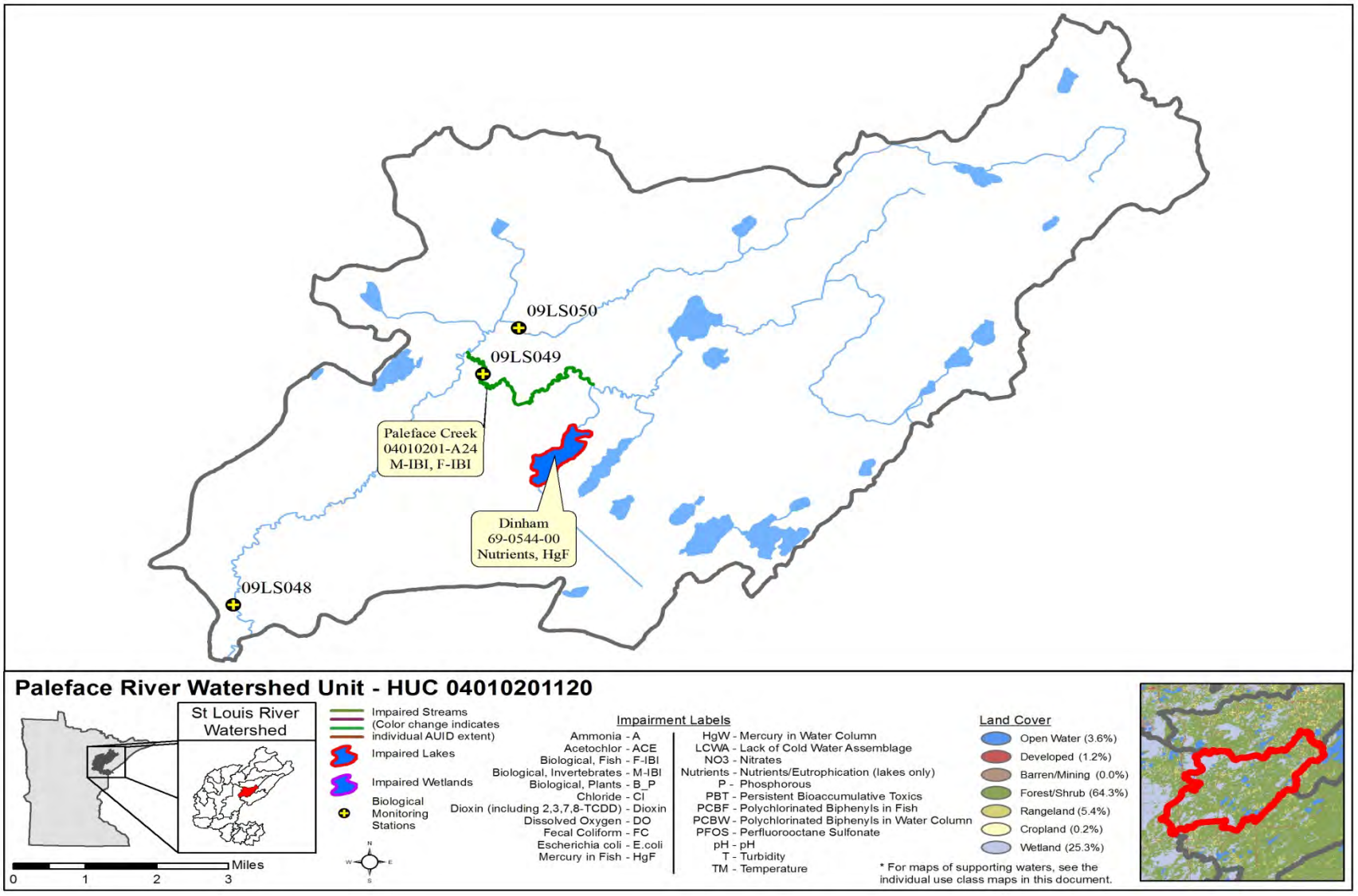

Figure 21. Currently listed impaired waters by parameter and land use in the Paleface Watershed Unit

Summary

Biological indicators showed mixed results in the Paleface River watershed. Two AUIDs were assessed for aquatic life with one showing full support. A strong relationship exists between the biological communities and MSHA scores. While no site in this watershed has great habitat, generally, lower MSHA scores produced lower IBI scores. Lower Paleface Creek (09LS049 on AUID 04010201-A24) scored below its respective thresholds for both fish and invertebrates and has the lowest MSHA score. Poor channel morphology coupled with poor substrate (Table 46) were the main factors that contributed to the low MSHA scores. This stream segment is also downstream of Dinham Lake which is impaired due to nutients.

Water chemistry data collected at the County Road 563 Bridge indicate that the Paleface River near the outlet has good water quality. Nutrient concentrations were similar, but slightly higher than those in the Middle Whiteface River watershed. A total of three samples exceeded the proposed phosphorus standard (0.055 mg / L). The Paleface River has a high percentage of wetlands which is likely a factor in the increased productivity and low sediment and turbidity levels.

This watershed contains 22 lakes greater than 10 acres; notable lakes include Morcom and Dinham. Dinham Lake contains a moderate amount of lakeshore development, is shallow, and drains a wetland dominated landscape. Other than the previously mentioned nutrient impairment on Dinham Lake (69-0544), no other lakes had assessment level data.

Lower Whiteface River Watershed Unit HUC 04010201130

The Lower Whiteface River watershed, located in south-central St. Louis County, encompasses an area of 247.3 square miles. The watershed starts at the confluence of the Paleface and Whiteface River and travels 35.7 miles to the Whiteface River's confluence with the St. Louis River. The watershed is largely undeveloped and consists predominantly of forest cover (47.5 percent) and wetlands (43 percent). Small portions of the watershed are actively used for pasture or range (6.1 percent), particularly in the vicinity of Meadowlands, the only city within this watershed.

From the Whiteface and Paleface River confluence, to the confluence with the St. Louis River, the Lower Whiteface River drops 60 feet in 35.7 miles. Named tributaries to the Whiteface River within this watershed include the Little Whiteface River, Otter Creek, Jenkins Creek and Spider Muskrat Creek. The water chemistry monitoring site for this watershed is station 09LS039 on the Whiteface River at the County State Aid Highway 5 Bridge, 2.5 miles southwest of Meadowlands.

Stream assessments

Table 50. Aquatic life and recreation assessments on AUIDs in the Lower Whiteface River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-509 **Whiteface River** *Paleface R to St Louis R*	35.67	2B	98LS046 09LS039	Upstream of CSAH 7, 8 mi NE of Meadowlands Downstream of CR 5, 2.5 mi. SW of Meadowlands	MTS	MTS		MTS	MTS	MTS	MTS		MTS	FS	FS
04010201-617 **Spider Creek (Spider Muskrat Creek)** *Unnamed Cr to Whiteface R*	1.22	2B †	98LS049	Upstream of CSAH 5, 5.5 mi S of Meadowlands	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-959 **Unnamed Creek (Otter Creek)** *Unnamed Cr to Whiteface R*	1.14	2B	09LS040	Upstream of CR 5, 3 mi. S of Meadowlands	MTS	MTS	-	-	-	-	-	-	-	FS	NA

Table 50 (Continued)

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 51. Non-assessed biological stations on channelized AUIDs in the Lower Whiteface 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-612 **Little Whiteface River** *Unnamed Cr to Unnamed Cr*	67LS005	Upstream of CR 7, 6 mi. E of Meadowlands	Good (2)	Fair
04010201-616 **Little Whiteface River** *Unnamed Cr to Whiteface R*	98LS045	Downstream of CR 209, 2 mi E of Meadowlands	Fair	Good

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 52. Minnesota Stream Habitat Assessment (MSHA) for the Lower Whiteface River 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	09LS039	Whiteface River	5	10	7	8	7	37	Poor
1	09LS040	Otter Creek	5	13	17	13	21	68	Good
2	67LS005	Little Whiteface River	5	11	15	11	13	54	Fair
2	98LS045	Little Whiteface River	5	12	10	8	16	50	Fair
2	98LS046	Whiteface River	5	9	20	10	24	68	Good
3	98LS049	Spider Muskrat Creek	5	13	20	11	27	76	Good
Average Habitat Results: *Lower Whiteface River 11 HUC Watershed*			5	11	15	10	18	59	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 53. Outlet water chemistry results for the Lower Whiteface River 11-HUC

Station location:	Whiteface River Downstream of CR 5, 5.5 mi. SW of Meadowlands									
Storet ID:	S005-763									
Station #:	09LS039									
Parameter	TSS	Turb.[4]	T-tube	D.O.	TP [5]	TKN	Chloro-phyll-a [5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	19	19
Min	3.4	4.8	36	4.6	0.025	0.76		15	7.2	71
Max	12.8	9.6	80	9.8	0.103	1.50		270	8.0	197
Mean[1]	6.1	6.2	60	7.0	0.041	1.02		35	7.6	128
Median	4.9	5.6	58	6.8	0.034	0.98		30	7.6	130
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	1/18	1/10			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 54. Lake morphometric and assessment data for the Middle Whiteface River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Nichols	69-0627-00	170	9	2.4	87	FS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

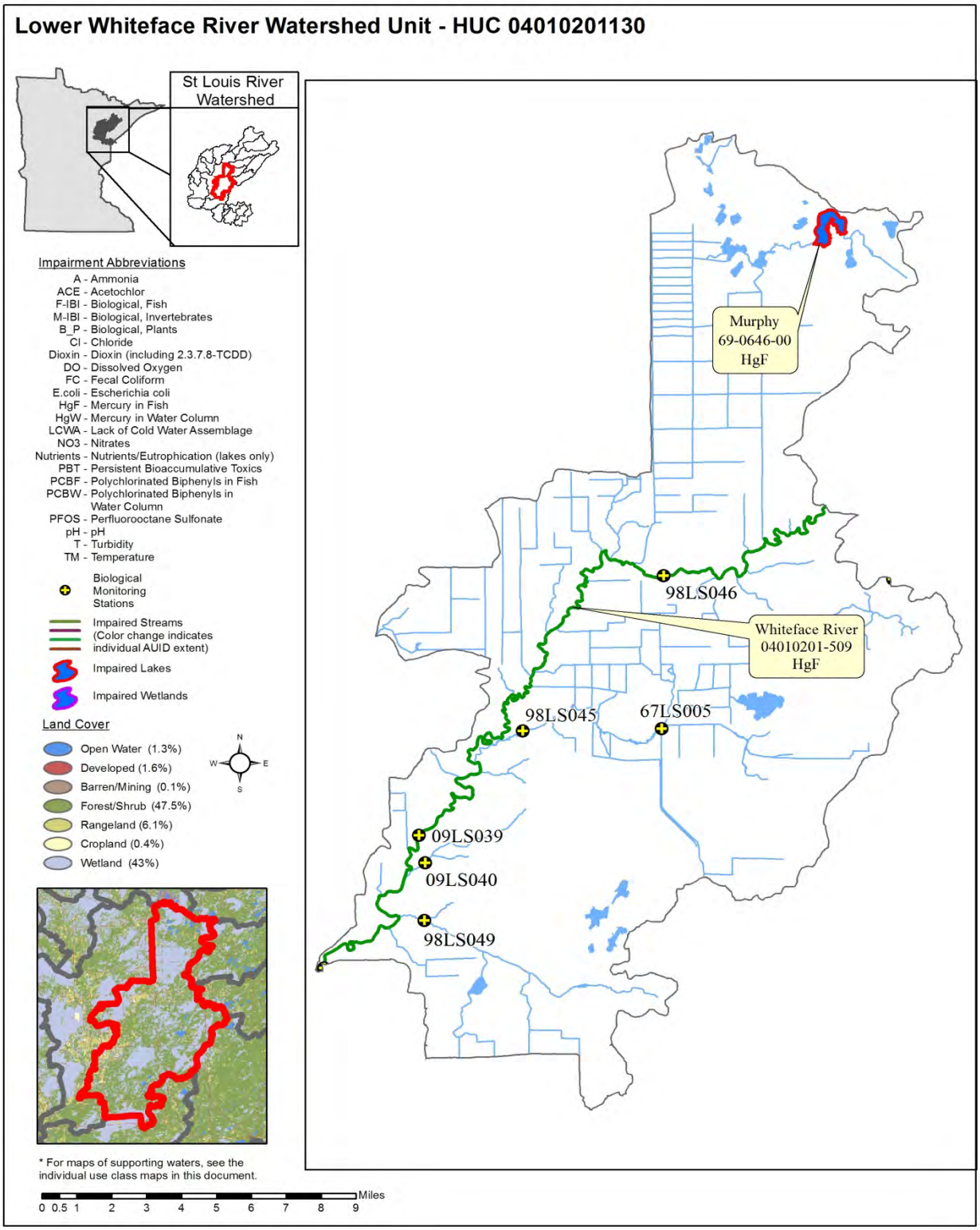

Figure 22. Currently listed impaired waters by parameter and land use in the Lower Whiteface River Watershed Unit

Summary

In general, biological communities within the Lower Whiteface River watershed all produced good IBI scores above their respective thresholds. A strong relationship exists between habitat and IBI scores for the assessable AUIDs in this watershed. All sites with high F-IBI scores produced strong scores on the MSHA (Table 51). Over 90 percent of the watershed is comprised of forest and wetland, likely contributing to these positive results. In addition to the assessable stream segments, two channelized segments of the Little Whiteface River (AUIDs 04010201-612, 04010201-614) were monitored but assessments were deferred due to the channelization. Both stations had poorer MSHA scores and mixed results for F-IBI and M-IBI ranging from good to fair.

Water chemistry data collected from the Whiteface River at the County Road 5 site indicate good water quality. Bacteria and nutrient concentrations were low. This portion of the Whiteface River watershed is a wetland-dominated low gradient area (the river falls at a rate of only 1.6 feet per mile). These natural characteristics may contribute to the exceedances of the DO standard (which was collected during low-flow in midsummer). The remainders of the DO samples were greater than the standard, averagingseven mg/L. This reach of the Whiteface River is meeting water quality standards.

This watershed contains 21 lakes greater than 10 acres; notable lakes include Nichols and Aerie. One lake, Nichols (69-0627), has assessment level data and it was assessed as fully supporting for recreational use. TP and chlorophyll-a concentrations in Nichols Lake are within the expected ranges for lakes in this region.

Upper Floodwood River Watershed Unit HUC 04010201140

The Upper Floodwood River watershed is located in southwestern St. Louis County, and southeastern Itasca County. The watershed encompasses an area of 71.4 square miles. The Floodwood River starts at Floodwood Lake and travels 14 miles to its confluence with the West Branch Floodwood River. Development is sparse, and land use predominantly consists of forest cover (67.7 percent) and wetlands (13.7 percent). Additionally, a small amount of the watershed is used as range (5.4 percent). Areas in the northern portion of the watershed have numerous lakes (a total 27 lakes > 10 acres or 5.1 percent of the watershed). There are no cities within the Upper Floodwood River Watershed.

From Floodwood Lake to the confluence with the West Branch Floodwood River the river, drops 50 feet in 14 miles. There are no named tributaries to the Floodwood River within this watershed. The water chemistry monitoring station (09LS027) is on the Floodwood River at County State Aid Highway 133 Bridge, 12 miles northwest of the town of Floodwood.

Stream assessments

Table 55. Aquatic life and recreation assessments on assessed AUIDs in the Upper Floodwood River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-560 **Floodwood River** *Headwaters (Floodwood Lk 69-0884-00) to St Louis R*	34.44	2B	09LS027	Upstream of CR 133, 3 mi. S of Little Swan	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	IF	FS	IF

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 56. Minnesota Stream Habitat Assessment (MSHA) for the Upper Floodwood River 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	09LS027	Floodwood River	5	12	14	12	18	61	Fair
Average Habitat Results: *Upper Floodwood River 11 HUC Watershed*			5	12	14	12	18	61	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 57. Outlet water chemistry results for the Upper Floodwood River 11-HUC

Station location:	Floodwood River Upstream of CR 133, 3 mi. S. of Little Swan
Storet ID:	S005-761
Station #:	09LS027

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	17	17	10	10	0	14	18	18
Min	1.2	1.8	70	5.0	0.020	0.53		25	7.2	171
Max	5.5	3.7	120	10.0	0.049	0.98		613	7.9	301
Mean[1]	2.5	2.6	111	7.4	0.036	0.78		129	7.6	236
Median	2.1	2.4	120	7.2	0.037	0.80		130	7.7	229
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/17	0/17	0/10			0/14	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 58. Lake morphometric and assessment data for the Upper Floodwood River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Long	31-0001-00	129.62	84	25	1.6	FS
Beauty	31-0028-00	218.4	32	22	4.4	FS

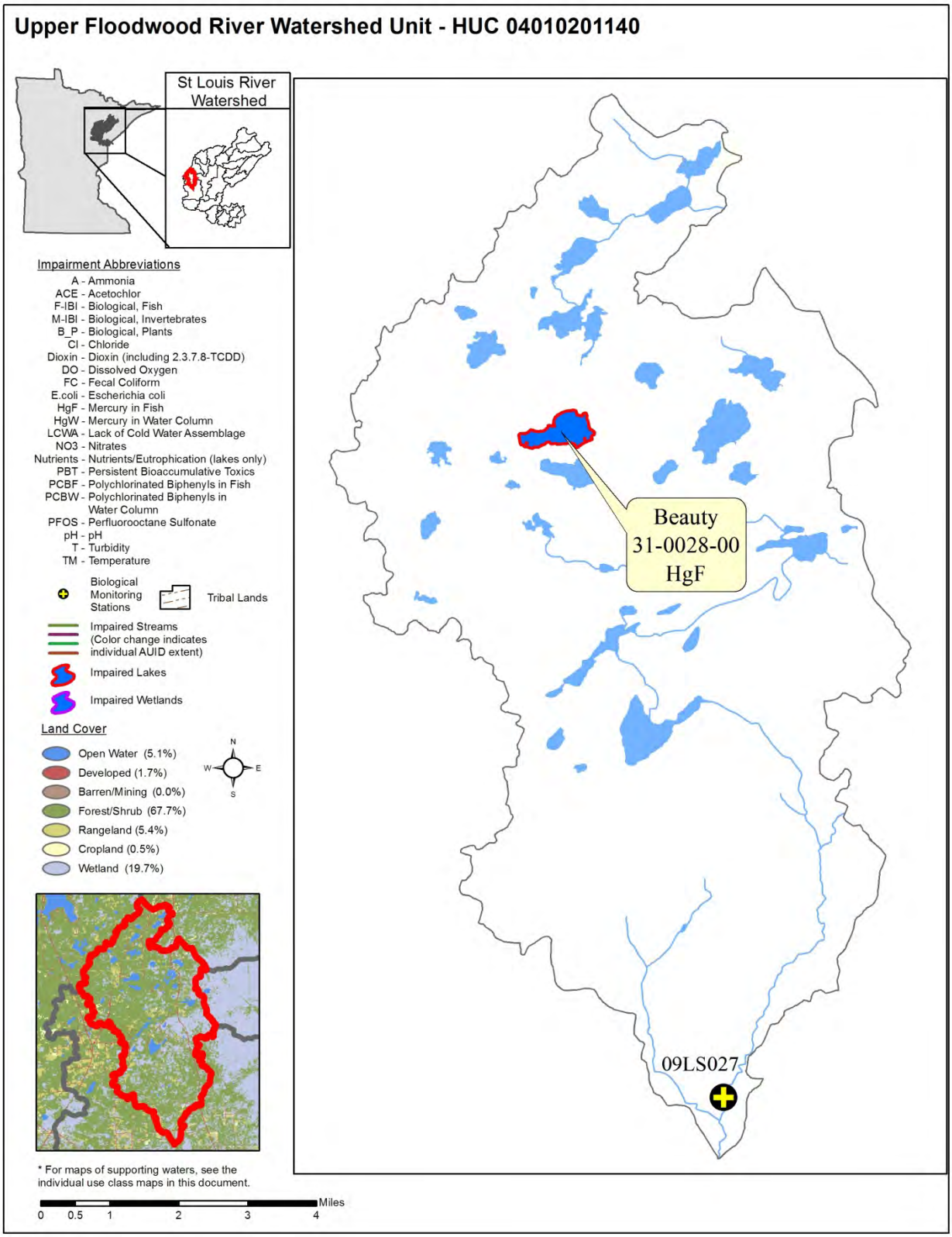

Figure 23. Currently listed impaired waters by parameter and land use in the Floodwood River Watershed Unit

Summary

One biological station was sampled and assessed for aquatic life along this 14 mile reach of the Floodwood River. Both fish and invertebrate IBI scores were good. The MSHA score is fair due to the lack of course substrates and high levels of bank erosion driving the score down.

Water chemistry data collected from the Floodwood River at the Highway 133 Bridge indicate excellent water quality. Sediment, turbidity, nutrient, and bacteria levels are low, and reflective of the forest and wetlands which dominate the landscape. No samples exceeded water quality standards, and data were within NLF ecoregion expectations. No additional monitoring is recommended at this time.

This watershed contains 27 lakes greater than 10 acres; notable lakes include, Long Floodwood and Beauty. A total of 2 lakes have assessment level data, Long (31-0001) and Beauty (31-0028). Both fully supported aquatic recreation and have excellent water quality. TP and chlorophyll-a concentrations in both lakes are within the expected ranges for lakes in this region and are indicative of the watersheds forest and wetland dominated landscape.

Lower Floodwood River Watershed Unit HUC 04010201150

The Lower Floodwood River watershed is located in southwestern St. Louis County, northeastern Aitkin County, and southwestern Itasca County. The watershed encompasses an area of 202.9 square miles. The Lower Floodwood River watershed includes the entire West Branch Floodwood River and the Floodwood River downstream of the confluence of the East Branch Floodwood River and the Floodwood River. The West Branch Floodwood River starts at Pancake Lake and flows 12.8 miles to its confluence with the Floodwood River. The Floodwood River then travels 30.4 miles from this confluence to its confluence with the St. Louis River. Development within this watershed is sparse, and land use predominantly consists of wetlands (53.7 percent) and forest cover (37.7 percent). Near the main stem Floodwood River, small portions of range land (6.1 percent) make up the remainder of the land use within this watershed. The only city within the watershed is Floodwood, located at the southeastern portion of the watershed.

From the headwaters of the West Branch Floodwood River to the confluence with the St. Louis River, the Lower Floodwood River drops 65 feet in 43.2 miles. Named tributaries to the Floodwood River in this watershed include Vara Creek and Joula Creek. The West Branch Floodwood River has no named tributaries. The water chemistry monitoring station (97LS033) is on the Floodwood River at the County Road 835 Bridge, one mile north of Floodwood.

Stream assessments

Table 59. Aquatic life and recreation assessments on assessed AUIDs in the Lower Floodwood River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-560 **Floodwood River** *Headwaters (Floodwood Lk 69-0884-00) to St Louis R*	34.44	2B	97LS033	.5mi. W of SH 73, 1.5mi. N of Floodwood	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	IF	FS	IF
04010201-A11 **Unnamed creek** *Unnamed Lk (31-1035-00) to WBr Floodwood R*	1.96	2B	09LS108	Upstream of CR 25, in Wawina	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-A16 **Joula Creek** *Headwaters to Floodwood R*	5.75	2B	09LS110	Downstream of CR 189, 8 mi. N of Floodwood	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-623 **Vaara Creek** *Unnamed Cr to Floodwood R*	2.54	2B	97LS034	Just W off SH 73, 10mi. NW of floodwood	EXP	EXP	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R.7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 60. Non-assessed biological stations on channelized AUIDs in the Lower Floodwood River 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-A10 **Unnamed Ditch** *Unnamed Ditch to Floodwood R*	09LS024	Upstream of Hwy 2, 1.5 mi. NW of Floodwood	Poor	Poor
04010201-618 **Floodwood River** *West Branch, Pancake Lk to Unnamed Cr*	98LS043	Downstream of CR 25 culvert, 7 mi SE of Worba	Good (2)	Poor

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 61. Minnesota Stream Habitat Assessment (MSHA) for the Lower Floodwood River 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	09LS024	Unnamed ditch	5	10	7	10	10	41	Poor
1	09LS108	Trib. to Floodwood River, West Branch	5	11	3	12	17	48	Fair
1	09LS110	Joula Creek	4	12	11	15	20	62	Fair
1	97LS033	Floodwood River	1	9	10	7	4	31	Poor
2	97LS034	Vaara Creek	4	13	7	6	17	48	Fair
3	98LS043	Floodwood River, West Branch	5	12	7	14	23	60	Fair
Average Habitat Results: *Lower Floodwood River 11 HUC Watershed*			4	11	7	11	15	48	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 62. Outlet water chemistry results for the Lower Floodwood River 11-HUC

Station location:	Floodwood River W. of Hwy. 73, 1 mi. N. of Floodwood
Storet ID:	S005-755
Station #:	97LS033

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	19	19
Min	2.4	2.6	35	3.5	0.030	0.62		15	6.8	83
Max	6.3	6.9	120	8.7	0.094	1.35		240	8.0	335
Mean[1]	3.9	4.8	64	6.6	0.049	0.99		53	7.5	178
Median	3.8	4.2	53	6.5	0.043	1.02		47	7.4	160
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	1/18	3/10			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

Table 63. Lake morphometric and assessment data for the Lower Floodwood River HUC-11 Watershed

Lake Name	Lake ID	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Littoral Area	Aquatic Recreation Use Support[4]
Pancake	31-0016-00	55	9.6	6	23	FS

[1]. Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

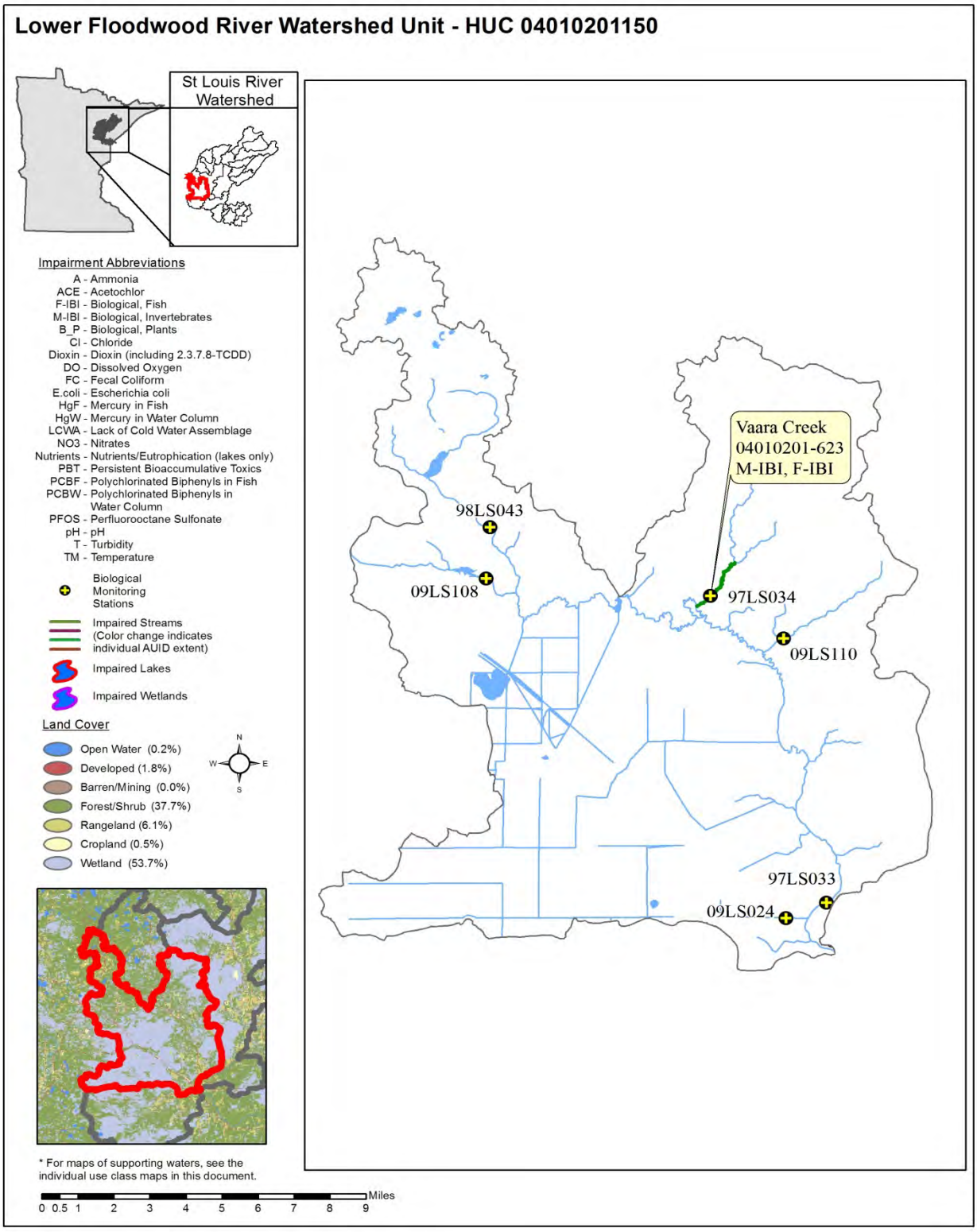

Figure 24. Currently listed impaired waters by parameter and land use in the Lower Floodwood River Watershed Unit

Summary

Six biological stations were sampled in the Lower Floodwood River watershed. In addition, two channelized stations were sampled but not assessed. IBI scores on the channelized streams ranged from good to poor. IBI scores on the assessable AUIDs were all above their respective thresholds indicating healthy biological communities, with the exception of Vaara Creek (09LS034 on AUID 04010201-623). Rangeland and row crop are abundant in the upstream portion of this minor HUC 14 watershed. Bank erosion upstream of this station may contribute to the high total suspended solids (14.4 mg/l), embedded pools and the overall reduction of quality substrates and fish cover that are needed to support sensitive biological communities..

Water chemistry data collected from the Floodwood River at the County Road 835 Bridge indicate good water quality, although nutrient concentrations were slightly elevated compared to other watersheds. A total of three samples exceeded the proposed phosphorus standard for northern Minnesota rivers (0.05 mg/L). The maximum phosphorus concentration (.094 mg/L) was collected during a rain event. Elevated nutrient concentrations (and low DO concentrations), during rain events are not uncommon in systems influenced by wetlands, as decaying organic material reaches the stream channel. Bacteria, turbidity, and TSS concentrations were low, and no samples exceeded standards. No additional monitoring is recommended at this time.

This watershed contains 21 lakes greater than 10 acres. Pancake Lake (31-0016) is the only lake with assessment level data in the watershed. The lake is moderately productive but met the nutrient standards and was assessed as fully supporting for aquatic recreation. The west Branch of the Floodwood River flows through the Pancake Lake and may influence it's productivity.

East Savannah Watershed Unit HUC 04010201160

The East Savannah River watershed is located in southwestern St. Louis County and northeastern Aitkin County. The watershed encompasses an area of 94.6 square miles. The East Savannah River starts at Wolf Lake in Savanna Portage State Park and travels 15 miles to its confluence with St. Louis River, just southeast of Floodwood. The watershed is largely undeveloped and consists predominantly of wetlands (49 percent) and forest cover (44.8 percent). Half of the Savannah River is within the boundaries of Savannah Portage State Park. Many of the watershed's wetland areas were historically channelized in an attempt to drain the landscape for farming. Currently small parts of the central and eastern areas of the watershed are used for range or pastureland (4.7 percent). There are no cities within the East Savannah River watershed.

From Wolf Lake to the confluence with the St Louis River the East Savannah River drops 35 feet in 15 miles. This is considered a lower gradient portion of the watershed. There are no named tributaries to the East Savannah River. The water chemistry monitoring station (98LS050) on the East Savannah River is at the County Road 836 Bridge, one mile southwest of Floodwood.

Stream assessments

Table 64. Aquatic life and recreation assessments on assessed AUIDs in the East Savannah 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-561															
East Savanna River	15.48	2B	98LS050	Just upstream of CR 836, 1 mi SW of Floodwood	NA	NA	IF	MTS	MTS	MTS	MTS	-	MTS	NA*	FS
Headwaters (Wolf Lk 01-0019-00) to St Louis R			09LS023	Upstream of CR 831, 4 mi. SW of Floodwood											

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 65. Non-assessed biological stations on channelized AUIDs in the East Savanna 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-A44 **Sixteen Creek (New Channel)** *Unnamed Ditch to Sixteen Cr (Old Channel)*	09LS111	Upstream of CR 832, 4.5 mi. W of Floodwood	Fair	Good
04010201-561 **East Savanna River** *Headwaters (Wolf Lk 01-0019-00) to St Louis R*	98LS050 09LS023	Just upstream of CR 836, 1 mi SW of Floodwood Upstream of CR 831, 4 mi. SW of Floodwood	Fair (2) Fair	Good Fair

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 66. Minnesota Stream Habitat Assessment (MSHA) for the East Savanna River 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	09LS023	East Savanna River	5	15	7	7	17	51	Fair
1	09LS111	Sixteen Creek	3	5	7	6	11	32	Poor
3	98LS050	East Savannah River	4	13	11	11	16	55	Fair
Average Habitat Results: *East Savannah River 11 HUC Watershed*			4	11	8	8	15	46	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 67. Minnesota Stream Habitat Assessment (MSHA) for the East Savanna River 11-HUC

Station location:	East Savanna River Upstream of CR 836, 1 mi. SW of Floodwood
Storet ID:	S005-756
Station #:	98LS050

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	19	19
Min	2.7	3.6	24	2.2	0.039	1.63		15	6.5	61
Max	8.6	6.6	99	7.4	0.116	2.21		1300	7.8	162
Mean[1]	5.0	5.1	43	4.9	0.083	1.91		82	7.1	111
Median	4.5	5.0	34	4.7	0.084	1.92		77	7.0	105
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	12/18	8/10			1/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

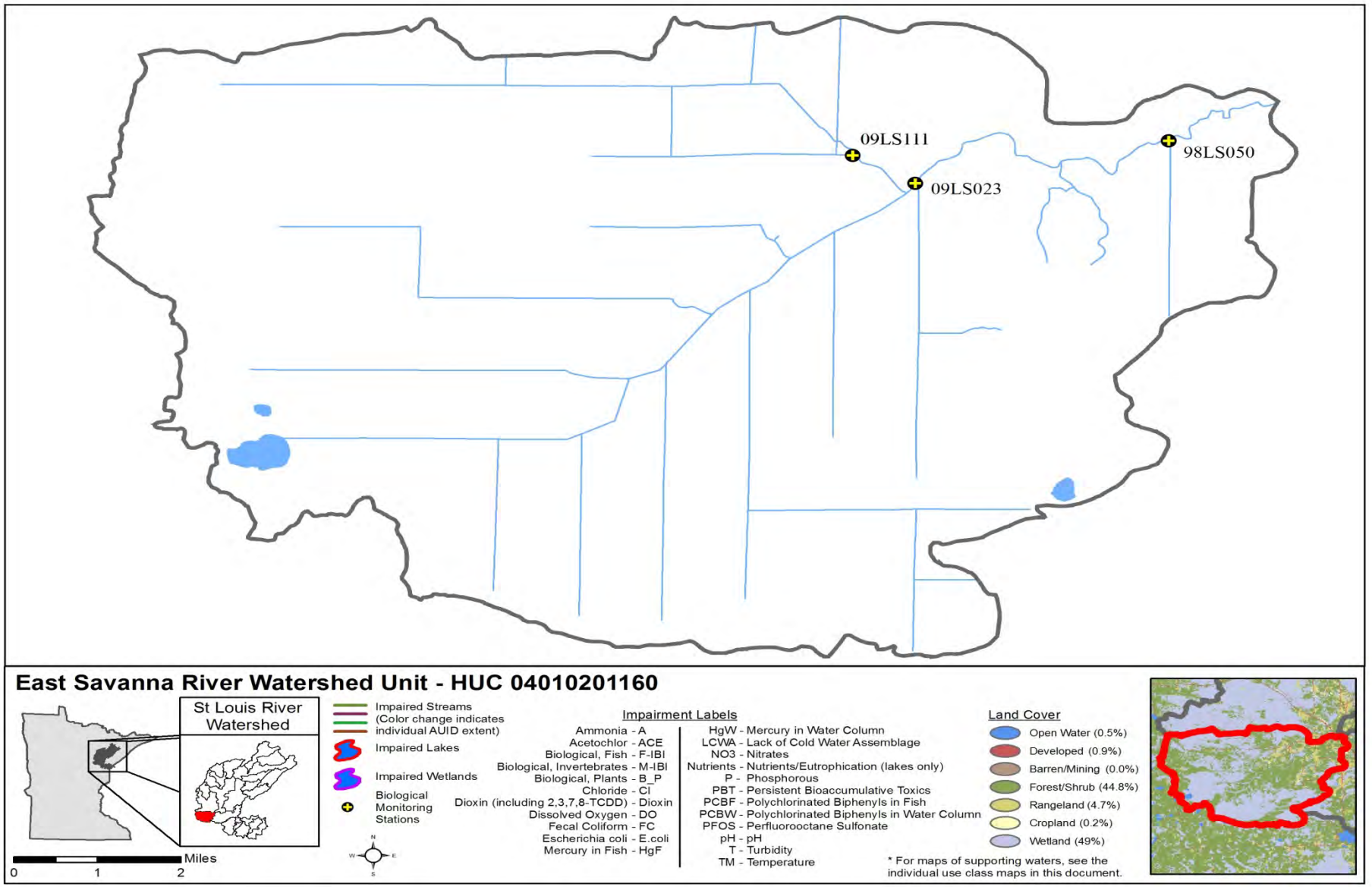

Figure 25. Currently listed impaired waters by parameter and land use in the East Savanna River Watershed Unit

Summary

The East Savanna River watershed is dominated by wetlands that have been channelized in an attempt to promote drainage. Three biological stations along AUID 04010201-461 were sampled for fish and invertebrates but assessments were deferred because all sites were predominately modified. In general, M-IBI scores were better than F-IBI throughout this watershed. For a system with low productivity, and being low gradient, macro-invertebrate species diversity is very good. All three sites in the watershed had a total taxa count ranging from 39-45, a strong indication that these streams are recovering from past channelization. Contrary to the invertebrates, fish communities were only fair. Many tolerant species were found such as central mudminnow, brook stickleback and northern pike. MSHA fish cover scores were poor for these sites and might be contributing to these results (Table 66).

Water Chemistry data collected from the East Savanna River at the County Road 836 Bridge suggests some problems. Bacteria levels in this watershed were low, reflective of the undeveloped nature of most of the watershed. The MPCA staff designated this watershed as fully supporting aquatic recreation. However, nutrient concentrations in the watershed were the highest found within the St. Louis River watershed. A total of eight TP samples exceeded the proposed standard, an 80 percent exceedance rate. Average TKN concentrations were over 2.5 times the NLF ecoregion expectation. Similarly, most dissolved oxygen samples were below the DO standard as well, with 12 of 18 samples below five mg/L. It is likely these water quality exceedances are due in part to the wetland-dominated low gradient landscape. However, further monitoring is recommended to determine the scope of natural versus legacy (i.e. ditching) impacts.

This watershed contains only three lakes greater than 10 acres; a notable lake includes Wolf, which is within Savannah Portage State Park. None of the lakes have assessment level data.

Lower St. Louis Watershed Unit HUC 04010201170

The Lower St. Louis River watershed is located in south-central St. Louis and northeastern Carlton Counties. The watershed encompasses an area of 252.9 square miles. The Lower St. Louis watershed starts at the confluence of the East Savannah and St. Louis River, and continues to just upstream of the Thompson Reservoir. The watershed is largely undeveloped and consists predominantly of forest cover (66.9 percent) and wetlands (16 percent). There is a fair amount of range (10 percent) scattered throughout the watershed. The cities of Brookston, Cloquet, Scanlon and Carlton all are within the watershed boundaries.

From the confluence of the East Savannah River to the Thompson Reservoir, the Lower St. Louis River drops 160 feet in 41.6 miles. Named tributaries to the St Louis River within this watershed include the McCarty River, Ahmik River, Artichoke River, Otter Creek and Little Otter Creek. Three 11 digit HUC watersheds flow into the St. Louis River in this section which include Stony Creek, Simian Creek and the White Pine River. Additionally, the Cloquet River eight digit HUC watershed (draining 793 square miles) joins the St Louis River in this watershed. The total contributing watershed area upstream of the Thompson Reservoir is estimated at 3,430 square miles. The water chemistry monitoring station (97LS093) is on the St. Louis River at the County State Aid Highway 61 Bridge in Scanlon.

Stream assessments

Table 68. Aquatic life and recreation assessments on assessed AUIDs in the Lower St. Louis 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-503 **St Louis River** *Cloquet R to Pine R*	9.55	2B	97LS091	Just N off USH 2, 2 mi. SE of Brookston	MTS	NA	MTS	IF	MTS	MTS	MTS	-	MTS	FS	FS
04010201-506 **St Louis River** *East Savanna R to Artichoke R*	18.55	2B	09LS009	Adjacent to boat launch, 1 mi. E of Paupores	MTS	NA	-	-	MTS	-	-	-	-	FS	NA
04010201-515 **St Louis River** *Scanlon Dam to Thomson Reservoir*	3.2	2B	97LS093	Just S of CSAH 61 bridge, E edge of Scanlon	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	FS	FS

Table 68 (Continued)

04010201-544 **Artichoke River** *Headwaters (Artichoke Lk 69-0623-00) to St Louis R*	12.44	2B	97LS088	Just S. of CR 8 bridge, 1/2 mile W. of Culver	MTS	MTS	-	MTS	-	-	-	-	IF	FS	IF
04010201-A08 **McCarty River** *Unnamed Ditch to St Louis R*	6.19	2B	09LS012	Upstream of CR 965, 2 mi. N of Gowan	MTS	MTS	-	-	-	-	-	-	-	FS	NA
04010201-629 **Otter Creek** *Little Otter Cr to T48 R16W S7, east line*	5.8	2A	09LS005	Upstream of CR 1, S of Carlton	MTS	EXP	-	-	-	-	-	-	IF	NS	IF
04010201-879 **Fond du Lac Creek** *Unnamed Cr to T49 R17W S9, north line*	2.95	2A	68LS039	Downstream of CR 114, 1.5 mi. NW of Cloquet	EXS	EXS	-	-	MTS	-	-	-	IF	NA	IF

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use. , = AUID located on Tribal Land and therefore not assessed
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 69. Non-assessed biological stations on channelized AUIDs in the Lower St. Louis 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-945 **Ahmik River** *Unnamed cr to St Louis R*	09LS010	Downstream of Lindstrom Rd, 2 mi. SE of Gowan	Good	Fair
04010201-A07 **Unnamed creek** *Unnamed cr to St Louis R*	09LS011	Downstream of Genew Rd, 1.5 mi. W of Gowan	Good	Good

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 70. Minnesota Stream Habitat Assessment (MSHA) for the Lower St. Louis 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	09LS005	Otter Creek	4	11	14	13	35	77	Good
1	09LS009	St Louis River	5	13	17	7	13	55	Fair
1	09LS010	Ahmik River	5	9	14	6	4	38	Poor
1	09LS011	Trib. to St Louis River	4	9	4	11	14	41	Poor
1	09LS012	McCarty River	5	12	17	11	22	67	Good
1	68LS039	Fond du Lac Creek	4	12	21	16	30	83	Good
2	97LS088	Artichoke River	5	13	23	14	30	84	Good
1	97LS091	St Louis River	5	12	14	11	30	71	Good
1	97LS093	St Louis River	4	8	25	12	27	76	Good
Average Habitat Results: *Lower St Louis River 11 HUC Watershed*			4	11	16	11	23	66	Fair

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 71. Outlet water chemistry results for the Lower St. Louis River 11-HUC

Station location:	Saint Louis River Downstream of CR 6 in Scanlon
Storet ID:	S000-046
Station #:	97LS093

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	11	9	19	18	11	11	0	15	19	20
Min	4.3	4.6	43	5.9	0.022	0.62		2	7.4	117
Max	22.0	8.3	86	11.2	0.048	4.53		310	8.0	343
Mean[1]	8.0	6.4	62	8.1	0.032	1.11		17	7.7	204
Median	6.3	6.1	65	7.9	0.029	0.71		17	7.7	196
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/19	0/18	0/11			0/15	0/19	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

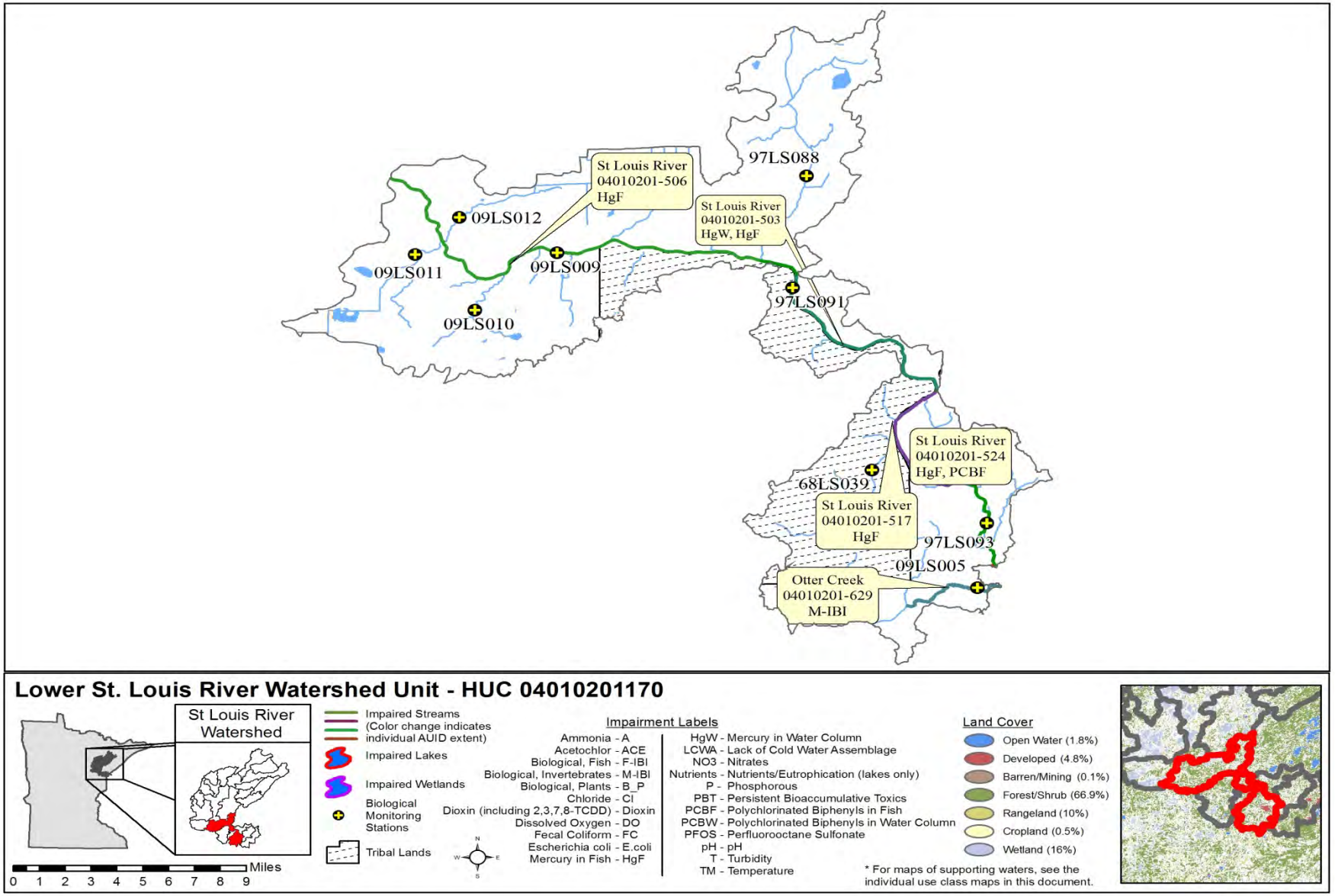

Figure 26. Currently listed impaired waters by parameter and land use in the Lower St. Louis River Watershed Unit

Summary

The Lower St. Louis River watershed is a largely undisturbed watershed that consists of predominately forest and wetlands (82.9 percent). In general, IBI scores for both fish and macroinvertebrates are good. Of the six assessable AUIDs within this watershed, five fully support aquatic life. A deep segment of the St. Louis River is impaired for aquatic life according to the M-IBI but the deep water and lack of riffle habitat in this area may have contributed to the impairment. Invertebrate taxa richness was high but lacked sensitive species. Fond du Lac Creek (68LS039 on AUID 04010201-879) failed to meet the MPCA's fish and invertebrate threshold for cold water streams. The fish survey conducted by the MPCA's Biological Monitoring staff included tolerant warm water species including fathead minnow, central mudminnow, brook stickleback and common shiner. The same is true with the macroinvertebrate sample which resulted in mostly warm water species and no sensitive species collected. The MDNR surveys conducted in the late 1960s indicate that brook trout were captured at the MPCA's monitoring station downstream of County Road 114 (Jarvi Road) and one MDNR station 0.4 miles upstream of the Fond du Lac Creek confluence with the St. Louis River. However, a review of recent aerial photography indicates that much of the stream is influenced by beaver impoundments. Beaver impoundments tend to warm water temperatures, modify habitat, and alter the water chemistry in ways that make sustaining reproducing populations of cold water fish and invertebrates difficult. Additional monitoring should be conducted to determine if Fond du Lac Creek is suitable to sustain viable cold water communities. The other cold water station located within this watershed is on Otter Creek (09LS005 on AUID 04010201-629). This station failed to meet its threshold for M-IBI and is therefore considered impaired for aquatic life. However, the fish community was comprised of many cold water species such as brook trout, brown trout and longnose dace.

The water chemistry data collected at the County Road 61 Bridge indicate good water quality in this section of the St. Louis River. As mentioned above, this site integrates water quality conditions from a large area, including the entire Cloquet River watershed which is a large forested landscape that is dominated by large reservoirs managed for hydroelectricity. Sediment, turbidity, nutrients, and bacteria levels are low, and no samples exceeded water quality standards. Water quality is better in this watershed compared to the upstream watersheds, likely due to dilution from the Cloquet River watershed. Further details about water quality in this watershed can be found in the major watershed loading section of this report, since this site was also sampled for that program.

No lakes in this watershed contain MPCA assessment level data.

Stony Brook Watershed Unit HUC 04010201180

The Stony Brook watershed, located in south-central St. Louis County and north-central Carlton County, encompasses an area of 100 square miles. Stony Brook starts at Rice Portage Lake and travels 25.8 miles to its confluence with St. Louis River in Brookston. The watershed is largely within the Fond du Lac Reservation, and is mostly undeveloped. Landuse consists of predominantly forests (73.1 percent) and wetlands (18 percent). There are no cities within the Stony Brook watershed.

From Rice Portage Lake to the confluence with the St. Louis River, the river drops 70 feet in 25.8 miles. Martin Branch (Joe Martin Creek) is the only named tributary to Stony Brook. The water chemistry monitoring for this watershed is the station 09LS016 on Stony Brook at the County State Aid Highway 31 Bridge, in Brookston.

Stream assessments

Table 72. Aquatic life and recreation assessments on assessed AUIDs in the Stony Brook 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-562 **Stoney Brook** *Headwaters (Rice Portage 09-0037-00) to St Louis R*	26.23	2B	09LS016 09LS018 09LS019 09LS113	Upstream of Hwy 31, in Brookston Upstream of CR 851, 4.5 mi. S of Brookston Downstream of Trail 427, 3 mi. NW of Sawyer Upstream of Hwy 2, 1 mi. S of Brookston	MTS	MTS	MTS	MTS	MTS	EXP	-	-	MTS	NA	NA
04010201-769 **Martin Branch (Joe Martin Creek)** *Unnamed Cr to Unnamed Cr*	2.33	2A †	09LS017	Upstream of CR 855, 1.5 mi. SW of Brookston	EXS	EXP	-	-	MTS	-	-	-	-	NA	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use, = AUID located on Tribal Land and therefore not assessed.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 73. Non-assessed biological stations on channelized AUIDs in the Stony Brook 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-996 **Unnamed creek** *Unnamed Ditch to Unnamed Cr*	09LS021	E of Arrowhead FR, 5 mi. SW of Brookston	Good	Fair
04010201-997 **Unnamed Ditch** *Unnamed Ditch to Unnamed Cr*	09LS020	Downstream of Trail 421, 4 mi. NW of Sawyer	Good	Poor

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 74. Minnesota Stream Habitat Assessment (MSHA) for the Stony Brook 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	09LS016	Stoney Brook	5	12	23	12	29	80	Good
1	09LS017	Martin Branch (Joe Martin Creek)	5	12	10	10	20	57	Fair
1	09LS018	Stoney Brook	5	12	10	11	18	56	Fair
2	09LS019	Stoney Brook	5	9	9	10	6	39	Poor
1	09LS020	Unnamed ditch	5	10	16	14	13	58	Fair
1	09LS021	Unnamed ditch	5	13	13	7	20	58	Fair
1	09LS113	Stoney Brook	5	12	26	8	33	84	Good
Average Habitat Results: *Stony Brook 11 HUC Watershed*			5	11	15	10	20	62	Fair

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)

Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)

Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 75. Outlet water chemistry results for the Stony Brook 11-HUC

Station location:	Stony Brook Upstream of Hwy. 31, in Brookston
Storet ID:	S004-594
Station #:	09LS016

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	4	3	9	9	3	3	0	7	10	10
Min	3.2	6.9	50	7.1	0.032	1.01		8	7.4	90
Max	5.7	7.9	120	11.9	0.037	1.24		326	8.2	312
Mean[1]	4.5	7.6	88	9.3	0.035	1.16		55	7.7	187
Median	4.6	7.8	92	9.1	0.035	1.23		57	7.6	195
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/3	0/9	0/9	0/3			0/7	0/10	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, PA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

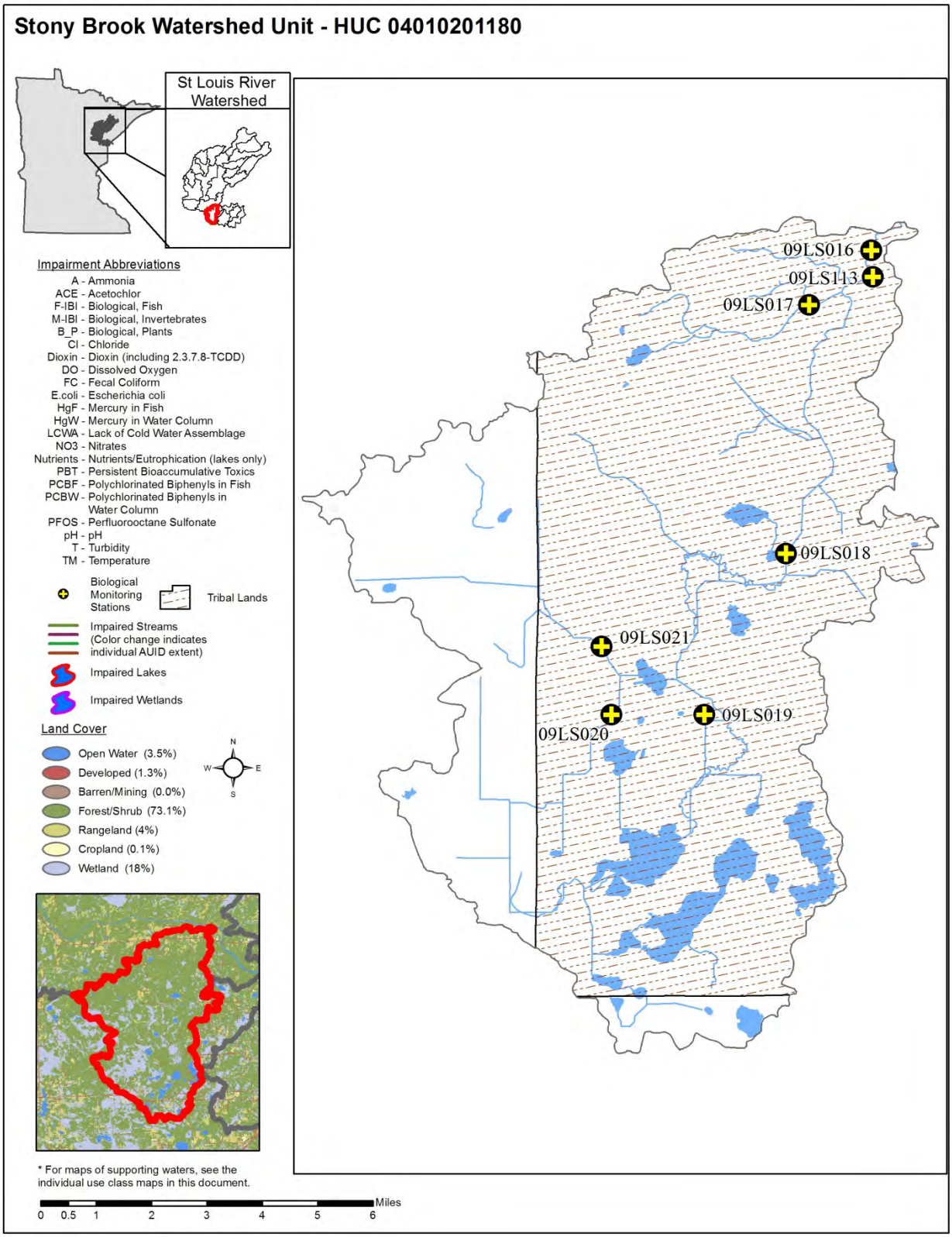

Figure 27. Currently listed impaired waters by parameter and land use in the Stony Brook Watershed Unit

Summary

The Stony Brook watershed is a largely undeveloped system lying mostly within the Fond Du Lac Indian Reservation. Seven biological stations across four AUIDs were sampled for biology in the summer of 2009. Of these, two unnamed streams (AUIDs 04010201-996, 04010201-997) were channelized and assessments were deferred. F-IBI scores on the channelized streams were good while M-IBI scores ranged from fair to poor. In addition, the remaining two AUIDs on Stony Brook and Martin Branch were natural systems on tribal land and were not assessed. Biological indicators throughout the watershed showed mixed results. When looking at the spatial pattern within the watershed, sites located on the main stem Stony Brook tend to perform better than the smaller headwater streams. All stations along the main stem Stony Brook had IBI scores above their respective thresholds. The abundance of sensitive species (mottled sculpin, longnose dace, burbot) and lack of tolerant taxa helped drive the IBI scores up. In contrast, Martin Branch (09LS017 on AUID 04010201-769) failed to meet the MPCA's fish and invertebrate thresholds for coldwater streams. The fish sample at Martin Branch included many tolerant warm water species including fathead minnow, brook stickleback and central mudminnow. The same was true of the macroinvertebrate population. The MDNR surveys conducted in the late 1970s and early 1980s indicate that brook trout were captured close to the MPCA monitoring location on Marshall Road. However, a review of recent aerial imagery indicates that the majority of the stream is influenced by beaver impoundments. Beaver impoundments tend to warm water temperatures, modify habitat, and alter the water chemistry in ways that make sustaining reproducing populations of coldwater fish and invertebrates difficult. Future monitoring should examine the suitability of Martin Branch to sustain viable coldwater communities.

Data collected at the Highway 31 Bridge indicate good water quality. No samples exceeded State water quality standards. Sediment, nutrients, turbidity, and bacteria levels were consistently low and reflective of the forested landscape. Because all of the MPCA sites within this watershed lie within the Fond du Lac Reservation, no assessments were made as the Fond du Lac Band of Lake Superior Chippewa have their own EPA approved set of water quality standards that are applied to Tribal waters.

This watershed contains 19 lakes greater than 10 acres; notable lakes include Big and Perch. Much of this watershed is within the Fond Du Lac Reservation, and those waters are managed under their authority. No lakes in the watershed have assessment level data. For information on lake water quality within the Fond du Lac Reservation, see http://www.fdlrez.com/newnr/environ/waterlakestream.htm.

Simian Creek Watershed Unit HUC 04010201190

The Simian Creek watershed, located in south-central St. Louis County and north-central Carlton County encompasses an area of 22 square miles. Simian Creek starts at Cedar Lake and travels 16.1 miles to its confluence with the St Louis River. The watershed is largely undeveloped and lies within the Fond du Lac Reservation. Land use in this watershed is predominantly forest cover (64.5 percent) and wetlands (19.7 percent). Scattered throughout the watershed are areas used for range activities (9.1 percent). There are no cities within the Simian Creek watershed.

From Cedar Lake to the confluence with the St. Louis River the river drops 110 feet in 16.1 miles. There are no named tributaries to Simian Creek. Due to the watershed's small drainage area (22 square miles) there was no water chemistry site selected for this watershed.

Stream assessments

Table 76. Aquatic life and recreation assessments on assessed AUIDs in the Simian Creek 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-989 **Unnamed Creek** *Simian Lk to St Louis R*	3.89	2B	09LS015	Downstream of Kultala Rd, 4 mi. SW of Saginaw	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	NA	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use. = AUID located on Tribal Land and therefore not assessed.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 77. Minnesota Stream Habitat Assessment (MSHA) for the Simian 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	09LS015	Simian Creek	5	12	19	11	26	73	Good
Average Habitat Results: *Simian Creek 11 HUC Watershed*			5	12	19	11	26	73	Good

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)

Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)

Poor: MSHA score below the median of the most disturbed sites (≤44)

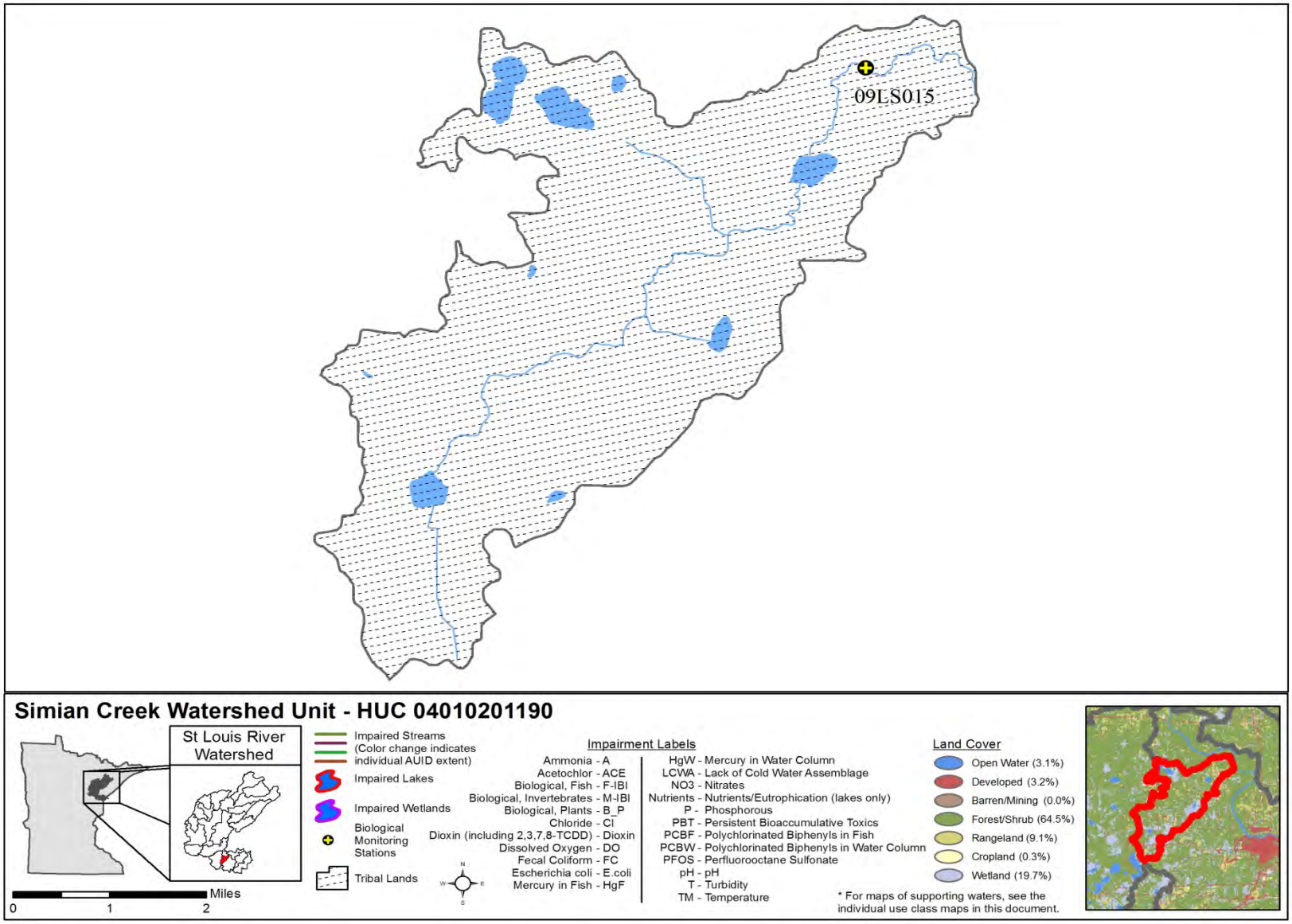

Figure 28 . Currently listed impaired waters by parameter and land use in the Simian Creek Watershed Unit

Summary

The Simian Creek watershed is a relatively undisturbed watershed located entirely within the Fond du Lac Indian Reservation. One biological site on one AUID was sampled for biology in 2009. The MPCA does not assess waters located within tribal boundaries, and therefore, assessments for this reach were deferred. F-IBI and M-IBI scores are well above their respective thresholds and habitat at the site was in good condition. The biological monitoring site was located downstream of a moderate amount of agricultural land. However, the majority of the stream upstream of the site is well buffered and as the results suggest there appears to be little, if any impact from land use practices in the watershed.

This watershed contains six lakes greater than 10 acres; notable lakes include East and West Twin. No lakes in the watershed have MPCA assessment level data.

White Pine River Watershed Unit HUC 04010201200

The White Pine River watershed, located in south-central St. Louis County, encompasses an area of 46.6 square miles. The White Pine River is a designated coldwater stream that starts at Pike Lake and travels 15.1 miles to its confluence with the St. Louis River. The watershed is largely undeveloped and consists predominantly of forested land (77 percent). There are small areas of range (9.7 percent), rural residential development (5.2 percent), wetlands (4.5 percent) and open water (2.7 percent). Portions of the communities of Twig and Saginaw are within the White Pine River watershed.

From the headwaters to its confluence with the St. Louis River, the White Pine River drops 205 feet in 15.1 miles. Named tributaries to the White Pine River include Dutch Slough, Johnson Creek and Railroad Creek. The water chemistry monitoring site for this watershed is the station 09LS013 on the White Pine River at the Highway 33 Bridge, five miles north of Cloquet.

Stream assessments

Table 78. Aquatic life and recreation assessments on assessed AUIDs in the White Pine 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
04010201-543 **Pine River (White Pine River)** *T50 R16W S4, north line to St Louis R*	10.63	2A	09LS013	Downstream of driveway off Hwy 33, 3.5 mi. S of Saginaw	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	EX	FS	NS
04010201-737 **Dutch Slough (Dutchess Slough Creek)** *Unnamed Cr to Pine R*	1.49	1B	09LS014	Upstream of CR 6, 3 mi. S of Saginaw	MTS	NA	-	-	-	-	-	-	-	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 79. Non-assessed biological stations on channelized AUIDs in the White Pine River 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
04010201-543 **Pine River (White Pine River)** *T50 R16W S4, north line to St Louis R*	09LS015	0.3 miles upstream of CSAH 6, 5 miles NE of Cloquet	Good	Poor

See Appendix 5 for clarification on the good/fair/poor thresholds and Appendix 4 for IBI results

Table 80. Minnesota Steam Habitat Assessment (MSHA) for the White Pine River 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	09LS013	Pine River	4	10	19	13	30	76	Good
1	09LS014	Dutch Slough (Dutchess Slough Creek)	5	11	8	8	19	50	Fair
1	09LS115	White Pine River	5	11	18	16	29	79	Good
Average Habitat Results: **W***hite Pine River 11 HUC Watershed*			5	11	15	12	26	68	Good

Qualitative Habitat Ratings:
Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 81. Outlet water chemistry results for the White Pine River 11-HUC

Station location:	Pine River Downstream of Hwy 33, 3.5 mi. S. of Saginaw									
Storet ID:	S005-759									
Station #:	09LS013 (Coldwater)									
Parameter	TSS	Turb.[4]	T-tube	D.O.	TP [5]	TKN	Chloro-phyll-a [5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	10	9	18	18	10	10	0	15	18	19
Min	1.2	1.9	100	7.6	0.017	0.32		31	7.0	190
Max	5.3	3.7	120	10.5	0.033	2.95		390	7.9	301
Mean[1]	2.8	2.7	114	8.9	0.025	0.78		108	7.6	259
Median	2.2	2.8	120	8.8	0.024	0.57		86	7.7	265
WQ standard		10	20	7.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/9	0/18	0/18	0/10			0/15	0/18	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

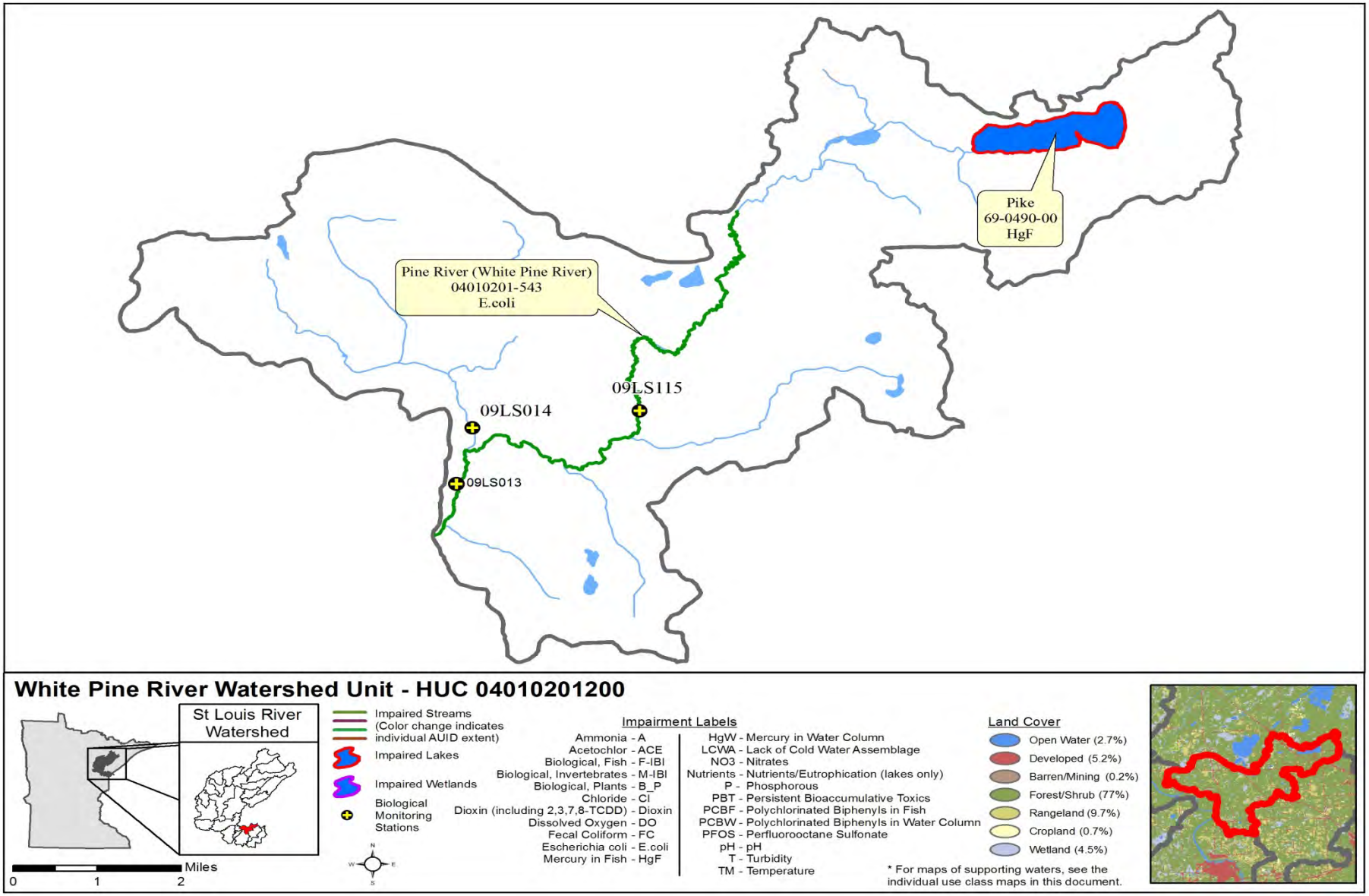

Figure 29. Currently listed impaired waters by parameter and land use in the White Pine River Watershed Unit

Summary

Three biological stations were sampled along two AUIDs in the White Pine River watershed. Assessments were deferred for the White Pine River at station 09LS115 because the channel was predominantly modified. At this station, fish and invertebrates show mixed results from good to poor. The remaining stations within the watershed were assessed for aquatic life. Both fish and invertebrates IBI scores were above the respective thresholds for coldwater streams in northern Minnesota, indicating healthy biological communitess. In general, MSHA scores were good throughout the watershed, and are one reason for the abundance of sensitive biological indicators.

Data collected at the Highway 33 Bridge indicate good water quality for most parameters. Similar to other St. Louis River watersheds, sediment, turbidity, and nutrients levels are low in the White Pine River. However, the geometric mean of bacteria samples was 108 colonies/100mL, a relatively high concentration. Although no individual samples exceeded the maximum standard of 1260 colonies / 100 mL, 6 of 15 samples exceeded the monthly geometric mean standard (126 colonies / 100 mL), enough to warrant an impairment of aquatic recreational use. Further monitoring is recommended to identify potential sources of the bacteria.

This watershed contains nine lakes greater than 10 acres; a notable lake is Pike located just north of Duluth. No lakes have current assessment level data, although Pike has been historically monitored by the MPCA, NRRI, and St. Louis County.

Midway River Watershed Unit HUC 04010201210

The Midway River watershed, located in southeastern St. Louis County, encompasses an area of 66.5 square miles. The Midway River starts two miles east of Hermantown and travels 18.8 miles to its confluence with the Thompson Reservoir and the St. Louis River. The watershed is largely undeveloped and consists predominantly of forest cover (71 percent). Additionally, there is a fair amount of range (16 percent), rural and residential development (7.7 percent) and wetlands (4.5 percent) within the watershed. The cities of Hermantown and Esko are within the watershed.

From its headwaters to the confluence with the Thompson Reservoir the Midway River drops 290 feet in 18.8 miles. Named tributaries to the Midway River include Hay Creek, Elm Creek, Anderson Creek and Rocky Run. The water chemistry monitoring site for this watershed is the station 09LS004 at the Corby Road Bridge, 1.5 miles north Thompson.

Stream assessments

Table 82. Aquatic life and recreation assessments on assessed AUIDs in the Midway River 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-625 **Unnamed Creek** *T50 R16W S11, north line to Midway R*	7.1	2A	97LS112	Rocky Run Creek; river mile 0.5; downstream of St. Louis River road	MTS	MTS	MTS	IF	-	MTS	-	-	EX	FS	NS
04010201-636 **Midway River** *T49 R16W S28, north line to St Louis R (Thomson Res)*	4.32	2B	09LS004	Upstream of Korby Rd, 1.5 mi. N of Thomson	MTS	MTS	MTS	MTS	MTS	MTS	-	-	IF	FS	FS
04010201-751 **Hay Creek** *Unnamed Cr to Midway R*	4.73	2A	97LS108	river mile 0.7; downstream of North Cloquet road	MTS	MTS	-	-	-	-	-	-	EX	FS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 83. Minnesota Stream Habitat Assessment (MSHA) for the Midway River 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	09LS004	Midway River	5	11	21	13	30	80	Good
1	97LS108	Hay Creek	5	14	22	15	36	92	Good
1	97LS112	Trib. to Midway River	5	15	24	14	34	92	Good
Average Habitat Results: *Midway River 11 HUC Watershed*			5	13	22	14	33	88	Good

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 84. Outlet water chemistry results for the Midway River 11-HUC

Station location:	Midway River Upstream of Korby Rd., 1.5 mi. N of Thompson
Storet ID:	S003-611
Station #:	09LS004

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	20	36	43	45	18	18	0	32	45	46
Min	1.0	1.7	44	7.7	0.004	0.38		3	7.2	134
Max	5.0	9.7	120	13.3	0.060	1.60		2420	8.7	325
Mean[1]	2.8	4.3	99	10.1	0.028	0.87		96	8.0	234
Median	2.7	3.5	100	10.1	0.025	0.72		73	8.0	239
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/36	0/43	0/45	2/18			4/32	0/45	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1] Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2] Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3] Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

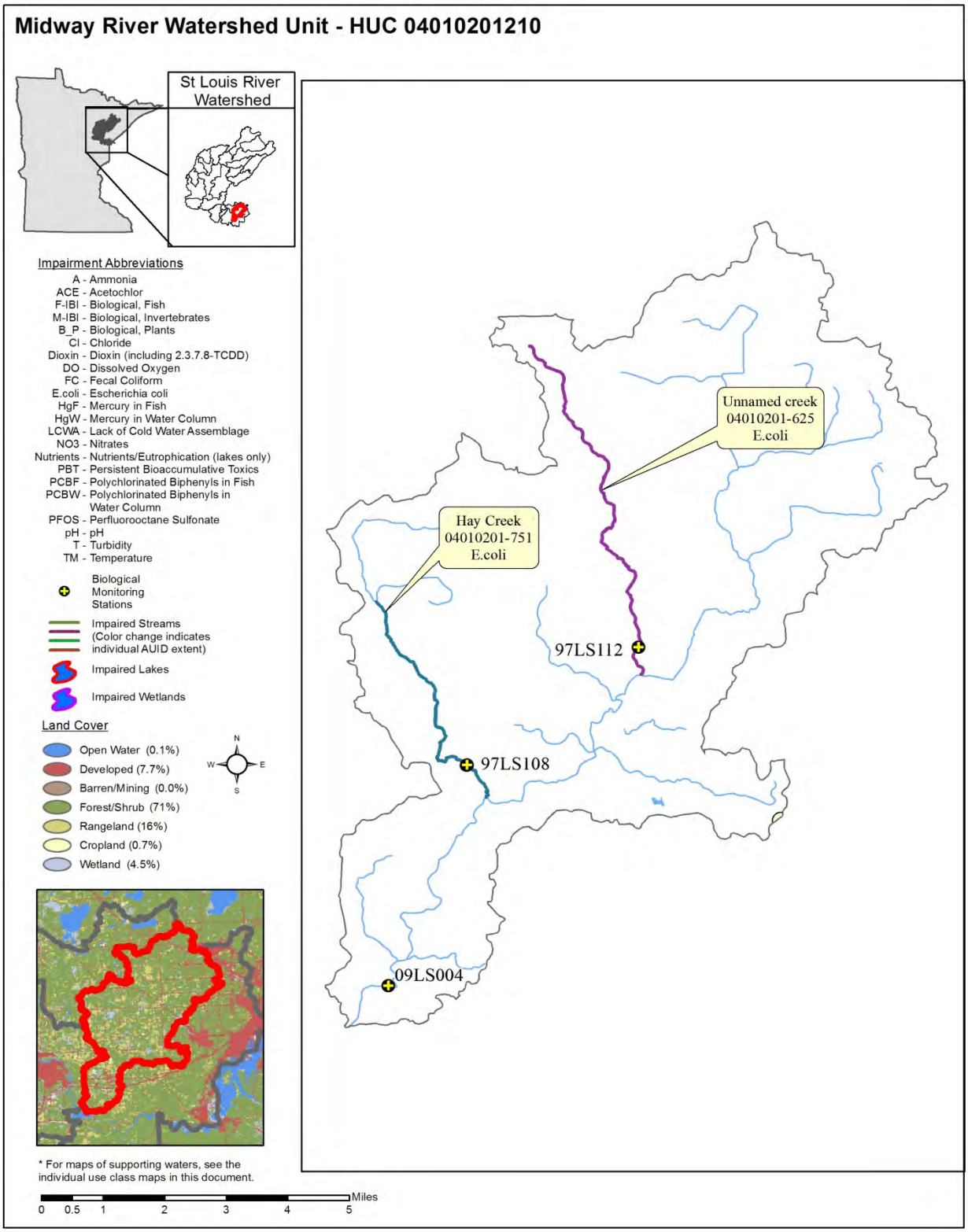

Figure 30. Currently listed impaired waters by parameter and land use in the Midway River Watershed Unit

Summary

The Midway River watershed is a largely undeveloped watershed consisting predominately of forest cover. Three biological stations on three AUIDs were assessed for aquatic life and were all fully supporting. Excellent habitat is present throughout this watershed and is likely contributing to the strong IBI scores. The lowest MSHA score for this watershed is 80, which is still 15 points above average. F- IBI and M-IBI scores were consistently above their upper confidence limits and many intolerant species were present at each site (brook trout, longnose dace, mottled sculpin). However, elevated levels of bacteria occurred on two cold water tributaries to the Midway River at 97LS112 and 97LS108 which both indicate new aquatic recreation impairments.

For most conventional parameters, water quality is good within the Midway River watershed. Nutrients, turbidity, and sediment concentrations are low, and oxygen concentrations were consistently sufficient (> 7 mg/L) to support cold water fisheries. Bacteria levels were periodically elevated during high flow events, with 4 of 32 samples exceeded the maximum E. coli standard of 1260 colonies / 100 mL. However, because geometric mean values were below the standard, the Midway River was determined to be meeting standards for aquatic recreation. Further bacteria monitoring is encouraged to track trends and potential correlations with land use change and stream flow conditions.

This watershed contains just one lake greater than 10 acres, an un-named body of water. It does not have assessment level data.

St. Louis Bay Watershed Unit HUC 04010201220

The St. Louis Bay watershed, located in southeastern St. Louis County, encompasses an area of 91.6 square miles. The St. Louis Bay watershed drains to the St. Louis River from the Thompson Reservoir which then travels 27.5 miles downstream to its confluence with Lake Superior. As such, it is the most developed watershed in the entire St. Louis River watershed with 20.2 percent of the land classified as developed. As discussed in the introduction, large sections of the St. Louis River in this area were heavily impacted from historical industrial activities. Consequently, the St. Louis River from Cloquet to Lake Superior has been designated as an Area of Concern by the International Joint Commission. Pollution remediation and recovery projects are ongoing. The remaining land in the watershed is forested (64.8 percent), range (8.6 percent), surface water (3.1 percent) and wetlands (2.6 percent). Jay Cooke State Park includes portions of the St. Louis River in the upstream portions of the watershed. The cities of Thompson, Wrenshall, Proctor and Duluth are all within the St. Louis Bay watershed.

From the Thompson Reservoir to its confluence with Lake Superior the St. Louis Rive drops 370 feet in 27.5 miles which is one of the highest gradients within Minnesota. Most of this drop occurs in the areas from the Thompson Reservoir to the Fond du Lac Dam. Named tributaries to the St. Louis River within this watershed include Silver Creek, Mission Creek, Sargent Creek, Stewart Creek, Kingsbury Creek, Keene Creek and Miller Creek. The water chemistry monitoring site, and fish contaminants site for the entire watershed is the station 09LS001 on the St. Louis River at the Highway 23 Bridge, near the community of Fond du Lac. Downstream of this location the river can be influenced by seiche effects from currents and wind events off Lake Superior. The Highway 23 monitoring site is also upstream of several small tributary streams mentioned above that flow into St. Louis Bay.

Stream assessments

Table 85. Aquatic lfie and recreation assessments on assessed AUIDs in the St. Louis Bay 11-HUC

AUID *Reach Name* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
04010201-513 **St Louis River** *Fond du Lac Dam to Mission Cr*	1.84	2B	09LS001	Upstream of Hwy 23, 0.5 mi. W of Fond du Lac	MTS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	FS	FS
04010201-567 **Mission Creek** *S5, south line*	6.56	2A	09LS002	Upstream of end of 131st Ave, 0.5 mi. S of Brewer	MTS	-	-	-	-	-	-	-	-	FS	NA
04010201-627 **Keene Creek** *Headwaters to St Louis R*	6.84	2A	95LS028	Upstream of W Skyline Pkwy, 0.5 mi. N of Bayview	MTS	MTS	MTS	MTS	-	MTS	MTS	-	EX	FS	NS

Table 85 (Continued)

04010201-626 **Kingsbury Creek** *Mogie Lk to St Louis R*	6.89	2A	95LS036	Downstream of Point Dr, in Proctor	EXS	EXS	-	IF	MTS	-	MTS	-	IF	NS	IF
04010201-512 **Miller Creek** *Headwaters to Lk Superior*	9.59	2A	09LS003	Upstream of Chambersberg Ave, 4 mi N of Hermantown	MTS	EXP	MTS	IF	EX	MTS	MTS	-	EX	NS	NS
04010201-848 **Sargent Creek** *Headwaters to St Louis R*	6.78	2A	-	-	-	-	-	-	-	-	MTS	-	EX	IF	NS
04010201-884 **Stewart Creek** *T49 R15W S21, west line to St Louis R*	2.8	2A	-	-	-	-	-	-	-	-	MTS	-	EX	IF	NS
04010201-987 **Unnamed Creek** *Unnamed Cr to St Louis R*	1.16	2B	-	-	-	-	IF	MTS	-	MTS	IF	-	EX	IF	NS
04010201-532 **St Louis River** *Mission Cr to Oliver bridge*	4.64	2B	-	-	-	-	-	-	-	-	-	-	MTS	NA	FS
04010201-566 **Silver Creek** *Headwaters to St Louis R*	3.67	2A	-	-	-	-	-	-	-	-	MTS	-	MTS	NA	FS
04010201-640 **Mission Creek** *T48 R15W S8, north line to St Louis R*	0.32	2B	-	-	-	-	-	-	-	-	MTS	-	IF	IF	IF
04010201-533 **St Louis River** *Oliver bridge to Pokegama R*	5.28	2B	-	-	-	-	-	-	-	-	-	-	IF	NA	IF

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
†Reach was assessed based on use class included in Table and existing use class as defined in Minn. R. 7050 is different. The MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 86. Minnesota Stream Habitat Assessment (MSHA) for the St. Louis Bay 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	09LS001	St Louis River	5	13	20	11	28	77	Good
2	09LS002	Mission Creek	5	14	22	12	35	88	Good
1	09LS003	Miller Creek	4	10	18	10	26	67	Good
1	95LS028	Keene Creek	5	15	21	12	35	88	Good
1	95LS036	Kingsbury Creek	2	10	14	5	19	50	Fair
Average Habitat Results: *St Louis Bay 11 HUC Watershed*			4	12	19	10	29	74	Good

Qualitative Habitat Ratings:

Good: MSHA score above the median of the least disturbed sites (≥66)
Fair: MSHA score between the median of the least disturbed sites and the median of the most disturbed sites (45-65)
Poor: MSHA score below the median of the most disturbed sites (≤44)

Table 87. Outlet water chemistry results for the St. Louis Bay 11-HUC

Station location:	Saint Louis River at Hwy 23, 0.5 mi. W. of Fond du Lac
Storet ID:	S000-021
Station #:	09LS001

Parameter	TSS	Turb.[4]	T-tube	D.O.	TP[5]	TKN	Chloro-phyll-a[5]	E. coli	pH	Spec. cond.
Units	mg/l	NTU	cm	mg/l	mg/l	mg/l	ug/l	#/100 ml	SU	uS/cm
# samples	20	19	25	27	20	16	4	14	26	28
Min	1.2	4.6	19	6.7	0.018	0.59	1.2	3	6.7	117
Max	7.6	20.4	110	12.6	0.088	1.12	2.4	730	8.7	265
Mean[1]	4.2	8.9	70	9.4	0.033	0.85	1.9	18	7.8	199
Median	3.9	7.2	70	9.1	0.029	0.81	2.1	13	7.9	196
WQ standard		25	20	5.0	0.055		<10	126/ 1260	6.5-9.0	
# WQ exceedances[2]		0/19	1/25	0/27	2/20		0/4	0/14	0/26	
NLF 75th percentile[3]	5.6	4			0.05	0.18-0.73			7.9	260

[1]Geometric mean of all samples is provided for *E. coli* or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993). TKN range based on EPA Rivers and Streams in Nutrient Ecoregion VIII, NLF and NMW, EPA 822 B-01-015. 2001
[4] Combined data from 3 turbidity methods, each with slightly different standard methods
[5] Proposed TP and Chlorophyll-a standards for the North region of Minnesota, see http://www.pca.state.mn.us/index.php/view-document.html?gid=14947

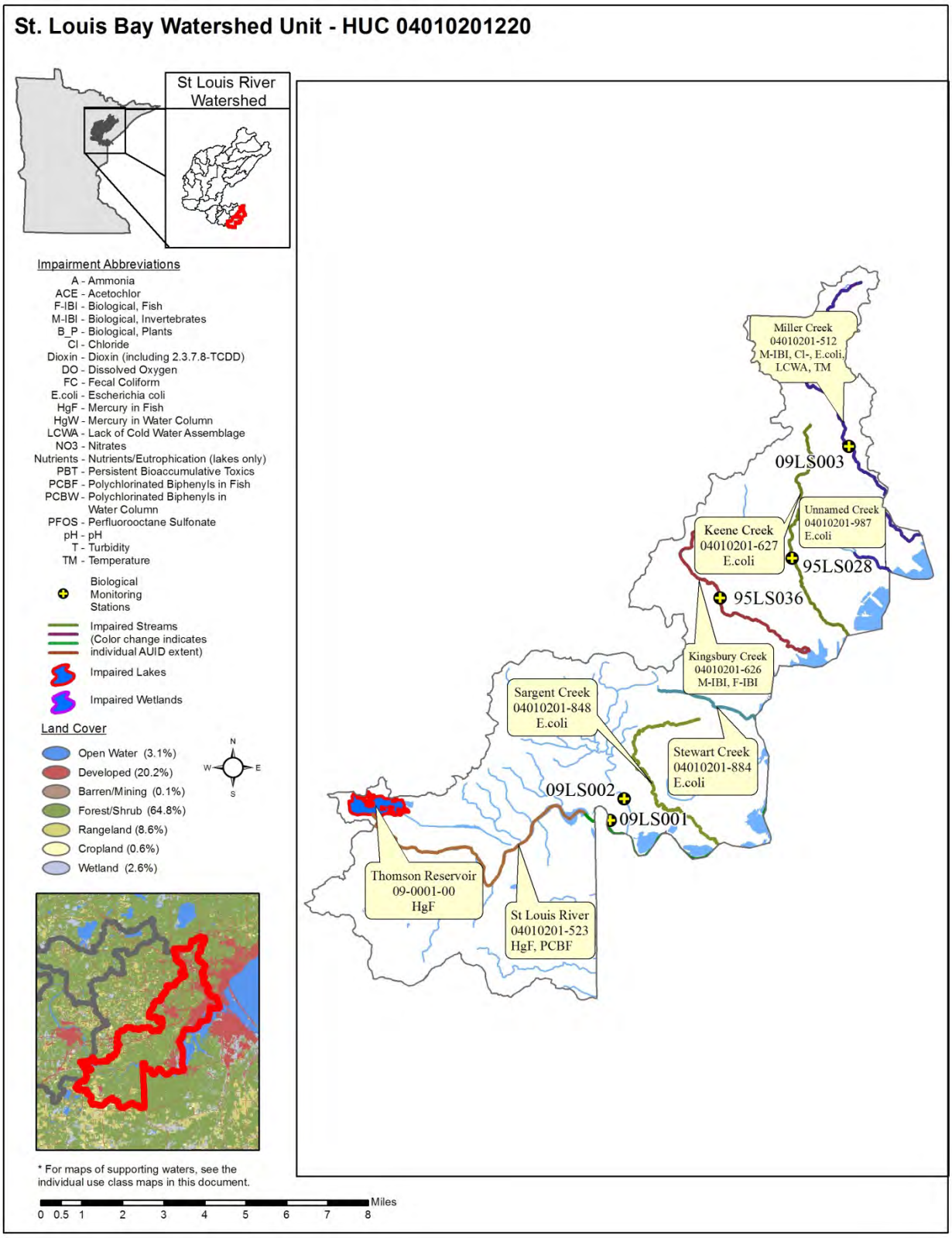

Figure 31. Currently listed impaired waters by parameter and land use in the St. Louis Bay Watershed Unit

Summary

The St. Louis Bay watershed contains the highest percentage of developed land in the St. Louis River watershed. Some of the smaller streams within the watershed flow through a predominantly urban landscape. It is therefore, not surprising that there are a number of identified impairments to aquatic life and aquatic recreation. F-IBI, M-IBI, and habitat scores were quite good in areas with little to moderate development. However, spatial co-occurrence between the more intensive development in the Duluth area and the biological, habitat and water chemistry results, was evident, most notably for small coldwater streams.

The northern and central portions of the watershed are predominantly more developed than the southern portions. Of the five AUIDs assessed for aquatic life, two (Miller and Kingbury Creeks) showed impaired fish and/or invertebrates communites. Both streams are designated cold water and are located in the northern portion of the watershed. Also, both stations on these streams had lower scores for the land use and channel morphology metrics in the MSHA. Miller Creek (09LS003), is currently on the TMDL list for a lack of a cold water assemblage and elevated water temperature. Additionally, elevated levels of bacteria were sampled at numerous tributaries in the Duluth area (Table 86). With large amounts of urban development and high stream gradients, localized pollution sources from storm water runoff are possible explanations for these impairments.

The Highway 23 monitoring site, which represents the outlet for the entire St. Louis River watershed, drains approximately 3,570 square miles (including the Cloquet River watershed). The recent data, overall, indicate good water quality. Sediment, nutrients, and bacteria levels are low, reflective of the large watershed area, and predominately forested land scape (which covers over 60 percent of the land area). Long term data collected at this location from the MPCA's "Milestone" program indicated statistically significant reductions in many conventional parameters (sediment, nutrients, biochemical oxygen demand, and bacteria) since the 1960s, due in large part to improvements in domestic and industrial wastewater treatment.

This watershed contains six lakes greater than 10 acres; notable lakes include Mogie and Thompson Reservoir. No lakes have assessment level data; historical monitoring has taken place on Thompson Reservoir, focusing on toxic chemicals in the bed sediment.

With some exceptions the St. Louis Bay watershed supports aquatic life and aquatic recreational uses. However, there is a well-known and studied legacy of industrial pollution in portions of the St. Louis River estuary which has resulted in diminishment of both recreational opportunities and healthy aquatic communities. The sampling strategy and indicators used in this survey to assess the riverine and lake environments in the St. Louis Bay watershed were not designed to address estuarian habitats. Rather, ongoing monitoring and evaluation of pollutants and their effect on St. Louis River estuary is being accomplished through another extensive monitoring program. For additional information see: *Contaminated Sediment Studies: St. Louis River Area of Concern* (MPCA, 2012) (http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/contaminated-sediments/sediment-studies-st.-louis-river-area-of-concern.html).

VII. Watershed-Wide Results and Discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the St. Louis River, grouped by sampling type. Summaries are provided for aquatic life and recreation uses in streams and lakes throughout the watershed, and for aquatic consumption results and 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 St. Louis River watershed.

Load monitoring

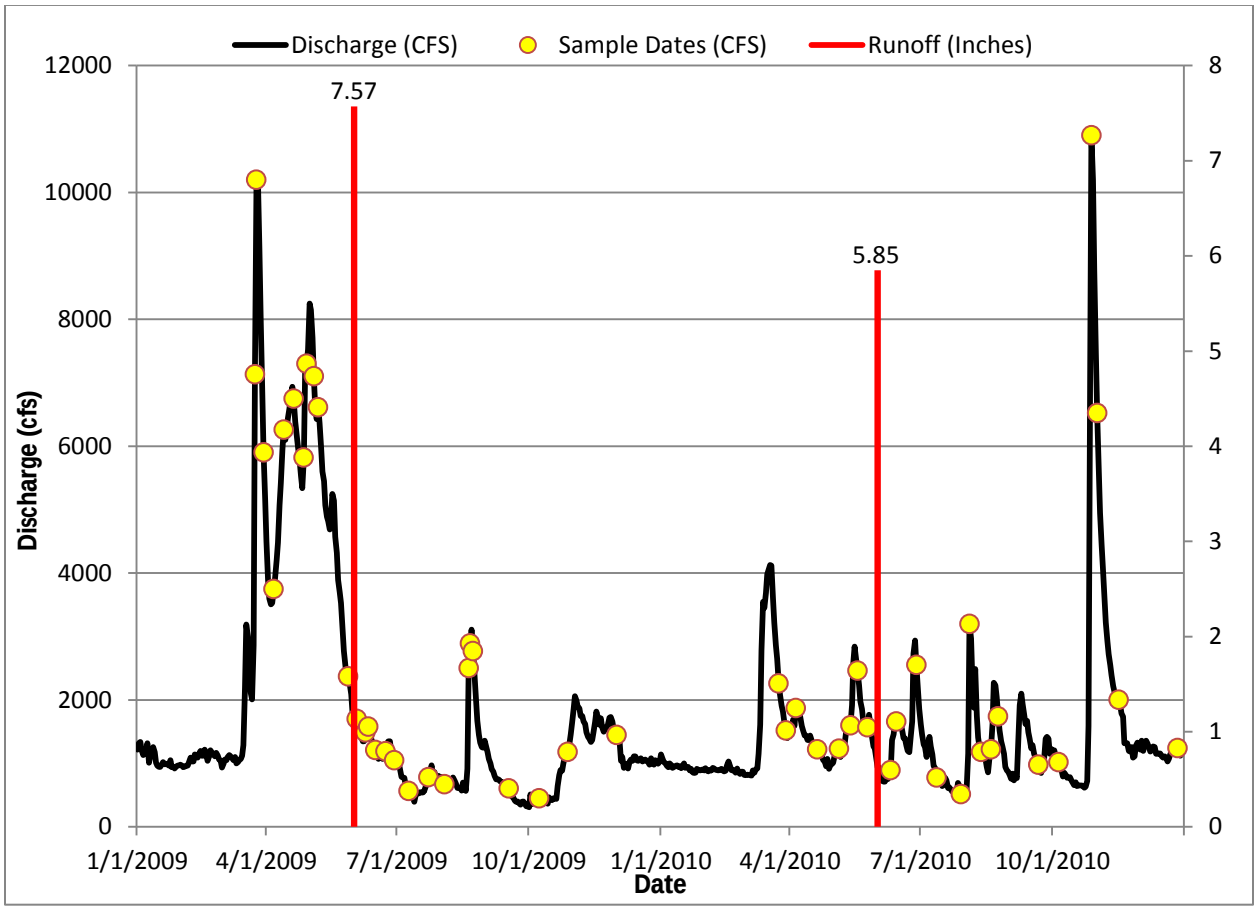

Figure 32. Hydrograph for the St. Louis River 2009-2010

Annual flow weighed mean pollutant concentrations (FWMCs) were calculated and compared for years 2007-2009 (Figures 32-35) and compared to the RNR standards (only Total Phosphorus (TP) and Total Suspended Solids (TSS) draft standards are available for the North RNR). It should be noted that while a FWMC exceeding a given water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10 percent and greater, over the most recent 10-year period and not based on comparisons with FWMCs (MPCA, 2012). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10 percent of the individual samples collected over the assessment period were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other factors. However, as a general rule, 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 diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP) can be attributed to "non-point" as well as "point" or end of pipe sources such as industrial or wastewater treatment plants. Major non-point sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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, for example, will typically be much higher following high intensity rain events prior to canopy development rather than after low intensity post-canopy events where less surface runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in flow weighted mean concentrations (FWMCs) and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated.

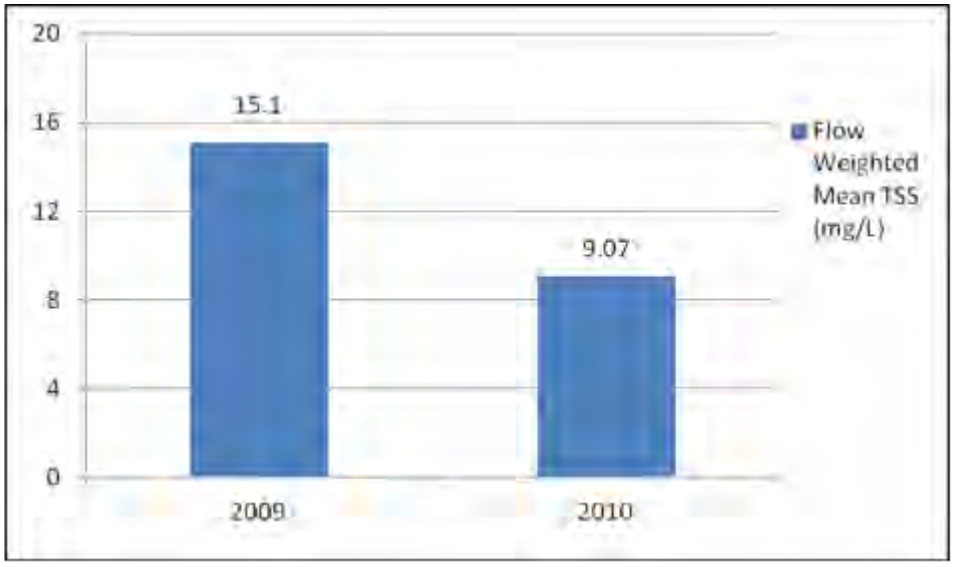

Figure 33. Total Suspended Solids (TSS) flow weighted mean concentrations for the St. Louis River

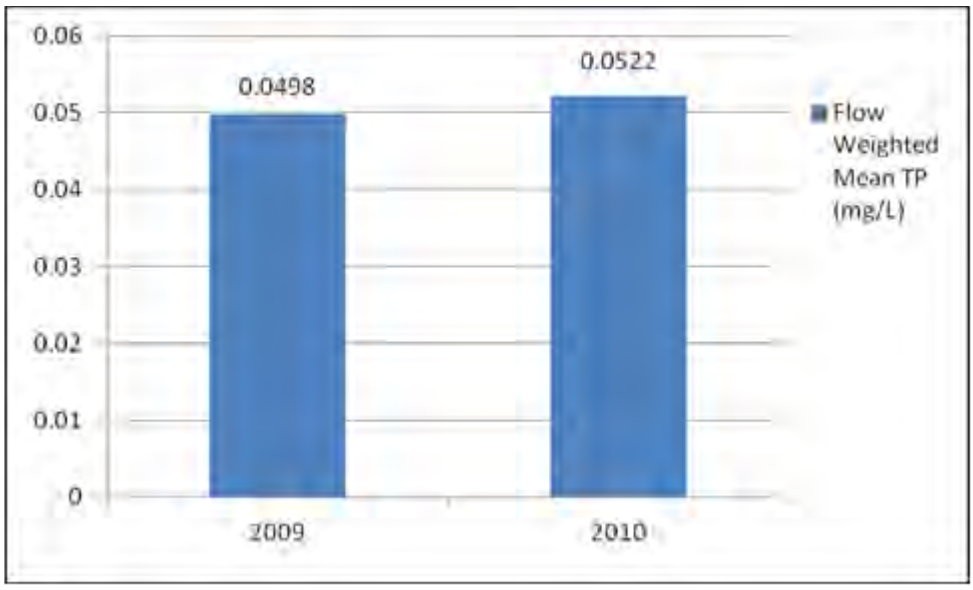

Figure 34. Total Phosphorus (TP) flow weighted mean concentrations for the St. Louis River

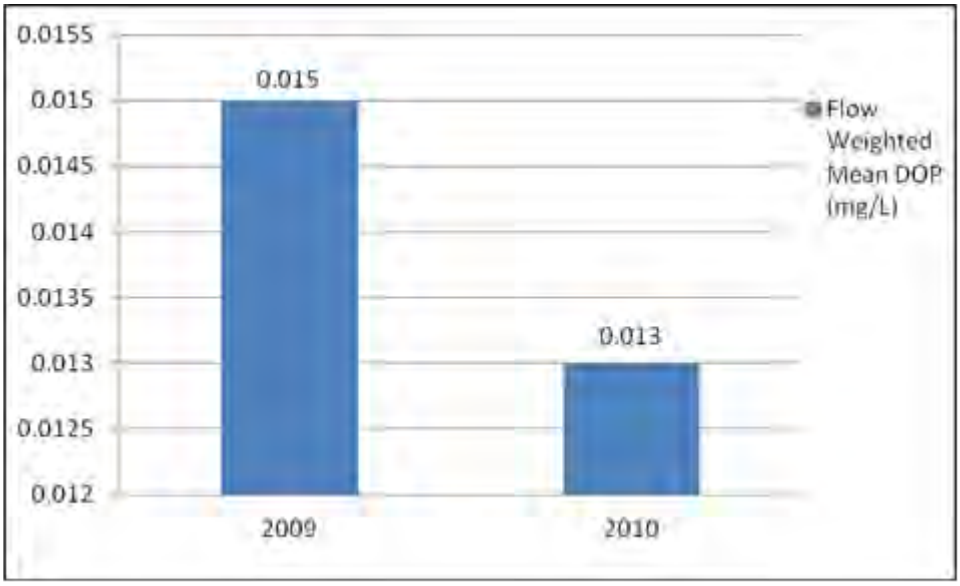

Figure 35. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the St. Louis River

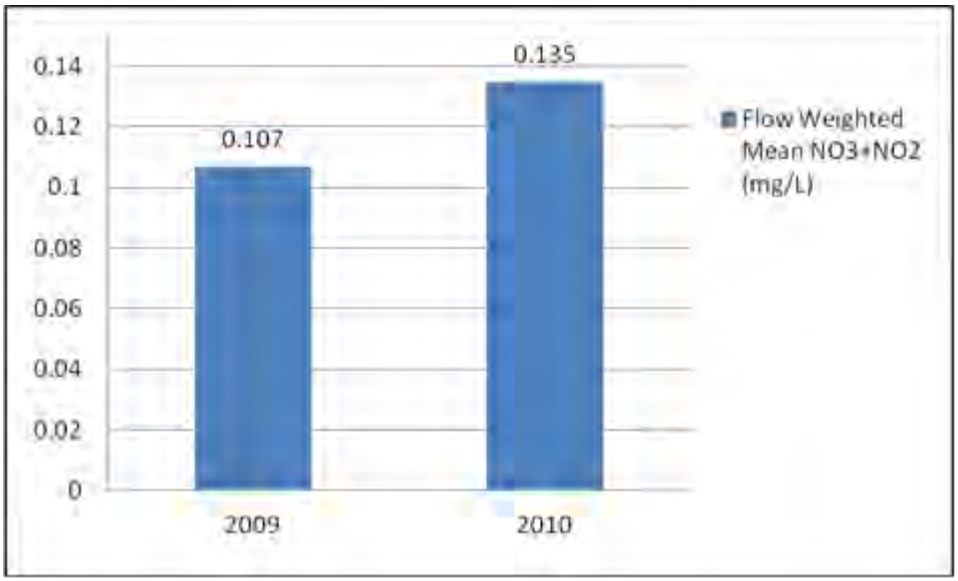

Figure 36. Nitrate + Nitrite Nitrogen (Nitrate-N) flow weighted mean concentrations for the St. Louis River

Table 88. Annual pollutant loads by parameter calculated for the St. Louis River

	2009		2010	
Parameter	**Mass (kg)**	**FWM (mg/L)**	**Mass (kg)**	**FWM (mg/L)**
Total Suspended Solids	25,752,937	15.1	11,975,117	9.07
Total Phosphorus	84,993	0.0498	68,883	0.0522
Othro Phorphorus	17,913	0.0105	17,195	0.013
Nitrate + Nitrite Nitrogen	182,708	0.107	6,377,309	0.135
Annual Volume	1,383,880 acre feet		1,070,660 acre feet	

Total Suspended Solids

Water clarity refers to the transparency of water. 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. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

Analysis has shown a strong correlation to exist between the measures of TSS and turbidity. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. High turbidity results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae species (MPCA and MSUM, 2009). An overabundance of algae can lead to increases in turbidity, further compounding the problem. Periods of high turbidity often occur when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles and overland flow transports fine particles of silt and clay into rivers and streams (MPCA and MSUM, 2009). Scouring of streambanks due to increased flows also increases turbidity.

Currently, the State of Minnesota's TSS standards are not fully approved and must be considered to be draft standards until the process is complete. Within the North River Nutrient Region (RNR), the TSS draft standard is 15 mg/L (MPCA 2010c), when greater than 10 percent of the individual samples exceed the draft standard, the river is out of compliance. Calculations from 2009 and 2010 show 21 and 9 percent of the individual samples exceeded the 15 mg/L draft standard, respectively. In addition, the

computed FWMC's for 2010 slightly exceeded the 15 mg/L draft standard, with a FWMC of 15.1 mg/L. The spring flows varied greatly for the 2009 and 2010 sampling period, high flows throughout the spring 2009 lead to higher TSS concentrations. Because of the strong correlation that often exists between pollutant loads and annual discharge volume, annual variability in pollutant loads can often be attributed to differences in annual runoff (Figure 32).

Total Phosphorus

Nitrogen, phosphorus, and potassium are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension, 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels over stimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality from over stimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension, 1999). Elevated levels of phosphorus in rivers and streams 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 (University of Missouri Extension, 1999). In non-point source dominated watersheds, total phosphorus (TP) concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

TP standards for Minnesota's rivers are also in the final approval phase and must be considered draft standards until final approval. Within the North RNR, the TP draft standard is 0.055 mg/L as a summer average. Summer average violations of one or more "response" variables (pH, biological oxygen demand (BOD), dissolved oxygen flux, or chlorophyll-a) must also occur along with the TP numeric violation for the water to be listed as impaired. In comparison of the data collected from June through September from 2009 to 2010, TP exceedences occurred 0 percent and 40 percent, respectively. Although there were exceedences to the draft standard, only 2010, had summer means greater than the draft standard (0.071 mg/L). Figure 33 illustrates FWMCs less than the draft standard for both 2009 and 2010 (0.049 and 0.052 mg/L), albeit this includes all data throughout the year, not just summer values. The higher summer concentrations are likely due to more rain events in early summer 2010.

Dissolved Orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available for plant uptake (MPCA and MSUM, 2009). 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 run-off. The DOP: TP ratios of FWMCs from the 2009 and 2010 years were 30 percent and 25 percent, respectively.

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, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA, 2008). 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, 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.

Nitrate-nitrogen can also be a common toxicant to aquatic organisms in Minnesota's surface waters, with invertebrates appearing to be the most sensitive to nitrate toxicity. Draft nitrate-N standards have been proposed for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a one-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a four-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate-N (four-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA, 2010).

Figure 35 shows the nitrate-N levels over the two-year period for the St. Louis River monitoring site. The FWMCs of nitrate-nitrogen for the two years were well below the acute and chronic nitrate-N standards. In 2010 there was one exceedence of the draft chronic standard which occurred during a period of poor, stagnant water quality.

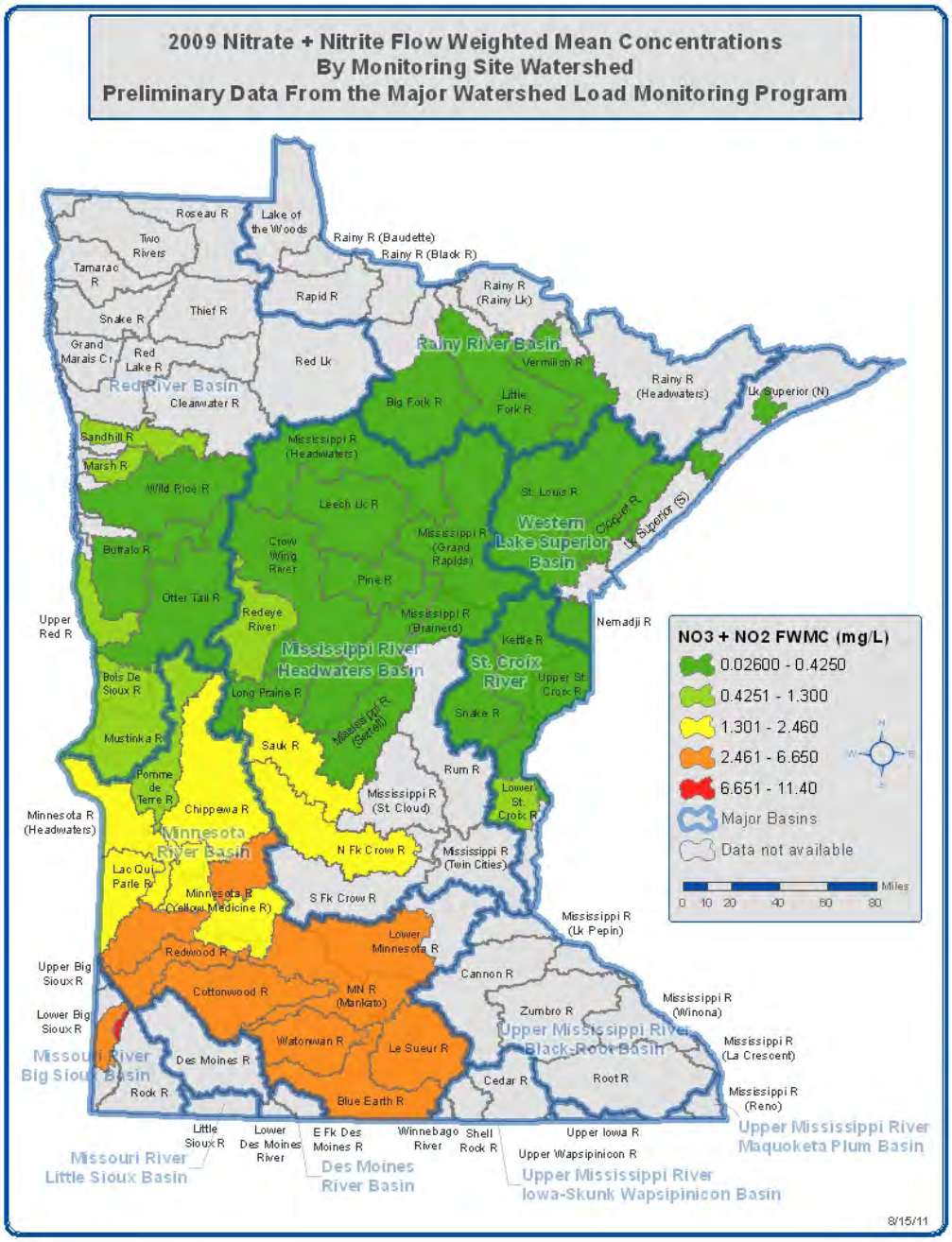

Figure 37. Nitrate - Nitrogen flow weighted mean concentrations for watershed throughout Minnesota, 2008

Stream water quality

Overall, water quality conditions are good, and reflect the forests and wetlands that dominate landcover within the St. Louis watershed. In 2009 the TSS and turbidity levels were elevated during the spring runoff. High concentrations are relatively normal during the spring runoff due to snowmelt and overland flow that picks up sediment and nutrients. The mean annual discharge for the St. Louis River at Scanlon is approximately 2,300 cfs; in 2009 the mean annual discharge was 3390 cfs, an above average (wetter) year, which could be the main contributor to the high TSS concentrations. Sources of the sediment and turbidity are numerous, and are a function of the watershed's geologic setting, the river's geomorphology, and current and historical landuse. The sampling location just below the Scanlon Dam, is situated between two dams upstream and two dams downstream.

Lake water quality

The distribution of lakes throughout the St. Louis River watershed varies greatly from just one lake in the Midway River watershed to 72 in the Upper St. Louis. Although the St. Louis River watershed has a fair number of lakes overall (352 greater than 10 acres), there are relatively few large lakes- those greater than 500 acres. Whiteface Reservoir, managed by Minnesota Power as a hydro power storage reservoir, is the largest at 3,592 acres. Other large and notable lakes include Seven Beaver, Big, West Two Rivers Reservoir, and Colby. A total of 54 lakes have been recently monitored and 25 of these have sufficient data for an assessment. Lake assessment monitoring within the watershed was done primarily in 2009-2010 by a mix of MPCA staff, Surface Water Assessment Grantees such as the University of Minnesota Duluth, and citizen volunteers.

A total of 18 lakes met eutrophication standards for warm water lakes in the Northern Lakes and Forest ecoregion. In these lakes, total phosphorus and chlorophyll-a concentrations are within the expected range given the area's forest and wetland dominated landscape. A total of seven lakes did not meet eutrophication standards, and were placed on the list of impaired waters. These lakes tended to be shallow and drain large, wetland dominated watersheds; or they have a range of anthropogenic impacts in their headwaters- such as treated domestic wastewater discharges, or iron mining which collectively may be factors in their relatively poor water quality. Lakes listed as impaired prompt an investigative study termed a Total Maximum Daily Load (TMDL) to determine the sources and magnitude of the pollution problem and to set pollutant reduction goals needed to restore the waters.

Biological Monitoring

Fish

The Minnesota portion of the Lake Superior Basin encompasses 6,200 miles^2 stretching across seven counties in Northeastern Minnesota. The St. Louis River watershed makes up over half of this area (3,584 miles^2). Historically, fisheries management in streams of this region has focused on stocking of various trout species. Brook trout were not native to the St. Louis River above the Fond du Lac Falls prior to 1894 (Smith and Moyle 1944). From 1894 through 1946, brook trout were stocked into 62 St. Louis River tributaries. Throughout those years, European brown and western rainbow trout were also periodically introduced into streams across the watershed. The first comprehensive investigation of the stocking success was completed in 1947 by Moyle and Kenyon which documented the cold water fisheries resources in the watershed. This study, unfortunately, did not include the warm water systems.

The St. Louis River watershed does not have any species of special concern but is susceptible to aquatic invasive species with its proximity to the Duluth Harbor. Lake Superior and the St. Louis River estuary are the home to many invasive species such as Eurasian ruffe, round goby, zebra mussels, quagga mussels

and spiny water flea. Most recently, viral hemorrhagic septicemia (VHS), a microscopic fish disease was discovered in Lake Superior in 2010.

There have been 88 fish species documented in the Lake Superior Basin (including Lake Superior). During the Intensive Watershed Monitoring effort in the St. Louis watershed, the MPCA's Biological Monitoring Unit collected 51 of those species (Appendix 10). Species richness varied greatly depending on site location. Some stations had high densities of intolerant species while others lacked species diversity and were dominated by tolerant species and/or low species richness. These variations are noticeable when looking at the scattered impairments throughout the watershed. The most commonly sampled species sampled in the watershed was white sucker, which was found at 115 sites. A number of species were only sampled at one site and totaled only one individual such as longnose sucker, emerald shiner, brown bullhead and freshwater drum. Of the popular species targeted by anglers, smallmouth bass had the highest number of individuals sampled with 612 followed by northern pike (138), brook trout (113) and walleye (24).

Macroinvertebrates

Invertebrate species found within the St. Louis River watershed ranged from tolerant to intolerant for levels of pollutants or impairments. Although the sampling techniques used to collect the invertebrates remained consistent throughout the watershed, the habitat sampled varied significantly depending on the type of stream. Given the large variation of in-stream habitat, samples were taken from wood, rock, bank and mid channel vegetation. The most common habitats sampled were wood and rock.

Overall there were 124 invertebrate families found in the watershed. The most commonly sampled invertebrate family was Hyalellidae, a rather tolerant species, consisting of 10.17 million individuals. Other commonly found families were Chironomidae and Physidae, totaling approximately 16.3 million individuals. In contrast, many invertebrate families had less than 300 individuals sampled throughout the watershed. Some examples include Tipulidae, Tanyderidae and Staphylinidae and Tabanidae. Similar to the fish species sampled, the distribution of invertebrates was very site specific.

Fish Contaminants

According to MPCA's 2012 draft Impaired Waters Inventory (http://www.pca.state.mn.us/enzq94b), the St. Louis River and Bay has 24 AUIDs listed as impaired for mercury in fish tissue; three of the AUIDs are in the St. Louis Bay (Table 90). Six of the AUIDs are impaired for mercury in the water column as well. The water quality standard for the Lake Superior basin is 1.3 ng/L for total unfiltered mercury. Ten AUIDs are impaired for PCBs in fish tissue. Five AUIDs are impaired for PCBs in the water column, as well as DDT and Dieldrin. The three AUIDs in the Bay also are impaired for Dioxin and Toxaphene. Whiteface River is the only tributary to the St. Louis River with data on mercury in fish and its three AUIDs are included in the Impaired Waters Inventory for mercury in fish tissue (but none of the other pollutants).

A summary of descriptive statistics for mercury and PCBs by fish species and year for lakes (Table 91) include the 90th percentiles of mercury concentration. Waterways impaired for mercury in fish tissue are marked with a red asterisk (*) and those impaired for PCBs in fish tissue are marked with a red tilde (~). Of the 43 lakes with fish contaminant data, only four lakes are not listed as impaired for mercury in fish tissue. A review of the results in Table 90 for these four lakes suggests all of them are most likely impaired for mercury, too. A minimum of five fish in a species is required for assessment of impairment. Perch Lake (09003600) and Moberg Lake (69084700) only had two northern pike tested in 2000 and 2001, respectively. The two fish in Perch Lake were at the impairment threshold of 0.2 mg/Kg, whereas the two fish from Moberg Lake were well above the threshold. Big Lake near Cloquet (09005000) had six northern pike in three composite samples, which could qualify for the minimum sample size; however, the fish were collected in 1988. Assessments for the 2008 impaired waters list used data since 1990 and more recent assessments are using the last 10 years of data. Similarly, Forsyth Pit (69130300) had

sufficient sample size for the rainbow trout tested (eight fish in five composites), but were collected in 1987. All four lakes should be tested again for mercury in fish tissue**.**

One lake is impaired for PCB in fish tissue and none of the lakes are impaired for the other pollutants. Golf Course Pond in Duluth, also known as Upper Twin Pond, was the only lake impaired for PCBs in fish tissue; the mean PCB concentration in two brown trout collected in 1993 was 0.235 mg/Kg. However, rainbow trout were tested from the pond in 2008—the only species tested—and found to have PCBs less than the reporting limit of 0.025 mg/Kg. Golf Course Pond should be tested again for PCBs with an emphasis on collecting brown trout.

A summary of descriptive statistics for mercury and PCBs by fish species and year for rivers (Table 92) follows the same format as Table 91. Impairments caused by fish contaminants are usually applied to all river AUIDs where fish could potentially swim from the collection site. The St. Louis River is divided into "Above Cloquet," "Cloquet to Fond du Lac Dam," and "Fond du Lac Dam to Lake Superior." The latter is commonly referred to as the St. Louis River Estuary. Multiple fish species have been tested for mercury in all reaches of the St. Louis River since 1971. Fish collected since 2000 indicate the river remains impaired due to elevated levels of mercury in fish tissue. From the 2005 collection, channel catfish had the highest concentrations in the Above Cloquet reach, whereas downstream catfish were not collected. Below Cloquet, walleye and smallmouth bass had the highest mercury concentrations. The mercury concentrations were sufficiently high (90^{th} percentile > 0.57 mg/Kg) that the St. Louis River was excluded from the Statewide Mercury TMDL and it remains on the 303d list for waters needing a TMDL. The MDNR will be collecting fish in the bay in 2012, which will be tested for at least mercury and PCBs and possibly the other contaminants that are identified in the Impaired Waters Inventory.

Impairment assessments for PCBs (and PFOS discussed below) in fish tissue are based on the MDH's fish consumption advisories and are considered impaired when the advisory is more restrictive than a meal per week. The fish consumption advisories use either a linear regression of concentration and fish total length or arithmetic mean concentrations when the sample size is not sufficient for a regression. The regression is applied for mercury and PCBs but not PFOS because PFOS has not been shown to increase with fish age or size. There is no minimum sample size required for fish consumption advisories; therefore a single fish exceeding the threshold for a meal per month is adequate for a determination of impairment for PCBs or PFOS in fish tissue.

As mentioned above, the lower 10 AUIDs of the St. Louis River/Bay are impaired for PCB in fish tissue. These AUIDs represent the lower two reaches below Cloquet. Above the Fond du Lac Dam, the PCB impairment was caused by two common carp collected in 1983. Below the Fond du Lac Dam, the PCB impairments resulted from multiple fish species having PCB concentrations above the impairment threshold. Most of fish with high PCB concentrations were collected and tested in the early 1980s. The highest PCB concentration, 3.60 mg/Kg, was in a walleye collected in 1982. The next highest PCB concentration, 2.34 mg/Kg, was a common carp collected in 1986. Walleye have been tested in seven years since 1982 and remained below the impairment threshold since 1986. Nevertheless, the last testing of walleye for PCBs in 2004 (n = 7) had concentrations ranging from 0.12 mg/Kg to 0.27 mg/Kg, indicating PCB concentrations have not fallen below the detectable level. Northern pike and white sucker are two other species that had high PCB concentrations in the early 1980s but have since shown a sharp drop in concentrations. The last testing of carp for PCBs below the Fond du Lac Dam was in 2002. The mean of two fish was 0.245 mg/Kg (average of 0.09 and 0.40 mg/Kg). Thus, the PCB concentration in carp appears to have dropped by 10-fold, but remains above the impairment threshold.

Perfluorooctane sulfonate (PFOS) results are presented in Table 93 for the four lakes and the St. Louis River Estuary. Mean PFOS concentrations for a fish species must exceed 200 ng/g to be classified as impaired for PFOS in fish tissue. Samples of bluegill in Embarrass (69049300) and Strand (69052900) lakes and black crappie in Whiteface Reservoir (69037500) collected in 2007 were very low in PFOS. Similarly, those two species and walleye tested in the St. Louis River Estuary in 2010 had detectable but

low PFOS concentrations. Mean PFOS concentrations exceed 40 ng/g are given a consumption advisory of one meal per week and the tested fish in the St. Louis River Estuary fell below that threshold. In contrast, Fish Lake Flowage, tested in 2008 and 2010, had five fish species with mean PFOS concentrations that exceeded the one meal per week threshold; however, none of them exceeded the 200 ng/g (one meal per month) threshold that would have classified them as impaired.

Overall, mercury clearly remains a major concern for fish consumption throughout the St. Louis River and most of the lakes within the watershed. PCBs remain a concern for the St. Louis River below Cloquet. From the limited testing of PFOS in fish tissue, Fish Lake Flowage appears to be contaminated and monitoring of fish for PFOS should continue in that reservoir.

Table 89. Aquatic Consumption Impairments for St. Louis River and Whiteface River

Reach name	AUID	Reach Description ['from' - 'to']	Pollutant							
			Mercury in Fish Tissue	Mercury in Water Column	PCB in Fish Tissue	PCB in Water Column	DDT	Dieldrin	Dioxin	Toxa-phene
St Louis River	04010201-631	Headwaters (Seven Beaver Lk 69-0002-00) to T58 R13W S36, west line	1							
	04010201-644	T58 R13W S35, east line to Partridge R	1							
	04010201-526	Partridge R to Embarrass R	1							
	04010201-511	Embarrass R to East Two R	1							
	04010201-554	East Two R to West Two R	1							
	04010201-510	West Two R to Swan R	1							
	04010201-525	Swan R to Whiteface R	1							
	04010201-508	Whiteface R to Floodwood R	1							
	04010201-507	Floodwood R to East Savanna R	1							
	04010201-506	East Savanna R to Artichoke R	1							
	04010201-505	Artichoke R to Stoney Bk	1							
	04010201-504	Stoney Bk to Cloquet R	1							
	04010201-503	Cloquet R to Pine R	1	1						
	04010201-517	Pine R to Knife Dam	1							
	04010201-524	Knife Dam to Potlatch Dam	1		1					
	04010201-	Potlatch Dam to Scanlon Dam	1		1					

	04010201-516									
	04010201-515	Scanlon Dam to Thomson Reservoir	1		1					
	04010201-523	Thomson Reservoir to Fond du Lac Dam	1		1					
	04010201-513	Fond du Lac Dam to Mission Cr	1	1	1	1	1	1		
	04010201-532	Mission Cr to Oliver Bridge	1	1	1	1	1	1		
	04010201-533	Oliver Bridge to Pokegama R	1		1					
St Louis River (St Louis Bay)	04010201-501	Pokegama R to Mouth of St Louis Bay at Blatnik Bridge	1	1	1	1	1	1	1	1
	04010201-530	Mouth of St Louis Bay at Blatnik Bridge to Duluth Ship Channel	1	1	1	1	1	1	1	1
	04010201-531	Mouth of St Louis Bay at Blatnik Bridge to Superior Entry	1	1	1	1	1	1	1	1
Whiteface River	04010201-509	Paleface R to St Louis R	1							
	04010201-528	Bug Cr to Paleface R	1							
	04010201-529	Whiteface Reservoir to Bug Cr	1							
		TOTAL AUIDS:	27	6	10	5	5	5	3	3

Table 90. Summary of fish length mercury and PCBs by waterway, species, and year for lakes in the St. Louis River Watershed

					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
BIG *	09003200	Black crappie	2008	10	2	10.0	8.3	11.6	0.352	0.352	0.416	0.287	0.416				
		Northern pike	1984	6	2	23.4	18.8	28.0	0.440	0.440	0.570	0.310	0.570	1	< 0.05		
			1987	5	1	22.6			0.270					1	< 0.01		
			2008	8	8	23.2	22.0	24.3	0.445	0.437	0.536	0.337	0.550				
		Walleye	1984	4	3	20.1	17.1	23.0	0.537	0.660	0.680	0.270	0.680	1	< 0.05		
			1987	5	1	18.9			0.540					1	< 0.01		
			2008	7	7	21.2	18.2	25.0	0.745	0.775	1.126	0.268	1.156				
PERCH	09003600	Northern pike	2000	2	2	20.9	18.5	23.2	0.200	0.200	0.200	0.200	0.200				
BEAUTY *	31002800	Black crappie	1998	8	1	9.1			0.080								
		Northern pike	1985	8	2	16.4	16.3	16.5	0.320	0.320	0.340	0.300	0.340				
		Walleye	1998	10	10	17.1	14.1	22.4	0.269	0.200	0.560	0.170	0.570				
		White sucker	1998	6	1	18.3			0.040								
PINE *	69000100	Bluegill sunfish	1992	9	1	6.8			0.120								
		Northern pike	1992	24	4	24.7	18.6	31.0	0.370	0.360	0.460	0.300	0.460	1	0.013		
			2007	24	24	22.8	18.9	28.7	0.505	0.471	0.750	0.284	0.891				
		Walleye	1992	16	3	17.4	13.4	21.7	0.467	0.460	0.590	0.350	0.590	1	< 0.01		
		White sucker	1992	3	1	16.8			0.130					1	< 0.01		
		Yellow perch	2007	12	3	5.7	5.5	6.0	0.049	0.054	0.055	0.038	0.055				
SEVEN BEAVER *	69000200	Northern pike	1992	12	2	19.5	17.0	21.9	0.355	0.355	0.400	0.310	0.400	1	< 0.01		
		Walleye	1992	16	2	14.8	12.7	16.9	0.355	0.355	0.440	0.270	0.440	1	< 0.01		
		White sucker	1992	15	2	14.9	12.9	16.8	0.120	0.120	0.140	0.100	0.140	1	< 0.01		
		Yellow perch	1992	8	1	9.9			0.230								
BIG	69005000	Northern pike	1988	6	3	23.0	19.1	27.7	0.373	0.420	0.480	0.220	0.480				
CADOTTE *	69011400	Walleye	1992	11	3	18.0	13.8	23.7	0.580	0.480	1.000	0.260	1.000	1	< 0.01		
		White sucker	1992	6	2	18.7	17.2	20.2	0.099	0.099	0.110	0.088	0.110	1	< 0.01		
		Yellow perch	1992	10	1	10.3			0.140								
OTTO *	69014400	Northern pike	1992	14	3	22.3	18.0	25.6	0.443	0.350	0.770	0.210	0.770	1	< 0.01		
		White sucker	1992	8	2	19.3	18.0	20.6	0.088	0.088	0.100	0.076	0.100	1	< 0.01		
		Yellow perch	1992	10	1	8.3			0.380								
LINWOOD *	69024800	Black crappie	1991	10	1	9.6			0.073								
		Northern pike	1991	17	4	24.3	17.6	30.6	0.395	0.380	0.650	0.170	0.650	3	< 0.01	< 0.01	< 0.01
		Walleye	1991	14	3	17.1	12.4	20.9	0.580	0.470	0.870	0.400	0.870	2	< 0.01	< 0.01	< 0.01
		White sucker	1991	7	2	14.2	10.0	18.3	0.046	0.046	0.050	0.042	0.050	1	< 0.01		
COLBY *	69024900	Bluegill sunfish	2000	10	1	6.9			0.230								
		Northern pike	1977	20	20	17.4	6.7	21.0	0.482	0.495	0.705	0.090	0.800				
			2000	6	6	25.1	16.9	34.1	0.847	0.800	1.079	0.660	1.090				
		Walleye	2000	6	6	15.3	13.5	17.4	1.038	1.005	1.227	0.860	1.230				
		White sucker	1977	21	21	16.7	13.1	19.6	0.277	0.160	0.590	0.090	0.860				
			2000	9	1	15.1			0.170								
		Yellow perch	1977	25	25	6.1	5.3	8.6	0.338	0.310	0.510	0.150	0.530				

WATERWAY	AUID	Species	Year	N of Fish	Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
					N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
WHITEFACE RESERVOIR *	69037500	Bluegill sunfish	2007	15	15	7.2	4.0	8.9	0.212	0.195	0.392	0.058	0.396				
		Black crappie	2007	15	15	7.1	4.0	11.4	0.153	0.122	0.295	0.063	0.376				
		Northern pike	1984	10	3	23.0	16.9	29.0	1.263	0.680	2.480	0.630	2.480				
			1989	10	3	21.5	16.9	26.6	0.473	0.530	0.590	0.300	0.590				
			1996	17	17	20.0	14.5	35.3	0.429	0.390	0.690	0.210	0.850				
			2001	22	22	21.7	13.9	32.1	0.567	0.484	0.895	0.280	0.959				
			2007	26	26	19.2	10.5	36.7	0.430	0.407	0.601	0.161	1.058				
		Rock bass	2007	6	6	7.0	3.2	9.4	0.396	0.515	0.598	0.087	0.604				
		Walleye	1984	10	6	12.6	9.4	16.6	0.398	0.290	0.714	0.210	0.720				
			1989	8	3	18.3	13.4	25.2	0.957	0.450	2.140	0.280	2.140				
			1991	5	5	14.3	10.3	27.1	0.760	0.360	2.490	0.230	2.490				
			1996	21	21	16.0	10.4	22.3	0.556	0.440	1.070	0.270	1.400				
			2001	26	26	15.4	10.0	24.4	0.542	0.476	0.970	0.217	1.374				
			2007	37	37	12.1	6.9	19.0	0.321	0.300	0.480	0.166	0.622				
		White sucker	1996	5	1	18.8			0.220								
		Yellow perch	1996	10	1	10.1			0.350								
			2007	15	15	8.6	5.4	11.9	0.233	0.237	0.391	0.043	0.656				
WHITEWATER *	69037600	Bluegill sunfish	1997	10	1	6.0			0.041								
			2002	8	1	6.1			0.085								
		Northern pike	1985	11	3	21.7	18.8	25.4	0.323	0.340	0.390	0.240	0.390				
			1997	10	10	19.0	16.1	20.7	0.227	0.235	0.295	0.120	0.300	1	< 0.01		
			2002	8	8	20.8	17.5	22.7	0.349	0.359	0.436	0.262	0.455				
			2007	24	24	20.7	12.2	30.0	0.318	0.315	0.428	0.192	0.503				
		Walleye	1985	14	3	16.9	13.9	20.5	0.430	0.320	0.690	0.280	0.690				
			1997	10	10	16.6	13.2	18.9	0.240	0.235	0.350	0.130	0.350	1	< 0.01		
			2002	8	8	16.7	11.8	20.1	0.503	0.499	0.822	0.273	0.901				
		White sucker	1997	8	1	17.8			0.330					1	< 0.01		
		Yellow perch	2007	10	2	6.1	5.7	6.4	0.146	0.146	0.148	0.143	0.148				
UPPER COMSTOCK *	69041201	Bluegill sunfish	2008	10	1	7.9			0.237								
		Black crappie	2000	10	1	9.1			0.270								
			2008	3	1	9.0			0.194								
		Northern pike	2008	5	5	20.4	15.7	29.5	0.599	0.601	0.689	0.500	0.689				
		Walleye	2000	6	6	17.5	12.6	24.0	1.207	0.990	1.862	0.780	1.870				
			2008	4	4	19.4	14.3	21.8	1.180	1.192	1.576	0.759	1.576				
		White sucker	2000	4	1	18.1			0.210								
		Yellow perch	2008	10	1	7.1			0.242								
LOWER COMSTOCK *	69041202	Black crappie	2000	10	1	9.4			0.250								
		Walleye	2000	7	7	18.2	13.5	25.4	1.054	0.970	1.432	0.900	1.500				
		White sucker	2000	4	1	19.4			0.260	0.260							

WATERWAY	AUID	Species	Year	N of Fish	Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
					N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
NORTH TWIN *	69041900	Bluegill sunfish	1993	8	1	6.3			0.230								
		Black crappie	1999	10	1	9.5			0.280								
		Northern pike	1993	9	2	23.5	17.4	29.5	0.500	0.500	0.500	0.500	0.500	1	< 0.01		
			1999	8	8	20.6	15.7	25.6	0.473	0.400	0.834	0.200	0.870				
		Walleye	1993	7	2	15.8	11.5	20.1	0.915	0.915	1.300	0.530	1.300	1	0.013		
			1999	3	3	19.9	19.0	20.5	0.570	0.580	0.600	0.530	0.600				
		White sucker	1993	8	2	18.0	16.5	19.5	0.270	0.270	0.380	0.160	0.380	1	< 0.01		
			1999	6	1	19.9			0.280					1	< 0.01		
SOUTH TWIN *	69042000	Bluegill sunfish	2003	10	1	7.5			0.109								
		Northern pike	2003	5	5	22.2	15.2	28.9	0.536	0.507	0.763	0.388	0.763				
		Walleye	2003	4	4	14.5	11.7	22.4	0.360	0.285	0.605	0.264	0.605				
LOON *	69042600	Bluegill sunfish	1996	8	1	6.9			0.130								
		Largemouth bass	1996	7	1	14.3			0.410								
		Northern pike	1996	19	7	22.3	14.0	33.9	0.471	0.510	0.822	0.170	0.860	1	< 0.01		
		Walleye	1996	16	5	17.4	12.6	22.0	0.568	0.630	0.770	0.350	0.770				
		White sucker	1996	7	1	16.7			0.051								
WYNNE/SABIN *	69043400	Bluegill sunfish	1996	8	1	8.6			0.480								
		Northern pike	1996	22	4	18.6	14.2	23.0	0.908	0.770	1.500	0.590	1.500				
		Walleye	1996	14	4	17.5	11.7	22.8	1.288	1.270	1.900	0.710	1.900	1	< 0.01		
		White sucker	1996	7	1	17.1			0.430								
SABIN *	69043401	Bluegill sunfish	2006	10	1	6.7			0.192								
		Northern pike	2006	8	8	20.0	15.5	26.8	0.584	0.554	0.775	0.442	0.784				
		Walleye	2006	6	6	17.3	12.9	21.8	1.127	1.222	1.604	0.611	1.624				
WYNNE *	69043402	Bluegill sunfish	2006	10	1	7.9			0.192								
		Cisco	2006	6	1	10.0			0.339								
		Northern pike	2006	5	5	18.3	14.4	22.1	0.582	0.618	0.736	0.354	0.736				
		Walleye	2006	6	6	17.1	12.2	21.5	1.274	1.237	2.030	0.544	2.062				

PIKE *	69049000	Black crappie	1999	4	1	6.4			0.030								
		Walleye	1999	8	8	19.5	15.2	26.3	0.406	0.240	0.888	0.190	0.900	1	0.058		
		White sucker	1999	4	1	18.5			0.100								
EMBARRASS *	69049600	Bluegill sunfish	2007	10	1	7.7			0.129								
		Black crappie	2007	10	1	9.6			0.212								
		Northern pike	1997	10	10	17.5	15.8	18.3	0.343	0.340	0.505	0.130	0.560	1	< 0.01		
			2002	13	13	18.8	13.6	25.0	0.773	0.821	1.116	0.234	1.340				
			2007	24	24	19.5	17.0	25.2	0.350	0.366	0.472	0.159	0.581				
		Walleye	1997	10	10	16.7	12.7	20.5	0.928	0.770	1.450	0.550	1.600	2	< 0.01	< 0.01	< 0.01
		White sucker	1997	8	1	17.0			0.230					1	< 0.01		
		Yellow perch	1997	10	1	9.5			0.330					1	< 0.01		
			2002	10	1	5.6			0.066								
			2007	8	2	9.1	8.0	10.1	0.246	0.246	0.309	0.183	0.309				
					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
STRAND *	69052900	Black crappie	1999	10	1	10.7			0.160								
			2007	8	1	10.4			0.140								
		Walleye	1999	8	8	16.0	12.4	20.5	0.288	0.180	0.676	0.130	0.700	1	< 0.01		
			2007	6	6	18.8	15.0	22.5	0.617	0.607	1.004	0.205	1.014				
		White sucker	2007	5	1	19.8			0.150								
BASS *	69055300	Bluegill sunfish	1998	10	1	6.9			0.080								
		Largemouth bass	1998	2	2	14.4	14.1	14.7	0.195	0.195	0.200	0.190	0.200				
		Northern pike	1998	10	10	25.1	18.9	35.0	0.252	0.205	0.540	0.075	0.660				
		Walleye	1998	10	10	19.6	13.6	26.9	0.282	0.290	0.495	0.096	0.580				
		White sucker	1998	4	1	17.0			0.030								

LOST *	69055600	Bluegill sunfish	1999	10	1	6.0			0.150								
		Northern pike	1999	8	8	21.2	15.1	28.6	0.251	0.255	0.400	0.110	0.400	1	< 0.01		
		White sucker	1999	5	1	19.2			0.100								
COE *	69056200	Bluegill sunfish	2008	4	1	8.5			0.261								
		Black crappie	2008	4	1	8.3			0.137								
		Largemouth bass	2007	5	5	10.8	9.1	12.2	0.455	0.462	0.486	0.413	0.486				
			2008	3	3	11.4	10.3	13.1	0.401	0.387	0.458	0.359	0.458				
		Northern pike	1983	13	3	24.4	19.0	33.0	0.727	0.650	1.000	0.530	1.000				
			1986	9	3	23.3	18.2	29.1	1.500	1.300	2.000	1.200	2.000				
		Yellow perch	2008	10	1	8.3			0.345								
ESQUAGAMA *	69056500	Bluegill sunfish	1999	10	1	7.2			0.140								
		Cisco	1999	4	1	12.4			0.400					1	0.099		
		Northern pike	1999	8	8	24.7	18.8	30.1	0.948	0.915	1.553	0.450	1.610	1	0.024		
		Walleye	1999	8	8	17.8	12.9	24.7	1.199	1.215	2.287	0.410	2.320	1	0.094		
MURPHY *	69064600	Black crappie	1996	10	1	9.8			0.150	0.150							
		Northern pike	1996	16	5	28.0	20.3	37.4	0.348	0.330	0.660	0.150	0.660	1	< 0.01		
		Walleye	1996	4	2	18.8	15.4	22.2	0.300	0.300	0.440	0.160	0.440				
PLEASANT *	69065500	Bluegill sunfish	2003	10	1	6.1			0.125								
		Black crappie	2003	10	1	7.2			0.129								
		Brown bullhead	2003	5	1	11.5			0.337	0.337							
		Northern pike	2003	5	5	22.4	18.6	25.7	0.308	0.262	0.532	0.168	0.532				
		Walleye	2003	5	5	15.9	11.6	20.5	0.370	0.333	0.784	0.116	0.784				
		Yellow bullhead	2003	1	1	12.9			0.342								

ELY *	69066000	Bluegill sunfish	1996	10	1	7.4			0.160									
		Northern pike	1996	22	4	28.0	22.7	34.2	0.428	0.375	0.650	0.310	0.650					
		Walleye	1996	22	4	20.7	14.2	27.9	0.608	0.710	0.770	0.240	0.770	1	< 0.01			
		White sucker	1996	2	1	19.1			0.058									

					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)				
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max	
SILVER *	69066200	Bluegill sunfish	1994	10	1	7.1			0.210									
			2003	10	1	6.7			0.284									
		Black crappie	1994	8	1	8.4			0.220									
			2003	9	1	7.4			0.293									
VIRGINIA *	69066300	Bluegill sunfish	1994	14	2	6.9	6.7	7.0	0.280	0.280	0.320	0.240	0.320					
DEEP *	69066600	Bluegill sunfish	1998	10	1	6.7			0.076									
		Northern pike	1998	3	3	30.2	26.0	36.9	0.357	0.390	0.470	0.210	0.470					
		Walleye	1998	3	3	22.2	18.0	27.4	0.440	0.570	0.630	0.120	0.630					
		White sucker	1998	6	1	13.6			0.026									
ELBOW *	69071700	Largemouth bass	2007	8	8	12.0	10.6	16.5	0.419	0.375	0.848	0.189	1.009					
		Northern pike	1988	14	5	24.1	18.5	29.2	0.594	0.560	0.750	0.460	0.750	5	< 0.01	< 0.01	< 0.01	
MASHKENODE *	69072500	Bluegill sunfish	2001	15	1	7.1			0.093									
		Black crappie	2001	10	1	9.0			0.362									
		Northern pike	2001	8	8	26.7	18.6	33.4	0.302	0.288	0.359	0.252	0.361	1	0.02			
		White sucker	2001	6	1	15.7			0.058									
SIX MILE *	69084000	Bluegill sunfish	1990	2	1	6.7			0.056					1	< 0.01			
		Black crappie	1990	3	1	9.2			0.150					1	< 0.01			
		Northern pike	1990	16	3	22.0	17.6	25.9	0.327	0.340	0.420	0.220	0.420	3	0.0107	< 0.01	0.011	
		White sucker	1990	9	2	14.6	13.4	15.8	0.047	0.047	0.053	0.040	0.053	2	< 0.01	< 0.01	< 0.01	
MOBERG	69084700	Northern pike	2001	2	2	22.5	19.8	25.1	0.305	0.305	0.357	0.252	0.357	1	< 0.01			

LONGYEAR *	69085700 (includes North Bay (-01) and South Bay (-02)	Northern pike	1986	11	3	25.4	23.9	26.2	0.357	0.360	0.370	0.340	0.370				
			1990	3	2	20.5	19.1	21.8	0.234	0.234	0.380	0.087	0.380	2	0.052	0.017	0.087
		Walleye	1986	2	1	19.8			0.380								
			1990	9	2	14.3	12.9	15.7	0.195	0.195	0.220	0.170	0.220	2	0.026	0.014	0.038
		White sucker	1990	12	2	14.4	13.4	15.4	0.045	0.045	0.060	0.029	0.060	2	0.068	0.046	0.09
		Yellow perch	1990	8	1	6.3			0.066					1	< 0.01		
KELLY *	69090100	Black crappie	1993	10	1	6.3			0.079								
		Northern pike	1989	3	1	17.8			0.082					1	0.076		
			1993	2	2	25.6	23.0	28.1	0.220	0.220	0.300	0.140	0.300	2	0.0565	0.013	0.1
		Walleye	1993	4	1	10.9			0.160								
		White sucker	1989	6	1	14.9			0.047					1	0.100		
			1993	4	1	17.7			0.057					1	0.039		
WEST TWO RIVERS RES. *	69099400	Black crappie	2005	9	1	6.5			0.185								
		Brown bullhead	1991	8	1	10.2			0.084					1	0.014		
			2005	10	1	10.6			0.092								
		Northern pike	1991	11	4	24.8	17.5	30.5	0.190	0.185	0.280	0.110	0.280	3	0.011	< 0.01	0.013
			2005	10	10	23.0	16.5	32.5	0.259	0.259	0.450	0.091	0.562				
FORSYTH PIT	69130300	Rainbow trout	1987	8	5	12.5	11.5	13.5	0.326	0.140	0.740	0.071	0.740	1	0.053		

					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
GILBERT PIT *	69130600	Bluegill sunfish	1990	6	1	6.5			0.120					1	< 0.01		
		Northern pike	1990	2	1	34.0			0.230					1	0.048		
		Rainbow trout	1990	5	1	11.9			0.041					1	0.039		
		Splake	1990	2	1	11.5			0.041					1	0.021		
		Walleye	1990	10	3	17.3	14.2	21.7	0.223	0.230	0.270	0.170	0.270	3	0.0137	< 0.01	0.02
		White sucker	1990	8	1	12.7			0.100					1	< 0.01		
GOLF COURSE (UPPER TWIN) POND * ~	69134500	Brown trout	1993	2	2	16.3	13.2	19.4	0.585	0.585	0.780	0.390	0.780	2	0.235	0.17	0.3
		Channel catfish	1993	1	1	9.3			0.180					1	0.130		
		Rainbow trout	1993	3	1	9.8			0.072					1	0.072		
			2008	8	8	11.8	10.1	14.0	0.078	0.077	0.090	0.065	0.091	2	< 0.025	< 0.025	< 0.025
		White sucker	1993	9	1	9.6			0.220					1	0.024		

***** Impaired for mercury in fish tissue

~ Impaired for PCBs in fish tissue

Table 91. Summary of fish length, mercury, and PCBs in St. Louis River and Whiteface River

ST. LOUIS R. *	Above Cloquet: 04010201-517, -503, -504, -505, -506, -507, -508, -525, -510, -554, -511, -526, -644, -631	Bluegill sunfish	1975	4	4	7.0	6.5	7.5	0.130	0.125	0.190	0.080	0.190				
		Black crappie	1975	3	2	6.0	4.4	7.5	0.175	0.175	0.210	0.140	0.210				
		Channel catfish	1976	1	1	17.0			0.250	0.250							
			1978	2	1	14.8			0.140	0.140				1	0.130		
			1979	23	2	16.8	13.2	20.4	0.515	0.515	0.610	0.420	0.610				
			1992	22	6	17.4	12.7	21.3	0.422	0.320	0.709	0.260	0.720	6	0.034	0.01	0.077
			2000	13	13	18.5	13.8	29.1	0.352	0.350	0.458	0.210	0.490	13	0.026	0.0097	0.054
			2002	5	5	19.7	15.2	23.6	0.362	0.348	0.648	0.174	0.648	3	0.0133	< 0.01	0.02
			2005	25	25	20.4	16.1	24.7	0.504	0.529	0.723	0.241	0.802	12	0.0158	< 0.01	0.03
		Northern pike	1971	2	2	16.8	16.5	17.0	0.210	0.210	0.320	0.100	0.320				
			1972	1	1	20.7			0.410	0.410							
			1975	6	6	17.9	11.5	22.5	0.462	0.370	0.696	0.310	0.700				
			1976	3	3	12.9	11.8	14.3	0.160	0.160	0.180	0.140	0.180				
			1977	4	4	17.4	12.2	26.0	0.348	0.340	0.530	0.180	0.530				
			1978	7	3	20.0	19.4	21.3	0.257	0.280	0.300	0.190	0.300	2	0.015	< 0.01	0.02
			2000	6	6	20.5	16.7	31.0	0.353	0.260	0.690	0.220	0.720	4	< 0.01	< 0.01	< 0.01
			2005	13	13	18.5	13.7	23.7	0.284	0.280	0.397	0.164	0.572				
		Redhorse, unknown sp.	1971	6	6	15.5	14.7	16.5	0.340	0.335	0.424	0.270	0.430				
			1972	4	4	15.4	14.1	16.6	0.563	0.535	0.900	0.280	0.900				
			1973	8	8	14.8	13.7	15.8	0.454	0.425	0.640	0.250	0.640				
			1975	10	10	15.2	12.0	17.0	0.526	0.515	0.900	0.160	0.900				
		Rock bass	1971	1	1	5.0			0.180	0.180							
			1975	2	2	7.1	6.5	7.7	0.260	0.260	0.370	0.150	0.370				
			1976	2	2	9.2	9.2	9.2	0.355	0.355	0.400	0.310	0.400				
			2005	15	4	6.7	4.9	8.0	0.176	0.146	0.311	0.101	0.311				
		Pumpkinseed sunfish	1975	1	1	7.5			0.120	0.120							
		Smallmouth bass	1975	1	1	11.5			0.850	0.850							
			1976	1	1	13.2			0.350	0.350							
			2000	12	12	12.7	10.1	14.1	0.316	0.275	0.581	0.090	0.630	2	< 0.01	< 0.01	< 0.01
			2005	34	34	12.9	8.8	17.0	0.319	0.265	0.540	0.161	0.877	1	< 0.01		
		Shorthead redhorse	1976	11	11	13.5	8.9	17.2	0.136	0.130	0.190	0.100	0.190				
			1977	11	11	14.9	11.0	18.1	0.274	0.230	0.468	0.160	0.630				
			1978	14	3	16.3	14.2	17.4	0.207	0.180	0.290	0.150	0.290	3	0.0733	0.02	0.12
			1979	25	1	15.7			0.490	0.490							
			2005	33	9	15.4	14.0	17.8	0.286	0.313	0.377	0.140	0.412				

WATERWAY	AUID	Species	Year	N of Fish	Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
					N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
		Walleye	1971	3	3	8.7	5.7	10.5	0.210	0.220	0.220	0.190	0.220				
			1976	4	4	9.0	7.6	11.7	0.160	0.165	0.220	0.090	0.220				
			1977	5	5	12.7	9.1	16.5	0.302	0.290	0.440	0.160	0.440				
			1978	1	1	17.6			0.320	0.320							
			1979	5	1	14.2			0.390	0.390							
			2000	8	8	11.9	9.7	14.4	0.265	0.245	0.448	0.120	0.460	1	< 0.01		
			2002	6	6	12.9	11.7	15.8	0.170	0.161	0.203	0.148	0.204				
			2005	15	15	13.2	10.5	17.1	0.277	0.240	0.473	0.158	0.566				
		White sucker	1971	7	7	16.8	15.0	18.8	0.263	0.260	0.466	0.080	0.480				
			1972	1	1	15.5			0.200	0.200							
			1973	1	1	14.1			0.300	0.300							
			1975	17	17	16.2	10.5	19.5	0.486	0.550	0.704	0.210	0.780				
			1976	3	3	18.2	17.7	19.0	0.247	0.230	0.280	0.230	0.280				
			1977	13	13	16.7	12.2	19.7	0.338	0.290	0.618	0.080	0.650				
			1978	1	1	15.5			0.120	0.120				1	0.03		
			1979	10	2	13.3	11.9	14.6	0.155	0.155	0.160	0.150	0.160				
			2005	16	5	16.5	14.4	19.1	0.327	0.263	0.531	0.184	0.531				
	Cloquet to Fond du Lac Dam ~ 04010201-523, -515, -516, -524	Black bullhead	1973	2	2	7.0	7.0	7.0	0.490	0.490	0.590	0.390	0.590				
			1975	13	13	7.1	6.5	8.0	0.465	0.500	0.594	0.220	0.610				
		Common Carp	1973	1	1	15.0			0.090	0.090							
			1975	1	1	18.0			0.290	0.290							
			1983	2	2	21.2	19.6	22.8						2	0.85	0.2	1.5
		Northern pike	1971	1	1	18.7			1.400	1.400							
			1986	1	1	35.5								1	0.05		
		Redhorse, unknown sp.	1973	1	1	18.5			0.340	0.340							
		Sauger	1973	3	3	20.8	19.5	22.0	0.903	0.890	1.080	0.740	1.080				
		Stonecat	1975	1	1	8.5			0.690	0.690							
		Smallmouth bass	2000	7	7	12.0	7.7	14.6	0.350	0.310	0.570	0.170	0.570	4	< 0.01	< 0.01	< 0.01
			2002	5	5	15.4	13.8	16.9	0.491	0.484	0.714	0.339	0.714				
		Sucker, unknown	1972	5	5	14.3	13.4	14.9	0.274	0.270	0.410	0.150	0.410				
		Walleye	1971	1	1	10.8			0.710	0.710							
			1972	3	3	16.8	16.8	16.8	0.750	0.750	0.750	0.750	0.750				
			1973	3	3	15.3	10.0	18.0	0.603	0.650	0.740	0.420	0.740				

			1975	10	10	15.4	12.0	18.5	0.616	0.545	0.930	0.380	0.950				
			1986	1	1	13.8								1	0.05		
			1988	2	2	13.8	13.8	13.8	0.280	0.280	0.280	0.280	0.280	2	0.05	0.05	0.05
			1991	22	22	12.5	10.6	15.4	0.268	0.210	0.476	0.150	0.490				
			2001	10	10	15.9	13.1	22.2	0.420	0.378	0.608	0.278	0.636	2	< 0.01	< 0.01	< 0.01
			2002	10	10	16.2	14.9	17.8	0.547	0.610	0.712	0.321	0.712				

					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
		White sucker	1971	14	14	13.2	11.5	16.3	0.446	0.470	0.621	0.090	0.630				
			1972	5	5	14.3	13.4	14.9	0.274	0.270	0.410	0.150	0.410				
			1982	4	4	11.7	11.6	11.7	0.980	0.980	0.980	0.980	0.980	2	0.05	0.05	0.05
			1988	2	2	16.2	16.2	16.2	0.180	0.180	0.180	0.180	0.180	2	0.05	0.05	0.05
			2002	2	2	17.5	17.5	17.5	0.213	0.213	0.213	0.213	0.213				
		White sucker	1975	16	16	15.5	9.5	17.0	0.464	0.525	0.707	0.150	0.800				
			2001	10	10	16.4	12.9	19.1	0.252	0.244	0.361	0.154	0.438	2	0.02	< 0.01	0.03
		Yellow perch	1973	4	4	6.3	6.0	6.5	0.330	0.255	0.590	0.220	0.590				
			1975	3	3	9.7	8.0	11.5	0.673	0.840	0.920	0.260	0.920				
	Below Fond du Lac Dam ~ 04010201-513, -532, -533, 501, 530, -531	Black crappie	1993	13	2	9.6	8.9	10.3	0.245	0.245	0.300	0.190	0.300				
			2000	8	8	7.7	6.1	11.3	0.071	0.060	0.150	0.040	0.180				
		Common Carp	1976	3	3	22.6	21.0	23.5	0.263	0.220	0.390	0.180	0.390				
			1977	1	1	22.4			0.330	0.330							
			1986	2	2	23.1	23.1	23.1						1	2.34		
			1989	1	1	11.1			0.110	0.110				1	< 0.01		
			1997	2	2	26.3	23.8	28.7									
			2002	2	2	25.4	24.2	26.6	0.415	0.415	0.492	0.337	0.492	2	0.245	0.09	0.4
			2006	2	2	27.7	27.3	28.1	0.350	0.350	0.437	0.263	0.437				
		Channel catfish	2000	13	13	15.7	12.2	19.3	0.291	0.200	0.500	0.110	1.220	13	0.159	0.019	0.789
			2002	2	2	23.8	23.6	23.9	0.579	0.579	0.772	0.386	0.772	2	0.21	0.21	0.21
			2004	4	4	17.9	17.3	18.7	0.250	0.223	0.399	0.154	0.399	4	0.165	0.09	0.24
		Lake sturgeon	1993	1	1	12.3			0.150	0.150				1	0.034		
			1994	2	2	14.0	12.8	15.2	0.100	0.100	0.106	0.093	0.106	2	0.168	0.16	0.177
			2000	3	3	23.1	17.9	27.4	0.100	0.090	0.190	0.020	0.190	1	0.013		
		Northern pike	1970	2	2	16.3	14.9	17.6	0.580	0.580	0.640	0.520	0.640				
			1971	14	14	19.6	11.3	23.5	0.492	0.455	0.711	0.120	0.810				
			1976	3	3	18.3	15.0	24.2	0.307	0.310	0.380	0.230	0.380				
			1977	2	2	22.9	17.7	28.0	0.395	0.395	0.550	0.240	0.550				
			1978	10	2	17.5	17.5	17.5	0.215	0.215	0.260	0.170	0.260	2	0.085	0.02	0.15

			1978	20	3	23.9	18.8	30.1	0.253	0.230	0.310	0.220	0.310				
			1979	20	4	23.2	15.6	29.3	0.403	0.400	0.460	0.350	0.460				
			1980	11	3	25.2	20.5	29.4	0.437	0.450	0.590	0.270	0.590	3	0.107	0.06	0.14
			1982	12	5	22.1	20.5	26.6	0.347	0.330	0.450	0.260	0.450	3	0.793	0.08	2.2
			1986	10	2	23.3	23.3	23.3						1	0.050		
			1989	5	2	25.7	23.2	28.2	0.225	0.225	0.230	0.220	0.230	2	0.020	0.017	0.024
			1993	19	19	22.4	18.7	27.0	0.375	0.350	0.556	0.230	0.590	4	0.042	0.019	0.084
			2000	8	8	20.4	16.3	31.0	0.339	0.300	0.494	0.250	0.530	4	0.043	< 0.01	0.116
		Smallmouth bass	1998	9	9	13.8	10.9	16.9	0.497	0.430	0.740	0.280	0.760	9	0.065	0.019	0.28
			2009	5	5	12.4	11.8	14.3	0.505	0.466	0.628	0.458	0.628	2	0.056	0.055	0.056

WATERWAY	AUID	Species	Year	N of Fish	Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
					N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
		Rainbow smelt	1971	1	1	8.3			0.130	0.130							
		Shorthead redhorse	1978	1	1	16.8			0.190	0.190				1	0.79		
			2009	1	1	15.9			0.259	0.259				1	< 0.025		
		Sunfish family	1989	3	1	6.2			0.054	0.054				1	< 0.01		
		Walleye	1971	6	6	12.9	5.1	17.4	0.525	0.520	0.819	0.250	0.850				
			1976	1	1	13.5			0.670	0.670							
			1978	1	1	15.5			0.370	0.370							
			1979	5	1	12.1			0.250	0.250							
			1980	5	2	17.7	16.0	19.3	0.855	0.855	1.000	0.710	1.000	2	0.215	0.06	0.37
			1982	3	1	21.8			0.780	0.780				1	3.60		
			1984	3	3	22.5	20.5	25.0	1.080	1.100	1.200	0.940	1.200	3	0.283	0.2	0.45
			1986	10	2	17.8	17.8	17.8						1	0.05		
			1989	8	3	16.7	13.1	22.2	0.277	0.180	0.480	0.170	0.480	3	0.099	0.029	0.2
			1993	31	31	17.1	14.2	19.6	0.503	0.390	0.920	0.230	1.300	4	0.165	0.12	0.2
			1996	10	10	19.0	13.6	25.0	0.602	0.550	1.200	0.190	1.300	10	0.043	< 0.01	0.12
			2000	16	16	17.0	14.0	23.8	0.394	0.340	0.751	0.120	1.080	6	0.033	< 0.01	0.134
			2002	5	5	12.4	10.7	14.2	0.361	0.373	0.387	0.306	0.387				
			2004	7	7	20.9	17.9	23.2	1.269	1.371	1.519	0.874	1.529	7	0.164	0.12	0.27
		White sucker	1970	2	2	14.4	13.2	15.6	0.555	0.555	0.590	0.520	0.590				
			1971	1	1	6.1	6.1	6.1	0.050	0.050							
			1976	13	13	14.3	11.1	17.0	0.492	0.530	0.860	0.170	0.860				
			1977	1	1	16.1			0.450	0.450							
			1978	14	2	16.7	16.7	16.7	0.230	0.230	0.280	0.180	0.280	2	0.225	0.13	0.32
			1979	25	1	14.9			0.210	0.210							
			1979	10	2	16.9	16.6	17.2	0.110	0.110	0.120	0.100	0.120				
			1980	5	2	16.9	16.1	17.6	0.285	0.285	0.340	0.230	0.340	2	0.78	0.53	1.03
			1982	35	7	16.0	15.2	16.9	0.250	0.245	0.290	0.220	0.290	4	0.27	0.2	0.37
			1989	3	1	16.0			0.260	0.260				1	0.072		
			1993	17	17	16.5	14.6	18.2	0.291	0.280	0.436	0.054	0.450	3	0.065	0.019	0.093
			1996	8	8	17.1	14.5	19.1	0.229	0.250	0.369	0.040	0.390	8	0.022	< 0.01	0.04
			2000	12	12	15.5	13.3	18.7	0.102	0.105	0.160	0.020	0.160				

		Yellow perch	1976	4	4	9.3	8.4	10.1	0.508	0.510	0.680	0.330	0.680				
			1996	3	3	9.6	7.9	10.6	0.203	0.200	0.270	0.140	0.270	3	< 0.01	< 0.01	< 0.01

					Length (in)				Hg (mg/Kg)					PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	N of Fish	N	Mean	Min	Max	Mean	Median	90th pctl	Min	Max	N	Mean	Min	Max
WHITEFACE R. *	04010201-509, -528, 529	Channel catfish	1999	8	8	19.2	16.6	21.5	0.318	0.310	0.455	0.220	0.500	8	0.017	0.012	0.021
		Northern pike	1999	3	3	19.6	17.9	20.6	0.213	0.190	0.270	0.180	0.270				
		Smallmouth bass	1999	2	2	13.8	13.0	14.5	0.305	0.305	0.390	0.220	0.390				
		Shorthead redhorse	1999	2	1	15.6			0.220	0.220							
		Walleye	1999	4	4	14.0	12.2	16.0	0.280	0.275	0.320	0.250	0.320				
		White sucker	1999	3	1	16.8	16.8	16.8	0.240	0.240		0.240	0.240				

* Impaired for mercury in fish tissue

~ Impaired for PCBs in fish tissue

Table 92. PFOS concentrations measured in selected waters between 2007 and 2010.

				N	N	Length (in)			PFOS (ng/g -wet weight)		
Waterway	AUID	Species	Year	Fish	Samples	Mean	Min	Max	Mean	Min	Max
Embarrass	69049600	Bluegill sunfish	2007	10	1	7.7			< 0.92		
Strand	69052900	Black Crappie	2007	8	1	10.4			< 0.92		
Whiteface Reservoir	69037500	Bluegill sunfish	2007	1	1	8.6			2.29		
Fish Lake Flowage	69049102	Bluegill sunfish	2008	5	5	7.7	6.7	8.3	42.6	33.3	57.3
(East Bay)		Black Crappie	2008	5	5	9.5	7.3	10.2	86.8	74.1	103
			2010	5	5	9.2	6.9	10.2	102.4	65.1	164
		Largemouth bass	2008	5	5	13.9	12.6	14.6	88.2	48.3	124
			2010	4	4	12.5	10.8	13.6	179	148	206
		Northern Pike	2008	5	5	18.7	16.9	20.1	47.1	7.3	82.9
		Walleye	2008	5	5	14.1	12.2	17.5	87.1	74.3	116
St. Louis Estuary	04010201-	Bluegill sunfish	2010	1	1	7.5			13.1		
	501, -530,	Black Crappie	2010	5	5	7.9	6.9	10.2	16.7	14.0	22.5
	531	Walleye	2010	5	5	17.1	14.0	21.1	11.1	4.8	17.3

Pollutant trends

The “Minnesota Milestones” sites provide the state’s best long-term water quality monitoring data. There are four such sites on the St. Louis River, from Forbes in the upper reaches to Duluth near the mouth.

As has been the case across much of the state, concentrations for most conventional pollutants have gone down over the overall period of record (36 to 57 years for these particular sites), showing the results of successful point-source pollution controls. The exception, as is the case generally across the state, is nitrogen, showing that considerable additional work needs to be done with regard to nonpoint sources of pollution.

The more recent period, 1995 to 2010, has less evidence of continued trends, although at this point it is difficult to tell if this is because the trends have leveled off or simply because reduced monitoring efforts have not provided enough data to discern the trends.

Pollutant Trends in Minnesota Rivers

Data is from Minnesota Pollution Control Agency "Milestone" monitoring sites.

St. Louis River below I-535 Bridge at Superior, WI (S000-277) and Duluth, MN (S003-975)(SLB-1) (period of record 1974 - 2010)

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
overall trend	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**decrease**
estimated average annual change	-4.3percent	-3.2percent	0.7percent	-3.8percent	-2.5percent	-1.4percent
estimated total change	-80percent	-70percent	27percent	-71percent	-61percent	-40percent
1995 - 2010 trend	**no trend**	**no trend**	**increase**	**increase**	**no trend**	**increase**
estimated average annual change			5.0percent	8.5percent		2.8percent
estimated total change			117percent	270percent		54percent
median concentrations first 10 years	11	0.10	0.10	0.11	2	14
median concentrations most recent 10 years	5	0.05	0.18	0.07	1	11

St. Louis River at Bridge on MN-23 at Fond Du Lac (S000-021)(SL-9) (period of record 1953 - 2010)

overall trend	**decrease**	**decrease**	**no trend**	**decrease**	**decrease**	**decrease**
estimated average annual change	-2.5percent	-3.4percent		-3.1percent	-4.9percent	-1.5percent
estimated total change	-77percent	-83percent		-69percent	-95percent	-58percent
1995 - 2010 trend	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**	little data
estimated average annual change	-2.3percent					
estimated total change	-32percent					
median concentrations first 10 years	13	0.12	0.06	0.10	5	7
median concentrations most recent 10 years	5	0.04	0.09	<.05	1	7

St. Louis River at Bridge on US-2, 2 Miles SE of Brookston (S000-023)(SL-38) (period of record 1953 - 2010)

overall trend	**decrease**	**decrease**	**no trend**	**decrease**	**decrease**	**increase**
estimated average annual change	-1.1percent	-2.3percent		-4.8percent	-1.6percent	2.5percent
estimated total change	-49percent	-67percent		-79percent	-61percent	225percent
1995 - 2010 trend	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	little data
estimated average annual change						
estimated total change						
median concentrations first 10 years	13	0.11	0.08	0.08	3	2
median concentrations most recent 10 years	4	0.04	0.06	<.05	1	5

St. Louis River at Bridge at CSAH-7, 0.5 Miles S of Forbes (S000-119)(SL-110) (period of record 1967 - 2010)

overall trend	**decrease**	**decrease**	**no trend**	**decrease**	**decrease**	little data
estimated average annual change	-1.7percent	-1.9percent		-4.4percent	-1.6percent	
estimated total change	-52percent	-58percent		-77percent	-50percent	
1995 - 2010 trend	**no trend**	**decrease**	**decrease**	**no trend**	**no trend**	little data
estimated average annual change		-3.2percent	-0.9percent			
estimated total change		-42percent	-15percent			
median concentrations first 10 years	6	0.04	<.05	0.08	1	6
median concentrations most recent 10 years	4	0.03	<.05	<.05	1	6

(Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90percent confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.)

(Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.)

Figure 38. Pollutant trends in the St. Louis River Watershed

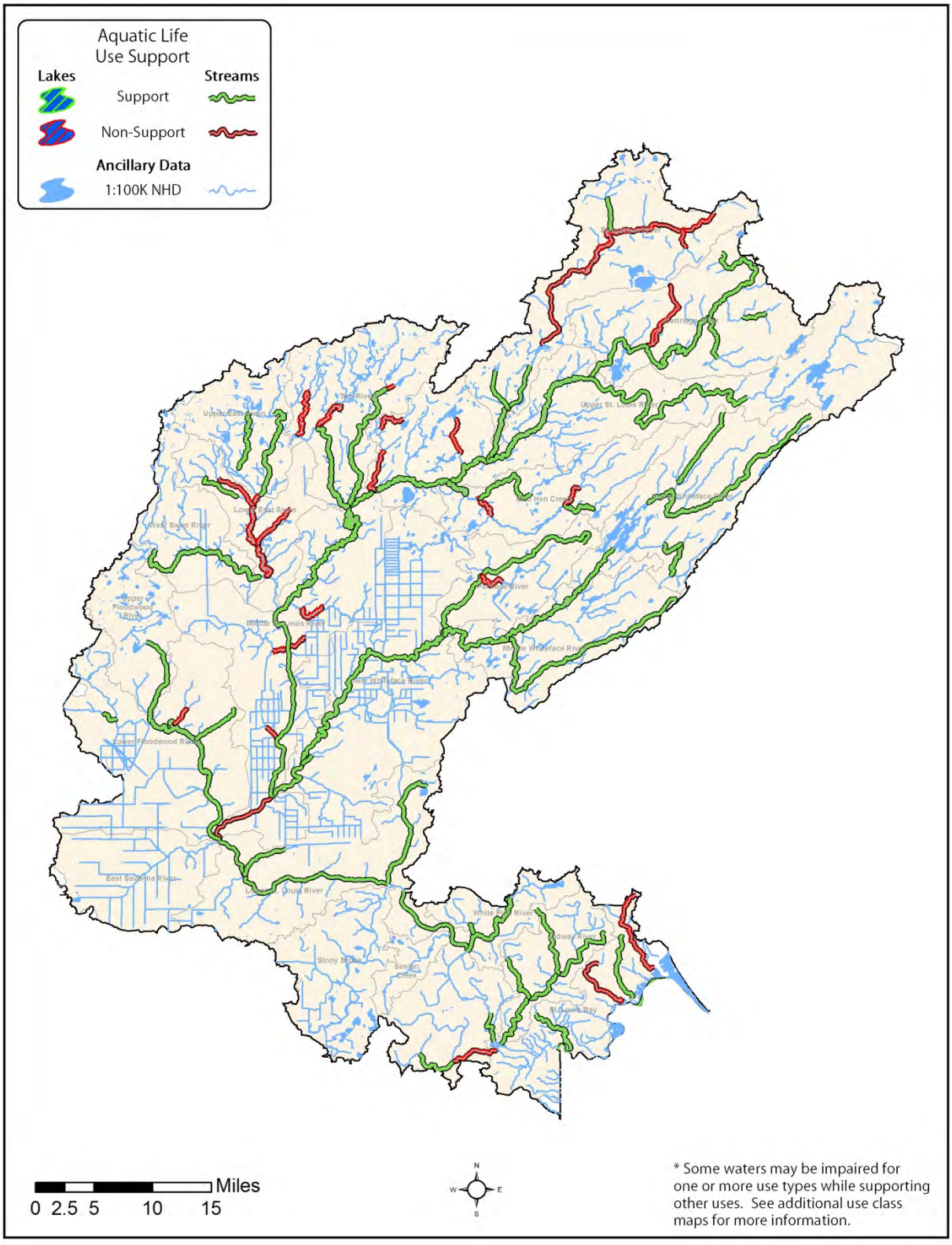

Figure 39. Aquatic life use support in the St. Louis River Watershed

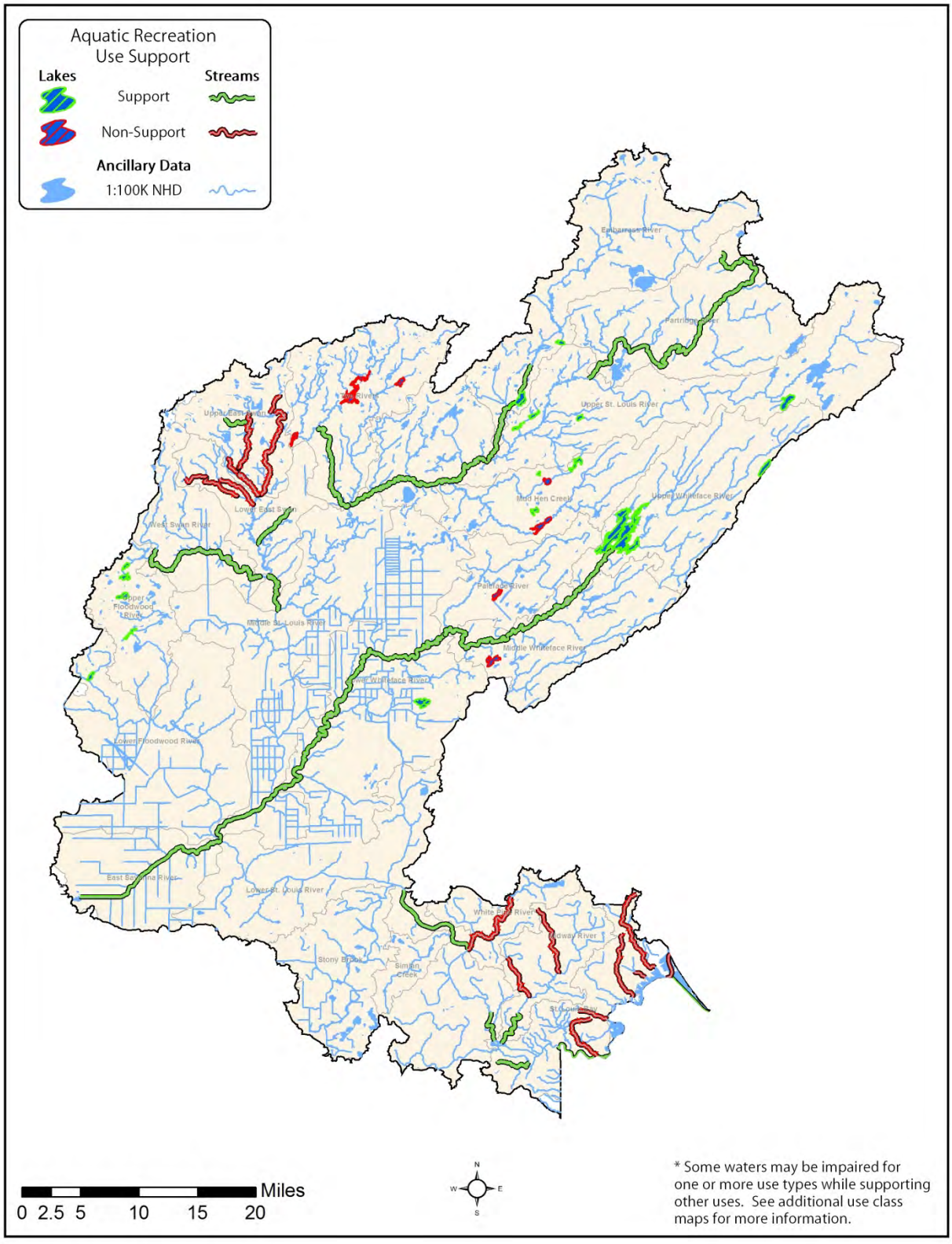

Figure 40. Aquatic recreation use support in the St. Louis River Watershed

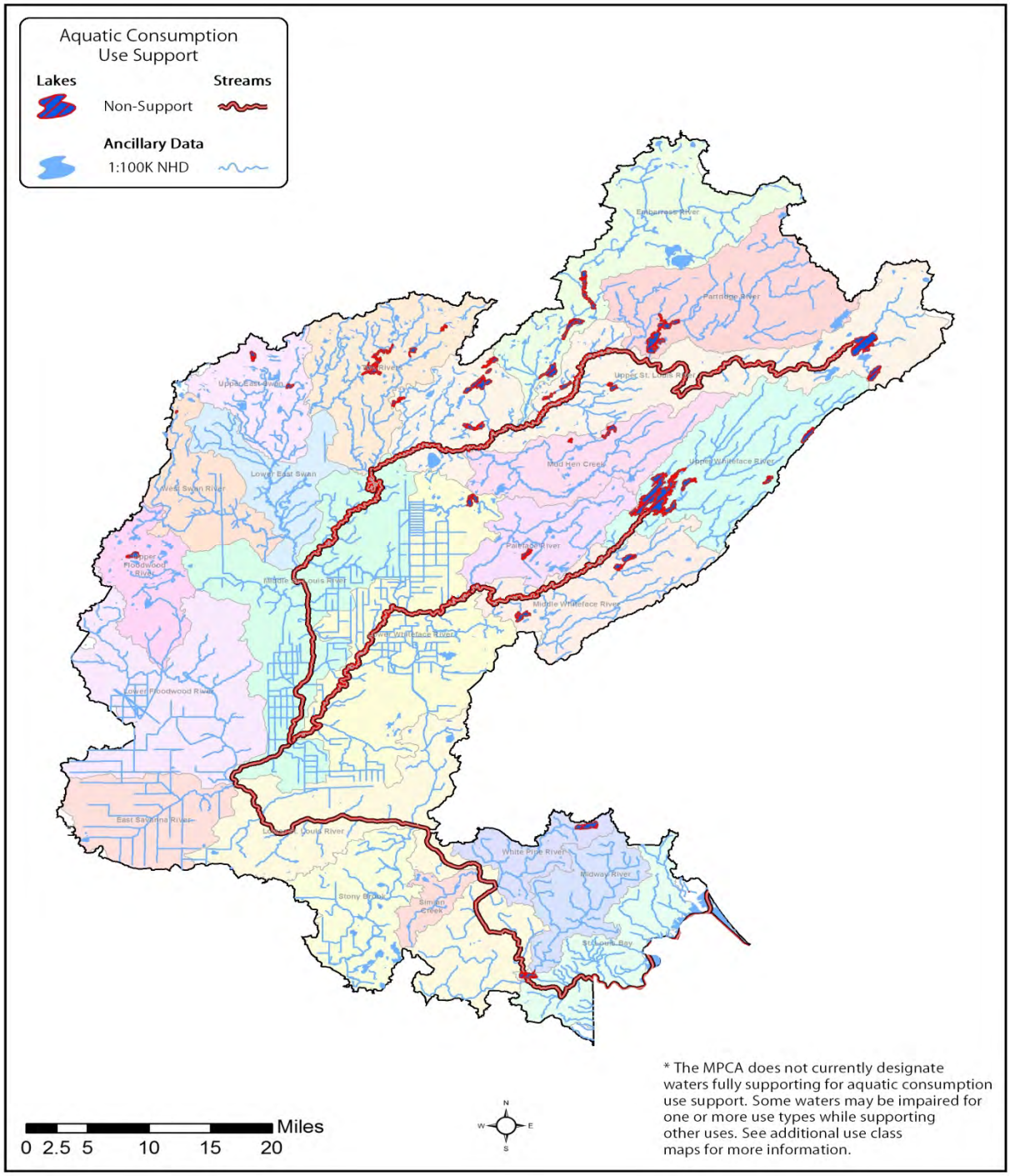

Figure 41. Aquatic consumption use support in the St. Louis River Watershed

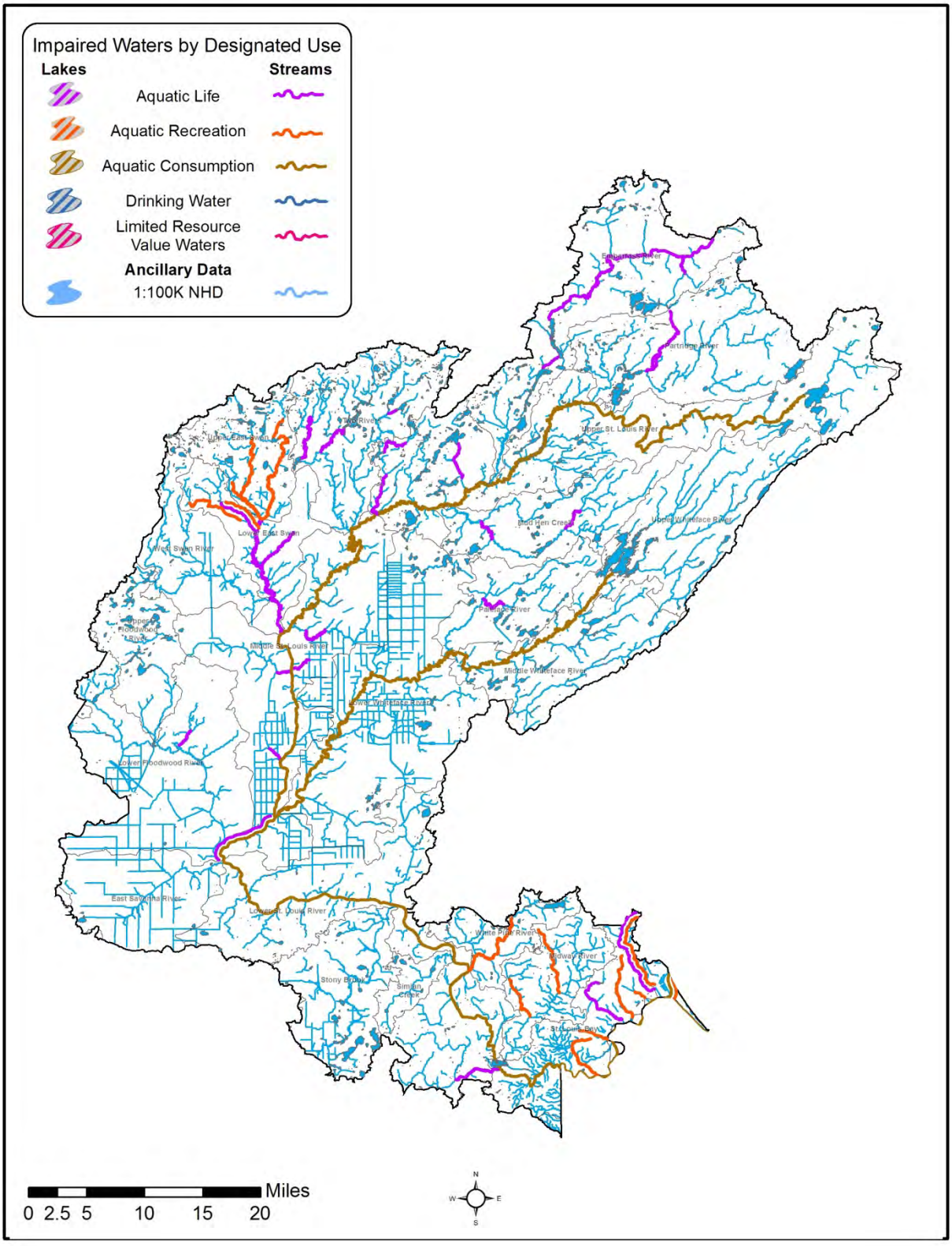

Figure 42. All impaired waters by designated use in the St. Louis River Watershed

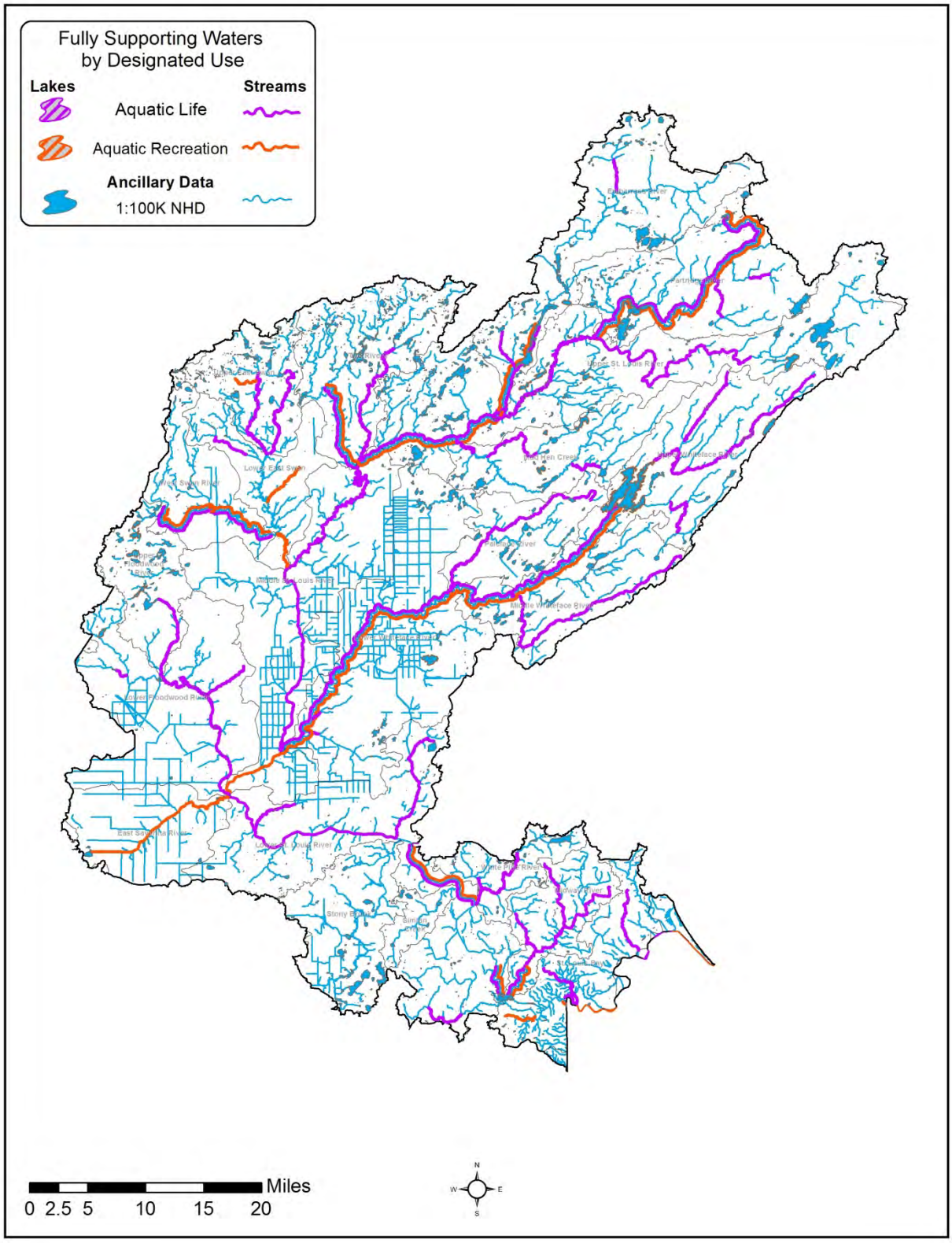

Figure 43. Fully supporting waters by designated use in the St. Louis River Watershed

VIII. Summaries and Recommendations

Although the St. Louis River watershed is considered one of Minnesota's most treasured resources, current and historic land use changes appear to have negatively affected some rivers, streams, and lakes in the watershed. Much of the watershed is forest or wetland (84.9 percent). However, localized areas of more intensive land use related to mining, urban and residential development, and agriculture occur throughout the watershed and have resulted in impairments for aquatic life, aquatic recreation and aquatic (fish) consumption.

Rivers and streams that do not support aquatic life were often affected by localized impairments from poor land use and riparian alterations. In these areas, additional monitoring should be conducted to more specifically identify the causes of the impairments. Most of the impairments occurred on streams emanating from the mining areas along the Laurentian Divide and in the Duluth area. Impaired streams were generally smaller headwater tributaries to the St. Louis River. The main stem rivers in this watershed are generally in good condition. Potential contributors to the poor biological performance in these smaller streams include mine drainage, habitat loss and the potential of other point or non-point source pollutants.

Throughout the St. Louis watershed, stream habitat was generally good but like the biological results, there were scattered pockets of poor stream habitat quality. Streams that were ditched or influenced by ditching, or surrounded by urban-developed land had noticeably poorer MSHA scores than streams surrounded by undisturbed forest and wetland. MSHA scores were usually a strong indicator of F-IBI and M-IBI results. In particular, the MSHA metric for substrate was a good indication of the macro-invertebrate community. Areas consisting of clay, sand, silt and detritus received below average scores and displayed communities of low taxa count and high tolerance to pollution. In contrast, streams with clean cobble, gravel and other course substrates showed communities of low pollution tolerance and high taxa counts.

Most aquatic recreation impairments were located in the northwest and southeast portions of the watershed where intensive land use is most prominent. Likely factors contributing to the high levels of E. coli found at these locations include stormwater runoff, altered hydrology and mining, and treated domestic wastewater from Iron Range cities.

Lake water quality is generally in good condition. However, of the 25 assessable lakes seven did not meet the eutrophication standards and were placed on the list of impaired waters. Similar to the impaired rivers and streams, many of the impaired lakes in the St. Louis River watershed are affected by a range of anthropogenic impacts in their headwaters, such as treated domestic wastewater, or iron mining, which together may be factors in their relatively poor water quality. Protection strategies need to be implemented by property owners in order to maintain the areas of good water quality. Examples of actions that could help improve or maintain the issues listed above include:

- Maintain buffer areas of natural vegetation between their lawns and the lakeshore and minimize removal of aquatic vegetation. These can filter runoff and benefit the fishery and aquatic life.
- Minimize the extent of manicured lawns on your property. If you must use fertilizers, use those that do not contain phosphorus.
- Conserve water in your home or cabin. This will reduce stress on your septic system and the lake.
- In the shoreland areas, setback and stormwater provisions should be strictly followed and the amount of impervious area (roads, rooftops, and parking lots) should be minimized. Studies have shown that the TP originating from these "non-point" sources can be greater that the TP originating from septic systems.

In Minnesota, the St. Louis River is currently impaired for a number of toxic pollutants, including mercury (fish and water), PCBs (fish & water), Dioxin, and several recalled/suspended pesticides (DDT, Dieldrin, Toxaphene). Most listings occurred in 1998 and 2002, with a number added since then. Additionally, the St. Louis River (Superior Harbor) in Wisconsin is currently impaired for mercury (fish), PCBs (fish), Lead, Dioxin, DDT, Dieldrin, PAHs, and other unspecified metals.

MPCA and local partners, including the US EPA, are looking at current research, modeling options, and data gaps in an effort to develop a TMDL for those listed toxic pollutants at some point in the future. It is hoped that further research into mercury and sulfate relationships, in addition to methylation and de-methylation of mercury and what is natural versus anthropogenic, will ultimately lead to effective restoration and protection strategies for the St. Louis River watershed.

IX. Literature Cited

Lindgren, et. al., 2006. A Study of the St. Louis River. Minnesota Department of Natural Resources Division of Fish and Waildlife. Section of Fisheries (MNDNR). 153 p.

McCollor, S. and S. Heiskary. 1993. Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions. Addendum to Fandrei, G., S. Heiskary, and S. McCollor. 1988. Descriptive Characteristics of the Seven Ecoregions in Minnesota. Division of Water Quality, Program Development Section, Minnesota Pollution Control Agency, St. Paul, Minnesota. Pp. 140.

Minnesota Pollution Control Agency. 2007a. Guidance Manual for Assessing the Quality of MinnesotaSurface Waters for the Determination of Impairment 305(b) Report and 303(d) List. Environmental Outcomes Division. St. Paul, Minnesota.

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

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

Minnesota Department of Natural Resources (MNDNR). 2011. Hydropower in Minnesota. Division of Waters.
http://www.dnr.state.mn.us/waters/surfacewater_section/stream_hydro/hydropower_sites.html

National Resource Conservation Service (NRCS). 2007. Rapid Watershed Assessment: St. Louis (MN) 04010201. NRCS. USDA.
http://www.mn.nrcs.usda.gov/technical/rwa/assessments/reports/st louis.pdf

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the Upper Midwest States. EPA/600/3-88/037

U.S. Environmental Protection Agency (EPA). 2012. St. Louis River: Background.
http://epa.gov/glnpo/aoc/stlouis.html#background

State Climatology Office. 2011. Water year precipitation maps.
http://www.climate.umn.edu/doc/hydro_yr_pre_maps.htm

Smith, L. L. Jr. and Moyle J. B. 1944. A biological survey and fishery management plan for the streams of the Lake Superior north shore watershed. Minnesota Department of Conservation. Technical Bulletin Number 1, 228 pages.

United States Geological Survey. 2010. Water Data Report 2010: 04024000 St Louis River at Scanlon, MN. USGS.

Waters, T.F. 1977. The Rivers and Streams of Minnesota. University of Minnesota Press, Minneapolis, Minnesota.

X. Appendices

Appendix 1. Water chemistry parameter 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.

Dissolved Orthophosphate - Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff.

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

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 does 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. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels overstimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality

from overstimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension 1999). Elevated levels of phosphorus in rivers and streams 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 (University of Missouri Extension 1999). In “non-point” source dominated watersheds, total phosphorus (TP) concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

Total Suspended Solids (TSS) – Water clarity refers to the transparency or clearness of water. 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. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

Analysis has shown a strong correlation to exist between the measures of TSS and turbidity. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. High turbidity results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem. Periods of high turbidity often occur when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles and overland flow transports fine particles of silt and clay into rivers and streams (MPCA and MSUM 2009).

Total Suspended Volatile Soilds (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 water chemistry monitoring stations in the St. Louis River Watershed

Biological Station ID	STORET ID	Stream Name	Sample Location	HUC-11
09LS080	S000-119	St. Louis River	Downstream of CR 7, 1 mi. S of Forbes	4010201015
09LS102	S005-752	Partridge River	Downstream of CR 110, 2 mi. E. of Aurora	4010201020
09LS095	S005-751	Embarrass River	Upstream of CR 95, 3 mi. NE of Makinen	4010201030
09LS090	S005-750	Mud Hen Creek	At CR 16, 3 mi. N. of Central Lakes	4010201040
09LS073	S004-601	West Two River	Upstream of CR 25, 3 mi. S. of Cherry	4010201050
97LS090	S005-303	St. Louis River	Upstream of CR 8 in Floodwood	4010201060
89LS026	S000-596	Barber Creek(East Swan River)	Upstream of Swinnerton Rd. 3 mi. E of Riley	4010201070
98NF115	S005-757	Wert Swan River	Upstream of CR927, 3 mi. S. of Little Swan	4010201080
09LS061	S005-770	Swan River	Upstream of CR 750, 2.5 mi. S. of Little Swan	4010201090
09LS056	S005-768	Whiteface River	Upstream of CR 4, 2 mi. S. of Markham	4010201100
09LS051	S005-765	Whiteface River	Upstream of CR 52, 1 mi. E. of Cotton	4010201110
09LS048	S005-764	Palefaace River	Upstream of Moberg Rd., 13.5 mi. NE of Meadowlands	4010201120
09LS039	S005-763	Whiteface River	Downstream of CR 5, 5.5 mi. SW of Meadowlands	4010201130
09LS027	S005-761	Floodwood River	Upstream of CR 133, 3 mi. S. of Little Swan	4010201140
97LS033	S005-755	Floodwood River	At Hwy. 73, 1 mi. N. of Floodwood	4010201150
98LS050	S005-756	East Savanna River	Upstream of CR 836, 1 mi. SW of Floodwood	4010201160
97LS093	S000-046	St. Louis River	Downstream of CR 6 in Scanlon	4010201170
09LS016	S004-594	Stony Brook	Upstream of Hwy. 31, in Brookston	4010201180
09LS013	S005-759	Pine River	Downstream of Hwy 33, 3.5 mi. S. of Saginaw	4010201200
09LS004	S003-611	Midway River	Upstream of Korby Rd., 1.5 mi. N of Thompson	4010201210
09LS001	S000-021	St. Louis River	At Hwy 23, 0.5 mi. W. of Fond du Lac	4010201120

Appendix 3. AUID table of results by parameter and beneficial use for the St. Louis River Watershed

					USES			BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 04010201015 (Upper St. Louis River)																					
04010201-511	St. Louis River	Embarrass R to East Two R	20.98	2B	FS	FS	NS	+	+							+	+	+	+	+	IF
04010201-644	St. Louis River	T58 R13W S35, east line to Partridge R	26.46	2B	FS	NA	NS	+	+												
04010201-526	St. Louis River	Partridge R to Embarrass R	25.09	2B	FS	NA	NA	+	+												
04010201-570	Elbow Creek	Unnamed ditch to St Louis R	5.55	2B	NS	NA	NA	+	-												
04010201-518	Elbow Creek	T57 R18W S12, north line to Elbow Lk	3.55	2B	NS	IF	NA	-	-											+	
04010201-A26	Ely Creek	Headwaters (Ely 69-0660-00) to Unnamed cr	4.12	2B	NS	IF	NA	-	+											+	
04010201-A39	Unnamed Creek	North Twin Lk to St Louis R	3.3	2B	NA	NA	NA	NA	NA												
04010201-521	Elbow Creek	Headwaters to T57 R18W S1, south line	1.72	7	NA	NA	NA	NA	NA												
04010201-594	Unnamed Creek	Unnamed cr to Pot Lk outlet	0.15	2B	NA	NA	NA	NA	NA												
09020106-A25	Long Lake Creek	Unnamed Ditch to Hay Creek	2.23	2B	NA	NA	NA	NA	NA							+	-	+	-	+	IF
HUC-11: 04010201020 (Partridge River)																					
04010201-552	Partridge River	Headwaters to St Louis R	36.99	2B	FS	FS	NA	+	+							+	+	+	+	+	+
04010201-942	Wyman Creek	Headwaters to Colby Lk	10	2A	NS	NA	NA	-	+												
04010201-946	Colvin Creek	Cranberry Cr to Partridge R	5.14	2B	FS	NA	NA	+	+												
04010201-587	Unnamed Creek	Unnamed cr to Unnamed cr	2.51	2B	FS	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.

					USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 04010201030 (Embarrass River)																						
04010201-577	Embarrass River	Embarrass Lk to St Louis R	14.53	2B	FS	FS	NA		+	+							+	+		+	+	
04010201-579	Embarrass River	Headwaters to Embarrass Lk	34.02	2B	NS	NA	NA		-	+										+		
04010201-583	Unnamed creek	Headwaters to Embarrass R	4.01	2B	FS	NA	NA		+	+												
04010201-A40	Bear Creek	Unnamed cr to Embarrass R	4.32	2B	FS	NA	NA		+	+												
04010201-A42	Spring Mine Creek	Ridge Cr to Embarrass R	1.96	2B	NS	NA	NA		-	-												
HUC-11: 04010201040 (Mud Hen Creek)																						
04010201-A28	Mud Hen Creek	Unnamed cr to St Louis R	5.83	2B	FS	IF	NA		+	+							+	IF	+	+	+	+
04010201-A30	Mud Hen Creek	Unnamed cr to Water Hen Cr	8.97	2B	FS	NA	NA		+	+												
04010201-A31	Water Hen Creek	Unnamed cr to Mud Hen Cr	4.03	2B	NS	NA	NA		+	-												
04010201-A35	Water Hen Creek	Unnamed cr to S Br Water Hen Cr	3.21	2B	NS	NA	NA		+	-												
04010201-A36	Water Hen Creek, South Branch	Unnamed cr to Water Hen Cr	4.42	2B	FS	NA	NA		+	+												
HUC-11: 04010201050 (Two Rivers)																						
04010201-534	West Two River	McQuade Lk outlet to St Louis R	14.55	2B	FS	FS	NA		+	+							+	+	IF	+	+	+
04010201-535	West Two River	West Two R Reservoir to McQuade Lk outlet	5.55	2B	NS	NA	NA		+	-												
04010201-548	Unnamed branch	Manganika Lk to East Two R	0.9	2B	NS	NA	NA		-	-												
04010201-551	East Two River	Unnamed cr to McQuade Lk	7.51	2B	NS	NA	NA		+	-												
04010201-555	St Louis River	Unnamed branch to St Louis R	19.62	2B	FS	NA	NA		+	+												
04010201-635	Manganika Creek	T58 R17W S19, north line to Manganika Lk	0.99	7	NA	NA	NA		NA	NA												
HUC-11: 04010201060 (Middle St. Louis River)																						
04010201-508	St Louis River	Whiteface R to Floodwood R	6.92	2B	NS	FS	NS		+	-							+	+	+	+	+	
04010201-510	St Louis River	West Two R to Swan R	22.57	2B	FS	NA	NS		+	+								IF		+		
04010201-525	St Louis River	Swan R to Whiteface R	18.45	2B	FS	IF	NS		+	+											+	
04010201-607	Sand Creek	Unnamed cr to St Louis R	2.28	2B	NS	NA	NA		-	+												
04010201-963	Stony Creek	Unnamed cr to Unnamed cr	5.49	2B	NS	NA	NA		-	-												
04010201-A17	Unnamed creek	Unnamed ditch to St Louis R	2.14	2B	NS	NA	NA		+	-												
04010201-A18	Skunk Creek	Unnamed cr to St Louis R	1.78	2B	NS	NA	NA		-	-												
04010201-A19	Unnamed creek	Unnamed cr to St Louis R	1.76	2B	NA	NA	NA		NA	NA												
04010201-A20	Unnamed creek	Unnamed cr to St Louis R	2.86	2B	NA	NA	NA		NA	NA												

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.

					USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 04010201070 (Upper East Swan River)																						
04010201-569	Barber Creek (East Swan River)	T57 R20W S28, east line to Dempsey Cr	6.53	2B	FS	NS	NA		+	+							+	-	+	+	+	+
04010201-582	Dempsey Creek	Six Mile Lk to T56 R20W S12, west line	15.55	2B	FS	NS	NA		+	+							+	-	+	+	+	+
04010201-641	Barber Creek (East Swan River)	T57 R20W S2, north line to T57 R20W S27, west line	7.54	2B	FS	NS	NA		+	+								-	+	+	+	-
04010201-580	Buhl Creek	T58 R19W S30, east line to Six Mile Lk	2.2	2B	IF	NS	NA											-				
04010201-936	Penobscot Creek	T57 R20W S28, north line to East Swan R	2	2A	IF	NS	NA											-	+	-	+	+
04010201-A23	Unnamed creek	Headwaters to Barber Cr	2.81	2B	NA	FS	NA											+				
04010201-520	Barber Creek	Headwaters (Longyear Lk 69-0857-02) to T58 R20W S35, south line	3.21	7	IF	IF	NA		NA	NA								+	+			+
04010201-553	Penobscot Creek	Headwaters to T57 R20W S21, south line	4.2	2B	NA	NA	NA		NA	NA							+					
HUC-11: 04010201080 (West Swan River)																						
04010201-559	West Swan River	T55 R21W S4, north line to T55 R20W S14, east line	26.05	2C	FS	FS	NA		+	+							+	+	+	+	+	+
HUC-11: 04010201090 (Lower East Swan)																						
04010201-542	Unnamed creek	Unnamed cr to T56 R20W S9, east line	4.15	2B	FS	NS	NA		+	+								-	+	+		-
04010201-557	Swan River	Confluence of East and West Swan R to St Louis R	5.12	2B	NS	FS	NA		-	+							+	+	+	-	+	
04010201-888	Unnamed creek (East Swan Creek)	T56 R20W S5, north line to East Swan R	4.63	2A	NS	NS	NA		+	-							+	-	+	+	+	+
04010201-891	Unnamed creek (Little Swan Creek)	Headwaters to East Swan R	6.29	2A	NS	FS	NA		-	NA								+				
04010201-558	East Swan River	Barber Cr to Swan R	19.13	2B	NS	NA	NA										+			-		
04010201-A22	Unnamed creek	Unnamed cr to Unnamed cr			NA	NS	NA											-				
04010201-887	Unnamed creek (East Swan Creek)	Headwaters (Bryan Lk 69-1012-00)) to T55 R20W S32, south line			IF	NA	NA		NA	NA							+			IF		
04010201-890	Unnamed creek (East Swan Creek Tributary)	T56 R20W S10, west line to Unnamed cr			IF	NA	NA		NA	NA							+					
HUC-11: 0401020100 (Upper Whiteface River)																						
04010201-529	Whiteface River	Whiteface Reservoir to Bug Cr	4.15	2B	FS	FS	NS		+	+							+	+	+	+	+	
04010201-549	Whiteface River, North Branch	Headwaters to Whiteface Reservoir	5.12	2B	FS	NA	NA		+	+												
04010201-600	Whiteface River, South Branch,	Unnamed cr to Unnamed cr	4.63	2A	FS	IF	NA		+	+											+	
04010201-766	Whiteface River, South Branch	Ryan Cr to Unnamed cr	6.29	2A	FS	IF	NA		+	+											+	
04010201-A37	Shiver Creek	Headwaters to Little Shiver Cr	19.13	2B	FS	NA	NA		+	+												

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.

					USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 0401020110 (Middle Whiteface River)																						
04010201-528	Whiteface River	Bug Cr to Paleface R	10.7	2B	FS	FS	NS		+	+							+	+		+	+	
04010201-529	Whiteface River	Whiteface Reservoir to Bug Cr	18	2B	FS	FS	NS		+	+							+	+	+	+	+	
04010201-545	Bug Creek	Headwaters to Whiteface R	26.88	2B	FS	IF	NA		+	+								IF			+	
HUC-11: 0401020120 (Paleface River)																						
04010201-550	Paleface River	Headwaters to Whiteface R	25.99	2B	FS	IF	NA		+	+							+	+	+	+	+	
04010201-A24	Paleface Creek	Unnamed cr to Paleface R	4.34	2B	NS	NA	NA		-	-												
HUC-11: 0401020130 (Lower Whiteface River)																						
04010201-509	Whiteface River	Paleface R to St Louis R	35.67	2B	FS	FS	NS		+	+							+	+	+	+	+	
04010201-617	Spider Creek (Spider Muskrat Creek)	Unnamed cr to Whiteface R	1.22	2B	FS	NA	NA		+	+												
04010201-959	Unnamed creek (Otter Creek)	Unnamed cr to Whiteface R	1.14	2B	FS	NA	NA		+	+												
04010201-612	Little Whiteface River	Unnamed cr to Unnamed cr	2.84	2B	NA	NA	NA		NA	NA												
04010201-616	Little Whiteface River	Unnamed cr to Whiteface R	2.49	1B	NA	NA	NA		NA	NA												
HUC-11: 0401020140 (Upper Floodwood River)																						
04010201-560	Floodwood River	Headwaters (Floodwood Lk 69-0884-00) to St Louis R	64.44	2B	FS	IF	NA		+	+							+	IF	+	+	+	+
HUC-11: 0401020150 (Lower Floodwood River)																						
04010201-560	Floodwood River	Headwaters (Floodwood Lk 69-0884-00) to St Louis R	34.44	2B	FS	IF	NA		+	+							+	IF	+	+	+	+
04010201-A11	Unnamed creek	Unnamed lk (31-1035-00) to W Br Floodwood R	1.96	2B	FS	NA	NA		+	+												
04010201-A16	Joula Creek	Headwaters to Floodwood R	5.75	2B	FS	NA	NA		+	+												
04010201-623	Vaara Creek	Unnamed cr to Floodwood R	2.54	2B	NS	NA	NA		-	-												
04010201-A10	Unnamed ditch	Unnamed ditch to Floodwood R	3.42	2B	NA	NA	NA		NA	NA												
04010201-618	Floodwood River	West Branch, Pancake Lk to Unnamed cr	4.7	2B	NA	NA	NA		NA	NA												
HUC-11: 0401020160 (East Savanna River)																						
04010201-561	East Savanna River	Headwaters (Wolf Lk 01-0019-00) to St Louis R	15.48	2B	NA	FS	NA		NA	NA							+	+	+	+	+	IF
04010201-A44	Sixteen Creek (New Channel)	Unnamed ditch to Sixteen Cr (Old Channel)	0.25	2B	NA	NA	NA		NA	NA												
04010201-A09	Wyman Creek	Headwaters to Colby Lk	0.83	2B	IF	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.

					USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 0401020170 (Lower St. Louis River)																						
04010201-503	St Louis River	Cloquet R to Pine R	9.55	2B	FS	FS	NS		+	NA							+	+	+	IF	+	+
04010201-506	St Louis River	East Savanna R to Artichoke R	18.55	2B	FS	NA	NS		+	NA							+					
04010201-515	St Louis River	Scanlon Dam to Thomson Reservoir	3.2	2B	FS	FS	NS		+	+							+	+	+	+	+	+
04010201-544	Artichoke River	Headwaters (Artichoke Lk 69-0623-00) to St Louis R	12.44	2B	FS	IF	NA		+	+								IF				
04010201-A08	McCarty River	Unnamed ditch to St Louis R	6.19	2B	FS	NA	NA		+	+										+		
04010201-629	Otter Creek	Little Otter Cr to T48 R16W S7, east line	5.8	2A	NS	IF	NA		+	-								IF				
04010201-879	Fond du Lac Creek	Unnamed Cr to T49 R17W S9, north line	2.95	2A	NA	IF	NA		-	-							+	IF				
04010201-945	Ahmik River	Unnamed cr to St Louis R	3.13	2B	NA	NA	NA		NA	NA												
04010201-A07	Unnamed creek	Unnamed cr to St Louis R	2.61	2B	NA	IF	NA		NA	NA								IF				
04010201-809	Otter Creek	Unnamed cr to Little Otter Cr	3.74	2A	IF	NA	NA										+					
HUC-11: 04010201180 (Stony Brook Creek)																						
04010201-562	Stoney Brook	Headwaters (Rice Portage 09-0037-00) to St Louis R	26.23	2B	NA	NA	NA		+	+							+	+	-	+		+
04010201-769	Martin Branch (Joe Martin Creek)	Unnamed cr to Unnamed cr	2.33	2B	NA	NA	NA		-	-							+					
04010201-996	Unnamed creek	Unnamed ditch to Unnamed cr	1.81	2B	NA	NA	NA		NA	NA												
04010201-997	Unnamed ditch	Unnamed ditch to Unnamed cr	3.02	2B	NA	NA	NA		NA	NA												
04010201-768	Martin Branch (Joe Martin Creek)	Headwaters (Martin Lk 69-0768-00) to Unnamed cr	1.5	1B	NA	NA	NA		NA	NA												
HUC-11: 04010201190 (Simian Creek)																						
04010201-989	Unnamed creek	Simian Lk to St Louis R	3.89	2B	NA	NA	NA		+	+							+	+	+	+	+	+
HUC-11: 04010201200 (White Pine River)																						
04010201-543	Pine River (White Pine River)	T50 R16W S4, north line to St Louis R	10.63	2A	FS	NS	NA		+	+							+	-	+	+	+	+
04010201-737	Dutch Slough (Dutchess Slough Creek)	Unnamed cr to Pine R	1.49	1B	FS	NA	NA		+	NA												
HUC-11: 04010201210 (Midway River)																						
04010201-625	Unnamed creek	T50 R16W S11, north line to Midway R	7.1	1 B	FS	NS	NA		+	+								-	+	IF		+
04010201-636	Midway River	T49 R16W S28, north line to St Louis R (Thomson Res)	4.32	2B	FS	FS	NA		+	+							+	IF	+	+		+
04010201-751	Hay Creek	Unnamed cr to Midway R	4.73	1B	FS	NS	NA		+	+								-				

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.

					USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											
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	Arsenic	Cadmium	Copper	Lead	Nickel	Zinc	Chloride	Escherichia coli	pH	Turbidity	Un-ionzed ammonia	Dissolved Oxygen
HUC-11: 04010201220 (St. Louis Bay)																						
04010201-513	St Louis River	Fond du Lac Dam to Mission Cr	1.84	2B	FS	FS	NS		+	+							+	+	+	+	+	+
04010201-567	Mission Creek	T49 R16W S26, north line to T48 R15W S5, south line	6.56	2A	FS	NA	NA		+													
04010201-627	Keene Creek	Headwaters to St Louis R	6.84	2A	FS	NS	NA		+	+								-	+	+	+	+
04010201-626	Kingsbury Creek	Mogie Lk to St Louis R	6.89	2A	NS	IF	NA		-	-							+	IF		IF	+	
04010201-512	Miller Creek	Headwaters to Lk Superior	9.59	2A	NS	NS	NA		+	-							-	-	+	IF	+	+
04010201-848	Sargent Creek	Headwaters to St Louis R	6.78	2A	IF	NS	NA											-			+	
04010201-884	Stewart Creek	T49 R15W S21, west line to St Louis R	2.8	2A	IF	NS	NA											-			+	
04010201-987	Unnamed creek	Unnamed cr to St Louis R	1.16	2B	IF	NS	NA											-	+	+	IF	IF
04010201-532	St Louis River	Mission Cr to Oliver bridge	4.64	2B	NA	FS	NS											+				
04010201-566	Silver Creek	Headwaters to St Louis R	3.67	2A	NA	FS	NA											+			+	
04010201-640	Mission Creek	T48 R15W S8, north line to St Louis R	0.32	2B	IF	IF	NA											IF			+	
04010201-533	St Louis River	Oliver bridge to Pokegama R	5.28	2B	NA	IF	NS											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. Minnesota Statewide IBI thresholds and confidence limits, 2012

Class	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B	46	±11	57	35
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
10	Southern Coldwater	2A	45	±13	58	32
11	Northern Coldwater	2A	37	±10	47	27
Invertebrates						
1	Northern Forest Rivers	2B	43.0	±10.8	53.8	32.2
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
8	Northern Coldwater	2A	26	±12.4	38.4	13.6
9	Southern Coldwater	2A	46.1	±13.8	59.9	32.3

Appendix 5. Good/fair/poor thresholds for biological monitoring stations on non-assessed channelized AUIDs, 2012

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	>39	39-25	<25
10	Southern Coldwater	>45	45-30	<30
11	Northern Coldwater	>37	37-22	<22
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
8	Northern Coldwater	>26	26-11	<11
9	Southern Coldwater	>46	46-31	<31

Ratings of Good for channelized streams are based on Minnesota's general use threshold for aquatic life. Stations with IBIs that score above this general threshold would be given a rating of Good. The Fair rating is calculated as a 15 point decrease 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.

Appendix 6. Biological sampled sites and F-IBI scores in the St. Louis River Watershed

Stream Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area (Mi^2)	Fish Class	Threshold	F-IBI	Visit Date
HUC-11:04010201-115(Upper St. Louis River)							
04010201-511	09LS080	St. louis River	715.78	4	35	65	20-Aug-09
04010201-511	09LS080	St. Louis River	715.78	4	35	81	13-Jul-09
04010201-644	97LS080	St. Louis Rivr	101.07	5	50	76	16-Jul-09
04010201-526	09LS085	St. louis River	361.25	5	50	0	15-Jul-09
04010201-526	09LS088	St. Louis River	291.92	5	50	80	14-Jul-09
04010201-570	09LS081	Elbow Creek	14.09	6	40	55	23-Jun-09
04010201-518	09LS082	Elbow Creek	3.17	6	40	26	23-Jun-09
04010201-A26	09LS084	Ely Creek	15.45	6	40	34	24-Jun-09
04010201-A39*	09LS087	Unnamed Creek	13.17	6		37	23-Jun-09
04010201-521*	98LS016	Elbow Creek	1.98	6		31	24-Jun-09
04010201-594*	98LS017	Unnamed Creek	9.26	6		37	23-Jun-09
04010201-A25*	09LS083	Long Lake Creek	9.06	6		48	25-Jun-09
HUC-11:04010201-020(Partridge River)							
04010201-587	97LS077	Unnamed creek	14.04	6	40	61	16-Jul-09
04010201-946	09LS106	Colvin Creek	21.94	7	40	58	15-Jul-09
04010201-942	81LS008	Wyman Creek	10.85	11	37	33	23-Jun-09
04010201-552	09LS102	Partridge River	152.58	5	50	41	18-Aug-09
04010201-552	09LS105	Partridge River	103.53	5	50	87	15-Jul-09
04010201-552	09LS114	Partridge River	152.62	5	50	79	16-Jul-09

HUC-11:04010201-030(Embarrass River)							
04010201-579	97LS005	Embarrass River	115.07	5	50	0	13-Jul-09
04010201-A42	09LS101	Spring Mine Creek	4.43	6	40	37	16-Sep-09
04010201-A42	09LS101	Spring Mine Creek	4.43	6	40	37	23-Jun-09
04010201-583	98LS011	Unnamed creek	18.99	6	40	42	01-Jul-09
04010201-577	09LS095	Embarrass River	189.61	5	50	93	08-Jul-09
04010201-A40	09LS098	Bear Creek	30.41	7	40	43	14-Jul-09
04010201-579	09LS100	Embarrass River	18.89	7	40	31	14-Jul-09
04010201-579	10EM045	Embarrass River	44.58	7	40	0	15-Jul-09
04010201-579	10EM045	Embarrass River	44.58	7	40	0	28-Jul-10
HUC-11:04010201-040(Mud Hen Creek)							
04010201-A28	09LS090	Mud Hen Creek	98.74	5	50	78	28-Jul-09
04010201-A28	09LS090	Mud Hen Creek	98.74	5	50	73	08-Jul-09
04010201-A30	09LS091	Mud Hen Creek	18.48	6	40	67	23-Jun-09
04010201-A31	09LS092	Water Hen River	68.47	5	50	44	13-Jul-09
04010201-A36	09LS093	Water Hen Creek, South Branch	21.38	6	40	38	22-Jun-09
04010201-A35	09LS094	Water Hen Creek	15.86	6	40	41	23-Jun-09
HUC-11:04010201-050(Two Rivers)							
04010201-534	09LS073	West Two River	77.81	5	50	83	28-Jul-09
04010201-534	09LS073	West Two River	77.81	5	50	77	09-Jul-09
04010201-551	09LS074	Trib. to McQuade Lake	17.50	6	40	-	13-Sep-11
04010201-551	09LS074	Trib. to McQuade Lake	17.50	6	40	67	01-Jul-09
04010201-535	09LS075	West Two River	33.48	6	40	55	11-Jun-09
04010201-555	09LS076	East Two River	49.35	6	40	66	13-Jul-09
04010201-548	09LS078	Trib. to East Two Rivers	5.70	6	40	0	25-Jun-09
04010201-635*	98LS015	Trib. to Manganika Lake	1.41	6		0	24-Jun-09

HUC-11:04010201-060(Middle St. Louis)							
04010201-508	97LS090	St Louis River	1936.38	4	35	84	08-Jul-09
04010201-508	97LS090	St Louis River	1936.38	4	35	89	17-Aug-09
04010201-510	09LS038	St Louis River	881.83	4	35	77	15-Jul-09
04010201-510	09LS109	St Louis River	941.37	4	35	67	28-Jul-09
04010201-525	09LS030	St Louis River	1323.24	4	35	80	08-Jul-09
04010201-525	09LS034	St Louis River	1196.41	4	35	78	27-Jul-09
04010201-607	09LS033	Sand Creek	63.99	5	50	43	08-Jun-09
04010201-963	09LS036	Stony Creek	21.54	6	40	39	01-Jul-09
04010201-A17	09LS035	Trib. to St Louis River	4.83	6	40	37	25-Jun-09
04010201-A18	09LS031	Skunk Creek	15.01	6	40	0	30-Jun-09
04010201-A19*	09LS032	Trib. to St Louis River	6.02	6	40	0	25-Jun-09
04010201-A20*	09LS037	Trib. to St Louis River	4.31	6	40	52	23-Jun-09
HUC-11:04010201-070(Upper East Swan)							
04010201-520	98LS012	Barber Creek	8.23	6	40	77	24-Jun-09
04010201-569	89LS026	Barber Creek	46.57	6	40	78	17-Aug-09
04010201-582	09LS068	Dempsey Creek	35.85	6	40	67	07-Jul-09
04010201-641	09LS071	Barber Creek (East Swan River)	33.71	6	40	63	14-Jul-09
04010201-641	09LS112	Barber Creek	31.75	6	40	62	24-Jun-09
04010201-553*	09LS070	Penobscot Creek	4.25	6		10	17-Aug-09
HUC-11:04010201-080(Upper West Swan)							
04010201-559	98NF115	West Swan River	90.70	5	50	78	18-Aug-09
04010201-559	98NF115	West Swan River	90.70	5	50	75	14-Jul-09
04010201-559	09LS066	West Swan River	39.82	7	40	36	22-Jun-09
04010201-559	09LS067	West Swan River	16.75	6	40	72	12-Aug-09

HUC-11:04010201-090(Lower East Swan)							
04010201-557	09LS061	Swan River	244.26	5	50	36	19-Aug-09
04010201-891	09LS062	Little Swan Creek	21.08	11	37	34	12-Aug-09
04010201-542	09LS063	Trib. to East Swan Creek	7.75	6	40	74	22-Jun-09
04010201-888	09LS064	East Swan Creek	7.06	11	37	54	07-Jul-09
HUC-11:04010201-100(Upper Whiteface)							
04010201-600	97LS019	Whiteface River, South Branch	25.98	6	40	76	19-Jun-09
04010201-529	09LS056	Whiteface River	134.88	5	50	77	10-Jul-09
04010201-766	09LS057	Whiteface River, South Branch	11.54	7	40	52	14-Jul-09
04010201-A37	09LS058	Shiver Creek	9.60	6	40	70	22-Jun-09
04010201-549	09LS059	Whiteface River, North Branch	47.31	6	40	76	29-Jul-09
04010201-549	09LS060	Whiteface River, North Branch	16.43	7	40	49	29-Jul-09
HUC-11:04010201-110(Middle Whiteface)							
04010201-529	97LS081	Whiteface River	187.67	5	50	83	08-Jul-09
04010201-528	09LS051	Whiteface River	254.15	5	50	80	18-Jun-09
04010201-545	09LS052	Bug Creek	24.55	7	40	54	19-Jun-09
04010201-545	99NF016	Bug Creek	11.35	6	40	83	13-Jul-99
HUC-11:04010201-120(Paleface)							
04010201-550	09LS048	Paleface River	62.70	5	50	56	05-Aug-09
04010201-550	09LS048	Paleface River	62.70	5	50	71	18-Jun-09
04010201-550	09LS050	Paleface River	15.08	7	40	48	23-Jun-09
04010201-A24	09LS049	Paleface Creek	29.45	7	40	31	01-Jul-09
04010201-A24	09LS049	Paleface Creek	29.45	7	40	21	09-Jun-09

HUC-11:04010201-130(Lower Whiteface)							
04010201-509	98LS046	Whiteface River	358.40	5	50	89	19-Aug-09
04010201-509	09LS039	Whiteface River	523.30	4	35	64	08-Jul-09
04010201-612	67LS005	Little Whiteface River	27.14	6	40	59	30-Jun-09
04010201-612	67LS005	Little Whiteface River	27.14	6	40	36	09-Jun-09
04010201-616	98LS045	Little Whiteface River	54.06	5	50	45	10-Jun-09
04010201-617	98LS049	Spider Muskrat Creek	31.39	6	40	69	11-Jun-09
04010201-617	98LS049	Spider Muskrat Creek	31.39	6	40	71	02-Jul-09
04010201-959	09LS040	Otter Creek	16.58	6	40	54	29-Jun-09
HUC-11:04010201-140(Upper Floodwood)							
04010201-560	09LS027	Floodwood River	26.43	7	40	41	25-Jun-09
HUC-11:04010201-150(Lower Floodwood)							
04010201-560	97LS033	Floodwood River	204.08	5	50	0	13-Jul-09
04010201-623	97LS034	Vaara Creek	27.77	7	40	0	12-Aug-09
04010201-A11	09LS108	Trib. to Floodwood River, West Branch	7.02	6	40	61	10-Aug-09
04010201-A16	09LS110	Joula Creek	13.87	6	40	33	30-Jun-09
04010201-618*	98LS043	Floodwood River, West Branch	12.71	7		59	08-Jun-09
04010201-618*	98LS043	Floodwood River, West Branch	12.71	7		66	30-Jun-09
04010201-A10*	09LS024	Unnamed ditch	2.79	6		14	08-Jun-09
04010201-A10*	09LS024	Unnamed ditch	2.79	6		53	30-Jun-09
HUC-11:04010201-160(East Savanna River)							
04010201-561	98LS050	East Savannah River	118.16	5	50	9	06-Aug-09
04010201-561	98LS050	East Savannah River	118.16	5	50	63	17-Jun-09
04010201-561	09LS023	East Savanna River	102.90	5	50	47	08-Jun-09
04010201-A44*	09LS111	Sixteen Creek	41.12	6	40	26	16-Jun-09

HUC-11:04010201-170(Lower St. Louis)							
04010201-503	97LS091	St Louis River	3316.30	4	35	72	25-Aug-09
04010201-506	09LS009	St Louis River	2347.68	4	35	76	24-Aug-09
04010201-515	97LS093	St Louis River	3432.51	4	35	55	14-Sep-09
04010201-544	97LS088	Artichoke River	27.26	6	40	66	09-Jun-09
04010201-629	09LS005	Otter Creek	39.72	11	37	43	09-Jun-09
04010201-879	68LS039	Squaw Creek	6.98	11	37	29	04-Aug-09
04010201-A08	09LS012	McCarty River	17.62	6	40	72	29-Jun-09
04010201-945*	09LS010	Ahmik River	11.78	6		66	11-Aug-09
04010201-A07*	09LS011	Trib. to St Louis River	17.29	6		78	01-Jul-09
HUC-11:04010201-180(Stony Brook)							
04010201-562	09LS016	Stoney Brook	100.03	5	50	81	04-Aug-09
04010201-562	09LS016	Stoney Brook	100.03	5	50	62	16-Jun-09
04010201-562	09LS019	Stoney Brook	29.10	7	40	72	03-Aug-09
04010201-562	09LS019	Stoney Brook	29.10	7	40	32	09-Jun-09
04010201-562	09LS018	Stoney Brook	73.12	5	50	45	03-Aug-09
04010201-562	09LS113	Stoney Brook	99.68	5	50	72	04-Aug-09
04010201-769	09LS017	Martin Branch (Joe Martin Creek)	5.80	11	37	23	04-Aug-09
04010201-996*	09LS021	Unnamed ditch	16.47	7	40	58	03-Aug-09
04010201-997*	09LS020	Unnamed ditch	6.97	6	40	80	03-Aug-09
HUC-11:04010201-190(Simian Creek)							
04010201-989	09LS015	Simian Creek	20.84	6	40	57	4-Aug-09

HUC-11:04010201-200(White Pine)							
04010201-543	09LS013	Pine River	43.43	11	37	53	05-Aug-09
04010201-543	09LS013	Pine River	43.43	11	37	50	23-Jun-09
04010201-543	09LS115	White Pine River	19.00	11	37	55	30-Jun-09
04010201-737	09LS014	Dutch Slough (Dutchess Slough Creek)	14.74	11	37	49	10-Aug-09
HUC-11:04010201-210(Midway)							
04010201-636	09LS004	Midway River	65.12	5	50	80	25-Jun-09
04010201-751	97LS108	Hay Creek	11.80	11	37	71	29-Jun-09
04010201-625	97LS112	Trib. to Midway River	8.86	11	37	52	01-Jul-09
HUC-11:04010201-220(St. Louis Bay)							
04010201-512	09LS003	Miller Creek	7.97	11	37	63	01-Jul-09
04010201-513	09LS001	St Louis River	3574.57	4	35	60	26-Aug-09
04010201-567	09LS002	Mission Creek	10.57	11	37	39	01-Jul-09
04010201-567	09LS002	Mission Creek	10.57	11	37	26	09-Jun-09
04010201-626	95LS036	Kingsbury Creek	7.11	11	37	36	02-Jul-09
04010201-627	95LS028	Keene Creek	4.49	11	37	61	02-Jul-09

Appendix 7. Biological sampled sites and M-IBI scores in the St. Louis River Watershed

Stream Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area (Mi^2)	Invert Class	Threshold	M-IBI	Visit Date
HUC-11:04010201-115(Upper St. Louis River)							
04010201-511	09LS080	St Louis River	715.78	1	51.3	0.00	21-Sep-10
04010201-511	09LS080	St Louis River	715.78	1	51.3	0.00	21-Sep-10
04010201-511	09LS080	St Louis River	715.78	1	51.3	77.84	11-Aug-09
04010201-518	09LS082	Elbow Creek	3.17	4	52.4	29.98	16-Sep-09
04010201-521*	98LS016	Elbow Creek	1.98	4		18.59	13-Aug-09
04010201-526	09LS088	St Louis River	291.92	3	50.3	81.62	27-Aug-09
04010201-570	09LS081	Elbow Creek	14.09	3	50.3		13-Sep-11
04010201-570	09LS081	Elbow Creek	14.09	3	50.3	37.52	17-Aug-09
04010201-594*	98LS017	Trib. to St Louis River	9.26	3		43.30	12-Aug-09
04010201-644	97LS080	St Louis River	101.07	3	50.3	70.33	25-Aug-09
04010201-A25*	09LS083	Long Lake Creek	9.06	4		28.21	18-Aug-09
04010201-A26	09LS084	Ely Creek	15.45	4	52.4	62.66	16-Sep-09
04010201-A39*	09LS087	Trib. to St Louis River	13.17	4		54.12	12-Aug-09
HUC-11:04010201-020(Partridge River)							
04010201-552	09LS102	Partridge River	152.58	3	50.3	83.79	13-Aug-09
04010201-552	09LS105	Partridge River	103.53	3	50.3	70.98	19-Aug-09
04010201-587	97LS077	Unnamed creek	14.04	3	50.3	59.93	18-Sep-09
04010201-942	81LS008	Wyman Creek	10.85	8	26	39.75	22-Sep-09
04010201-942	81LS008	Wyman Creek	10.85	8	26	26.39	12-Aug-09
04010201-946	09LS106	Colvin Creek	21.94	4	52.4	75.52	19-Aug-09

HUC-11:04010201-030(Embarrass River)							
04010201-577	09LS095	Embarrass River	189.61	4	52.4	89.17	10-Aug-09
04010201-579	97LS005	Embarrass River	115.07	4	52.4	68.97	12-Aug-09
04010201-579	09LS100	Embarrass River	18.89	4	52.4	60.64	19-Aug-09
04010201-579	10EM045	Embarrass River	44.58	4	52.4	38.71	06-Sep-09
04010201-579	10EM045	Embarrass River	44.58	4	52.4	40.77	22-Sep-10
04010201-583	98LS011	Unnamed creek	18.99	4	52.4	56.36	12-Aug-09
04010201-A40	09LS098	Bear Creek	30.41	4	52.4	67.20	19-Aug-09
04010201-A42	09LS101	Spring Mine Creek	4.43	4	52.4	46.35	19-Aug-09
HUC-11:04010201-040(Mud Hen Creek)							
04010201-A28	09LS090	Mud Hen Creek	98.74	4	52.4	81.48	10-Aug-09
04010201-A30	09LS091	Mud Hen Creek	18.48	4	52.4	80.59	18-Aug-09
04010201-A31	09LS092	Water Hen Creek	68.47	4	52.4	-	12-Sep-11
04010201-A31	09LS092	Water Hen Creek	68.47	4	52.4	42.24	18-Aug-09
04010201-A35	09LS094	Water Hen Creek	15.86	4	52.4	33.79	12-Aug-09
04010201-A36	09LS093	Water Hen Creek, South Branch	21.38	4	52.4	59.18	12-Aug-09
04010201-A64	04LS002	Unnamed creek		4	52.4	19.51	11-Sep-04
HUC-11:04010201-050(Two Rivers)							
04010201-534	09LS073	West Two River	77.81	3	50.3	61.15	11-Aug-09
04010201-535	09LS075	West Two River	33.48	4	52.4	34.00	13-Aug-09
04010201-548	09LS078	Trib. to East Two Rivers	5.70	4	52.4	14.45	18-Aug-09
04010201-551	09LS074	Trib. to McQuade Lake	17.50	3	50.3	-	13-Sep-11
04010201-551	09LS074	Trib. to McQuade Lake	17.50	3	50.3	41.37	18-Aug-09
04010201-555	09LS076	East Two River	49.35	3	50.3	57.82	18-Aug-09
04010201-635*	98LS015	Trib. to Manganika Lake	1.41	4		0.89	13-Aug-09

HUC-11:04010201-060(Middle St. Louis River)							
04010201-508	97LS090	St Louis River	1936.38	1	51.3	33.68	08-Sep-09
04010201-508	97LS090	St Louis River	1936.38	1	51.3	45.82	01-Sep-09
04010201-510	09LS109	St Louis River	941.37	1	51.3	67.58	10-Aug-09
04010201-510	09LS038	St Louis River	881.83	1	51.3	56.51	17-Aug-09
04010201-525	09LS030	St Louis River	1323.24	1	51.3	52.84	06-Aug-09
04010201-525	09LS034	St Louis River	1196.41	1	51.3	69.55	12-Aug-09
04010201-525	09LS034	St Louis River	1196.41	1	51.3	38.92	10-Aug-09
04010201-607	09LS033	Sand Creek	63.99	4	52.4	81.40	10-Aug-09
04010201-963	09LS036	Stony Creek	21.54	4	52.4	42.48	10-Aug-09
04010201-A17	09LS035	Trib. to St Louis River	4.83	4	52.4	31.80	10-Aug-09
04010201-A18	09LS031	Skunk Creek	15.01	4	52.4	39.64	11-Aug-09
04010201-A19*	09LS032	Trib. to St Louis River	6.02	4		44.86	06-Aug-09
04010201-A20*	09LS037	Trib. to St Louis River	4.31	4		45.89	13-Aug-09
HUC-11:04010201-070(Upper East Swan River)							
04010201-520	98LS012	Barber Creek	8.23	3	50.3	29.81	13-Aug-09
04010201-520	98LS012	Barber Creek	8.23	3	50.3	17.82	13-Aug-09
04010201-553*	09LS070	Penobscot Creek	4.25	4		26.37	10-Sep-09
04010201-569	89LS026	Barber Creek	46.57	4	52.4	63.85	10-Sep-09
04010201-582	09LS068	Dempsey Creek	35.85	4	52.4	84.02	01-Sep-09
04010201-641	09LS071	Barber Creek (East Swan River)	33.71	4	52.4	52.69	10-Sep-09
04010201-641	09LS112	Barber Creek	31.75	4	52.4	28.12	21-Sep-10
HUC-11:04010201-080(Upper West Swan River)							
04010201-559	09LS066	West Swan River	39.82	4	52.4	54.90	17-Aug-09
04010201-559	09LS067	West Swan River	16.75	3	50.3	54.40	20-Aug-09
04010201-559	98NF115	West Swan River	90.70	4	52.4	68.90	11-Aug-09

HUC-11:04010201-090(Lower East Swan River)							
04010201-542	09LS063	Trib. to East Swan Creek	7.75	4	52.4	49.73	17-Aug-09
04010201-557	09LS061	Swan River	244.26	4	52.4	51.68	22-Sep-09
04010201-557	09LS061	Swan River	244.26	4	52.4	63.96	18-Aug-09
04010201-888	09LS064	East Swan Creek	7.06	8	26	21.89	10-Sep-09
04010201-891	09LS062	Little Swan Creek	21.08	8	26	22.26	22-Sep-09
HUC-11:04010201-100(Upper Whiteface River)							
04010201-529	09LS056	Whiteface River	134.88	3	50.3	79.98	13-Aug-09
04010201-549	09LS059	Whiteface River, North Branch	47.31	3	50.3	54.20	26-Aug-09
04010201-549	09LS060	Whiteface River, North Branch	16.43	3	50.3	48.84	20-Aug-09
04010201-549	09LS059	Whiteface River, North Branch	47.31	3	50.3	57.62	26-Aug-09
04010201-600	97LS019	Whiteface River, South Branch	25.98	3	50.3	83.71	09-Sep-09
04010201-766	09LS057	Whiteface River, South Branch	11.54	4	52.4	55.62	09-Sep-09
04010201-A37	09LS058	Shiver Creek	9.60	3	50.3	76.67	12-Aug-09
HUC-11:04010201-110(Middle Whiteface River)							
04010201-529	97LS081	Whiteface River	187.67	3	50.3	77.55	05-Aug-09
04010201-528	09LS051	Whiteface River	254.15	4	52.4	84.63	10-Aug-09
04010201-545	09LS052	Bug Creek	24.55	4	52.4	77.70	04-Sep-09
HUC-11:04010201-120(Paleface River)							
04010201-550	09LS048	Paleface River	62.70	4	52.4	58.65	10-Aug-09
04010201-550	09LS050	Paleface River	15.08	4	52.4	34.49	12-Aug-09
04010201-550	09LS050	Paleface River	15.08	4	52.4	51.53	05-Aug-09
04010201-A24	09LS049	Paleface Creek	29.45	4	52.4	38.79	05-Aug-09

HUC-11:04010201-130(Lower Whiteface River)							
04010201-509	09LS039	Whiteface River	523.30	1	51.3	58.82	01-Sep-09
04010201-509	98LS046	Whiteface River	358.40	3	50.3	75.35	05-Aug-09
04010201-509	09LS039	Whiteface River	523.30	1	51.3	40.86	06-Aug-09
04010201-612*	67LS005	Little Whiteface River	27.14	4		42.06	11-Aug-09
04010201-616*	98LS045	Little Whiteface River	54.06	4		56.39	06-Aug-09
04010201-617	98LS049	Spider Muskrat Creek	31.39	3	50.3	66.23	11-Aug-09
04010201-959	09LS040	Otter Creek	16.58	3	50.3	50.12	06-Aug-09
HUC-11:04010201-140(Upper Floodwood River)							
04010201-560	09LS027	Floodwood River	26.43	4	52.4	61.26	07-Aug-09
HUC-11:04010201-150(Lower Floodwood River)							
04010201-560	97LS033	Floodwood River	204.08	4	52.4	34.95	07-Aug-09
04010201-618*	98LS043	Floodwood River, West Branch	12.71	4		26.56	13-Aug-09
04010201-623	97LS034	Vaara Creek	27.77	4	52.4	48.06	25-Aug-09
04010201-A10*	09LS024	Unnamed ditch	2.79	4		12.76	11-Aug-09
04010201-A11	09LS108	Trib. to Floodwood River, West Branch	7.02	4	52.4	50.29	25-Aug-09
04010201-A16	09LS110	Joula Creek	13.87	4	52.4	56.19	11-Aug-09
HUC-11:04010201-160(East Savanna River)							
04010201-561*	09LS023	East Savanna River	102.90	4		50.34	13-Aug-09
04010201-561*	98LS050	East Savannah River	118.16	4		50.50	07-Aug-09
04010201-A44*	09LS111	Sixteen Creek	41.12	4		61.31	08-Sep-09

HUC-11:04010201-170(Lower St. Louis River)							
04010201-503	97LS091	St Louis River	3316.30	1	51.3	0.00	26-Aug-10
04010201-506	09LS009	St Louis River	2347.68	1	51.3	0.00	26-Aug-10
04010201-515	97LS093	St Louis River	3432.51	1	51.3	50.17	12-Aug-09
04010201-515	97LS093	St Louis River	3432.51	1	51.3	0.00	26-Aug-10
04010201-544	97LS088	Artichoke River	27.26	3	50.3	59.44	04-Aug-09
04010201-629	09LS005	Otter Creek	39.72	8	26	24.86	10-Sep-09
04010201-879	68LS039	Squaw Creek	6.98	8	26	9.74	15-Sep-09
04010201-945*	09LS010	Ahmik River	11.78	4		38.62	25-Aug-09
04010201-A07*	09LS011	Trib. to St Louis River	17.29	4		63.75	08-Sep-09
04010201-A08	09LS012	McCarty River	17.62	4	54.4	69.81	11-Aug-09
HUC-11:04010201-180(Stony Brook)							
04010201-562	09LS019	Stoney Brook	29.10	4	50	47.25	15-Sep-09
04010201-562	09LS016	Stoney Brook	100.03	3	50	53.44	15-Sep-09
04010201-562	09LS018	Stoney Brook	73.12	4	40	47.81	15-Sep-09
04010201-562	09LS016	Stoney Brook	100.03	3	40	59.51	15-Aug-09
04010201-562	09LS113	Stoney Brook	99.68	3	50	55.56	15-Sep-09
04010201-769	09LS017	Martin Branch (Joe Martin Creek)	5.80	8	50	16.60	15-Sep-09
04010201-996*	09LS021	Unnamed ditch	16.47	4		37.42	15-Sep-09
04010201-997*	09LS020	Unnamed ditch	6.97	4		35.46	15-Sep-09
HUC-11:04010201-190(Simian Creek)							
04010201-989	09LS015	Simian Creek	20.84	3	50.3	60.91	15-Sep-09

HUC-11:04010201-200(White Pine River)							
04010201-543	09LS013	Pine River	43.43	8	26	33.37	14-Sep-09
04010201-543	09LS115	White Pine River	19.00	8	26	12.11	11-Aug-09
04010201-737	09LS014	Dutch Slough (Dutchess Slough Creek)	14.74	8	26	11.45	25-Aug-09
HUC-11:04010201-210(Midway River)							
04010201-625	97LS112	Trib. to Midway River	8.86	8	26	40.46	09-Sep-09
04010201-636	09LS004	Midway River	65.12	3	50.3	64.07	06-Aug-09
04010201-751	97LS108	Hay Creek	11.80	8	26	34.58	11-Aug-09
HUC-11:04010201-220(St. Louis Bay)							
04010201-512	09LS003	Miller Creek	7.97	8	26	19.37	11-Aug-09
04010201-512	09LS003	Miller Creek	7.97	8	26	17.12	21-Sep-09
04010201-513	09LS001	St Louis River	3574.57	1	51.3	49.11	18-Aug-09
04010201-567	09LS002	Mission Creek	10.57	8	26	23.65	26-Aug-10
04010201-626	95LS036	Kingsbury Creek	7.11	8	26	5.93	09-Sep-09
04010201-627	95LS028	Keene Creek	4.49	8	26	41.90	09-Sep-09

Appendix 8. Biological monitoring results for non-assessed channelized AUIDs – Fish IBI scores

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Good	Fair	Poor	F-IBI	Visit Date
HUC-11: 04010201115 (Upper St. Louis River)									
04010201-A39	09LS087	Unnamed Creek	13.17	6	100 - 40	39 - 25	24 - 0	37	23-Jun-09
04010201-521	98LS016	Elbow Creek	1.98	6	100 - 40	39 - 25	24 - 0	31	24-Jun-09
04010201-594	98LS017	Unnamed Creek	9.26	6	100 - 40	39 - 25	24 - 0	37	23-Jun-09
04010201-A25	09LS083	Long Lake Creek	9.06	6	100 - 40	39 - 25	24 - 0	48	25-Jun-09
HUC-11: 04010201050 (Two Rivers)									
04010201-635	98LS015	Trib. to Manganika Lake	1.41	6	100 - 40	39 - 25	24 - 0	0	24-Jun-09
HUC-11: 04010201060 (Middle St. Louis River)									
04010201-A19	09LS032	Trib. to St Louis River	6.02	6	100 - 40	39 - 25	24 - 0	0	25-Jun-09
04010201-A20	09LS037	Trib. to St Louis River	4.31	6	100 - 40	39 - 25	24 - 0	52	23-Jun-09
HUC-11: 04010201070 (Upper East Swan River)									
04010201-553	09LS070	Penobscot Creek	4.25	6	100 - 40	39 - 25	24 - 0	10	17-Aug-09
HUC-11: 04010201130 (Lower Whiteface River)									
04010201-612	67LS005	Little Whiteface River	27.14	6	100 - 40	39 - 25	24 - 0	36	09-Jun-09
04010201-616	98LS045	Little Whiteface River	54.06	5	100 - 50	49 - 35	34 - 0	45	10-Jun-09
HUC-11: 04010201150 (Lower Floodwood River)									
04010201-618	98LS043	Floodwood River, West Branch	12.71	7	100 - 40	39 - 25	24 - 0	59	08-Jun-09
04010201-618	98LS043	Floodwood River, West Branch	12.71	7	100 - 40	39 - 25	24 - 0	66	30-Jun-09
04010201-A10	09LS024	Unnamed ditch	2.79	6	100 - 40	39 - 25	24 - 0	14	08-Jun-09
04010201-A10	09LS024	Unnamed ditch	2.79	6	100 - 40	39 - 25	24 - 0	53	30-Jun-09
HUC-11: 04010201160 (East Savanna River)									
04010201-561	98LS050	East Savannah River	118.16	5	100 - 50	49 - 35	34 - 0	9	06-Aug-09
04010201-561	98LS050	East Savannah River	118.16	5	100 - 50	49 - 35	34 - 0	63	17-Jun-09
04010201-561	09LS023	East Savanna River	102.90	5	100 - 50	49 - 35	34 - 0	47	08-Jun-09
04010201-A44	09LS111	Sixteen Creek	41.12	6	100 - 40	39 - 25	24 - 0	26	16-Jun-09

HUC-11: 04010201170 (Lower St. Louis River)									
04010201-945	09LS010	Ahmik River	11.78	6	100 - 40	39 - 25	24 - 0	66	11-Aug-09
04010201-A07	09LS011	Trib. to St Louis River	17.29	6	100 - 40	39 - 25	24 - 0	78	01-Jul-09
HUC-11: 04010201180 (Stony Brook)									
04010201-996	09LS021	Unnamed ditch	16.47	7	100 - 40	39 - 25	24 - 0	58	03-Aug-09
04010201-997	09LS020	Unnamed ditch	6.97	6	100 - 40	39 - 25	24 - 0	80	03-Aug-09

Appendix 9. Biological monitoring results for non-assessed channelized AUIDs – Invertebrate IBI Scores

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Good	Fair	Poor	M-IBI	Visit Date
HUC-11: 04010201115 (Upper St. Louis River)									
04010201-A39	09LS087	Unnamed Creek	13.17	4	100 - 53	52 - 37	36 - 0	54.12	12-Aug-09
04010201-521	98LS016	Elbow Creek	1.98	4	100 - 53	52 - 37	36 - 0	18.59	13-Aug-09
04010201-594	98LS017	Unnamed Creek	9.26	3	100 - 51	50 - 35	34 - 0	43.30	12-Aug-09
04010201-A25	09LS083	Long Lake Creek	9.06	4	100 - 53	52 - 37	36 - 0	28.21	18-Aug-09
HUC-11: 04010201050 (Two Rivers)									
04010201-635	98LS015	Trib. to Manganika Lake	1.41	4	100 - 53	52 - 37	36 - 0	0.89	13-Aug-09
HUC-11: 04010201060 (Middle St. Louis River)									
04010201-A19	09LS032	Trib. to St Louis River	6.02	4	100 - 53	52 - 37	36 - 0	44.86	06-Aug-09
04010201-A20	09LS037	Trib. to St Louis River	4.31	4	100 - 53	52 - 37	36 - 0	45.89	13-Aug-09
HUC-11: 04010201070 (Upper East Swan River)									
04010201-553	09LS070	Penobscot Creek	4.25	4	100 - 53	52 - 37	36 - 0	26.37	10-Sep-09

HUC-11: 04010201130 (Lower Whiteface River)									
04010201-612	67LS005	Little Whiteface River	27.14	4	100 - 53	52 - 37	36 - 0	42.06	11-Aug-09
04010201-616	98LS045	Little Whiteface River	54.06	4	100 - 53	52 - 37	36 - 0	56.39	06-Aug-09
HUC-11: 04010201150 (Lower Floodwood River)									
04010201-618	98LS043	Floodwood River, West Branch	12.71	4	100 - 53	52 - 37	36 - 0	26.56	13-Aug-09
04010201-A10	09LS024	Unnamed ditch	2.79	4	100 - 53	52 - 37	36 - 0	12.76	11-Aug-09
HUC-11: 04010201160 (East Savanna River)									
04010201-561*	98LS050	East Savannah River	118.16	4	100 - 53	52 - 37	36 - 0	50.50	07-Aug-09
04010201-561*	09LS023	East Savanna River	102.90	4	100 - 53	52 - 37	36 - 0	50.34	13-Aug-09
04010201-A44*	09LS111	Sixteen Creek	41.12	4	100 - 53	52 - 37	36 - 0	61.31	08-Sep-09
HUC-11: 04010201170 (Lower St. Louis River)									
04010201-945	09LS010	Ahmik River	11.78	4	100 - 53	52 - 37	36 - 0	38.62	25-Aug-09
04010201-A07	09LS011	Trib. to St Louis River	17.29	4	100 - 53	52 - 37	36 - 0	63.75	08-Sep-09
HUC-11: 04010201180 (Stony Brook)									
04010201-996	09LS021	Unnamed ditch	16.47	4	100 - 53	52 - 37	36 - 0	37.42	15-Sep-09
04010201-997	09LS020	Unnamed ditch	6.97	4	100 - 53	52 - 37	36 - 0	35.46	15-Sep-09

Appendix 10. Fish species, site and total number of individuals collected in the St. Louis Watershed

Common Name	Sites Collected At	Total Number Collected
bigmouth shiner	5	49
black bullhead	27	81
black crappie	8	20
blacknose dace	42	1768
blacknose shiner	31	182
bluegill	8	44
brassy minnow	20	199
brook stickleback	49	969
brook trout	13	113
brown trout	2	8
burbot	52	267
central mudminnow	98	1436
channel catfish	5	11
common carp	1	6
common shiner	61	1064
creek chub	76	1760
emerald shiner	1	1
fathead minnow	29	468
finescale dace	13	139
freshwater drum	1	1
Gen: Notropis	1	2
Gen: redhorses	1	1
golden shiner	20	206
green sunfish	5	20
hornyhead chub	5	339
hybrid Phoxinus	4	43
hybrid sunfish	1	3
Iowa darter	12	59
johnny darter	81	1355
largemouth bass	5	8
logperch	29	254
longnose dace	55	1539
longnose sucker	1	1
mimic shiner	15	1141
mottled sculpin	62	867
northern pike	58	138
northern redbelly dace	39	1179
pearl dace	39	700
pumpkinseed	9	19
rock bass	41	251
shorthead redhorse	28	234
silver redhorse	1	24
smallmouth bass	29	612
spottail shiner	4	15
tadpole madtom	28	96
trout-perch	15	58
walleye	12	25
white sucker	115	2435
yellow bullhead	3	4
yellow perch	41	445

Appendix 11. Morphometric characteristics for all assessed lakes within the St. Louis River Watershed

Lake ID	Lake Name	County	Subwatershed	Lake area	Watershed area	Max Depth	Mean Depth	Littoral Area	Aquatic Recreation Use Support
				Hectares	Hectares	Meters	Meters	%	
69-0429-00	Sabin (Embarrass Mine)	St. Louis	Embarrass River	63	38	141	60	8	FS
69-0565-00	Esquagama	St. Louis	Embarrass River	191	41008	27	15	19	FS
69-0496-00	Embarrass	St. Louis	Embarrass River	182	39202	4.5	3	92	FS
31-0016-00	Pancake	Itasca	Lower Floodwood	55	2479	9.6	6	23	FS
69-0627-00	Nichols	St. Louis	Lower Whiteface	170	872	9	2.4	87	FS
69-0426-00	Loon	St. Louis	Mud Hen Creek	105	392	25.5	10.6	24	FS
69-0550-00	Section Fourteen	Itasca	Mud Hen Creek	54	200	8.1	2.5	78	FS
69-0562-00	Coe	St. Louis	Mud Hen Creek	21	119	6.6	4.6	82	FS
31-0001-00	Long	Itasca	Upper Floodwood	52	2155	25.2	9.1	35	FS
31-0028-00	Beauty	Itasca	Upper Floodwood	88	264	9.6	3.3	70	FS
69-0044-00	Butterball	St. Louis	Upper St. Louis	177	1206	1.8	1.5	100	FS
69-0420-00	South Twin	St. Louis	Upper St. Louis	45	641	14.4	10.6	43	FS
69-0553-00	Bass	St. Louis	Upper St. Louis	59	723	10.5	7.6	35	FS
69-0556-00	Lost	St. Louis	Upper St. Louis	44	1298	13.2	6.1	16	FS
69-0114-00	Cadotte	St. Louis	Upper Whiteface	119	86	5.4	3	71	FS
69-0375-00	Whiteface Reservoir	Itasca	Upper Whiteface	1454	33266	9.9	3.6	62	FS
31-0022-00	Little Island	Itasca	West Swan	42	1987	13.5	6.8	46	FS
31-0023-00	Helen	Itasca	West Swan	66	1507	9	6.1	52	FS
69-0529-00	Strand	St. Louis	Middle Whiteface	127	1047	4.8	2.3	99	NS
69-0494-00	Mud Hen	St. Louis	Mud Hen Creek	64	1376	2.4	1.8	100	NS
69-0495-00	Long	St. Louis	Mud Hen Creek	151	12546	4.2	2.1	100	NS

69-0544-00	Dinham	St. Louis	Paleface River	81	1772	7.5	3.7	63	NS
69-0726-00	Manganika	St. Louis	Two Rivers	71	1263	7.2	3	88	NS
69-0775-00	McQuade	St. Louis	Two Rivers	70	4983	6.3	4.6	96	NS
69-0994-00	West Two Rivers Reservoir	St. Louis	Two Rivers	294	7816	8.2	3.6	70	NS

Appendix 12. MINLEAP modeling results and observed water quality data for all assessed lakes within the St. Louis River Watershed

*- to improve predictions, lake inflow TP concentration set to 10X stream average concentration, and not the 52 ug/L default for the NLF ecoregion
** to improve predictions, lake inflow TP concentrations set to monitored municipal wastewater concentration

Lake ID	Lake Name	Obs. TP	MINLEAP TP	Obs. Chl-a	MINLEAP Chl-a	Obs. Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Background TP	P Retention	Outflow	Residence Time	Areal Load
		ug/L	ug/L	ug/L	ug/L	m	m	ug/L	kg/yr	ug/L	%	hm3/yr	years	m/yr
31-0001	Long	10	27	2	8	4.4	2.3	53	266	18.7	49	5.0	0.9	9.6
31-0016	Pancake	21	30	6	10	1.9	2.0	53	305	21.4	43	5.7	0.6	10.4
31-0022	Little Island	9	30	2	9	3.0	2.1	53	244	16.4	43	4.6	0.6	10.9
31-0023	Helen	15	26	6	8	2.0	2.3	54	190	16.1	52	3.5	1.1	5.3
31-0028	Beauty	17	19	5	5	2.1	3.1	62	45	16.5	70	0.7	4.0	0.8
69-0044	Butterball	24	29	3	9	0.9	2.1	57	171	16.5	49	3.0	0.9	1.6
69-0114	Cadotte	11	15	4	4	3.4	3.7	80	28	11.6	81	0.3	10.1	0.3
69-0375	Whiteface Reservoir	26	30	8	9	1.3	2.1	54	4197		45	78.4	0.7	5.3
69-0420	South Twin	17	19	4	5	2.2	3.1	54	84	12.6	65	1.5	3.1	3.3
69-0426	Loon	9	12	2	3	5.9	4.4	60	63	17.5	79	1.0	10.7	0.9
69-0429	Sabin / Embarrass Pit	3	3	0.2	0.2	15.0	13.3	83	14	9.6	96	0.7	226	0.2
69-0550	Section 14	15	22	5	6	2.6	2.7	60	32		64	0.5	2.6	0.9

69-0553	Bass *	9	12	3	2	3.7	4.7	25	44	15	54	1.7	2.6	2.9
69-0556	Lost *	8	14	2	3	4.1	4.0	23	69	18	39	3.0	0.9	6.9
69-0562	Coe	22	20	5	5	1.7	3.0	58	17	7.8	66	0.3	3.2	1.4
69-0565	Esquagama *	16	12	3	2	2.5	4.6	15	1443	11	23	94.5	0.3	49.5
69-0627	Nichols	24	24	7	7	2.1	2.5	58	130	21.2	59	2.2	1.8	1.3
69-0496	Embarrass *	22	14	7	3	1.7	4.1	15	1380	22	11	90.4	0.1	49.6
69-0494	Mudhen	34	34	8	11	1.9	1.8	54	174	27.6	36	3.2	0.4	5.0
69-0495	Long	51	40	16	15	0.9	1.6	52	1523	20.4	23	29.0	0.1	19.2
69-0529	Strand	55	27	7	8	1.0	2.3	56	144		52	2.5	1.1	2.0
69-0544	Dinham	36	29	21	9	1.4	2.1	54	224	16.8	46	4.1	0.7	5.1
69-0726	Manganika **	308	166	67	115	0.8	0.5	575	162		71	3.0	0.7	4.2
69-0775	McQuade	65	35	21	12	1.6	1.8	52	606	26.1	33	11.5	0.3	16.5
69-0994	West Two River Reservoir	41	31	15	10	1.7	2.0	53	979	28.4	43	18.3	0.6	6.2