Lower St. Croix River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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Authors

MPCA Lower St. Croix River Watershed Report Team:
Jordan Donatell, Chris Klucas, Pam Anderson, David Duffey, Bruce Monson,
Gerald Flom, Joel Chirhart, Kris Parson and Dave Christopherson

Contributors / acknowledgements

Citizen Lake Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture
Metropolitan Council Environmental Services
Chisago County Soil and Water Conservation District
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Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 | www.pca.state.mn.us | 651-296-6300
Toll free 800-657-3864 | TTY 651-282-5332

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Executive summary

This assessment report is the first in a series of reports for watershed work being conducted in the Lower St. Croix River Watershed. The results of surface water monitoring activities and assessments in the Lower St. Croix River Watershed are reported here. Subsequent reports will explain stressor identification, Total Maximum Daily Loads (TMDLs), and restoration and protection plans for the watershed.

The Lower St. Croix Watershed (07030005) encompasses 585,735 acres in east central Minnesota within the St. Croix River Basin. In the mid 1800's intensive logging of large pine forests in the northern portion of the watershed began; once the logging boom subsided, cleared land was converted to agricultural production. Currently, agriculture accounts for 51 percent of this watershed's land use, 23 percent being cropland and 28 percent rangeland.

The Minnesota Pollution Control Agency (MPCA) started the intensive watershed monitoring effort of the Lower St. Croix River Watershed in the summer of 2009. This watershed experienced a significant drought in the summer 2009, affecting the assess ability of biological data collected. Biological data was collected at 45 stations located at the outlet of subwatersheds; these locations included the mouth of the Sunrise River, the outlets of other major tributaries and the outlets of small headwater tributaries. In 2011, a holistic approach was taken to assess all of the watershed's surface water bodies for aquatic life, aquatic recreation, and fish consumption use support, where data was available. Twenty-six stream reaches were assessed for aquatic life support, 24 stream reaches for aquatic recreation, and 105 lakes were assessed for aquatic recreation use support. Not all lake and streams were able to be assessed due to insufficient data, modified channel condition, low flow conditions, or having a status as limited resources waters (class 7).

Ten stream reaches were found to be fully supporting of aquatic life use in the Lower St. Croix Watershed. Nine new impairments of aquatic life have been added to the Lower St. Croix River watershed during the 2011 assessment cycle. Three corrections from non-supporting status to supporting status on the Impaired Waters List have been made; these were for fish and invertebrate IBI on Rock Creek, and invertebrate IBI on Goose Creek and the North Branch Sunrise River. Twenty-four reaches were assessed for aquatic recreation and five were found to be fully supporting. Aquatic recreation impairments involving high bacteria concentrations are common throughout the watershed's tributaries. Aquatic consumption impairments span the entire length of the Lower St. Croix River for polychlorinated biphenyl (PCBs) and mercury (HgF) concentrations in fish; the mainstem Sunrise River is listed as impaired due to mercury concentrations as well. Channelized streams throughout the watershed are generally in poor to below average biological condition. Habitat assessments on tributaries to the Lower St. Croix show a variety of habitat qualities; the best habitat conditions are located in some of the small coldwater tributaries in the southern part of the watershed.

This watershed's close proximity to expanding suburban landscapes will pose a challenge to maintaining water quality in some southern and central tributaries. Addressing issues associated with stormwater runoff from impervious surfaces will be an important aspect, as will riparian management and protection. Restoration implementation measures will be necessary to improve water quality of other tributaries (e.g. Sunrise River, Rush Creek, portions of Browns Creek, and Goose Creek). Many restoration projects are being developed or are already underway on tributaries that have failed to meet water quality standards. Considering the recreational and economic value of the Lower St. Croix River to the region, restoring and/or maintaining water quality conditions in its tributaries will be vital to the future of the river.

I. Introduction

Water is one of Minnesota's most abundant and precious resources. The 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 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 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 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 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 Lower St. Croix River Watershed beginning in the summer of 2009.This report provides a summary of all water quality assessment results in the Lower St. Croix River Watershed, incorporating 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 Clean Water Act goal of protecting, restoring, and preserving the quality of Minnesota's water resources.

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 Monitoring and Assessment* (MPCA 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

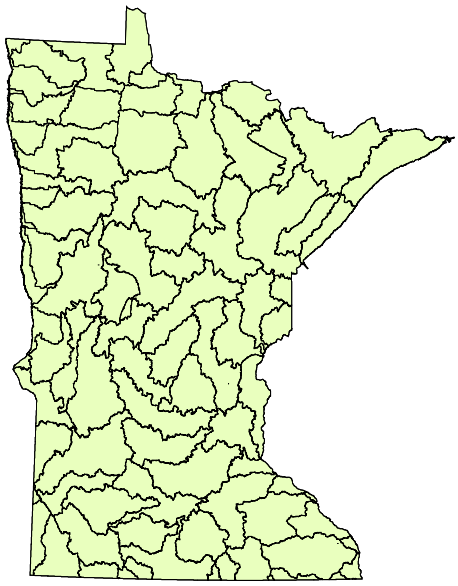

Figure 1. Major watersheds within Minnesota (8-Digit HUC)

Load monitoring network

The first component of this effort is the Watershed Pollutant Load Monitoring Program (WPLMN), which involves permanent flow and water chemistry monitoring stations on Minnesota's major rivers, including the Red, Minnesota, Mississippi, and Rainy rivers, and the outlets of major tributaries (also referred to as major watersheds). WPLMN staff and program cooperators monitor water quality at many of these outlets and at various locations along Minnesota's major rivers. Initiated in 2007, and funded with appropriations from Minnesota's Clean Water Fund, the WPLMN's multi-agency monitoring approach combines site-specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MDNR) flow gauging stations. This partnership effort, along with water quality data collected by the Metropolitan Council Environmental Services (MCES), and local monitoring organizations, is a cornerstone of the watershed approach.

Water quality samples are collected year round at all WPLMN monitoring sites. Approximately 30-35 mid-stream grab samples are collected per site per year. Sample collection intensity is greatest during periods of moderate and high flow due to the importance these samples carry in pollutant load calculations. Sampling also occurs during low flow periods but at a lower frequency. Water quality and discharge data are combined in the "Flux32 Pollutant Load Model" to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs from Flux32 include pollutant loads and flow weighted mean concentrations (FWMC). A pollutant load is defined as the amount (mass) of a pollutant passing a stream location over a given unit of time. The flow weighted mean concentration is used to estimate the overall quality of water passing this point, computed by dividing the pollutant load by the total flow volume that passed the stream location over the same given unit of time. Annual pollutant loads are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), and nitrate plus nitrite-nitrogen (nitrate-N). Primary outputs from Flux32 include pollutant loads (Table 1) and FWMC (Figures 1-4). When fully implemented, the MWLMP will monitor and compute pollutant loads at 81 stream sites across the State.

The on-going monitoring performed by the program is designed to measure and compare regional differences and long-term trends in water quality. This will be particularly helpful in putting the intensive watershed monitoring data for a given watershed (see below) into a longer-term context, given that the intensive monitoring will occur only once every 10 years. The load monitoring network will also provide critical information for identifying baseline or acceptable loads for maintaining and protecting water resources. In the case of impaired waters, the data collected through these efforts will be used to aid in the development of TMDL studies, implementation of plans, assist watershed modeling efforts, and provide information to watershed research projects.

Intensive watershed monitoring

Stream monitoring

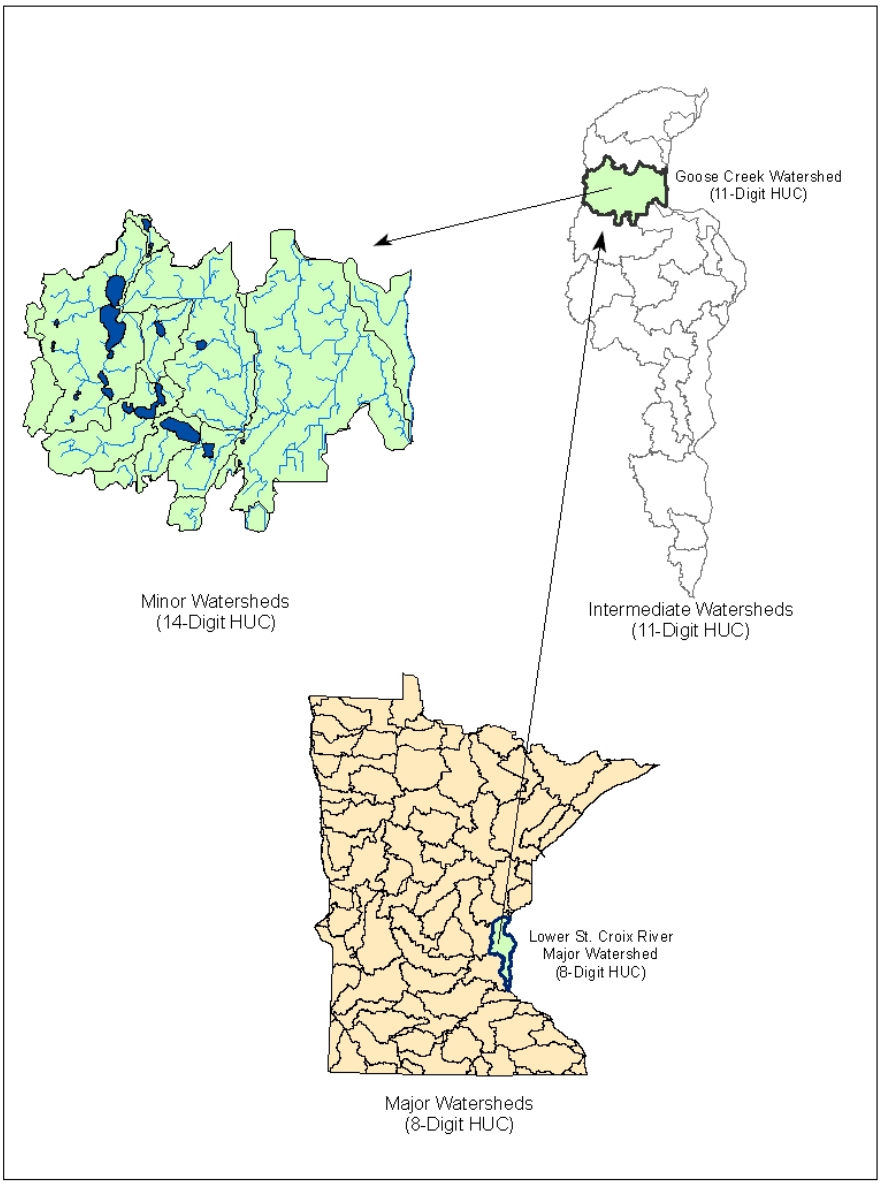

Figure 2. The intensive watershed monitoring design

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale (Figure 2). The foundation of this comprehensive approach is the 81 major watersheds within Minnesota. Streams are broken into segments by hydrologic unit codes (HUC) to define separate waterbodies within a watershed. 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). River/stream sites are selected near the outlet at all watershed scales. This approach provides holistic assessment coverage of rivers and streams without monitoring every single stream reach (See Figure 3 for an illustration of the monitoring site coverage within the Lower St. Croix River Watershed).

The mainstem Sunrise River (green dot in Figure 3) was sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation, and aquatic consumption use support. Each 11-HUC outlet (orange dots in Figure 3) 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 mi^2. Lastly, most minor watersheds (typically 10-20 mi^2) are sampled for biology (fish and macroinvertebrates) to assess aquatic life use support (magenta dots in Figure 3). Specific locations for sites sampled as part of the intensive monitoring effort in the Lower St. Croix River Watershed can be found in individual watershed results.

The second step of the intensive watershed monitoring effort consists of follow-up monitoring at areas 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 to be addressed in 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.

Even when pooling MPCA and local resources, the MPCA is 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 the primary focus is on monitoring and assessing larger lakes, the MPCA is also committed to directly monitoring, or supporting the monitoring of, the majority of lakes between 100-499 acres ("small lakes") for assessment purposes.

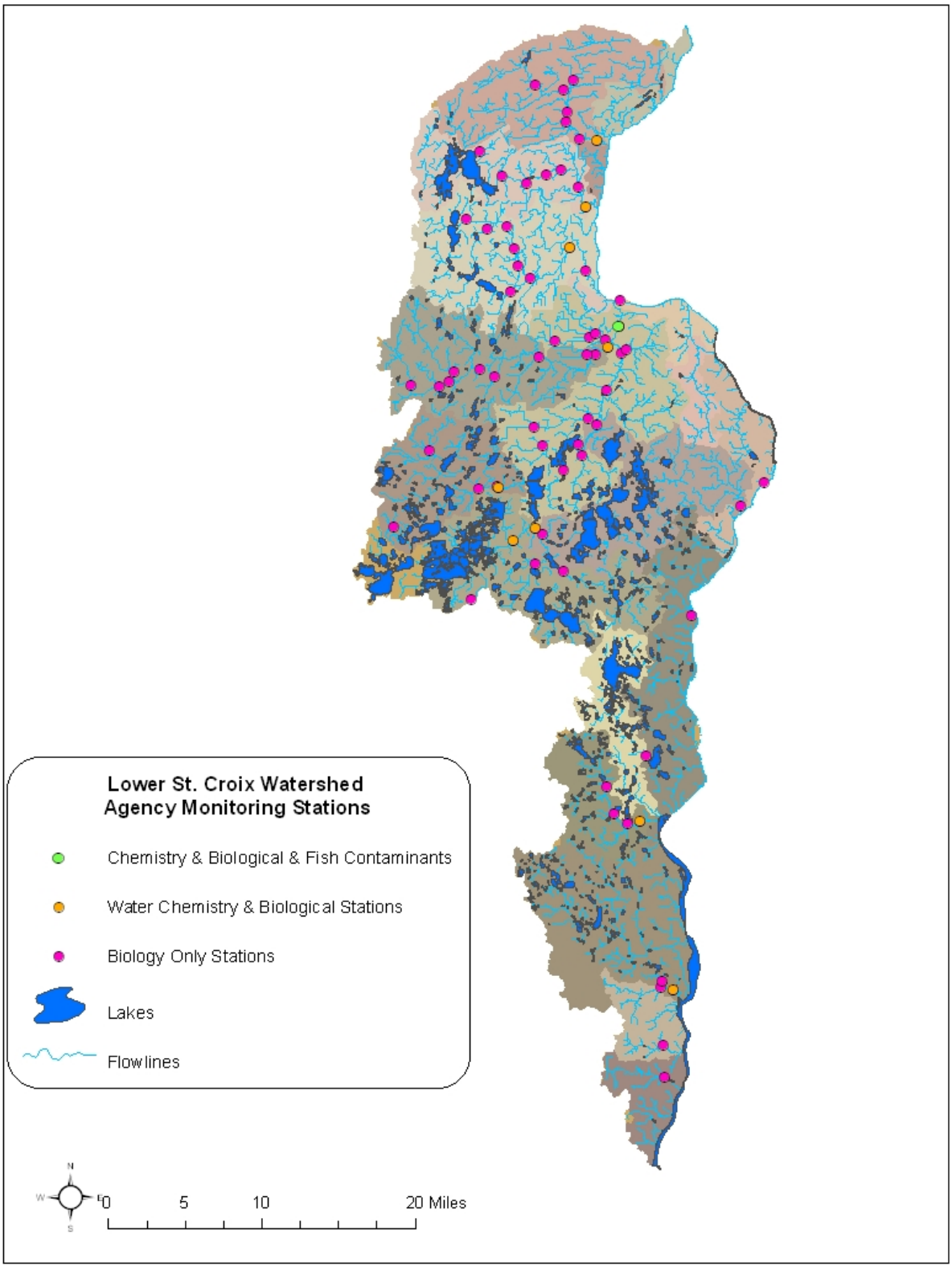

Figure 3. Intensive watershed monitoring stream stations in the Lower St. Croix River Watershed

Citizen and local monitoring

Citizen monitoring is an important component of the watershed monitoring approach. The MPCA coordinates two programs aimed at encouraging citizen surface water monitoring: the Citizen Lake Monitoring Program and the Citizen Stream Monitoring Program. Like the permanent load monitoring network, sustained citizen monitoring can provide the long-term picture needed to help evaluate current status and trends. The advanced identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites, so that water quality data collected by volunteers are available for the years before and after the intensive monitoring effort by MPCA staff. This citizen-collected data helps agency staff interpret the results from the intensive monitoring effort, which only occurs one out of every 10 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 planning and tracking purposes will help local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change. Figure 4 provides an illustration of the locations where citizen monitoring data was collected in the Lower St. Croix River Watershed.

The MPCA also passes through funding via Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts, watershed districts, non-profits, and educational institutions to monitor lake and stream water quality. The southern portion of the Lower St. Croix Watershed benefits from the existence of these organizations. These local partners greatly expand our overall capacity to conduct sampling. Many SWAG grantees invite citizen participation in their monitoring projects. The annual SWAG Request for Proposal (RFP) identifies the major watersheds that are scheduled for upcoming intensive monitoring activities. HUC-11 stream outlet chemistry sites and lakes less than 500 acres that need monitoring are identified in the RFP and local entities are invited to request funds to complete the sampling. SWAG grantees conduct detailed sampling efforts following the same established monitoring protocols and quality assurance procedures used by the MPCA. All of the lake and stream monitoring data from SWAG projects are combined with the MPCA's monitoring data to assess the condition of Minnesota lakes and streams.

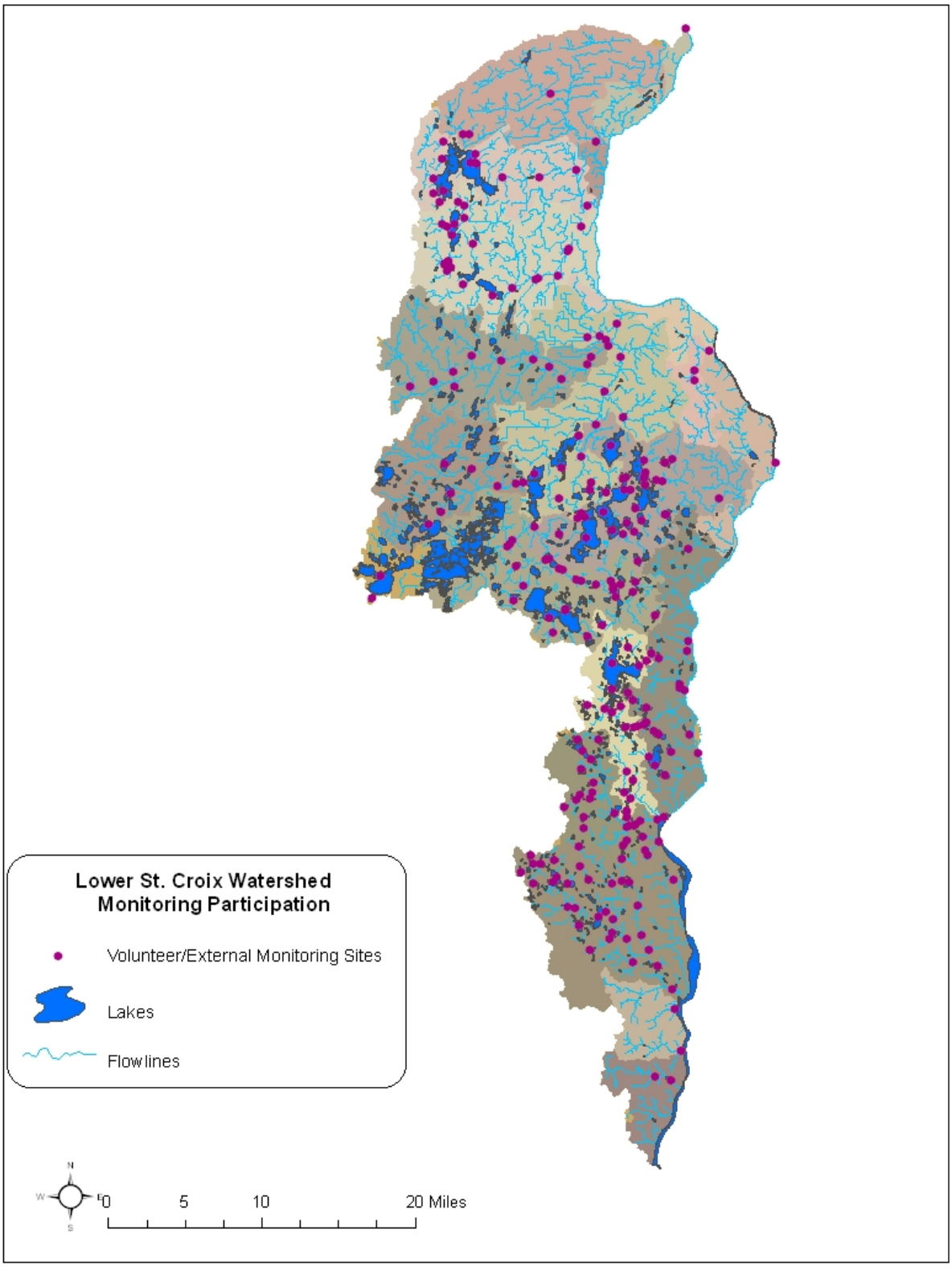

Figure 4. Monitoring locations of local groups and citizens in the Lower St. Croix River Watershed

III. Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses. The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodology see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012). http://www.pca.state.mn.us/index.php/view-document.html?gid=16988.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. Use attainment status describes whether or not a waterbody is supporting its designated use as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams and wetlands are protected for aquatic life and recreation where these uses are attainable. Protection of aquatic life means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms, including fish and invertebrates. Protection of recreation means the maintenance of conditions suitable for swimming and other forms of water recreation. Protection of consumption means protecting citizens who eat fish inhabiting Minnesota waters or receive their drinking water from waterbodies protected for this use.

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

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

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R. ch 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into

multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale, high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its AUID), comprised of the USGS eight digit hydrologic unit code plus a three character code that is unique within each HUC. Lake and wetland identifiers are assigned by the MDNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs, and wetlands. These identification numbers serve as the AUID and are composed of an eight digit number indicating county, lake, and bay for each basin.

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

Determining use attainment status

Conceptually, the process for determining use attainment status of a waterbody is similar for each designated use: comparison of monitoring data to established water quality standards. However, the complexity of that process and the amount of information required to make accurate assessments varies between uses. In part, the level of complexity in the assessment process depends on the strength of the dose-response relationship; i.e., if chemical B exceeds water quality criterion X, how often is beneficial use Y truly not being attained. For beneficial uses related to human health, such as drinking water, the relationship is well understood and thus, the assessment process is a relatively simple interpretation of numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 5.

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

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012) http://www.pca.state.mn.us/index.php/view-document.html?gid=16988 for guidelines and factors to consider when making such determinations.

Any new impairment determination (i.e., waterbody not attaining its beneficial use) is reviewed using Geographic Information Services to determine if greater than 50 percent of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use framework. For additional information see: Tiered Aquatic Life Use (TALU) Framework (http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/tiered-aquatic-life-use-talu-framework.html). Since large portions of a watershed may be channelized, reaches with biological data are evaluated on a "good-fair-poor" system to help evaluate their condition.

The last step in the assessment process is the Professional Judgement Group or PJG meeting. At this meeting results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might have a vested interest in the outcomes of the assessment process. Information obtained during this meeting may be used to revise previous use attainment decisions. The result of this meeting is a compilation of the assessed waters which will be included in the watershed assessment report. Waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List.

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments, and volunteers. The data must meet rigorous quality-assurance protocols before being used. All monitoring data required or paid for by MPCA is entered into Environmental Quality Information System (EQuIS), MPCA's data system. The MPCA uploads the data from EQuIS to USEPA's STORET data warehouse. Water quality monitoring projects required to store data in EQuIS are those with federal or state funding under CWA Section 319, Clean Water Partnership (CWP), CWLA Surface Water Assessment Grants, and the TMDL program. Many local projects not funded by the MPCA choose to submit their data to the MPCA in EQuIS-ready format so that it may be utilized in the assessment process. Prior to each assessment cycle, the MPCA requests data from local entities and partner organizations using the most effective methods, including direct contacts and Gov-Delivery distribution lists.

Period of records

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

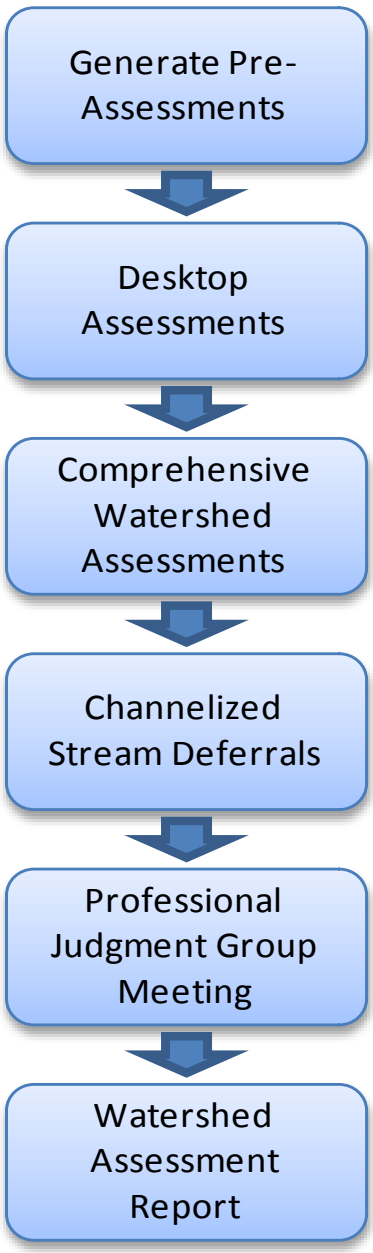

Figure 5. Flowchart of aquatic life use assessment process

IV. Watershed overview

The Lower St. Croix River Watershed is one of four major watersheds in the St. Croix River Basin. It begins just downstream of the confluence of the St. Croix and Snake rivers near Pine City, and runs parallel to the St. Croix River to the confluence with the Mississippi River near the city of Prescott, Wisconsin. This watershed consists of several tributaries that drain directly into the Lower St. Croix River, including tributaries from Wisconsin. The official name of this hydrologic unit is known as the Lower St. Croix River (Stillwater); the hydrologic unit code is 07030005. This report is limited to the Minnesota portion of this hydrologic unit.

The Lower St. Croix River Watershed is approximately 915 mi^2 and includes portions of Pine, Chisago, Isanti, Anoka and Washington Counties (Figure 6). The majority of the Lower St. Croix River Watershed is located within the North Central Hardwood Forest ecoregion, but there are small portions of the Northern Lakes and Forests in the north and Western Corn Belt Plains to the south (Omernik 1988). Alfisols and Entisols soil types are prominent throughout this watershed; these are usually loamy or sandy soils which allow productive row crop agricultural practices to thrive (Anderson, Bell, Cooper, and Grigal 2001).

As the land changes from agricultural uses in the low gradient headwater areas of the watershed to more forested near the mouths of the tributaries, the stream gradients increase as the elevation drops on the path to the St. Croix River. Gradient is particularly low in the central portion of the watershed creating areas of wetland dominated river systems. There are numerous springs along the St. Croix River corridor, creating cool water and coldwater conditions, particularly in the southern part of the watershed. Due to the presence of these springs in the forested areas of the watershed, there are currently 15 designated trout streams recognized by the MDNR.

There are many lakes in the Lower St. Croix River Watershed; these include Big Marine, Big Carnelian, the Chisago Lakes Chain, Forest, Rush, and Rock, located in the central and southern parts of the watershed. Most of these lakes are linked through a chain of small connector waterways. Small impoundments are also a part of the Sunrise River System. These lakes and impoundments contribute to the biological communities of the adjacent tributaries.

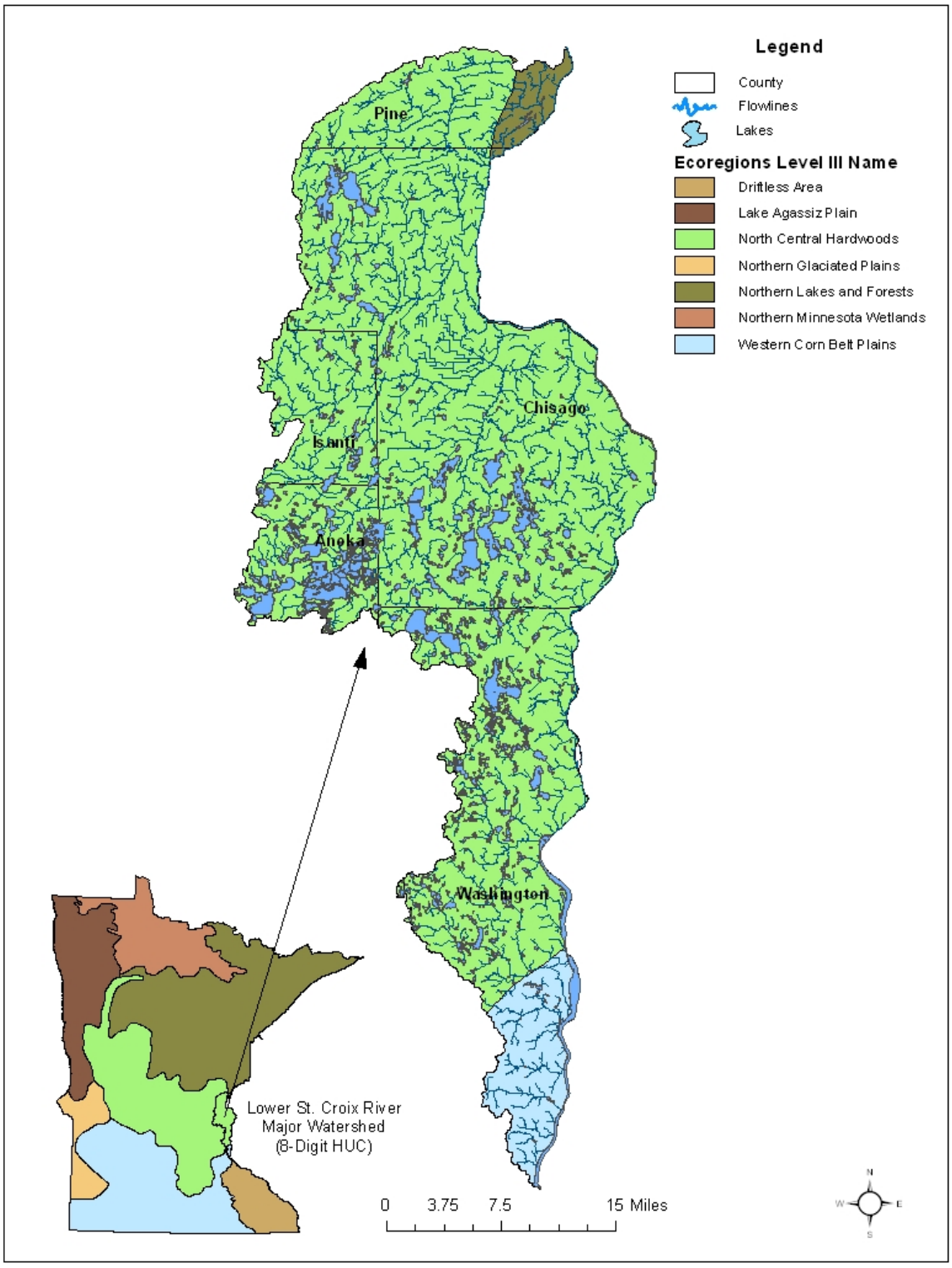

Figure 6. Level III ecoregions and counties within the Lower St. Croix River Watershed

Land use summary

The Lower St. Croix River valley is comprised of rolling, wooded bluff land, and small wooded valleys; above the bluffs agriculture and urban land uses becomes much more prevalent. The Lower St. Croix River was designated as a Wild and Scenic River in 1972 (Interagency Wild and Scenic Rivers Council 1972), giving its stricter regulations on the development of surrounding riparian land and additional protection of instream hydrological changes and water quality. This has allowed the bluffs surrounding the Lower St. Croix River to remain relatively undisturbed; this is where the majority of untouched forestland lies in this watershed.

Before western settlement, the river valley was dominated by hardwood forests and mixed savannah with large white pine stands in the far northern portion of the watershed. Once the treaty of 1837 was signed, the federal government obtained the land within the Lower St. Croix Watershed, and started intensively logging it, producing 15 billion board feet of timber between 1839-1916 (St. Croix Valley Community Foundation 1999). The river was used to transport large amounts of timber south to mills which shipped lumber across the country. Following the logging boom, fertile land that was cleared for logging was converted to agricultural production.

Today land cover in the watershed is distributed as follows: 23.3 percent cropland, 28.2 percent rangeland, 25.2 percent forest/shrub, 9.0 percent developed, 5.9 percent open water, and 8.3 percent wetland (Figure 6).

Farmland accounted for 115,280 and 81,237 acres in Washington and Chisago counties respectively (USDA 2007). The number of farms in these counties has dropped by eight percent and 15 percent between 2002 and 2007 (USDA 2007). The majority of farms in these two counties are smaller than 180 acres (USDA 2007). There are 189 permitted feedlots in the watershed (Figure 8), scattered throughout the watershed with higher densities in the east and north central regions of the watershed.

Significant population centers are located along the I-35 and I-94 corridors, including the eastern Twin Cities metropolitan area, Stillwater, Forest Lake, Wyoming, and North Branch. Urban sprawl has increasingly affected the southern portion of this watershed, with metropolitan communities (e.g. Oakdale, Woodbury, and Mahtomedi) expanding east further into the watershed. Woodbury was the third fastest growing city in the metropolitan area, expanding by 12,875 residents between 2000-2009 (MET Council 2009). From 2000 to 2010, Washington and Chisago counties grew by 18 percent and 31 percent respectively, among the highest growth rates for counties in Minnesota (Census Bureau 2012). Urban growth results in more impervious surfaces (e.g. parking lots, driveways, roads, sidewalks, rooftops) which impede natural infiltration processes, and can lead to higher runoff rates, increased sedimentation and altered thermal regimes in urban waterways.

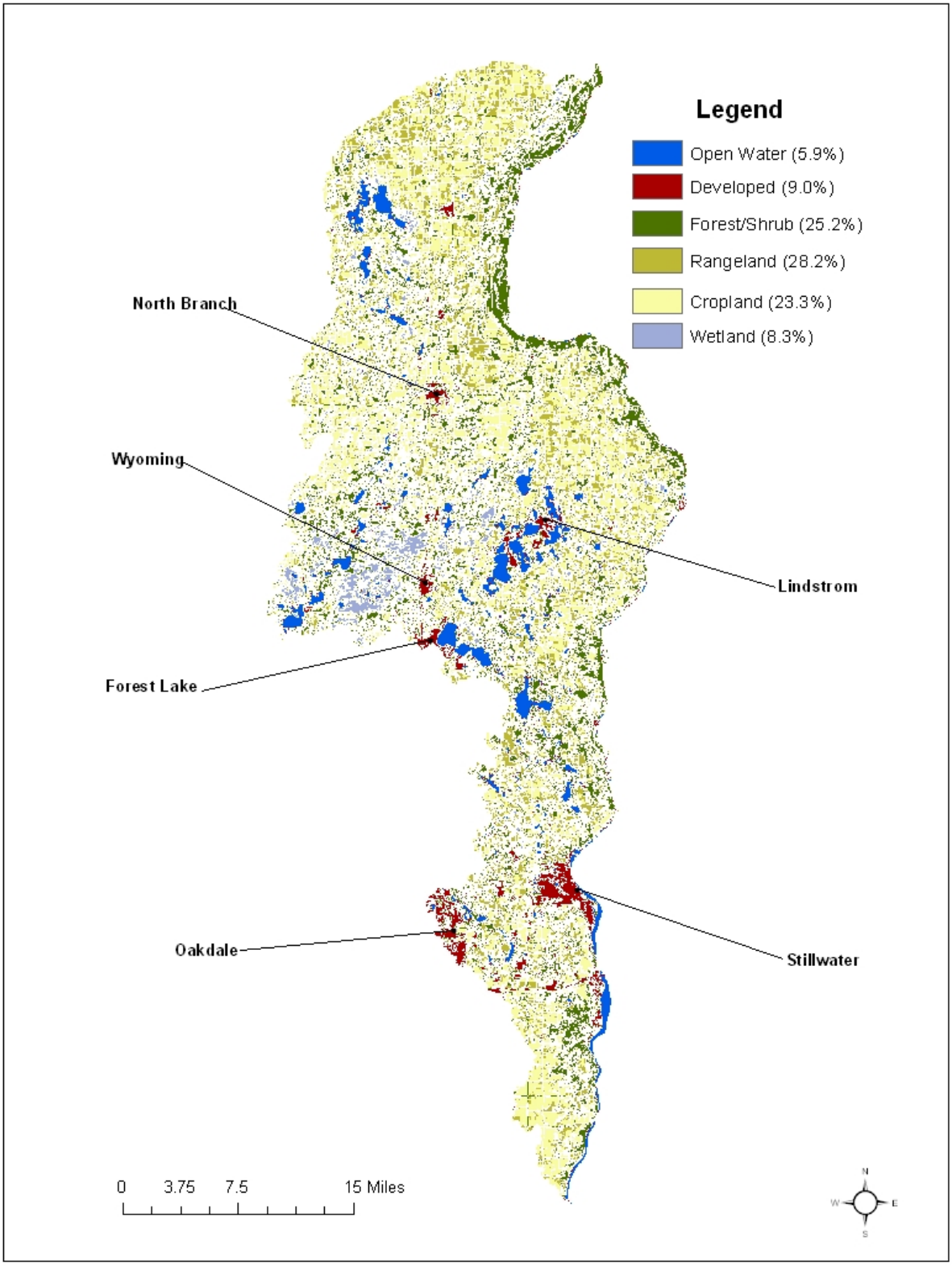

Figure 7. Land use in the Lower St. Croix Watershed

Surface water hydrology

As the mainstem St. Croix River flows south from the confluence with the Snake River, the main channel meanders through a narrow flood plain with numerous oxbow lakes, back channels and sloughs. Upon reaching the Arcola sandbar north of Stillwater, the river becomes known as Lake St. Croix, a large open-water basin with little flow or gradient change. The channel constricts flow at a few locations throughout Lake St. Croix; creating characteristics of a large river system with increased flow and channel development.

There are seven major tributaries to the St. Croix River; Rock Creek, Rush Creek, Goose Creek, the Sunrise River system, Browns Creek, and Valley Branch Creek. Some smaller tributaries include Lawrence Creek, Trout Brook, and Silver Creek. The majority of other tributaries in this watershed are unnamed, intermittent streams that have not been monitored and thus were not assessed by the MPCA.

There are numerous lakes located in the central and northern portion of this watershed. Most lakes are interconnected with outlets and channels eventually flowing in the Lower St. Croix River. The most significant lakes in the watershed are Rock, Rush, Goose, Sunrise River pools, Big Marine, Forest, Green, Chisago, North Center, South Center, Carnelian, and Elmo. Stormwater retention ponds concentrated near urban centers are numerous throughout the central and southern regions in this watershed; their water levels can fluctuate greatly when compared to larger lakes.

Wetlands are prevalent throughout this watershed, playing a large role in the dynamics of some lakes and rivers. Wetlands can be a major collection point for run-off from urban areas; pretreatment of stormwater is necessary in most situations to prevent these wetlands from becoming impaired. The central and southern sections of the mainstem St. Croix River included in this watershed have few wetlands in the immediate riparian areas, while riparian wetlands are more prevalent in northern sections of the river. Lagoons, sloughs, and oxbow lakes are an important part of the floodplain throughout the river as the water levels fluctuate seasonally.

There are 27 National Pollutant Discharge Elimination System (NPDES) permitees in this watershed (Figure 8). These permits are required for entities that discharge treated effluent to surface waters. While there are some private permitees that rely on large septic systems, most permits are issued to Waste Water Treatment Plants in cities throughout the watershed.

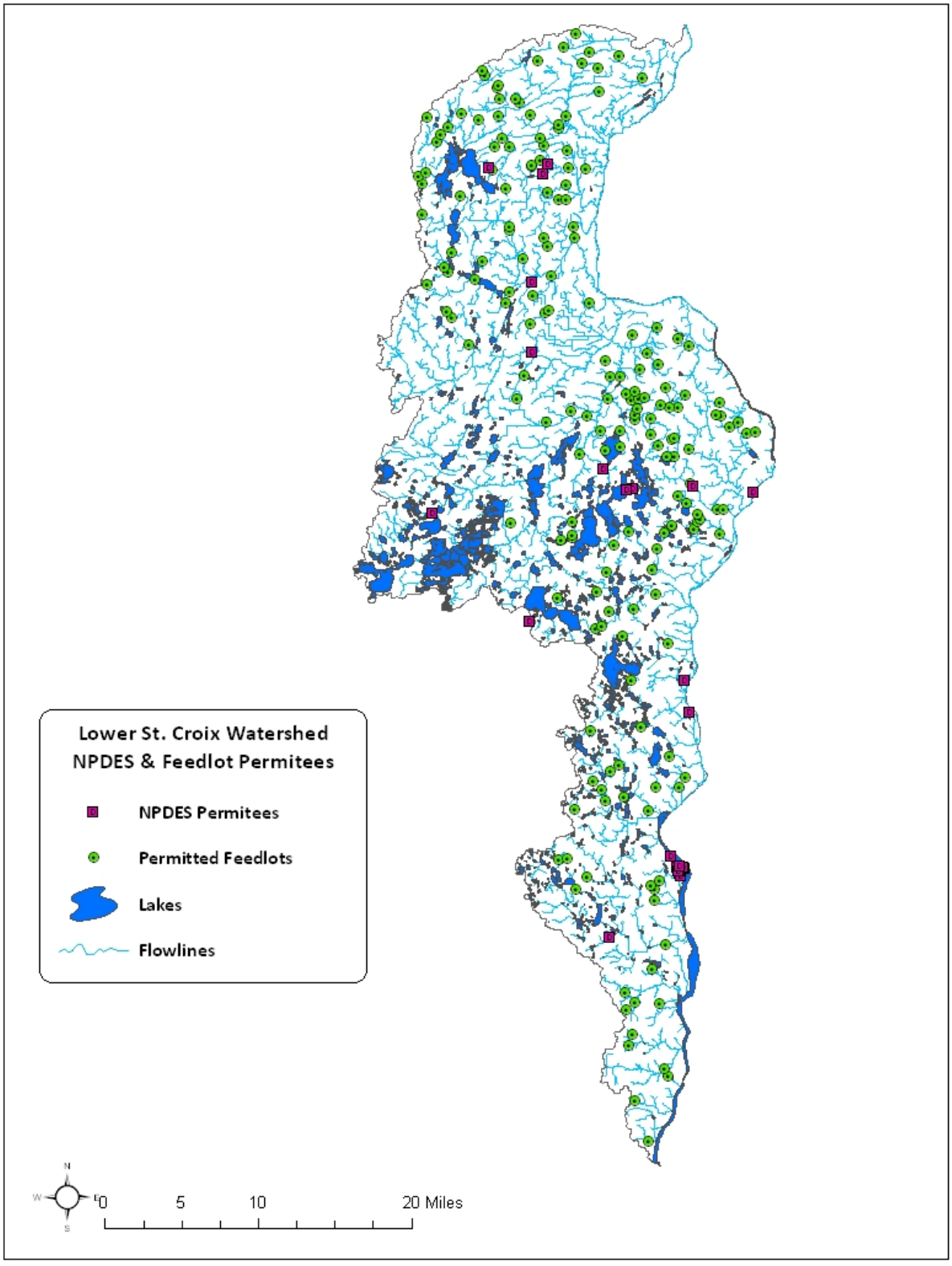

Figure 8. NPDES and feedlot permitees in the Lower St. Croix River Watershed

Climate and precipitation

Average annual precipitation in the Lower St. Croix Watershed ranged from 28 to 32 inches, depending on location (http://climate.umn.edu/img/normals/precip/precip_norm_annual.htm). During the 2009, water year (October 2008-September 2009), when most of the monitoring was conducted in the watershed, precipitation was significantly below average causing drought conditions across the watershed. The data in Figure 9 is taken from the State Climatology Office Link: http://climate.umn.edu/doc/hydro_yr_pre_maps.htm.

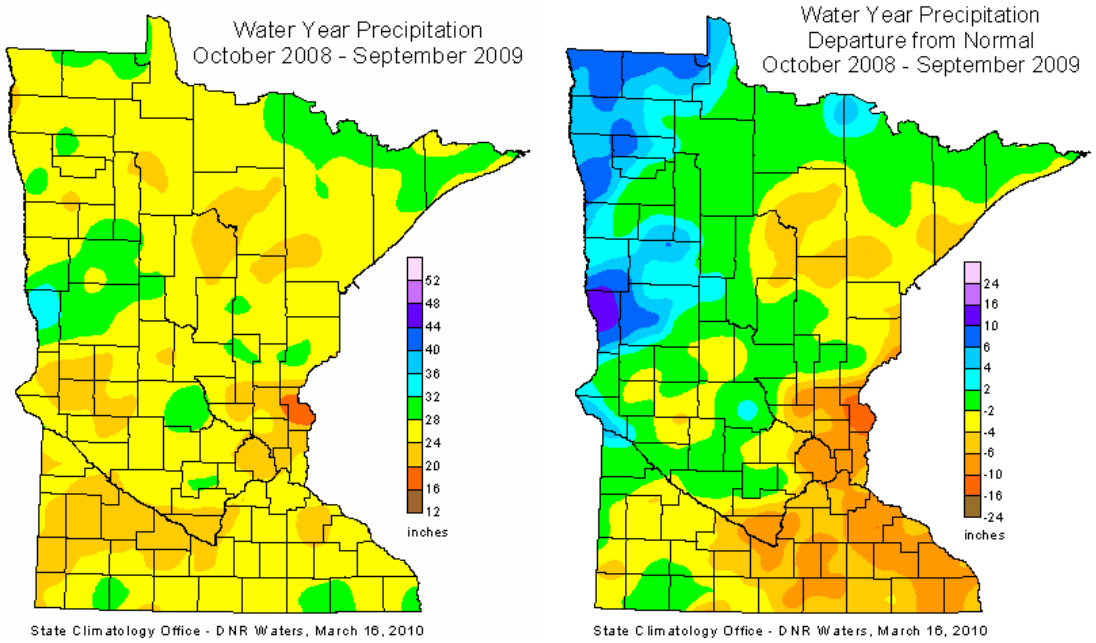

Figure 9. Statewide precipitation levels during the 2009 water year

Precipitation is the primary source of hydrologic input to a watershed, and therefore is a good indicator of stream hydrological conditions. Figure 9 displays an area average of precipitation in east central Minnesota. An area average is a spatial average of all the precipitation data collected within a certain area. This data is taken from the Western Regional Climate Center, available at University of Minnesota Climate website (http://www.wrcc.dri.edu/spi/divplot1map.html).

Rainfall in the east central region displays no significant trend over the last 20 years (Figure 10). Though rainfall has varied in intensity on an annual basis, average precipitation in east-central Minnesota has not changed dramatically over this time period.

Looking further into historical records, precipitation in east-central Minnesota over the past 100 years displays a statistically significant rising trend (Figure 11).This long term trend is typical for Minnesota over this time period.

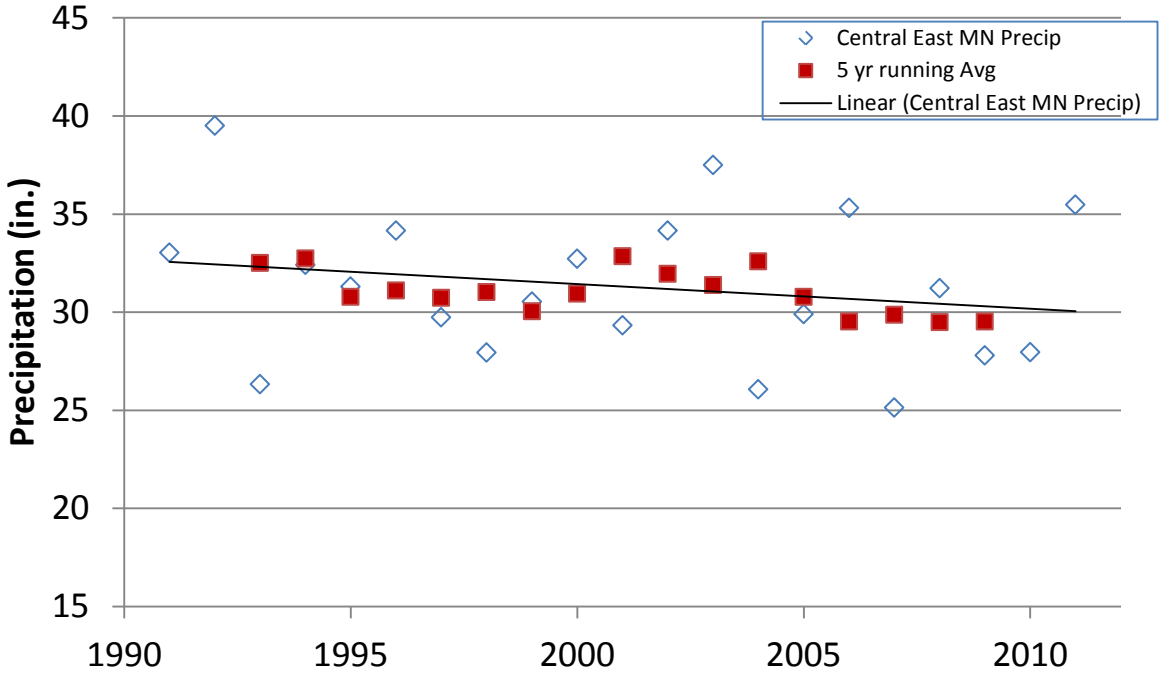

Figure 10. Precipitation trends in east central Minnesota across the last 20 years

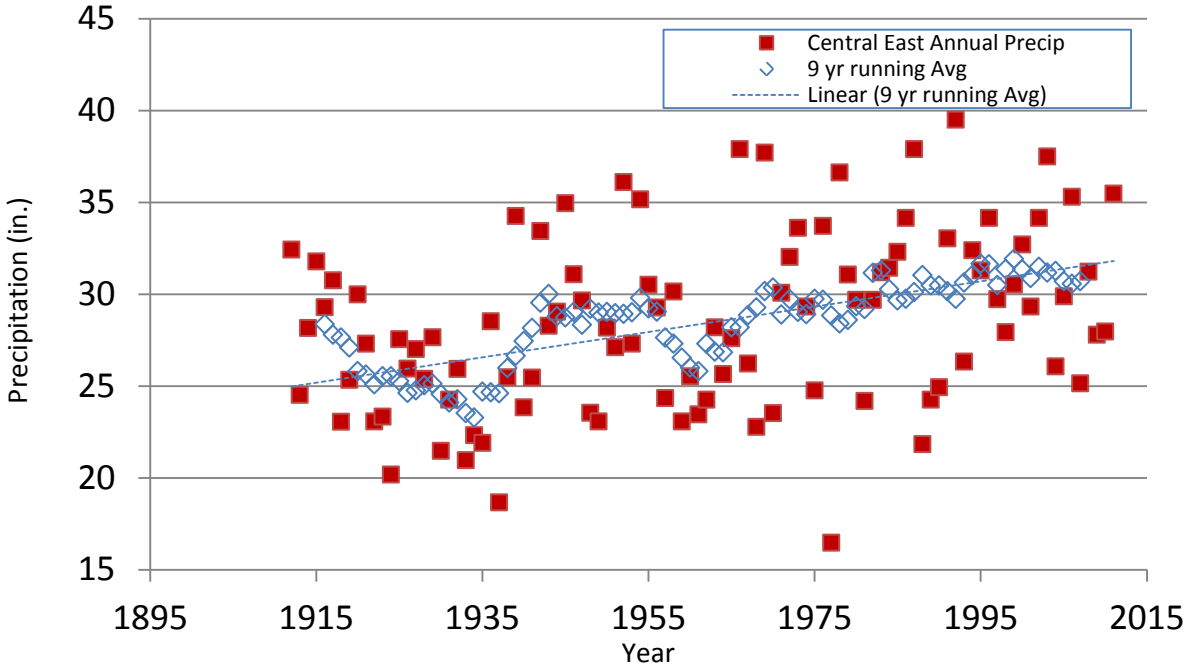

Figure 11. Precipitation trends in east central Minnesota across the last 100 years

Surficial and groundwater withdrawals

Permitted water withdrawals

The MDNR issues permits for all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or one million gallons/year. Permit holders are required to track water use and report to the MDNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html.

Figure 12 displays locations of these permitted groundwater and surface water withdrawals in the Lower St. Croix River Watershed, as well as withdrawals in the immediate area to the west; this is because groundwater sheds and surface watersheds do not always coincide. Blue symbols are groundwater withdrawals and red are surface water withdrawals (water taken from lake, stream or other surface water feature).

The three largest permitted users of water in the state are municipalities, industries and agricultural irrigation. The Lower Saint Croix Watershed withdrawals are largely for municipal use with a mix of golf course irrigation, crop irrigation and sand and gravel washing.

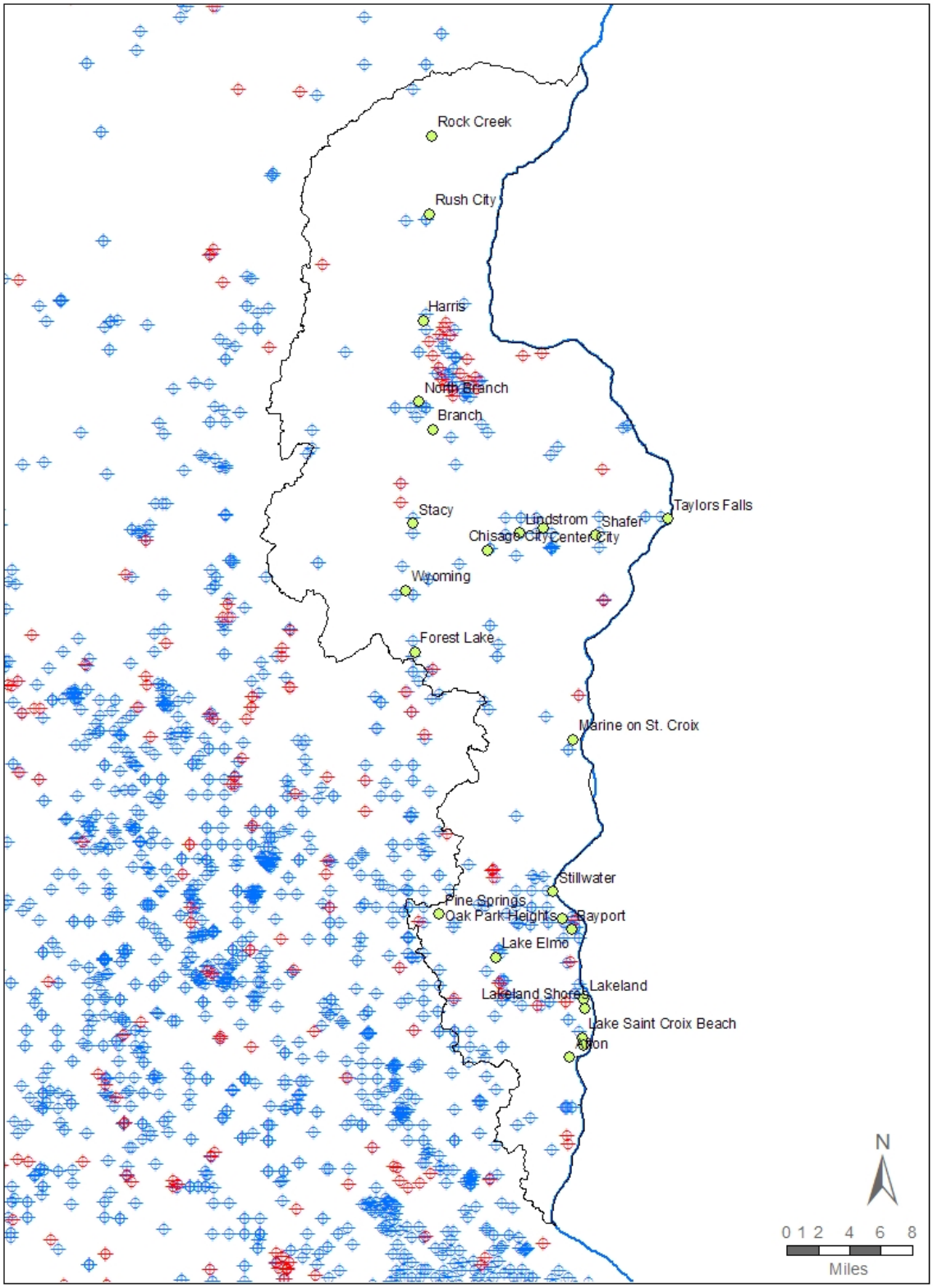

Figure 12. Locations of permitted water withdrawals in the Lower St. Croix Watershed

Figure 13 shows a statistically significant increase in groundwater withdrawals over the past 20 years. A USGS study to characterize groundwater/surface water interactions in White Bear Lake (just west of the Lower St. Croix Watershed) is underway and is scheduled to be completed in September of 2012. Preliminary results of the work suggest that regional high-capacity pumping may be adversely affecting lake levels by drawing down the bedrock aquifer(s). Communities within the Lower Saint Croix Watershed also utilize these bedrock aquifers for water supply. The potential for negative effects on surface water bodies from excessive pumping is cause for communities to adequately plan for their sustained water use.

The study is summarized at: http://mn.water.usgs.gov/projects/description/NQ00EHR00.html.

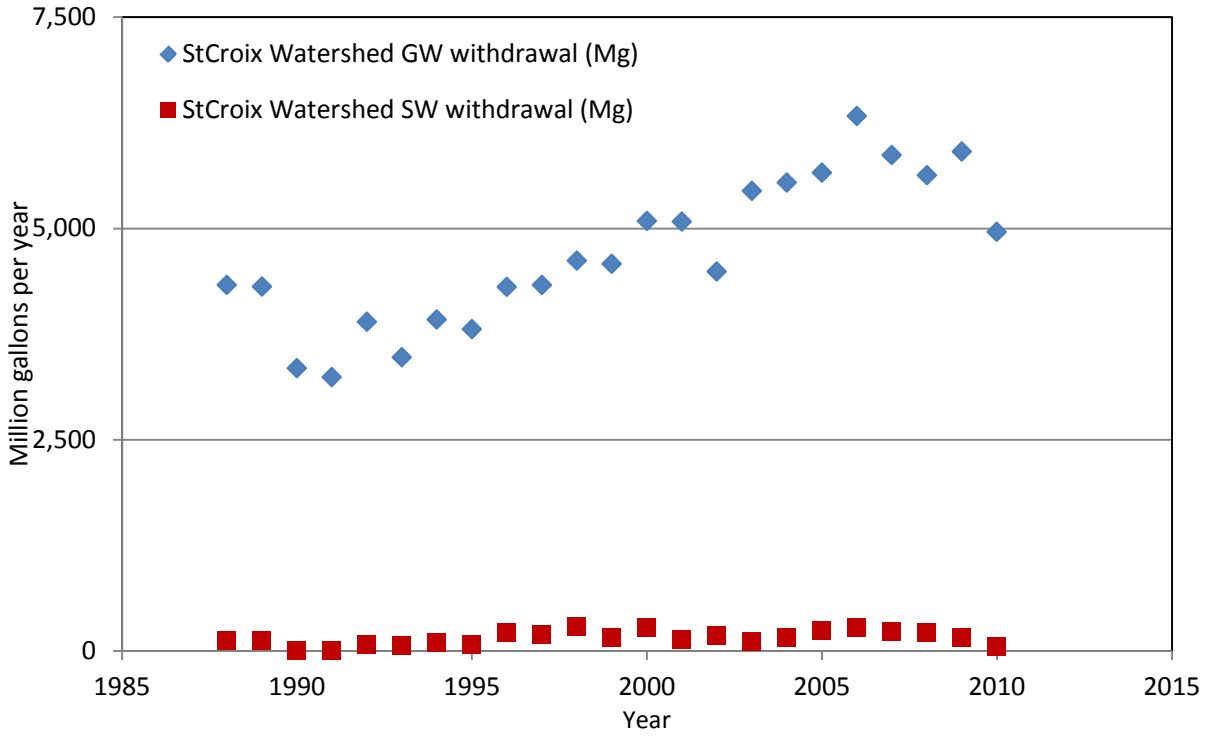

Figure 13. Quantity of water withdrawal within the Lower St. Croix Watershed by type (groundwater versus surficial)

Observation wells

Monitoring wells from the MDNR Observation Well Network track the elevation of groundwater across the state. Data available at: http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html.

The MDNR monitors levels in three water table aquifer wells in Chisago County in the northern portion of the Saint Croix River Watershed (Figure 14), there were no water table aquifer wells monitored in the southern part of the watershed.

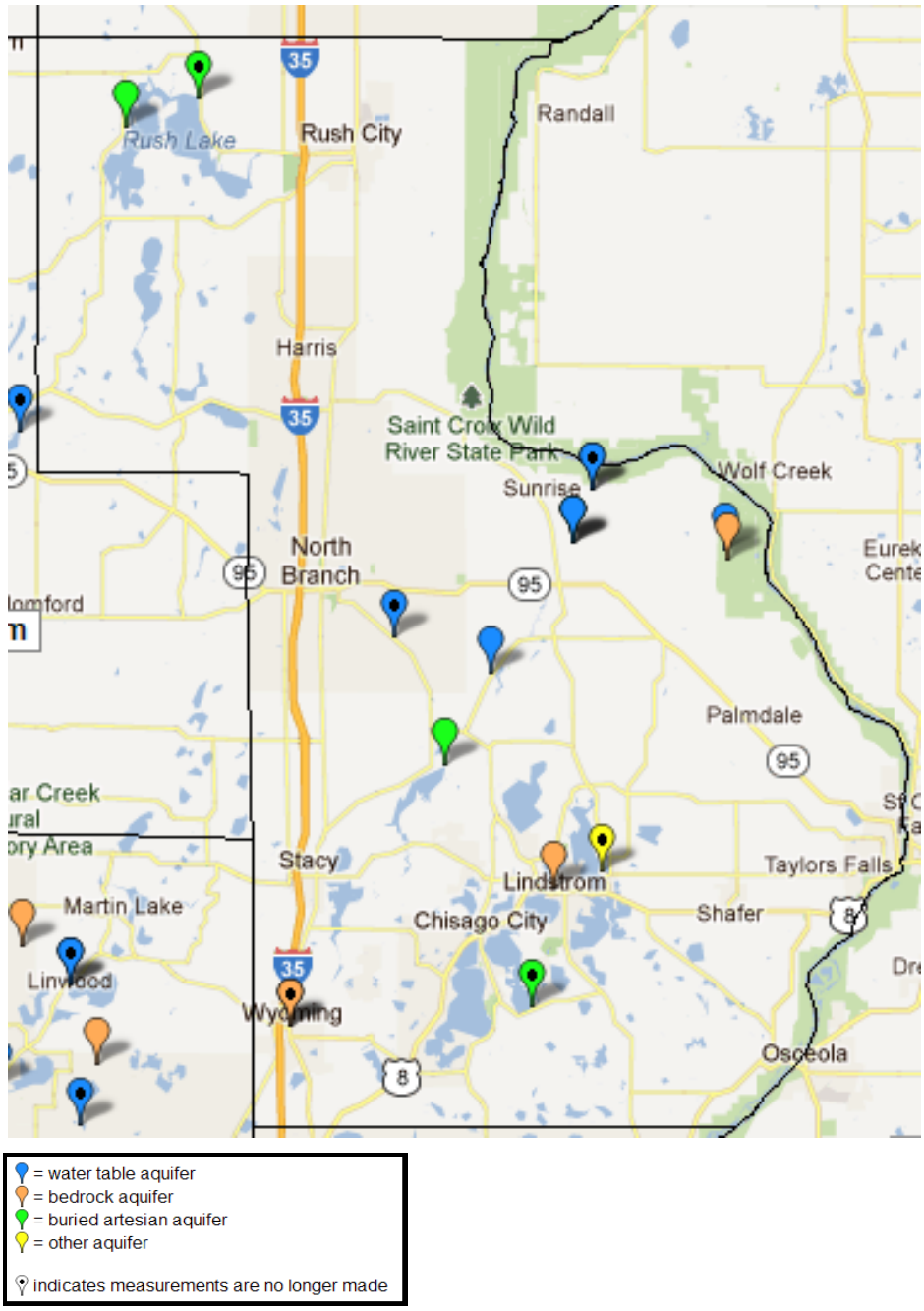

Figure 14. MDNR observation wells in Chisago County

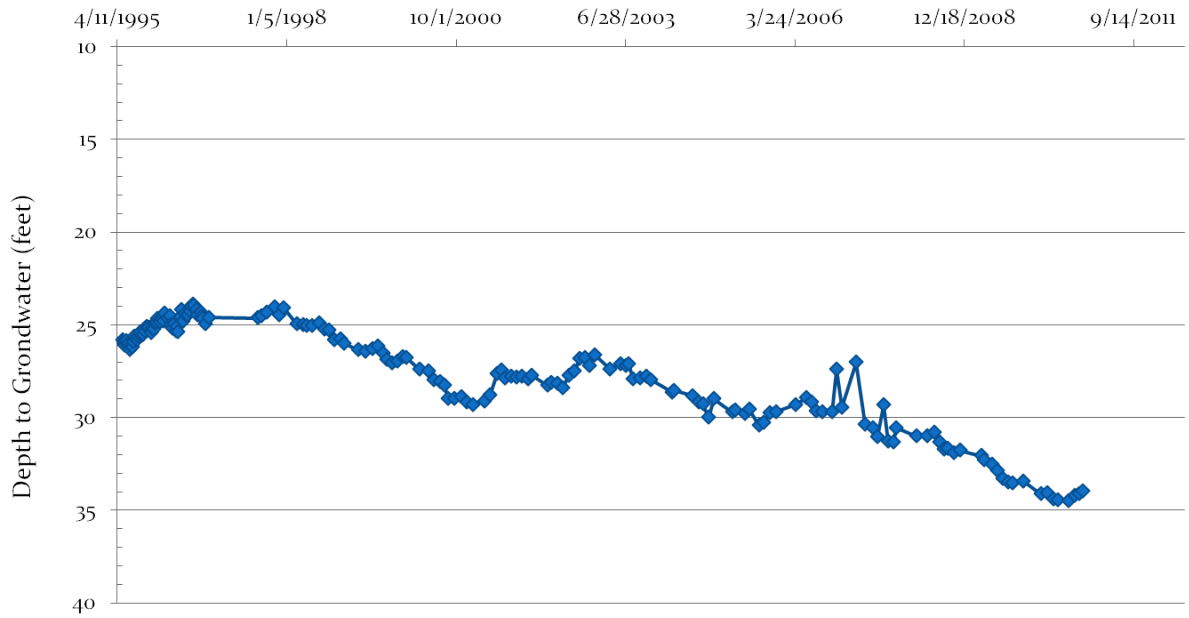

Figure 15. Depth to water at MDNR Observation Well 82041 (near Lake Elmo)

Well 82041, a bedrock well, near Lake Elmo Minnesota shows a declining trend in water levels for the 15-year period from 1995, through 2010 (Figure 15).

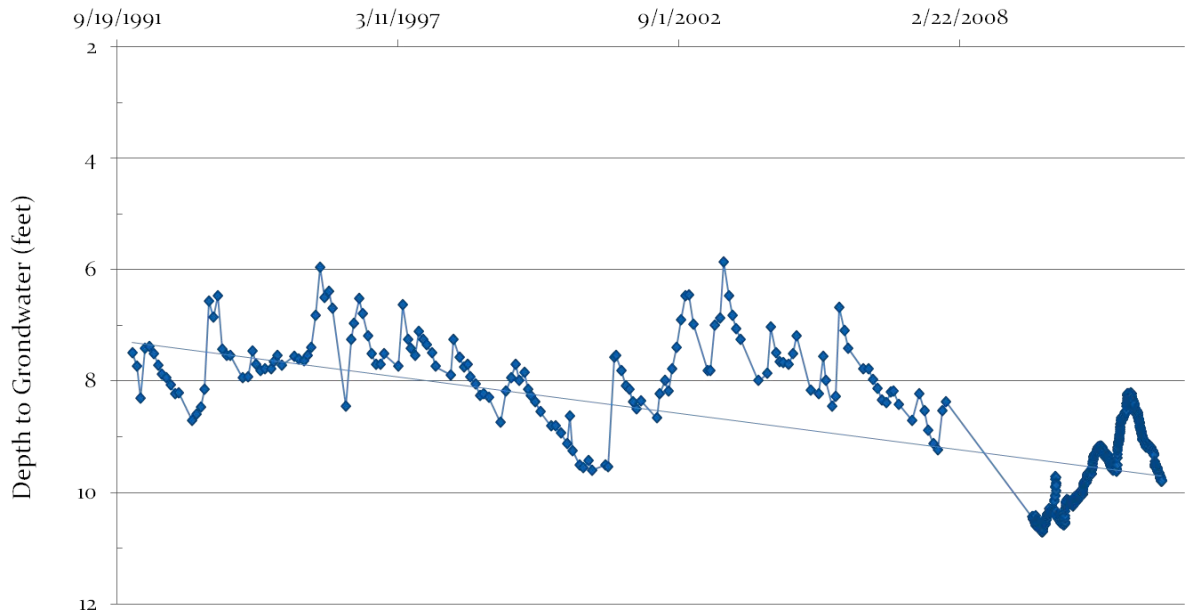

Figure 16. Depth to water at MDNR Observation Well 13008 (near Stacy)

Well 13008, a water table aquifer well near Stacy, Minnesota shows a declining trend in water levels since 1990. The MDNR began remotely collecting hourly groundwater levels in 2008, and the dark line on the graph indicates the density of those data points (Figure 16).

Ambient groundwater monitoring

The ambient groundwater monitoring program monitors trends in statewide groundwater quality by sampling a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds.

The MPCA has sampled 37 locations within the Lower St. Croix River Watershed (Figure 17). These sites include both domestic water supply wells and monitoring wells. Common detections included chloride and naturally occurring metals like iron and manganese. These do not pose a risk to public health in the concentrations detected.

Elevated levels of chloride are commonly an indicator of impacts from road salt. Naturally occurring metals that either affects the taste or appearance of drinking water are commonly referred to as "aesthetic contaminants". Private well owners may refer to the Minnesota Department of Health Well Handbook for additional information on these contaminants (http://www.health.state.mn.us/divs/eh/wells/construction/handbook.pdf).

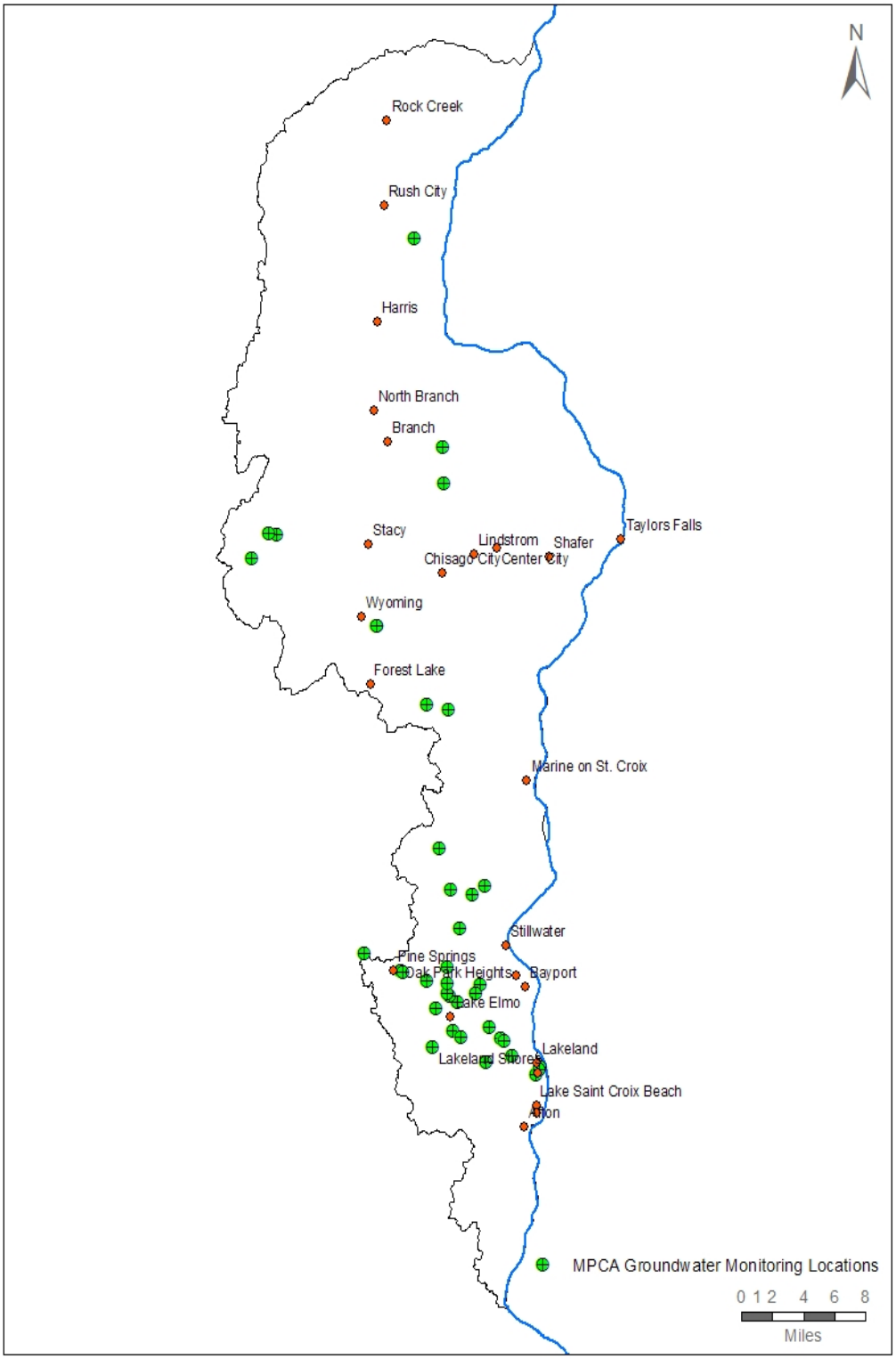

Figure 17. MPCA ambient groundwater monitoring stations in the Lower St. Croix Watershed

V. Watershed-wide data collection methodology

Load monitoring network

Funded with appropriations from Minnesota's Clean Water Legacy Fund, the Watershed Pollutant Load Monitoring Network (WPLMN) 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, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers. Since the program's inception in 2007, the WPLMP has adopted a multi-agency monitoring design that combines site specific stream flow data from USGS and MDNR flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services, local monitoring organizations, and MPCA WPLMN 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 variable from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. However, as a general rule, elevated levels of Total Suspended Solids (TSS) and Nitrate (NO_3) are generally regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess Total Phosphorus TP can be attributed to both "non-point" as well as "point" and end of pipe sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as: canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations, 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. 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 NO_3 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 and NO_3 levels tend to be elevated.

Many years of water quality data from throughout Minnesota combined with previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR) (MPCA 2010a), each with unique nutrient standards. Of the state's three RNRs (North, Central, South), the Lower St. Croix River Watershed is located within the Central RNR.

Annual water quality and daily average discharge data are coupled in the "Flux32," pollutant load model, originally developed by Dr. Bill Walker and recently upgraded by the U.S. Army Corp of Engineers and MPCA, to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary output includes annual and daily pollutant loads and flow weighted mean concentrations (pollutant load/total flow volume). Loads and flow weighted mean concentrations are calculated for TSS, (TP), and Nitrate plus Nitrite Nitrogen (Nitrate-N).

Stream water sampling

Nine stations were sampled from May thru September in 2009 and again in June thru August of 2010 to provide sufficient water chemistry data for assessing aquatic life and aquatic recreation designated uses in the 11-HUC subwatersheds (orange dots in Figure 3). Following the IWM design, sampling locations were established near the outlets of these subwatersheds. A water chemistry monitoring station was not placed within the Basswood Grove, Afton, Big Marine, Deer Creek, Taylors Falls, Lindstrom and Marine on St. Croix 11-HUCs because these subwatersheds lacked representative perennial streams for collections. See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study.

Stream biological sampling

The biological monitoring component of intensive watershed monitoring in the Lower St. Croix River Watershed was completed during the summer of 2009. Forty-five biological monitoring stations were sampled within the watershed, 16 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 the 2011 assessment was collected in 2009. A total of 31 stream assessment units were sampled for biology in the Lower St. Croix River Watershed, and aquatic life assessments were conducted for twenty-four (24) of these units. In anticipation of transitioning to a 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 aquatic life at each biological monitoring station, indices of biological integrity (IBI), specifically Fish and Invert IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure. Minnesota's streams and rivers were divided into seven distinct classes, with each class having its own unique Fish IBI and Invertebrate IBI. The classification factors used to produce the seven classes were drainage area, gradient, water temperature and geographic region of the state. Fish and macroinvertebrate communities occurring at sites within each class are more similar to each other than those occurring in other classes. These classification factors are unaffected by human disturbance to ensure that the framework reflects natural variability and that the resulting IBIs reflect human-induced impacts to the waterbody. IBI development was stratified by class, with a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals identified for each. IBI scores higher than the impairment threshold indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold indicate that the stream reach does not support aquatic life. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, land use activities, etc. For individual biological monitoring station IBI scores, thresholds and confidence intervals for all biological monitoring sites within the watershed refer to Appendices 4.2 and 4.3.

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Sunrise River and 30 lakes in the watershed. Fish from the Sunrise River were collected in 2009 by MPCA biomonitoring staff. MDNR Fisheries staff collected fish from the lakes. In addition, fish from 13 lakes 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 and several lakes in the Twin Cities Metropolitan Area.

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 (MDH). 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 MDH's fish consumption advisory. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if ten percent of the fish samples (measured as the 90^{th} percentile) 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 pour points are analyzed for PCBs.

Lake water sampling

Lakes were not targeted during the Intensive Watershed Monitoring efforts that took place in 2009. However, extensive monitoring of lakes has occurred in the metropolitan area and through grant funded and local monitoring efforts in Chisago County. Lake water chemistry and Secchi data used in this report was taken from the MPCA's EQuIS database. This data was collected by local partners including CLMP volunteers. Sampling methods are similar among lake monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at: http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a ten year period for phosphorus, chlorophyll-a and Secchi depth.

VI. Individual watershed results

HUC-11 watershed units

Assessment results are presented for each of the HUC-11 watershed units within the Lower St. Croix River Watershed. This is intended to enable the assessment of all surface waters at one time and the ability to develop comprehensive TMDL studies on a watershed basis, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. This scale provides a robust assessment of water quality condition in the 11-digit watershed unit and is a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The primary objective 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 2011 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2009; intensive watershed monitoring effort but also considers available data from the last ten years.

Given all the potential sources of data and differing assessment methodologies for indicators and designated uses, it is not currently 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 watershed is provided. Each account includes a brief description of the subwatershed, a table summarizing stream aquatic life and aquatic recreation assessments, a table summarizing the biological condition of channelized streams and ditches, a stream habitat results table, a summary of water chemistry results for the HUC-11 outlet, a summary of lake aquatic recreation assessments, and a narrative summary of the assessment results for the subwatershed. A brief description of each of these components is provided below.

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the watershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2011, assessment process (2012 Environmental Protection Agency reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 5). Assessment of aquatic life is derived from the analysis of biological (fish and invert IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*Escherichia coli*) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Stream reaches that do not have sufficient information for either an aquatic life or aquatic recreation assessment (from current or previous assessment cycles) are not included in these tables, but are included in Appendix 4.1. Where applicable and sufficient data exists, assessments of other designated uses (e.g., drinking water & aquatic consumption) are discussed in the summary section of each HUC-11 as well as in the Watershed-Wide Results and Discussion section.

Channelized stream evaluations

Biological criteria has not been developed yet for channelized streams and ditches, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible at some monitoring stations. A separate table provides a narrative rating of the condition of fish and macroinvertebrate communities at such stations based on IBI results. Evaluation criteria are based on aquatic life use assessment thresholds for each individual IBI class (see Appendix 5.1). IBI scores above this threshold are given a "good" rating, scores falling below this threshold by less than ~15 points (i.e., value varies slightly by IBI class) are given a "fair" rating, and scores falling below the threshold by more than ~15 points are given a "poor" rating. For more information regarding channelized stream evaluation criteria refer to Appendix 5.2.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each HUC-11 section. These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the HUC-11 watershed. MSHA data was not available for all watershed units or stations in the Lower St. Croix Watershed, data will be displayed only were it is available.

Watershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the HUC-11 watershed. This data along with other data collected within the 10-year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to the standards or expectations used for assessing aquatic life and recreation.

Lake assessments

A summary of lake water quality appears in the following sections. For lakes with sufficient data, basic modeling was completed; these results and the corresponding morphometric inputs to the model are available in Appendix 6.1 and 6.2. Two hundred fifty-six basins greater than four ha are in the St. Croix River Watershed; of those one hundred 44 had data available for review against aquatic recreation use standards and will be summarized below.

The St. Croix Tributaries, Rock Creek, North Branch Sunrise River, Taylor Falls, and Basswood Grove Watershed Units did not have any lakes that were reviewed for aquatic recreation use support; no lake discussion will appear in those sections.

Portions of the watershed, particularly near the metropolitan area, are managed locally by watershed districts and watershed management organizations. Appendix 6.3 includes a list of the active organizations and their webpage's. Watershed management plans required by these organizations provide further detail and were used as references for the table in Appendix 6.1. Additionally, a number of TMDLs are either completed or underway for lakes in the watershed. These lakes will be referenced in the discussions below and links to the TMDL will be included in Appendix 6.3.

Rock Creek Watershed Unit 07030005170

The Rock Creek Watershed Unit is located in the far northern part of the Lower St. Croix Watershed within Pine County and a small portion of northern Chisago County, draining roughly 74.6 square miles. Rock Creek begins as an outlet of Rock Lake 2.5 miles south of Pine City, flowing in a southeasterly direction approximately 15.6 miles before its confluence with the St. Croix River, about five miles East of Rush City. Along its course Rock Creek has numerous small tributaries and three unnamed creeks. Agricultural landscapes dominate this watershed, with 39.7 percent pasture and 33.8 percent cropland. The majority of forested land within this subwatershed is near the confluence with the St. Croix River. The outlet of this watershed is represented by biological station 09SC002 on Rock Creek, which is located 4.5 miles northeast of Rush City. There are no assessed lakes in this watershed.

Table 1. Aquatic life and recreation assessments on stream reaches in the Rock Creek Watershed Unit

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			
07030005-584, Rock Creek, Rock Lk to St Croix R	15.6	2Bd	96SC022 06SC023 07SC004 07SC005 09SC002 09SC010	Near C.S.A.H. 3, 3 mi. N.E. of Rush City Downstream of CR 104, 4 miles NE of Rush City Upstream of CR 104, 2 mi. SE of Rock Creek Downstream of MN 361, one mi. NW of Rock Creek Upstream of CR 3, 5 mi. NE of Rush City Upstream of CR 106 (Military Rd), 2 mi. NE of Rock Creek	MTS	MTS	MTS	MTS	MTS	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 2. Minnesota Stream Habitat Assessment (MSHA) results for the Rock Creek 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
2	96SC022	Rock Creek	3.9	12.3	19.5	12	27	74.6	good
1	06SC023	Rock Creek	0	9	13.55	13	17	52.55	fair
1	07SC004	Rock Creek	2.5	12.5	18	12	28	73	good
1	07SC005	Rock Creek	2.5	14	16	11	22	65.5	fair
1	09SC002	Rock Creek	4.25	11.5	22.5	12	31	81.25	good
2	09SC010	Rock Creek	0	9.8	19.9	12.5	14.5	56.6	fair
Average Habitat Results: *Rock Creek Watershed Unit*			**2.1**	**11.5**	**16.5**	**12.1**	**23.25**	**65.45**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 3. Outlet water chemistry results for the Rock Creek 11-HUC
09SC002/S005-532 ROCK CK AT CSAH-3, 5 MI NE OF RUSH CITY

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	0.06	0.3	< 0.05		
Chloride	mg/l	9	12.7	18.9	15.6	15.7	230	
Chlorophyll-a, corrected	ug/l	3	3.2	5.0	4.2	4.3		
Dissolved oxygen (DO)	mg/l	19	6.8	12.4	9.0	8.6	5	
Escherichia coli	MPN/100ml	15	50	1300	303	200	126	10
Inorganic nitrogen (nitrate and nitrite)	mg/l	9	0.05	0.6	0.35	0.36		
Kjeldahl nitrogen	mg/l	10	0.4	2.3	1.0	0.9		
pH	--	19	7.3	9.5	8.2	8.2	6.5-9	
Pheophytin-a	ug/l	3	2.2	5.5	3.7	3.4		
Phosphorus	ug/l	9	87	317	158	132		
Specific conductance	uS/cm	19	170	609	420	466		

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Temperature, water	deg C	19	11	24	18.5	18.6		
Total suspended solids	mg/l	9	2.4	17	6.5	4.4		
Total volatile solids	mg/l	10	< 1	15	3.3	1.5		
Transparency tube (100)	cm	14	40	> 100	84	94		
Transparency tube (60)	cm	6	26	53	39	39		

Summary

Water quality data was available on the 15-mile reach of Rock Creek from Rock Lake to the St. Croix River. Excess bacteria resulted in aquatic recreation use impairment on the creek. Drinking water standards for nitrates were met, and oxygen and sediment were at levels that support aquatic life uses. There were numerous visits providing biological data from six stations on Rock Creek, and habitat conditions at these biological stations were average to above average. The availability of quality habitat contributes to the creeks above average fish and invertebrate communities. Previous assessments concluded this AUID was non-supporting for Fish IBI, but during the 2011, assessments a decision was made to correct this AUID based on the new IBIs to show supporting for fish and invertebrate communities. While this subwatershed is heavily agricultural, the riparian corridor along Rock Creek remains largely intact which could contribute to its full support status for aquatic life. One channelized tributary to Rock Creek was added to the Impaired Waters List prior to the policy decision to defer assessments for aquatic life on channelized AUIDs.

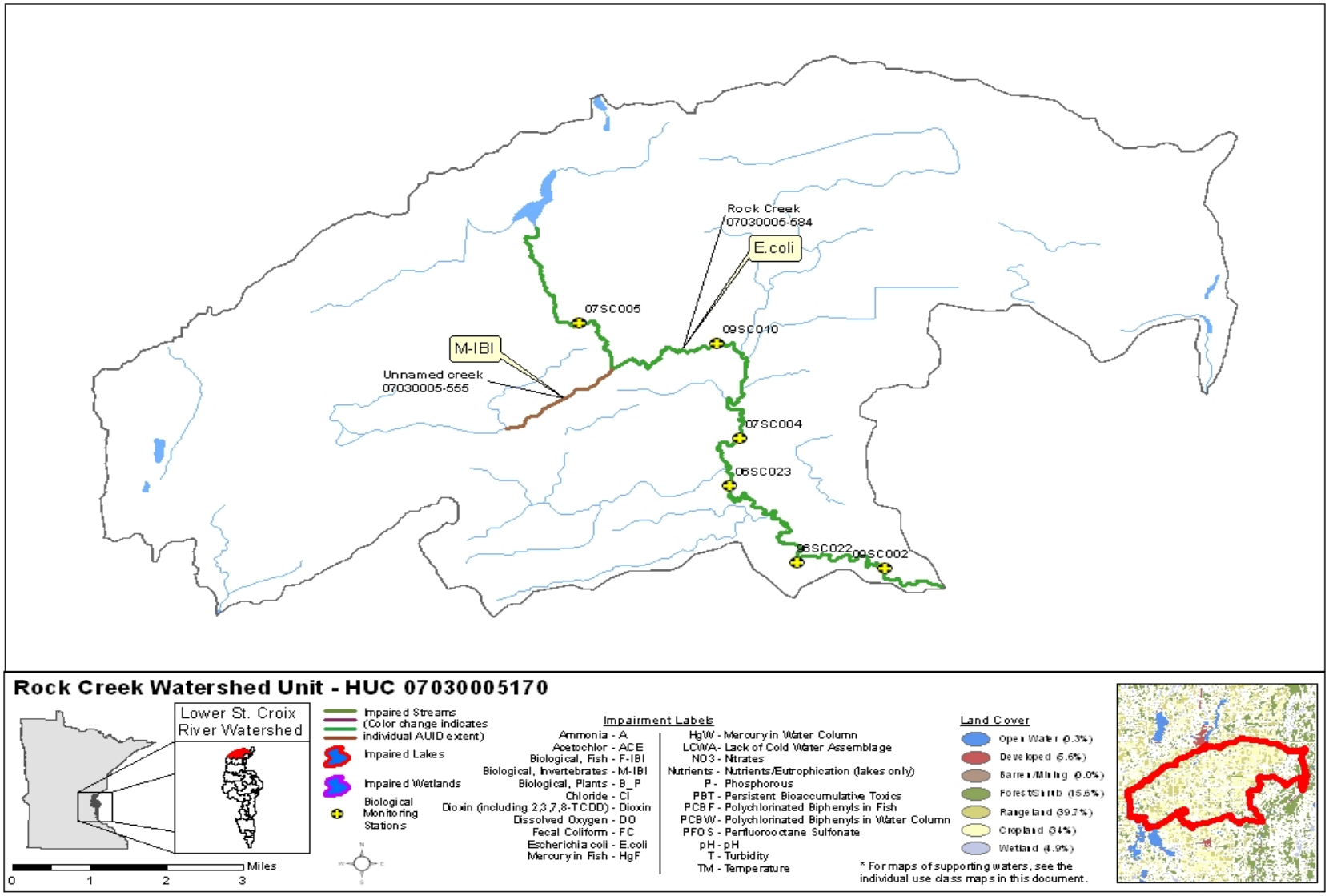

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Rock Creek Watershed Unit

Rush Creek Watershed Unit 07030005190

The Rush Creek Watershed Unit is located in the northern portion of the Lower St. Croix Watershed within Chisago County, it drains 49.3 square miles. Rush Creek begins as an outlet of Rush Lake and flows east approximately 14 miles, passing through the town of Rush City before it reaches the St. Croix River. The watershed contains two large lakes, East and West Rush Lakes, and a number of smaller lake basins. Agricultural land uses make up 56.2 percent of the watershed landscape, with 33.5 percent pasture and 22.7 percent cropland. The upper two-thirds of this watershed are dominated by agricultural cropland with urban areas and small parcels of woodland present, while the lower portion of this unit is predominately forested. The outlet for this watershed is represented by site 98SC004 which is located four miles southwest of Rush City.

Table 4. Aquatic life and recreation assessments on stream reaches in the Rush Creek Watershed Unit

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.
07030005-509, Rush Creek, Rush Lk to St Croix R	14.75	2Bd	96SC081 98SC004 98SC001 98SC002 98SC003	@ C.S.A.H. 5, 2 mi. E. of Rush City Just upstream of C.R. 56, 3 mi S.E. of Rush City Upstream of Evergreen Ave, 1.5 mi W of Rush City Access at address 380 CR 55 .2 mi E of Rush City Downstream of CR 55 across from cemetery .8 mi E. of Rush City	EXP	EXS	MTS	MTS	MTS	MTS	MTS	--	EX	NS	NS
07030005-680, County Ditch 6, Headwaters to Rush R	2.92	2B	07SC013	Upstream of CR 7, 0.5 mi. W of Rush City	NA	--	--	--	--	--	--	--	--	NA*	NA
07030005-695, Unnamed Creek, Headwaters to Rush Lk	2.01	2B	06SC077	Upstream of CR 1, 3 mi. NW of Rush City	NA	--	--	--	--	--	--	--	--	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream

Table 5. Non-assessed biological stations on channelized AUIDs in the Rush Creek 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07030005-680, County Ditch 6, Headwaters to Rush R	**07SC013**	**Upstream of CR 7, 0.5 mi. W of Rush City**	**Poor**	--
07030005-695, Unnamed Creek, Headwaters to Rush Lk	**06SC077**	**Upstream of CR 1, 3 mi. NW of Rush City**	**Poor**	--

Table 6. Minnesota Stream Habitat Assessment (MSHA) results for the Rush Creek 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	96SC015	Rush Creek	1	8.5	16.7	15	14	55.2	fair
7	96SC081	Rush Creek	2.5	11	9.4	7.7	21.7	52.4	fair
4	98SC002	Rush Creek	1.5	12.3	15.1	9.8	19.3	57.9	fair
4	98SC003	Rush Creek	1.25	10.9	18	8.5	22.5	61.1	fair
6	98SC001	Rush Creek	2.2	12	14.9	12	21.7	62.8	fair
6	98SC004	Rush Creek	4.7	12.8	19.4	11	31.3	79.2	good
1	07SC013	County Ditch 6	4	13	6	6	16	45	fair
1	06SC077	Trib. to Rush Lake	0	6	3	12	10	31	poor
Average Habitat Results: *Rush Creek Watershed Unit*			**2.1**	**10.8**	**12.8**	**10.3**	**19.6**	**55.6**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 7. Outlet water chemistry results for the Rush Creek 11-HUC

98SC0004/S000-125 RUSH CREEK CR-56 BY RUSH CITY

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	0.07	0.03	0.025		
Chloride	mg/l	9	14.9	40.3	24.7	22.1	230	
Dissolved oxygen (DO)	mg/l	19	7.0	11.5	8.5	8.0	5	
Escherichia coli	MPN/100ml	15	73	690	201	130	126	8
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	< 0.05	0.49	0.24	0.26		
Kjeldahl nitrogen	mg/l	10	0.56	1.17	0.92	0.89		
pH	--	19	7.8	9.1	8.1	8.1	6.5-9	1
Phosphorus	ug/l	10	79	484	159	125		
Specific conductance	uS/cm	19	295	720	436	405		
Temperature, water	deg C	19	12.3	23.4	19.0	18.7		
Total suspended solids	mg/l	10	1.2	11	6.1	6.0		
Total volatile solids	mg/l	10	< 1	3.4	2	2		
Transparency tube	cm	19	37	> 100	81	83		

Table 8. Aquatic recreation assessments on lakes in the Rush Creek Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
13-0069-01	East Rush	Chisago	Lake	Deep	NS	NCHF
13-0069-02	West Rush	Chisago	Lake	Deep	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on the 15-mile reach of Rush Creek from Rush Lake to the St. Croix River, and biological data from five stations was also collected on this reach. Data from multiple sampling visits from these stations display a wide range in both fish and invertebrate community quality on Rush Creek. The majority of scores fall at or below the threshold supporting the previous designation of impairment of aquatic life use. Communities appear to somewhat improve at the outlet station(98SC004) of the watershed, possibly signaling the improved water quality in downstream reaches as a result of higher gradient and better substrate from aquatic reproduction. Habitat conditions on this stretch of creek appear average, requiring more investigation to see if habitat quality is a potential stressor. A dam was recently removed by MDNR on Rush Creek in Rush City; habitat restoration in that area may improve the streams ability to support diverse aquatic communities. The riparian corridor of this creek becomes forested as it flows downstream past Rush City, allowing for natural infiltration of surface water runoff. Rush Creek is considered impaired for aquatic recreation use with excess bacteria present in the creek. Turbidity and dissolved oxygen met standards; phosphorus was elevated. Nitrate levels are protective of drinking water use standards, although insufficient amounts of data existed to make a final assessment. Two channelized AUIDs were sampled in this subwatershed; both have poor fish communities and below average habitat conditions which could result from channelization. East and West Rush Lakes are impaired for aquatic recreation; the elevated phosphorus concentrations in the lakes are seen in the downstream stream reach as well. Shoreland development and upstream watershed land use are likely contributing phosphorus via overland runoff to the impaired conditions in East and West Rush Lakes. Additional monitoring directly downstream of these eutrophic lakes may give a more precise picture of the effects they are having on the creek itself.

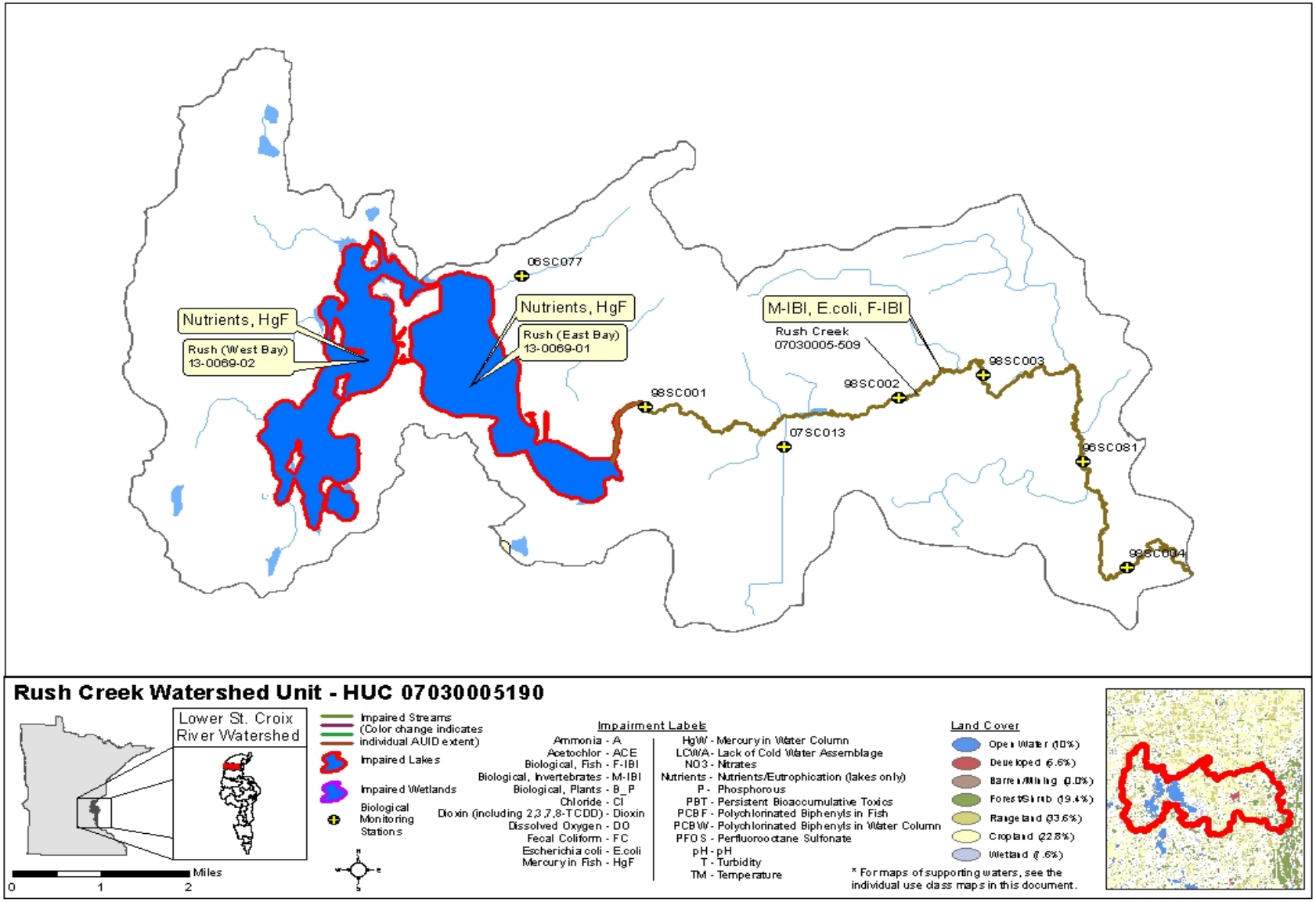

Figure 19. Currently listed impaired waters by parameter and land use characteristics in the Rush Creek Watershed Unit

Goose Creek Watershed Unit 07030005200

The Goose Creek Watershed Unit is located in the northern portion of the Lower St. Croix Watershed, draining 77.5 square miles, and lies within central Chisago County. The headwaters of Goose Creek start with small watercourses that flow into Goose Lake, eventually draining through an outlet of Goose Lake in the Township of Fish Lake. Flowing southeast approximately 22.2 miles, Goose Creek passes through the town of Harris and eventually into the heavily forested Wild River State Park, before its confluence with the St. Croix River, approximately 4.5 miles east of Harris. Sixteen lake basins are in the watershed, the most prominent being Goose Lake (North and South Basins), Horseshoe Lake, and Fawn Lake. Agricultural lands comprise 51.9 percent of this watershed, with 30.1 percent being pasture and 21.8 in cropland. The outlet site is represented by site 09SC003 and is located two miles northeast of Harris.

Table 9. Aquatic life and recreation assessments on stream reaches in the Goose Creek Watershed Unit

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			
07030005-510, Goose Creek, Headwaters (Goose Lk 13-0083-01) to St Croix	22.3	2B	07SC003 07SC019 09SC003 09SC011 09SC014 96SC023 96SC084	Downstream of CR 9, 2.5 mi. NW Harris Upstream of CR 9, 5 mi. S of Rush City Downstream of CR 59, 5 mi. NE of Harris Downstream of I-35, 1.5 mi. NW of Harris Downstream of CR 8 (Cedarcrest Trail), 5 mi. NW of Harris @ Wild River State Park @ C.S.A.H. 30 in Harris	EXP	MTS	MTS	MTS	MTS	MTS	MTS	--	EX	NS	NS
07030005-729, Unnamed creek, Headwaters to St Croix R	3.5	2B	--	--	--	--	--	MTS	--	--	--	--	EX	IF	IF
07030005-741, Unnamed creek (Goose Lake Inlet),Headwaters to Goose Lk	1.93	2B	--	--	--	--	--	MTS	--	--	--	--	--	IF	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream

Table 10. Minnesota Stream Habitat Assessment (MSHA) results for the Goose Creek 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	96SC084	Goose Creek	2.25	13	19.95	14	10	59.2	fair
1	96SC023	Goose Creek	5	11	13	8	31	68	good
1	07SC003	Goose Creek	2.5	9.5	16.2	8	20	56.2	fair
1	09SC003	Goose Creek	1.25	14.5	20.3	13	26	75.05	good
1	09SC014	Goose Creek	3.75	9	12.3	11	24	60.05	fair
1	09SC011	Goose Creek	1.25	9.5	12.3	15	25	63.05	fair
1	96SC023	Goose Creek	5	13	12.85	15	20	65.85	fair
6	96SC084	Goose Creek	2.7	11.3	18.7	7.7	17.5	57.9	fair
1	07SC019	Goose Creek	2.5	9.5	14	7	9	42	poor
1	09SC013	Trib. to Goose Creek	1.25	12	17	10	21	61.25	fair
1	09SC012	Trib. to Goose Creek	5	11	9	7	17	49	fair
Average Habitat Results: *Goose Creek Watershed Unit*			**3.0**	**11.2**	**15.1**	**10.5**	**20.0**	**59.8**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 11. Outlet water chemistry results for the Goose Creek 11-HUC

09SC003/S000-410 GOOSE CK AT RD BTN S11/14 3 MI NE OF HARRIS

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	9	< 0.05	0.15	0.04	< 0.05		
Chloride	mg/l	9	19.1	37.7	30.0	31.5	230	
Dissolved oxygen (DO)	mg/l	19	7.2	12.8	9.0	8.6	5	
Escherichia coli	MPN/100ml	15	98	1200	360	250	126	13
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	< 0.05	0.5	0.2	0.16		
Kjeldahl nitrogen	mg/l	10	0.5	1.24	0.86	0.88		
pH	--	19	7.6	9.2	8.2	8.1	6.5-9	1
Phosphorus	ug/l	10	61	141	91	89		
Specific conductance	uS/cm	19	248	460	364	370		
Temperature, water	deg C	19	14	23.7	18.9	18.3		
Total suspended solids	mg/l	10	< 1	8.8	4.5	4.1		
Total volatile solids	mg/l	10	< 1	3.2	1.7	1.2		
Transparency tube	cm	19	23	> 100	88	> 100		

Table 12. Aquatic recreation assessments on lakes in the Goose Creek Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
13-0068-00	Fish	Chisago	Lake	Deep	FS	NCHF
13-0073-00	Horseshoe	Chisago	Lake	Deep	NS	NCHF
13-0083-01	Goose (North Bay)	Chisago	Lake	Shallow	NS	NCHF
13-0083-02	Goose (South Bay)	Chisago	Lake	Deep	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on the twenty-two mile reach of Goose Creek from Goose Lake to the St. Croix River, and five biological stations were also located on this reach. Goose Creek's fish community varies from poor to above average, supporting the existing assessment of aquatic life use impairment. Invertebrate communities, in contrast, show improvement over previous visits and the assessments have been corrected to meeting standards for aquatic life use based on the new IBI. Habitat quality in this creek varies from poor to good; this is likely a result of small channelized sections degrading habitat, while other undisturbed portions maintain natural habitat characteristics that are supportive of healthy aquatic communities. Goose Creek is considered impaired for aquatic recreation use with excess bacteria present in the creek. Turbidity and dissolved oxygen met standards; phosphorus was elevated. The creek begins at Goose Lake and has a tributary draining from Horseshoe Lake, both of which are impaired by excess nutrients. Shoreland development, upstream watershed land use, and in the case of the north bay of Goose Lake, internal phosphorus loading are contributing to the reduced water quality in these basins.

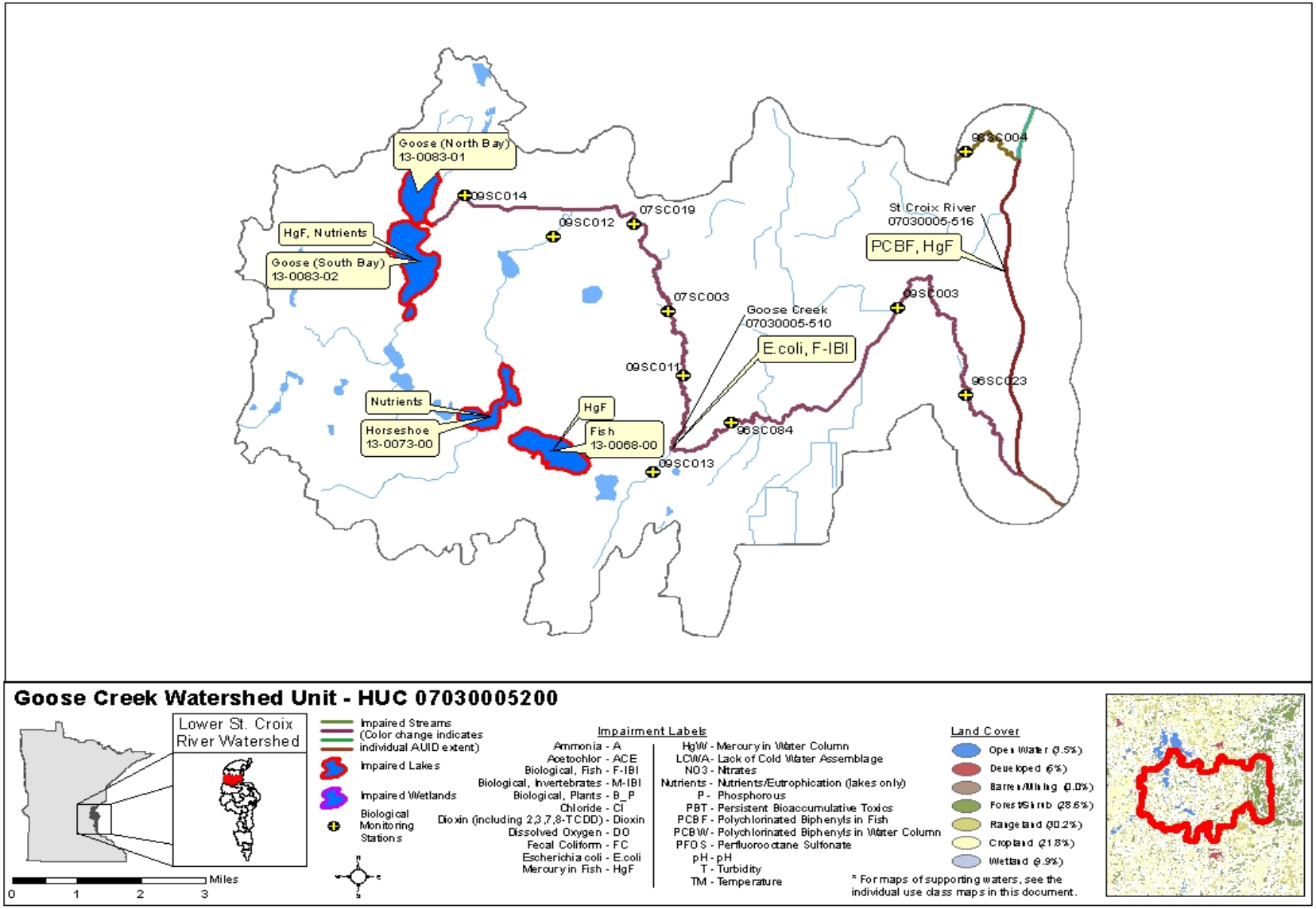

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Goose Creek Watershed Unit

North Branch Sunrise River Watershed Unit 07030005250

The North Branch Sunrise River Watershed Unit drains approximately 76 square miles in eastern Isanti and central Chisago Counties. The headwaters of the North Branch Sunrise River begin roughly 4.75 miles east of Isanti, in the township of North Branch. The North Branch Sunrise River then flows east approximately 24.1 miles, and through the city of North Branch before reaching its confluence with the main stem of the Sunrise River in the Township of Sunrise. Along its course, four named tributaries flow into the North Branch Sunrise River; County Ditch 7, County Ditch 19, Judicial Ditch 4, and Hay Creek. Agricultural landscapes comprise 60.2 percent of this watershed's area, with 40.6 percent in cropland and 19.6 percent in rangeland. The outlet of this watershed unit is represented by station 09SC004 on the North Branch Sunrise River, which is located 5.25 miles east of North Branch.

Table 13. Aquatic life and recreation assessments on stream reaches in the North Branch Sunrise River Watershed Unit

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.
07030005-501, Sunrise River, North Branch, Headwaters to Sunrise R	24.11	2B	98SC008 06SC049 06SC053 09SC004 09SC016 09SC017	Just upstream of SH 95, .5 mi E of North Branch Downstream of CR 12, 6 miles SW of North Branch Downstream of Hwy 95, 4 miles E. of North Branch Upstream of Trulson Rd, 5 mi. E of North Branch Upstream of CR 55, 7 mi. W of North Branch Upstream of Potomac St NE, 5 mi. SW of North Branch	EXP	MTS	IF	MTS	MTS	MTS	MTS	--	EX	NS	NS
07030005-514, County Ditch 7, Unnamed cr to N Br Sunrise R	3.8	2B	--	--	--	--	--	MTS	--	--	--	--	IF	IF	IF
07030005-683, Unnamed ditch, Headwaters to N Br Sunrise R	2.66	2B	07SC015	Upstream of CR 67, 2.5 mi. E of North Branch	NA	NA	--	--	--	--	--	--	--	NA*	NA
07030005-909, Unnamed creek, to Unnamed cr	0.58	2B	--	--	--	--	--	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 listed 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 (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 14. Non-assessed biological stations on channelized AUIDs in the North Branch Sunrise River 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07030005-683, Unnamed ditch, Headwaters to N Br Sunrise R	**07SC015**	**Upstream of CR 67, 2.5 mi. E of North Branch**	**Poor**	--

Table 15. Minnesota Stream Habitat Assessment (MSHA) results for the North Branch Sunrise River 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	06SC049	Sunrise River, North Branch	3.5	10	14	8	24	59.5	fair
1	06SC053	Sunrise River, North Branch	5	11	18	7	23	64	fair
2	09SC004	Sunrise River, North Branch	0.6	10.8	16.9	13	24	65.3	good
1	09SC016	Sunrise River, North Branch	3.5	0	8	12	21	56.5	fair
1	09SC017	Sunrise River, North Branch	0	9.5	9.25	12	18	48.75	fair
3	98SC008	Sunrise River, North Branch	2.2	11.2	10.3	8.3	18	49.9	fair
1	07SC015	Trib. to Sunrise River, North Branch	5	14	9.25	0	19	47.25	fair
1	09SC018	Hay Creek	3.75	13	9	7	18	50.75	fair
1	09SC015	County Ditch 19	3.75	14	9	10	13	49.75	fair
Average Habitat Results: *North Branch Sunrise River Watershed Unit*			**3.0**	**10.9**	**11.1**	**9.3**	**18.5**	**53.7**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 16. Outlet water chemistry results for the North Branch Sunrise River 11-HUC

09SC004/S003-472 SUNRISE R, N BR, AT TRULSON RD, 5 MI E OF N BR, Minnesota

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	< 0.05				
Chloride	mg/l	9	25.5	37.3	32.7	33.8	230	
Chlorophyll-a, corrected	ug/l	3	1.62	3.59	2.4	1.89		
Dissolved oxygen (DO)	mg/l	19	7.5	11.4	8.7	8.6	5	
Escherichia coli	MPN/100ml	15	87	> 2400	549	380	126	14
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	1.6	2.5	2.1	2.2		
Kjeldahl nitrogen	mg/l	10	0.25	0.69	0.5	0.6		
pH	--	19	7.8	9.2	8.3	8.2	6.5-9	1
Pheophytin-a	ug/l	2	1.05	1.35	1.2	1.2		
Phosphorus	ug/l	10	74	127	105	105		
Specific conductance	uS/cm	19	267	459	408	420		
Temperature, water	deg C	19	12	20.6	17.2	16.8		
Total suspended solids	mg/l	9	1.6	18	8.8	8		
Total volatile solids	mg/l	10	1	5.2	2.32	1.8		
Transparency tube (100)	cm	16	46	> 100	83.5	92		
Transparency tube (60)	cm	26	15	> 60	47	52		

Summary

Water quality data was available on the North Branch Sunrise River and partial datasets on a number of tributaries, including County Ditch 19, Judicial Ditch 4, Hay Creek, and County Ditch 7. There was a large amount of biological data available from stations on the North Branch Sunrise River; these stations had average fish communities, while the invertebrate community was in good condition in the single station assessed. A station downstream of the North Branch (98SC008) has a history of biological impairment which may be due to excessive sedimentation. Habitat scores indicate average conditions to support aquatic communities. The riparian corridor of this river is largely undisturbed outside of the city of North Branch, where impervious surfaces decrease natural infiltration. Turbidity and dissolved oxygen were meeting standards on the North Branch Sunrise River. Excess bacteria were present in this reach, resulting in an aquatic recreation use impairment. The upstream tributaries had partial datasets for bacteria, and while not enough to determine impairment, each reach had a number of values that were elevated. Limited biological data was available on one channelized reach within this subwatershed; its fish communities were in poor condition. Overall, habitat seems average for supporting aquatic communities in the channelized reach, but lack of cover for certain aquatic species could be contributing to poor diversity.

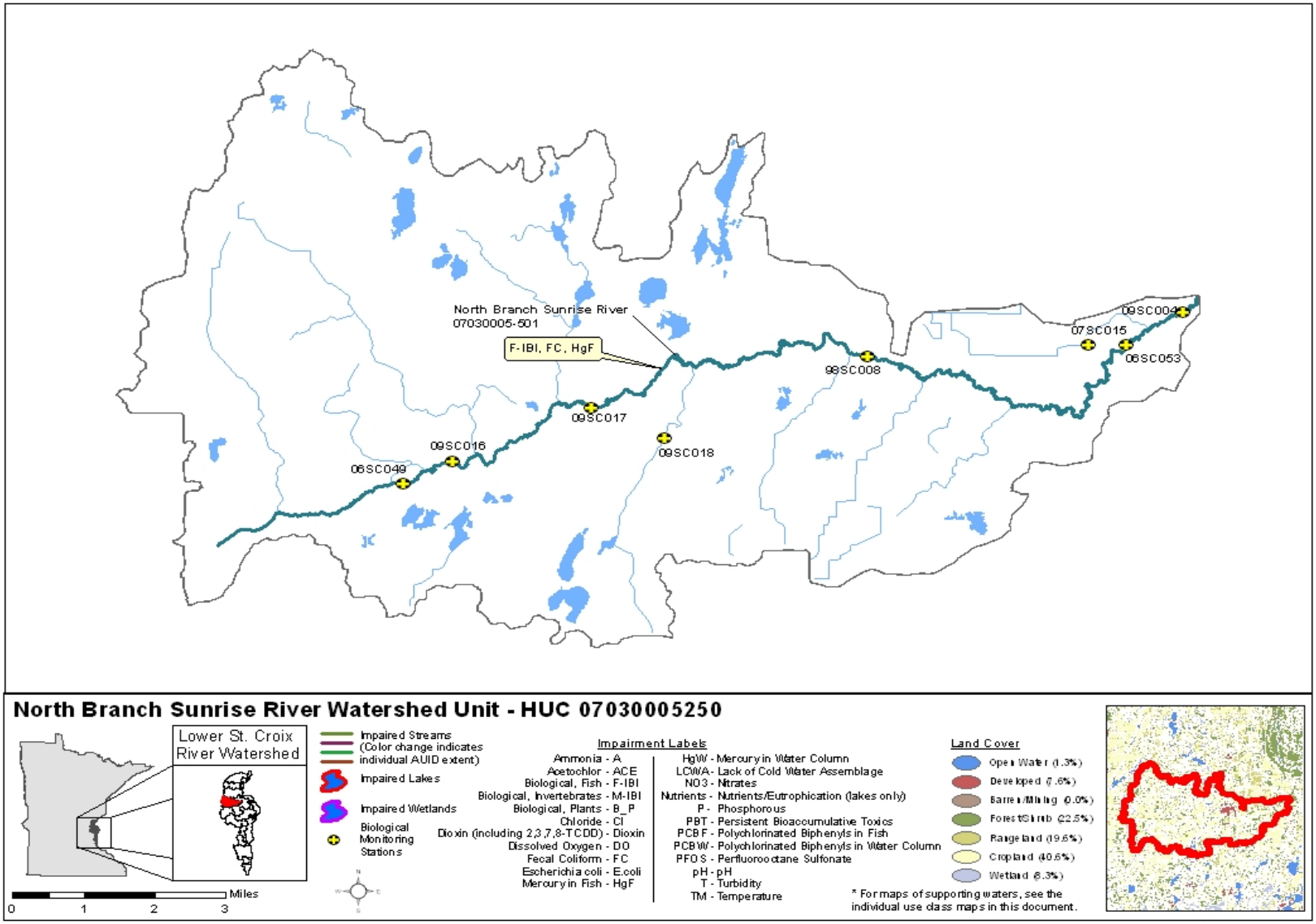

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the North Branch Sunrise River Watershed Unit

West Branch Sunrise River Watershed Unit 07030005220

The West Branch Sunrise River Watershed Unit is located in the west central portion of the Lower St. Croix Watershed, encompassing roughly 55.7 square miles in parts of Isanti, Anoka, and Chisago Counties. The West Branch Sunrise River begins in the township of Oxford, and then flows in a southeasterly direction 15.4 miles until it reaches Pool 1 of the Sunrise River just east of the town of Stacy. In that span this waterway flows through two nutrient impaired lakes (Typo and Martin) and a mix of agricultural land use and wetland complexes. Twenty-two basins are in the watershed, all but one are shallow. Agricultural production accounts for 34.1 percent of the land use in this watershed, with 22.4 percent being cropland and 11.7 percent rangeland. The outlet of this watershed is represented by station 09SC005 on the West Branch Sunrise River, which is located 1.25 miles west of Stacy.

Table 17. Aquatic life and recreation assessments on stream reaches in the West Branch Sunrise River Watershed Unit

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.
07030005-529, Sunrise River, West Branch, Martin Lk to Sunrise R (Pool 1)	7.72	2Bd	09SC030 09SC005 00SC001	Upstream of Ryan Lake Dr NE, 2.5 mi. E of Martin Lake Downstream of Lyons St, one mi. W of Stacy Upstream of Anoka CR 77, 1.6 mi W of Stacy	EXS	EXP	IF	EXP	MTS	MTS	MTS	--	IF	NS	IF
07030005-561, Sunrise River, West Branch (County Ditch 13), Headwaters to Typo Lk	5.03	2B	07SC018	Downstream of CR 20, 8 mi. SW of North Branch	--	--	IF	MTS	MTS	MTS	--	--	--	IF	NA
07030005-563, Sunrise River, West Branch, Typo Lk to Martin Lk	2.32	2B	--	--	--	--	--	EXP	MTS	--	--	--	--	NS	NA
07030005-576, Unnamed creek (Boot Lake Inlet), Rice Lk to Boot Lk	0.47	2B	--	--	--	--	--	--	MTS	--	--	--	--	NA	NA

07030005-578, Unnamed creek (Island Lake Inlet), Linwood Lk to Island Lk	0.53	2B	--	--	--	--	--	--	MTS	--	--	--	--	NA	NA
07030005-579, Unnamed creek (Martin Lake Inlet), Island Lk to Martin Lk	0.75	2B	--	--	--	--	--	--	MTS	--	--	--	--	NA	NA
07030005-580, Unnamed creek, Headwaters to W Br Sunrise R	1.39	2B	--	--	--	--	--	--	MTS	--	--	--	--	NA	NA
07030005-581, Unnamed creek, Unnamed ditch to W Br Sunrise R	1.47	2B	--	--	--	--	--	--	MTS	--	--	--	--	IF	NA
07030005-582, Unnamed ditch, Headwaters to W Br Sunrise R	2.68	2B	--	--	--	--	--	--	MTS	--	--	--	--	IF	NA
07030005-711, County Ditch 16, Unnamed ditch to Rice Lk	1.19	2B	06SC068	Upstream of 209th Ave, 4 mi. E of East Bethel	NA	--	--	--	--	--	--	--	--	NA*	NA
07030005-915, Unnamed creek, Headwaters to W Br Sunrise R	0.6	2B	--	--	--	--	--	--	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).

Key for Cell Shading: = previous impairment listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream

Table 18. Non-assessed biological stations on channelized AUIDs in the West Branch Sunrise River 11-HUC

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07030005-711, County Ditch 16, Unnamed ditch to Rice Lk	**06SC068**	**Upstream of 209th Ave, 4 mi. E of East Bethel**	**Fair**	--

Table 19. Minnesota Stream Habitat Assessment (MSHA) results for the West Branch Sunrise River 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	06SC068	County Ditch 16	2	8	9	13	6	38	poor
3	07SC018	Sunrise River, West Branch	4.8	11.8	9.1	8.3	10.7	44.7	poor
1	09SC005	Sunrise River, West Branch	5	10	10	5	13	43	poor
1	09SC030	Sunrise River, West Branch	3.75	8.5	8.5	8	16	44.75	poor
Average Habitat Results: *West Branch Sunrise River Watershed Unit*			**3.9**	**9.6**	**9.2**	**8.6**	**11.4**	**42.6**	**poor**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 20. Outlet water chemistry results for the West Branch Sunrise River 11-HUC

09SC005/S001-424 W BR SUNRISE R NEAR CR-19 1 MI W OF STACY

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	0.14	0.04	0.03		
Chloride	mg/l	9	16.8	20	18.3	18.4	230	
Dissolved oxygen (DO)	mg/l	19	5.51	10.95	8.25	8.1	5	
Escherichia coli	MPN/100ml	15	30	440	110	91	126	3
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	< 0.05	0.14	0.04	< 0.05		
Kjeldahl nitrogen	mg/l	10	1.45	3.05	2.1	2.0		
pH	--	19	6.8	8.92	8.1	8.1	6.5-9	
Phosphorus	ug/l	10	109	254	164	159		

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Specific conductance	uS/cm	19	245	327	278	276		
Temperature, water	deg C	19	15.3	27.6	22	21.3		
Total suspended solids	mg/l	10	16	51	33	32		
Total volatile solids	mg/l	10	13	36	23	24		
Transparency tube	cm	52	13	> 60	34	35		

Table 21. Aquatic recreation assessments on lakes in the West Branch Sunrise River Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
02-0022-00	Island	Anoka	Lake	Shallow	FS	NCHF
02-0026-00	Linwood	Anoka	Lake	Shallow	NS	NCHF
02-0034-00	Martin	Anoka	Lake	Shallow	NS	NCHF
02-0035-00	Fawn	Anoka	Lake	Deep	FS	NCHF
30-0009-00	Typo	Isanti	Lake	Shallow	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on three reaches of the West Branch Sunrise River; upstream of Typo Lake, between Typo and Martin lakes, and downstream of Martin Lake to Pool 1 of the Sunrise River. Fish and Invertebrate communities on the West Branch Sunrise River downstream of Martin Lake show an impaired condition, with tolerant species dominating the communities resulting in low fish and invertebrate IBI scores. Poor habitat quality at separate stations on the reach downstream of Martin Lake could be driving low diversity in the aquatic communities. Homogenous channel development throughout this stretch of river is characteristic of a low gradient system (i.e. absence of riffles); these stations were scored in the low gradient fish class but still fail to meet thresholds. The reach downstream of Martin Lake is impaired for aquatic life due in part to impairment involving turbidity exceedances from excess algae growth, which can be attributed to the extreme nutrient impairment in Martin Lake. This reach meets nitrate standards for drinking water. This reach was previously listed for pH (downstream of a highly eutrophic lake), but more recent data indicates that pH is within standards, so it will be removed from the impaired waters list. The reach between Typo and Martin lakes is impaired for aquatic life use due to excess turbidity and pH. Typo and Martin Lakes are highly eutrophic, and high nutrient levels and algal respiration may drive the swing in pH values observed. Dissolved oxygen levels are low in the reach upstream of Typo Lake; this reach is also completely channelized and within a large wetland complex. With the exception of Fawn Lake, all the basins in this watershed are shallow; as a result, reductions in watershed phosphorus loads and addressing internal loading will be important to see improved water quality in the area lakes. The TMDL for Martin and Typo Lakes has been completed (Appendix 6.3)

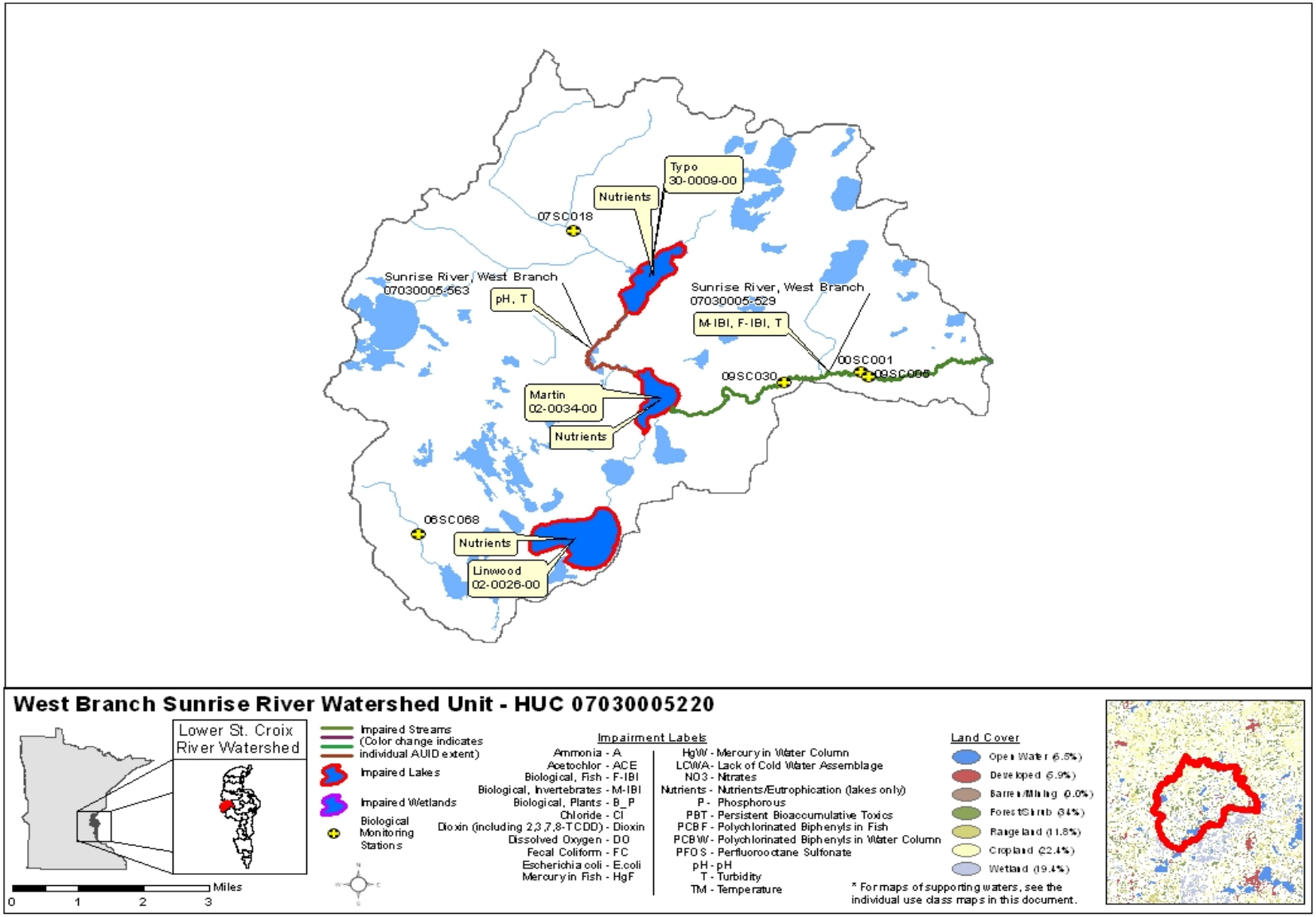

Figure 22. Currently listed impaired waters by parameter and land use characteristics in the West Branch Sunrise River Watershed Unit

Sunrise River Watershed Unit 07030005230

The Sunrise River Watershed Unit is the largest subwatershed in the Lower St. Croix, draining 93.2 square miles within central Chisago County. This watershed unit begins just east of the town of Stacy where the West and South Branch Sunrise River combine at the Sunrise Pool 1. The main stem Sunrise River drains northeast through Carlos Avery Wildlife Management Area (WMA) where the riparian area is dominated by wetland complexes and forests. The lower portion of this watershed unit, outside of the Carlos Avery WMA, maintains an intact forested riparian area, while cropland dominates outside of the riparian corridor. A series of small dams were built on this 24.3 mile stretch of the Sunrise River, creating a few small, nutrient rich impoundments. Below the Kost Dam gradient increases greatly relative to the upstream reaches of the river; this allows for a more natural riverine environment. Fifteen basins are located in the watershed, all of which are small and shallow. Agricultural production accounts for 60.2 percent of the land use in this watershed, with 39.2 percent vested in cropland and 29 percent vested in pasture lands. The outlet for this watershed unit is represented by biological station 09SC001, located on the main stem of the Sunrise River 6 miles east of North Branch.

Table 22. Aquatic life and recreation assessments on stream reaches in the Sunrise River Watershed Unit

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
07030005-526, Sunrise River, Upstream from Comfort Lk	2.84	2B	07SC017	South of Goodwin St, one mi. W of Comfort Lake	--	--	EXS	MTS	IF	MTS	MTS	--	EX	IF	NS
07030005-527, Sunrise River, Comfort Lk to Pool 1	4.36	2B	96SC024 09SC006	Near C.R. 84, one mi. E. of Wyoming Upstream of CR 84, 2.5 mi. NE of Wyoming	EXS	EXP	EXP	MTS	MTS	MTS	MTS	--	MTS	NS	FS
07030005-539, Sunrise River (Pool 3), Sunrise Pool 3	3.85	2B	09SC024	Upstream of CR 19, 3 mi. E of Stacy	EXS	--	NA	--	--	--	--	--	--	NS	NA
07030005-540, Sunrise River, Pool 3 to Kost Dam Reservoir	9.44	2B	06SC009 09SC035	Upstream of CR 14, 5 miles NW of Lindstrom Downstream of CR 14, 6 mi. SE of North Branch	EXS	--	IF	MTS	--	--	--	--	--	NS	NA
07030005-542, Sunrise River, Kost Dam to N Br Sunrise R	7.21	2B	96SC065 06SC021	Downstream of Kost Dam County Park Downstream of Hwy 95, 2 miles S. of Sunrise	MTS	MTS	IF	MTS	MTS	MTS	MTS	--	IF	FS	IF

07030005-543, Sunrise River, N Br Sunrise R to St Croix R	3.99	2B	09SC001	Upstream of CR 88 (Wilcox Rd) in Sunrise	MTS	MTS	IF	MTS	MTS	MTS	MTS	--	EX	FS	NS
07030005-545, Hay Creek, CD 3 (Beaver Cr) to Sunrise R	0.74	2A	09SC040	Upstream of CR 88 (Wilcox Rd.),1.5 mi. SW of Sunrise	--	--	EXP	MTS	--	--	--	--	EX	IF	NS
07030005-546, Beaver Creek (County Ditch 3), Unnamed ditch to Hay Cr	6.32	2A	07SC014	Downstream of CR 67, 5 mi. NE of North Branch	--	--	--	MTS	--	--	--	--	--	IF	NA
07030005-593, Unnamed ditch, Headwaters to Beaver Cr (CD 3)	2.26	2A	06SC033	Along CR 67, 1 mile N. of Branch	NA	NA	--	--	--	--	--	--	--	NA*	NA
07030005-596, Unnamed creek, Unnamed cr to Unnamed cr	0.2	2B	--	--	--	--	--	MTS	--	--	--	--	--	IF	NA
07030005-723, Unnamed ditch, T34 R21W S24, east line to Sunrise R	1.17	2B	09SC025	Downstream of Ivywood Tr N, 3.5 mi. NW of Lindstrom	EXP	--	EXS	MTS	MTS	MTS	EX	--	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream

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

AUID, Reach Name, Reach Description	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07030005-593, Unnamed Ditch, Headwaters to Beaver Cr (CD 3)	**06SC033**	**Along CR 67, one mile N. of Branch**	**Fair**	**Poor**

Table 24. Minnesota Stream Habitat Assessment (MSHA) results for the Sunrise River11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	09SC024	Sunrise River	5	9.5	9	7	23	53.5	fair
1	06SC009	Sunrise River	5	10	12.25	12	18	57.25	fair
6	96SC065	Sunrise River	2.5	10.3	16.6	8.8	18	57.2	fair
2	06SC021	Sunrise River	2.8	14	21.2	14.5	27	79.5	good
1	09SC001	Sunrise River	1.25	13	17.9	12	27	71.15	good
2	96SC024	Sunrise River	5	11	9.5	14	22	61.5	fair
1	09SC006	Sunrise River	5	10	12	15	11	53	fair
1	09SC035	Sunrise River	3	9.5	20.2	13	15	60.7	fair
2	98SC007	Hay Creek	2.5	12.5	13	6.5	19	53.5	fair
1	09SC040	Hay Creek	2.5	14	18	10	26	70.5	good
2	07SC014	County Ditch 3	3	11.5	14.9	8.5	17	54.9	fair
1	96SC016	Unnamed ditch to Hay Creek	0	9	2	13	13	37	poor
1	06SC033	Trib. to County Ditch 3	0	5	13.7	2	10	30.7	poor
1	09SC021	Trib. to Sunrise River	3.5	13.5	14	12	20	63	fair
1	09SC023	Trib. to Sunrise River	2.5	13.5	20.5	9	26	71.5	good
1	09SC025	Unnamed ditch (Bloomquist Cr)	3.5	10.5	9.25	12	22	57.25	fair
2	09SC019	Hay Creek	2.1	13	8	8	11	42.1	poor
Average Habitat Results: *Sunrise River Watershed Unit*			**2.7**	**11.3**	**13.3**	**9.5**	**18.8**	**55.6**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 25. Outlet water chemistry results for the Sunrise River 11-HUC

09SC001/S004-032 SUNRISE R AT CR-88 IN SUNRISE, Minnesota

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	0.07	0.03	< 0.05		
Chloride	mg/l	9	23	29	27	27.4	230	
Dissolved oxygen (DO)	mg/l	19	7	12.8	8.7	8.6	5	
Escherichia coli	MPN/100ml	15	91	2000	314	190	126	12
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	1.0	1.7	1.4	1.5		
Kjeldahl nitrogen	mg/l	10	0.41	0.97	0.7	0.7		
pH	--	19	7.8	9.3	8.2	8.1	6.5-9	1
Phosphorus	ug/l	10	64	131	86	84		
Specific conductance	uS/cm	19	283	414	372	381		
Temperature, water	deg C	19	12.7	23.2	18.7	18.8		
Total suspended solids	mg/l	10	2	9.6	5.4	4.4		
Total volatile solids	mg/l	10	< 1	3.2	1.8	1.6		
Transparency tube	cm	19	23	> 100	84	91		

Table 26. Aquatic recreation assessments on lakes in the Sunrise River Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
13-0029-00	Wallmark	Chisago	Lake	Shallow	NS	NCHF
13-0030-00	Vibo	Chisago	Lake	Shallow	NS	NCHF
13-0044-00	School	Chisago	Lake	Shallow	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on two reaches of the Sunrise River, two reaches of Hay Creek, and one ditch that drain from Wallmark Lake to the Sunrise River northwest of Lindstrom. The reach upstream of Pool one was considered to be fully supporting of aquatic recreation uses with low bacteria counts. Fish and invertebrate community data was also available at numerous stations on the mainstem Sunrise River and its tributaries. From the headwaters to Kost Dam, the Sunrise River has fish communities that fall below standards for the low gradient class; throughout this stretch of river habitat quality is average. Upstream of Kost Dam is also falling below standards for dissolved oxygen on both reaches; dissolved oxygen may be a potential stressor. Turbidity was meeting standards on these reaches. Below the Kost Dam to the St. Croix River, both fish and invertebrate communities improve significantly, indicating the stream is supporting aquatic life use. Habitat quality is in better condition in this stretch of river providing support to healthy aquatic communities. Downstream of the North Branch Sunrise River, the Sunrise River is impaired for aquatic recreation use due to excess bacteria. This reach has good levels of both dissolved oxygen and turbidity, and is fully supporting aquatic life uses. One station was located on a channelized AUID and was deferred for aquatic life use assessment; overall the fish community was in average to below average biological condition at this station, and habitat quality was in poor condition. The ditch from Wallmark Lake is impaired for aquatic life use due to both low dissolved oxygen and excess un-ionized ammonia. Hay Creek is impaired for aquatic recreation due to excess bacteria. The headwaters reach is supporting for aquatic recreation. Downstream of Beaver Creek, dissolved oxygen may be a stressor to aquatic life, but the dataset was not adequate enough to make an assessment. Wallmark, Vibo, and School lakes exceed the eutrophication standard for recreational uses. These basins are small and shallow; internal loading is contributing to extremely high phosphorus concentrations observed. A TMDL is underway on area lakes and the Sunrise River Watershed (Appendix 6.3).

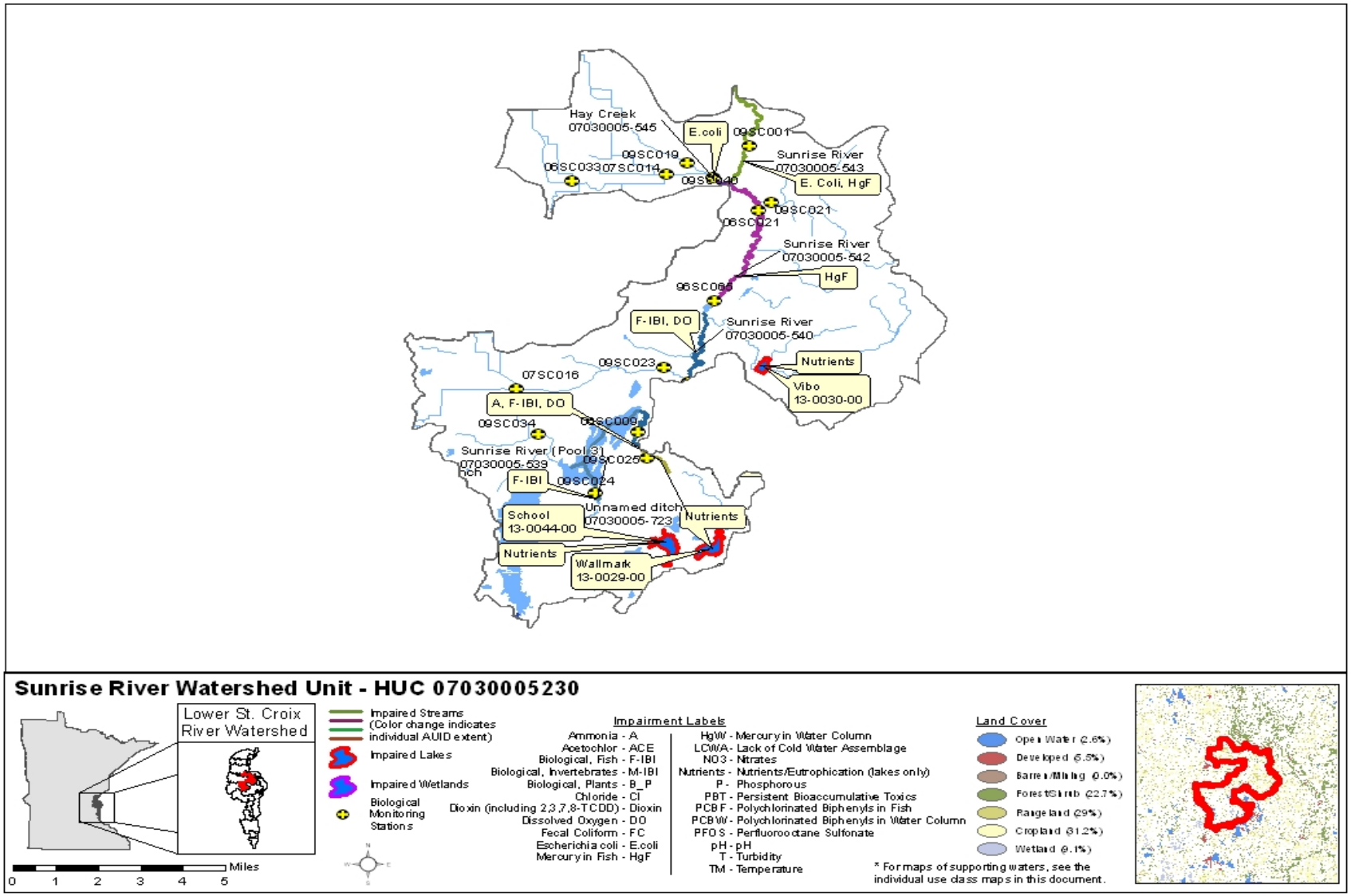

Figure 23. Currently impaired waters by parameter and land use characteristics in the Sunrise River Watershed Unit

Deer Creek Watershed Unit 07030005270

The Deer Creek Watershed Unit drains 12.5 square miles in eastern Chisago County; this sub watershed is one of the smallest 11-HUCs in the Lower St. Croix Watershed. The main watercourse within this sub watershed is Dry Creek, which begins in the township of Shafer then flows northeast nearly seven miles before draining through Wild River State Park and into the St. Croix River 3.3 miles northeast of the town of Almelund. The riparian cover remains mostly intact forests and wetlands in the middle and lower stretches of Dry Creek. Agricultural comprises 71.7 percent of land use in this sub watershed, with 41.2 percent vested in cropland and 30.5 percent in pasture. There is not an outlet site associated with this watershed due to its small size.

Table 27. Aquatic life and recreation assessments on stream reaches in the Deer Creek Watershed Unit

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			
07030005-570, Dry Creek, Unnamed cr to St Croix R	6.95	2B	--	--	--	--	IF	MTS	--	MTS	MTS	--	IF	IF	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Summary

Water quality data was available on the seven mile reach of Dry Creek immediately upstream of the St. Croix River. The dataset was small, and determination of support for aquatic life and aquatic recreation uses was not able to be completed. Available data did indicate that turbidity was meeting expectations and dissolved oxygen may be stressing aquatic life. A biological station was not available for assessment on this AUID.

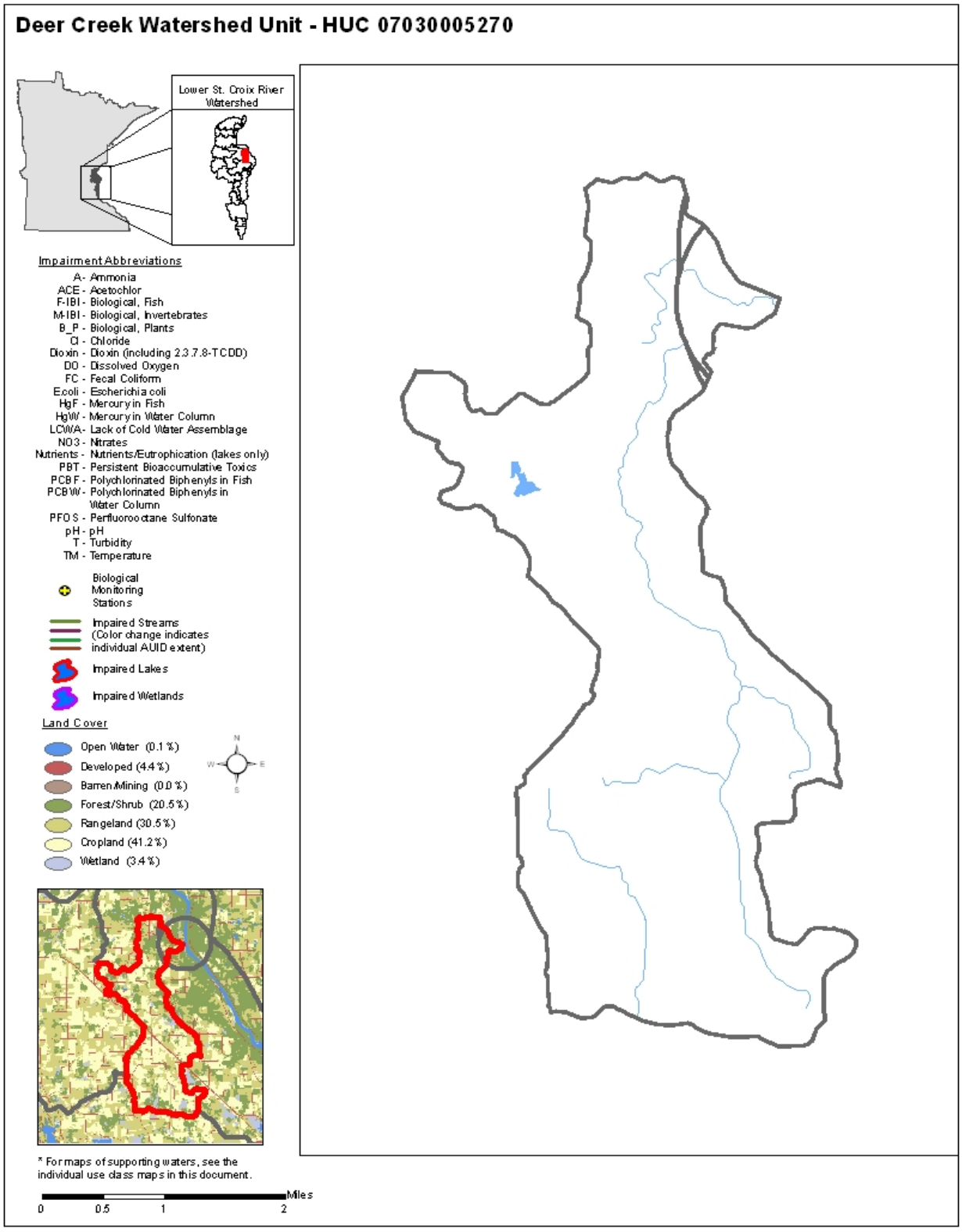

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Deer Creek Watershed Unit

Taylors Falls Watershed Unit 07030005290

The Taylors Falls Watershed Unit is located along the western bluffs of the Lower St. Croix River, draining 21 square miles in eastern Chisago County. This sub watershed consists of mostly ephemeral waterways that flow directly into the St. Croix, which creates a border along the eastern side of this sub watershed. Land cover is predominately forest located along the river bluffs (41.2 percent), while agricultural production accounts for 45.7 percent of the land use. No outlet station was established in this watershed due to the lack of perennial streams for collection.

Table 28. Aquatic life and recreation assessments on stream reaches in the Taylors Falls Watershed Unit

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			
07030005-518, St. Croix River, Trade R (WI) to Taylors Falls Dam	13.53	2Bd	--	--	--	--	MTS	--	IF	MTS	MTS	MT	--	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Summary

Water quality data was available on the thirteen mile reach of the St. Croix River upstream of the Taylor's Falls dam. The St. Croix River is meeting drinking water standards for nitrate along this reach. Available chemical data met standards and did not appear to be negatively impacting aquatic life.

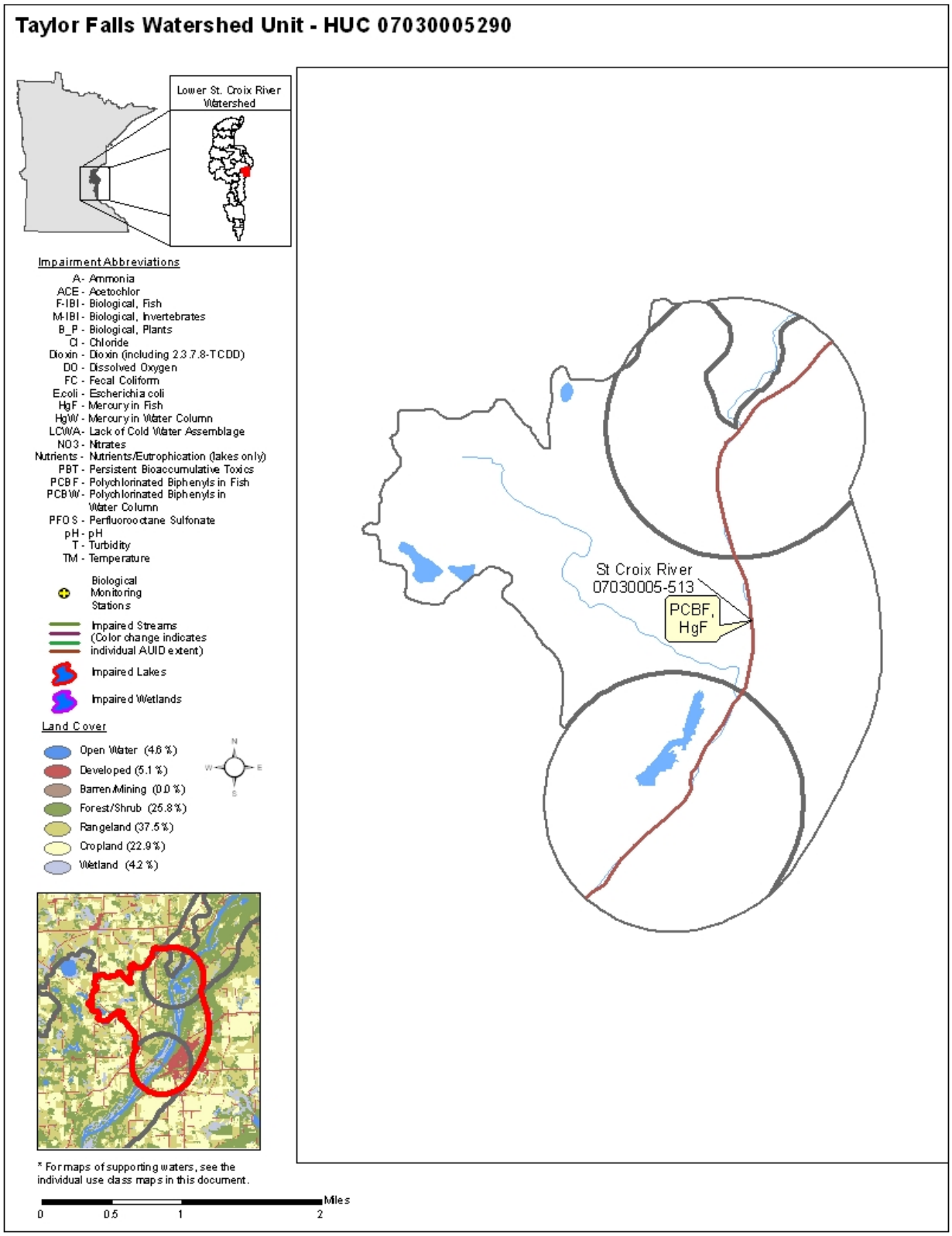

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Taylors Falls Watershed Unit

Lindstrom Watershed Unit 07030005240

The Lindstrom Watershed Unit is located in the central part of the Lower St. Croix Watershed, draining 75.9 square miles all within Chisago County. Lawrence Creek is a designated coldwater fishery, beginning in the township of Shafer and flowing southeast 11.1 miles before reaching the St. Croix River near the town of Franconia. Twenty-seven basins are located in the watershed, a mix of deep and shallow, large, and small lakes. Agricultural landscapes comprise 51.3 percent of this watershed unit, with 29.1 percent as pasture lands and 22.2 percent cropland. The outlet of this watershed unit is represented by biological station 00SC002 on Lawrence Creek, which is located in Franconia.

Table 29. Aquatic life and recreation assessments on stream reaches in the Lindstrom Watershed Unit

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			
07030005-553, Unnamed creek, Headwaters to Lawrence Cr	3.78	2B	--	--	--	--	--	MTS	--	--	--	--	--	IF	NA
07030005-572, Unnamed creek, Headwaters to South Center Lk	2.03	2B	--	--	--	--	--	MTS	MTS	--	MTS	--	--	FS	NA
07030005-574, Lawrence Creek, T33 R19W S3, north line to St Croix R	2.25	2A	00SC002	Upstream of Summer St in Franconia	MTS	MTS	IF	MTS	MTS	MTS	MTS	--	IF	FS	IF
07030005-719, Unnamed creek, Headwaters to Little Lk	2.31	2B	--	--	--	--	--	--	--	--	MTS	--	--	IF	NA
07030005-721, Unnamed creek, Little Lk to North Center Lk	1.84	2B	--	--	--	--	--	--	--	--	MTS	--	--	IF	NA
07030005-911, Unnamed creek, Wetland to Chisago Lk	0.32	2B	--	--	--	--	--	--	--	--	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 30. Minnesota Stream Habitat Assessment (MSHA) results for the Lindstrom 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
2	00SC002	Lawrence Creek	4.4	14.3	23.1	12.5	30.5	84.7	good
Average Habitat Results: *Lindstrom Watershed Unit*			**4.4**	**14.3**	**23.2**	**12.5**	**30.5**	**84.7**	**good**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 31. Aquatic recreation assessments on lakes in the Lindstrom Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
13-0011-00	Ogrens	Chisago	Lake	Deep	NS	NCHF
13-0012-01	Chisago (North Bay)	Chisago	Lake	Deep	FS	NCHF
13-0012-02	Chisago (South Bay)	Chisago	Lake	Shallow	FS	NCHF
13-0014-00	Linn	Chisago	Lake	Shallow	NS	NCHF
13-0019-00	Spider	Chisago	Lake	Shallow	FS	NCHF
13-0027-00	South Center	Chisago	Lake	Deep	NS	NCHF
13-0028-00	South Lindstrom	Chisago	Lake	Deep	FS	NCHF
13-0032-01	North Center Lake	Chisago	Lake	Deep	NS	NCHF
13-0033-00	Little	Chisago	Lake	Shallow	NS	NCHF
13-0034-00	Pioneer	Chisago	Lake	Shallow	NS	NCHF
13-0035-00	North Lindstrom	Chisago	Lake	Deep	FS	NCHF
13-0041-01	Green(Little Green)	Chisago	Lake	Shallow	FS	NCHF
13-0041-02	Green (Main Basin)	Chisago	Lake	Deep	FS	NCHF
13-0046-00	Emily	Chisago	Lake	Shallow	NS	NCHF
13-0048-00	White Stone	Chisago	Lake	Shallow	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data is available on Lawrence Creek, and a number of small creeks connecting chains of lakes. Lawrence Creek appears to be fully supporting for aquatic life use; one biological station on the creek had fish and invertebrate communities that score well above the threshold. Habitat quality in Lawrence Creek is very good accommodating diverse aquatic communities. The riparian corridor in the lower reaches of Lawrence Creek is comprised of intact forestland. In the headwater portions agricultural land uses are more prominent in the riparian area, with small sections of the river having been channelized. This creek met the drinking water standard for nitrates. The small creeks draining to North and South Center lakes had elevated phosphorus levels. Seven lakes supported aquatic recreation uses, including North and South Lindstrom and Lake Chisago, and eight are not supporting aquatic recreation use, including North and South Center lakes. The remaining basins did not have sufficient data to make a determination of support. A TMDL has been completed for Comfort Lake and the remaining lakes will be addressed by the Chisago Lakes TMDL.

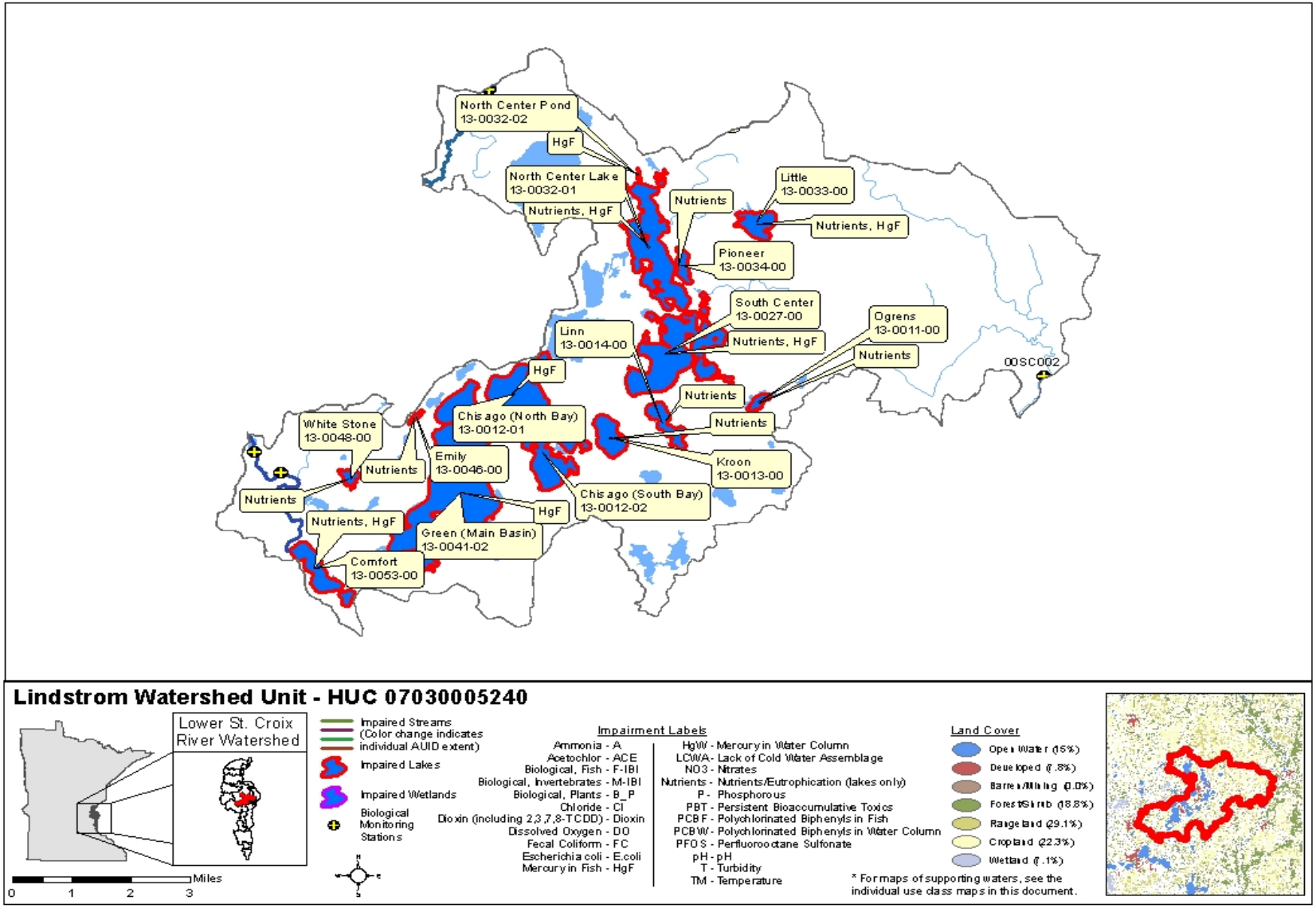

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Lindstrom Watershed Unit

South Branch Sunrise River Watershed Unit 07030005210

The South Branch Sunrise River Watershed Unit is located in the west central part of the Lower St. Croix Watershed, draining 79.9 square miles in eastern Anoka, northern Washington and southern Chisago Counties. The South Branch Sunrise River begins in the township of Columbus within the Carlos Avery WMA, and continues flowing northeast across numerous wetland complexes approximately 5.1 miles until it drains into the main stem Sunrise River, two miles northeast of the town of Wyoming. Agricultural production accounts for 33.4 percent of this watersheds land use, of that 21.9 percent is pasture while 11.5 percent is cropland. Three unnamed creeks and two unnamed ditches are located within this watershed unit. Sixteen lakes in the watershed had data available for assessment with a mix of deep and shallow basins. The outlet of this watershed is represented by station 09SC007 on the South Branch Sunrise River, located in Wyoming.

Table 32. Aquatic life and recreation assessments on stream reaches in the South Branch Sunrise River Watershed Unit

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			
07030005-521, Unnamed creek, Birch Lk to School Lk	0.68	2B	--	--	--	--	EXS	MTS	MTS	--	MTS	--	EX	NA	NS
07030005-522, Unnamed creek, School Lk to Little Comfort Lk	1.3	2B	09SC036	Upstream of Itasca Ave N, 2.5 mi. NE of Forest Lake	--	--	EXS	MTS	MTS	--	MTS	--	EX	NS	NS
07030005-525, Judicial Ditch 2, Headwaters to Sunrise R	2.05	2B	--	--	--	--	EXS	MTS	EX	--	MTS	--	EX	NS	IF
07030005-528, Sunrise River, South Branch, Unnamed lk (02-0500-00) to Sunrise R	5.02	2B	09SC007	Upstream of CR 30, in Wyoming	--	--	EXS	MTS	MTS	MTS	MTS	--	MTS	NS	FS

07030005-637, Unnamed creek, Moody Lk to Bone Lk	0.43	2B	--	--	--	--	--	EXP	MTS	--	MTS	--	IF	NA	IF
07030005-639, Unnamed creek, Bone Lk to Unnamed lk	0.03	2B	--	--	--	--	--	MTS	--	--	--	--	IF	NA	IF
07030005-641, Unnamed creek, Unnamed lk to Birch Lk	1.7	2B	--	--	--	--	EXS	MTS	MTS	--	MTS	--	EX	IF	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 33. Minnesota Stream Habitat Assessment (MSHA) results for the South Branch Sunrise River 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
2	07SC017	Sunrise River	1	10.75	9	7.5	10.5	38.7	poor
1	09SC007	Sunrise River, South Branch	1.75	11.5	9	12	16	50.25	fair
1	09SC036	Trib. to Comfort Lake	1.75	11.5	10	11	11	45.25	fair
Average Habitat Results: *South Branch Sunrise River Watershed Unit*			**1.5**	**11.25**	**9.3**	**10.1**	**12.5**	**44.7**	**poor**

Qualitative habitat ratings

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

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

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

Table 34. Outlet water chemistry results for the South Branch Sunrise River 11-HUC

09SC007/S005-530 SUNRISE R, SB AT CSAH-30 IN WYOMING

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	10	< 0.05	0.1	-	-		
Chloride	mg/l	9	34	214	112	101	230	
Dissolved oxygen (DO)	mg/l	19	0.3	11.3	6.0	6.2	5	7
Escherichia coli	MPN/100ml	15	17	260	87	54	126	3
Inorganic nitrogen (nitrate and nitrite)	mg/l	10	< 0.05	0.27	0.07	< 0.05		
Kjeldahl nitrogen	mg/l	10	0.45	1.2	0.83	0.87		
pH	--	19	6.5	8.7	7.5	7.4	6.5-9	
Phosphorus	ug/l	10	17	64	37	34		
Specific conductance	uS/cm	19	225	1042	478	397		
Temperature, water	deg C	19	13.8	24.8	19.9	20.2		
Total suspended solids	mg/l	9	1.2	3.6	2.1	1.6		
Total volatile solids	mg/l	10	< 1	2	1.2	< 1		
Transparency tube	cm	14	78	> 100	98	> 100		

Table 35. Aquatic recreation assessments on lakes in the South Branch Sunrise River Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
02-0042-00	Coon	Anoka	Lake	Deep	FS	NCHF
13-0023-00	Moody	Chisago	Lake	Deep	NS	NCHF
13-0024-00	Third	Chisago	Lake	Shallow	FS	NCHF
13-0025-00	Second	Chisago	Lake	Shallow	NS	NCHF
13-0057-00	School	Chisago	Lake	Shallow	NS	NCHF
82-0054-00	Bone	Washington	Lake	Deep	NS	NCHF
82-0059-00	Goose	Washington	Lake	Deep	NS	NCHF
82-0080-00	Sylvan (Halfbreed)	Washington	Lake	Deep	FS	NCHF
82-0107-00	Sunfish	Washington	Lake	Shallow	NS	NCHF
82-0159-00	Forest	Washington	Lake	Deep	FS	NCHF
82-0162-00	Shields	Washington	Lake	Shallow	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on a five mile reach of the South Branch Sunrise River immediately upstream of the Sunrise River, Judicial Ditch 2, and on a series of creeks that connect a chain of lakes in the watershed. This subwatershed has a large amount of both wetlands and altered waterways. Fish and invertebrate community assessments on data from a station in this sub watershed were deferred due to stations being located on predominately channelized stream reaches. Habitat quality at these stations was in poor condition, possibility from the influence of altered stream courses. Low dissolved oxygen was identified as an aquatic life use impairment in four of the reaches; two of those are deferred due to highly altered channels. Excess bacteria resulted in aquatic recreation use impairments on three creeks between Bone and Little Comfort Lakes, and one on the Sunrise River. In addition, toxic levels of chloride were identified on Judicial Ditch 2 resulting in an aquatic life impairment. Assessments were completed for eleven lakes in the subwatershed. Four of the lakes have TMDLs completed through the Comfort Lake Forest Lake Watershed District Impaired Lakes TMDL (Moody, School, Bone, and Shields Lakes), and one of the lakes has a TMDL completed through the Carnelian Marine St. Croix Watershed District Lakes TMDL (Goose Lake). Second and Sunfish lakes are also considered impaired for aquatic recreation use. These lakes are less developed than in previous watersheds, but the land use in the larger watershed has been converted from forest to agricultural uses. Forest, Coon, Sylvan, and Third lakes are all meeting the recreation use standard. Forest and Coon Lakes are large and relatively deep, which will allow for greater assimilation of phosphorus into the basin without an immediate visible change in the chlorophyll-a and Secchi. However both lakes are approaching the phosphorus threshold, and in Forest Lake, the chlorophyll-a levels do exceed the threshold. These lakes are also the most heavily developed in the watershed. Work in this watershed to reduce phosphorus runoff would benefit all the lakes. A number of the impaired lakes are also shallow, which will require addressing internal loading in addition to watershed sources.

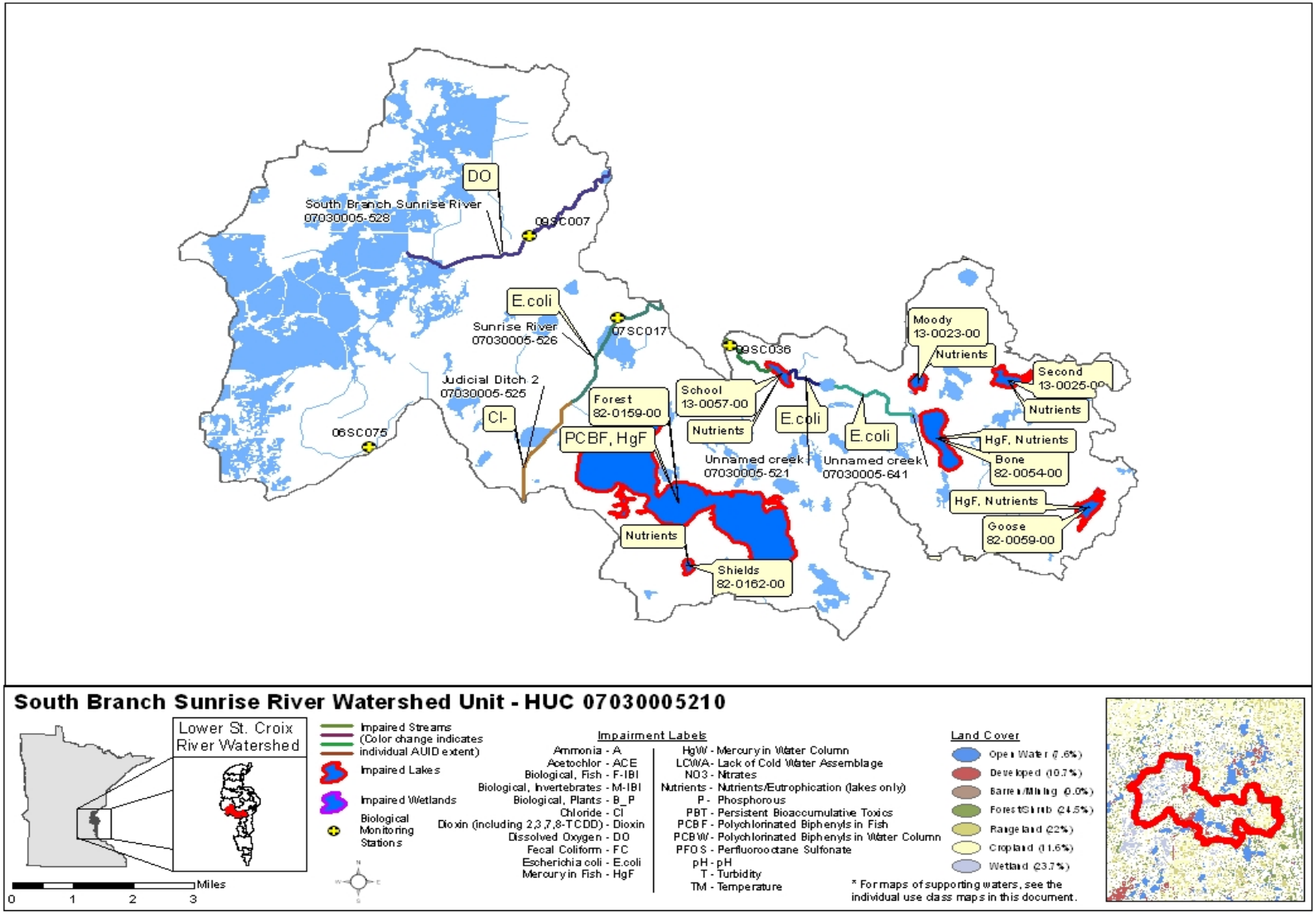

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the South Branch Sunrise River Watershed Unit

Marine on the St. Croix Watershed Unit 07030005340

The Marine on the St. Croix Watershed Unit is set along the Lower St. Croix River, draining approximately 62.1 square miles in northern Washington and southern Chisago Counties. This watershed unit is composed of small tributaries flowing east through the river bluffs directly into the Lower St. Croix River. Data associated with biological stations that are used for stream assessments were limited in this subwatershed for a variety of reasons (i.e. proximity to larger body of water and drainage area <5 square miles). There is no outlet chemistry station in this watershed due to a lack of representative perennial streams for collection. Nineteen basins are present in the watershed, with a mix of deep and shallow lakes.

Table 36. Aquatic life and recreation assessments on stream reaches in the Marine on the St. Croix Watershed Unit

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			
07030005-549, Roadside Ditch (Old Mill Stream), Headwaters to St Croix R	1.43	2A	99SC008	Upstream of Hwy 95	--	--	IF	MTS	MTS	EXP	MTS	--	IF	IF	IF
07030005-603, Unnamed creek, Big Carnelian Lk to Little Carnelian Lk	0.62	2B	--	--	--	--	--	MTS	MTS	--	--	--	--	NA	NA
07030005-713, Unnamed creek, Unnamed cr to St Croix R	0.44	2B	--	--	--	--	IF	EXS	MTS	--	MTS	--	EX	IF	NS
07030005-752, Unnamed creek, Headwaters to St Croix R	0.19	2B	--	--	--	--	--	--	MTS	--	--	--	IF	IF	IF
07030005-904, Unnamed creek (Willow Branch), to St Croix R	0.83	2A	99SC010	Upstream of Hwy 95	--	--	IF	MTS	MTS	EXP	MTS	--	IF	IF	IF
07030005-913, Unnamed creek, Headwaters to St Croix R	0.3	2A	99SC011	Downstream of public access in Scandia, barrier falls to mouth	--	--	IF	MTS	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 37. Aquatic recreation assessments on lakes in the Marine on the St. Croix Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
13-0005-00	Duck	Chisago	Lake	Shallow	FS	NCHF
82-0014-00	Little Carnelian	Washington	Lake	Deep	FS	NCHF
82-0030-00	Long	Washington	Lake	Shallow	FS	NCHF
82-0046-00	Square	Washington	Lake	Deep	FS	NCHF
82-0048-00	Twin	Washington	Lake	Deep	FS	NCHF
82-0049-00	Big Carnelian	Washington	Lake	Deep	FS	NCHF
82-0065-00	Hay	Washington	Lake	Shallow	NS	NCHF
82-0067-00	Sand	Washington	Lake	Shallow	FS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

This subwatershed consists of five short tributaries to the St. Croix River. Excess bacteria were found in tributaries near Otisville and Copas, resulting in aquatic recreation use impairments. Old Mill Stream and Willow Branch Creek both had pH values that indicated possible stressed conditions for aquatic life; not enough data was available to determine if the use was impaired or not. Biological community data from stations in this subwatershed fell outside the 10-year assessment window and were not assessed. The mainstem Lower St. Croix River is classified as a large river (i.e. Lower Mississippi and Minnesota rivers) and was deferred for aquatic life assessment until biological indicators are developed to match these unique systems. Aquatic recreation is assessable on the river, and was found to be meeting bacteria standards. Eight lakes had sufficient data for aquatic recreation use assessment; of those only Hay Lake exceeded the standard and is considered impaired; a TMDL has already been developed for this basin. The remaining lakes, including Big and Little Carnelian and Square Lakes, meet the water quality standard. The watershed has a mix of deep and shallow basins, with the land use dominated by forested and pastured land uses. Less disturbed land cover is likely contributing to the high quality recreational opportunities in this watershed.

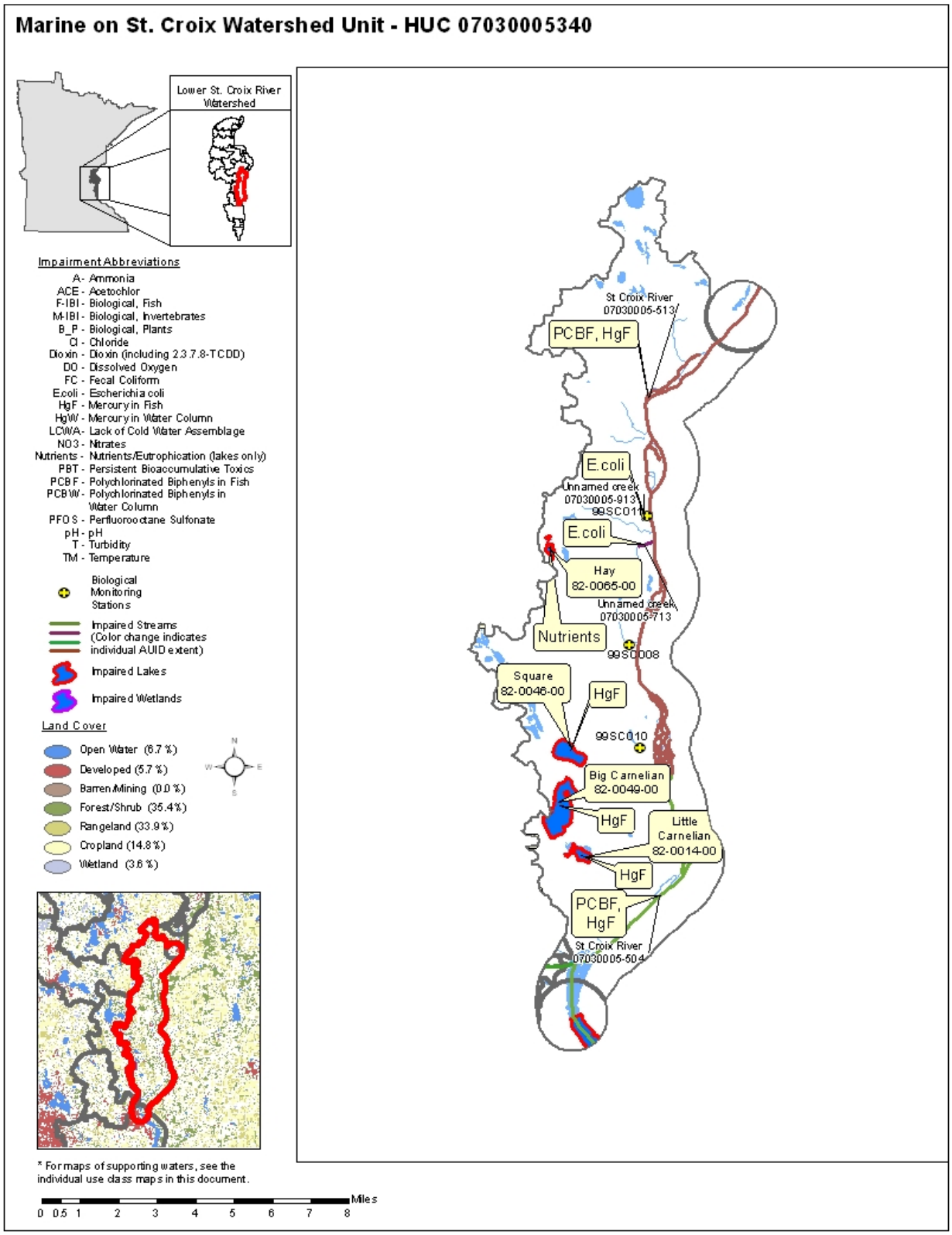

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Marine on the St. Croix Watershed Unit

Big Marine Lake Watershed Unit 07030005360

The Big Marine Lake Watershed Unit drains approximately 34.6 square miles in central Washington County. This watershed unit encompasses an area from Big Marine Lake in the township of New Scandia to just north of the City of Stillwater. Silver Creek is the only named tributary in this unit, draining east 2.6 miles within Stillwater Township before reaching the St. Croix River. This subwatershed is dominated by small, shallow basins, only Big Marine Lake is over 60 ha. An unnamed creek outlets Big Marine Lake flowing six miles before reaching Big Carnelian Lake. No outlet chemistry data was collected from this unit due to a lack of perennial streams for collection.

Table 38. Aquatic life and recreation assessments on stream reaches in the Big Marine Lake Watershed Unit

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.
07030005-559, Silver Creek, Headwaters to St Croix R	2.66	2B	--	--	--	--	IF	MTS	MTS	--	--	--	IF	IF	IF
07030005-601, Unnamed creek, Unnamed lk to Big Carnelian Lk	1.81	2B	09SC033	Downstream of CSAH 11 (Otchipwe Ave N), 8 mi. SW of Marine on St. Croix	EXS	--	IF	EXP	MTS	--	MTS	--	EX	NS	NS
07030005-644, Unnamed creek, Unnamed lk (82-0296-00) to Bass Lk	0.2	2B	--	--	--	--	--	MTS	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 39. Minnesota Stream Habitat Assessment (MSHA) results for the Big Marine Lake 11-HUC

Visit	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	09SC033	Trib. to Big Carnelian Lake	4.5	11.5	14	14	18	62	fair
Average Habitat Results: *Big Marine Lake Watershed Unit*			**4.5**	**11.5**	**14**	**14**	**18**	**62**	**fair**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 40. Aquatic recreation assessments on lakes in the Big Marine Lake Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
82-0015-02	Loon (Main Lake)	Washington	Lake	Shallow	NS	NCHF
82-0016-00	Silver	Washington	Lake	Shallow	FS	NCHF
82-0017-00	Carol	Washington	Lake	Shallow	FS	NCHF
82-0018-00	North Twin	Washington	Lake	Shallow	FS	NCHF
82-0019-00	South Twin	Washington	Lake	Shallow	NS	NCHF
82-0025-00	Louise	Washington	Lake	Shallow	NS	NCHF
82-0026-02	Mud (Main Lake)	Washington	Lake	Shallow	NS	NCHF
82-0028-00	Staples	Washington	Lake	Shallow	FS	NCHF
82-0031-00	Terrapin	Washington	Lake	Shallow	FS	NCHF
82-0033-00	Mays	Washington	Lake	Deep	FS	NCHF
82-0034-00	East Boot	Washington	Lake	Deep	NS	NCHF
82-0035-00	Bass	Washington	Lake	Shallow	FS	NCHF
82-0044-00	West Boot	Washington	Lake	Deep	FS	NCHF
82-0045-00	Clear	Washington	Lake	Shallow	FS	NCHF
82-0052-02	Big Marine (Jellums)	Washington	Lake	Shallow	NS	NCHF
82-0052-04	Big Marine	Washington	Lake	Deep	FS	NCHF
82-0056-00	German	Washington	Lake	Shallow	FS	NCHF
82-0062-00	Unnamed	Washington	Lake	Shallow	FS	NCHF

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
82-0064-00	Fish	Washington	Lake	Shallow	NS	NCHF
82-0068-00	Long	Washington	Lake	Shallow	NS	NCHF
82-0076-00	Barker	Washington	Lake	Deep	NS	NCHF
82-0077-00	Unnamed (Goggins)	Washington	Lake	Shallow	NS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on a tributary to Big Carnelian Lake and on Silver Creek. The Big Carnelian Lake tributary was considered impaired for aquatic recreation due to excess bacteria. The fish community was assessed in the low gradient class for streams; it was determined to be non-supporting of aquatic life use, with excess sedimentation being a potential stressor. Habitat quality in this small tributary is average, signaling it may not be the stressor impacting aquatic communities. Recently collected data on this tributary did not verify the turbidity impairment, but there was not enough quality data to remove the impairment. On Silver Creek, the dataset was not large enough to determine use support; although bacteria and dissolved oxygen may be potential problems. Of the twenty-six basins in this watershed, twelve are meeting recreational uses and ten are considered impaired due to excess nutrients. Of the impaired lakes, only two are considered deep, East Boot Lake and Barker Lake. TMDLs have been developed for all the impaired lakes except for Barber and Goggins. Of the supporting lakes, only Mays, West Boot, and Big Marine are considered to be deep. Shallow basins have less ability to assimilate phosphorus; watershed loading and internal loading will both have to be addressed to improve conditions in the impaired lakes.

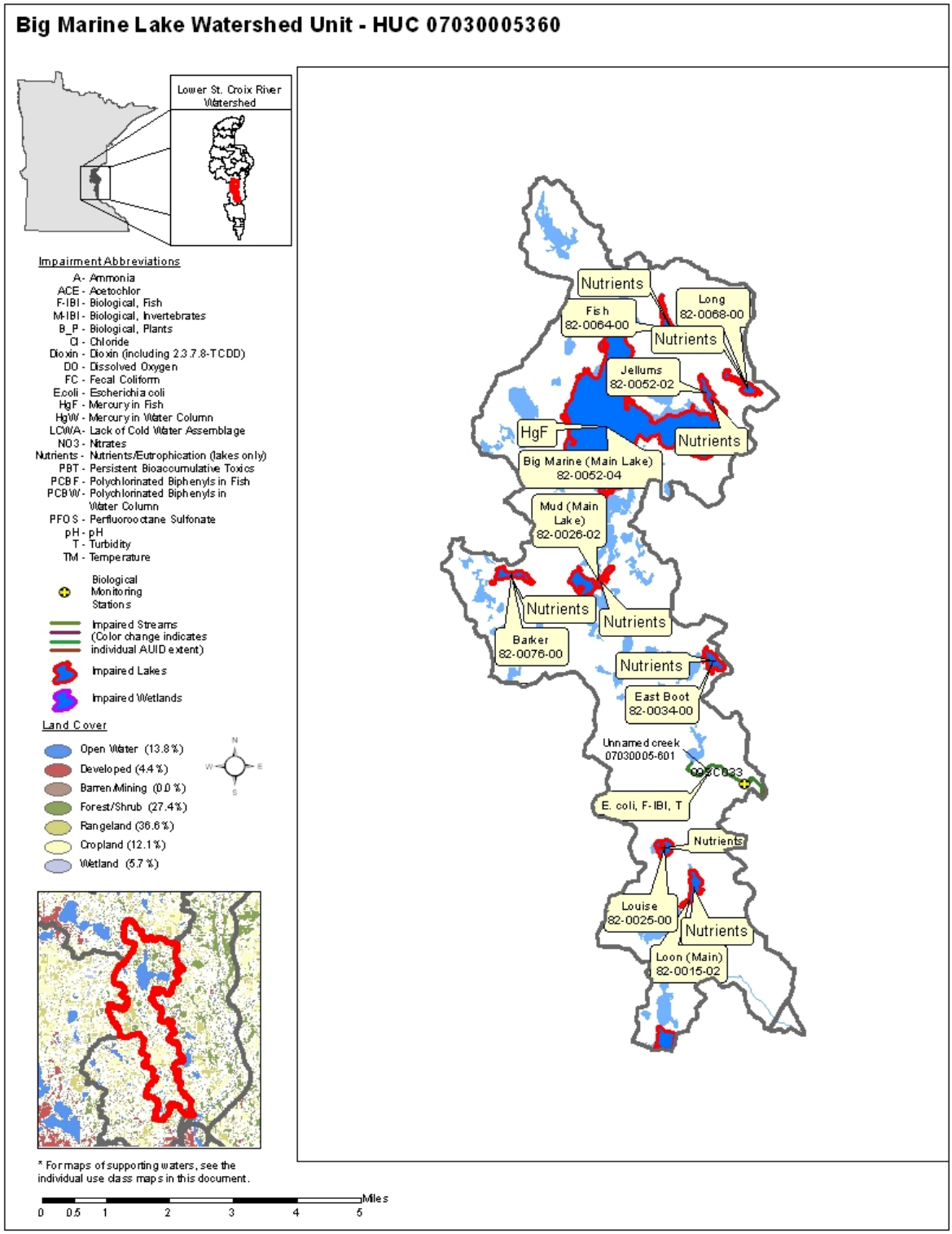

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Big Marine Lake Watershed Unit

Browns Creek Watershed Unit 07030005370

The Browns Creek watershed unit covers 34.1 square miles in central Washington County. The MDNR has classified a 7.12 mile stretch of Browns Creek as Designated Trout Waters, stocking it annually with 1,000 young of year Brown Trout trying to establish a recreational fishery (MDNR 2010). The headwaters of Browns Creek begin in Grant township; flowing south it passes through a series of small wetland complexes before veering east near the City of Stillwater. Flowing on the north side of Stillwater, Browns Creek splits the urban landscape, finally passing through a deep ravine into the St. Croix River. A more in depth look at this subwatershed is offered on the Browns Creek Watershed District's (BCWD) website (http://www.bcwd.org/). The lakes in this watershed are predominately small and shallow. Agriculture comprises 54.4 percent of the watershed units land use, with 43.2 percent in rangeland and 11.2 percent planted with row crops. Developed land uses comprise 13.2 percent of this watershed, which could impact the natural infiltration due to impervious surfaces. The outlet of this watershed unit is represented by station 07SC002 on Browns Creek, 0.25 miles north of downtown Stillwater.

Table 41. Aquatic life and recreation assessments on stream reaches in the Browns Creek Watershed Unit

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			
07030005-520, Browns Creek, T30 R20W S18, west line to St Croix R	4.76	2A	07SC002 06SC055 99SC002 99SC006	Upstream of CR 5, 1 mi. NW of Stillwater Upstream of CR 64, 1 mile NW of Stillwater Upstream of Hwy 95 Upstream of Neal Ave.	EXP	MTS	EXP	EXS	MTS	EXP	MTS	--	EX	NS	NS
07030005-586, Browns Creek, Headwaters to T30 R21W S1, south line	1.1	2B	--	--	--	--	--	MTS	MTS	--	--	--	IF	IF	IF
07030005-587, Browns Creek, T30 R21W S12, north line to T30 R21W S13, east line	2.39	2A	07SC001 96SC066	Upstream of Hwy 15, 2.5 mi. NW of Stillwater @ C.R. 68, 4 mi. N.W. of Stillwater	EXP	--	EXP	MTS	MTS	MTS	MTS	--	EX	NS	NS

07030005-767, Unnamed creek, T30 R20W S19, south line to underground diversion	0.68	2A	--	--	--	--	IF	EXP	MTS	--	MTS	--	EX	IF	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 listed 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 (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 42. Minnesota Stream Habitat Assessment (MSHA) results for the Browns Creek 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
2	06SC055	Browns Creek	5	14.5	19.8	13.5	31.5	84.3	good
3	07SC002	Browns Creek	2.5	13	20.9	12	29.3	77.7	good
2	07SC001	Browns Creek	5	11	21.2	9.5	26.5	73.2	good
3	96SC066	Browns Creek	3.1	13.8	16.7	10.7	23	67.3	good
Average Habitat Results: *Browns Creek Watershed Unit*			3.9	13.1	19.7	11.4	27.6	75.6	good

Qualitative habitat ratings

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

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

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

Table 43. Outlet water chemistry results for the Browns Creek 11-HUC

S004-925 BROWNS CK AT STONEBRIDGE TR IN STILLWATER

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Dissolved oxygen (DO)	mg/l	19	6.5	10.4	8.5	8.8		
Escherichia coli	MPN/100ml	18	81	> 2420	482	291	126	2
pH	--	18	7.6	8.9	8.2	8.3	6.5-8.5	1
Specific conductance	uS/cm	19	328	844	430	413		
Temperature, water	deg C	19	11.8	23.4	17.1	16.7		
Transparency tube	cm	22	29	> 100	87	> 100		

Table 44. Aquatic recreation assessments on lakes in the Browns Creek Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
82-0020-00	McKusick	Washington	Lake	Shallow	FS	NCHF
82-0021-00	Long	Washington	Lake	Shallow	NS	NCHF
82-0042-00	Lynch	Washington	Lake	Shallow	NS	NCHF
82-0120-00	Benz	Washington	Lake	Shallow	NS	NCHF
82-0123-00	Bass	Washington	Lake	Shallow	FS	NCHF
82-0124-00	Unnamed	Washington	Lake	Shallow	FS	NCHF
82-0125-00	Pat	Washington	Lake	Shallow	FS	NCHF
82-0126-00	Masterman	Washington	Lake	Shallow	FS	NCHF
82-0132-00	Wood Pile	Washington	Lake	Shallow	FS	NCHF
82-0148-00	Plaisted	Washington	Lake	Shallow	NS	NCHF
82-0151-00	South School Section	Washington	Lake	Deep	NS	NCHF
82-0333-00	Unnamed - Kismet Basin	Washington	Lake	Shallow	FS	NCHF
82-0334-00	Unnamed	Washington	Lake	Shallow	FS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on Browns Creek, downstream of 110th Avenue, and on the tributary that feeds the Browns Creek Diversion to Lake McKusick. Browns Creek is impaired over the entire reach for aquatic recreation use due to excess bacteria, and for aquatic life use due to low dissolved oxygen. The tributary upstream of Washington County 15 is proposed to be changed to a warm water use class which would result in meeting dissolved oxygen standards. A TMDL completed on the lower reach did not identify dissolved oxygen as a stressor. Downstream of Washington County 15, the creek has an additional impairment due to turbidity. Excessive sediment runoff during storm events could be driving this exceedance, and also contributing to sediment loading and erosion in this stretch of creek. This sediment may be blanketing habitat used by certain aquatic species for reproduction, and a TMDL was developed to address this issue. Fish communities throughout Browns Creek are mostly limited to tolerant species; some Brown Trout specimens were collected, but overall this creek is not meeting standards for cold water Fish IBI. Increasing development and urban runoff can seriously disturb the thermal makeup of the creek, and may be impacting the survival and reproduction of trout and other coldwater species. Invertebrate data for numerous sampling visits at four separate stations shows communities are healthy and conditions are supporting of aquatic life use. Habitat quality throughout the creek is in good condition, indicating that it is not a primary stressor to aquatic organisms. This lower reach is meeting the drinking water standard for nitrite-nitrate. The tributary to the Browns Creek Diversion to Lake Mckusik has an aquatic recreation use impairment for excess bacteria. This small tributary is mainly limited groundwater fed base flow and surface water runoff events. The available data for aquatic life use is not sufficient to determine support. Eight lakes in the watershed met the aquatic recreation use standard, including lakes McKusick, Bass, and Pat and five were considered impaired (Long, Lynch, Benz, Plaisted, and South School Section). Only South School Section Lake is deep; the remaining basins are shallow. Supporting lakes will require that watershed sources of phosphorus be limited while the impaired lakes will likely require additional focus on internal loading to meet standards.

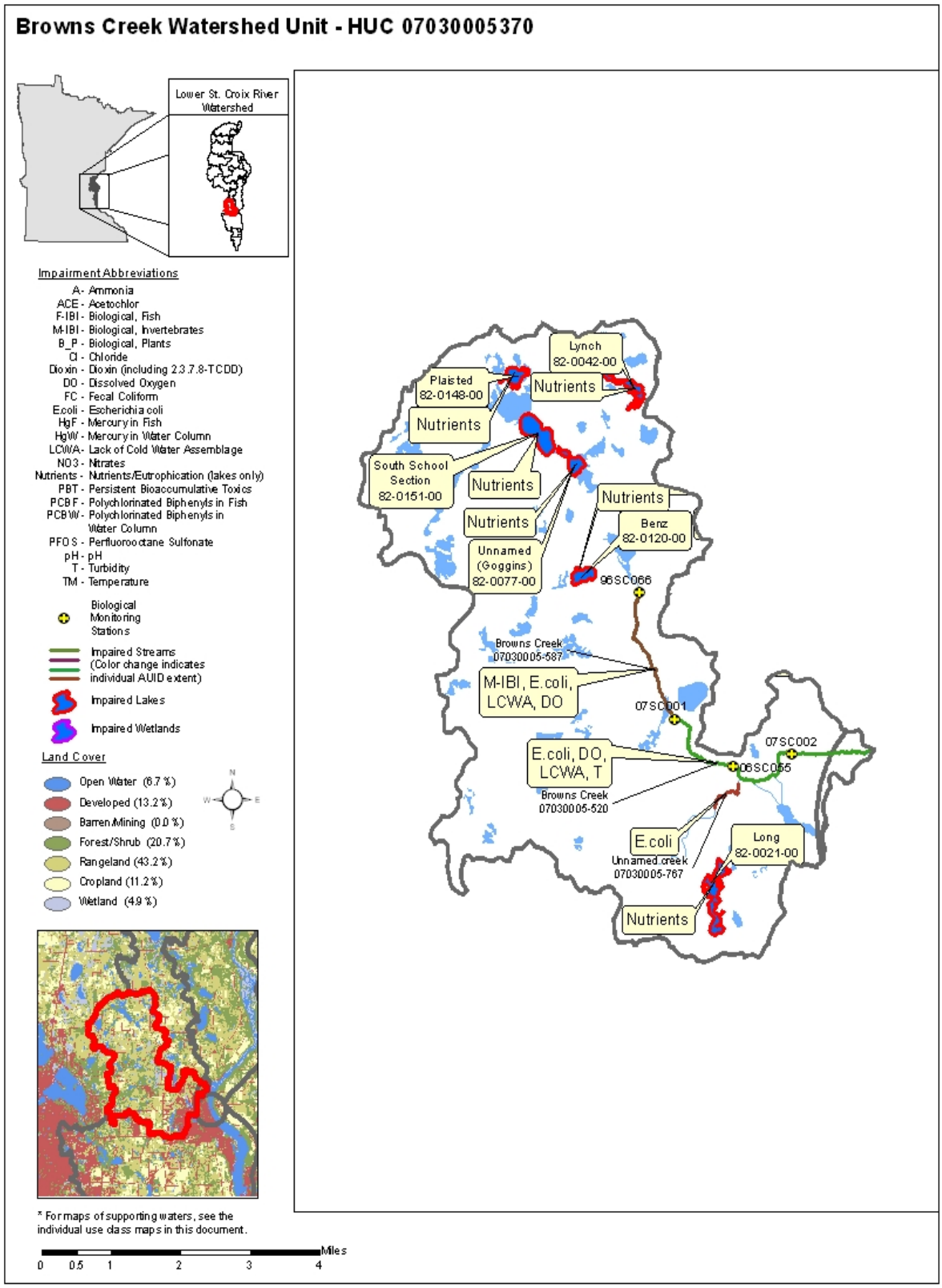

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Browns Creek Watershed Unit

Stillwater Watershed Unit 07030005210

The Stillwater Watershed Unit is the second largest 11-HUC unit in the Lower St. Croix, draining 92.3 square miles in central Washington County. Valley Branch Creek, often referred to as Valley Creek, is the most significant tributary in this subwatershed. It begins as an outlet of Lake Edith, flowing three miles southeast before entering the St. Croix River just north of Afton. Valley Branch, often referred to as South Fork Valley Creek, is a very small tributary that begins 2.5 miles west of Afton, and flows 2.2 miles until the confluence with Valley Creek. Both of these creeks are designated coldwater tributaries. Valley Branch Watershed District (VBWD) has a more detailed view of this tributary and its watershed on their webpage (http://vbwd.org/WMP/Index.html). Urban land uses dominate this watershed accounting for 30.1 percent of the land area. The St. Croix River borders the east side of this watershed unit; also known as Lake St. Croix, this section is approximately 12.2 miles long. There are numerous stormwater retention ponds and smaller lakes throughout this watershed unit. The outlet of this watershed is represented by biological station 99SC003 on Valley Creek, located one mile north of Afton.

Table 45. Aquatic life and recreation assessments on stream reaches in the Stillwater Watershed Unit

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			
07030005-504, St Croix River, Apple R (WI) to Willow R (WI)	15.41	2Bd	--	--	--	--	IF	MTS	MTS	MTS	MTS	--	MTS	NA	FS
07030005-560, Valley Branch (Valley Creek), Valley Cr to St Croix R	2.31	2A	99SC003	Upstream of Putnam Rd., .5 mi. W of St. Mary's Point	MTS	MTS	IF	MTS	MTS	MTS	MTS	--	IF	FS	IF
07030005-566, Valley Branch (Valley Creek), Unnamed cr to Valley Cr	1.03	2A	09SC039	Downstream of CR 21, 1.5 mi. W of Afton	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07030005-567, Valley Creek, Unnamed cr to Valley Br	1.89	2A	99SC004	Upstream of CR 21 (Valley Creek Trail), 2 mi. W of St. Marys Point	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07030005-612, Unnamed creek, Headwaters to St Croix R	2.19	2B			--	--	--	EXP	--	--	MTS	--	EX	IF	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 listed 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 channelized

Table 46. Minnesota Stream Habitat Assessment (MSHA) results for the Stillwater 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	99SC003	Valley Creek	5	14.5	18	11	31	79.5	good
1	09SC039	Valley Creek	4.25	14.5	20.4	12	23	74.15	good
1	99SC004	Trib. to Valley Branch	5	14	20.9	15	32	86.9	good
Average Habitat Results: *Stillwater Watershed Unit*			**4.6**	**14.5**	**19.2**	**11.5**	**27.0**	**76.8**	**good**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 47. Outlet water chemistry results for the Stillwater 11-HUC (located on Valley Creek)

99SC003/S005-529 VALLEY CK AT PUTNAM BLVD S, 1 MI W OF ST. MARYS POINT

Parameter	Units	# Samples	Minimum	Maximum	Mean[1]	Median	WQ standard[2]	# WQ exceedances[3]
Ammonia-nitrogen	mg/l	6	<0.05	< 0.05				
Chloride	mg/l	5	19.2	20.1	19.7	19.7	230	
Dissolved oxygen (DO)	mg/l	12	8.7	11.4	9.9	9.8	7	
Escherichia coli	MPN/100ml	9	61	710	191	130	126	5
Inorganic nitrogen (nitrate and nitrite)	mg/l	6	5.4	6.2	5.8	5.8		
Kjeldahl nitrogen	mg/l	6	0.24	0.43	0.32	0.32		
pH	--	12	7.8	8.5	8.1	8.2	6.5-8.5	
Phosphorus	ug/l	6	23	29	25.7	25.5		
Specific conductance	uS/cm	12	448	545	503	511		
Temperature, water	deg C	12	11.6	18.7	14.8	14.7		
Total suspended solids	mg/l	6	2	5.2	3.7	3.8		
Total volatile solids	mg/l	6	1	2.8	1.5	1.2		
Transparency tube	cm	12	88	< 100	98	< 100		

Table 48. Aquatic recreation assessments on Stillwater Watershed Unit

LAKE_ID	Lake Name	County	Type	Standard	[1]Aquatic Recreation Use Support	Ecoregion
62-0001-00	Silver (East)	Ramsey	Lake	Shallow	FS	NCHF
82-0001-00	St. Croix	Washington	Lake	Deep	NS	WCBP/NCHF
82-0004-00	Edith	Washington	Lake	Deep	FS	NCHF
82-0009-00	Cloverdale	Washington	Lake	Deep	FS	NCHF
82-0011-00	Unnamed	Washington	Lake	Shallow	NS	NCHF
82-0023-00	Lily	Washington	Lake	Shallow	NS	NCHF
82-0101-00	Demontreville	Washington	Lake	Deep	FS	NCHF
82-0102-00	Mud	Washington	Lake	Shallow	FS	NCHF
82-0103-00	Olson	Washington	Lake	Shallow	FS	NCHF
82-0104-00	Jane	Washington	Lake	Deep	FS	NCHF
82-0106-00	Elmo	Washington	Lake	Deep	FS	NCHF
82-0109-00	Eagle Point	Washington	Lake	Shallow	NS	NCHF
82-0110-00	Downs	Washington	Lake	Shallow	NS	NCHF
82-0113-01	Goose (North)	Washington	Lake	Shallow	NS	NCHF
82-0113-02	Goose (South)	Washington	Lake	Shallow	NS	NCHF
82-0117-00	Kramer	Washington	Lake	Shallow	NS	NCHF
82-0118-00	Long	Washington	Lake	Deep	FS	NCHF
82-0119-00	Unnamed	Washington	Lake	Shallow	FS	NCHF
82-0133-00	Sunnybrook	Washington	Lake	Shallow	FS	NCHF
82-0135-00	Unnamed	Washington	Lake	Shallow	NS	NCHF
82-0313-00	Unnamed (Goetschel)	Washington	Lake	Shallow	FS	NCHF
82-0365-00	Unnamed	Washington	Lake	Shallow	FS	NCHF

1. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)

Summary

Water quality data was available on a tributary to the St. Croix River in Bayport, Valley Branch Creek, and the main stem St. Croix River from the Apple River to the Willow River in Wisconsin. The tributary in Bayport has an impairment of aquatic recreation due to excess bacteria and an impairment due to excess turbidity; because the reach is highly altered (>50 percent channelized) the turbidity impairment has been deferred until more appropriate standards are developed. All stations on Valley Branch Creek are fully supporting of fish and invertebrate communities. Habitat quality on this creek is good, contributing to thriving aquatic communities. A mostly undisturbed riparian area promotes infiltration and buffers the effect of summer runoff events, protecting the thermal regime of this coldwater tributary. The small tributary (Valley Creek) to Valley Branch Creek has healthy fish and invertebrate communities contributing to its designation of full support of aquatic life use; habitat quality is excellent, providing support for healthy aquatic communities. Valley Branch Creek meets drinking water standards for nitrite-nitrate. The St. Croix River is meeting both the aquatic recreation use and drinking water standard for nitrite-nitrate. There are thirty-seven lake basins in the Stillwater subwatershed; thirteen lakes were considered to be fully supporting recreational uses and nine lakes were not meeting the recreation standard. This watershed is a mix of both deep and shallow lakes with small surface areas. Lake St. Croix is considered part of this subwatershed; the TMDL for this lake has been completed. The remaining impaired waters, including Lake Lily and Lake Downs, have not yet undergone TMDL development. This is the most urban developed subwatershed in the basin.

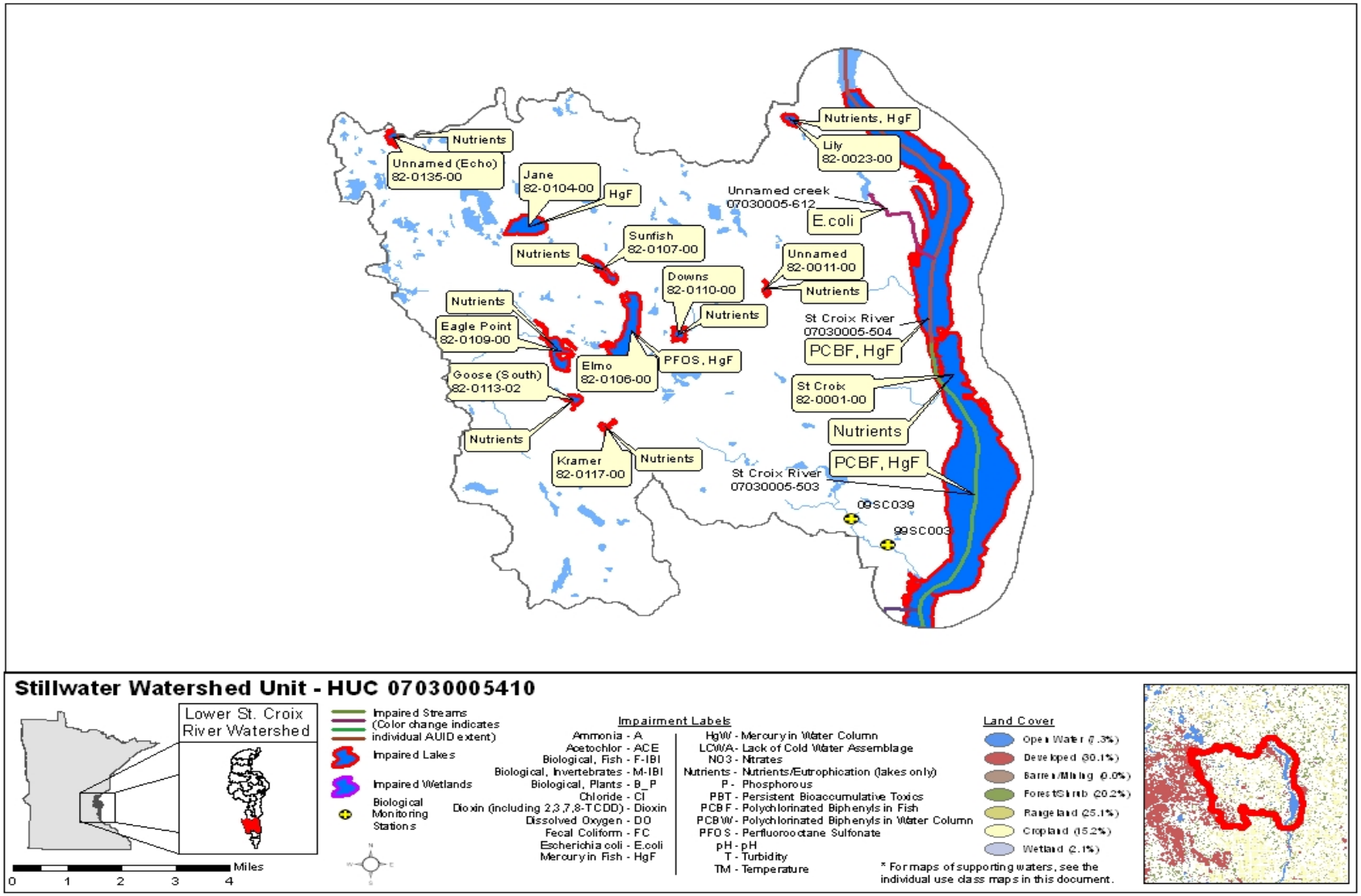

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Stillwater Watershed Unit

Afton Watershed Unit 07030005420

The Afton watershed unit is located in southern Washington County draining 21.1 square miles south and west of city of Afton. This watershed unit primarily consists of small tributaries draining east directly into the St. Croix River, which borders this unit along the eastern bluffs. Trout Brook, a small coldwater tributary that begins 3.8 miles southwest of Afton, drains through a mix of agricultural fields, steep wooded ravines, and some small residential parcels before flowing through Afton State Park to its confluence with the St. Croix River three miles south of Afton. Before meeting the St. Croix River, Trout Brook flows through Afton Alps, a large outdoor recreation area near Afton, and the riparian cover is significantly modified throughout this reach. This unit also includes a 3.1 mile stretch of the St. Croix River and Lake St. Croix. Although Valley Creek is included with this watershed unit within the 11-HUC design, because it flows into Valley Branch Creek it was included with the analysis of the Stillwater Watershed Unit. Agriculture accounts for 60 percent of land use in this unit, with 29.8 percent pasture and 31.9 percent cropland. There was no outlet chemistry station established for this watershed unit due to the small drainage area of its waterways.

Table 49. Aquatic life and recreation assessments on stream reaches in the Afton Watershed Unit

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.
07030005-568, Trout Brook, Unnamed cr to St Croix R	3.9	2A	96SC092	Downstream of C.S.A.H. 21 @ Afton State Park	--	MTS	IF	MTS	MTS	--	MTS	--	EX	FS	NS
07030005-606, Unnamed creek, Headwaters to St Croix R	3.08	2B	--	--	--	--	IF	EXP	MTS	--	MTS	--	EX	IF	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 listed 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 channelized

Table 50. Minnesota Stream Habitat Assessment (MSHA) results for the Afton 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
2	96SC092	Trout Brook	4.4	12.8	17.6	11	20	65.7	good
Average Habitat Results: *Afton Watershed Unit*			**4.4**	**12.8**	**17.6**	**11**	**20**	**65.7**	**good**

Qualitative habitat ratings
Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Summary

Water quality data was available on a tributary to the St. Croix River in Afton, and Trout Brook in Afton State Park. In Afton, the tributary exceeded the standard for bacteria resulting in aquatic recreation use impairment. Trout Brook has also shown exceedances of the bacteria standard, resulting in aquatic recreation use impairment. Trout Brook was determined to represent a cold water fishery; the invertebrate community was in good condition and is considering fully supporting of aquatic life use. The fish community data was not assessed due to low flow conditions during the sampling visit that are not indicative of normal conditions in this waterway. Habitat quality in Trout Brook appears to be adequate for supporting healthy aquatic communities.

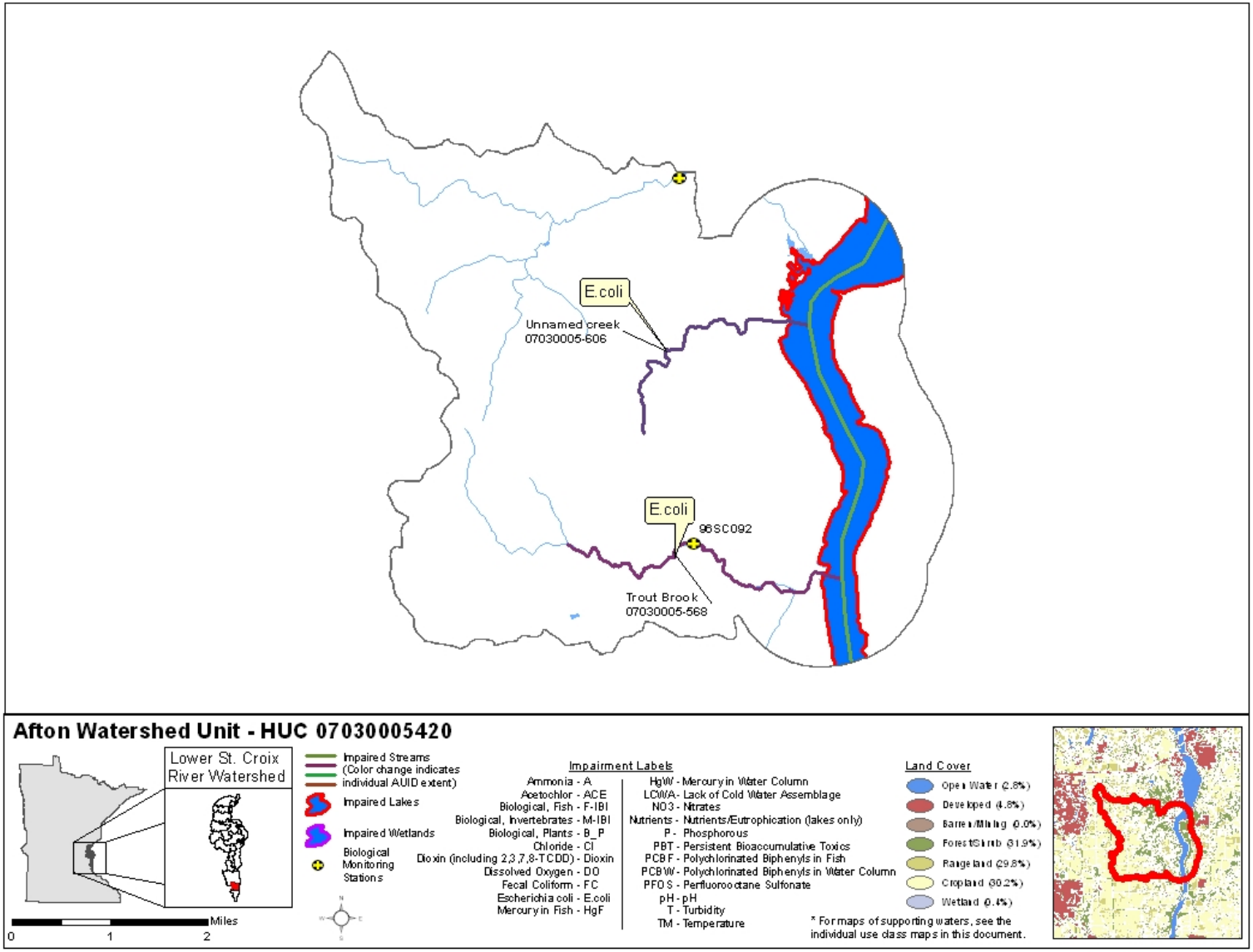

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Afton Watershed Unit

Basswood Grove Watershed Unit 07030005900

The Basswood Grove Watershed Unit is the southernmost subwatershed located in the Lower St. Croix, draining 22.6 square miles in southern Washington County. This watershed unit consists of small Unnamed Creeks flowing east through the bluffs directly into the St. Croix River. Besides the heavily wooded bluffs along the river, agricultural landscapes dominate this unit with approximately 73.1 percent being vested in pasture or cropland. This watershed unit also borders the St. Croix River and Lake St. Croix to the east, which drains into the Mississippi River on the southeastern edge of this unit. There was no outlet chemistry station established for this watershed unit due to the small drainage area of its waterways.

Table 51. Aquatic life and recreation assessments on stream reaches in the Basswood Grove Watershed Unit

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			
07030005-502, St Croix River, Kinnickinnic R (WI) to Mississippi R	6.4	2Bd	--	--	--	--	--	--	--	--	--	--	MTS	NA	FS
07030005-607, Unnamed creek, Unnamed cr to O'Connors Lk	0.58	2B	99SC018	South of junction CR 21 and 80th	--	--	--	--	MTS	--	--	--	IF	IF	IF
07030005-684, Unnamed creek, Unnamed cr to Unnamed cr	0.64	2B	--	--	--	--	IF	MTS	MTS	--	MTS	--	IF	IF	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 listed 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 channelized

Table 52. Minnesota Stream Habitat Assessment (MSHA) results for the Basswood Grove 11-HUC

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morphology (0-36)	MSHA Score (0-100)	MSHA Rating
1	99SC018	Trib. to O'Connor's Lake	1.25	11.5	8.75	12	8	41.5	poor
Average Habitat Results: *Basswood Grove Watershed Unit*			**1.25**	**11.5**	**8.75**	**12**	**8**	**41.5**	**poor**

Summary

The biological data for this subwatershed was limited to one station located on a tributary to O'Connors Lake. The fish community data was deferred for assessed at this station due to the location on a channelized reach. Habitat data from that visit suggests below average conditions for supporting aquatic communities.

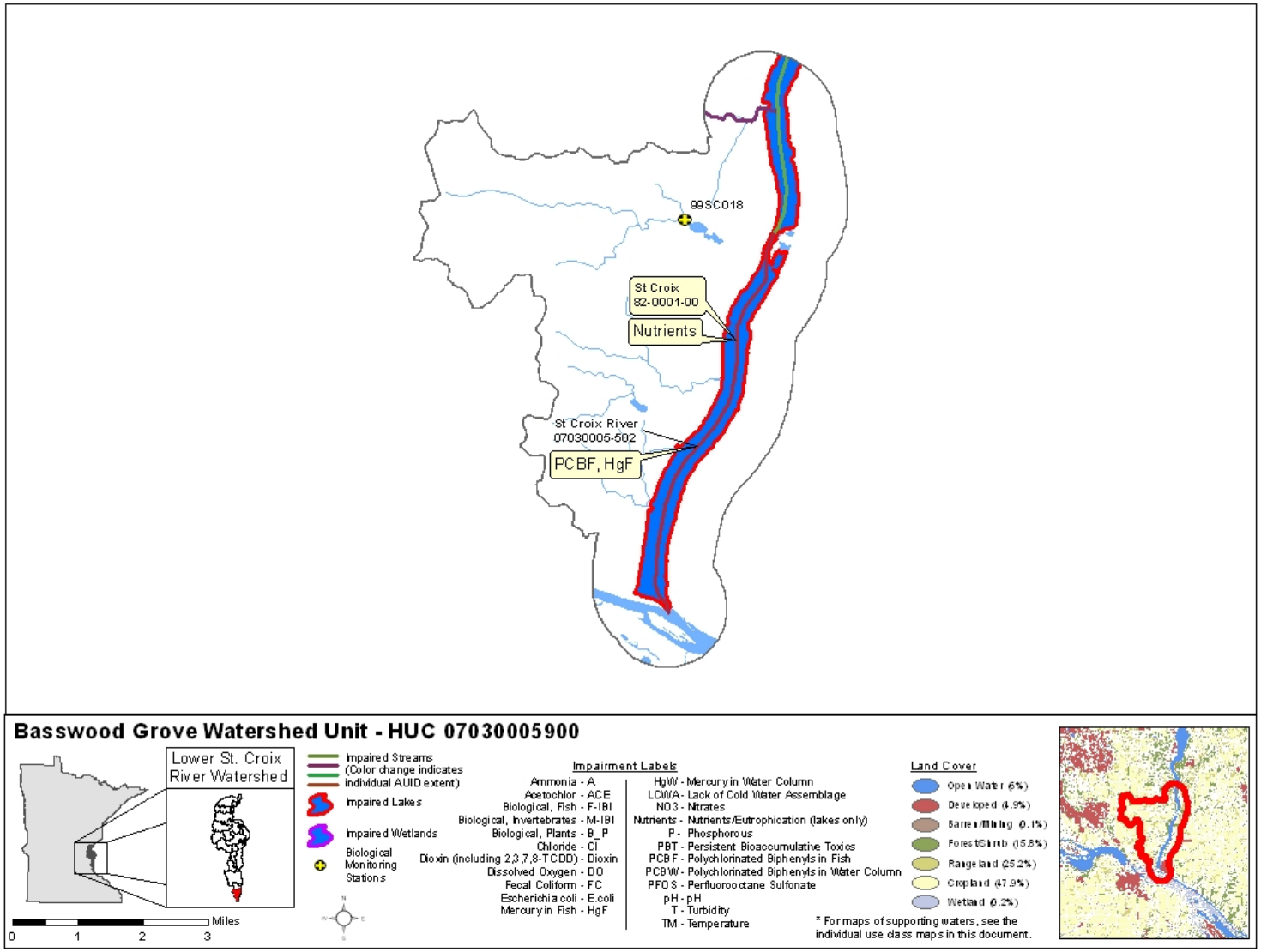

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Basswood Grove Watershed Unit

VII. Watershed-wide results and discussion

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

Following the results are a series of graphics that provide an overall summary of assessment results by designated use, impaired waters and fully supporting waters within the entire Lower St. Croix River Watershed.

Load monitoring

The Lower St. Croix Watershed is not currently monitored by the Major Watershed Load Monitoring Program. The outlet of the watershed is near Prescott, Wisconsin. Water quality sampling and measuring flow at this location are compromised by the confluence with the Mississippi River. Approximately 23 miles upstream of Prescott, pollutant loads in the Lower St. Croix River watershed are monitored by the MCES at the Hwy 36 lift-bridge at Stillwater Minnesota. Flows are calculated by adding USGS flow data for the St. Croix River at St. Croix Falls, Wisconsin and the USGS flow data for the Apple River (Wisconsin). Yearly Daily Average Flows are shown in Figure 34. Water quality monitoring at the Stillwater site captures most of the loadings of the Lower St. Croix but does not include the Willow and Kinnickinnic Rivers, small streams, and direct runoff downstream of Stillwater. It is important to note that upstream loading occurs from the three other 8-digit major watersheds that contribute to the Lower St. Croix River at this station. Data from this station in many cases may not be representative of Lower St. Croix watershed alone but more a picture of the St. Croix River Basin as a whole. Understanding the interrelationships between all 8-HUCs in the St. Croix River basin and how they contribute to downstream loading conditions is key to analyzing load monitoring data from this station.

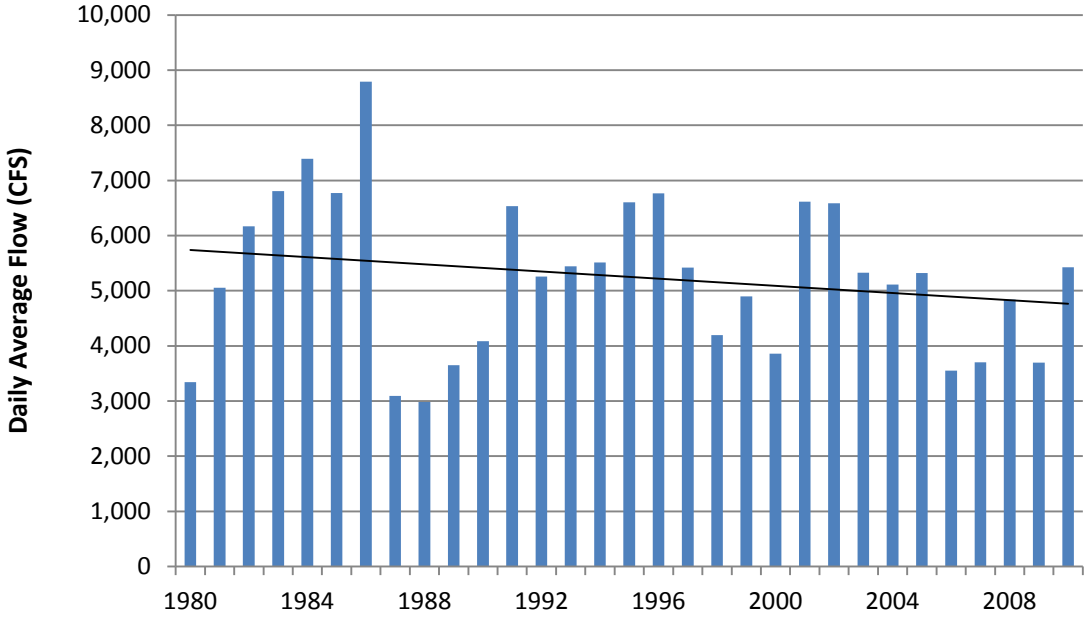

Figure 34. St. Croix River at Stillwater, Minnesota. Annual Daily Average Flows for the years 1980-2010. Daily average flow calculated as follows: (Daily average flow collected by USGS at Station USGS 05340500 ST. CROIX RIVER AT ST. CROIX FALLS, Wisconsin) + (Daily average flow collected by USGS at Station USGS 05341500 Apple River at Somerset) = Daily average flow at Stillwater (MCES).

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). Turbidity can also result from eroding stream banks and gully formation exacerbated by higher flows from agricultural and urban drainage practices.

Currently, thestate of Minnesota's TSS standards are moving from the "development phase" into the "approval phase" and must be considered to be draft standards until the process is complete. Within the Central RNR, the TSS draft standard is 30mg/L (MPCA 2010c). None of the computed FWMCs for the thirty sample years exceeded the 30 mg/L draft standard at the Stillwater monitoring site. Across the 30-year window, little significant change has occurred in TSS FWMC's.

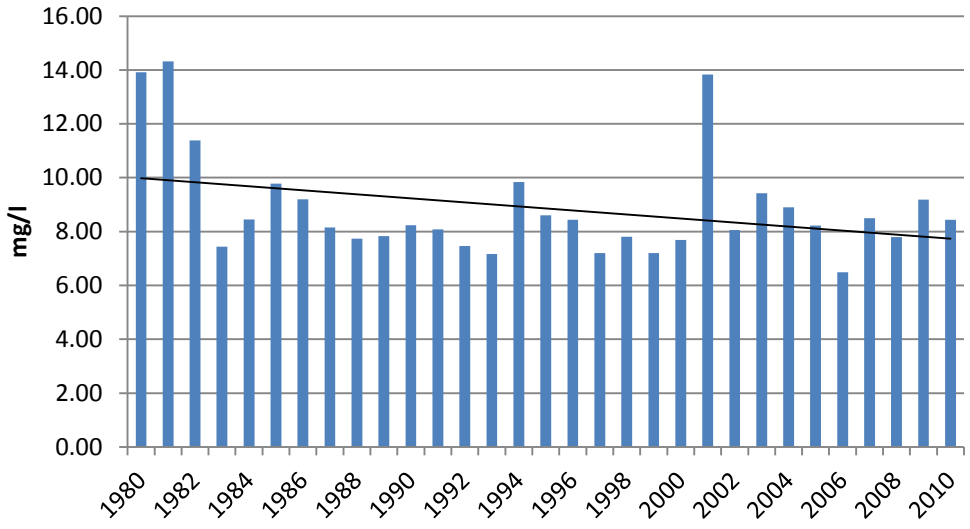

Figure 35. Total Suspended Solids (TSS) flow weighted mean concentrations (mg/l) for the Lower St. Croix Watershed Minnesota, 1980-2010 (MCES)

Total phosphorus

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 over stimulate 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 Phosphorus standards for Minnesota's rivers are also in the final approval phase and must be considered draft standards until final approval. The Central RNR proposed draft standard is 100ug/L as a summer average. Summer average violations of one or more "response" variables (pH, biological oxygen demand (BOD), dissolved oxygen flux, chlorophyll-a) must also occur along with the TP numeric violation for the water to be listed. FWMCs from 1980-2010 show that TP FWMC's averaged 57ug/L for the 30 years of sampling.

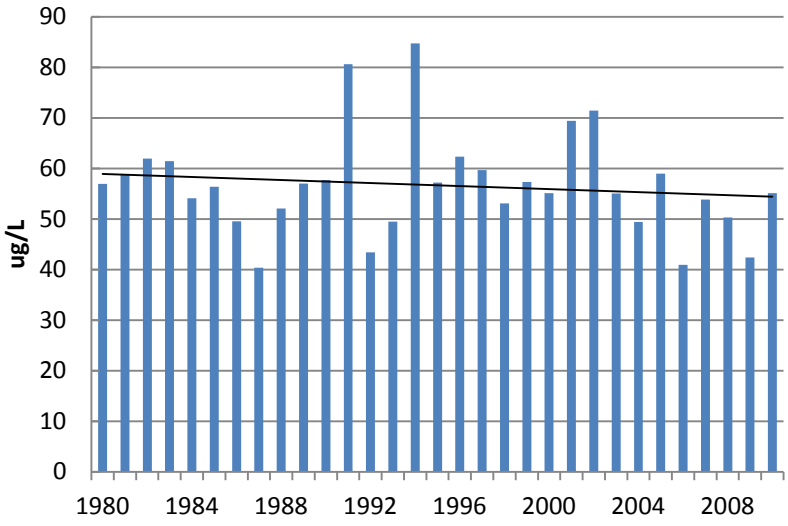

Figure 36. Total Phosphorus flow weighted mean concentrations (ug/l) for the Lower St. Croix Watershed, Stillwater, Minnesota, 1980-2010 (MCES)

Nitrogen

Nitrate (NO_3) and nitrite (NO_2) 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 2010b). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrate-N 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.

Currently there are no nitrate-N standards for Minnesota rivers, but they are in the "development phase," with a scheduled adoption deadline of September 2012. The draft acute nitrate-N value (maximum standard) is 41 mg/L for a one-day duration, and the draft chronic value 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 (4-day duration) was determined for protection of class 2A surface waters. FWMC's of nitrate-nitrogen within the Lower St. Croix River Watershed are well below the acute and chronic nitrate-N standards, statistically little changed has occurred over the 30-year window (Figure 37).

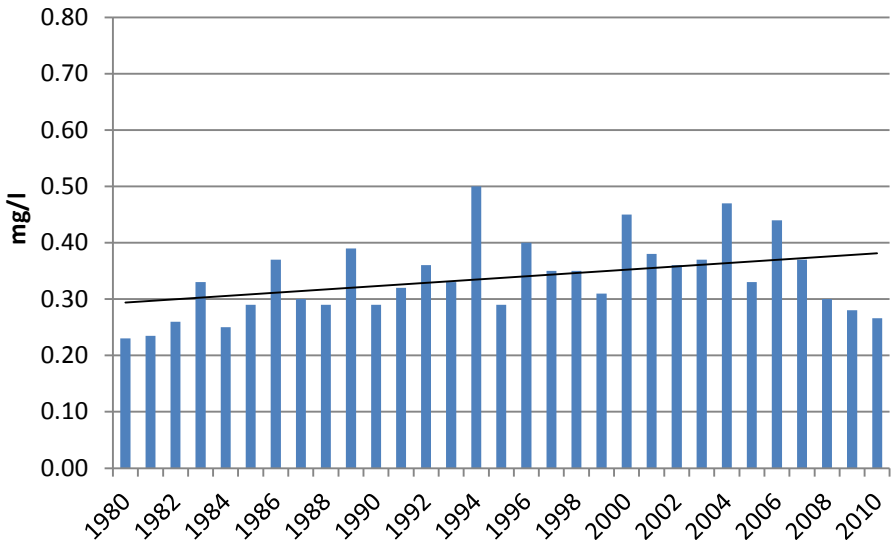

Figure 37. Nitrate plus Nitrite flow weighted mean concentrations (mg/l) by year for the years 1980-2010 (MCES).

Annual pollutant loads

Annual pollutant loads can be calculated in kilograms per year(kg/year) using Flux32. Although trends may seem significant, TSS, TP, and Nitrate-Nitrite can still are characterized as relatively stable over the past 30 years.

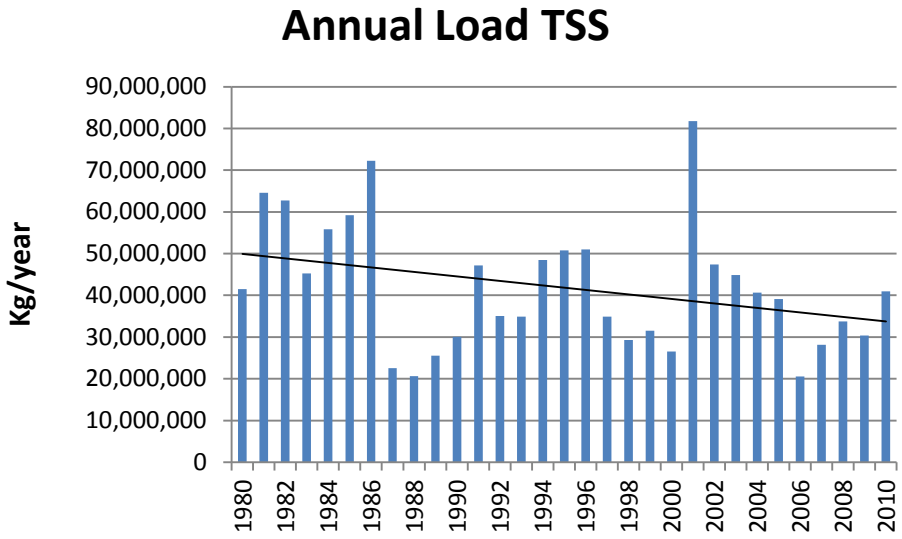

Figure 38. Annual pollutant load (kg/year) for Total Suspended Solids calculated for the St. Croix River Watershed, Stillwater Minnesota, 1980-2010. MCES Metropolitan Council. 2010a. Standard Operating Procedure: Estimation of Annual Tributary Stream Pollutant Loads with Flux32.

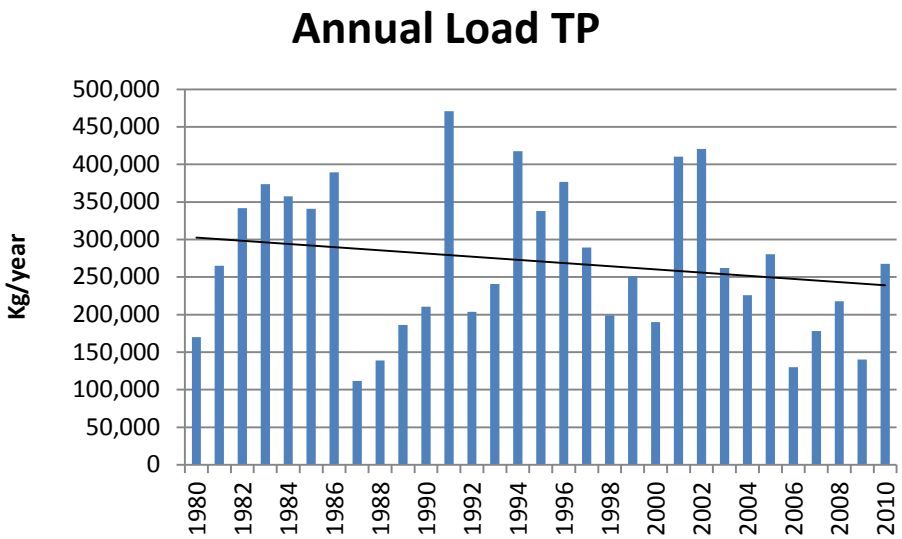

Figure 39. Annual pollutant load (kg/year) for Total Phosphorus calculated for the St. Croix River Watershed, Stillwater, Minnesota, 1980-2010. MCES Metropolitan Council. 2010a. Standard Operating Procedure: Estimation of Annual Tributary Stream Pollutant Loads with Flux32.

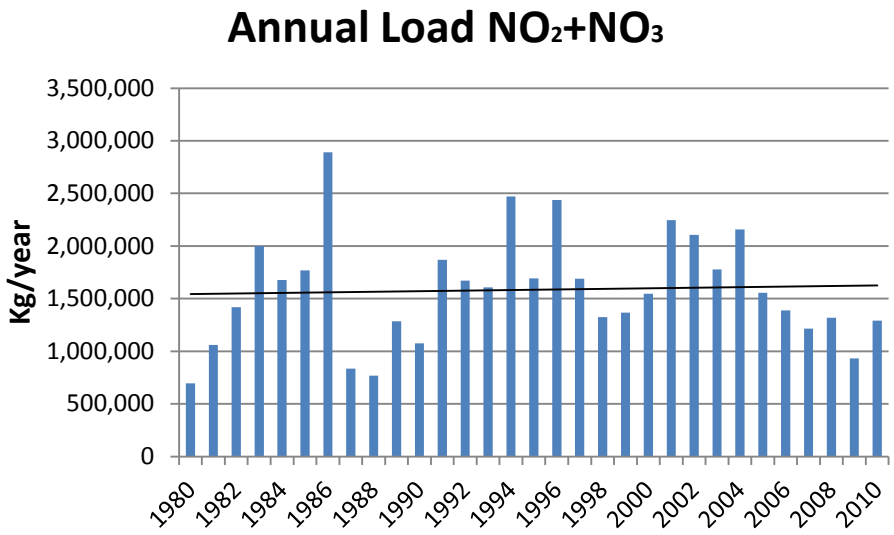

Figure 40. Annual pollutant load (kg/year) for Nitrate+Nitrite calculated for the St. Croix River Watershed, Stillwater, Minnesota, 1980-2010. MCES Metropolitan Council. 2010a. Standard Operating Procedure: Estimation of Annual Tributary Stream Pollutant Loads with Flux32.

Stream water quality

Thirty-five of the 89 stream AUIDs were assessed (Table 53). Of the assessed streams, ten stream AUIDs were considered to be fully supporting of aquatic life and five aquatic recreation. Five stream AUIDS were not assessed for aquatic biology because greater than 50 percent of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID. Three corrections from past "non-supporting" assessments to "supporting" on the Impaired Waters List have been made - fish and invertebrate IBI on Rock Creek, and invertebrate IBI on Goose Creek and the North Branch Sunrise River.

Throughout the watershed, 33 stream AUIDs are non-supporting of aquatic life and/or aquatic recreation. Of those AUIDs, 15 are non-supporting of aquatic life and 18 are non-supporting of aquatic recreation. The mainstem Lower St. Croix River was deferred for aquatic life assessment due to the lack of adequate biological indicators established for large rivers in Minnesota. Other biological impairments on main stem tributaries to the Lower St. Croix are located on natural stream AUIDs that can be assessed - Rush Creek, Goose Creek, North Branch Sunrise, portions of the Sunrise River and Browns Creek subwatershed. Drought-like low flow conditions were taken into account for the assess ability of 2009 sampling data for both fish and invertebrate communities across the watershed. Fish IBI scores falling below the threshold affect six subwatershed units - Rush Creek, Goose Creek, West Branch Sunrise, upper portions of the mainstem Sunrise, North Branch Sunrise, and Browns Creek. Assessable invertebrate data was limited; only three AUIDs across the watershed had Invertebrate IBI scores below the thresholds (West Branch Sunrise River, the upper Sunrise, and Rush Creek). Water chemistry impairments involving low dissolved oxygen impact three of the Lower St. Croix River major tributaries, including South Branch Sunrise, upper reaches of the mainstem Sunrise River, and Browns Creek. High bacteria concentrations are a common problem across the watershed on Rock Creek, Rush Creek, Goose Creek, the Sunrise River system, Browns Creek, and Trout Brook triggering non-support designation for aquatic recreation use. A few AUIDs are exceeding turbidity standards on the West Branch Sunrise River and a small portion of Browns Creek, as well as some small unnamed tributaries scattered across the watershed.

Table 53. Assessment summary for stream water chemistry in the Lower St. Croix River Watershed

			Supporting		Non-Support		Insufficient Data	
Waterbody	Area(Acres)	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation
Lower St. Croix HUC 8	**585735**	**35**	**10**	**5**	**14**	**19**	**27**	**30**
Rock Creek	47788	1	1	0	0	1	0	0
Rush Creek	31575	1	0	1	0	1	0	0
Goose Creek	49661	1	0	0	1	1	2	3
North Branch Sunrise	48665	1	0	0	1	1	2	9
West Branch Sunrise	35699	2	0	0	2	0	3	1
Sunrise River	59678	8	2	1	4	3	5	2
Deer Creek	7976	0	0	0	0	0	1	1
Lindstrom	48542	2	2	0	0	0	3	1
South Branch Sunrise	51158	5	0	1	3	3	1	4
Marine on St. Croix	39762	2	1	0	0	2	4	3
Big Marine Lake	22135	1	0	0	1	1	1	2
Browns Creek	21826	3	0	0	2	3	2	1
Stillwater	59087	5	3	1	0	1	1	1
Afton	13548	2	1	0	0	2	1	0
Basswood Grove	14473	1	0	1	0	0	1	2

Lake water quality

One hundred forty-four (144) of the two hundred fifty-six (256) lakes greater than 4 ha were assessed (Table 54). Of the assessed lakes, 54 were considered to be fully supporting for aquatic recreation and 51 were not supporting recreation uses. An evaluation of the basins that were shallow was made to determine those that were functioning as a wetland instead of a shallow lake. Those determined to be a wetland, while sampled for traditional lake water quality parameters, were not assessed against the lake recreation standards and are tracked in the not assessed column in Table 54.

Table 54. Assessment summary for lake water chemistry in the Lower St. Croix River Watershed

Watershed	Area(Acres)	# Assessed AUIDs	# Supporting Recreation Use	# Not Supporting Recreation Use	# Insufficient information	# Not assessed (wetland)
Lower St. Croix HUC 8	**585735**	**144**	**54**	**51**	**25**	**14**
Rock Creek	47788	0	0	0	0	0
Rush Creek	31575	2	0	2	0	0
Goose Creek	49661	6	1	3	2	0
North Branch Sunrise	48665	1	0	0	1	0
West Branch Sunrise	35699	5	2	3	0	0
Sunrise River	59678	6	0	3	2	1
Deer Creek	7976	0	0	0	0	0
Lindstrom	48542	22	7	8	6	1
South Branch Sunrise	51158	16	4	7	5	0
Marine on St. Croix	39762	8	7	1	0	0
Big Marine Lake	22135	27	12	10	3	2
Browns Creek	21826	15	8	5	1	1
Stillwater	59087	35	13	9	5	8
Afton	13548	0	0	0	0	0
Basswood Grove	14473	1	0	0	0	1

Fish contaminant results

A summary of descriptive statistics for mercury and PCBs in Table 55 indicates the 90th percentiles of mercury concentration exceeded the threshold of 0.2 mg/Kg in smallmouth bass and shorthead redhorse from the Sunrise River. PCBs were tested in the two largest fish of each species and were not detected (reporting limit = 0.025 mg/Kg). Impairments caused by fish contaminants are usually applied to all river AUIDs where fish could potentially swim from the collection site. Sunrise River has 17 AUIDs; however, fish were collected on the main stem of the river and only apply to the two AUIDs downstream of the Kost Dam (07030005-543 and -542) and to the North Branch of the Sunrise River (07030005-501) because no dams impede fish movement among these AUIDs. The three AUIDs of Sunrise River were added to the 2012 Impaired Waters Inventory (http://www.pca.state.mn.us/index.php/view-document.html?gid=20346) for mercury in fish tissue.

Five of the 30 lakes tested for fish contaminants were divided into two AUIDs because of separate, but connected basins. MDNR usually treats all basins as a single lake if fish can move between the basins. All connected lake AUIDs are used for the impairment listing. Consequently, Chisago (13001200), North Center (13003200), Green (13004100), and Goose (13008300) are listed by a single AUID for fish contaminants (Table 58), but have two AUIDs (ending in “01” and “02” rather than “00”) on the

Impaired Waters Inventory. Rush Lake is an exception to the rule in having two basins—East Bay (13006901) and West Bay (13006902)—but in fish contaminants results (Table 55), there is a Rush Lake (13006900) and an East Rush Lake (13006901). The two set of results occurred because in 1992 and 2006 the MDNR identified the collection as Rush Lake and in 2002 and 2007 they specified East Rush Lake. This clarification of how AUIDs are used is necessary to understand that 30 lakes were identified as having fish contaminant results in Table 55 of the lakes are listed as impaired for mercury in fish tissue, but Impaired Waters Inventory includes 25 AUIDs.

All lakes tested for PCBs were mostly below or near the reporting limit, except for Forest Lake. Forest Lake (82015900) is on the Impaired Waters Inventory for PCBs in fish tissue (as well as for mercury), because the mean PCBs concentration of 0.24 mg/Kg in common carp collected in 1998 exceeded the threshold for impairment.

PFOS results are presented Table 56 for the 13 lakes tested between 2007 and 2010. PFOS was detected in fish from 10 of the lakes. Only Lake Elmo had mean PFOS concentrations that exceeded the impairment threshold of 200 ng/g (the same as 0.200 mg/Kg). Bluegill sunfish and largemouth bass were tested in 2007 and 2008 in Lake Elmo. In the one year between collections, the mean PFOS concentration in bluegills dropped from 256 ng/g to 153 ng/g, whereas in largemouth bass the mean values in the two years were 563 ng/g and 560 ng/g. Because largemouth bass are in a higher trophic level than bluegill sunfish, these results appear to show biomagnifications—the increase of contaminant concentration with higher trophic levels. Northern pike feed on yellow perch and are therefore, at different trophic levels, yet their respective mean PFOS concentrations in Lake Elmo from 2010 were 299 ng/g and 294 ng/g. A study of PFOS in fish from Mississippi River Pool 2 in 2009 compared PFOS concentrations among five fish species with 60 fish per species (http://www.pca.state.mn.us/index.php/view-document.html?gid=15527). The results from the Pool 2 study showed, unlike mercury and PCBs, PFOS concentrations were not higher in species from higher trophic levels.

Overall, mercury clearly remains a major concern for fish consumption in the Lower St. Croix watershed. PCBs were only elevated in carp from Forest Lake; additional testing may be beneficial to see if PCB levels decrease like in many other waters. Lake Elmo continues to be contaminated with PFOS in fish tissue. Consequently, mercury will continue to be periodically tested in fish from most of the lakes and PFOS in fish from Lake Elmo.

Table 55. Descriptive statistics of mercury and PCB concentrations in fish species in the Sunrise River and lakes within the Lower St. Croix Watershed

					Length (in)				Mercury (mg/Kg)						PCBs (mg/Kg)			
WATERWAY	AUID	Species	Year	Total Fish	N	Mean	Min	Max	N	Mean	90th Pctl	Median	Min	Max	N	Mean	Min	Max
SUNRISE RIVER *	07030005-501, 543, 542	Smallmouth bass	2009	8	8	12.1	9.6	15.6	8	0.141	0.215	0.123	0.087	0.216	2	< 0.025	< 0.025	< 0.025
		Shorthead redhorse	2009	6	6	15.2	11.6	17.9	6	0.162	0.315	0.154	0.035	0.323	2	< 0.025	< 0.025	< 0.025
LINWOOD	02002600	Black crappie	1999	10	1	8.2	8.2	8.2	1	0.040								
		Northern pike	1999	8	8	21.5	17.0	27.4	8	0.076	0.135	0.065	0.030	0.150	1	< 0.01		
			2009	15	15	25.3	19.2	29.4	15	0.155	0.199	0.176	0.087	0.227				
		Walleye	1999	8	8	18.6	17.9	19.8	8	0.131	0.160	0.145	0.080	0.160				
		Yellow bullhead	1999	8	1	11.7	11.7	11.7	1	0.120								
MARTIN	02003400	Black crappie	2004	10	1	6.9	6.9	6.9	1	0.036								
		Walleye	2004	5	5	16.6	13.8	19.1	5	0.140	0.180	0.137	0.096	0.180				
		White sucker	2004	5	1	17.4	17.4	17.4	1	0.063								
COON *	02004200	Bluegill sunfish	1983	5	1	5.1	5.1	5.1	1	0.020								
			2003	10	1	6.1	6.1	6.1	1	0.068								
		Black bullhead	2009	8	1	9.0	9.0	9.0	1	0.029								
		Northern pike	1983	5	1	20.6	20.6	20.6	1	0.190					1	< 0.05		
			2003	5	5	24.7	20.2	32.0	5	0.165	0.238	0.142	0.092	0.238				
		White sucker	1983	4	1	16.1	16.1	16.1	1	0.030					1	< 0.05		
		Yellow bullhead	2003	9	1	8.2	8.2	8.2	1	0.118								
CHISAGO *	13001200	Bluegill sunfish	2010	5	1	7.6	7.6	7.6	1	0.030								
		Black bullhead	2010	3	1	13.0	13.0	13.0	1	0.133								
		Walleye	2010	5	5	19.1	17.3	23.4	5	0.151	0.258	0.141	0.101	0.258				
SOUTH CENTER *	13002700	Bluegill sunfish	2008	10	2	6.9	6.5	7.2	2	0.050	0.054	0.050	0.045	0.054				
		Black crappie	2008	10	2	7.4	6.8	7.9	2	0.044	0.052	0.044	0.036	0.052				
		Northern pike	2008	3	3	21.2	18.3	23.8	3	0.061	0.071	0.057	0.056	0.071				
		Walleye	2008	6	6	19.2	16.8	24.2	6	0.149	0.244	0.137	0.096	0.253				
		Yellow perch	2008	10	2	6.0	5.6	6.4	2	0.025	0.026	0.025	0.023	0.026				
SOUTH LINDSTROM	13002800	Bluegill sunfish	2010	5	1	6.9	6.9	6.9	1	0.038								
		Black bullhead	2010	3	1	13.3	13.3	13.3	1	0.112								
		Northern pike	2010	6	6	19.2	12.4	25.5	6	0.101	0.135	0.115	0.023	0.135				

SUNRISE	13003100	Bluegill sunfish	1993	10	1	6.7	6.7	6.7	1	0.096								
		Black bullhead	1993	6	1	12.9	12.9	12.9	1	0.030								
		Northern pike	1993	9	4	27.3	22.6	31.9	4	0.145	0.200	0.140	0.098	0.200	1	< 0.01		
NORTH CENTER *	13003200	Black bullhead	2010	3	1	10.5	10.5	10.5	1	0.022								
		Black crappie	2010	5	1	7.3	7.3	7.3	1	0.093								
		Walleye	2010	8	8	16.4	11.7	24.3	8	0.146	0.247	0.121	0.093	0.254				
LITTLE *	13003300	Bluegill sunfish	2007	5	1	7.3	7.3	7.3	1	0.074								
		Black crappie	2007	9	1	7.3	7.3	7.3	1	0.062								
		Largemouth bass	2007	6	6	11.6	9.4	13.9	6	0.161	0.230	0.161	0.078	0.235				
		Northern pike	1984	9	2	24.6	23.0	26.2	2	0.250	0.300	0.250	0.200	0.300				
GREEN *	13004100	Black crappie	1996	10	1	8.8	8.8	8.8	1	0.056								
		Common Carp	1996	2	1	21.4	21.4	21.4	1	0.061					1	< 0.01		
		Largemouth bass	2006	6	6	14.6	12.0	16.9	6	0.197	0.280	0.207	0.108	0.282				
		Walleye	1996	20	5	18.4	11.7	24.2	5	0.120	0.240	0.086	0.081	0.240				
		White sucker	1996	4	1	21.9	21.9	21.9	1	0.092								
COMFORT *	13005300	Bluegill sunfish	1990	9	1	6.6	6.6	6.6	1	0.061					1	< 0.01		
		Black bullhead	1990	2	1	7.7	7.7	7.7	1	0.065					1	< 0.01		
		Common Carp	1990	8	2	23.6	20.8	26.4	2	0.300	0.380	0.300	0.220	0.380	2	0.087	0.054	0.12
		Northern pike	1990	12	2	24.0	21.7	26.3	2	0.215	0.250	0.215	0.180	0.250	2	< 0.01	< 0.01	< 0.01
		Walleye	1990	3	1	16.8	16.8	16.8	1	0.230					1	< 0.01		
		White sucker	1990	5	1	16.7	16.7	16.7	1	0.020					1	< 0.01		
FISH *	13006800	Bluegill sunfish	1991	15	1	6.6	6.6	6.6	1	0.220								
		Black crappie	1991	6	1	8.6	8.6	8.6	1	0.100								
		Common Carp	1991	1	1	11.9	11.9	11.9	1	0.032					1	< 0.01		
		Northern pike	1991	19	4	20.7	14.1	28.8	4	0.165	0.220	0.160	0.120	0.220	3	< 0.01	< 0.01	< 0.01
		Walleye	1991	18	3	17.1	13.1	22.0	3	0.357	0.590	0.280	0.200	0.590	2	0.014	< 0.01	0.018
		Yellow bullhead	1991	10	1	10.9	10.9	10.9	1	0.230								
		Yellow perch	1991	3	1	5.9	5.9	5.9	1	0.039								
RUSH *	13006900	Black crappie	1992	10	1	7.8	7.8	7.8	1	0.054								
		Common Carp	1992	6	2	24.8	21.8	27.7	2	0.075	0.110	0.075	0.040	0.110	1	< 0.01		
		Largemouth bass	2006	5	5	13.5	12.0	15.1	5	0.168	0.346	0.098	0.072	0.346				
		Northern pike	1992	12	3	27.4	22.8	32.5	3	0.173	0.250	0.150	0.120	0.250	1	< 0.01		
		Walleye	1992	12	3	19.9	10.8	25.7	3	0.220	0.310	0.270	0.080	0.310	1	0.023		

EAST RUSH *	13006901	Bluegill sunfish	2007	10	1	6.3	6.3	6.3	1	0.019								
		Black crappie	2007	10	1	7.7	7.7	7.7	1	0.017								
		Freshwater Drum	2002	4	1	17.8	17.8	17.8	1	0.034								
		Northern pike	2002	5	5	25.4	21.0	29.8	5	0.103	0.130	0.094	0.093	0.130				
		Yellow perch	2002	8	1	9.6	9.6	9.6	1	0.042								
GOOSE *	13008300	Black bullhead	2007	8	1	9.9	9.9	9.9	1	0.060								
		Black crappie	2007	10	1	6.7	6.7	6.7	1	0.024								
		Northern pike	2007	5	5	20.9	17.0	25.0	5	0.181	0.455	0.127	0.057	0.455				
		Walleye	2007	5	5	20.9	19.0	22.5	5	0.403	0.866	0.346	0.136	0.866				
SILVER	62000100	Bluegill sunfish	1990	11	1	6.0	6.0	6.0	1	0.055					1	0.026		
		Largemouth bass	1990	2	1	14.3	14.3	14.3	1	0.120					1	0.03		
		Northern pike	1990	4	3	22.0	17.4	25.6	3	0.127	0.150	0.140	0.090	0.150	3	0.011	< 0.01	0.013
		Walleye	1990	10	3	16.9	12.0	20.2	3	0.183	0.200	0.190	0.160	0.200	3	0.021	< 0.01	0.037
		White sucker	1990	8	2	19.6	18.5	20.7	2	0.063	0.065	0.063	0.061	0.065	2	< 0.01	< 0.01	< 0.01
		Yellow bullhead	1990	2	1	8.4	8.4	8.4	1	0.056					1	< 0.01		
LITTLE CARNELIAN *	82001400	Northern pike	1997	36	36	21.4	15.5	26.2	36	0.329	0.448	0.330	0.150	0.510	2	< 0.01	< 0.01	< 0.01
		Yellow perch	1997	10	10	5.9	5.4	6.6	10	0.171	0.245	0.165	0.110	0.280				
LILY *	82002300	Bluegill sunfish	2000	10	1	5.9	5.9	5.9	1	0.040								
		Northern pike	2000	7	7	23.5	18.5	27.5	7	0.197	0.360	0.190	0.090	0.390	1	< 0.01		
LOUISE	82002500	Bluegill sunfish	2008	14	7	5.3	4.9	5.7	1	0.089								
		Black crappie	2008	15	7	4.5	4.3	4.7	1	0.049								
SQUARE *	82004600	Northern pike	1998	33	33	16.9	13.6	23.1	32	0.207	0.286	0.212	0.094	0.320	1	< 0.01		
			2008	12	12	18.0	13.5	36.8	12	0.227	0.312	0.218	0.155	0.323				
		Yellow perch	1998	6	2	7.1	5.7	8.4	2	0.077	0.094	0.077	0.060	0.094				
			2008	5	1	9.5	9.5	9.5	1	0.046								
BIG CARNELIAN *	82004900	Bluegill sunfish	2003	10	1	6.9	6.9	6.9	1	0.089								
		Northern pike	1983	5	1	21.3	21.3	21.3	1	0.330					1	0.05		
			2003	5	5	22.3	16.7	30.3	5	0.390	0.747	0.388	0.193	0.747				
		White sucker	1983	5	1	17.3	17.3	17.3	1	0.030					1	0.05		
		Yellow bullhead	2003	7	1	11.1	11.1	11.1	1	0.269								

BIG MARINE *	82005200	Bluegill sunfish	1999	10	1	6.7	6.7	6.7	1	0.110								
			2010	5	1	6.5	6.5	6.5	1	0.062								
		Black crappie	1999	10	1	9.7	9.7	9.7	1	0.310								
		Northern pike	1984	10	2	18.2	18.2	18.2	1	0.260					1	0.05		
			1999	8	8	24.2	19.6	29.8	8	0.444	0.708	0.415	0.210	0.780	1	< 0.01		
			2010	8	8	21.7	18.4	27.0	8	0.227	0.331	0.196	0.172	0.357				
		Walleye	1999	7	7	21.5	17.9	27.3	7	0.676	1.302	0.580	0.370	1.460	1	0.014		
		Yellow bullhead	1999	8	1	13.0	13.0	13.0	1	0.550					1	< 0.01		
			2010	5	1	12.2	12.2	12.2	1	0.180								
BONE *	82005400	Bluegill sunfish	1996	8	1	6.9	6.9	6.9	1	0.074								
		Walleye	1996	19	5	17.4	11.7	23.4	5	0.244	0.380	0.200	0.098	0.380	1	< 0.01		
		Yellow bullhead	1996	8	1	12.0	12.0	12.0	1	0.150								
GOOSE *	82005900	Bluegill sunfish	2010	8	2	7.8	6.9	8.7	2	0.113	0.114	0.113	0.112	0.114				
		Northern pike	2010	6	6	26.6	17.6	35.6	6	0.588	0.899	0.594	0.150	0.912				
DEMON-TREVILLE	82010100	Bluegill sunfish	1992	15	1	5.5	5.5	5.5	1	0.040					1	< 0.01		
OLSON	82010300	Bluegill sunfish	1993	15	1	5.5	5.5	5.5	1	0.039								
		Black bullhead	1993	4	1	12.9	12.9	12.9	1	0.028								
		Northern pike	1993	4	2	21.6	17.2	25.9	2	0.120	0.180	0.120	0.060	0.180	1	< 0.01		
		Walleye	1993	2	1	18.5	18.5	18.5	1	0.130					1	< 0.01		
JANE *	82010400	Bluegill sunfish	2002	10	1	6.5	6.5	6.5	1	0.161								
			2007	28	7	4.9	3.0	7.1	2	0.097	0.110	0.097	0.084	0.110				
		Northern pike	2002	5	5	19.9	16.3	27.5	5	0.439	0.663	0.385	0.342	0.663				
			2007	25	25	20.5	13.5	38.2	25	0.631	0.685	0.498	0.284	2.387				
		Yellow bullhead	2002	8	1	10.6	10.6	10.6	1	0.409								

ELMO *	82010600	Bluegill sunfish	1991	6	1	5.9	5.9	5.9	1	0.100									
			1996	10	1	6.4	6.4	6.4	1	0.130									
			2008	16	7	5.3	4.9	5.9	1	0.090									
		Black bullhead	1991	5	1	11.3	11.3	11.3	1	0.180					1	< 0.01			
		Black crappie	1991	10	1	6.2	6.2	6.2	1	0.084									
		Common Carp	1991	7	2	21.1	17.2	24.9	2	0.150	0.240	0.150	0.060	0.240	2	0.023	0.016	0.03	
			1996	2	2	22.5	20.9	24.1	2	0.125	0.130	0.125	0.120	0.130	1	0.02			
		Largemouth bass	1991	2	2	13.9	12.0	15.7	2	0.315	0.370	0.315	0.260	0.370	1	< 0.01			
		Northern pike	1991	10	2	25.1	22.0	28.2	2	0.260	0.270	0.260	0.250	0.270	2	0.0145	< 0.01	0.019	
			1996	19	5	22.3	16.1	30.1	5	0.338	0.560	0.230	0.160	0.560					
			2001	21	21	21.6	15.8	30.3	21	0.212	0.338	0.210	0.081	0.400	1	0.02			
		Walleye	1991	9	3	16.8	11.2	22.4	3	0.290	0.410	0.260	0.200	0.410	2	0.021	< 0.01	0.032	
			2008	9	9	16.1	14.6	18.7	9	0.166	0.260	0.151	0.117	0.327					
		White sucker	1991	3	1	17.5	17.5	17.5	1	0.040					1	< 0.01			
FOREST * ~	82015900	Bluegill sunfish	1984	10	2	5.9	5.9	5.9	1	0.100					1	0.05			
			1998	10	1	6.9	6.9	6.9	1	0.040									
			2009	10	1	5.9	5.9	5.9	1	0.022									
		Common Carp	1998	2	2	29.5	26.0	33.0	2	0.052	0.067	0.052	0.037	0.067	2	0.2375	0.052	0.423	
			2003	3	1	28.3	28.3	28.3							1	0.135			
		Largemouth bass	2006	6	6	12.9	9.9	16.3	6	0.128	0.180	0.139	0.055	0.181					
		Northern pike	1984	10	2	21.0	21.0	21.0	1	0.040					1	0.05			
			1998	10	10	23.1	19.2	27.6	10	0.098	0.145	0.089	0.060	0.160	2	< 0.01	< 0.01	< 0.01	
			2009	10	5	23.0	18.2	30.0	5	0.149	0.277	0.091	0.062	0.277					
		Walleye	1998	11	11	19.6	14.8	26.4	11	0.143	0.314	0.098	0.080	0.530	2	< 0.01	< 0.01	< 0.01	
			2009	8	5	19.2	17.3	24.0	3	0.121	0.163	0.104	0.095	0.163					
		White crappie	1998	9	1	10.4	10.4	10.4	1	0.090									
		Yellow bullhead	1998	8	1	12.3	12.3	12.3	1	0.150									

* Impaired for mercury in fish tissue
~ Impaired for PCBs in fish tissue

Table 56. Descriptive statistics of PFOS concentrations in fish species in lakes within the Lower St. Croix Watershed

						Length (in)			PFOS (ng/g –ww)		
Waterway	DOWID	Species	Year	Total Fish	Sam- ples	Mean	Min	Max	Mean	Min	Max
Coon	02004200	Bluegill sunfish	2009	10	2	5.9	5.9	5.9	< 4.92	< 4.92	< 4.92
		Black bullhead	2009	8	1	9.1	9.1	9.1	< 4.44		
		Northern pike	2009	8	8	25.4	22.8	28	< 4.97	< 4.97	5.73
Little	13003300	Bluegill sunfish	2007	5	1	7.3	7.3	7.3	< 0.92		
East Rush	13006901	Bluegill sunfish	2007	20	2	6.3	6.3	6.3	< 0.92	< 0.92	< 0.92
Goose	13008300	Black crappie	2007	10	1	6.7	6.7	6.7	1.25		
Lake St Croix	82000100	Bluegill sunfish	2009	3	1	6.7	6.7	6.7	22.4		
		Black crappie	2009	2	1	9.4	9.4	9.4	8.33		
		Smallmouth bass	2009	2	2	12.8	12.2	13.4	5.78	5.57	5.99
		Walleye	2009	2	2	15	14.6	15.4	9.15	8.83	9.47
		White bass	2009	3	3	12.3	11.4	13	34.5	18.2	64.5
Louise	82002500	Bluegill sunfish	2008	10	6	5.4	4.9	5.7	5.15	< 4.74	6.72
		Black crappie	2008	10	6	4.5	4.3	4.7	5.12	< 4.76	6.14
Square	82004600	Bluegill sunfish	2007	10	6	5.7	3.9	7.3	< 4.76	< 4.57	< 4.95
		Black crappie	2007	5	5	7.1	6.5	7.9	< 4.95	< 4.76	5.2
		Largemouth bass	2007	5	5	11	10.4	11.6	< 4.88	< 4.67	< 5.03
Demontreville	82010100	Bluegill sunfish	2007	10	6	5.6	4.3	7.3	15.5	< 5.0	35.3
		Largemouth bass	2007	5	5	14.3	13	15.4	42.8	25.8	84.4
Olson	82010300	Bluegill sunfish	2007	10	6	5	3.9	5.9	13.7	4.9	24.7
		Largemouth bass	2007	5	5	15.6	14.6	16.5	39.3	19.7	77.5
Jane	82010400	Bluegill sunfish	2007	10	6	5.5	4.1	7.1	19.6	< 4.95	46.3
		Black crappie	2007	8	8	7.2	5.9	8.3	24.6	10.2	39.7
		Largemouth bass	2007	5	5	13.6	13	14.2	47.2	25.8	83.4

Elmo *	82010600	Bluegill sunfish	2007	10	6	4.5	3.9	5.1	256	149	345
		Bluegill sunfish	2008	10	6	5.3	4.9	5.9	153	98	196
		Bluegill average	**07,'08**	**20**	**12**	**4.9**	**3.9**	**5.9**	**205**	98	345
		Black crappie	2007	5	5	9.6	8.7	11	495	374	574
		Largemouth bass	2007	5	5	13.8	12.2	15.4	563	281	711
		Largemouth bass	2008	2	2	11.6	11	12.2	560	521	632
		L. Bass Average	**07,'08**	**7**	**7**	**13.2**	**11**	**15.4**	**562**	281	711
		Northern pike	2010	6	6	22.3	19.5	24.6	299	131	390
		Yellow perch	2010	11	1	5.9	5.9	5.9	294		
Forest	82015900	Bluegill sunfish	2009	10	1	5.9	5.9	5.9	5.82		
		Northern pike	2009	5	5	22.4	18.1	25.2	7.47	< 5.26	9.18
		Walleye	2009	5	5	19.1	17.3	20.5	10.9	7.04	13.2
Northland	82030500	Bluegill sunfish	2008	9	6	4.7	4.5	4.9	32.1	24.9	45
		Black crappie	2008	5	5	6.4	5.5	8.9	68.4	48.5	85.5

* Impaired for PFOS in fish tissue

Trends

Water Chemistry data was analyzed for trends for the long term period of record (1953-2009) at the St. Croix River Bridge in Stillwater(S000-019), for the period (1967-2009) at the Railroad Bridge near Hudson, Wisconsin (82-0001), and near term period of record (1995-2009) at both stations (Table 57). The long term period of record had significant decreases in total suspended solids, total phosphorus, and biological oxygen demand at the St. Croix River Bridge in Stillwater. While the station at the Railroad bridge in Hudson shows similar trends, the addition of ammonia data points to a decreasing long term trend. During the same period, significant increases in nitrite/nitrate and chloride were found at both stations on the St. Croix River. During the short term period there was a no significant change in trends, or little data was available.

Table 57. Pollutant trends from milestone stations on the St. Croix River

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
St. Croix River downstream of MN-212 Bridge in Stillwater (S000-019) (SC-23) (period of record 1953 - 2009)						
overall trend	**decrease**	**decrease**	**increase**	**no trend**	**decrease**	**increase**
estimated average annual change	-1.5%	-1.6%	1.9%		-1.0%	1.3%
estimated total change	-59%	-57%	74%		-44%	87%
1995 - 2009 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	18	0.2	0.10	0.06	3.6	4.0
median concentrations most recent 10 years	10	0.1	0.14	0.03	2.4	7.3
St. Croix River at RR Bridge at Hudson (82-0001)(SC-17) (period of record 1967 - 2009)						
overall trend	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**increase**
estimated average annual change	-2.2%	-2.5%	2.3%	-5.1%	-2.2%	2.0%
estimated total change	-61%	-65%	112%	-80%	-60%	131%
1995 - 2009 trend	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**
estimated average annual change						
estimated total change						
median concentrations first 10 years	9	0.1	0.1	0.16	2.7	4.0
median concentrations most recent 10 years	5	0.1	0.2	0.03	1.2	7.2

Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90 percent 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 (June-August) values, except for chlorides, which are median year-round values. All concentrations are in mg/L. Data is from Minnesota Pollution Control Agency "Milestone" monitoring sites.

Water clarity trends

The MPCA calculates trends on transparency data collected on lakes and streams annually. A minimum of eight years of data is required to provide a statistically significant trend; for this analysis a seasonal Kendal test is run using the statistical package “R.” None of the 146 sites with transparency tube data in the watershed had sufficient data for trend analysis. Seventy-one lakes had sufficient data for trend analysis; 27 had improving trends, nine had decreasing trends and the remainder had no significant trend (Figure 41).

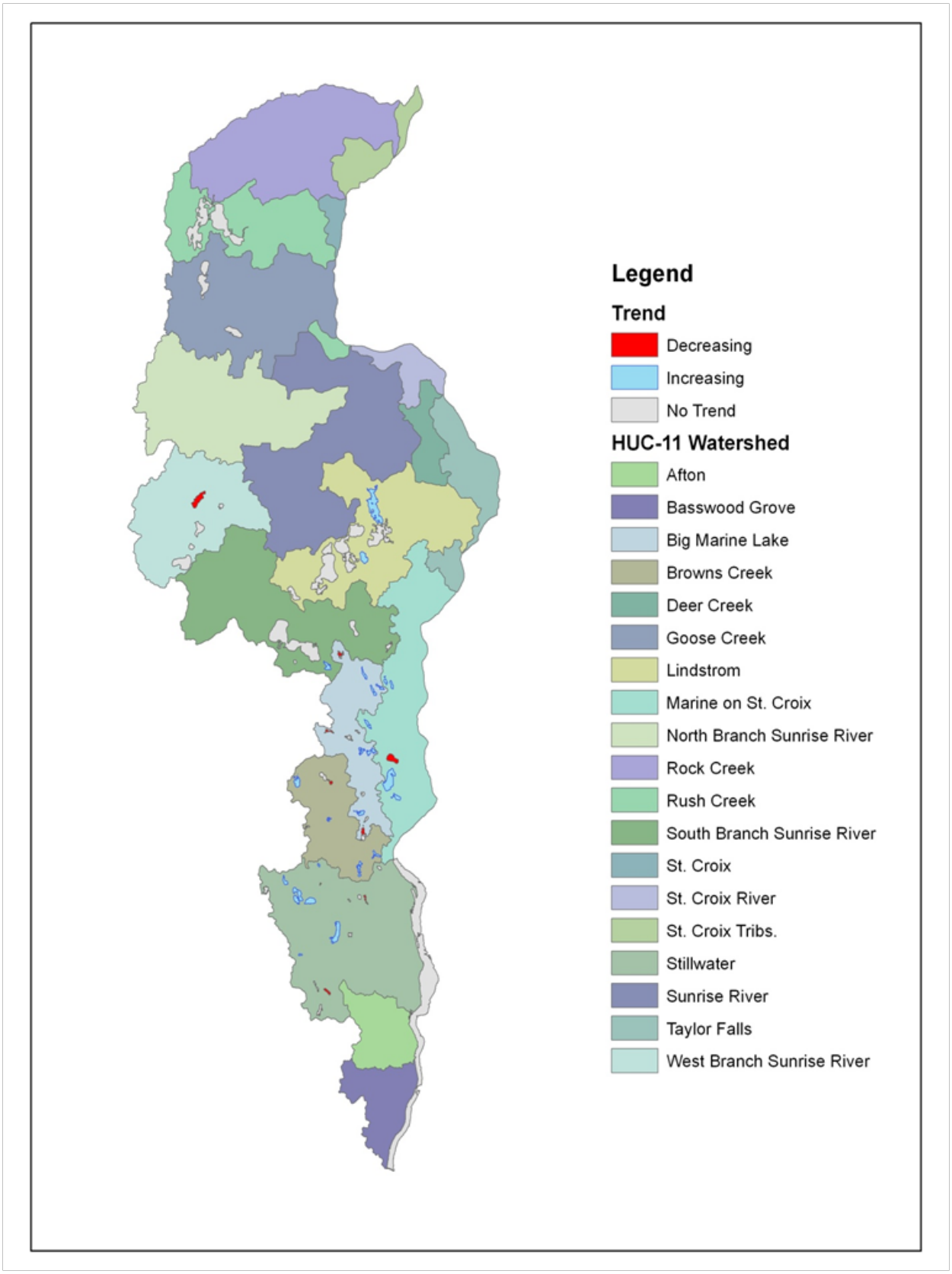

Figure 41. Transparency trends in the Lower St. Croix Watershed

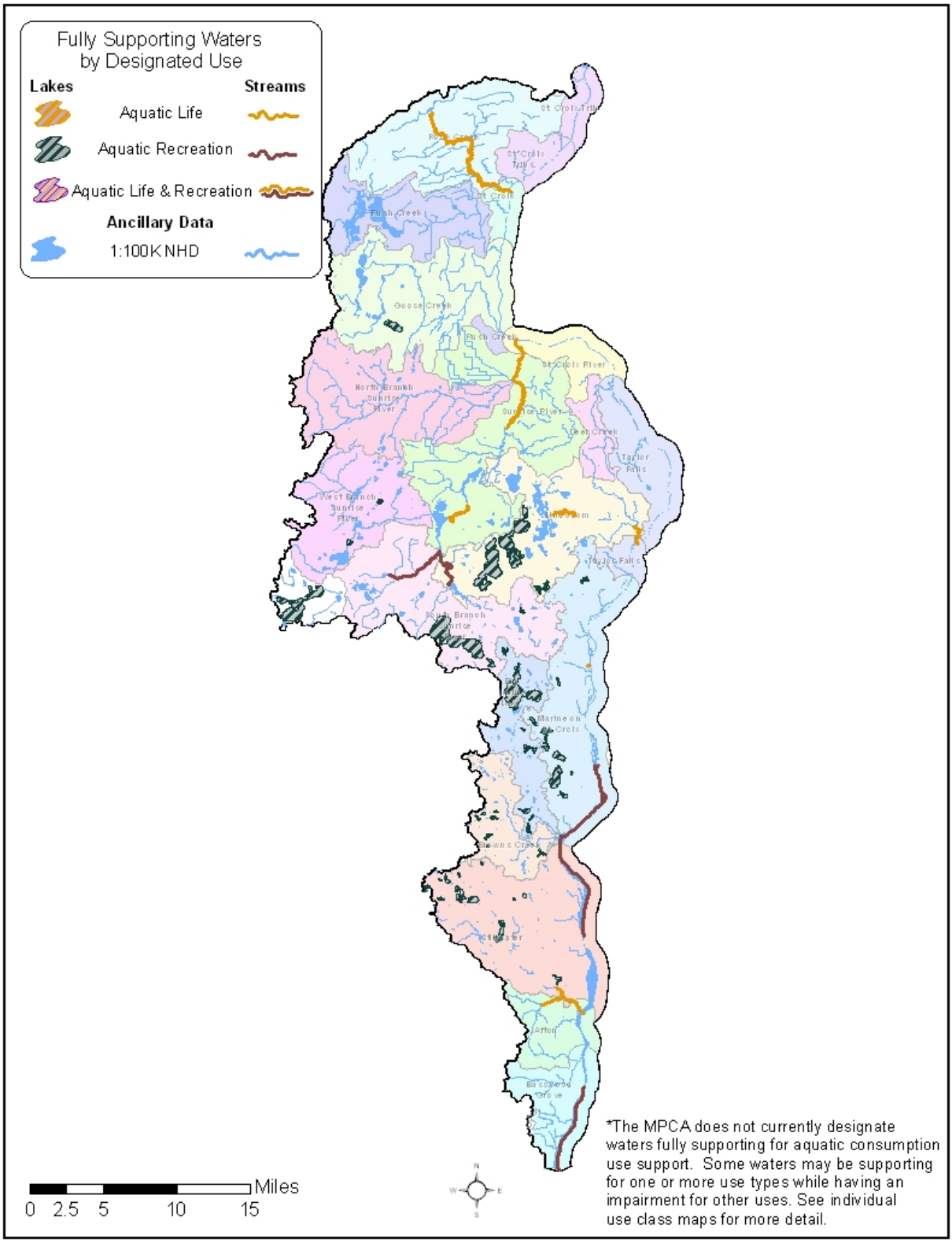

Figure 42. Fully supporting waters by designated use in the Lower St. Croix River Watershed

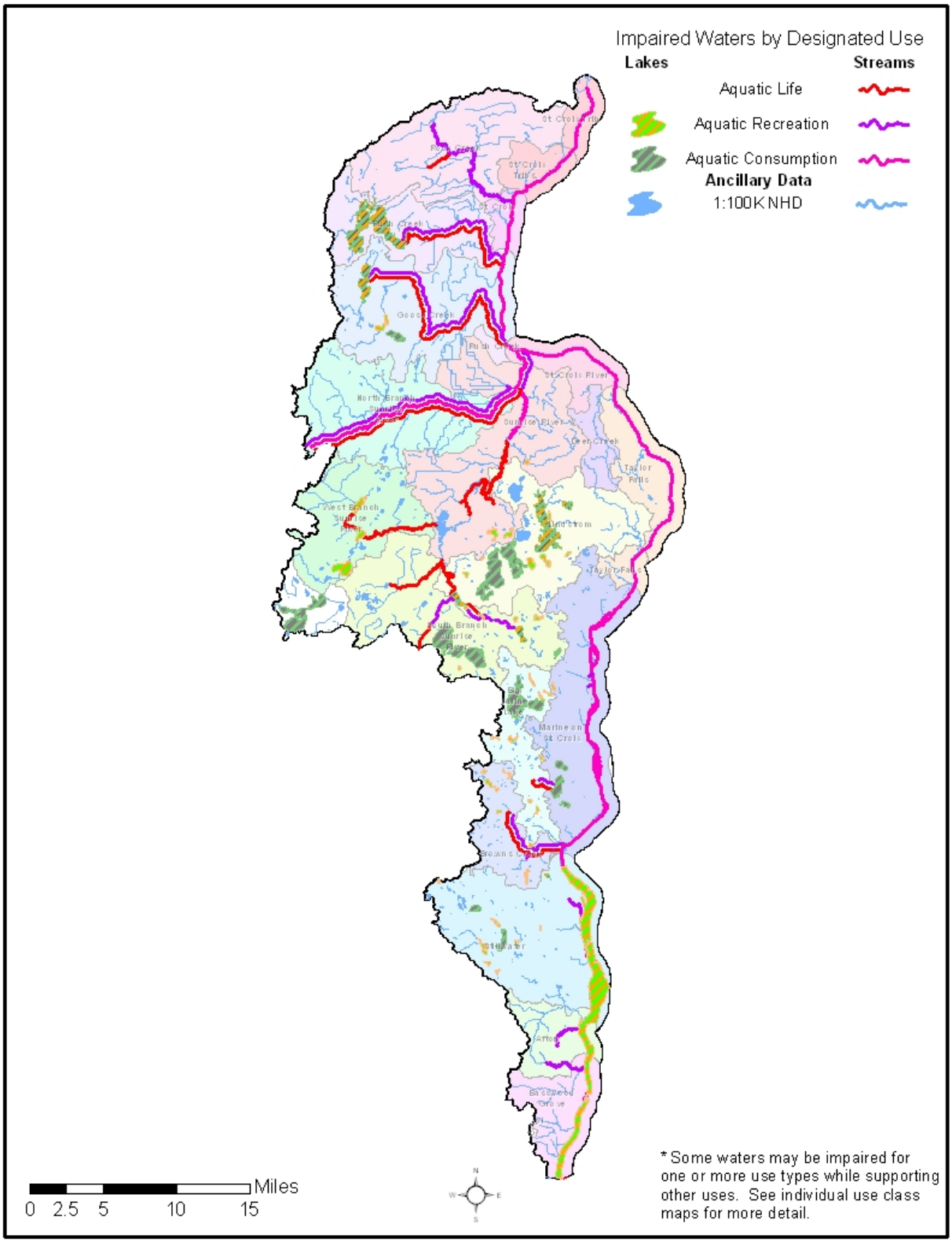

Figure 43. Impairment waters by designated use in the Lower St. Croix River Watershed

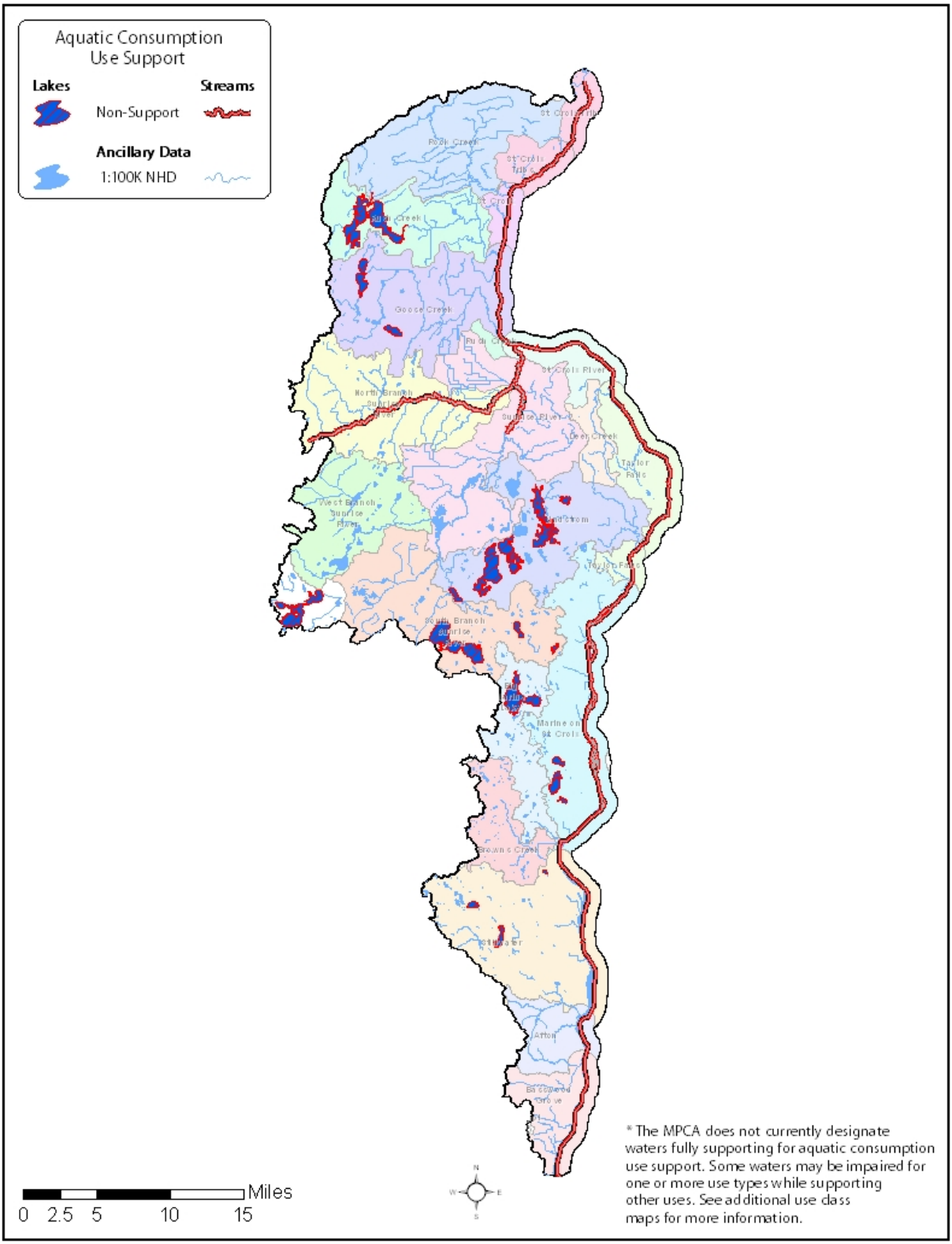

Figure 44. Aquatic consumption use support in the Lower St. Croix River Watershed

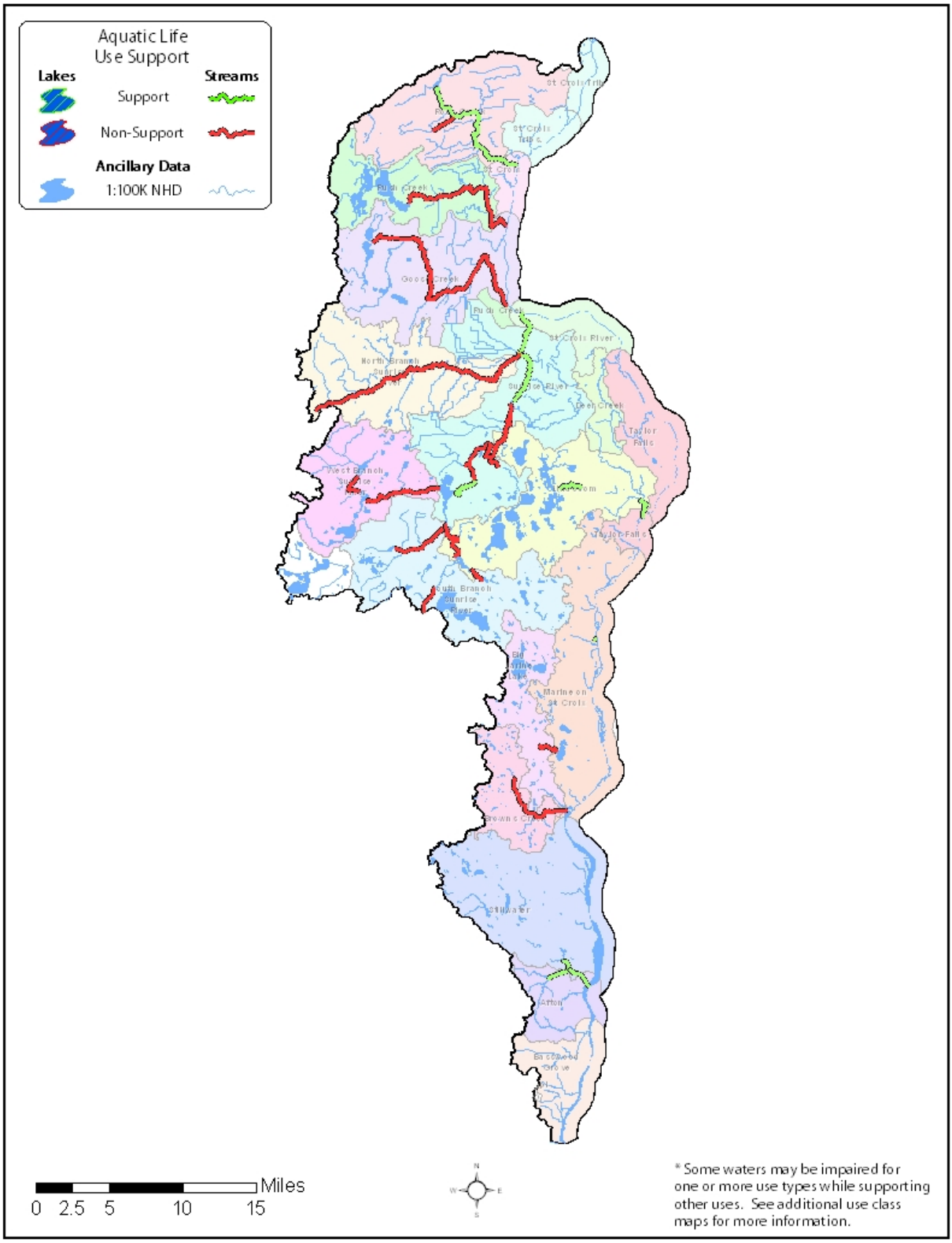

Figure 45. Aquatic life use support in the Lower St. Croix River Watershed

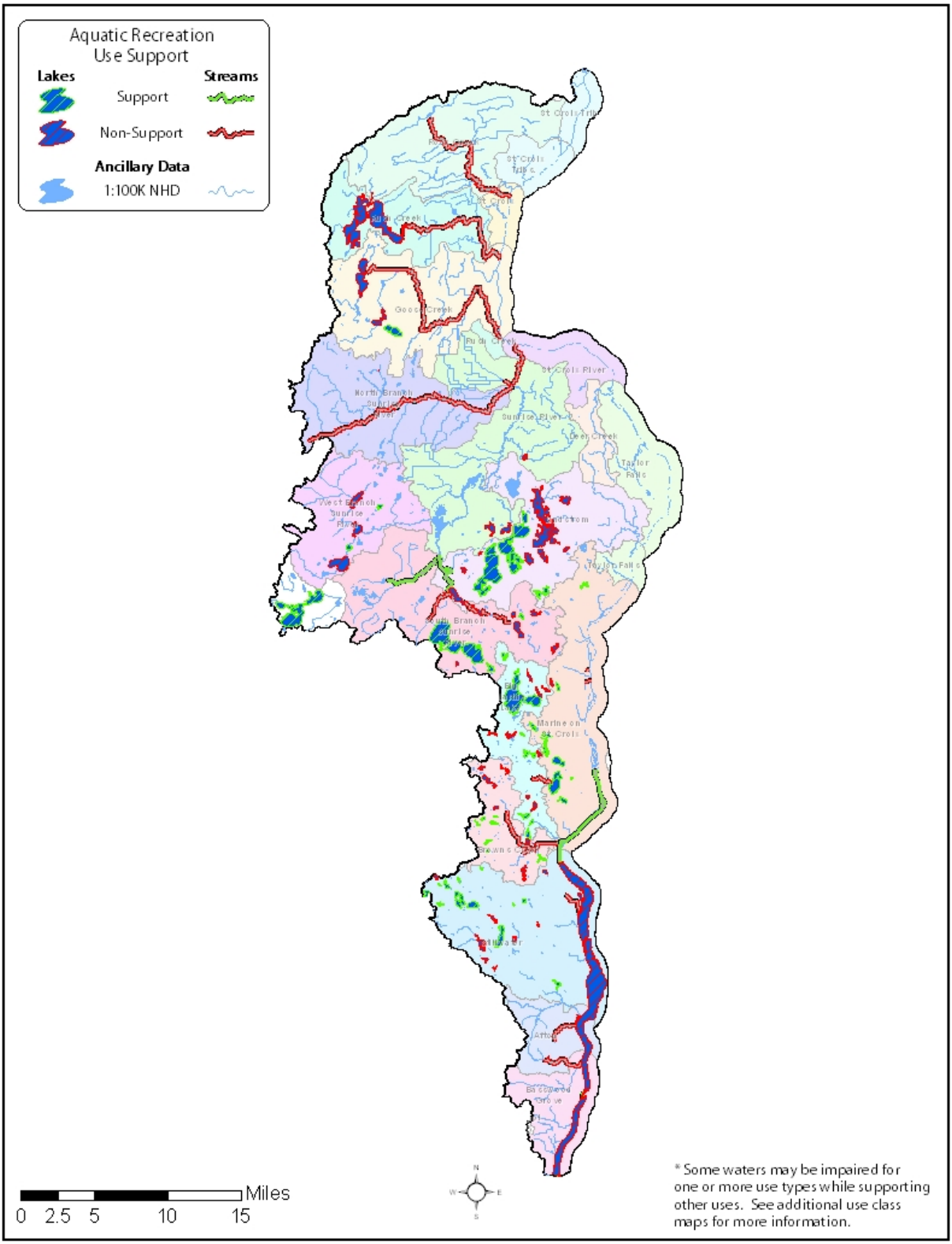

Figure 46. Aquatic recreation use support in the Lower St. Croix River Watershed

VIII. Summaries and recommendations

The tributaries in the Lower St. Croix Watershed each present varying degrees of protection and implementation needs to maintain and improve water quality. While some fail to meet expectations (i.e. most of the Sunrise River System, Goose Creek, portions of Browns Creek, Rush Creek) others met standards (i.e. Valley Branch Creek, Lawrence Creek, Rock Creek). In order to see measureable improvements in water quality, continued collaboration of federal, state and local organizations as well as local citizens will be vital.

Three tributaries stand out when considering protection of existing water quality conditions - Valley Branch Creek, Lawrence Creek and Rock Creek. The future of water quality in Valley Branch Creek will in some way be tied to management of the effects of urban sprawl from nearby suburbs. Currently riparian land is significantly undisturbed and protection measures have already been started by local citizens and the VBWD; collaboration of both groups will be important for maintaining high standards. Lawrence Creek should also be protected at existing water quality conditions. The riparian management of upper Lawrence Creek is much different that the lower reaches. Responsible agricultural practices upstream can help ensure this creek maintains its high water quality downstream. Maintaining and enforcing buffer setbacks to prevent sedimentation and agricultural runoff management should be top priorities. The Rock Creek watershed also should maintain current water quality conditions that support aquatic life. The location of this tributary in the northern, less disturbed portion of this watershed contributed to its intact riparian corridor.

Other tributaries will require a restoration approach to address water quality concerns. Water quality on sections of Goose Creek appears to be negatively impacted by altered stream channels. One possible improvement to these altered channels would be the implementation of a remeandering project, which would reintroduce natural sinuosity and associated instream habitat. Both Goose and Rush Lakes have excessive algal growth due to high nutrient runoff, resulting in impacts on their outlet streams, Goose Creek and Rush Creek. The addition of monitoring stations directly downstream of these eutrophic lakes may clarify exactly what impacts they are having on biology and chemistry. Enhanced management of high-nutrient runoff to these lakes could be beneficial to the water quality of both the lakes and their outlet creeks.

The mainstem Sunrise River has a gradient of water quality conditions, ranging from poor in the headwaters to above average in downstream reaches, the Kost Dam appears to be the point at which conditions change. Low dissolved oxygen values in the headwaters could be driving poor water quality and may be driven by wetland environments created by small impoundments. Downstream of Kost Dam the Sunrise River takes on a higher gradient, riverine character and biological condition improves. A TMDL work plan has been written to develop strategies to address the impairments across the watershed (MPCA 2008).

The North Branch Sunrise River appears to have more coldwater attributes than the mainstem Sunrise River; coldwater species, water temperatures and springs located along its banks are key indicators of this. Excessive sedimentation covering reproductive habitat may be a potential stressor limiting the ability of coldwater species populations to thrive. The management of pasturelands to prevent severe trampling of stream banks could be a one key to addressing the sedimentation problem. More data collection may be necessary in this tributary to investigate to what extent excessive sediment deposition could be attributed to natural versus anthropogenic processes.

Potential stressors of Browns Creek appear to be associated with urban influences from Stillwater and surrounding communities. A TMDL plan has been developed for Browns Creek to address potential stressors involving turbidity, excessive sedimentation and thermal disturbances affecting the creek and its aquatic communities (MPCA 2010). A few reaches on Browns Creek exhibit severely eroded banks that could be due to high flow conditions associated with large runoff events. Excessive sedimentation

and turbidity in these sections could be due to the sediment associated with collapsing banks as well as directly from urban runoff. The natural coldwater thermal regime of the creek can be disturbed during summer runoff events, increasing water temperatures and stressing obligate coldwater organisms. Stormwater management within the city will be crucial to the future health of Browns Creek and the viability of coldwater organisms in its waters. The continued efforts at the local level by Browns Creek Watershed District and citizens along with state level support will be crucial to restoring Browns Creek.

High bacteria concentrations appear to be common throughout this watershed. Most subwatersheds have at least one AUID exceeding the bacteria standard. The high bacteria concentrations could be the result of a combination of various impacts, such as manure in runoff from pastures and feedlots following precipitation, animal access to waterways, and natural wildlife processes. Addressing these impairments and finding the main sources of bacteria will require further research to understand the relationships between sources and their impacts. A TMDL plan has been developed on the North Branch Sunrise River to address bacteria exceedances; implementation is now underway to lower bacteria to safe levels for human recreation (MPCA 2006).

The 25 mile section of river referred to as Lake St. Croix is one of the most popular places for outdoor recreation in the region. Increasing trends for algal blooms in the summer months due to elevated phosphorus levels have led to the investigation of Lake St. Croix, and its associated phosphorus inputs. The St. Croix Basin Water Resources Planning Team (made up of the MPCA, Wisconsin DNR, MDNR and other federal, state, and local organizations) has developed a draft TMDL to address this problem. Tributaries, from both Minnesota and Wisconsin, contributing to nutrient loading of Lake St. Croix, will receive the primary focus of investigation. Analysis of subwatersheds within these tributaries will help focus the areas of concern were Best Management Practices can be developed to reduce nutrient loading. If dense algae blooms in the summer months persist, the recreational use will be negatively impacted, which could indirectly affect local economies that thrive on the tourism this river brings.

This watershed is quite varied in land use, lake size and lake depth, as would be expected in this transitional part of the state. Similar to the streams, several watersheds stand out for their lake quality. The Marine on St. Croix subwatershed has considerable forested land cover and small amounts of urban and cultivated land. As a result of the low percentage of altered land uses, the lakes within this subwatershed tend to be of quite high quality. Square Lake, Little Carnelian, and Big Carnelian Lake are all very low in phosphorus concentrations. An essential part of preserving these high quality lakes will be planning development that keeps the land intact and limits the amount of watershed runoff. Goose Creek, Rush Creek, and the Sunrise River watersheds, on the other hand, have higher disturbed land uses and as a result the lake quality has diminished. Shallow lakes in particular are sensitive to inputs of phosphorus. Internal loading results in lakes with extremely high concentrations that is very difficult to counteract. In these watersheds it will be important that steps are taken to reduce watershed inputs of phosphorus.

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Appendix 1 - Water chemistry definitions

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

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

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

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

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

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

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

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

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

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

The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. Higher turbidity results in less light penetration which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

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

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

Appendix 2 - Intensive watershed stations in the Lower St. Croix River Watershed

Biological Station ID	STORET ID	Waterbody Name	Location	11-digit HUC
98SC004	S000-125	Rush Creek	Upstream of County Road 56, 3 mi. SE of Rush City	7030005190
99SC003	S005-529	Valley Creek	Upstream of Putnam Blvd, 1 mi. W of St. Marys Point	7030005410
07SC002	S004-925	Browns Creek	Upstream of Stonebridge Tr N, 1.5 mi. NW of Stillwater	7030005370
09SC001	S004-032	Sunrise River	Upstream of County Road 88 in Sunrise	7030005230
09SC002	S005-532	Rock Creek	Upstream of County Road 3, 5 mi. NE of Rush City	7030005170
09SC003	S000-410	Goose Creek	Downstream of County Road 59, 5 mi. NE of Harris	7030005200
09SC004	S003-472	North Branch Sunrise River	Trulson Road, 5 mi. E of North Branch	7030005250
09SC005	S001-424	West Branch Sunrise River	Lyons St, 1 mi. W of Stacy	7030005220
09SC006	S005-531	Sunrise River	Upstream of County Road 84, 2.5 mi.NE of Wyoming	7030005230
09SC007	S005-530	South Branch Sunrise River	Downstream of County Road 30, in Wyoming	7030005210

Appendix 3 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B	39	±11	50	28
2	Southern Streams	2B	45	±9	54	36
3	Southern Headwaters	2B	51	±7	58	44
4	Northern Rivers	2B	35	±9	44	26
5	Northern Streams	2B	50	±9	59	41
6	Northern Headwaters	2B	40	±16	56	24
7	Low Gradient	2B	40	±10	50	30
10	Southern Coldwater	2A	45	13	58	32
11	Northern Coldwater	2A	37	10	47	27
Invertebrates						
1	Northern Forest Rivers	2B	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B	52.4	±13.6	66	38.8
5	Southern Streams RR	2B	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B	38.3	±13.6	51.9	24.7
8	Northern Coldwater	2A	26	±12.4	38.4	13.6
9	Southern Coldwater	2A	46.1	±13.8	59.9	32.3

Appendix 4.1 - AUID table of results (by parameter and beneficial use)

					Uses				Biological Criteria		Water Quality Standards					
National Hydrography Dataset (NHD) Assessment Unit ID	Stream Segment Name	Segment Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Drinking Water		Fish IBI	Invert IBI	Chloride	Bacteria	Dissolved Oxygen	pH	Turbidity	Unionized Ammonia
HUC 11: 07030005170 (Rock Creek)																
07030005-584	Rock Creek	Rock Lk to St Croix R	15.68	2B	FS	NS	IF		MTS	MTS	MTS	EX	MTS	MTS	MTS	MTS
HUC 11: 07030005180 (Rush Creek)																
07030005-509	Rush Creek	Rush Lk to St Croix R	14.75	2B	NS	NS	IF		EXP	EXS	MTS	EX	MTS	MTS	MTS	MTS
07030005-680	County Ditch 6	Headwaters to Rush Creek	2.92	2B	NA*	--	--		NA	--	--	--	--	--	--	--
07030005-695	Unnamed Creek	Headwaters to Rush Lk	2.01	2B	NA*	--	--		NA	--	--	--	--	--	--	--
HUC 11: 07030005200 (Goose Creek)																
07030005-510	Goose Creek	Headwaters (Goose Lk 13-0083-01) to St Croix R	22.33	2B	NS	NS	--		EXP	MTS	MTS	EX	MTS	MTS	MTS	MTS
07030005-548	Unnamed ditch	Headwaters to Goose Cr	1.44	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-729	Unnamed creek	Headwaters to St Croix R	3.54	2B	IF	IF	--		--	--	--	EX	--	--	MTS	--
07030005-730	Unnamed ditch	Unnamed ditch to Goose Cr	1.64	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-731	Unnamed creek	Unnamed cr to Goose Cr	1.6	2B	NA	NA	--		--	--	--	--	--	--	--	--
07030005-733	Unnamed creek	Neander Lk to Goose Cr	1.56	2B	NA	NA	--		--	--	--	--	--	--	--	--
07030005-741	Unnamed creek (Goose Lake Inlet)	Headwaters to Goose Lk	1.93	2B	IF	NA	--		--	--	--	--	--	--	MTS	--
HUC 11: 07030005210 (South Branch Sunrise River)																
07030005-521	Unnamed creek	Birch Lk to School Lk	0.68	2B	NA	NS	--		--	--	MTS	EX	EXS	--	MTS	MTS
07030005-522	Unnamed creek	School Lk to Little Comfort Lk	1.3	2B	NS	NS	--		--	--	MTS	EX	EXS	--	MTS	MTS
07030005-524	Unnamed ditch	Forest Lk to Sunrise R	0.68	2B	NA	IF	--		--	--	--	IF	--	--	IF	--

					Uses				Biological Criteria		Water Quality Standards					
National Hydrography Dataset (NHD) Assessment Unit ID	Stream Segment Name	Segment Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Drinking Water		Fish IBI	Invert IBI	Chloride	Bacteria	Dissolved Oxygen	pH	Turbidity	Unionized Ammonia
07030005-525	Judicial Ditch 2	Headwaters to Sunrise R	2.05	2B	NS	IF	--		--	--	EX	EX	EXS	--	MTS	MTS
07030005-528	Sunrise River, South Branch	Unnamed lk (02-0500-00) to Sunrise R	5.02	2B	NS	FS	--		--	--	MTS	MTS	EXS	MTS	MTS	MTS
07030005-637	Unnamed creek	Moody Lk to Bone Lk	0.43	2B	NA	IF	--		--	--	MTS	IF	--	--	EXP	MTS
07030005-639	Unnamed creek	Bone Lk to Unnamed lk	0.03	2B	NA	IF	--		--	--	--	IF	--	--	MTS	--
07030005-641	Unnamed creek	Unnamed lk to Birch Lk	1.7	2B	IF	NS	--		--	--	MTS	EX	EXS	--	MTS	MTS
07030005-643	Unnamed creek	Shields Lk to Forest Lk	0.82	2B	IF	IF	--		--	--	--	IF	--	--	--	--
07030005-756	Unnamed ditch	Headwaters to Unnamed creek	3.63	2B	NA*	NA	--		--	--	--	--	--	--	--	--
HUC 11: 07030005220 (West Branch Sunrise River)																
07030005-529	Sunrise River, West Branch	Martin Lk to Sunrise R (Pool 1)	7.72	2B	NS	IF	IF		EXS	EXP	MTS	IF	IF	MTS	EXP	MTS
07030005-561	Sunrise River, West Branch (County Ditch 13)	Headwaters to Typo Lk	5.03	2B	IF	NA	NA		--	--	MTS	--	IF	MTS	MTS	--
07030005-563	Sunrise River, West Branch	Typo Lk to Martin Lk	2.32	2B	NS	NA	NA		--	--	MTS	--	--	--	EXP	--
07030005-576	Unnamed creek (Boot Lake Inlet)	Rice Lk to Boot Lk	0.47	2B	NA	NA	--		--	--	MTS	--	--	--	--	--
07030005-578	Unnamed creek (Island Lake Inlet)	Linwood Lk to Island Lk	0.53	2B	NA	NA	--		--	--	MTS	--	--	--	--	--
07030005-579	Unnamed creek (Martin Lake Inlet)	Island Lk to Martin Lk	0.75	2B	NA	NA	--		--	--	MTS	--	--	--	--	--
07030005-580	Unnamed creek	Headwaters to W Br Sunrise R	1.39	2B	NA	NA	--		--	--	MTS	--	--	--	--	--
07030005-581	Unnamed creek	Unnamed ditch to W Br Sunrise R	1.47	2B	IF	NA	--		--	--	MTS	--	--	--	--	--
07030005-582	Unnamed ditch	Headwaters to W Br Sunrise R	2.68	2B	IF	NA	--		--	--	MTS	--	--	--	--	--
07030005-711	County Ditch 16	Unnamed ditch to Rice Lk	1.19	2B	NA*	NA	--		--	--	--	--	--	--	--	--
07030005-915	Unnamed creek	Headwaters to W Br Sunrise R	0.6	2B	NA	NA	--		--	--	MTS	--	--	--	--	--
HUC 11: 07030005230 (Sunrise River)																
07030005-526	Sunrise River	Upstream from Comfort Lk	2.84	2B	IF	NS	--		--	--	IF	EX	EXS	MTS	MTS	MTS
07030005-527	Sunrise River	Comfort Lk to Pool 1	4.36	2B	NS	FS	--		EXS	EXP	MTS	MTS	EXP	MTS	MTS	MTS

					Uses				Biological Criteria		Water Quality Standards					
National Hydrography Dataset (NHD) Assessment Unit ID	Stream Segment Name	Segment Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Drinking Water		Fish IBI	Invert IBI	Chloride	Bacteria	Dissolved Oxygen	pH	Turbidity	Unionized Ammonia
07030005-539	Sunrise River (Pool 3)	Sunrise Pool 3	3.85	2B	NS	NA	--		EXS	--	--	--	NA	--	--	--
07030005-540	Sunrise River	Pool 3 to Kost Dam Reservoir	9.44	2B	NS	NA	--		EXS	--	--	--	IF	--	MTS	--
07030005-542	Sunrise River	Kost Dam to N Br Sunrise R	7.21	2B	FS	IF	--		MTS	MTS	MTS	IF	IF	MTS	MTS	MTS
07030005-543	Sunrise River	N Br Sunrise R to St Croix R	3.99	2B	FS	NS	--		MTS	MTS	MTS	EX	IF	MTS	MTS	MTS
07030005-545	Hay Creek	CD 3 (Beaver Cr) to Sunrise R	0.74	2A	IF	NS	NA		--	--	--	EX	EXP	--	MTS	--
07030005-546	Beaver Creek (County Ditch 3)	Unnamed ditch to Hay Cr	6.32	2A	IF	NA	NA		--	--	--	--	--	--	MTS	--
07030005-571	Unnamed creek	Vibo Lk to Sunrise R	3.21	2B	IF	NA	--		--	--	--	--	--	--	IF	--
07030005-593	Unnamed ditch	Headwaters to Beaver Cr (CD 3)	2.26	2A	NA *	NA	--		--	--	--	--	--	--	--	--
07030005-596	Unnamed creek	Unnamed cr to Unnamed cr	0.2	2B	IF	NA	--		--	--	--	--	--	--	MTS	--
07030005-597	Unnamed creek	Unnamed cr to Sunrise R	0.88	2B	NA	NA	--		--	--	--	--	--	--	--	--
07030005-630	County Ditch 10	Headwaters to Unnamed cr	3.67	2B	NA *	NA	--		--	--	--	--	--	--	--	--
07030005-708	County Ditch 5	Unnamed ditch to Unnamed ditch	1.58	2B	NA *	NA	--		--	--	--	--	--	--	--	--
07030005-710	County Ditch 5	Unnamed ditch to Sunrise R	2.71	2B	NA	NA	--		--	--	--	--	--	--	--	--
07030005-723	Unnamed ditch	T34 R21W S24, east line to Sunrise R	1.17	2B	NS	IF	--		EXP	--	MTS	IF	EXS	MTS	MTS	EX
HUC 11: 07030005240 (Lindstrom)																
07030005-553	Unnamed creek	Headwaters to Lawrence Cr	3.78	2B	IF	NA	--		--	--	--	--	--	--	MTS	--
07030005-572	Unnamed creek	Headwaters to South Center Lk	2.03	2B	FS	NA	--		--	--	MTS	--	--	--	MTS	MTS
07030005-574	Lawrence Creek	T33 R19W S3, north line to St Croix R	2.25	2A	FS	IF	IF		MTS	MTS	MTS	IF	IF	MTS	MTS	M
07030005-719	Unnamed creek	Headwaters to Little Lk	2.31	2B	IF	NA	--		--	--	--	--	--	--	--	MTS
07030005-721	Unnamed creek	Little Lk to North Center Lk	1.84	2B	IF	NA	--		--	--	--	--	--	--	--	MTS
07030005-723	Unnamed ditch	T34 R21W S24, east line to Sunrise R	1.17	2B	NS	IF	--		EXP	--	MTS	IF	EXS	MTS	MTS	EX
07030005-911	Unnamed creek	Wetland to Chisago Lk	0.32	2B	NA	NA	--		--	--	--	--	--	--	--	MTS
HUC 11: 07030005250 (North Branch Sunrise River)																
07030005-501	Sunrise River, North Branch	Headwaters to Sunrise R	24.11	2B	NS	NS	--		EXP	MTS	MTS	EX	IF	MTS	MTS	MTS
07030005-514	County Ditch 7	Unnamed cr to N Br Sunrise R	3.8	2B	IF	IF	--		--	--	--	IF	--	--	MTS	--

					Uses				Biological Criteria		Water Quality Standards					
National Hydrography Dataset (NHD) Assessment Unit ID	Stream Segment Name	Segment Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Drinking Water		Fish IBI	Invert IBI	Chloride	Bacteria	Dissolved Oxygen	pH	Turbidity	Unionized Ammonia
07030005-556	Judicial Ditch 4	Unnamed cr to N Br Sunrise R	0.74	2B	NA*	IF	--		--	--	--	IF	--	--	--	--
07030005-569	Unnamed creek	Headwaters to N Br Sunrise R	3.64	2B	IF	IF	--		--	--	--	IF	--	--	IF	--
07030005-595	Unnamed creek	Unnamed cr to N Br Sunrise R	1.08	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-683	Unnamed ditch	Headwaters to N Br Sunrise R	2.66	2B	NA*	NA	--		NA	--	--	--	--	--	--	--
07030005-707	Unnamed creek	Unnamed cr to N Br Sunrise R	1.43	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-714	Hay Creek	Mud Lk (30-0011-00) to N Br Sunrise R	3.31	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-728	County Ditch 19	Unnamed ditch to N Br Sunrise R	2.98	2B	NA*	IF	--		--	--	--	IF	--	--	--	--
07030005-753	Unnamed creek	Headwaters to N Br Sunrise R	2.71	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-755	Unnamed creek	Unnamed ditch to N Br Sunrise R	3.12	2B	NA	IF	--		--	--	--	IF	--	--	--	--
07030005-909	Unnamed creek	to Unnamed cr	0.58	2B	NA	NA	--		--	--	--	--	--	--	MTS	--
HUC 11: 07030005340 (Marine on the St. Croix)																
07030005-549	Roadside Ditch (Old Mill Stream)	Headwaters to St Croix R	1.43	2A	IF	IF	NA		--	--	MTS	IF	IF	EXP	MTS	MTS
07030005-559	Silver Creek	Headwaters to St Croix R	2.66	2B	IF	IF	--		--	--	MTS	IF	IF	--	MTS	--
07030005-603	Unnamed creek	Big Carnelian Lk to Little Carnelian Lk	0.62	2B	NA	NA	--		--	--	MTS	--	--	--	MTS	--
07030005-713	Unnamed creek	Unnamed cr to St Croix R	0.44	2B	IF	NS	--		--	--	MTS	EX	IF	--	EXS	MTS
07030005-752	Unnamed creek	Headwaters to St Croix R	0.19	2B	IF	IF	--		--	--	MTS	IF	--	--	--	--
07030005-904	Unnamed creek (Willow Branch)	to St Croix R	0.83	2A	IF	IF	NA		--	--	MTS	IF	IF	EXP	MTS	MTS
07030005-913	Unnamed creek	Headwaters to St Croix R	0.3	2A	FS	NS	NA		--	--	MTS	EX	IF	--	MTS	MTS
HUC 11: 07030005360 (Big Marine Lake)																
07030005-559	Silver Creek	Headwaters to St Croix R	2.66	2B	IF	IF	--		--	--	MTS	IF	IF	--	MTS	--
07030005-601	Unnamed creek	Unnamed lk to Big Carnelian Lk	1.81	2B	NS	NS	--		EXS	--	MTS	EX	IF	--	EXP	MTS
07030005-644	Unnamed creek	Unnamed lk (82-0296-00) to Bass Lk	0.2	2B	NA	IF	--		--	--	MTS	IF	--	--	MTS	--
HUC 11: 07030005370 (Browns Creek)																
07030005-520	Browns Creek	T30 R20W S18, west line to St Croix R	4.76	2A	NS	NS	IF		EXP	MTS	MTS	EX	EXP	EXP	EXS	MTS
07030005-586	Browns Creek	Headwaters to T30 R21W S1, south line	1.1	2B	IF	IF	--		--	--	MTS	IF	--	--	MTS	--

					Uses				Biological Criteria		Water Quality Standards					
National Hydrography Dataset (NHD) Assessment Unit ID	**Stream Segment Name**	**Segment Description**	**Reach Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Drinking Water**		**Fish IBI**	**Invert IBI**	**Chloride**	**Bacteria**	**Dissolved Oxygen**	**pH**	**Turbidity**	**Unionized Ammonia**
07030005-587	Browns Creek	T30 R21W S12, north line to T30 R21W S13, east line	2.39	2A	NS	NS	NA		EXP	--	MTS	EX	EXP	MTS	MTS	MTS
07030005-767	Unnamed creek	T30 R20W S19, south line to underground diversion	0.68	2A	IF	NS	NA		--	--	MTS	EX	IF	--	EXP	MTS
HUC 11: 07030005410 (Stillwater)																
07030005-504	St. Croix River	Apple R(WI) to Willow R(WI)	15.41	2B	NA	FS	IF		NR	--	MTS	MTS	IF	MTS	MTS	MTS
07030005-560	Valley Branch (Valley Creek)	Valley Cr to St Croix R	2.31	2A	FS	IF	IF		MTS	MTS	MTS	IF	IF	MTS	MTS	MTS
07030005-566	Valley Branch (Valley Creek)	Unnamed cr to Valley Cr	1.03	2A	FS	NA	NA		MTS	MTS	--	--	--	--	--	--
07030005-567	Valley Creek	Unnamed cr to Valley Br	1.89	2A	FS	NA	NA		MTS	MTS	--	--	--	--	--	--
07030005-612	Unnamed creek	Headwaters to St Croix R	2.19	2B	IF	NS	--		--	--	--	EX	--	--	EXP	MT
HUC 11: 07030005420 (Afton)																
07030005-568	Trout Brook	Unnamed cr to St Croix R	3.9	2B	FS	NS	--		--	MTS	MTS	EX	IF	--	MTS	MTS
07030005-606	Unnamed creek	Headwaters to St Croix R	3.08	2B	IF	NS	--		--	--	MTS	EX	IF	--	EXP	MTS
HUC 11: 07030005420 (Basswood Grove)																
07030005-502	St. Croix River	Kinnickinnic R (WI) to Mississippi R	6.4	2B	NA	FS	NA		--	--	MTS	--	--	--	--	--
07030005-607	Unnamed creek	Unnamed cr to O'Connors Lk	0.58	2B	IF	IF	--		--	--	MTS	IF	--	--	--	--
07030005-684	Unnamed creek	Unnamed cr to Unnamed cr	0.64	2B	IF	IF	--		--	--	MTS	IF	IF	--	MTS	MTS

Appendix 4.2 - Biological monitoring results - Fish IBI

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Threshold	Fish IBI	Visit Date
HUC 11: 07030005170 Rock Creek							
07030005-584	09SC002	Rock Creek	54.13	5	50	52	8-Jun-09
07030005-584	07SC005	Rock Creek	11.70	6	40	51	18-Jun-07
07030005-584	09SC010	Rock Creek	23.69	6	40	63	10-Jun-09
07030005-584	09SC010	Rock Creek	23.69	6	40	57	29-Jun-09
07030005-584	96SC022	Rock Creek	53.43	5	50	47	9-Aug-06
07030005-584	07SC004	Rock Creek	43.47	6	40	72	18-Jun-07
07030005-584	06SC023	Rock Creek	50.06	5	50	29	16-Jun-06
HUC 11: 07030005190 Rush Creek							
07030005-509	98SC002	Rush Creek	42.93	6	40	24	21-Jun-99
07030005-509	98SC002	Rush Creek	42.93	6	40	56	18-Jul-00
07030005-509	98SC002	Rush Creek	42.93	6	40	41	23-Jul-01
07030005-509	98SC001	Rush Creek	36.20	6	40	31	21-Jun-99
07030005-509	98SC001	Rush Creek	36.20	6	40	30	20-Jun-00
07030005-509	98SC001	Rush Creek	36.20	6	40	31	9-Aug-01
07030005-509	98SC001	Rush Creek	36.20	6	40	42	9-Jun-09
07030005-509	98SC003	Rush Creek	45.87	6	40	52	16-Jun-99
07030005-509	98SC003	Rush Creek	45.87	6	40	57	13-Jul-00
07030005-509	98SC003	Rush Creek	45.87	6	40	59	23-Jul-01
07030005-509	98SC004	Rush Creek	56.41	5	50	60	17-Jun-99
07030005-509	98SC004	Rush Creek	56.41	5	50	49	21-Jun-00
07030005-509	98SC004	Rush Creek	56.41	5	50	73	9-Aug-01
07030005-509	98SC004	Rush Creek	56.41	5	50	55	8-Jun-09
07030005-509	98SC004	Rush Creek	56.41	5	50	56	30-Jun-09
07030005-509	96SC081	Rush Creek	51.63	5	50	33	29-Jul-99
07030005-509	96SC081	Rush Creek	51.63	5	50	44	18-Jul-00
07030005-509	96SC081	Rush Creek	51.63	5	50	34	9-Aug-01

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Threshold	Fish IBI	Visit Date
HUC 11: 07030005200 Goose Creek							
07030005-731	09SC013	Trib. to Goose Creek	5.54	6	40	17	9-Jun-09
07030005-733	09SC012	Trib. to Goose Creek	8.83	7	40	25	9-Jun-09
07030005-510	09SC014	Goose Creek	15.02	7	40	66	9-Jun-09
07030005-510	96SC084	Goose Creek	43.84	6	40	68	16-Jun-99
07030005-510	96SC084	Goose Creek	43.84	6	40	47	20-Jun-00
07030005-510	96SC084	Goose Creek	43.84	6	40	71	12-Jul-07
07030005-510	09SC011	Goose Creek	34.71	7	40	48	11-Jun-09
07030005-510	07SC003	Goose Creek	31.78	7	40	30	9-Jul-07
07030005-510	96SC023	Goose Creek	68.65	5	50	55	9-Jul-07
07030005-510	09SC003	Goose Creek	65.72	5	50	43	9-Jun-09
07030005-510	09SC003	Goose Creek	65.72	5	50	42	25-Jul-11
07030005-510	07SC019	Goose Creek	28.99	7	40	51	21-Jun-07
HUC 11: 07030005210 South Branch Sunrise							
07030005-522	09SC036	Trib. to Comfort Lake	20.40	7	40	35	15-Jun-09
07030005-528	09SC007	Sunrise River, South Branch	46.33	7	40	29	15-Jun-09
HUC 11: 07030005220 West Branch Sunrise							
07030005-529	09SC030	Sunrise River, West Branch	42.77	7	40	40	29-Jun-09
07030005-529	09SC005	Sunrise River, West Branch	49.14	7	40	20	18-Jun-09
07030005-529	00SC001	Sunrise River, West Branch	49.09	7	40	39	2-Sep-00
07030005-561	07SC018	Sunrise River, West Branch	6.40	6	40	25	28-Jun-07
07030005-561	07SC018	Sunrise River, West Branch	6.40	6	40	0	1-Jul-09
07030005-561	07SC018	Sunrise River, West Branch	6.40	6	40	0	8-Jun-09
HUC 11: 07030005230 Sunrise River							
07030005-526	07SC017	Sunrise River	26.21	7	40	49	25-Jun-07
07030005-526	07SC017	Sunrise River	26.21	7	40	32	1-Jul-09
07030005-527	96SC024	Sunrise River	53.24	5	50	33	14-Aug-06
07030005-527	09SC006	Sunrise River	54.14	5	50	34	11-Jun-09
07030005-539	09SC024	Sunrise River	164.29	5	50	30	4-Jun-09
07030005-540	06SC009	Sunrise River	175.11	5	50	26	16-Aug-06
07030005-540	09SC035	Sunrise River	239.11	5	50	34	18-Jun-09
07030005-542	96SC065	Sunrise River	269.36	5	50	54	22-Jul-99
07030005-542	96SC065	Sunrise River	269.36	5	50	66	22-Jun-00

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Threshold	Fish IBI	Visit Date
07030005-542	06SC021	Sunrise River	276.05	5	50	72	3-Aug-06
07030005-542	06SC021	Sunrise River	276.05	5	50	58	17-Jun-09
07030005-543	09SC001	Sunrise River	380.52	5	50	92	1-Jul-09
07030005-545	09SC040	Hay Creek	14.04	11	37	50	10-Jun-09
07030005-546	07SC014	County Ditch 3	7.77	11	37	20	10-Jun-09
07030005-597	09SC021	Trib. to Sunrise River	10.37	6	40	54	10-Jun-09
07030005-710	09SC023	Trib. to Sunrise River	9.67	6	40	17	11-Jun-09
07030005-723	09SC025	Unnamed ditch (Bloomquist Cr)	56.26	5	50	0	5-Jun-09
HUC 11: 07030005240 Lindstrom							
07030005-574	00SC002	Lawrence Creek	13.05	10	45	93	19-Jun-00
07030005-574	00SC002	Lawrence Creek	13.05	10	45	96	16-Jun-09
07030005-574	00SC002	Lawrence Creek	13.05	10	45	95	29-Jun-09
HUC 11: 07030005250 North Branch Sunrise							
07030005-501	06SC049	Sunrise River, North Branch	10.10	7	40	54	16-Jun-06
07030005-501	98SC008	Sunrise River, North Branch	63.84	5	50	44	9-Jun-09
07030005-501	09SC004	Sunrise River, North Branch	77.73	5	50	67	9-Jun-09
07030005-501	09SC004	Sunrise River, North Branch	77.73	5	50	67	30-Jun-09
07030005-501	09SC017	Sunrise River, North Branch	39.97	7	40	34	10-Jun-09
07030005-501	06SC053	Sunrise River, North Branch	76.19	5	50	66	31-Jul-06
07030005-501	09SC016	Sunrise River, North Branch	13.51	7	40	40	15-Jun-09
07030005-714	09SC018	Hay Creek	6.69	6	40	0	9-Jun-09
HUC 11: 07030005270 Deer Creek							
NONE							
HUC 11: 07030005340 Marine on St. Croix							
07030005-549	99SC008	Old Mill Stream	4.37	10	45	81	20-Aug-99
07030005-904	99SC010	Unnamed Creek (Willow Branch)	0.40	10	45	79	26-Aug-99
07030005-913	99SC011	Unnamed Creek (Gilbertson Creek)	0.02	10	45	49	1-Sep-99

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Threshold	Fish IBI	Visit Date
HUC 11: 07030005360 Big Marine Lake							
07030005-601	09SC033	Trib. to Big Carnelian Lake	22.98	7	40	22	16-Jun-09
07030005-601	09SC033	Trib. to Big Carnelian Lake	22.98	7	40	0	27-Jul-11
HUC 11: 07030005370 Browns Creek							
07030005-520	07SC002	Browns Creek	27.34	10	45	35	2-Jul-07
07030005-520	07SC002	Browns Creek	27.34	10	45	33	29-Jun-09
07030005-520	07SC002	Browns Creek	27.34	10	45	55	8-Jun-09
07030005-520	99SC002	Browns Creek	28.46	10	45	28	22-Jun-99
07030005-520	06SC055	Browns Creek	17.87	10	45	38	16-Aug-06
07030005-520	06SC055	Browns Creek	17.87	10	45	32	7-Jul-06
07030005-520	99SC006	Browns Creek	26.39	10	45	24	24-Jun-99
07030005-587	96SC066	Browns Creek	9.72	3	51	54	15-Jun-07
07030005-587	96SC066	Browns Creek	9.72	3	51	48	15-Jun-09
07030005-587	07SC001	Browns Creek	16.94	3	51	53	15-Jun-07
07030005-587	07SC001	Browns Creek	16.94	3	51	44	2-Jul-07
HUC 11: 07030005410 Stillwater							
07030005-560	99SC003	Valley Creek	12.85	10	45	70	22-Jun-99
07030005-560	99SC003	Valley Creek	12.85	10	45	70	16-Jun-09
07030005-566	09SC039	Valley Creek	3.65	10	45	76	16-Jun-09
07030005-567	99SC004	Trib. to Valley Branch	8.16	10	45	87	24-Jun-99
07030005-567	99SC004	Trib. to Valley Branch	8.16	10	45	86	16-Jun-09
HUC 11: 07030005420 Afton							
07030005-568	96SC092	Trout Brook	5.96	10	45	52	16-Jun-09
07030005-568	99SC001	Trout Brook	8.04	10	45	45	18-Jun-99
HUC 11: 07030005900 Basswood Grove							
07030005-607	99SC018	Trib. to O'Connor's Lake	8.92	3	51	0	22-Sep-99
07030005-607	99SC018	Trib. to O'Connor's Lake	8.92	3	51	0	16-Jun-09

Appendix 4.3 - Biological monitoring results - macroinvertebrate IBI

National Hydrograph Dataset(NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Invert Class	Threshold	Invert IBI	Visit Date
HUC 11: 07030005170 Rock Creek							
07030005-584	96SC022	Rock Creek	53.43	5	36	48	9-Aug-06
07030005-584	06SC023	Rock Creek	50.06	5	36	34	9-Aug-06
07030005-584	06SC023	Rock Creek	50.06	5	36	37	9-Aug-06
07030005-584	07SC004	Rock Creek	43.47	5	36	46	2-Aug-07
07030005-584	09SC002	Rock Creek	54.13	5	36	42	18-Aug-09
07030005-584	09SC002	Rock Creek	54.13	5	36		8-Sep-11
07030005-758	09SC009	Trib. to Rock Creek	11.98	6	47	26	17-Aug-09
HUC 11: 0703000510 Rush Creek							
07030005-509	96SC081	Rush Creek	51.63	6	47	39	15-Sep-99
07030005-509	96SC081	Rush Creek	51.63	6	47	31	4-Oct-00
07030005-509	96SC081	Rush Creek	51.63	6	47	38	25-Sep-01
07030005-509	98SC001	Rush Creek	36.20	5	36	32	30-Aug-99
07030005-509	98SC001	Rush Creek	36.20	5	36	22	25-Sep-01
07030005-509	98SC001	Rush Creek	36.20	5	36		8-Sep-11
07030005-509	98SC002	Rush Creek	42.93	5	36	50	15-Sep-99
07030005-509	98SC002	Rush Creek	42.93	5	36	49	4-Oct-00
07030005-509	98SC002	Rush Creek	42.93	5	36	35	25-Sep-01
07030005-509	98SC003	Rush Creek	45.87	5	36	53	15-Sep-99
07030005-509	98SC003	Rush Creek	45.87	5	36	61	4-Oct-00
07030005-509	98SC003	Rush Creek	45.87	5	36	52	25-Sep-01
07030005-509	98SC004	Rush Creek	56.41	5	36	56	7-Oct-99
07030005-509	98SC004	Rush Creek	56.41	5	36	71	4-Oct-00
07030005-509	98SC004	Rush Creek	56.41	5	36	62	25-Sep-01
07030005-509	98SC004	Rush Creek	56.41	5	36	49	18-Aug-09
HUC 11: 07030005200 Goose Creek							
07030005-510	96SC023	Goose Creek	68.65	6	47	50	8-Aug-07
07030005-510	96SC084	Goose Creek	43.84	5	36	62	2-Sep-99
07030005-510	96SC084	Goose Creek	43.84	5	36	65	4-Oct-00
07030005-510	96SC084	Goose Creek	43.84	5	36	42	8-Aug-07
07030005-510	07SC003	Goose Creek	31.78	6	47	46	8-Aug-07

National Hydrograph Dataset(NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Invert Class	Threshold	Invert IBI	Visit Date
07030005-510	07SC019	Goose Creek	28.99	6	47	43	9-Aug-07
07030005-510	07SC019	Goose Creek	28.99	6	47	36	9-Aug-07
07030005-510	09SC003	Goose Creek	65.72	5	36	61	18-Aug-09
HUC 11: 07030005210 South Branch Sunrise River							
NONE							
HUC 11: 07030005220 West Branch Sunrise River							
07030005-529	09SC005	Sunrise River, West Branch	49.14	6	47	41	17-Aug-09
07030005-561	07SC018	Sunrise River, West Branch	6.40	6	47	38	2-Aug-07
07030005-711	06SC068	County Ditch 16	1.11	6	47	24	1-Aug-07
HUC 11: 07030005230 Sunrise River							
07030005-526	07SC017	Sunrise River	26.21	6	47	40	1-Aug-07
07030005-527	96SC024	Sunrise River	53.24	6	47	54	16-Aug-06
07030005-527	96SC024	Sunrise River	53.24	6	47	42	16-Aug-06
07030005-527	09SC006	Sunrise River	54.14	6	47	38	17-Aug-09
07030005-527	09SC006	Sunrise River	54.14	6	47	34	17-Aug-09
07030005-540	06SC009	Sunrise River	175.11	6	47	71	16-Aug-06
07030005-542	96SC065	Sunrise River	269.36	5	36	52	20-Sep-99
07030005-542	96SC065	Sunrise River	269.36	5	36	71	10-Oct-00
07030005-542	06SC021	Sunrise River	276.05	5	36	57	7-Aug-06
07030005-543	09SC001	Sunrise River	380.52	5	36	63	18-Aug-09
07030005-546	07SC014	County Ditch 3	7.77	9	46	28	2-Aug-07
07030005-710	09SC023	Trib. to Sunrise River	9.67				18-Aug-11
HUC 11: 07030005240 Lindstrom							
07030005-574	00SC002	Lawrence Creek	13.05	9	46	57	17-Aug-09
HUC 11: 07030005250 North Branch Sunrise River							
07030005-501	98SC008	Sunrise River, North Branch	63.84	6	47	0	18-Aug-11
07030005-501	06SC049	Sunrise River, North Branch	10.10	6	47	49	7-Aug-06
07030005-501	06SC053	Sunrise River, North	76.19	6	47	71	3-Aug-06

National Hydrograph Dataset(NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Invert Class	Threshold	Invert IBI	Visit Date
07030005-501	09SC004	Sunrise River, North Branch	77.73	6	47	88	18-Aug-09
07030005-501	09SC016	Sunrise River, North Branch	13.51				8-Sep-11
07030005-501	09SC017	Sunrise River, North	39.97				8-Sep-11
HUC 11: 07030005270 Deer Creek							
NONE							
HUC 11: 07030005340 Marine on St. Croix							
NONE							
HUC 11: 07030005360 Big Marine Lake							
NONE							
HUC 11: 07030005370 Browns Creek							
07030005-520	99SC002	Browns Creek	28.46	9	46	76	23-Sep-08
07030005-520	99SC006	Browns Creek	26.39	9	46	61	23-Sep-08
07030005-520	06SC055	Browns Creek	17.87	9	46	75	11-Aug-06
07030005-520	06SC055	Browns Creek	17.87	9	46	78	11-Aug-06
07030005-520	06SC055	Browns Creek	17.87	9	46	81	23-Sep-08
07030005-520	07SC002	Browns Creek	27.34	9	46	55	1-Aug-07
07030005-520	07SC002	Browns Creek	27.34	9	46	79	14-Aug-09
07030005-520	07SC002	Browns Creek	27.34	9	46	79	14-Aug-09
07030005-587	96SC066	Browns Creek	9.72	5	36	42	1-Aug-07
07030005-587	07SC001	Browns Creek	16.94	5	36	38	1-Aug-07
07030005-587	07SC001	Browns Creek	16.94	5	36	31	23-Sep-08
HUC 11: 07030005410 Stillwater							
07030005-560	99SC003	Valley Creek	12.85	9	46	77	14-Aug-09
07030005-566	09SC039	Valley Creek	3.65	9	46	80	14-Aug-09
07030005-567	99SC004	Trib. to Valley Branch	8.16	9	46	89	14-Aug-09
HUC 11: 07030005420 Afton							
07030005-568	96SC092	Trout Brook	5.96	9	46	72	14-Aug-09
HUC 11: 07030005900 Basswood Grove							
NONE							

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

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

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

Appendix 5.2 - Channelized stream AUID IBI score Fish

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Good	Fair	Poor	FishIBI	Visit Date
HUC 11: 07030005190 Rush Creek									
07030005-695	06SC077	Trib. to Rush Lake	1.50	6	100 - 40	39 - 25	24 - 0	0	25-Jun-07
07030005-680	07SC013	County Ditch 6	2.47	7	100 - 40	39 - 25	24 - 0	0	25-Jun-07
HUC 11: 07030005220 West Branch Sunrise River									
07030005-711	06SC068	County Ditch 16	1.11	6	100 - 40	39 - 25	24 - 0	25	9-Jul-07
HUC 11:07030005230 Sunrise River									
07030005-593	06SC033	Trib. to County Ditch 3	1.86	7	100 - 40	39 - 25	24 - 0	48	22-Jun-06
National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Fish Class	Good	Fair	Poor	FishIBI	Visit Date
HUC 11: 07030005250 North Branch Sunrise River									
07030005-683	07SC015	Trib. to Sunrise River, North Branch	1.26	6	100 - 40	39 - 25	24 - 0	12	28-Jun-07

Appendix 5.3 - Channelized stream AUID IBI score macroinvertebrate

National Hydrograph Dataset (NDH) AUID	Biological Station ID	Stream Segment Name	Drainage Area (mi2)	Invert Class	Good	Fair	Poor	Invert IBI	Visit Date
07030005-593	06SC033	Trib. to County Ditch 3	1.86	6	100-48	47-32	31-0	20	3-Aug-06

Appendix 6.1 – Lake morphometric and assessment data

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	Watershed Area (ha)	% Littoral	HUC-11
13-0069-01	East Rush	Chisago	Lake	Deep	NS	NCHF	603	7.3	2.4	9128	75.8	07030005190
13-0069-02	West Rush	Chisago	Lake	Deep	NS	NCHF	634	12.8	3.8	6203	58.9	07030005190
13-0068-00	Fish	Chisago	Lake	Deep	FS	NCHF	131	17.4	5.0	719	45.8	07030005200
13-0073-00	Horseshoe	Chisago	Lake	Deep	NS	NCHF	91	16.2	4.0	1641	57	07030005200
13-0074-00	Mandall	Chisago	Lake	Deep	IF	NCHF	17	7.6	2.9	1639	66.5	07030005200
13-0079-00	Rabour	Chisago	Lake	Deep	IF	NCHF	19	13.1	3.4	607	73	07030005200
13-0083-01	Goose (North Bay)	Chisago	Lake	Shallow	NS	NCHF	108	16.8	1.5	3760	0	07030005200
13-0083-02	Goose (South Bay)	Chisago	Lake	Deep	NS	NCHF	179	16.8	5.7	3066	0	07030005200
02-0042-00	Coon	Anoka	Lake	Deep	FS	NCHF	720	8.2	2.0	2548		07030005210
13-0023-00	Moody	Chisago	Lake	Deep	NS	NCHF	20	14.6	[3]4.3	[8]937	63.2	07030005210
13-0024-00	Third	Chisago	Lake	Shallow	FS	NCHF	22		[7]1.0	55	100	07030005210
13-0025-00	Second	Chisago	Lake	Shallow	NS	NCHF	26		[7]1.0	248	100	07030005210
13-0042-00	Birch	Chisago	Wetland		NA	NCHF	26	2.4	[7]1.0	[8]3193	100	07030005210
13-0056-00	Heims	Chisago	Lake	Shallow		NCHF	36		[7]1.0	413	100	07030005210
13-0057-00	School	Chisago	Lake	Shallow	NS	NCHF	19	6.1	[3]3.4	[8]3348	0	07030005210
82-0053-00	Sea	Washington	Lake	Shallow	IF	NCHF	20		[3]5.8	1210	0	07030005210
82-0054-00	Bone	Washington	Lake	Deep	NS	NCHF	89	9.1	4.1	4058	59	07030005210
82-0059-00	Goose	Washington	Lake	Deep	NS	NCHF	45	7.6	3.7	[8]209	55.3	07030005210
82-0080-00	Sylvan (Halfbreed)	Washington	Lake	Deep	FS	NCHF	35	10.4	1.5	[4]1380	89.9	07030005210
82-0107-00	Sunfish	Washington	Lake	Shallow	NS	NCHF	24	3.7	[7]1.0	[4]212	100	07030005210
82-0159-00	Forest	Washington	Lake	Deep	FS	NCHF	893	11.0	3.3	[4]3302	33.2	07030005210
82-0162-00	Shields	Washington	Lake	Shallow	NS	NCHF	12	7.9	2.2	[8]218	86.4	07030005210
82-0187-00	Unnamed	Washington	Wetland		NA	NCHF	2		[7]1.0	11	100	07030005210
02-0022-00	Island	Anoka	Lake	Shallow	FS	NCHF	44	6.1	[6]1.7	3029		07030005220
02-0026-00	Linwood	Anoka	Lake	Shallow	NS	NCHF	233	12.8	2.8	2882	84.4	07030005220
02-0034-00	Martin	Anoka	Lake	Shallow	NS	NCHF	90	5.2	2.7	1955	83.3	07030005220
02-0035-00	Fawn	Anoka	Lake	Deep	FS	NCHF	23	7.0	[6]2.0	72	84.5	07030005220
30-0009-00	Typo	Isanti	Lake	Shallow	NS	NCHF	110	1.8	0.8	4882	100	07030005220
13-0029-00	Wallmark	Chisago	Lake	Shallow	NS	NCHF	69	2.1	1.2	9803	100	07030005230
13-0030-00	Vibo	Chisago	Lake	Shallow	NS	NCHF	26		[7]1.0	3227		07030005230
13-0043-00	Mattson	Chisago	Lake	Shallow	IF	NCHF	21		[7]1.0	234	100	07030005230

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	Watershed Area (ha)	% Littoral	HUC-11
13-0044-00	School	Chisago	Lake	Shallow	NS	NCHF	66	1.2	[7]1.0	437	100	07030005230
13-0059-02	Mud Lake	Chisago	Lake	Shallow	IF	NCHF	80		[7]1.0	322	100	07030005230
13-0062-00	Unnamed	Chisago	Wetland		NA	NCHF	10		[7]1.0	75	100	07030005230
13-0011-00	Ogrens	Chisago	Lake	Deep	NS	NCHF	77	12.5	[6]3.9	1626	47.8	07030005240
13-0012-01	Chisago (North Bay)	Chisago	Lake	Deep	FS	NCHF	224	8.2	3.6	9578		07030005240
13-0012-02	Chisago (South Bay)	Chisago	Lake	Shallow	FS	NCHF	198	8.2	1.0	1717		07030005240
13-0013-00	Kroon	Chisago	Lake	Deep	IF	NCHF	81	9.1	2.5	914	78.1	07030005240
13-0014-00	Linn	Chisago	Lake	Shallow	NS	NCHF	73	4.6	[7]1.0	551	100	07030005240
13-0019-00	Spider	Chisago	Lake	Shallow	FS	NCHF	66	2.4	1.0	477	100	07030005240
13-0027-00	South Center	Chisago	Lake	Deep	NS	NCHF	369	33.2	4.4	4367	67.1	07030005240
13-0028-00	South Lindstrom	Chisago	Lake	Deep	FS	NCHF	269	10.4	4.7	7424	42	07030005240
13-0031-00	Sunrise	Chisago	Lake	Shallow	IF	NCHF	328	6.4	1.1	949	96	07030005240
13-0032-01	North Center Lake	Chisago	Lake	Deep	NS	NCHF	309	14.0	2.5	6746		07030005240
13-0032-02	North Center Pond	Chisago	Lake	Shallow	IF	NCHF	2	12.5	[7]1.0	44		07030005240
13-0033-00	Little	Chisago	Lake	Shallow	NS	NCHF	93	7.0	3.0	874	78	07030005240
13-0034-00	Pioneer	Chisago	Lake	Shallow	NS	NCHF	31	2.4	[7]1.0	69	100	07030005240
13-0035-00	North Lindstrom	Chisago	Lake	Deep	FS	NCHF	65	8.8	4.9	6984		07030005240
13-0041-01	Green(Little Green)	Chisago	Lake	Shallow	FS	NCHF	91	8.8	2.2	2344		07030005240
13-0041-02	Green (Main Basin)	Chisago	Lake	Deep	FS	NCHF	603	8.8	3.2	2136		07030005240
13-0046-00	Emily	Chisago	Lake	Shallow	NS	NCHF	8		[7]1.0	55	100	07030005240
13-0047-00	Ellen	Chisago	Wetland		NA	NCHF	8		[7]1.0	2425	100	07030005240
13-0048-00	White Stone	Chisago	Lake	Shallow	NS	NCHF	19		[7]1.0	95	100	07030005240
13-0053-00	Comfort	Chisago	Lake	Deep	IF	NCHF	89	14.3	5.8	12644	41.1	07030005240
13-0054-00	Little Comfort	Chisago	Lake	Deep	IF	NCHF	19	16.5	5.3	[8]4050	44.4	07030005240
13-0154-00	Unnamed	Chisago	Lake	Shallow	IF	NCHF	6		[7]1.0	36		07030005240
13-0066-00	Mud	Chisago	Lake	Shallow	IF	NCHF	29		[7]1.0	1303		07030005250
13-0005-00	Duck	Chisago	Lake	Shallow	FS	NCHF	23		[7]1.0	349	100	07030005340

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	Watershed Area (ha)	% Littoral	HUC-11
82-0014-00	Little Carnelian	Washington	Lake	Deep	FS	NCHF	29	8.8	[6]3.6	[2]420	58.8	07030005340
82-0030-00	Long	Washington	Lake	Shallow	FS	NCHF	36	3.7	[6]1.9	[2]401	100	07030005340
82-0046-00	Square	Washington	Lake	Deep	FS	NCHF	80	20.7	9.0	1350	33.3	07030005340
82-0048-00	Twin	Washington	Lake	Deep	FS	NCHF	14	[2]9.5	[7]2.4	[2]177		07030005340
82-0049-00	Big Carnelian	Washington	Lake	Deep	FS	NCHF	179	20.1	7.6	6630	28.1	07030005340
82-0065-00	Hay	Washington	Lake	Shallow	NS	NCHF	23	[2]2.4	[8]1.2	[8]87	100	07030005340
82-0067-00	Sand	Washington	Lake	Shallow	FS	NCHF	17	5.5	[6]2.5	[2]350	92	07030005340
82-0015-01	Loon (South Basin)	Washington	Wetland		NA	NCHF	3		[7]1.0	159	100	07030005360
82-0015-02	Loon (Main Lake)	Washington	Lake	Shallow	NS	NCHF	21	5.2	[6]1.7	[8]159	100	07030005360
82-0016-00	Silver	Washington	Lake	Shallow	FS	NCHF	34	[2]3.4	[7]1.0	[2]269	100	07030005360
82-0017-00	Carol	Washington	Lake	Shallow	FS	NCHF	38	[2]1.8	[7]1.0	[2]184	100	07030005360
82-0018-00	North Twin	Washington	Lake	Shallow	FS	NCHF	26	[2]1.8	[7]1.0	[2]161	100	07030005360
82-0019-00	South Twin	Washington	Lake	Shallow	NS	NCHF	21	[2]4.0	1.6	[8]34	100	07030005360
82-0025-00	Louise	Washington	Lake	Shallow	NS	NCHF	15	[2]3.7	81.3	[8]89	100	07030005360
82-0026-02	Mud (Main Lake)	Washington	Lake	Shallow	NS	NCHF	34		[8]1.5	[8]129		07030005360
82-0028-00	Staples	Washington	Lake	Shallow	FS	NCHF	6	[2]4.3	[7]1.0	[2]129	100	07030005360
82-0031-00	Terrapin	Washington	Lake	Shallow	FS	NCHF	56	2.0	0.5	833	100	07030005360
82-0033-00	Mays	Washington	Lake	Deep	FS	NCHF	17	6.4	[6]1.5	[2]62	90.1	07030005360
82-0034-00	East Boot	Washington	Lake	Deep	NS	NCHF	18	8.2	1.7	[8]122	84.1	07030005360
82-0035-00	Bass	Washington	Lake	Shallow	FS	NCHF	33	[2]4.3	[7]1.0	[2]469	100	07030005360
82-0036-00	Turtle	Washington	Lake	Shallow	IF	NCHF	25	[2]2.4	[7]1.0	[2]347	100	07030005360
82-0038-00	Unnamed (Maple Marsh)	Washington	Lake	Shallow	IF	NCHF	12		1.2	[2]75	100	07030005360
82-0044-00	West Boot	Washington	Lake	Deep	FS	NCHF	45	10.4	2.9	[2]128	55.8	07030005360
82-0045-00	Clear	Washington	Lake	Shallow	FS	NCHF	17	5.8	[6]1.5	[2]43	91	07030005360

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	Watershed Area (ha)	% Littoral	HUC-11
82-0052-02	Big Marine (Jellums)	Washington	Lake	Shallow	NS	NCHF	25	[2]4.9	[8]1.8	[8]222	100	07030005360
82-0052-04	Big Marine	Washington	Lake	Deep	FS	NCHF	567	18.0	3.5	[2]2121		07030005360
82-0056-00	German	Washington	Lake	Shallow	FS	NCHF	55	[2]2.7	[7]1.0	400	100	07030005360
82-0062-00	Unnamed	Washington	Lake	Shallow	FS	NCHF	7		[7]1.0	19		07030005360
82-0064-00	Fish	Washington	Lake	Shallow	NS	NCHF	26	[2]3.0	1.2	[8]172	100	07030005360
82-0068-00	Long	Washington	Lake	Shallow	NS	NCHF	17	2.1	[6]1.5	[8]89	100	07030005360
82-0076-00	Barker	Washington	Lake	Deep	NS	NCHF	16	5.8	[6]1.5	[2]244		07030005360
82-0077-00	Unnamed (Goggins)	Washington	Lake	Shallow	NS	NCHF	18	[1]2.4	[7]1.0	809	100	07030005360
82-0301-00	Unnamed	Washington	Wetland		NA	NCHF	10		[7]1.0	5666	100	07030005360
82-0020-00	McKusick	Washington	Lake	Shallow	FS	NCHF	28	3.8	[7]1.0	2671	100	07030005370
82-0021-00	Long	Washington	Lake	Shallow	NS	NCHF	39	6.7	1.4	770	95.5	07030005370
82-0042-00	Lynch	Washington	Lake	Shallow	NS	NCHF	18	[1]4.0	[7]1.0	220	100	07030005370
82-0120-00	Benz	Washington	Lake	Shallow	NS	NCHF	14	[1]2.1	[7]1.0	79	100	07030005370
82-0123-00	Bass	Washington	Lake	Shallow	FS	NCHF	11	[1]2.7	[7]1.0	294	100	07030005370
82-0124-00	Unnamed	Washington	Lake	Shallow	FS	NCHF	8	[1]3.7	[7]1.0	380	100	07030005370
82-0125-00	Pat	Washington	Lake	Shallow	FS	NCHF	5	[1]4.3	[7]1.0	486	100	07030005370
82-0126-00	Masterman	Washington	Lake	Shallow	FS	NCHF	15	[1]2.1	[7]1.0	169	100	07030005370
82-0128-00	Unnamed	Washington	Lake	Shallow	IF	NCHF	8	2.4	[7]1.0	59	100	07030005370
82-0132-00	Wood Pile	Washington	Lake	Shallow	FS	NCHF	5	5.2	[6]1.3	49	94.5	07030005370
82-0148-00	Plaisted	Washington	Lake	Shallow	NS	NCHF	18	[1]2.7	[7]1.0	301	100	07030005370
82-0151-00	South School Section	Washington	Lake	Deep	NS	NCHF	38	7.9	3.0	808		07030005370
82-0318-00	Unnamed	Washington	Wetland		NA	NCHF	5	[1]2.3	[7]1.0	45	100	07030005370
82-0333-00	Unnamed - Kismet Basin	Washington	Lake	Shallow	FS	NCHF	7		[7]1.0	77	100	07030005370

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	[10]Watershed Area (ha)	% Littoral	HUC-11
82-0334-00	Unnamed	Washington	Lake	Shallow	FS	NCHF	4	[1]1.8	[7]1.0	109	100	07030005370
62-0001-00	Silver (East)	Ramsey	Lake	Shallow	FS	NCHF	28	5.5	1.8	[4]176	98.1	07030005410
82-0001-00	St. Croix	Washington	Lake	Deep	NS	WCBP/NCHF	3306	23.8	8.7	1734274		07030005410
82-0004-00	Edith	Washington	Lake	Deep	FS	NCHF	38	11.6	[6]4.5	[4]637	52.1	07030005410
82-0005-00	Unnamed	Washington	Wetland		NA	NCHF	4		[7]1.0	[4]1108		07030005410
82-0009-00	Cloverdale	Washington	Lake	Deep	FS	NCHF	14	8.5	[4]3.0	[4]331		07030005410
82-0010-00	Mcdonald	Washington	Lake	Shallow	IF	NCHF	16	[4]4.0	[4]1.8	[4]425	100	07030005410
82-0011-00	Unnamed	Washington	Lake	Shallow	NS	NCHF	7	[4]1.0	[7]1.0	[4]344	100	07030005410
82-0023-00	Lily	Washington	Lake	Shallow	NS	NCHF	17	15.5	5.4	239	55	07030005410
82-0101-00	Demontreville	Washington	Lake	Deep	FS	NCHF	59	7.3	[4]2.3	[4]448	90	07030005410
82-0102-00	Mud	Washington	Lake	Shallow	FS	NCHF	20	[4]3.0	[4]0.7	[4]120	100	07030005410
82-0103-00	Olson	Washington	Lake	Shallow	FS	NCHF	34	4.4	2.3	[4]81	100	07030005410
82-0104-00	Jane	Washington	Lake	Deep	FS	NCHF	57	11.9	4.0	[4]567	72	07030005410
82-0106-00	Elmo	Washington	Lake	Deep	FS	NCHF	118	38.7	10.7	[4]482	20.9	07030005410
82-0108-00	Friedrich Pond	Washington	Wetland		NA	NCHF	7		[7]1.0	[4]146	100	07030005410
82-0109-00	Eagle Point	Washington	Lake	Shallow	NS	NCHF	58	[4]1.8	[4]0.9	[4]882	100	07030005410
82-0110-00	Downs	Washington	Lake	Shallow	NS	NCHF	13	[4]2.1	[4]1.5	[4]947	100	07030005410
82-0112-00	Rose	Washington	Lake	Shallow	IF	NCHF	7		[7]1.0	[4]267	100	07030005410
82-0113-01	Goose (North)	Washington	Lake	Shallow	NS	NCHF	2	[4]1.5	[7]1.0	[4]302	100	07030005410
82-0113-02	Goose (South)	Washington	Lake	Shallow	NS	NCHF	15	[4]2.1	[7]1.0	[4]302	100	07030005410
82-0117-00	Kramer	Washington	Lake	Shallow	NS	NCHF	8	[4]1.4	[7]1.0	[4]173	100	07030005410
82-0118-00	Long	Washington	Lake	Deep	FS	NCHF	25	10.4	[4]3.6	[4]833		07030005410
82-0119-00	Unnamed	Washington	Lake	Shallow	FS	NCHF	7	[4]1.5	[7]1.0	[4]57	100	07030005410
82-0133-00	Sunnybrook	Washington	Lake	Shallow	FS	NCHF	6	[4]6.1	[4]2.0	[4]425		07030005410

LAKE_ID	Lake Name	County	Type	Standard	[9]Aquatic Recreation Use Support	Ecoregion	Lake Area (ha)	Maximum Depth (m)	Mean Depth (m)	Watershed Area (ha)	% Littoral	HUC-11
82-0135-00	Unnamed	Washington	Lake	Shallow	NS	NCHF	12	[4]1.8	[4]0.8	[4]78	100	07030005410
82-0308-00	Brick Pond	Washington	Lake	Shallow	IF	NCHF	4	[5]1.5	[7]1.0	38	100	07030005410
82-0313-00	Unnamed (Goetschel)	Washington	Lake	Shallow	FS	NCHF	4	[4]4.3	[4]1.2	[4]1138	100	07030005410
82-0365-00	Unnamed	Washington	Lake	Shallow	FS	NCHF	5		[7]1.0	[4]72	100	07030005410
82-0368-00	Klawitter Pond	Washington	Wetland		NA	NCHF	1		[7]1.0	[4]68	100	07030005410
82-0385-00	Deer Pond	Washington	Wetland		NA	NCHF	2		[7]1.0	2023	100	07030005410
82-0399-00	Beutel's Pond	Washington	Wetland		NA	NCHF	2		[7]1.0	[4]618	100	07030005410
82-0462-00	Legion Pond	Washington	Wetland		NA	NCHF	6		[7]1.0	[4]90	100	07030005410
82-0488-00	Unnamed	Washington	Wetland		NA	NCHF	1		[7]1.0	[4]461	100	07030005410
82-0514-00		Washington	Wetland		NA	NCHF	3		[7]1.0	13395	100	07030005410
82-0002-00	O'Connors	Washington	Wetland		NA	WCBP	5	3.8	[6]1.1	2484	100	07030005900

1. Area or depth information from the Brown's Creek Watershed District
2. Area or depth information from the Carnelian Marine St. Croix Watershed Management Organization
3. Area or depth information from the Comfort Lake Forest Lake Watershed District
4. Area or depth information from the Valley Branch Watershed District
5. Area or depth information from the Middle St. Croix Watershed Management Organization
6. Area or depth information calculated by MPCA
7. Area or depth information estimated by MPCA
8. Area or depth information determined via a Total Maximum Daily Load study.
9. NS = not supporting, FS = supporting, IF = insufficient information to determine support, NA = not assessed (too small or wetland-like)
10. Watershed area reported includes lake area

Appendix 6.2 – MINLEAP modeling results[1]

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
02-0022-00	Island	30	91	11.3	48	1.5	0.8	151	588		40	3.90	0.2	8.86
02-0026-00	Linwood	45	49	27.7	20	1.0	1.3	164	580		70	3.54	1.8	1.52
02-0034-00	Martin	105	60	56.5	26	0.9	1.1	157	386		62	2.46	1.0	2.73
02-0035-00	Fawn	22	36	6.1	12	4.4	1.8	224	16		84	0.07	6.3	0.32
02-0042-00	Coon	37	37	7.0	13	1.9	1.7	213	568		82	2.66	5.4	0.37
13-0005-00	Duck	47	74	5.8	35	2.0	0.9	161	69		54	0.43	0.5	1.88
13-0011-00	Ogrens	55	81	27.9	40	1.1	1.1	150	315		46	2.10	0.3	12.34
13-0012-01	Chisago (North Bay)	34	66	27.2	30	2.0	1	152	1867	18.8	56	12.25	0.7	5.44
13-0012-02	Chisago (South Bay)	58	64	31.0	29	1.4	1.1	171	352		63	2.05	1.0	1.04
13-0013-00	Kroon	37	50	25.5	20	1.5	1.3	165	185	22.6	70	1.12	1.8	1.38
13-0014-00	Linn	218	62	97.3	27	0.4	1.1	175	114		65	0.65	1.1	0.89
13-0019-00	Spider	53	61	14.5	27	1.1	1.1	176	99		65	0.56	1.2	0.85
13-0023-00	Moody	167	65	63.7	29	0.7	1.1	152	182		57	1.20	0.7	6.00
13-0024-00	Third	27	46	1.5	18	1.9	1.4	250	13		82	0.05	4.3	0.24
13-0025-00	Second	77	66	29.3	30	0.6	1.0	169	51		61	0.30	0.9	1.15
13-0027-00	South Center	50	41	41.8	15	1.2	1.6	165	880	17.6	75	5.34	3.0	1.45
13-0028-00	South Lindstrom	30	53	24.2	22	2.3	1.3	155	1457	17.4	66	9.41	1.3	3.50
13-0029-00	Wallmark	397	109	177.9	63	0.6	0.7	149	1893	23.9	27	12.68	0.1	18.38
13-0030-00	Vibo	516	110	82.0	63	0.4	0.7	150	624		26	4.17	0.1	16.05
13-0031-00	Sunrise	40	46	22.0	18	1.6	1.4	232	218		80	0.94	3.8	0.29
13-0032-01	North Center Lake	72	62	50.4	27	1.0	1.1	157	1331	21.1	61	8.50	0.9	2.79
13-0033-00	Little	173	44	1568.6	16	0.7	1.5	169	178	16.9	74	1.05	2.7	1.13
13-0034-00	Pioneer	315	45	95.3	17	0.4	1.5	269	17		83	0.06	5.0	0.20

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
13-0035-00	North Lindstrom	28	78	16.3	38	1.9	0.9	150	1351		48	9.02	0.4	13.88
13-0041-01	Green(Little Green)	39	67	15.0	31	1.4	1.0	155	461		57	2.97	0.7	3.26
13-0041-02	Green (Main Basin)	35	30	32.2	10	2.0	2.1	213	476		86	2.23	8.6	0.37
13-0042-00	Birch	110	110	47.8	63	1.4	0.7	150	617		26	4.13	0.1	15.88
13-0043-00	Mattson	24	68	3.9	32	1.5	1.0	166	47		59	0.29	0.7	1.36
13-0044-00	School	215	60	80.2	26	0.4	1.1	179	91		67	0.51	1.3	0.77
13-0046-00	Emily	337	60	152.1	26	0.3	1.1	178	11		66	0.06	1.2	0.80
13-0047-00	Ellen	94	122	20.2	73	0.8	0.6	149	468		18	3.15	< 1 month	39.33
13-0048-00	White Stone	98	55	66.8	23	0.6	1.2	191	20		71	0.11	1.8	0.56
13-0053-00	Comfort	34	80	15.4	40	1.7	0.9	149	2442		46	16.36	0.3	18.38
13-0054-00	Little Comfort	44	90	11.1	47	1.6	0.8	149	781		40	5.25	0.2	27.63
13-0056-00	Heims	37	69	15.4	32	0.5	1.0	165	83		58	0.50	0.7	1.40
13-0057-00	School	63	95	38.8	51	1.2	0.8	149	646		36	4.33	0.1	22.81
13-0062-00	Unnamed	49	62	5.9	27	0.9	1.1	175	16		65	0.09	1.1	0.89
13-0066-00	Mud	31	94	4.5	50	1.5	0.8	152	254		39	1.67	0.2	5.75
13-0068-00	Fish	22	29	7.3	9	2.6	2.1	187	152	21.2	85	0.82	8.0	0.62
13-0069-01	East Rush	82	56	35.3	23	1.3	1.2	161	1821	28	65	11.32	1.3	1.88
13-0069-02	West Rush	72	40	50.3	15	1.4	1.6	168	1262	23.9	76	7.49	3.2	1.18
13-0073-00	Horseshoe	53	49	26.3	19	1.3	1.4	159	326	22.9	69	2.05	1.8	2.25
13-0083-01	Goose (North Bay)	170	80	84.1	40	0.7	0.9	153	735	31.9	48	4.79	0.3	4.40
13-0083-02	Goose (South Bay)	54	42	15.4	15	1.7	1.5	159	609	21.6	74	3.82	2.7	2.14
30-0009-00	Typo	284	98	167.1	53	0.2	0.7	152	951		36	6.25	0.1	5.68
62-0001-00	Silver (East)	41	47	11.9	18	1.9	1.4	181	37	25	74	0.20	2.5	0.73
82-0002-00	O'Connors	55	430	18.2	462	1.2	0.2	570	1838		25	3.23	< 1 month	64.51
82-0004-00	Edith	23	45	6.4	17	2.1	1.4	160	127		71	0.79	2.2	2.09
82-0005-00	Unnamed	211	121	6.8	73	0.6	0.6	149	214		19	1.44	< 1 month	35.92

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
82-0009-00	Cloverdale	36	59	11.8	26	2.4	1.1	156	65		62	0.42	1	2.99
82-0010-00	Mcdonald	52	72	48.2	34	1.4	1	155	83		54	0.54	0.5	3.36
82-0011-00	Unnamed	393	95	258.3	51	0.4	0.8	152	67		37	0.44	0.2	6.28
82-0014-00	Little Carnelian	15	47	2.8	18	5.9	1.4	161	84		71	0.52	2.0	1.79
82-0015-01	Loon (South Basin)	100	79	45.7	39	1.2	0.9	158	31		50	0.20	0.4	2.49
82-0015-02	Loon (Main Lake)	137	51	112.8	21	0.5	1.3	175	33		71	0.19	1.9	0.90
82-0016-00	Silver	54	62	15.2	28	1.9	1.1	174	55		64	0.32	1.1	0.94
82-0017-00	Carol	33	55	9.3	23	1.1	1.2	193	39		72	0.20	1.9	0.54
82-0018-00	North Twin	30	59	7.0	25	1.2	1.2	181	34		68	0.19	1.4	0.72
82-0019-00	South Twin	73	33	34.4	11	1.2	1.9	359	9		91	0.02	14.0	0.11
82-0020-00	Mckusick	65	106	15.9	60	2.1	0.7	150	517		29	3.45	0.1	12.31
82-0021-00	Long	81	71	45.8	34	1.0	1	158	152		55	0.96	0.6	2.47
82-0023-00	Lily	44	40	14.6	14	2.0	1.6	162	48		75	0.30	3.1	1.74
82-0025-00	Louise	148	52	55.6	21	0.9	1.3	183	19		71	0.10	1.9	0.68
82-0026-02	Mud (Main Lake)	158	33	155.5	11	0.8	1.9	403	35		92	0.09	15.9	0.09
82-0028-00	Staples	30	80	8.2	40	2.7	0.9	157	25		49	0.16	0.4	2.71
82-0030-00	Long	45	55	10.8	23	2.2	1.2	166	81		67	0.49	1.4	1.36
82-0031-00	Terrapin	30	89	3.5	46	3.1	0.8	161	166		45	1.03	0.3	1.84
82-0033-00	Mays	14	43	2.6	16	5.6	1.5	211	14		80	0.07	3.9	0.38
82-0034-00	East Boot	45	49	24.7	19	2.2	1.3	178	25		72	0.14	2.1	0.79
82-0035-00	Bass	38	73	12.6	34	2.1	1.0	162	94		55	0.58	0.6	1.76
82-0036-00	Turtle	83	72	9.1	34	1.3	1.0	162	69		55	0.43	0.6	1.71
82-0038-00	Unnamed (Maple Marsh)	180	55	84.6	23	0.9	1.2	181	16		70	0.09	1.6	0.73
82-0042-00	Lynch	392	70	393.4	33	0.2	1.0	164	44		57	0.27	0.7	1.50
82-0044-00	West Boot	20	29	3.8	9	3.9	2.1	233	30		87	0.13	10.3	0.28

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
82-0045-00	Clear	19	39	2.9	14	5.8	1.7	246	10		84	0.04	6.1	0.25
82-0046-00	Square	14	34	2.9	12	5.6	1.8	159	268		78	1.68	4.3	2.10
82-0048-00	Twin	17	52	4.5	21	4.6	1.3	163	36		68	0.22	1.5	1.55
82-0049-00	Big Carnelian	21	49	6.6	20	3.8	1.3	153	1295		0.68	8.46	1.6	4.73
82-0052-02	Big Marine (Jellums)	91	52	60.0	21	1.0	1.3	171	45		69	0.27	1.7	1.06
82-0052-04	Big Marine	26	29	7.5	9	3.0	2.1	209	469		86	2.25	8.8	0.40
82-0053-00	Sea	80	64	24.0	28	1.0	1.1	151	235		58	1.56	0.7	7.78
82-0054-00	Bone	52	65	28.2	29	1.3	1.1	152	790		57	5.20	0.7	5.84
82-0056-00	German	27	61	5.1	27	2.1	1.1	176	83		65	0.47	1.2	0.86
82-0059-00	Goose	60	31	40.9	10	1.6	2.0	195	45		84	0.23	7.2	0.51
82-0062-00	Unnamed	26	48	4.9	19	2.8	1.4	234	5		80	0.02	3.6	0.28
82-0064-00	Fish	106	56	68.5	23	0.9	1.2	179	36		69	0.20	1.6	0.77
82-0065-00	Hay	78	47	45.9	19	1.4	1.4	208	19		77	0.09	3.0	0.40
82-0067-00	Sand	47	60	23.8	26	1.9	1.1	157	69		62	0.44	1.0	2.59
82-0068-00	Long	71	48	47.4	19	1.1	1.4	189	19		75	0.10	2.5	0.59
82-0076-00	Barker	103	65	57.1	29	1.1	1.1	161	49		59	0.30	0.8	1.89
82-0077-00	Unnamed (Goggins)	100	94	45.4	50	0.9	0.8	152	158		39	1.04	0.2	5.76
82-0080-00	Halfbreed	20	83	3.0	42	4.8	0.9	153	269		46	1.76	0.3	5.04
82-0101-00	Demontreville	31	45	12.6	17	2.8	1.4	175	93		74	0.53	2.6	0.9
82-0102-00	Mud	45	66	12.0	30	0.6	1.0	183	25		64	0.14	1.0	0.69
82-0103-00	Olson	24	31	9.2	10	2.8	2.0	258	19		88	0.07	10.5	0.22
82-0104-00	Jane	14	40	3.1	14	4.4	1.6	168	115		76	0.69	3.3	1.21
82-0106-00	Elmo	20	18	2.5	4	3.9	3.2	203	105		91	0.52	24.3	0.44
82-0107-00	Sunfish	63	64	37.8	29	0.6	1.1	171	43		62	0.25	0.9	1.06
82-0108-00	Friedrich Pond	354	79	68.9	39	0.4	0.9	157	29		49	0.18	0.4	2.60
82-0109-00	Eagle Point	488	76	56.7	37	0.5	0.9	161	176		53	1.09	0.5	1.89

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
82-0110-00	Downs	173	94	85.0	50	0.3	0.8	151	183		37	1.22	0.2	9.37
82-0112-00	Rose	124	91	116.0	48	0.5	0.8	153	52		41	0.34	0.2	4.87
82-0113-01	Goose (North)	325	113	246.1	66	0.3	0.7	149	58		24	0.39	0.1	19.48
82-0113-02	Goose (South)	206	79	177.9	39	0.3	0.9	158	60		50	0.38	0.4	2.53
82-0117-00	Kramer	496	80	175.2	40	0.5	0.9	157	34		49	0.22	0.4	2.71
82-0118-00	Long	32	62	14.1	27	2.4	1.1	154	163		60	1.06	0.8	4.25
82-0119-00	Unnamed	55	63	5.4	28	1.0	1.1	173	12		64	0.07	1.0	0.97
82-0120-00	Benz	163	57	70.1	24	0.9	1.2	185	17		69	0.09	1.6	0.64
82-0123-00	Bass	38	84	12.8	43	2.2	0.8	155	58		46	0.37	0.3	3.38
82-0124-00	Unnamed	55	95	26.8	51	2.0	0.8	152	74		38	0.49	0.2	6.09
82-0125-00	Pat	63	106	15.0	60	1.5	0.7	150	94		29	0.63	0.1	12.55
82-0126-00	Masterman	53	69	15.3	32	1.9	1.0	166	34		59	0.21	0.7	1.37
82-0132-00	Wood Pile	51	60	17.1	26	2.0	1.1	169	10		64	0.06	1.1	1.16
82-0133-00	Sunnybrook	33	88	7.4	46	2.2	0.8	151	82		41	0.55	0.2	9.10
82-0135-00	Unnamed	70	64	93.8	29	0.7	1.1	180	16		64	0.09	1.1	0.76
82-0148-00	Plaisted	91	76	52.0	37	1.2	0.9	160	60		53	0.38	0.5	2.08
82-0151-00	South School Section	56	57	34.0	24	1.7	1.2	157	159		64	1.01	1.1	2.67
82-0159-00	Forest	34	30	17.9	10	1.6	2.1	210	731		86	3.49	8.4	0.39
82-0162-00	Shields	246	61	46.0	26	1.2	1.1	159	43		62	0.27	1.0	2.27
82-0187-00	Unnamed	202	57	179.7	24	0.5	1.2	187	2		70	0.01	1.6	0.63
82-0301-00	Unnamed	90	128	31.8	79	1.6	0.6	148	1091		13	7.36	< 1 month	73.56
82-0308-00	Brick Pond	118	66	6.9	30	1.1	1.0	169	8		61	0.05	0.9	1.15
82-0313-00	Unnamed (Goetschel)	37	119	6.7	71	1.6	0.6	149	219		20	1.47	< 1 month	36.86
82-0318-00	Unnamed	214	65	197.0	29	0.6	1.1	170	9		62	0.05	0.9	1.08
82-0333-00	Unnamed - Kismet Basin	43	68	25.8	31	2.0	1.0	166	16		59	0.09	0.7	1.34

Lake ID	Lake Name	Obs TP	MINLEAP TP	Obs Chl-a	MINLEAP Chl-a	Obs Secchi	MINLEAP Secchi	Average TP Inflow	TP Load	Back-ground TP	P Retention	Outflow	Residence Time	Areal Load
82-0334-00	Unnamed	50	85	26.8	43	1.3	0.8	155	21		45	0.14	0.3	3.45
82-0365-00	Unnamed	77	73	17.1	34	1.0	1.0	162	14		55	0.09	0.6	1.76
82-0368-00	Klawitter Pond	118	100	34.9	55	0.7	0.7	151	13		33	0.09	0.1	8.62
82-0399-00	Beutel's Pond	61	122	4.6	74	0.7	0.6	149	119		18	0.8	< 1 month	40.08
82-0462-00	Legion Pond	118	74	48.8	35	0.8	0.9	161	18		54	0.11	0.5	1.86
82-0488-00	Unnamed	82	126	21.7	77	1.5	0.6	148	89		15	0.6	< 1 month	59.71
82-0514-00	Unnamed	227	141	96.6	91	0.6	0.5	148	2578		5	17.41	< 1 month	580.36

1. The MINLEAP model was run with best available data found in Appendix A. There was not a comprehensive stormwater GIS layer to determine accurate watersheds with for many of the lakes at the time of this report. Several of the lakes likely have inaccurate results due to poor estimates of mean depth or watershed area. This should be taken into consideration when using the data from Appendix B.

Appendix 6.3 – TMDLs/Lake Management Plans/ WD/ WMO Links

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/st.-croix-river-basin-tmdl/project-carnelian-marine-st-croix-wd-lakes-excess-nutrients.html Minnesota's Impaired Waters and TMDLs
Project: Carnelian-Marine St. Croix WD Lakes TMDL — Excess Nutrients

http://cmscwd.org/ Carnelian-Marine St Croix WD

Lake Name Lake ID Year Listed Target Start/Completion

East Boot 82-0034-00 2004 2011/2015

Fish 82-0064-00 2004 2011/2015

Goose 82-0059-00 2002 2011/2015

Hay 82-0065-00 2002 2011/2015

Jellum's 82-0052-02 2004 2011/2015

Long 82-0068-00 2004 2011/2015

Loon 82-0015-02 2004 2011/2015

Louise 82-0025-00 2004 2011/2015

Mud (Main Lake) 82-0026-02 2010 2008/2012

South Twin 82-0019-00 2006 2012/2016

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/st.-croix-river-basin-tmdl-projects/project-lake-st-croix-excess-nutrients.html

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/st.-croix-river-basin-tmdl-projects/project-martin-typo-lakes-excess-nutrients.html?menuid=&redirect=1

http:/www.srwmo.org/

TMDL Project: Comfort Lake-Forest Lake Watershed District Impaired Lakes - Excess Nutrients

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/st.-croix-river-basin-tmdl-projects/project-comfort-lake-forest-lake-watershed-district-impaired-lakes-excess-nutrients.html

Lake name: **Moody Lake Bone Lake School Lake Shields Lake Comfort Lake**

DNR ID#: 13-0023-00 82-0054-00 13-0057-00 82-0162-00 13-0053-00

http://www.clflwd.org/

Minnesota's Impaired Waters and TMDLs

Project: Chisago Lakes TMDL - Nutrient/Eutrophication Biological Indicators – TMDL underway
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl-projects/chisago-lakes-tmdl-nutrient/eutrophication-biological-indicators-tmdl-project.html

Lake summary sheets

North Center	Lake South Center Lake	Lake Emily	Kroon Lake
Linn Lake	Little Lake	Ogren's Lake	
Pioneer Lake	School Lake	Wallmark Lake	

http://www.bcwd.org/ Brown's Creek

http://www.mscwmo.org/ Middle St. Croix WMO

http://www.swwdmn.org/ South Washington WD

http://www.vbwd.org/ Valley Branch WD