# Mississippi River Lake Pepin Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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## Authors

**MPCA Watershed Report Development Team**
Bryan Spindler, Pam Anderson, Justin Watkins, Dan Hewig, Tiffany Schauls, Bruce Monson and Kris Parson

## Contributors

**Citizen Lake Monitoring Program Volunteers**
Citizen Stream Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture



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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 Mississippi River Lake Pepin watershed. The results of surface water monitoring activities in the Mississippi River Lake Pepin watershed are reported here. Subsequent reports will explain stressor identification, Total Maximum Daily Loads (TMDLs), and restoration and protection plans for the watershed.

The Mississippi River Lake Pepin watershed includes 205,747 acres that drain several small, coldwater streams in bedrock-dominated bluff country and karst topography. The largest of these streams is Wells Creek (45,954 acres), which winds through 18 miles of bluff lands and joins the Mississippi near Old Frontenac, southeast of Red Wing. Hay Creek is a popular trout stream (30,405 acres) that flows from south to north, joining the Cannon River bottoms at Red Wing. Three other named streams are all designated trout waters, and drain directly to the Mississippi River: Bullard Creek (10,245 acres), Gilbert Creek (16,007 acres), Miller Creek (11,168 acres).

The Mississippi River Lake Pepin watershed consists of forests, bluff lands and cultivated lands. The top of the watershed is rolling cropland interspersed by many small tributaries that drop steeply through forested valleys with scattered prairies atop cliffs. Since European settlement in the 1860s, the tributaries in the Mississippi River Lake Pepin Watershed have undergone considerable land use modification, including the plowing of its native prairies, harvesting of its hardwood forests, draining of its wetlands and modifications to its natural stream courses. The hydrology of the watershed has been dramatically altered by land cover changes brought about by settlement. These land use changes have caused an increase in high peak stream flows during rain events and lower water levels during low flow time periods. Base flow in Wells Creek is supported year round by groundwater recharge (Anderson 1975). Agriculture practices account for the majority of land use activities within the watershed. Corn and soybeans make up over half the tilled acreage of the area, with barley, oats and pasture land present. The watershed's wealth of surface waters is a valuable resource for aquatic recreation and its health is essential to resident aquatic life.

In 2008 the Minnesota Pollution Control Agency (MPCA) undertook an intensive watershed monitoring effort of the Mississippi River Lake Pepin Watershed's surface waters. Fourteen (14) sites were sampled for biology at the outlets of variable sized sub-watersheds within the Mississippi River Lake Pepin tributaries. Data from eight previously sampled sites were also included in the assessment of the watershed. These locations included the mouth of Wells Creek, the outlets of the other tributaries (Hay Creek, Gilbert Creek, Miller Creek) and the outlets of headwater tributaries. The MPCA completed stream water chemistry sampling at the outlets of the Mississippi River Lake Pepin six major subwatersheds. In 2010, a holistic approach was taken to assess all of the watershed's surface water bodies for aquatic life, recreation and fish consumption use support, where data was available. Eleven streams reaches were sampled for fish, and ten stream reaches were sampled for macroinvertebrates in the Mississippi River Lake Pepin Watershed during the assessment window. Nine (9) streams were assessed for aquatic life support and no lakes (there are no lakes in the watershed) were assessed for aquatic recreation in this effort. Two stream reaches were unable to be assessed due to insufficient data or a modified channel condition.

Eight stream reaches were found to be fully supporting of aquatic life use in the Mississippi River Lake Pepin Watershed. The only new aquatic biological impairment was found on Gilbert Creek for fish. There is also an existing turbidity impairment on Hay Creek; however, data assessed during the current cycle indicated improved turbidity conditions. More turbidity sampling should be conducted in order to determine if delisting is possible. Habitat assessments also indicate mostly good to fair habitat conditions. Only one site on Gilbert Creek had poor habitat conditions. Land use modification, hydrologic changes and lack of habitat may be contributing factors to the observed poor water quality conditions. Most areas of the watershed have shown more resilience to disturbance, but additional monitoring, restoration, and protection strategies should be implemented to improve conditions and attain water quality standards for all parameters in the Mississippi River Lake Pepin Watershed.

There are five new aquatic recreation impairments based on E. coli in the Mississippi River Lake Pepin watershed. Agriculture is the primary land use in the watershed (approximately 63 percent). Aquatic consumption assessments indicate that there are no impairment issues for contaminants in fish tissue in the watershed.

Overall the health of the Mississippi River Lake Pepin watershed is good for fish (except for Gilbert Creek), macroinvertebrate communities, and consumption of fish tissue. E. coli and turbidity should be monitored closely in the watershed as these parameters may indicate that there is some stress due to land practices that may be affecting the health of this valuable watershed.

# 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. The MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) requiring states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of water bodies that do not meet established standards. Such waters are referred to as "impaired waters," and the state must take appropriate actions to restore these waters, including the development of TMDLs. A TMDL is a comprehensive study identifying all pollution sources causing or contributing to impairment and the reductions needed to restore a water body so that it can support its designated use.

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

The passage of Minnesota's Clean Water Legacy Act (CWLA) of 2006 provided a policy framework and the initial resources to state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. Funding from the Clean Water Fund 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 Mississippi River Lake Pepin watershed beginning in the summer of 2008. This report provides a summary of all water quality assessment results in the Mississippi River Lake Pepin watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units. Consequently, there is an opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. A watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and non-point sources of pollution, and further the CWA goal of protecting, restoring, and preserving the quality of Minnesota's water resources.

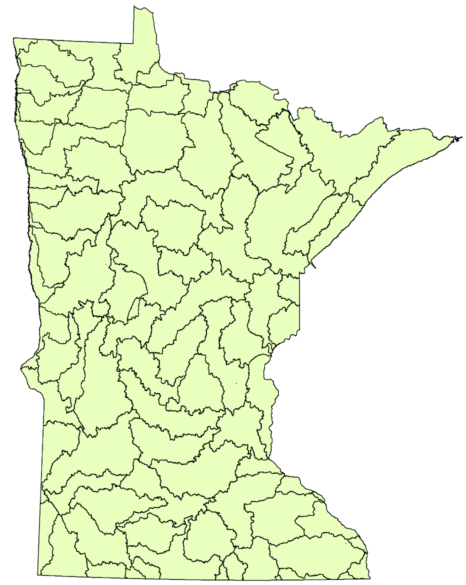

**Figure 1. Major watershed within Minnesota (8-Digit HUC)**

# 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).

## Load monitoring network

The first component of this effort is the Major Watershed Load Monitoring Program (MWLMP), 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). MWLMP 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 MWLMP'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 MWLMP 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 79 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

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 Mississippi River Lake Pepin watershed).

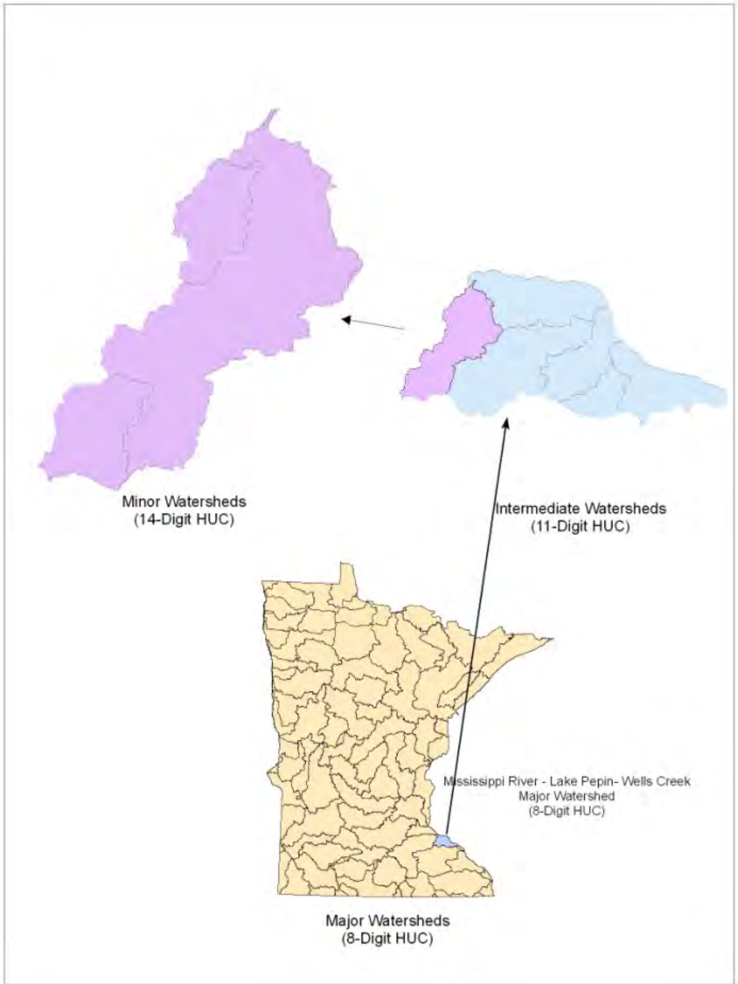


**Figure 2. The intensive watershed monitoring design**

Typically, the outlet site of the major watershed is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation, and aquatic consumption use support. However, considering these streams are trout streams, a special effort was made to collect fish contaminant samples from Hay and Wells Creeks (purple dots in Figure 3) instead of being located near the outlet site. Each 11-HUC outlet (green 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 (red dots in Figure 3). Specific locations for sites sampled as part of the intensive monitoring effort in the Mississippi River Lake Pepin watershed can be found in Appendix 4.

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. The only lake in the Mississippi River Lake Pepin watershed is

Lake Pepin. Due to the size and complexity of this basin and the ongoing work developing a TMDL, Lake Pepin is outside of the scope of this document. More information can be found at: http://www.pca.state.mn.us/mvri97f.

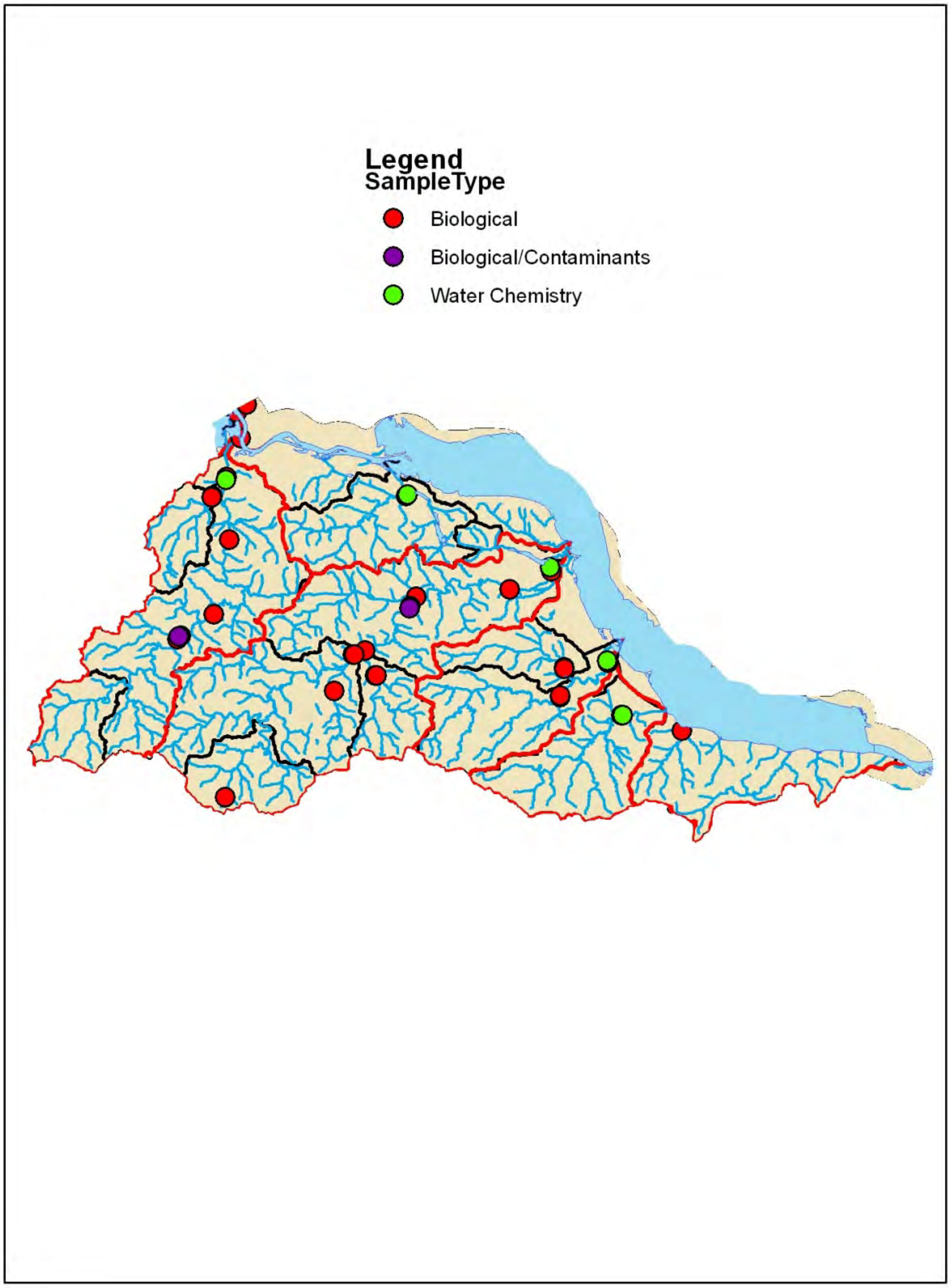


**Figure 3. Intensive watershed monitoring stream stations in the Mississippi River Lake Pepin watershed**

## Citizen and local monitoring

Citizen monitoring is an important component of the watershed monitoring approach. The MPCA coordinates two programs aimed at encouraging citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, sustained citizen monitoring can provide the long-term picture needed to help evaluate current status and trends. The advance identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites, so that water quality data 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 were used for assessment in the Mississippi River Lake Pepin watershed.

The MPCA also passes through funding via Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits, and educational institutions to monitor lake and stream water quality. 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.

For the Mississippi River Lake Pepin watershed, citizen involvement was limited to stream monitoring and monitoring transparency on Lake Pepin. No grants were awarded in this watershed and MPCA staff collected the water chemistry data.

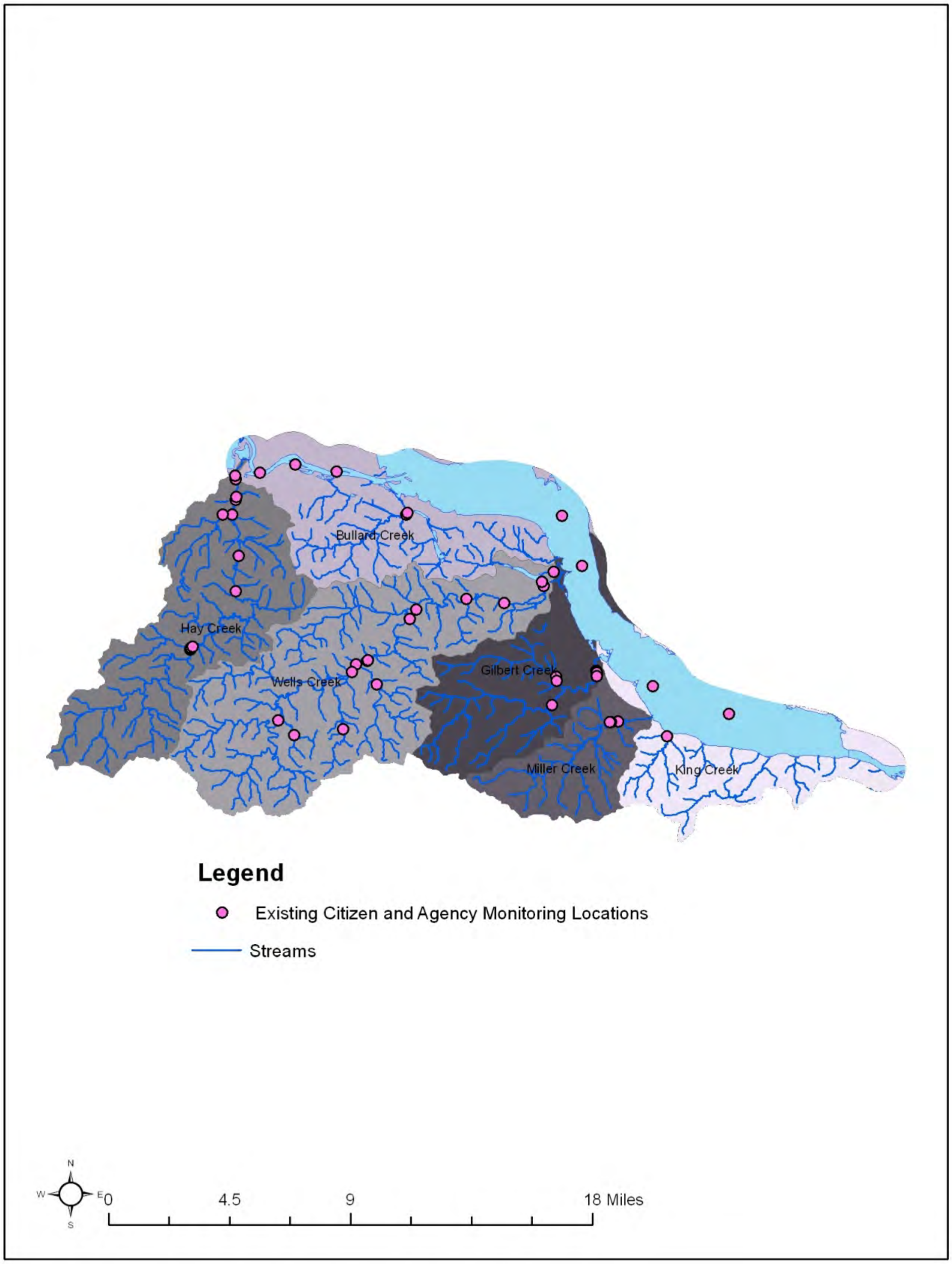


**Figure 4. Monitoring locations of local groups, citizens, and the MPCA lake monitoring staff in the Mississippi River Lake Pepin watershed**

# III. Assessment Methodology

The Clean Water Act requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses. The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodology see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012). http://www.pca.state.mn.us/index.php/view-document.html?gid=8601.

## 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=8601 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 GIS to determine if greater than 50 percent of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use framework. For additional information see: Tiered Aquatic Life Use (TALU) Framework (http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/the-tiered-aquatic-life-use-talu-framework.html). 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 (see Section VI).

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 the MPCA is entered into EQuIS (Environmental Quality Information System), 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 GovDelivery distribution lists.

## Period of record

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

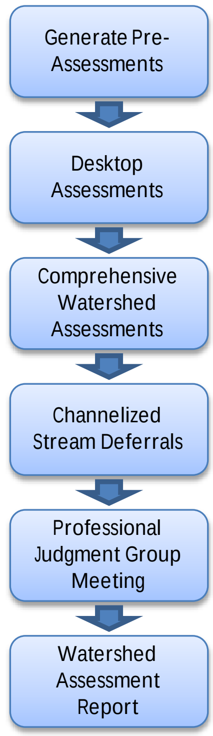


**Figure 5. Flowchart of aquatic life use assessment process**

# IV. The Mississippi River Lake Pepin Watershed Overview

Originating in Goodhue County, the Mississippi River Lake Pepin tributaries flow north or east before joining the Mississippi River near the cities of Red Wing and Lake City. The watershed has been grouped together with several other tributaries of the Mississippi River (including those on the Wisconsin side) in USGS's hydrologic unit classification (HUC) system. This hydrologic unit is known as the Vermillion-Rush, which has a hydrologic unit code of 07040001. The Minnesota portion of this unit is called the Mississippi River–Lake Pepin watershed. This report is limited to the Minnesota portion of this hydrologic unit, south of the Cannon River watershed (i.e., the Mississippi River Lake Pepin watershed including Bullard Creek, Miller Creek, King Creek, Gilbert Creek, and Hay Creek). The largest of these streams is Wells Creek (45,954 acres), which winds through 18 miles of bluff lands and joins the Mississippi near Old Frontenac, southeast of Red Wing. Hay Creek is a popular trout stream (30,405 acres) that flows from south to north, joining the Cannon River bottoms at Red Wing. Three other named streams are all designated trout waters, and drain directly to the Mississippi River: Bullard Creek (10,245 acres), Gilbert Creek (16,007 acres), Miller Creek (11,168 acres). Monitoring and assessment results for the Vermillion River portion of the watershed are presented in a separate report.

## Land use summary

The Mississippi River Lake Pepin watershed includes 205,747 acres that drain several small, coldwater streams in bedrock-dominated bluff and karst topography. The Mississippi River Lake Pepin watershed consists of forests, bluff lands and cultivated lands. All of the watershed lies within the Driftless Area ecoregion (Figure 6). The watershed drains to the northeast into Lake Pepin and the Mississippi River. The top of the watershed is rolling cropland interspersed by many small tributaries that drop steeply through forested valleys with scattered prairies atop cliffs. The tributaries join to form the named streams, which drain directly into the Mississippi River. The watershed is only ~50 miles southeast of downtown St. Paul. As a result, the watershed is subject to residential development pressures.

Rangeland and cropland are the primary land uses in the watershed (approximately 63 percent, Figure 7). Approximately 10 percent of the land is in grass. Corn and soybeans make up over half the tilled acreage of the area, with barley, oats and pasture land present. Forage production is strong because of the large number of dairy cows in the region. Of the grassland, 90 percent is in pasture and a small percentage (<10 percent) is in a management intensive rotational grazing system. Most of the remaining acreage is deciduous forest. Frontenac State Park, Lake Pepin and the coldwater fisheries are significant natural resources that provide recreation and revenue in the region (Boody and Krinke et al.) Overall land cover percentages in the watershed are: forest (25.8 percent), rangeland (24.5 percent), wetland (1.1 percent), cropland (33.2 percent), developed (6.6 percent), mining (0.05 percent) and open water (8.7 percent) (Figure 6). There are currently 305 permitted feedlots and 24 permitted waste water dischargers in the watershed.

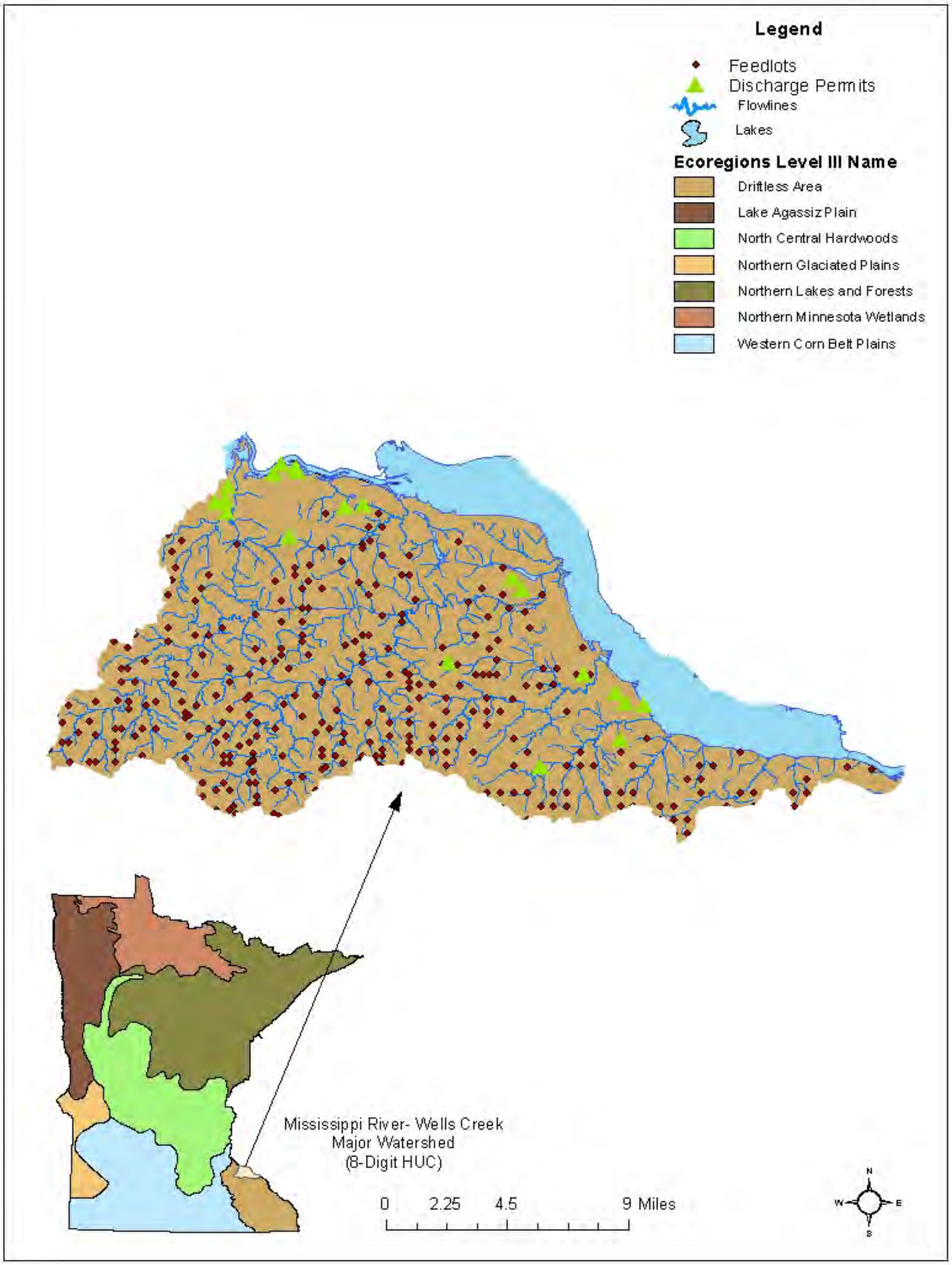


**Figure 6. Ecoregion map, wastewater permits, and feedlots for the Mississippi River Lake Pepin watershed**

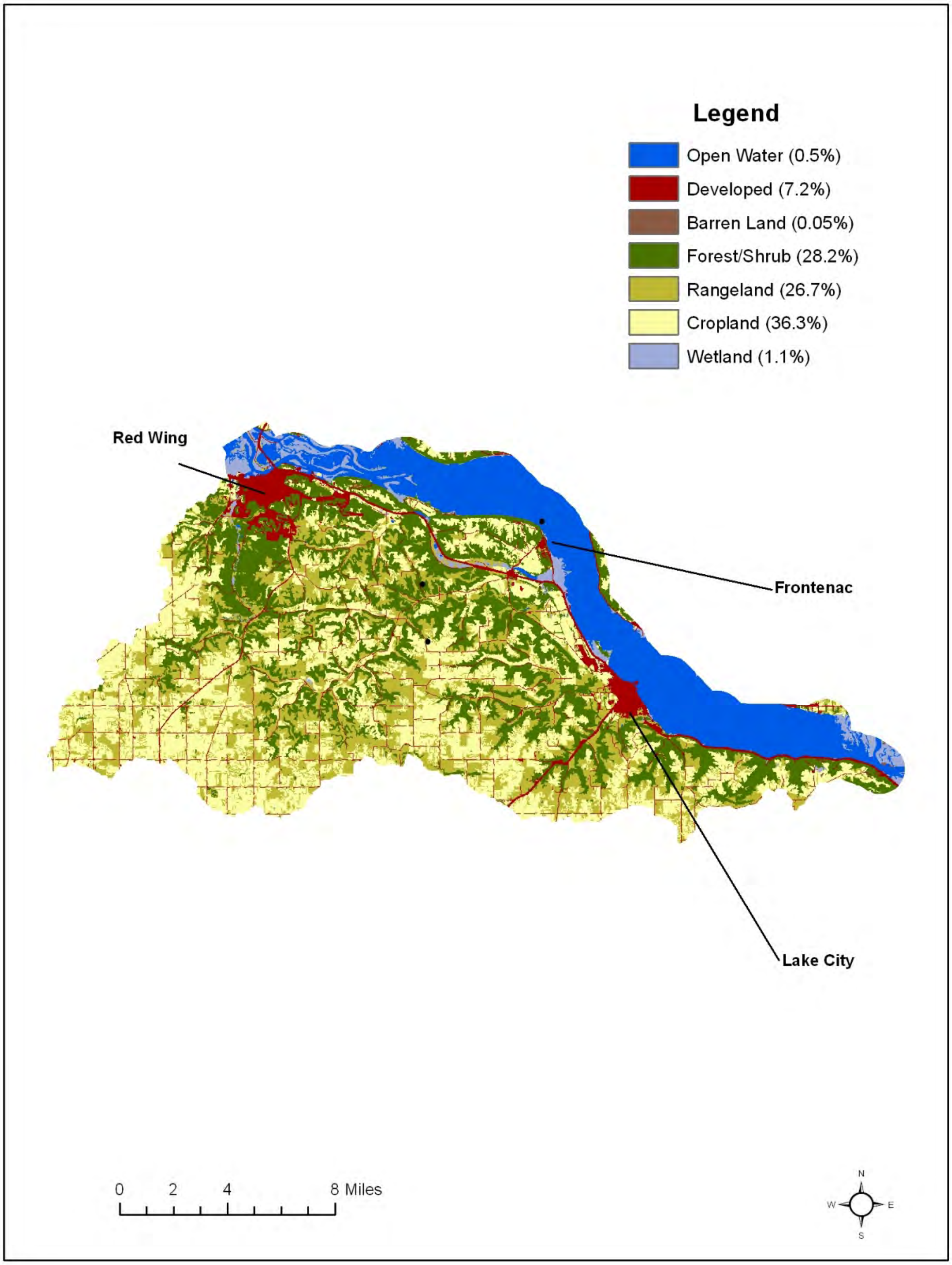


**Figure 7. Land use map for the Mississippi River Lake Pepin watershed**

## Surface water hydrology

The Mississippi River Lake Pepin watershed avoided much of the glaciations that covered Minnesota, and is comprised of karst (limestone) topography. The limestone rock, as it erodes, leads to underground streams, springs, and sink holes (USDA-NRCS 2009). The land has limited capacity to store water on the land surface; as a result, there are no lakes in this watershed. Lake Pepin forms the eastern border of this watershed and directly drains most of the subwatersheds. Because this lake drains much of the state, no further discussion on the basin will be included in this report. A nutrient TMDL is currently underway for the Lake Pepin basin and more detailed information can be found at: [http://www.pca.state.mn.us/zihy97a](http://www.pca.state.mn.us/zihy97a).

The hydrology of the Mississippi River Lake Pepin watershed has been dramatically altered by land cover changes brought about by settlement. These land use changes have caused an increase in higher peak stream flows during rain events and lower water levels during low flow time periods. Base flow in the Mississippi River Lake Pepin watershed is supported year round by groundwater recharge (Anderson 1975).

Like other parts of southern Minnesota, the Mississippi River Lake Pepin watershed has less than 50 percent of its original wetlands remaining (BWSR 2004). The majority of wetlands that exist in the watershed today are confined to the Mississippi River floodplain as well as the riparian corridor of Mississippi River Lake Pepin and the other small direct tributaries. Meanwhile, the number of stormwater ponds in the watershed has dramatically increased in recent decades in association with urban development.

### Climate and precipitation

Average annual precipitation in the Mississippi River Lake Pepin watershed ranged from 31 to 35 inches, depending on location, for the 1981 to 2010 period (NCDC 2011). During the 2008 water year (October 2007-September 2008), when most of the monitoring was conducted in the watershed, precipitation was slightly drier than normal (Figure 8).

## Climate and precipitation

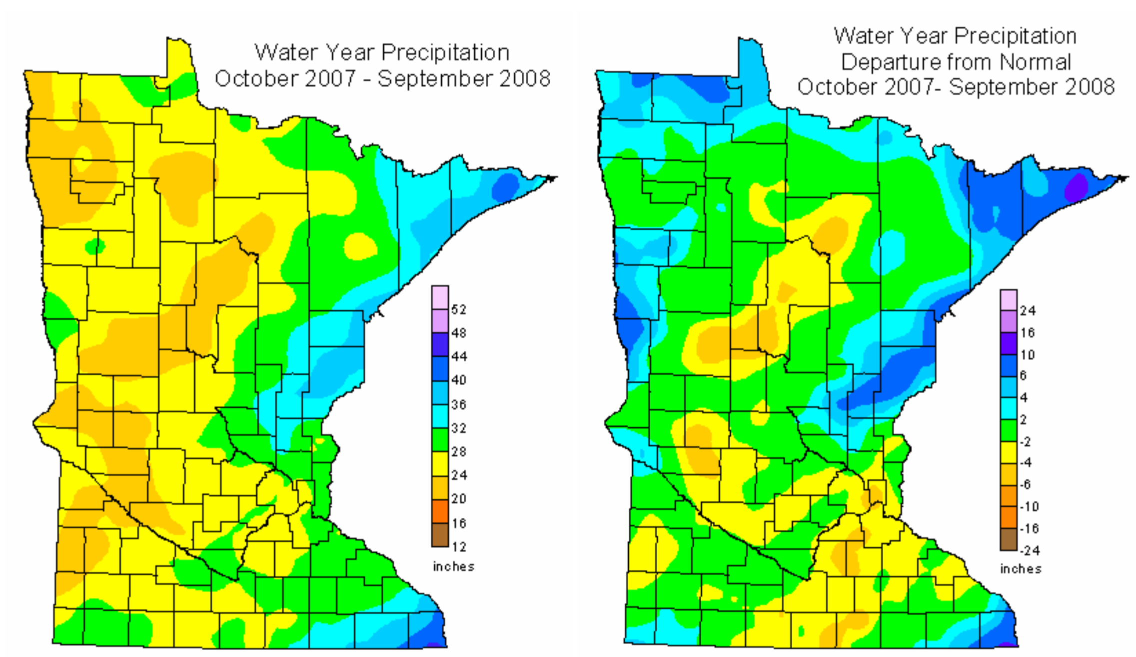


**Figure 8. State-wide precipitation levels during the 2008 water year**

# V. Watershed-Wide Data Collection Methodology

## Load monitoring

The Mississippi River Lake Pepin watershed has one temporary load monitoring site. The site is located on Wells Creek and is monitored for pollutant loading at Highway 61 near Frontenac right before its confluence with Lake Pepin. Water chemistry and discharge data are input into the “Flux32” load estimation program to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs include: annual pollutant loads, defined as the amount (mass) of a pollutant passing a stream location over a defined period of time; watershed yield, which describes amount of pollutant delivered per acre; and flow weighted mean concentrations, which are computed by dividing the pollutant load by the total seasonal flow volume. These are calculated for total suspended solids (TSS), total phosphorus (TP), orthophosphate (OP), Total Kjeldahl Nitrogen (TKN) and nitrate plus nitrite nitrogen (nitrate-N).

## Stream water sampling

Five stations were sampled from May through September in 2008 and again June through August of 2009 to provide sufficient water chemistry data for assessing aquatic life and aquatic recreation designated uses in the 11-HUC subwatersheds (green 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 Hardwood 11-HUC because this subwatershed lacked perennial streams. Similarly, the IWM design did not include stream monitoring stations within the Mississippi (Direct) River (HUC 07040001080) subwatershed due to it being more representative of the Mississippi River and its upstream watershed. 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 Mississippi River Lake Pepin watershed was completed during the summer of 2008. Biological monitoring sites were established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds based on the sampling design. In addition, biological data from four existing monitoring stations within the watershed were included in the assessment process. These monitoring stations were established as part of a random Lower Mississippi River Basin survey in 2004 or as part of a 2007 investigation of the quality of channelized streams with intact riparian zones. While data from the last 10-years contributed to the watershed assessments, the majority of data utilized for the 2011 assessment was collected in 2008. A total of 13 stream assessment units were sampled for biology in the Mississippi River Lake Pepin watershed and aquatic life assessments were conducted for nine of these. 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 crucial to 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 (IBIs), specifically Fish and Invertebrate 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 5.3 and 5.4.

## Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from Wells and Hay Creeks in 2008 and 2010 by the MPCA biomonitoring staff. Fish samples had been collected by MDNR fisheries from Hay Creek in 1993. The largest white sucker from Wells Creek and the largest brown trout from Hay Creek were tested for PCBs in 2008.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled, filleted, and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue.

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

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

# VI. Individual Watershed Results

## HUC-11 watershed units

Assessment results are presented for each of the HUC-11 watershed units within the Mississippi River Lake Pepin watershed. This is intended to enable the assessment of all surface waters of the watershed 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 2012 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2008 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 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 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); these are 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 invertebrate 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. Where applicable and sufficient data exists, assessments of other designated uses (e.g., drinking water, and 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 have 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 6.1). 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 6.1.

## 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.

## 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.

# Bullard Creek watershed unit HUC 07040001110

## Watershed description

The Bullard Creek HUC-11 watershed unit is located in northeastern Goodhue County and the eastern portion of the Mississippi River Lake Pepin watershed HUC-8. Bullard Creek is a designated 2A coldwater stream that flows directly into the Mississippi River near the headwaters of Lake Pepin. The headwaters of Bullard Creek are located southeast of Red Wing and are comprised of several small unnamed tributaries. Forest and shrub land (43 percent) and cropland (24 percent) are the predominant land uses in the watershed. Biological station 08LM129 at US highway 61 represents the outlet of the 11-digit HUC.

**Table 1. Aquatic life and recreation assessments on stream reaches in the Bullard 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.** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **07040001-526** ***Bullard Creek***, *T112 R14W S10, west line to T113 R4W S36, north line* | 6 | 2A | 08LM129 | Upstream of Hwy 61, 4 mi. E of Red Wing | MTS | MTS | IF | NA | -- | MTS | MTS | -- | EX | FS | NS |

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment for 2012 reporting cycle; = full support of designated use for 2012 reporting cycle.

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

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 08LM129 | Bullard Creek | 4 | 13.5 | 16 | 8 | 27 | 68.5 | Good |
| Average Habitat Results: *Bullard Creek 11 HUC* | | | **4** | **13.5** | **16** | **8** | **27** | **68.5** | **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 3. Outlet stream water chemistry for the Bullard Creek 11-HUC**

Site ID: S004-863

Location: Bullard Creek at US-61, Red Wing, MN (2A)

| Parameter | Units | # Samples | Minimum | Maximum | Mean[1] | Median | WQ standard[2] | # WQ exceedances[3] |
|---|---|---|---|---|---|---|---|---|
| Ammonia-nitrogen | mg/l | 10 | <0.05 | <0.05 | <0.05 | <0.05 | | |
| Chlorophyll a, corrected for pheophytin | ug/l | 5 | 1.3 | 2.0 | 1.6 | 1.5 | | |
| Dissolved oxygen (DO) | mg/l | 19 | 8.6 | 12.4 | 10.2 | 10.2 | 7 | 0 |
| Escherichia coli | MPN/100ml | 15 | 130 | 2000 | 681 | 580 | 126 | 15 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | 10 | 1.2 | 1.5 | 1.4 | 1.4 | 10 | 0 |
| Kjeldahl nitrogen | mg/l | 10 | 0.25 | 0.47 | 0.37 | 0.36 | | |
| pH | -- | 19 | 6.7 | 8.3 | 8.0 | 8.1 | 6.5-8.5 | 0 |
| Pheophytin a | ug/l | 5 | 0.7 | 2.5 | 1.7 | 2.0 | | |
| Phosphorus | mg/l | 10 | 55 | 110 | 83 | 81 | | |
| Specific conductance | uS/cm | 19 | 535 | 611 | 583 | 587 | | |
| Temperature, water | deg C | 19 | 11.7 | 22.5 | 15.8 | 15.1 | | |
| Total suspended solids | mg/l | 10 | 3.2 | 32 | 17.7 | 16.5 | | |
| Total volatile solids | mg/l | 10 | < 1 | 4.8 | 4.8 | 3.2 | | |
| Transparency, tube without disk | cm | 19 | 32 | > 100 | 60.3 | 60 | | |

## Stream assessment results

The assessed AUID on Bullard Creek was fully supporting for fish and macroinvertebrate IBI and is fully supporting of aquatic life (Table 1). Water quality data was available on the cold water section of Bullard Creek; no tributaries had water chemistry or bacteria data available for review. Assessments for aquatic recreation in this watershed unit indicate non-support based on and E. coli impairment on the assessed AUID (Figure 9, Table 3). Water quality parameters, pH, unionized ammonia, and dissolved oxygen were meeting the criteria. No turbidity data was available and only 10 TSS measurements were made. The habitat evaluation on one site on Bullard Creek indicated good habitat conditions (Table 2).

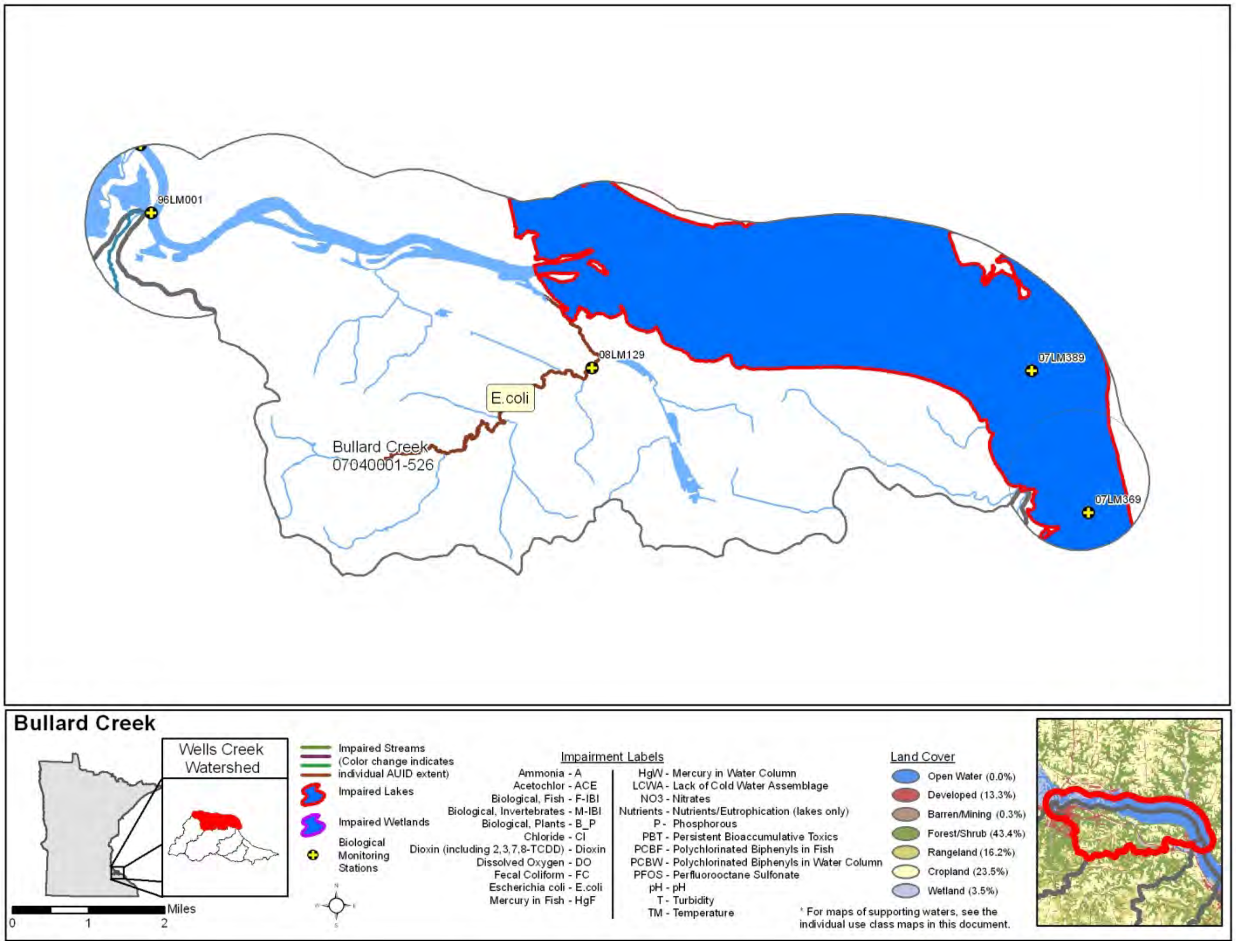


**Figure 9. Currently listed impaired waters by parameter and land use characteristics in the Bullard Creek watershed unit**

## Hay Creek watershed unit HUC 07040001100

The Hay Creek HUC-11 watershed unit is located in eastern Goodhue County, and the northern part of the Mississippi River Lake Pepin HUC-8 watershed unit. Hay Creek is a designated 2A cold water stream that flows from south to north and drains directly into the Mississippi River near Red Wing. Biological station 08LM128 at Featherstone Road represents the outlet of the 11-digit HUC. The land use in the watershed is predominantly crop land (39 percent) and range land (26 percent) and forested (27 percent). There are several small unnamed tributaries that flow into Hay Creek, and the only larger tributary flowing into Hay Creek is Trout Brook.

**Table 4. Aquatic life and recreation assessments on stream reaches in the Hay Creek watershed unit**

| | | | | | Aquatic Life Indicators: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AUID**<br>***Reach Name***,<br>*Reach Description* | **Reach Length (miles)** | **Use Class** | **Biological Station ID** | **Location of Biological Station** | Fish IBI | Invert IBI | Dissolved Oxygen | Turbidity | Chloride | pH | $NH_3$ | Pesticides | Bacteria | **Aquatic Life** | **Aquatic Rec.** |
| **07040001-518**<br>***Hay Creek,*** *T111 R15W S4, west line to Mississippi R* | 18 | 2A | 04LM089<br>08LM133<br>04LM132<br>08LM128 | Upstream of 325th St, 5.5 mi. N of Goodhue<br>Downstream of 325th St, 5.5 mi. N of Goodhue<br>Upstream of Hay Creek Trail, 2 mi. S of Red Wing<br>Downstream of Featherstone Rd, 0.5 mi. W of Red Wing | MTS | MTS | IF | MTS | MTS | MTS | MTS | -- | EX | FS | NS |
| **07040001-537**<br>***Trout Brook,*** *T113 R15W S35, south line to Hay Cr* | 1 | 2A | 08LM132 | Downstream of Pioneer Rd, 2 mi. SW of Red Wing | MTS | MTS | -- | -- | -- | -- | -- | -- | -- | FS | NA |

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

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

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

**Table 5. Minnesota Stream Habitat Assessment (MSHA) results for the Hay Creek 11-HUC**

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04LM089 | Hay Creek | 5 | 13 | 20.5 | 13 | 26 | 77.5 | Good |
| 1 | 08LM133 | Hay Creek | 5 | 12 | 16.8 | 12 | 29 | 74.8 | Good |
| 1 | 04LM132 | Hay Creek | 5 | 12 | 16.5 | 9 | 28 | 70.5 | Good |
| 1 | 08LM128 | Hay Creek | 2.5 | 11 | 17.9 | 7 | 15 | 53.4 | Fair |
| 1 | 08LM132 | Trout Brook | 5 | 11.5 | 16 | 12 | 21 | 65.5 | Fair |
| Average Habitat Results: *Hay Creek 11 HUC* | | | **4.5** | **11.9** | **17.5** | **10.6** | **23.8** | **68.3** | **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 6. Outlet stream water chemistry for the Hay Creek 11-HUC**

Site ID: S000-430
Location: Hay Creek at Featherstone Trail, Red Wing, MN (2A)

| Parameter | Units | # Samples | Minimum | Maximum | Mean[1] | Median | WQ standard | # WQ exceedances |
|---|---|---|---|---|---|---|---|---|
| Ammonia-nitrogen | mg/l | 10 | <0.05 | <0.05 | <0.05 | <0.05 | | |
| Chlorophyll a, corrected for pheophytin | ug/l | 5 | 0.8 | 3.2 | 1.5 | 1.36 | | |
| Dissolved oxygen (DO) | mg/l | 19 | 9.1 | 11.4 | 10.3 | 10.35 | 7 | 0 |
| Escherichia coli | MPN/100ml | 15 | 44 | 490 | 249 | 200 | 126 | 11 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | 10 | 2.5 | 3.1 | 2.8 | 2.8 | 10 | 0 |
| Kjeldahl nitrogen | mg/l | 10 | 0.16 | 0.44 | 0.29 | 0.27 | | |
| pH | -- | 19 | 6.99 | 8.31 | 8.0 | 8.1 | 6.5-8.5 | 0 |
| Pheophytin a | ug/l | 3 | 0.49 | 4.45 | 2.0 | 1.2 | | |
| Phosphorus | mg/l | 10 | 50 | 119 | 79 | 74 | | |
| Specific conductance | uS/cm | 20 | 514 | 586 | 547 | 545 | | |
| Temperature, water | deg C | 19 | 11.6 | 21.6 | 14.9 | 14.3 | | |
| Total suspended solids | mg/l | 10 | 7.2 | 54 | 23.2 | 19.5 | | |
| Total volatile solids | mg/l | 10 | 1.2 | 4.8 | 2.74 | 2.6 | | |
| Transparency, tube with disk | cm | 12 | 51 | > 100 | 87 | 93 | | |

## Stream assessments results

Both of two assessed streams for fish IBI were found to be fully supporting (Table 4). Macroinvertebrate IBI assessments indicate support for both assessed AUIDs in the watershed unit. Assessment results from the current dataset indicate that all of the assessed AUIDs are fully supporting of aquatic life. Assessments for aquatic recreation in this watershed unit indicate non-support based on a bacteria impairment on the assessed AUID of Hay Creek (Figure 10, Table 6). Water chemistry parameters, pH, unionized ammonia, and chloride were meeting the criteria. The streams meet drinking water standards for nitrates. The reach on Hay Creek was listed for turbidity, but was listed using a limited dataset. More monitoring is scheduled to determine if this impairment still exists, and if the reach can be de-listed. The habitat evaluation on three sites on Hay Creek indicated good habitat conditions. One site on Hay Creek with poor substrate and one on Trout Brook with poor fish cover had a fair habitat rating and appear to be lacking as good of quality habitat compared to the other stream reaches in the HUC-11 (Table 5).

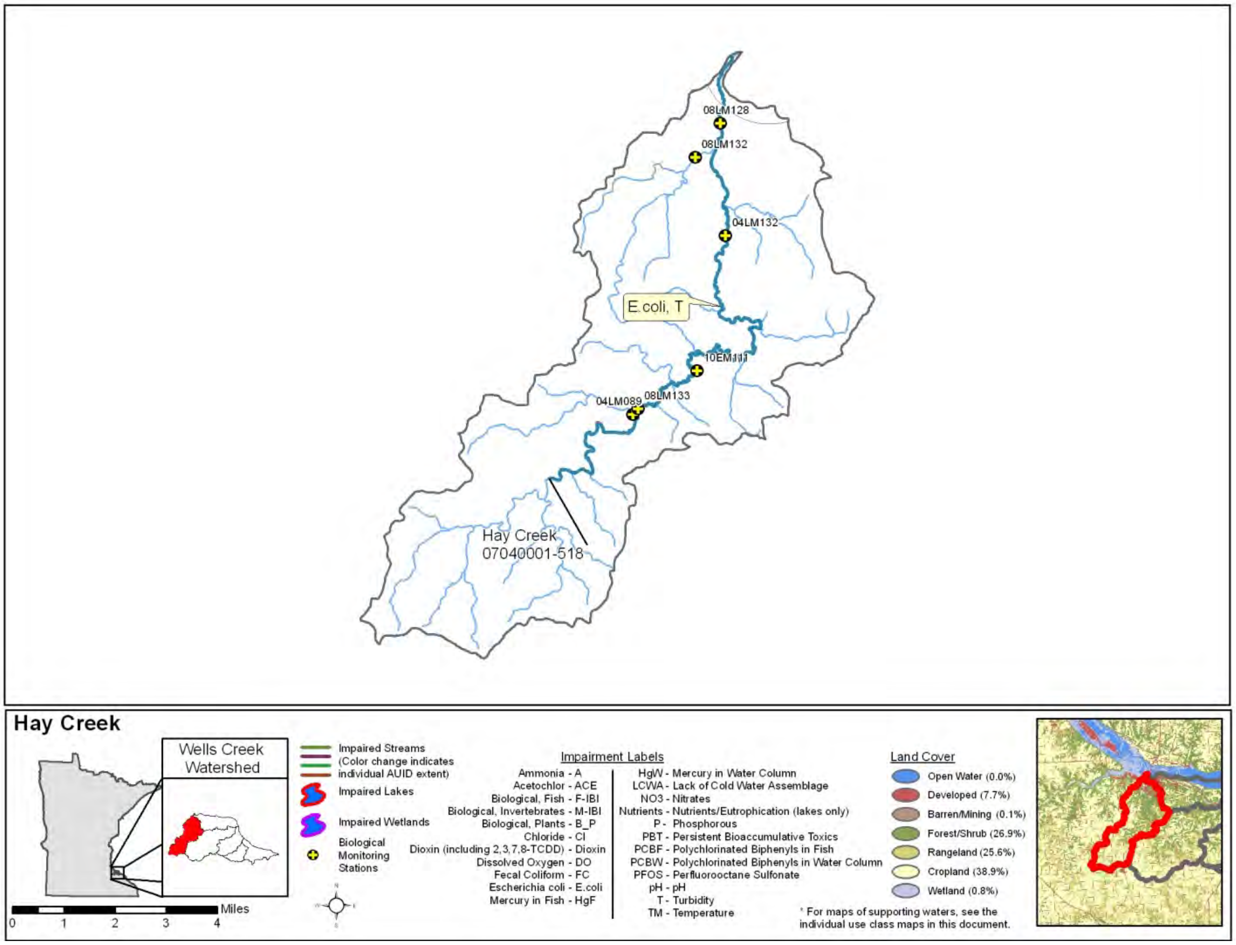


**Figure 10. Currently listed impaired waters by parameter and land use characteristics in the Hay Creek watershed unit**

# Wall Creek watershed unit HUC 07040001120

The Wells Creek HUC-11 watershed unit is the largest HUC-11 in the southern portion the Mississippi River Lake Pepin HUC-8 watershed. Wells Creek is the major stream in this HUC-11 and is located in Goodhue County. The creek flows from southwest to northeast and outlets to the Mississippi River near Frontenac State Park. Portions of the river are proposed to be classified as coldwater based on the cold water fish assemblage found by sampling crews. The outlet of the watershed on Wells Creek was represented by biological station 08LM127 at US-61, Frontenac, MN. There are numerous small unnamed tributaries, but there are no major named tributaries that flow into Wells Creek mainstem. Predominant land use in the Wells Creek watershed are crop land (40 percent), rangeland (31 percent) and forest shrub land (23 percent).

**Table 7. Aquatic life and recreation assessments on stream reaches in the Wells 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **07040001-708** ***Wells Creek***, *Headwaters to Hwy 61* | 22 | 2A† | 08LM136<br>04LM031<br>08LM135<br>04LM070<br>04LM007<br>08LM127 | Upstream of CSAH 2, 9 mi. NE of Goodhue<br>Upstream of Hwy 5, 4 mi. SE of Hay Creek<br>Downstream of CSAH 5, 4.5 mi. SW of Frontenac Stat.<br>Downstream of CSAH 5, 4 mi. SW of Frontenac Stat.<br>Upstream of Hwy 61/63, 1 mi. S of Frontenac Station<br>Upstream of Hwy 61/63, 1 mi. E of Frontenac Station | MTS | MTS | MTS | IF | MTS | MTS | MTS | -- | EX | FS | NS |
| **07040001-700** ***Unnamed creek,*** *Unnamed cr to Wells Cr* | 1 | 2A† | 08LM134 | Downstream of CR 45, 8 mi. SE of Red Wing | MTS | MTS | -- | -- | -- | -- | -- | -- | -- | FS | NA |

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

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

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

*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.

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

**Table 8. Minnesota Stream Habitat Assessment (MSHA) results for the Wells Creek 11-HUC**

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 08LM136 | Wells Creek | 0 | 12.5 | 22.8 | 13 | 32 | 80.3 | Good |
| 1 | 04LM031 | Wells Creek | 2.5 | 9 | 15.9 | 10 | 16 | 53.4 | Fair |
| 1 | 08LM135 | Wells Creek | 5 | 13 | 21.1 | 13 | 30 | 82.1 | Good |
| 1 | 04LM070 | Wells Creek | 5 | 11 | 14 | 7 | 15 | 52 | Fair |
| 1 | 04LM007 | Wells Creek | 5 | 10 | 18.0 | 9 | 11 | 53.0 | Fair |
| 1 | 08LM127 | Wells Creek | 5 | 11 | 19 | 4 | 13 | 52 | Fair |
| 2 | 08LM134 | Trib. to Wells Creek | 2 | 13.8 | 21.5 | 13.5 | 28.5 | 79.2 | Good |
| Average Habitat Results: Wells *Creek 11 HUC* | | | **3.5** | **11.5** | **18.9** | **9.9** | **20.8** | **64.6** | **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 9. Outlet stream water chemistry for the Wells Creek 11-HUC**

Site ID: S004-859
Location: Wells Creek at US-61, Frontenac, MN (2B, proposed 2A)

| Parameter | Units | # Samples | Minimum | Maximum | Mean[1] | Median | WQ standard[2] | # WQ exceedances[3] |
|---|---|---|---|---|---|---|---|---|
| Ammonia-nitrogen | mg/l | 10 | <0.05 | <0.05 | <0.05 | <0.05 | | |
| Chlorophyll a, corrected for pheophytin | ug/l | 5 | 0.69 | 2.69 | 1.5 | 1.1 | | |
| Dissolved oxygen (DO) | mg/l | 19 | 9.1 | 11.2 | 10.3 | 10.3 | 7 | 0 |
| Escherichia coli | MPN/100ml | 15 | 48 | 1300 | 469 | 440 | 126 | 11 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | 10 | 2.7 | 3.3 | 3.1 | 3.2 | 10 | 0 |
| Kjeldahl nitrogen | mg/l | 10 | 0.24 | 0.67 | 0.38 | 0.37 | | |
| pH | -- | 19 | 7.9 | 8.5 | 8.2 | 8.2 | 6.5-8.5 | 0 |
| Pheophytin a | ug/l | 5 | 0.68 | 6.28 | 2.9 | 3.0 | | |
| Phosphorus | mg/l | 10 | 51 | 238 | 103 | 88 | | |
| Specific conductance | uS/cm | 20 | 516 | 581 | 547 | 543 | | |
| Temperature, water | deg C | 19 | 11.5 | 25 | 17 | 16.6 | | |
| Total suspended solids | mg/l | 10 | 8.8 | 98 | 36.2 | 23.5 | | |
| Total volatile solids | mg/l | 10 | 1.2 | 10 | 3.7 | 2.9 | | |
| Transparency, tube with disk | cm | 16 | 15 | 88 | 53 | 55 | | |

## Stream biology assessment results

Both of two assessed stream AUIDs for fish IBI were found to be fully supporting (Table 7). Macroinvertebrate IBI assessments indicate support for both assessed AUIDs in the watershed unit. Water quality data was available for much of Wells Creek. Cold water temperature and cold fish species found while sampling indicated that a change to a cold water designated use was needed. Assessment results from the current dataset indicate that all of the assessed AUIDs are fully supporting for cold water aquatic life. Assessments for aquatic recreation in this watershed unit indicate non-support based on an E. coli impairment on the assessed AUID of Wells Creek (Figure 11, Table 9). pH, unionized ammonia, and chloride were meeting the criteria. Nitrate levels met drinking water standards. Turbidity was identified as a possible stressor to aquatic life but was not conclusive enough to warrant a listing for aquatic life impairment. The habitat evaluation on two sites on Wells Creek and one site on a tributary to Wells Creek indicated good habitat conditions (Table 9). Four sites on Wells Creek had fair habitat conditions and appear to be lacking quality habitat and substrates compared to the other stream reaches in the HUC-11 that received a good rating. Contaminants in fish tissue for fish from Wells Creek indicate that mercury and PCB concentrations are well below the impairment threshold (See section V for more information).

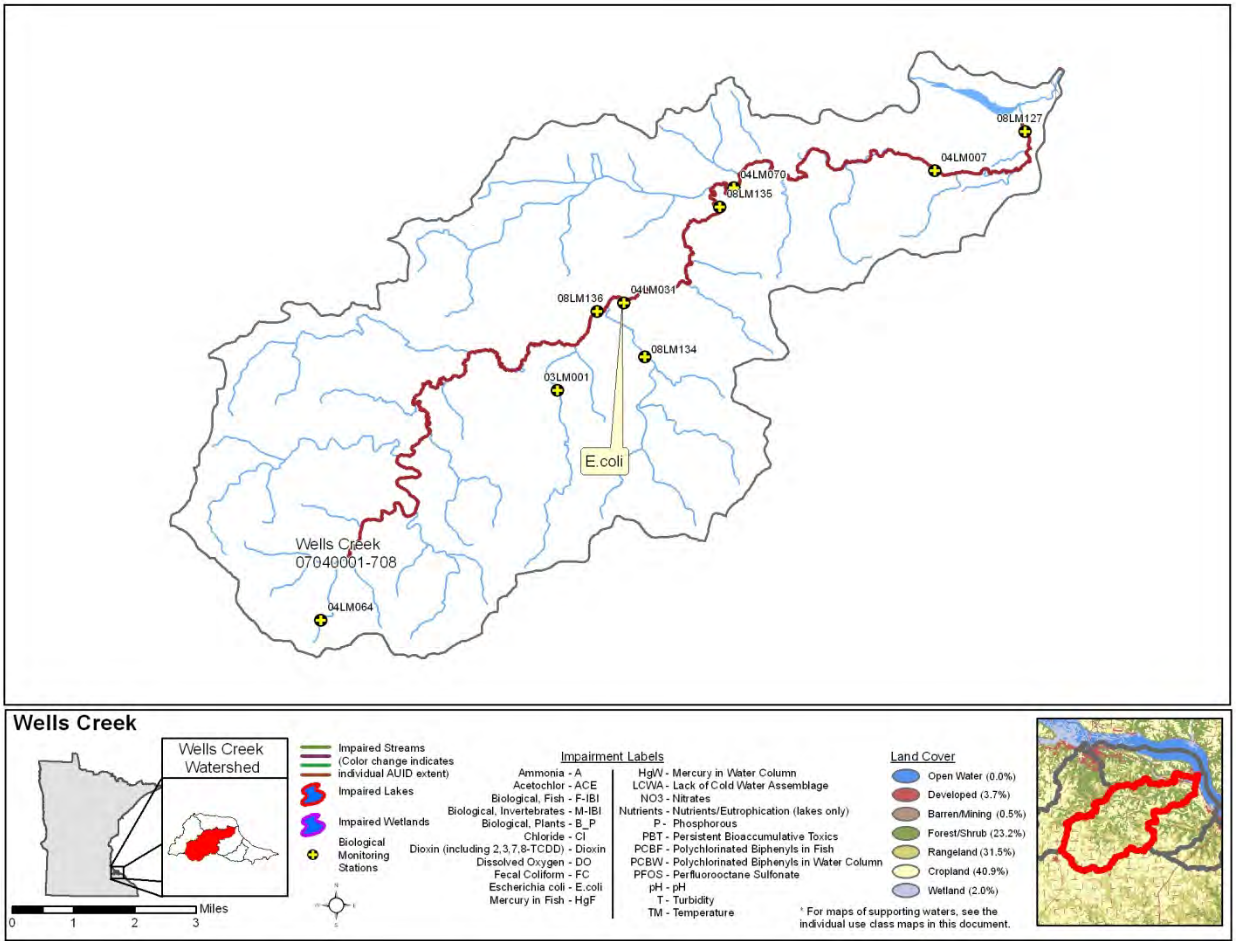


**Figure 11. Currently listed impaired waters by parameter and land use characteristics in the Wells Creek watershed unit**

## Gilbert Creek watershed unit

## HUC 07040001130

The Gilbert Creek HUC-11 watershed unit is located in southern Goodhue and northern Wabasha counties and is located in the middle portion of the Mississippi River Lake Pepin watershed. There are multiple unnamed tributaries and a larger tributary (Sugarloaf Creek) that flow into Gilbert Creek. Cropland (38 percent), Forest (28 percent), and Rangeland (26 percent) are the predominant land uses in this watershed. Gilbert Creek starts in northern Wabasha County and flows northeast into Lake Pepin just north of Lake City. Biological station 08LM130 located on Gilbert Creek a CSAH 5, one mile northwest of Lake City, represents the outlet of Gilbert Creek.

**Table 10. Aquatic life and recreation assessments on stream reaches in the Gilbert 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **07040001-662** ***Sugarloaf Creek,*** *Headwaters to T112 R13W S36, south line* | 5 | 2C | 08LM139 | Downstream of 340th St, 3 mi. NW of Lake City | EXP | MTS | -- | -- | -- | -- | -- | -- | -- | FS | NA |
| **07040001-530** ***Gilbert Creek,*** *Sugarloaf Cr to T112 R12W S31, east line* | 4 | 2A | 08LM130 | Upstream of CSAH 5, 1 mi. NW of Lake City | EXP | MTS | IF | NA | -- | MTS | MTS | -- | EX | NS | NS |

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

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

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

**Table 11. Non-assessed biological stations on channelized AUIDs in the Gilbert Creek 11-HUC**

| AUID *Reach Name,* *Reach Description* | Reach Length (miles) | Use Class | Biological Station ID | Location of Biological Station | Fish IBI | Invert IBI |
|---|---|---|---|---|---|---|
| **07040001-532** ***Gilbert Creek,*** *T111 R13W S4, west line to Sugarloaf Cr* | 6 | 2A | 08LM138 | Upstream of CSAH 5, 2.5 mi. W of Lake City | Good | Good |

**Table 12. Minnesota Stream Habitat Assessment (MSHA) results fro the Gilbert Creek 11-HUC**

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 08LM139 | Sugarloaf Creek | 1.5 | 8.5 | 13.7 | 15 | 21 | 59.7 | Fair |
| 1 | 08LM130 | Gilbert Creek | 2.5 | 10.5 | 13.1 | 2 | 16 | 44.1 | Poor |
| 1 | 08LM138 | Gilbert Creek | 5 | 10 | 13.2 | 15 | 22 | 65.2 | Fair |
| Average Habitat Results: *Gilbert Creek 11 HUC* | | | **3** | **9.7** | **13.3** | **10.7** | **19.7** | **56.3** | **Fair** |

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

**Table 13. Outlet stream water chemistry for the Gilbert Creek 11-HUC**

Site ID: S001-597
Location: Gilbert Creek at CSAH-5, Lake City, MN (2A)

| Parameter | Units | # Samples | Minimum | Maximum | Mean[1] | Median | WQ standard[2] | # WQ exceedances[3] |
|---|---|---|---|---|---|---|---|---|
| Ammonia-nitrogen | mg/l | 10 | <0.05 | <0.05 | <0.05 | <0.05 | | |
| Chlorophyll a, corrected for pheophytin | ug/l | 5 | 1.36 | 3.72 | 2.1 | 1.7 | | |
| Dissolved oxygen (DO) | mg/l | 19 | 9.2 | 11.2 | 10.4 | 10.6 | 7 | 0 |
| Escherichia coli | MPN/100ml | 15 | 170 | 1700 | 647 | 520 | 126 | 15 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | 10 | 1.7 | 2.5 | 1.9 | 1.8 | 10 | 0 |
| Kjeldahl nitrogen | mg/l | 10 | .28 | .53 | .38 | .35 | | |
| pH | -- | 19 | 8.03 | 8.54 | 8.3 | 8.3 | 6.5-8.5 | 0 |
| Pheophytin a | ug/l | 4 | 2.2 | 2.9 | 2.6 | 2.6 | | |
| Phosphorus | mg/l | 10 | 65 | 173 | 108 | 99 | | |
| Specific conductance | uS/cm | 19 | 486 | 556 | 521 | 520 | | |
| Temperature, water | deg C | 18 | 11.3 | 21.2 | 15.5 | 15.6 | | |
| Total suspended solids | mg/l | 10 | 14 | 41 | 31.3 | 33 | | |
| Total volatile solids | mg/l | 10 | 2 | 4.8 | 3.6 | 3.8 | | |
| Transparency, tube with disk | cm | 19 | 25 | 84 | 52 | 47 | | |

### Stream assessment results

One of two assessed stream AUIDs for fish IBI was found to be fully supporting (Table 10). Macroinvertebrate IBI assessments indicate support for both assessed AUIDs in the watershed unit. A channelized (non-assessed) reach of Gilbert Creek appears to be in good condition (Table 11). Water quality data was available only on a 3.6-mile reach of Gilbert Creek immediately downstream of the Sugarloaf Creek confluence. Assessment results from the current dataset indicate that Sugarloaf Creek is fully supporting of aquatic life and Gilbert Creek is non-supporting of aquatic life. Assessments for aquatic recreation in this watershed unit indicate non-support based on an E. coli impairment on the assessed AUID of Gilbert Creek (Figure 12, Table 13). Sugarloaf Creek is not assessed for bacteria. pH and unionized ammonia were meeting the criteria. Nitrate levels met drinking water standards. Insufficient data was available to determine if dissolved oxygen or turbidity were meeting standards. The habitat evaluation on one site on Gilbert Creek and one site on Sugarloaf Creek had fair habitat conditions (Table 12). One site on Gilbert Creek had poor habitat conditions and appears to be lacking quality habitat and substrates compared to the other stream reaches in the HUC-8 that received a good rating.

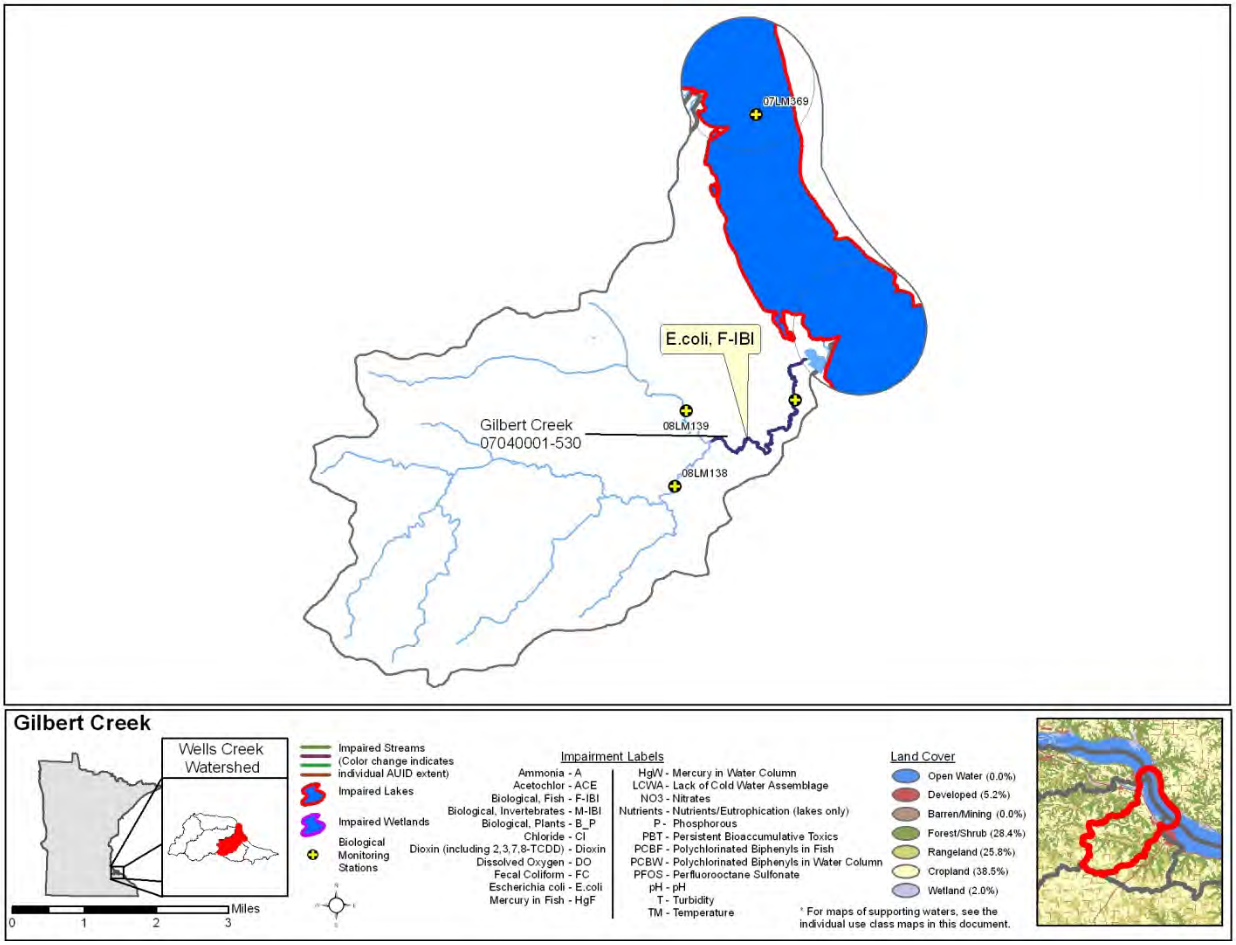

**Figure 12. Currently listed impaired waters by parameter and land use characteristics in the Gilbert Creek watershed unit**

## King Creek watershed unit HUC 07040001150

The King Creek HUC-11 watershed unit is located in the southern portion of the Mississippi River Lake Pepin watershed. This subwatershed is located in northern Wabasha County. The streams in this subwatershed are actually small tributaries that flow directly into the Mississippi River. King Coulee and Handshaw Coulee are the only named streams in this small subwatershed. Land use in the watershed is predominantly forested/shrub land (33 percent) and cropland (33 percent). Due to the small watershed size, there were no intensive water quality data monitoring stations in this HUC-11 watershed unit.

**Table 14. aquatic life and recreation assessments on stream reaches in the King 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **07040001-553** ***Handshaw Coulee (Second Creek),*** *T111 R12W S15, south line to Mississippi R* | 1 | 2A | 04LM138 | Upstream of Hwy 61, 1.5 mi. SE of Lake City | MTS | MTS | -- | -- | -- | -- | -- | -- | -- | FS | NA |

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment for 2012 reporting cycle; = full support of designated use for 2012 reporting cycle.

**Table 15. Minnesota Stream Habitat Assessment (MSHA) results for the King Creek 11-HUC**

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04LM138 | Handshaw Coulee | 5 | 13 | 14.8 | 15 | 20 | 67.8 | Good |
| Average Habitat Results: *King Creek 11 HUC* | | | **5** | **13** | **14.8** | **15** | **20** | **67.8** | **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)

## Stream biology assessment results

The only assessed stream AUID (Handshaw Coulee) for fish IBI was found to be fully supporting (Table 14). Macroinvertebrate IBI assessments for Handshaw Coulee indicate support as well. Assessment results from the current dataset indicate that Handshaw Coulee is fully supporting of aquatic life. No AUIDs were assessed for aquatic recreation in the King Creek HUC-11 (Figure 13, Table 14). One site on Handshaw Coulee had good habitat conditions (Table 15). Overall water quality appears to be good in this watershed.

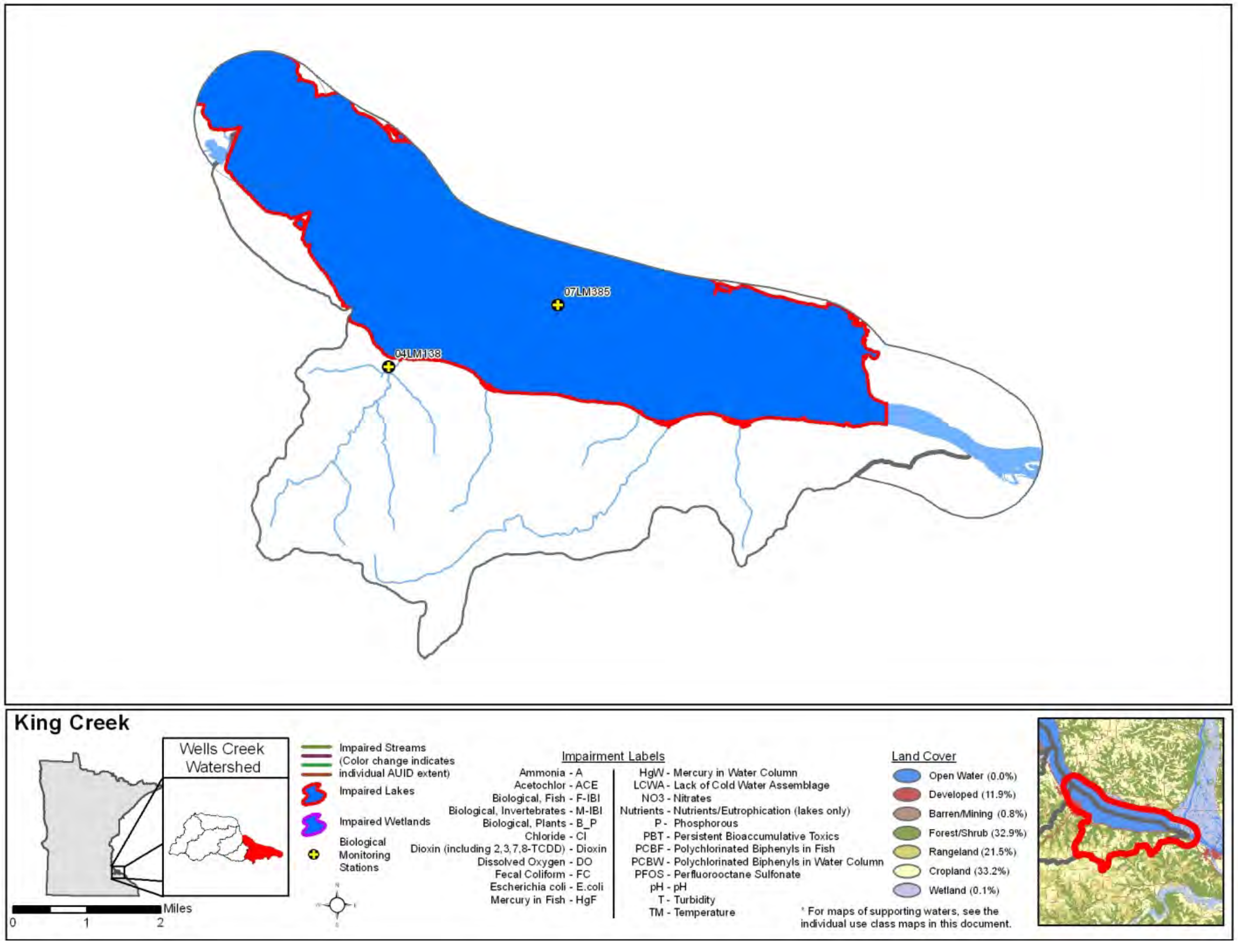


**Figure 13. Currently listed impaired waters by parameter and land use characteristics in the King Creek watershed unit**

## Miller Creek watershed unit HUC 07040001140

The Miller Creek HUC-11 watershed unit is located in the southern part of the Mississippi River Lake Pepin HUC-8 watershed in northern Wabasha County. Rangeland (36 percent) and cropland (33 percent) are the major land uses in the watershed. Miller Creek is a designated cold water stream that starts in Boston Coulee about five miles southwest of Lake City, and flows north where it flows into Lake Pepin just southeast of Lake City. Biological station 08LM131 located on Miller Creek, at West Marion St., 0.5 mile south of Lake City represents the outlet of Miller Creek.

**Table 16. Aquatic life and recreation assessments on stream reaches in the Miller 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. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **07040001-534** ***Miller Creek,*** *Boston Coulee to Mississippi R* | 5 | 2A | 08LM131 | Upstream of W Marion St, 0.5 mi. S of Lake City | MTS | MTS | -- | NA | -- | -- | MTS | -- | EX | FS | NS |

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = previous impairment or deferred impairment prior to 2012 reporting cycle; = new impairment for 2012 reporting cycle; = full support of designated use for 2012 reporting cycle.

**Table 17. Minnesota Stream Habitat Assessment (MSHA) results for the Miller Creek 11-HUC**

| # Visits | Biological Station ID | Reach Name | Land Use (0-5) | Riparian (0-15) | Substrate (0-27) | Fish Cover (0-17) | Channel Morph. (0-36) | MSHA Score (0-100) | MSHA Rating |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 08LM131 | Miller Creek | 5 | 14.5 | 18 | 7 | 22 | 66.5 | Good |
| Average Habitat Results: *Miller Creek 11 HUC* | | | **5** | **14.5** | **18** | **7** | **22** | **66.5** | **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 18. Outlet stream water chemistry for the Miller Creek 11-HUC**

Site ID: S002-449
Location: Miller Creek at CR-66, Lake City, MN (2A)

| Parameter | Units | # Samples | Minimum | Maximum | Mean[1] | Median | WQ standard[2] | # WQ exceedances[3] |
|---|---|---|---|---|---|---|---|---|
| Ammonia-nitrogen | mg/l | 10 | <0.05 | <0.05 | <0.05 | <0.05 | | |
| Chlorophyll a, corrected for pheophytin | ug/l | 5 | 1.2 | 2.3 | 1.6 | 1.6 | | |
| Dissolved oxygen (DO) | mg/l | 19 | 9.3 | 11.9 | 11.0 | 11.1 | 7 | 0 |
| Escherichia coli | MPN/100ml | 14 | 180 | < 2400 | 1063 | 980 | 126 | 15 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | 10 | 2.2 | 2.7 | 2.6 | 2.6 | 10 | 0 |
| Kjeldahl nitrogen | mg/l | 10 | < 0.20 | 0.39 | 0.29 | 0.29 | | |
| pH | -- | 19 | 7.7 | 8.5 | 8.2 | 8.2 | 6.5-8.5 | 0 |
| Pheophytin a | ug/l | 5 | 1.4 | 5.9 | 3.0 | 2.5 | | |
| Phosphorus | mg/l | 10 | 18 | 96 | 48 | 44 | | |
| Specific conductance | uS/cm | 19 | 506 | 565 | 540 | 542 | | |
| Temperature, water | deg C | 18 | 10.8 | 21.1 | 14.5 | 13.4 | | |
| Total suspended solids | mg/l | 10 | 1.6 | 28 | 11.5 | 10.3 | | |
| Total volatile solids | mg/l | 10 | < 1 | 4 | 1.7 | 1.4 | | |
| Transparency, tube with disk | cm | 19 | 37 | > 100 | 87 | > 100 | | |

## Stream assessment results

The assessed AUID on Miller Creek was found to be fully supporting for fish IBI (Table 16). Macroinvertebrate IBI assessments indicate full support for the assessed AUID in the watershed unit. Assessment results from the current dataset indicate that Miller Creek is fully supporting of aquatic life. Water quality data was available on Miller Creek between Boston Coulee and the Mississippi River confluence. Assessments for aquatic recreation in this watershed unit indicate non-support based on an E. coli impairment on the assessed AUID of Miller Creek (Table 18, Figure 14). Unionized ammonia data were meeting the criteria. Nitrate levels met drinking water standards. Insufficient data was available to determine if dissolved oxygen or turbidity were meeting standards. The habitat evaluation on one site on Miller Creek had good habitat conditions (Table 17).

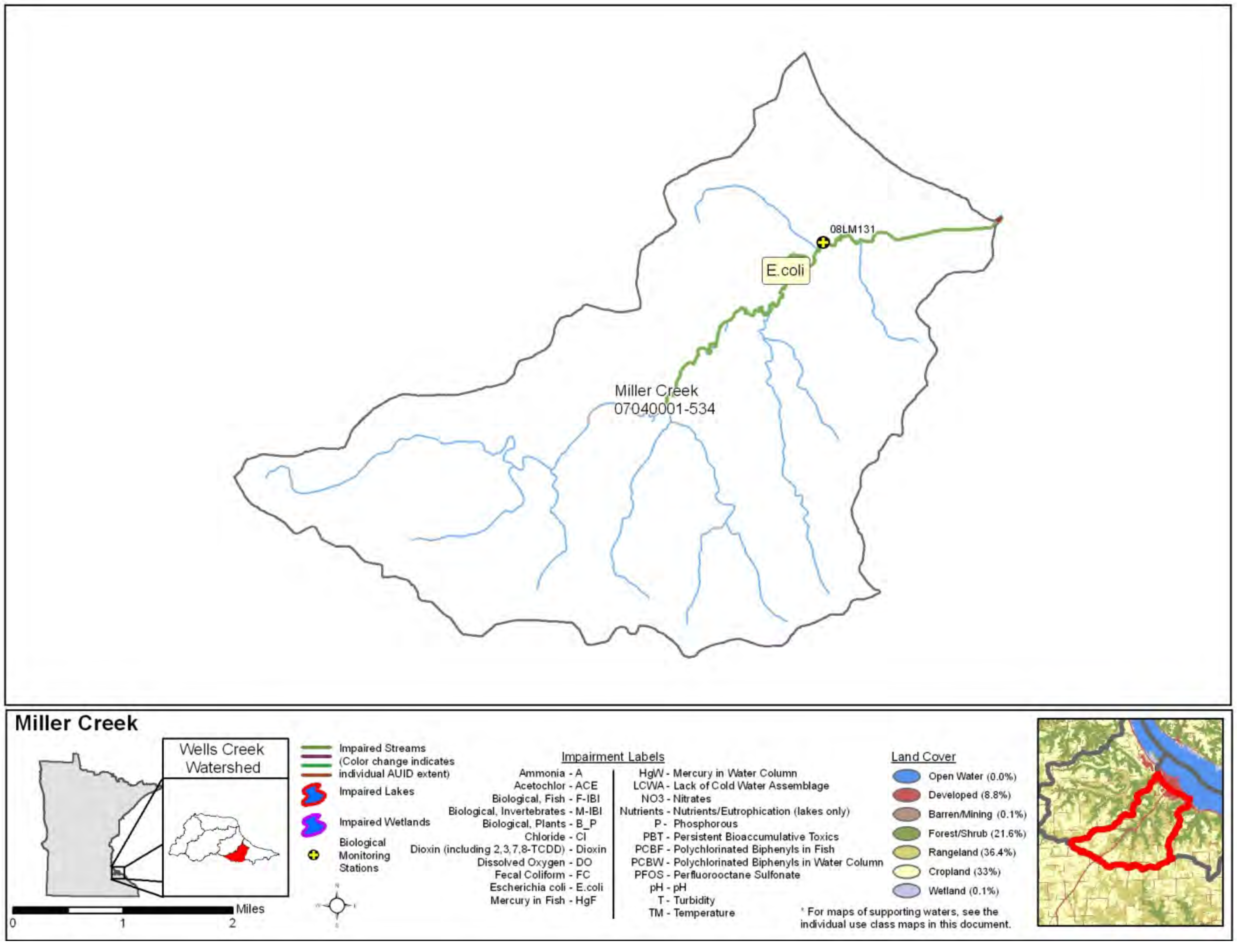


Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Miller Creek watershed unit

# VII. Watershed-Wide Results and Discussion

Assessment results and data summaries are included below for the entire Mississippi River Lake Pepin HUC-8 watershed unit and are grouped by sample type. Summaries are provided for load monitoring and aquatic consumption results on select river reaches in the watershed, and aquatic life and aquatic recreation uses in streams throughout the watershed.

## Load monitoring

Annual FWMCs were calculated for the 2009 sampling year (Table 19) and compared to the River Nutrient Region (RNR) standards (only TP and TSS draft standards are available for the South RNR). It should be noted that while a FWMC exceeding given water quality standard is generally a good indicator that the water body may be out of compliance with the RNR standard, this does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding a given standard, generally 10 percent and greater (MPCA 2010a), over the most recent 10-year period and not based on comparisons with FWMCs. A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10 percent of the individual samples collected over the assessment period were above the standard.

**Table 19. Annual pollutant loads by parameter calculated for Wells Creek**

| | 2009 | |
|---|---|---|
| **Parameter** | **Mass (kg)** | **FWMC mg/L** |
| Total Suspended Solids | 1,371,100 | 51.3 |
| Total Phosphorus | 2,885 | 0.108 |
| Ortho Phosphorus | 1362 | 0.051 |
| Nitrate + Nitrite Nitrogen | 85,147 | 3.19 |

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. However, as a general rule, elevated levels of total suspended solids (TSS) and nitrate plus nitrite-nitrogen (nitrate-N) are generally regarded as “non-point” source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP) can be attributed to both “non-point” as well as “point”, and end of pipe, sources such as industrial or municipal 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 and help explain between-storm and temporal differences in FWMCs and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated.

## 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 during spring snowmelt and 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). High turbidity can also be caused by the erosion of stream banks, bluffs, and ravines caused by high flows (MNACP Final Report 2011).

Currently, the State of Minnesota's TSS standards are moving from the "development phase" into the "approval phase" and must be considered to be draft standards until complete approval. Within the South RNR, the TSS draft standard is 65 mg/L (MPCA 2010c); Wells Creek was below the standard for 2009.

## 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, TP concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

TP standards for Minnesota's rivers are also in the final approval phase and must be considered draft standards until final approval. Within the South RNR, the TP draft standard is 150 ug/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 numeric TP violation for the water to be listed. Concentrations from 2009 show that phosphorus did not exceed the 150 ug/L draft standard.

## Dissolved orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The 2009 FWMC ratio of DOP to TP shows that 47 percent of TP is in the orthophosphate form.

## Nitrate plus nitrite-nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems, and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA 2010b). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-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. This occurs by nitrate-nitrogen stimulating the growth of algae which, through death and biological decomposition, consume large amounts of dissolved oxygen and thereby threaten aquatic life (MPCA and MSUM 2009).

Nitrate- N can also be a common toxicant to aquatic organisms in Minnesota's surface waters with invertebrates appearing to be the most sensitive to nitrate toxicity. Draft nitrate-N standards have been proposed (2012) for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a four-day duration. No load measurements exceeded the standard during monitoring.

## Stream quality

Streams reaches in the Mississippi River Lake Pepin watershed were assessed for aquatic life, aquatic recreation, and aquatic consumption during the 2011 assessment cycle. Twenty-one (21) sites were sampled for biology at the outlets of variable sized sub-watersheds within the Mississippi River Lake Pepin watershed and tributaries during the 10-year assessment window. Eleven streams reaches were sampled for fish, and ten stream reaches were sampled for macroinvertebrates in the Mississippi River Lake Pepin watershed during the 2008 intensive watershed monitoring year. Nine (9) streams that were assessed for aquatic life support were also assessed for aquatic recreation in this effort (Table 19). Two stream reaches were unable to be assessed due to insufficient data, modified channel condition. Eight stream reaches were found to be fully supporting of aquatic life use in the Mississippi River Lake Pepin watershed (Table 19, Figure 16, and Figure 18). The only new aquatic biological impairment was of fish found on Gilbert Creek, and appears to be habitat related. There is already a turbidity impairment on Hay Creek; however, data assessed during the 2011 assessment cycle indicated improved turbidity conditions, but not enough to consider delisting. More turbidity sampling is being conducted in order to determine if delisting is possible.

There are five new aquatic recreation impairments based on E. coli in the Mississippi River Lake Pepin watershed (Figure 15). Agriculture is the primary land use in the watershed (approximately 70 percent). Corn and soybeans make up over half the tilled acreage of the area, with barley, oats and pasture land present. Approximately 10 percent of the land is in grass. Of the grassland, 90 percent is in pasture and may be contributing to the prevalent E. coli impairments due to the high density of livestock in the watershed.

Nitrates are low across the watershed. Aquatic consumption assessments indicate that there are no impairment issues for contaminants in fish tissue (Figure 17, Table 20). Habitat assessments also indicate mostly good to fair habitat conditions throughout the watershed.

**Table 20. Stream AUID assessment results for the Mississippi River Lake Pepin watershed**

| | | | | Supporting | | | Non-support | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mississippi River Lake Pepin | **Area (acres)** | **# AUIDs Sampled** | **# Assessed AUIDs** | **# Aquatic Life** | **# Aquatic Recreation** | **# DW** | **# Aquatic Life** | **# Aquatic Recreation** | **# DW** | **Insufficient Data** |
| **HUC 8 Totals** | 172,215 | **11** | **9** | **8** | **0** | **0** | **1** | **5** | **0** | **8** |
| *Hay Creek* | 30,483 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 2 |
| *Wells Creek* | 44,855 | 3 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 1 |
| *Bullard Creek* | 34,498 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| *Miller Creek* | 11,377 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| *King Creek* | 27,061 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gilbert Creek* | 23,938 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 2 |

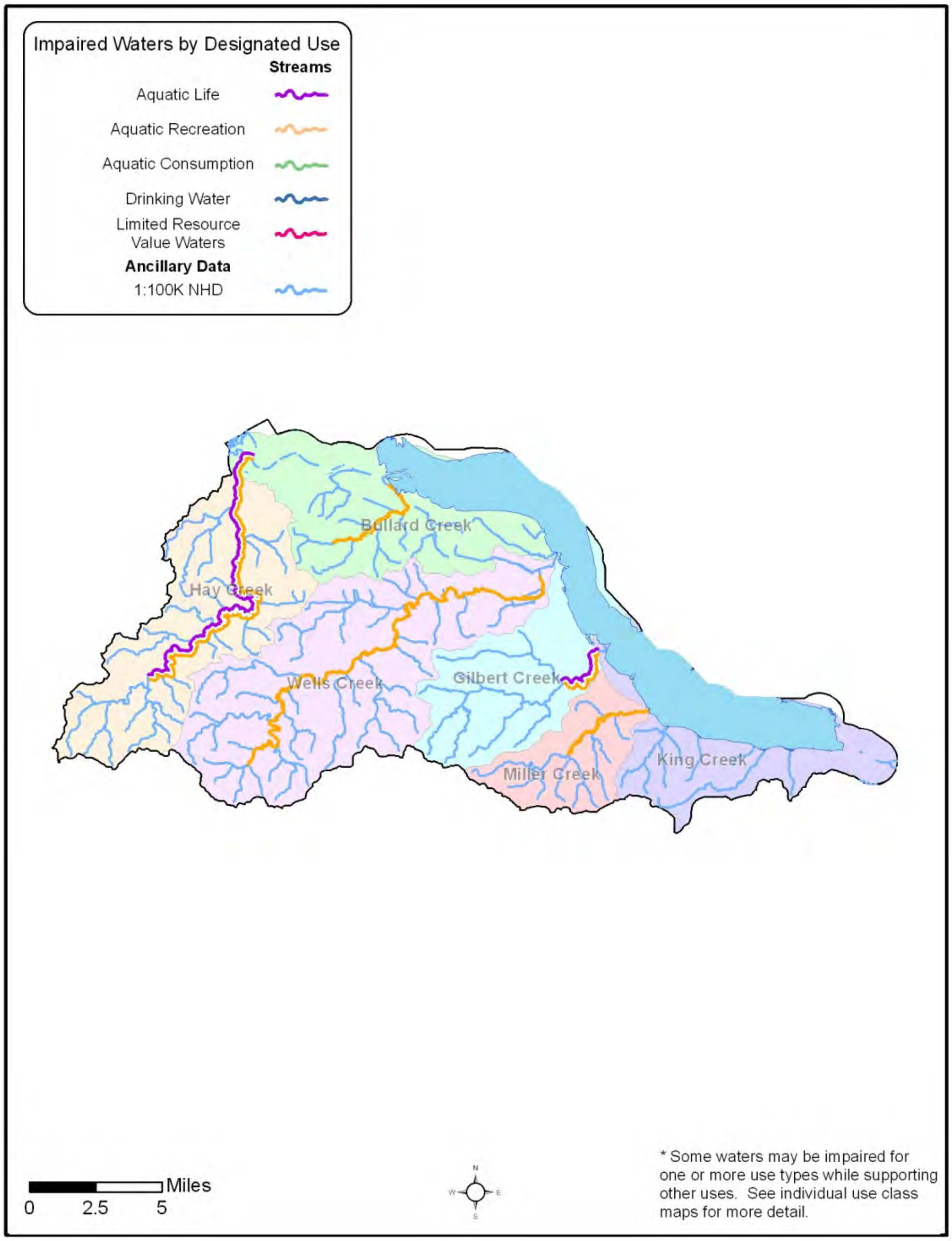


**Figure 15. Map of identified impaired waters for the Mississippi River Lake Pepin watershed**

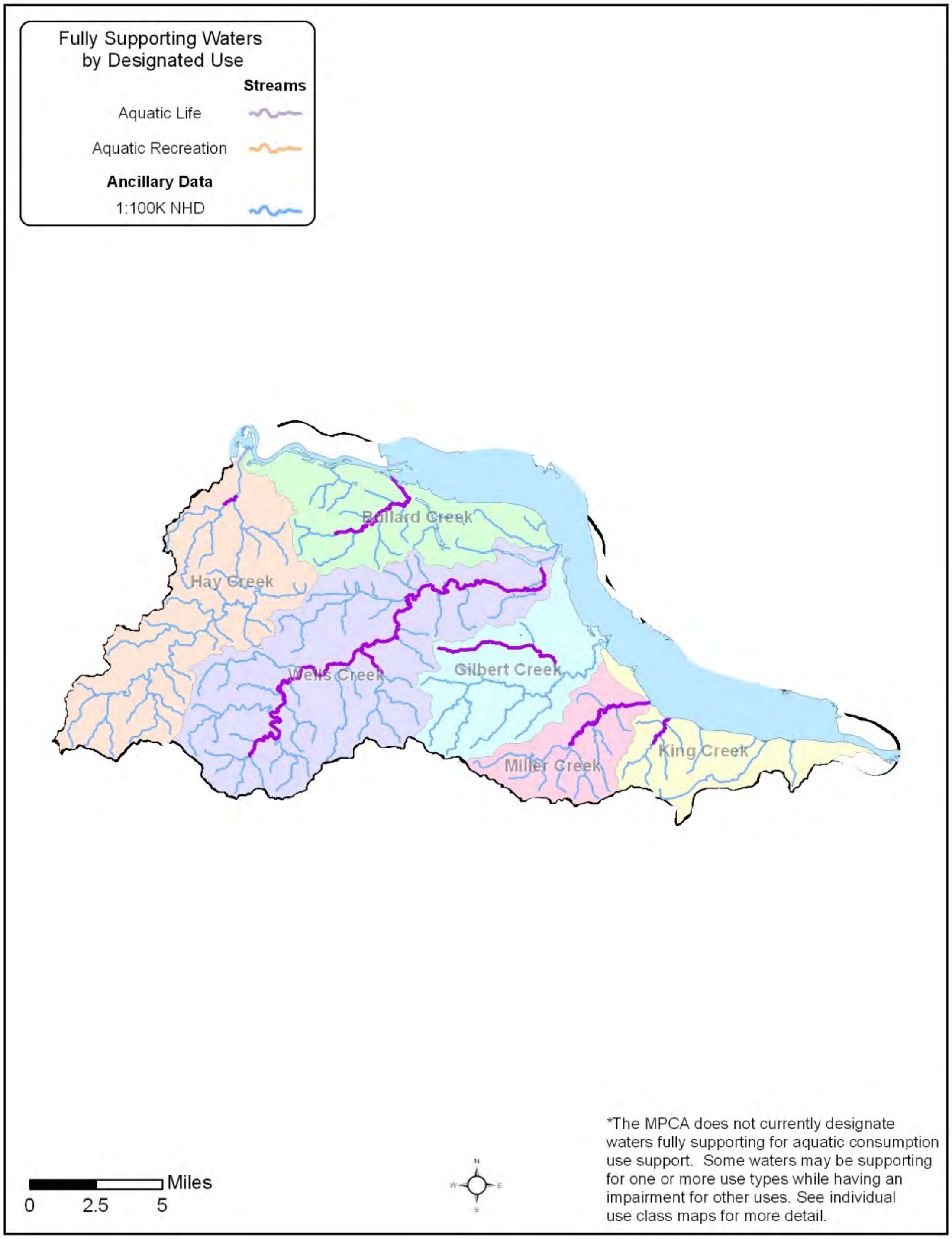


**Figure 16. Map of all supporting waters n the Mississippi River Lake Pepin Watershed**

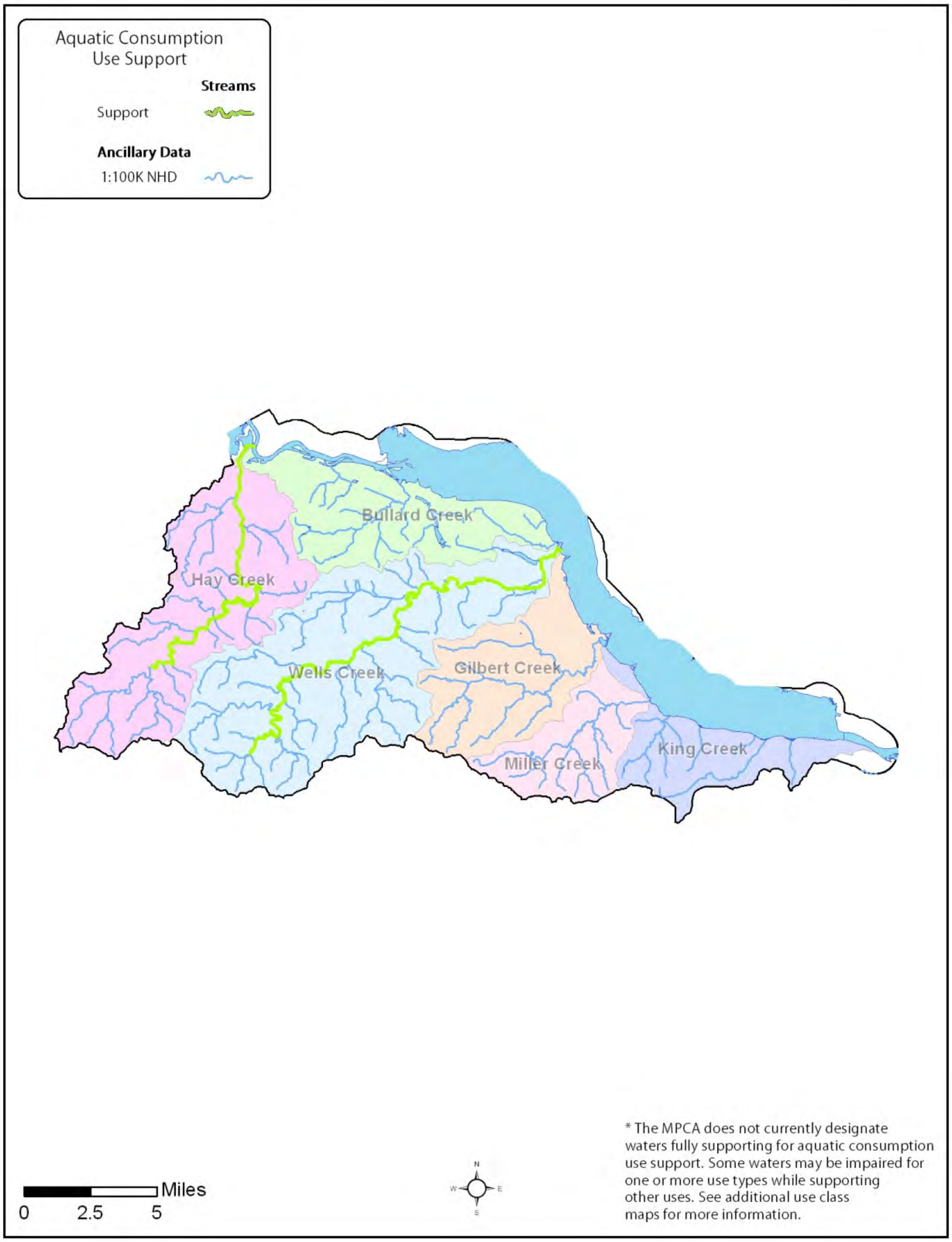


**Figure 17. Aquatic consumption support map for the Mississippi River Lake Pepin watershed**

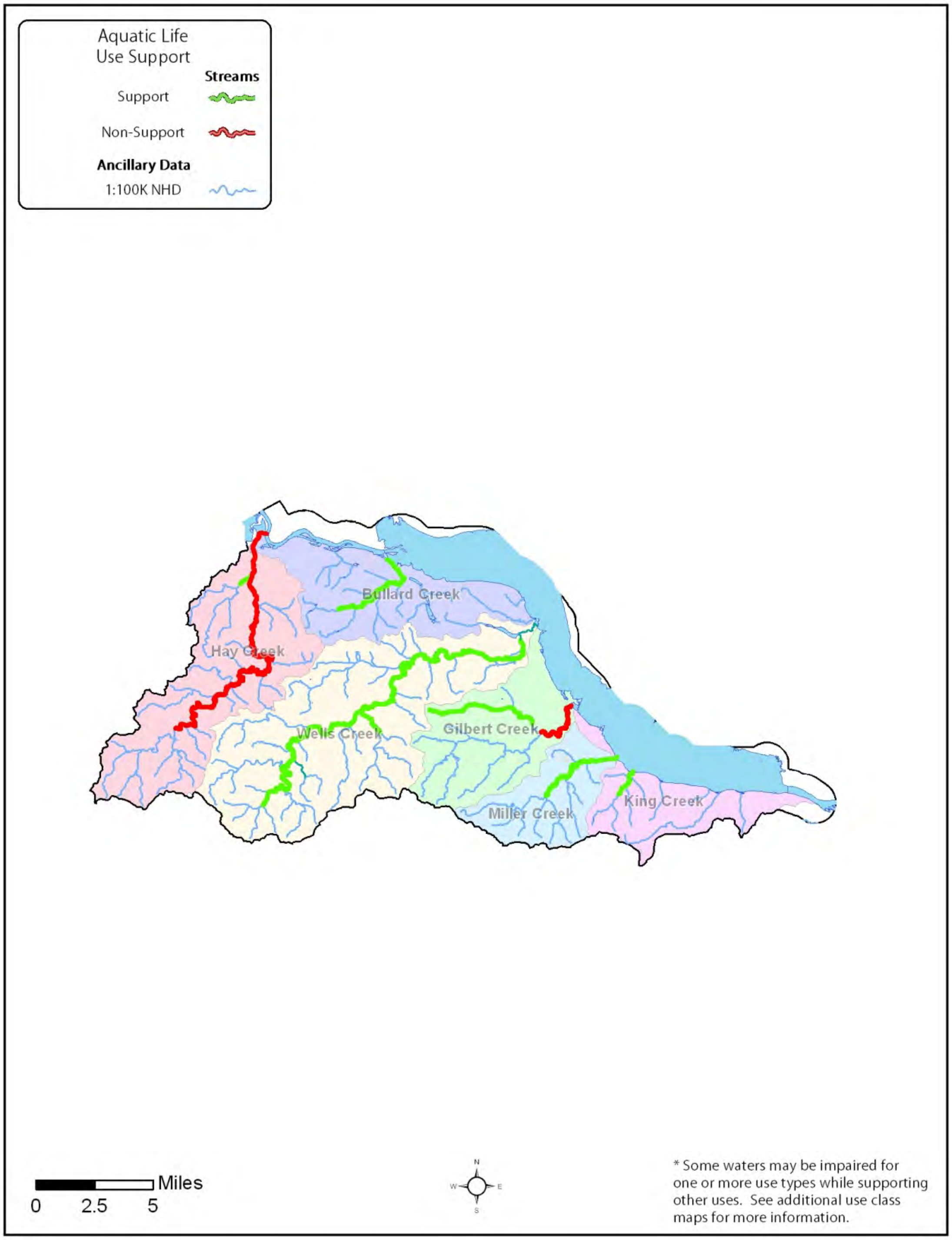


**Figure 18. Aquatic life support map for the Mississippi River Lake Pepin watershed**

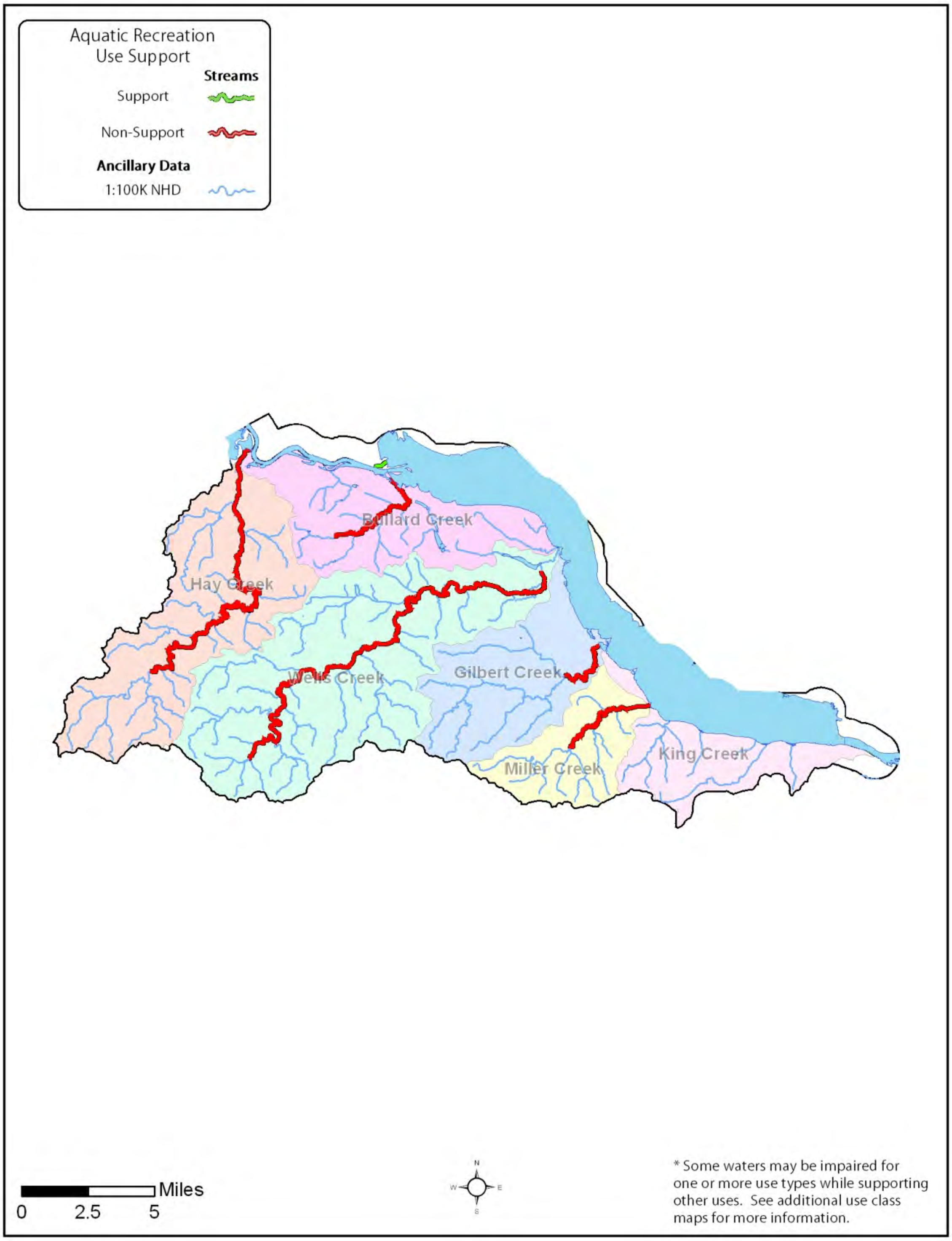


**Figure 19. Aquatic recreation use support map for the Mississippi River Lake Pepin watershed**

# Mississippi River Lake Pepin fish contaminants

## Results

Wells Creek and Hay Creek are not on the Impaired Waters Inventory for mercury or PCBs in fish tissue. A summary of descriptive statistics for mercury and PCBs (Table 20) shows mercury and PCB concentrations from 2008 and 2010 are well below the threshold for impairment. The largest white sucker from Wells Creek and the largest brown trout from Hay Creek had PCBs concentration below the detection limit of 0.025 mg/Kg (parts per million).

MDNR fisheries staff collected brown trout and white sucker from Hay Creek in 1993. Two composite samples of eight and three brown trout had mercury concentrations of 0.023 mg/Kg and 0.063 mg/Kg. A composite sample of 5 white sucker had a mercury concentration of 0.065 mg/Kg. PCBs in the white sucker composite sample were below the detection limit (0.01 mg/Kg).

**Table 21. Descriptive statistics of mercury and PCB concentrations in fish from Wells Creek**

| | | | | | Length (in) | | | Mercury (mg/Kg) | | | PCBs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Waterway | AUID | Species | Year | N | Minimum | Maximum | Mean | Minimum | Maximum | Mean | N | mg/Kg |
| Wells Creek | 07040001-708, -709 | White sucker | 2008 | 5 | 13.2 | 14.8 | 13.8 | 0.110 | 0.160 | 0.134 | 1 | < 0.025 |
| | | Brown trout | 2010 | 6 | 10.5 | 12.0 | 11.4 | 0.018 | 0.041 | 0.030 | NA | NA |
| Hay Creek | 07040001-518 | Brown trout | 2008 | 8 | 10.0 | 13.1 | 11.4 | 0.067 | 0.118 | 0.096 | 1 | < 0.025 |

NA - not available

## Trends

Trend data for water chemistry parameters has typically been obtained using the MPCA's Milestone Monitoring sites. There are no Milestone site locations in the Mississippi River Lake Pepin watershed; therefore, trends for water chemistry cannot be calculated at this time. Sampling will need to be renewed at the Wells site to have enough data from the load monitoring station data to obtain trends for water chemistry. The only other possible trend data available for the watershed is from MPCA's Citizen Stream Monitoring Program (CSMP) and the Citizen Lake Monitoring Program (CLMP). CSMP and CLMP data in the Mississippi River Lake Pepin watershed is very limited and no trends were able to be calculated at this time.

# VIII. Summary and Recommendations

The biological sampling for the Mississippi River Lake Pepin was conducted in the summer of 2008. The official assessment of the watershed was in June 2011, and the planning for Stressor ID began shortly after that. The Stressor ID monitoring plan should be based on the best currently available information from the assessment results in order to begin the Stressor ID process. The stressor ID process will help to identify the causes of biological impairment in the watershed. Overall, one biological impairment was found in the Mississippi Wells watershed (of 14 AUIDs assessed). This biological (fish) impairment was found on Gilbert Creek, a small direct tributary to Lake Pepin.

Use classification questions are one of the complications in this watershed, and will continually be considered as we collect more data. For example, a tributary to Gilbert Creek named Sugarloaf Creek is currently classified as a warm water fishery. We did not have enough information at the time of assessment to recommend a change to a coldwater designation, but with more information this change is a possibility. Currently, this site meets warm water thresholds for fish and invertebrates, but would likely fail coldwater thresholds. The Stressor ID process/data collection may help better inform us on this issue.

Hay Creek is currently on the impaired waters list for aquatic life due to turbidity. During assessment, turbidity was found to be meeting the standard, and could potentially be an incorrect listing. As a result, a continuous turbidity sensor will be deployed to gather the data necessary for potential de-listing of that reach. Aquatic life data indicates support throughout the watershed, so it is not believed that turbidity related to sediment is a stressor in this watershed.

Overall, Stressor ID for Mississippi River Lake Pepin should target Gilbert Creek. Given there is only one impairment (fish), this may provide an opportunity for additional watershed wide work. Sampling activities that will inform the Stressor ID process in Gilbert Creek should be collection of pesticide data, continuous chemistry data, and habitat data. Further analysis of existing data collected by the MPCA, locals, and DNR Fisheries should be done in order to determine what is causing the fish impairment in Gilbert Creek. Comparisons with other nearby streams, like Miller Creek, which have similar size, land use, and slopes should be made to help gain insight into the cause of the problem in the watershed.

Aquatic recreation impairments for bacteria were found extensively throughout the watershed. Stressor ID is focused on aquatic life and will not address the bacteria pollutant directly, but is still an important indicator, because of the relationship to other pollutants that can have an impact on aquatic life. TMDLs will need to be developed to address the aquatic recreation impairments in the watershed.

# IX. Literature Cited


Anderson, H.W., D.F. Farrell, W.L. Broussard, and M.F. Hult, 1975, Water Resources of the Zumbro River watershed, Southeastern Minnesota, USGS Hydrologic Investigations Atlas HA-543, 3 plates.

Chapman, K., B. Olsen, H. Kieweg, and B. Nerbonne. 2008. Groundwater environment and temperature in the Vermillion River watershed. Report prepared for Vermillion River watershed Joint Powers Organization, Apple Valley, MN.

National Climatic Data Center (NCDC). 2011. Climatography of the United States No. 20 (1981-2010). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC.

National Resource Conservation Service (NRCS). 2007. Rapid Watershed Assessment: Rush – Vermillion (MN/WI) HUC: 07040001. NRCS. USDA. http://www.mn.nrcs.usda.gov/technical/rwa/assessments/reports/rush_vermillion.pdf.

White, D. and J.M. Omernik. 2007. Minnesota level III and IV ecoregions map (scale 1:2,500,000). U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, OR. ftp://ftp.epa.gov/wed/ecoregions/mn/mn_map.pdf.

## Appendix 1.-Biological monitoring stations in the Mississippi River Lake Pepin watershed

| Field Number | WBName | Location | DrainSqMi |
|---|---|---|---|
| 03LM001 | Clear Creek | ~1 mile upstream of County Route 2, 7.5 miles NE of Goodhue (DNR station 1.1) | 3.48 |
| 04LM007 | Wells Creek | Upstream of TH 61/63, 1 mi. S of Frontenac | 64.68 |
| 04LM031 | Wells Creek | Upstream of Hwy 5, 4 mi. SE of Hay Creek | 41.09 |
| 04LM070 | Wells Creek | downstream of CR 5, ~3.6 miles WSW of Frontenac station. | 55.92 |
| 04LM089 | Hay Creek | 6 Miles SSW of Redwing | 16.36 |
| 04LM132 | Hay Creek | 2 mi. S of Red Wing | 33.46 |
| 04LM138 | Handshaw Coulee | 0.25 miles above Hwy 61, ~1,5 miles SE of Lake City | 5.10 |
| 08LM127 | Wells Creek | Upstream of Hwy 61, 1 mi. S of Frontenac Station | 67.89 |
| 08LM128 | Hay Creek | Downstream of Featherstone Rd, 0.5 mi. W of Red Wing | 46.03 |
| 08LM129 | Bullard Creek | Upstream of Hwy 61, 4 mi. E of Red Wing | 11.20 |
| 08LM130 | Gilbert Creek | Upstream of CSAH 5, 1 mi. NW of Lake City | 24.07 |
| 08LM131 | Miller Creek | Upstream of W Marion St, 0.5 mi. S of Lake City | 14.66 |
| 08LM132 | Trout Brook | Downstream of Pioneer Rd, 2 mi. SW of Red Wing | 6.21 |
| 08LM133 | Hay Creek | Downstream of 325th St, 5.5 mi. N of Goodhue | 20.12 |
| 08LM134 | Trib. To Wells Creek | Downstream of CR 45, 8 mi. SE of Red Wing | 6.40 |
| 08LM135 | Wells Creek | Downstream of CSAH 5, 4.5 mi. SW of Frontenac Station | 45.87 |
| 08LM136 | Wells Creek | Upstream of CSAH 2, 9 mi. NE of Goodhue | 33.36 |
| 08LM138 | Gilbert Creek | Upstream of CSAH 5, 2.5 mi. W of Lake City | 14.93 |
| 08LM139 | Sugarloaf Creek | Upstream of 340th St, 3 mi. NW of Lake City | 6.35 |
| 10EM111 | Hay Creek | 0.5 mi. upstream of 320th St, 6 mi. SW of Red Wing | 23.78 |

## Appendix 2.-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 54 coliform bacteria that comes from human and animal waste. E. coli levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of E. coli.

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

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

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

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

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

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

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

**Total Suspended Solids (TSS) –** TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. Higher turbidity results in less light penetration which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

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

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

## Appendix 3.-Intensive watershed monitoring stations in the Mississippi River Lake Pepin watershed

| Field Number | STORET ID | Stream Name | Location | HUC 11 |
|---|---|---|---|---|
| 08LM127 | S004-859 | Wells Creek | Upstream of Hwy 61, 1 mi. S of Frontenac Station | 07040001120 |
| 08LM128 | S000-430 | Hay Creek | Downstream of Featherstone Rd, 0.5 mi. W of Red Wing | 07040001100 |
| 08LM129 | S004-863 | Bullard Creek | Upstream of Hwy 61, 4 mi. E of Red Wing | 07040001110 |
| 08LM130 | S001-597 | Gilbert Creek | Upstream of CSAH 5, 1 mi. NW of Lake City | 07040001130 |
| 08LM131 | S002-449 | Miller Creek | Upstream of W Marion St, 0.5 mi. S of Lake City | 07040001140 |

# Appendix 4.-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 | Nitrate and Nitrite | pH | Turbidity | Unionized ammonia |
| **07040001100 (Hay Creek)** | | | | | | | | | | | | | | | | |
| 07040001-518 | Hay Creek | T111 R15W S4, west line to Mississippi R | 18.48 | 1B, 2A | FS | NS | IF | MTS | MTS | MTS | EX | IF | MTS | MTS | MTS | MTS |
| 07040001-537 | Trout Brook | T113 R15W S35, south line to Hay Cr | 0.72 | 1B, 2A | FS | NA | NA | MTS | MTS | | | | | | | |
| **07040001110 (Bullard Creek)** | | | | | | | | | | | | | | | | |
| 07040001-526 | Bullard Creek | T112 R14W S10, west line to T113 R4W S36, north line | 6.27 | 1B, 2A | FS | NS | IF | MTS | MTS | | EX | IF | MTS | MTS | NA | MTS |
| **07040001120 (Wells Creek)** | | | | | | | | | | | | | | | | |
| 07040001-528 | Unnamed creek | Unnamed cr to Wells Cr | 1.66 | 1B, 2A | NA | NA | NA | | | | | | | | NA | |
| 07040001-700 | Unnamed creek | Unnamed cr to Wells Cr | 1.47 | 1B, 2A | FS | NA | | MTS | MTS | | | | | | | |
| 07040001-708 | Wells Creek | Headwaters to Hwy 61 | 22 | 1B, 2A | FS | NS | | MTS | MTS | MTS | EX | MTS | MTS | MTS | IF | MTS |
| **07040001130 (Gilbert Creek)** | | | | | | | | | | | | | | | | |
| 07040001-530 | Gilbert Creek | Sugarloaf Cr to T112 R12W S31, east line | 3.65 | 1B, 2A | NS | NS | IF | EXP | MTS | | EX | IF | MTS | MTS | NA | MTS |
| 07040001-532 | Gilbert Creek | T111 R13W S4, west line to Sugarloaf Cr | 6.49 | 1B, 2A | NA | NA | NA | | | | | | | | | |
| 07040001-662 | Sugarloaf Creek | Headwaters to T112 R13W S36, south line | 5.28 | 2C | FS | NA | | EXP | MTS | | | | | | | |
| **07040001140 (Miller Creek)** | | | | | | | | | | | | | | | | |
| 07040001-534 | Miller Creek | Boston Coulee to Mississippi R | 5.39 | 1B, 2A | FS | NS | IF | MTS | MTS | | EX | | MTS | | NA | MTS |
| **07040001150 (King Creek)** | | | | | | | | | | | | | | | | |
| 07040001-553 | Handshaw Coulee (Second Creek) | T111 R12W S15, south line to Mississippi R | 1.49 | 1B, 2A | FS | NA | NA | MTS | MTS | | | | | | | |

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

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

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

## Appendix 5.1-Minnesota statewide IBI thresholds and confidence limits

| Class # | Class Name | Use Class | Threshold | Confidence Limit | Upper | Lower |
|---|---|---|---|---|---|---|
| **Fish** | | | | | | |
| 1 | Southern Rivers | 2B | 39 | ±11 | 50 | 28 |
| 2 | Southern Streams | 2B | 45 | ±9 | 54 | 36 |
| 3 | Southern Headwaters | 2B | 51 | ±7 | 58 | 44 |
| 4 | Northern Rivers | 2B | 35 | ±9 | 44 | 26 |
| 5 | Northern Streams | 2B | 50 | ±9 | 59 | 41 |
| 6 | Northern Headwaters | 2B | 40 | ±16 | 56 | 24 |
| 7 | Low Gradient | 2B | 40 | ±10 | 50 | 30 |
| 8 | Southern Coldwater | 2A | 45 | 13 | 58 | 32 |
| 9 | Northern Coldwater | 2A | 37 | 10 | 47 | 27 |
| **Class #** | **Class Name** | **Use Class** | **Threshold** | **Confidence Limit** | **Upper** | **Lower** |
| 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 | 26.0 | ±12.4 | 38.4 | 13.6 |
| 9 | Southern Coldwater | 2A | 46.1 | ±13.8 | 59.9 | 32.3 |

# Appendix 5.2-Biological monitoring results-fish IBI

| HUC11 | AUID | Station ID | Drainage Area Sq. Mi | FishClass | Threshold | FishIBI |
|---|---|---|---|---|---|---|
| 07040001100 | 07040001-537, Trout Brook, T113 R15W S35, south line to Hay Cr | 08LM132 | 6.21 | 10 | 45 | 93 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 08LM128 | 46.03 | 10 | 45 | 56 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 04LM089 | 16.36 | 10 | 45 | 72 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 04LM132 | 33.46 | 10 | 45 | 62 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 08LM133 | 20.12 | 10 | 45 | 62 |
| 07040001110 | 07040001-526, Bullard Creek, T112 R14W S10, west line to T113 R4W S36, north line | 08LM129 | 11.20 | 10 | 45 | 78 |
| 07040001120 | 07040001-700, Unnamed creek, Unnamed cr to Wells Cr | 08LM134 | 6.40 | 10 | 45 | 93 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM070 | 55.92 | 10 | 45 | 62 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM136 | 33.36 | 10 | 45 | 55 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM031 | 41.09 | 10 | 45 | 68 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM007 | 64.68 | 10 | 45 | 63 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM135 | 45.87 | 10 | 45 | 65 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM127 | 67.89 | 10 | 45 | 41 |
| 07040001120 | 07040001-700, Unnamed creek, Unnamed cr to Wells Cr | 08LM134 | 6.40 | 10 | 45 | 94 |
| 07040001120 | 07040001-529, Clear Creek, T111 R14W S15, west line to Wells Cr | 03LM001 | 3.48 | 10 | 45 | 60 |
| 07040001130 | 07040001-530, Gilbert Creek, Sugarloaf Cr to T112 R12W S31, east line | 08LM130 | 24.07 | 10 | 45 | 42 |
| 07040001130 | 07040001-662, Sugarloaf Creek, Headwaters to T112 R13W S36, south line | 08LM139 | 6.35 | 3 | 51 | 54 |
| 07040001140 | 07040001-534, Miller Creek, Boston Coulee to Mississippi R | 08LM131 | 14.66 | 10 | 45 | 62 |
| 07040001150 | 07040001-553, Handshaw Coulee (Second Creek), T111 R12W S15, south line to Mississippi R | 04LM138 | 5.10 | 10 | 45 | 77 |

## Appendix 5.3-Biological monitoring results-macroinvertebrate IBI

| HUC11 | AUID | Station ID | WBName | Drainage Area Sq. Mi | InvertClass | Threshold | MIBI |
|---|---|---|---|---|---|---|---|
| 07040001100 | 07040001-537, Trout Brook, T113 R15W S35, south line to Hay Cr | 08LM132 | Trout Brook | 6.21 | 9 | 46.1 | 59.45 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 08LM128 | Hay Creek | 46.03 | 9 | 46.1 | 89.96 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 04LM089 | Hay Creek | 16.36 | 9 | 46.1 | 60.49 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 04LM132 | Hay Creek | 33.46 | 9 | 46.1 | 79.07 |
| 07040001100 | 07040001-518, Hay Creek, T111 R15W S4, west line to Mississippi R | 08LM133 | Hay Creek | 20.12 | 9 | 46.1 | 46.49 |
| 07040001110 | 07040001-526, Bullard Creek, T112 R14W S10, west line to T113 R4W S36, north line | 08LM129 | Bullard Creek | 11.20 | 9 | 46.1 | 53.34 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM127 | Wells Creek | 67.89 | 9 | 46.1 | 55.91 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM127 | Wells Creek | 67.89 | 9 | 46.1 | 65.22 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM135 | Wells Creek | 45.87 | 9 | 46.1 | 32.53 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM135 | Wells Creek | 45.87 | 9 | 46.1 | 59.93 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM007 | Wells Creek | 64.68 | 9 | 46.1 | 74.29 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM031 | Wells Creek | 41.09 | 9 | 46.1 | 53.47 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 08LM136 | Wells Creek | 33.36 | 9 | 46.1 | 52.66 |
| 07040001120 | 07040001-708, Wells Creek, Headwaters to Hwy 61 | 04LM070 | Wells Creek | 55.92 | 9 | 46.1 | 71.41 |
| 07040001120 | 07040001-700, Unnamed creek, Unnamed cr to Wells Cr | 08LM134 | Trib. to Wells Creek | 6.40 | 9 | 46.1 | 52.30 |
| 07040001130 | 07040001-662, Sugarloaf Creek, Headwaters to T112 R13W S36, south line | 08LM139 | Sugarloaf Creek | 6.35 | 6 | 46.8 | 60.65 |
| 07040001130 | 07040001-530, Gilbert Creek, Sugarloaf Cr to T112 R12W S31, east line | 08LM130 | Gilbert Creek | 24.07 | 9 | 46.1 | 53.96 |
| 07040001140 | 07040001-534, Miller Creek, Boston Coulee to Mississippi R | 08LM131 | Miller Creek | 14.66 | 9 | 46.1 | 56.59 |
| 07040001150 | 07040001-553, Handshaw Coulee (Second Creek), T111 R12W S15, south line to Mississippi R | 04LM138 | Handshaw Coulee | 5.10 | 9 | 46.1 | 82.48 |
| 07040001150 | 07040001-553, Handshaw Coulee (Second Creek), T111 R12W S15, south line to Mississippi R | 04LM138 | Handshaw Coulee | 5.10 | 9 | 46.1 | 61.75 |

# Appendix 6.1-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 5.1). 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 |
| 10 | Southern Coldwater | >45 | 45-30 | <30 |
| **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 |
| 9 | Southern Coldwater | >46.1 | 46.1-31.1 | <31.1 |

## Appendix 6.2-Channelized stream AUID IBI score FISH

| HUC11 | AUID | FieldNum | DrainSqMi | Fish Class | Good | Fair | Poor | FishIBI |
|---|---|---|---|---|---|---|---|---|
| 07040001130 | 07040001-532, Gilbert Creek, T111 R13W S4, west line to Sugarloaf Cr | 08LM138 | 14.93 | 10 | 100-45 | 44-30 | 29-0 | 52 |

## Appendix 6.3-Channelized stream AUID IBI score macroinvertbrate

| HUC11 | AUID | FieldNum | WBName | DrainSqMi | InvertClass | Good | Fair | Poor | MIBI |
|---|---|---|---|---|---|---|---|---|---|
| 07040001130 | 07040001-532, Gilbert Creek, T111 R13W S4, west line to Sugarloaf Cr | 08LM138 | Gilbert Creek | 14.93 | 9 | 100-46.1 | 46-31 | 30.9-0 | 61.87 |