Minnesota River-Mankato Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

October 2016

Authors

MPCA Minnesota River – Mankato Watershed Report Team:
Dan Fettig, Jordan Donatell, Joel Chirhart, Mark Gernes, David Duffey, Bruce Monson, Shawn Nelson, Pat Baskfield, Dan Helwig, Brian Spindler, Kim Laing

Contributors/acknowledgements

Citizen Stream Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture
Great River Greening
Redwood – Cottonwood River Control Area
MPCA Biological Monitoring Unit Seasonal Staff

Project dollars provided by the Clean Water Fund (from the Clean Water, Land and Legacy Amendment).

The MPCA is reducing printing and mailing costs by using the Internet to distribute reports and information to wider audience. Visit our website for more information.

MPCA reports are printed on 100% post-consumer recycled content paper manufactured without chlorine or chlorine derivatives.

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

This report is available in alternative formats upon request, and online at www.pca.state.mn.us.

Document number: wq-ws3-07020007b

List of acronyms

AUID Assessment Unit Identification Determination

AQL Aquatic Life Use Standards

AQR Aquatic Recreation Use Standards

CCSI Channel Condition and Stability Index

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CTY County

CWA Clean Water Act

CWLA Clean Water Legacy Act

DOP Dissolved Orthophosphate

E Eutrophic

EQuIS Environmental Quality Information System

EU Tiered Aquatic Life Exceptional Use Class

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

F-IBI Fish Community Index of Biotic Integrity

FS Full Support

FWMC Flow Weighted Mean Concentration

GU Tiered Aquatic Life General Use Class

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

M-IBI Macroinvertebrate Index of Biotic Integrity

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MNDNR Minnesota Department of Natural Resources

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

MU Tiered Aquatic Life Modified Use Class

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WHAF Minnesota Department of Natural Resources Watershed Health Assessment Framework online tool.

WPLMN Water Pollutant Load Monitoring Network

Contents

Tables

Figures

Executive summary

The Minnesota River-Mankato Watershed (HUC 07020007) drains 1,347 square miles (861,882 acres) in South Central Minnesota and contains 1,564 miles of streams. The watershed encompasses the Minnesota River from approximately Redwood Falls to Saint Peter. Portions of nine counties make up the watershed, including: Nicollet, Brown, Renville, Blue Earth, Redwood, Le Sueur, Cottonwood, Sibley, and a very small portion of Watonwan. This report discusses monitoring and assessment results for the tributaries to the Minnesota River. The mainstem Minnesota River monitoring and assessment results will be discussed in a separate Large River monitoring and assessment report.

In 2013, the Minnesota Pollution Control Agency (MPCA) undertook an intensive watershed monitoring effort of the Minnesota River-Mankato Watershed's surface waters utilizing biological and water chemistry data to assess the condition of the waterbodies. Of 97 Assessment Unit Identification Determinations (AUID's), 86 were assessed, with 14 supporting Aquatic Life (AQL), and no AUID's supporting of Aquatic Recreation. Of the non-supporting waters, 54 AUID's did not support Aquatic Life and 27 AUID's did not support Aquatic Recreation.

As part of this effort, MPCA staff joined with local partners to complete stream water chemistry sampling at the outlets of 13 of the subwatersheds. In 2015, a holistic approach was taken to assess all of the watersheds' surface waterbodies for support of aquatic life, recreation, and fish consumption where sufficient data were available. During this process, 11 lakes and 74 streams were assessed for aquatic recreation and/or aquatic life. Biological data, including Indexes of Biotic Integrity for lakes were used to assess aquatic life use on lakes, two were found to be not supporting for aquatic life use, while two were full support. Contributing watershed land uses are clearly impacting lakes in this watershed.

Fish community data was used to assess Aquatic Life Use (AQL) for 54 AUID's, of which 18 were supporting of Aquatic Life and 36 were not supporting of Aquatic Life. Among the AQL supporting AUID's, 6 fall under the General Use category, and 12 are under the Modified Use designation. For AQL non-supporting AUID's, 20 were designated as General Use, 12 were designated Modified Use, and 4 are cold water, General Use. Streams with lower IBI thresholds in designated Modified Use AUID's had a greater proportion of supporting Aquatic Life (50% supporting, 50% not supporting) compared to the 23% supporting and 76% not supporting demonstrated within the General Use class. All of the coldwater streams did not support Aquatic Life likely due to the marginal conditions found in trout streams in this region.

Fish community assemblages were often dominated by species tolerant of degraded habitat and water quality conditions, as well as variable hydrology. The most abundant five species collected during the monitoring effort are all considered tolerant. Large abundance of these tolerant species were found in each survey (43-78%) resulting in lower F-IBI scores. Sensitive species were found in the watershed, but at fewer locations, and in lower abundance. The most common five sensitive species were present between 5-30% of the surveys. Sensitive species are indicative of good habitat condition, stable stream channels, and better water quality conditions. Declines in these stream conditions severely limit the presence of these species.

A similar pattern was noted among stream macroinvertebrates in the Minnesota Mankato Watershed; 70% of assessed stream reaches were determined to harbor impaired macroinvertebrate communities. Of the 19 assessment units that were determined to have macroinvertebrate communities supporting of the relevant designated use, three were designated general aquatic life use streams (Unnamed Creek, -694, Threemile Creek, -704, and Unnamed Creek, -663), and one was a stream being proposed to be designated as coldwater (Unnamed Creek, -668).

The Minnesota River has demonstrated to be a significant contributor of the Total Suspend Solids (TSS), Total Phosphorus (TP), and Nitrate/Nitrite pollutant load in the Mississippi River. A MPCA Load Monitoring station on Seven Mile Creek is representative of the pollutant inputs to the mainstem Minnesota River among the tributaries in the Minnesota River-Mankato watershed. Data from this station frequently showed elevated levels of TSS, TP, and Nitrate/Nitrite, indicating that this station is contributing to the pollutant inputs to the Minnesota River, and the major watershed is a source of pollutants for downstream waters, such as the Mississippi River. Implementing Best Management Practices in more areas of the watershed could help reduce the pollutant load in the Minnesota River and downstream waters.

Fish contaminants within the watershed were tested at nine lakes for mercury, and seven lakes for polychlorinated biphenyls (PCB's). No streams were tested within the watershed due to difficulty collecting a sufficient sample. Five lakes are impaired for mercury, while no lakes are impaired for PCB's. Of the five lakes impaired for mercury, four of these are covered by the Statewide Mercury Total Maximum Daily Load (TMDL). Lake George had high enough mercury concentrations in fish to warrant a TMDL for mercury to cover the waterbody.

In this agriculturally dominated watershed, the primary groundwater concerns are arsenic in drinking water, and the quantity of groundwater. Continued monitoring of arsenic in drinking water wells establishes the extent of this contaminant. Increasing groundwater withdrawals coupled with slight decreasing flows in some streams reinforces the need for continued need for monitoring groundwater.

Approximately 44%, or 382,940 acres, of the historical wetland have been lost since over the course of European settlement. Subwatersheds within the Minnesota River-Mankato Watershed have lost between 30-65% of the historical wetlands, depending on the location of the watershed. Many of the current wetlands are found in the floodplain of the Minnesota River, making the river valley a significant natural corridor. Wetlands that remain are likely to be degraded due to invasive species, altered hydrology, as well as nutrient enrichment. Restoration of drained wetlands would positively affect the condition of waterbodies within the watershed.

Introduction

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

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment. To successfully prevent and address problems, decision makers need good information regarding the status of the resources, potential and actual threats, options for addressing the threats and data on the effectiveness of management actions.

The MPCA's monitoring efforts are focused on providing that critical information. Overall, the MPCA is striving to provide information to assess, and ultimately, to restore or protect the integrity of Minnesota's waters.

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

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

This watershed-wide monitoring approach was implemented in the Minnesota River – Mankato Watershed beginning in the summer of 2013. The Minnesota River mainstem flows throughout this entire 8-HUC watershed, but was not monitored as part of the intensive watershed monitoring strategy, rather it will be monitored and assessed under a Large River Monitoring project starting in 2014. This report provides a summary of all water quality assessment results in the Minnesota River – Mankato Watershed, excluding the mainstem Minnesota River, and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Watershed Pollutant Load Monitoring Network

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers. Since the program's inception in 2007, the WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MNDNR) flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and MPCA to compute pollutant loads for 200 stream and river monitoring sites across Minnesota. Monitoring sites span three ranges of scale with annual loads calculated for basin and major watershed sites and seasonal loads for subwatershed sites:

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

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

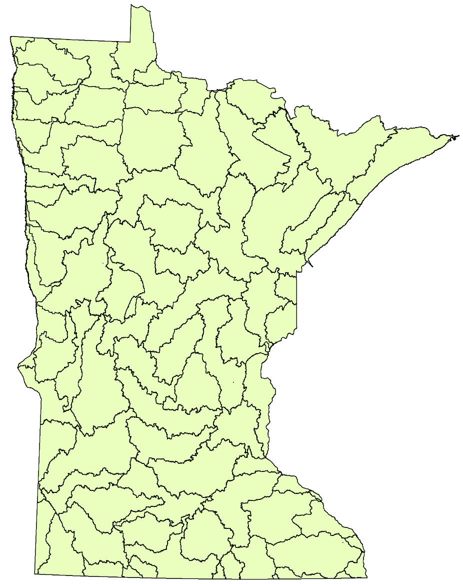


Figure 1. Major watersheds within Minnesota (8-Digit HUC).

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

Data will also be used to assist with: TMDL studies and implementation plans; watershed modeling efforts; watershed research projects and watershed restoration and protection strategies.

More information can be found at the WPLMN website including a map of the sites.

The WPLMN monitors five sites contained within the Minnesota River-Mankato 8 digit HUC Watershed (Figure 2 and Table 63): three basin sites located on the Minnesota River and two subwatershed sites that drain to the Minnesota River. The three Minnesota River mainstem sites include the Minnesota River at Morton (DNR/MPCA ID 28012001, USGS ID 05316580, EQuis ID S000-145), the Minnesota River at Judson (DNR/MPCA ID 28054001, EQuis ID S001-759), and the Minnesota River at St Peter, MN 22 (DNR/MPCA ID 28038002, USGS ID 5325300, EQuis ID S000-041). Subwatershed sites include the Little Cottonwood River near Courtland, MN68 (DNR/MPCA ID 28057001, USGS ID 05317200, EQuis ID S000-377), and Seven Mile Creek near St. Peter, US169 (DNR/MPCA ID 28063001, EQuis ID S002-937). The Minnesota River at Morton (MNR-Morton) gage is operated by the USGS and is located at the head of the 8 digit HUC. The Minnesota River at Judson (MNR-Judson) gage is operated by the MNDNR and is located approximately 11 miles above the confluence of the Blue Earth River with the Minnesota River in Mankato. The Minnesota River at St Peter (MNR-St Peter) gage is operated by the MNDNR and is located near the end of the 8 digit HUC, approximately 13 miles downstream of Mankato. Monitoring information from the Minnesota River mainstem sites along with assessment information collected from the Blue Earth River and its major tributaries, the Watonwan and Le Sueur rivers, which outlet to the Minnesota River Mankato Watershed, will be touched on in this watershed report. More extensive detail will be provided in separate watershed assessment reports (Watonwan, Le Sueur, and Blue Earth rivers) and the "Minnesota River Large River Report," (Minnesota River mainstem sites) due to be published in 2017. Data within this report will largely focus on one WPLMN subwatershed site contained within the Minnesota River-Mankato watershed: Seven Mile Creek near St. Peter, US169. The Little

Cottonwood River near Courtland, MN68 gage was added to the WPLMN in 2013, data from this site was not available at the time of this report.

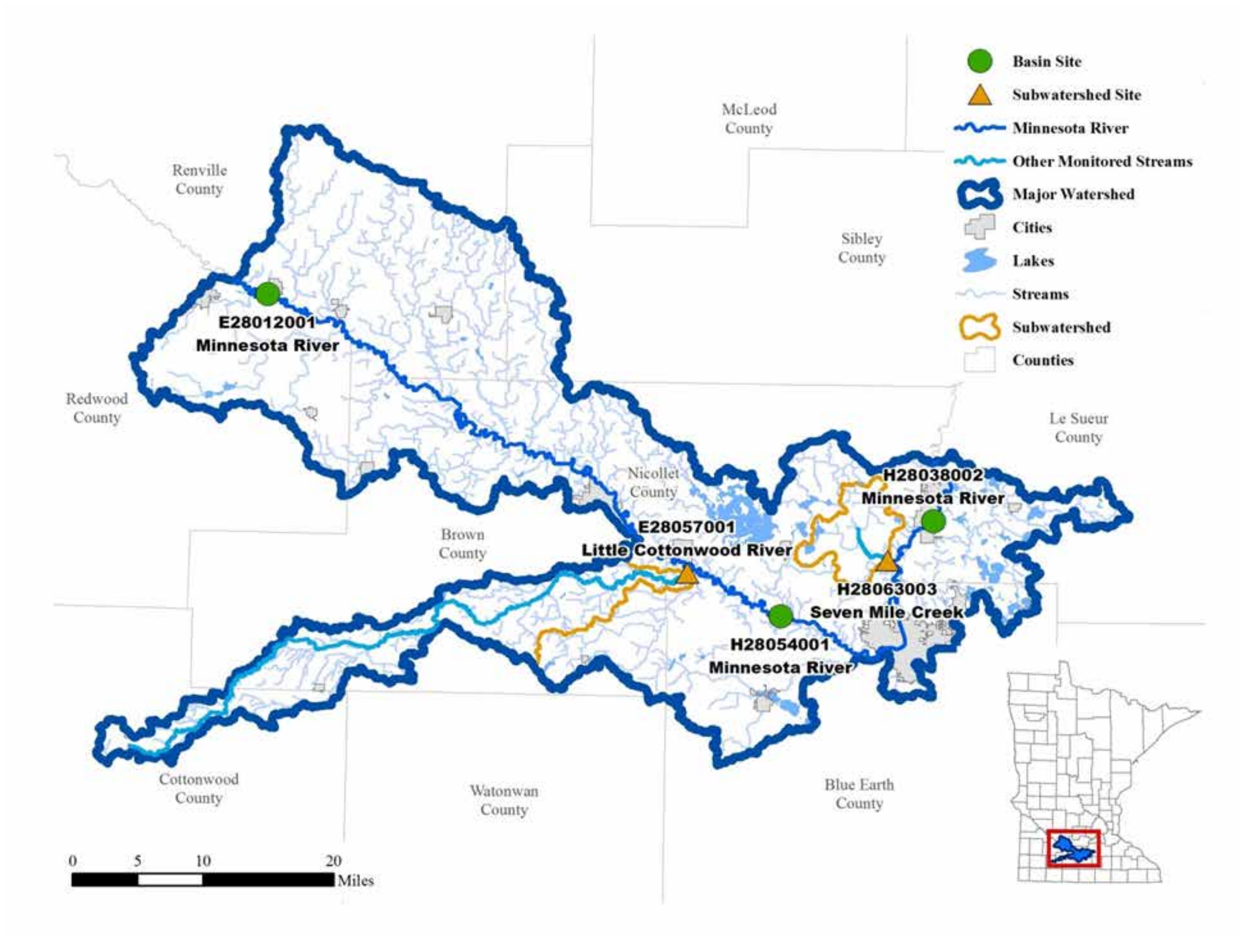


Figure 2. WPLMN monitoring sites in Minnesota River-Mankato Watershed.

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale (Figure 3). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 80 major watersheds (8-HUC) within Minnesota. Using this approach many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least one year within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, 8-HUC, aggregated 12-HUC and 14-HUC (Figure 3). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the 8-HUC scale. The outlet of the major 8-HUC watershed (purple dot in Figure 4) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The aggregated 12-HUC is the next smaller subwatershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated 12-HUC outlet (green dots in Figure 4) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each aggregated 12-HUC, smaller watersheds (14 HUCs, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated 12-HUC tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 4).

The Minnesota River – Mankato Watershed is different from a traditional watershed, with the Minnesota River flowing throughout the watershed. Because it is a flow-thru watershed, stream sites are selected slightly differently. The aggregated 12-HUC scale consists of major tributaries to the Minnesota River, or areas of numerous smaller tributaries that directly flow into the mainstem Minnesota River. When the Aggregated 12-HUC is a major tributary, the outlet is sampled for biology and water chemistry to asses for aquatic life and recreation (green dots in Figure 4), the same as a traditional watershed. In some cases, were the major tributary is large and a suitable fish contaminant sample may be collected, such as the Little Cottonwood River, fish contaminants for aquatic consumption assessments may be collected at the aggregated 12-HUC outlet (purple dots Figure 4). When an aggregated 12-HUC watershed consists of numerous smaller direct tributaries, outlet sites in the most of the subwatersheds are typically only sampled for biology. In some cases, the largest tributary's pour point may be selected as a water chemistry site if the stream is suitable (green dots Figure 4). Minor watershed (14 HUC) outlets (red dots in Figure 4) are sampled for biology, the same as in a traditional watershed.

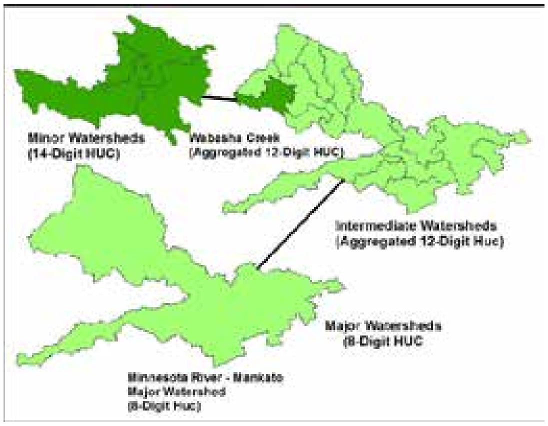


Figure 3. The Intensive Watershed Monitoring Design.

Within the intensive watershed monitoring strategy, lakes are selected to represent the range of conditions and lake type (size and depth) found within the watershed. Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported. Lakes are sampled monthly from May-September for a two-year period. There is currently no tool that allows us to determine if lakes are supporting aquatic life; however, a method that includes monitoring fish and aquatic plant communities is in development.

Specific locations for sites sampled as part of the intensive monitoring effort in the Minnesota River – Mankato Watershed are shown in Figure 4 and are listed in Appendix 2.1, Appendix 2.2, and Appendix 3.2.

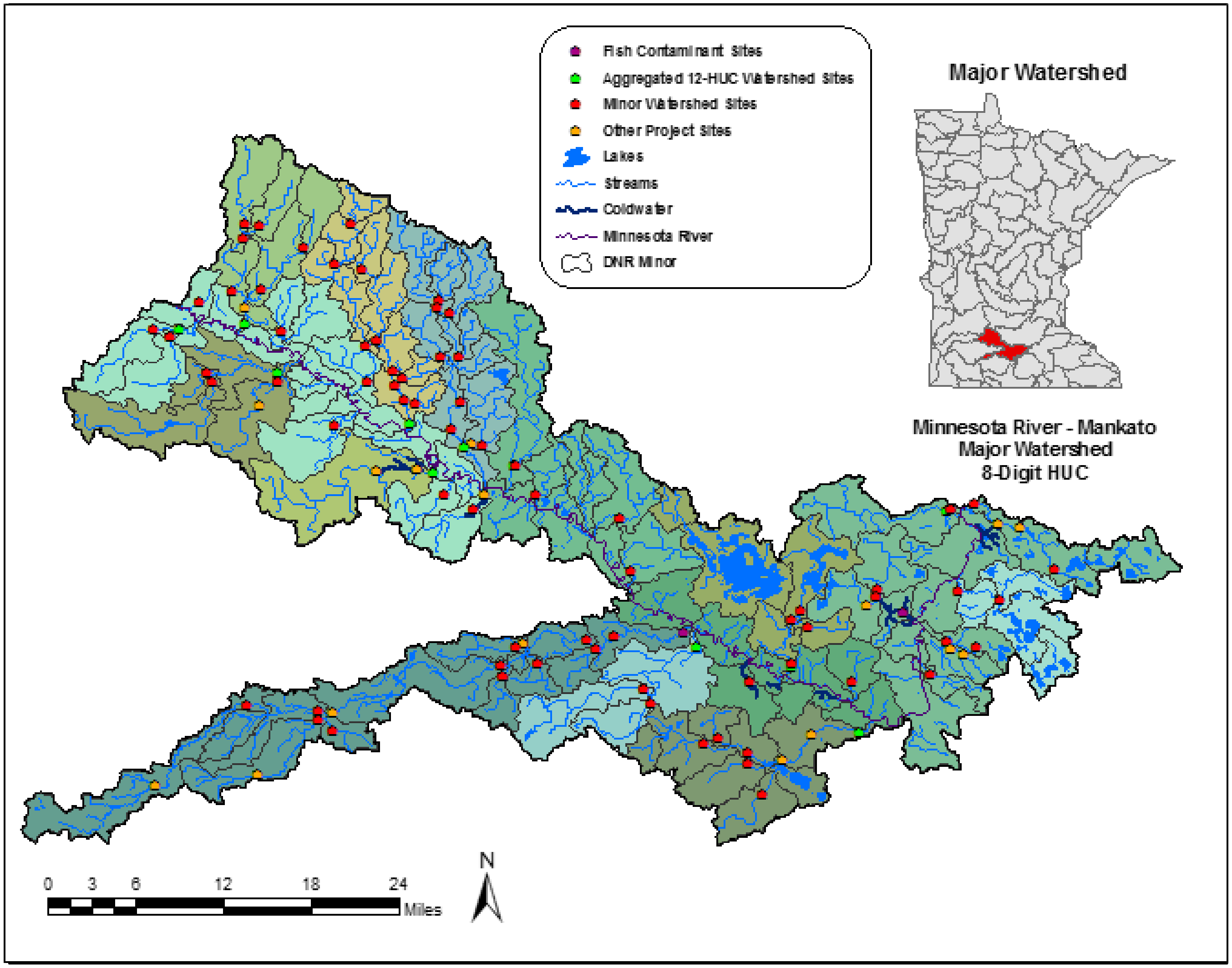


Figure 4. Intensive watershed monitoring stations for streams in the Minnesota River – Mankato Watershed

Citizen and local monitoring

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

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 5 provides an illustration of the locations where citizen monitoring data were used for assessment in the Minnesota River – Mankato Watershed.

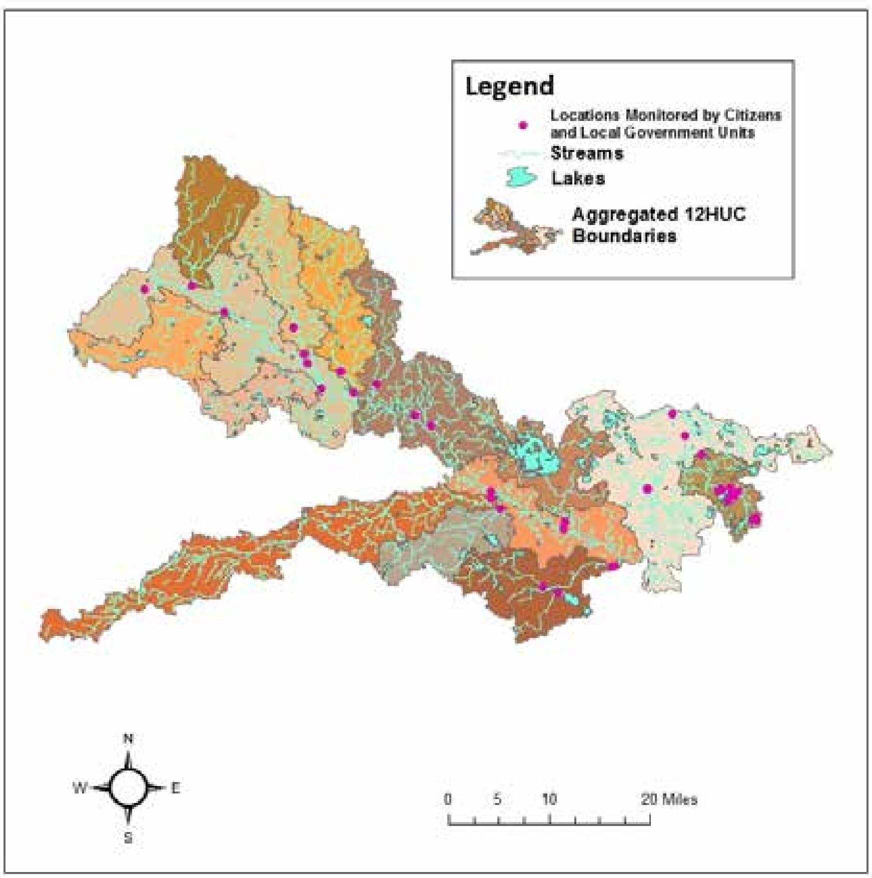


Figure 5. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Minnesota River – Mankato Watershed.

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 as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012). 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. These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams and wetlands are protected for aquatic life and recreation where these uses are attainable. Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses.

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

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

Table 1. Table of Proposed Tiered Aquatic Life Use Standards.

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

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

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

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

Assessment units

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

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 6.

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

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

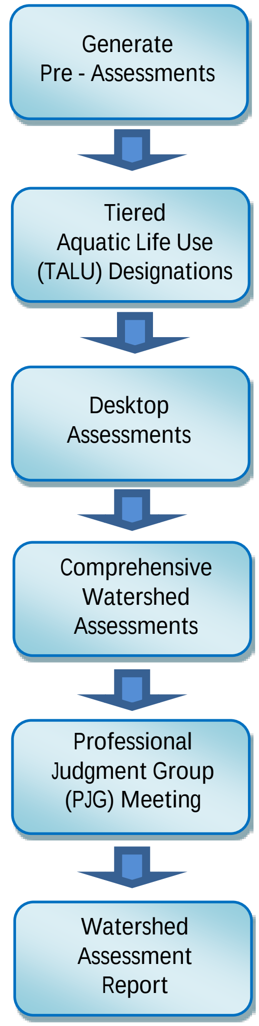


Figure 6. Flowchart of aquatic life use assessment process.

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 considered when making such determinations.

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

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments and volunteers. The data must meet rigorous quality assurance protocols before being used. All monitoring data required or paid for by MPCA are entered into EQuIS (Environmental Quality Information System), MPCA's data system and are also uploaded to the US Environmental Protection Agency's data warehouse. Data for monitoring projects with federal or state funding are required to be stored in EQuIS (e.g., Clean Water Partnership, CWLA Surface Water Assessment Grants and TMDL program). Many local projects not funded by MPCA also choose to submit their data to the MPCA in an EQuIS-ready format so that the monitoring data may be utilized in the assessment process. Prior to each assessment cycle, the MPCA sends out a request for monitoring data to local entities and partner organizations.

Period of record

The MPCA uses data collected over the most recent 10-year period for all water quality assessments. This time-frame 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. The goal is to use data that best represents current water quality conditions. Therefore, recent data for pollutant categories such as toxics, lake eutrophication and fish contaminants may be given more weight during assessment.

Watershed overview

The Minnesota River – Mankato (07020007) 8-HUC major watershed in South Central Minnesota follows the Minnesota River from approximately Redwood Falls at the Western boundary of the watershed, Southeast to Mankato, and turns Northeast to approximately St Peter. The watershed is bisected by its main feature, the Minnesota River and its substantial valley, which was created by the Glacial River Warren. The watershed contains 1,564 stream miles (NRCS 2009). Within the Minnesota River basin, the watershed is the second to the last major watershed (HUC 8) before the Minnesota River's confluence with the Mississippi River (Figure 7).

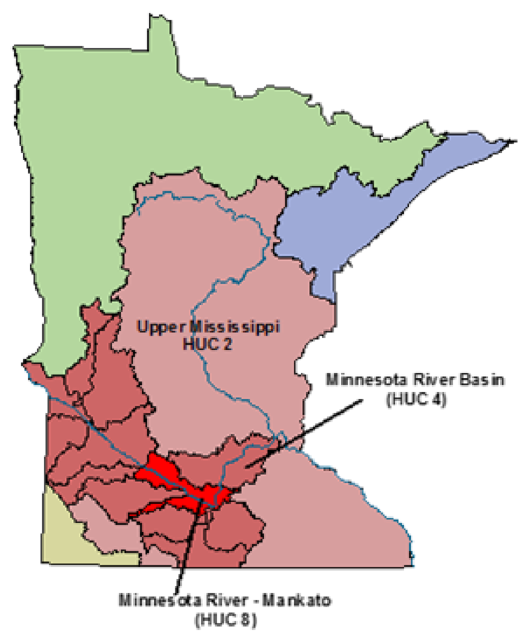


Figure 7. Location of the Minnesota River –Mankato Watershed within the Minnesota River Basin and the Upper Mississippi River HUC 2.

The watershed encompasses an area of 1347 square miles, or 861,882 acres (MDNR 2015). The watershed includes portions of nine Minnesota Counties, in order from the largest percentage of the watershed to the smallest: Nicollet (24.2%), Brown (21.6%), Renville (18.4%), Blue Earth (13.2%), Redwood (10.5%), Le Sueur (6.5%), Cottonwood (2.8%), Sibley (2.7%), and a very small portion of

Watonwan (0.0%) (NRCS 2009). The largest cities in the watershed include: Mankato, New Ulm, Saint Peter, and Lake Crystal. Notable towns on the north side of the river include: Morton, Franklin, Fairfax, Courtland, and Nicollet. Other notable towns on the south side of the river include: part of Redwood Falls, Morgan, Comfrey, Hanska, Judson, Kasota, and Cleveland.

The majority of the Minnesota River-Mankato Watershed lies in the Western Corn Belt Plains Level III Ecoregion (Figure 8) from the Environmental Protection Agency (EPA) (Omernik and Gallant 1988). The Western Corn Belt Plains consists of gently rolling glaciated till plains and hilly loess plains that were once tallgrass prairie, with some small areas of bur oak and oak-hickory woodlands (Wiken et. al. 2011). During the last glaciation, the area was once covered by the Des Moine Lobe so the area consists of thick loess and glacial till deposits overlying Mesozoic and Paleozoic shale, sandstone, and limestone bedrock (Wiken et. al. 2011). For soils, Mollisols and Alfisols are dominant with mesic soil temperatures and udic soil moisture (Wiken et. al. 2011).

A smaller portion of the watershed from approximately St Peter and to the east lies in the North Central Hardwood Forest Level III Ecoregion (Figure 8) (Omernik and Gallant 1988). This ecoregion is primarily a transition between the forested ecoregions in the north and the predominately agricultural ecoregions to the south (Wiken et. al. 2011). Terrain consists of nearly level to rolling till plains, lacustrine basins, outwash plains, and rolling to hilly moraines dominated by oak savanna, oak-hickory forests, and maple-basswood forests (Wiken et. al. 2011). After European settlement, the ecoregion is now a mosaic of forestland, cropland, and pasture (Wiken et. al. 2011).

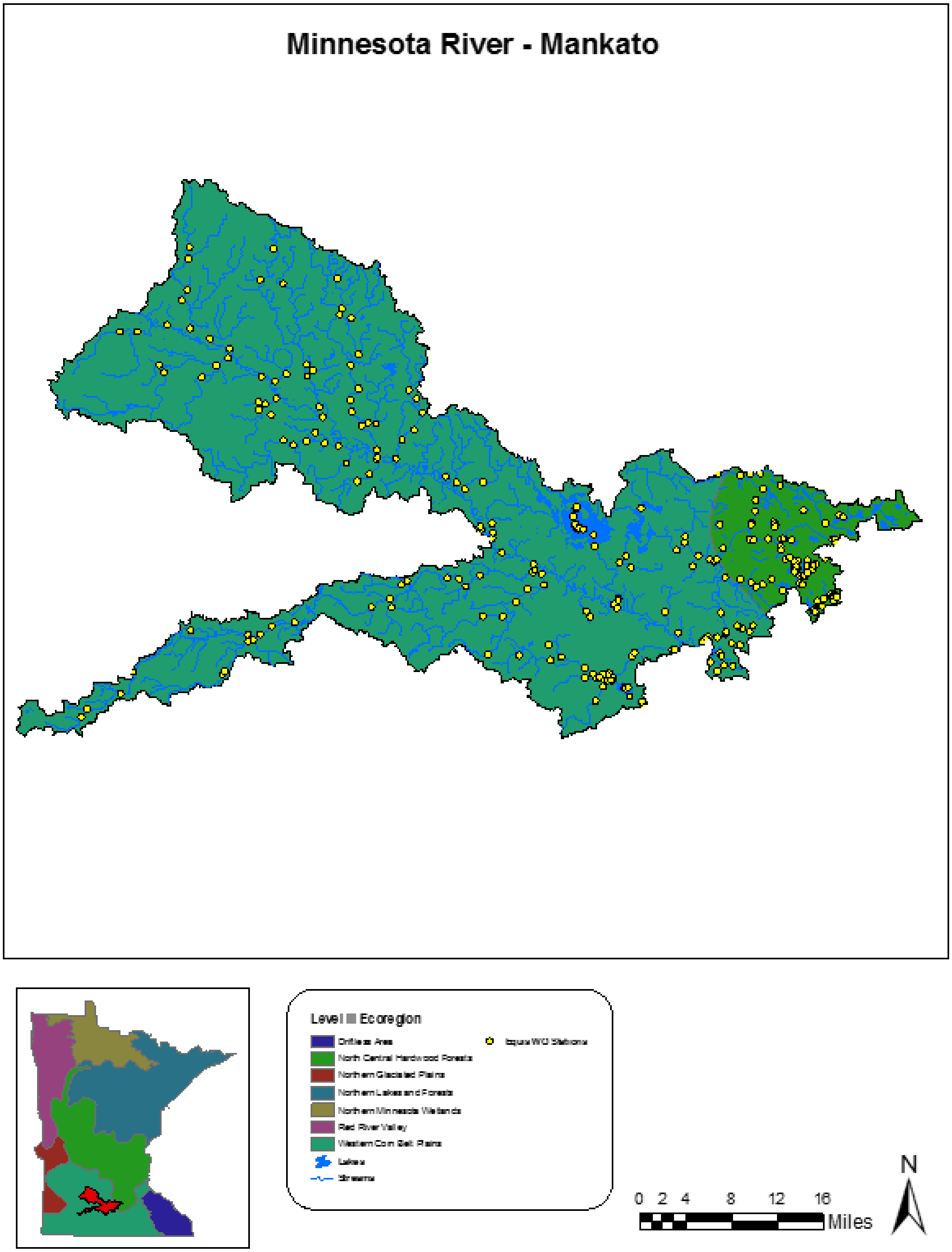


Figure 8. The Minnesota River – Mankato Watershed within the Western Corn Belt Plains ecoregion of South Central Minnesota.

Similar to the U. S. Environmental Protection Agency's (EPA) Ecoregions, the United State Department of Agriculture (USDA) has defined Major Land Resource Areas (MLRA) with an emphasis on soils. The Minnesota River-Mankato Watershed falls entirely within the Central Iowa and Minnesota Till Prairies (Figure 9). This region is primarily a young, nearly level to gently rolling glaciated till plain with moraines (NRCS 2006). Common resource concerns for this resource area include: water erosion, depletion of organic matter in soil, excess surface and subsurface water, and poor water quality (NRCS 2006). The Central Iowa and Minnesota Till Prairies also see a variety of conservation practices employed, including: systems of crop residue management (no till, strip till, mulch till), cover crops, surface and subsurface drainage, nutrient and pest management, grassed waterways, buffer strips, and wildlife habitat development (NRCS 2006).

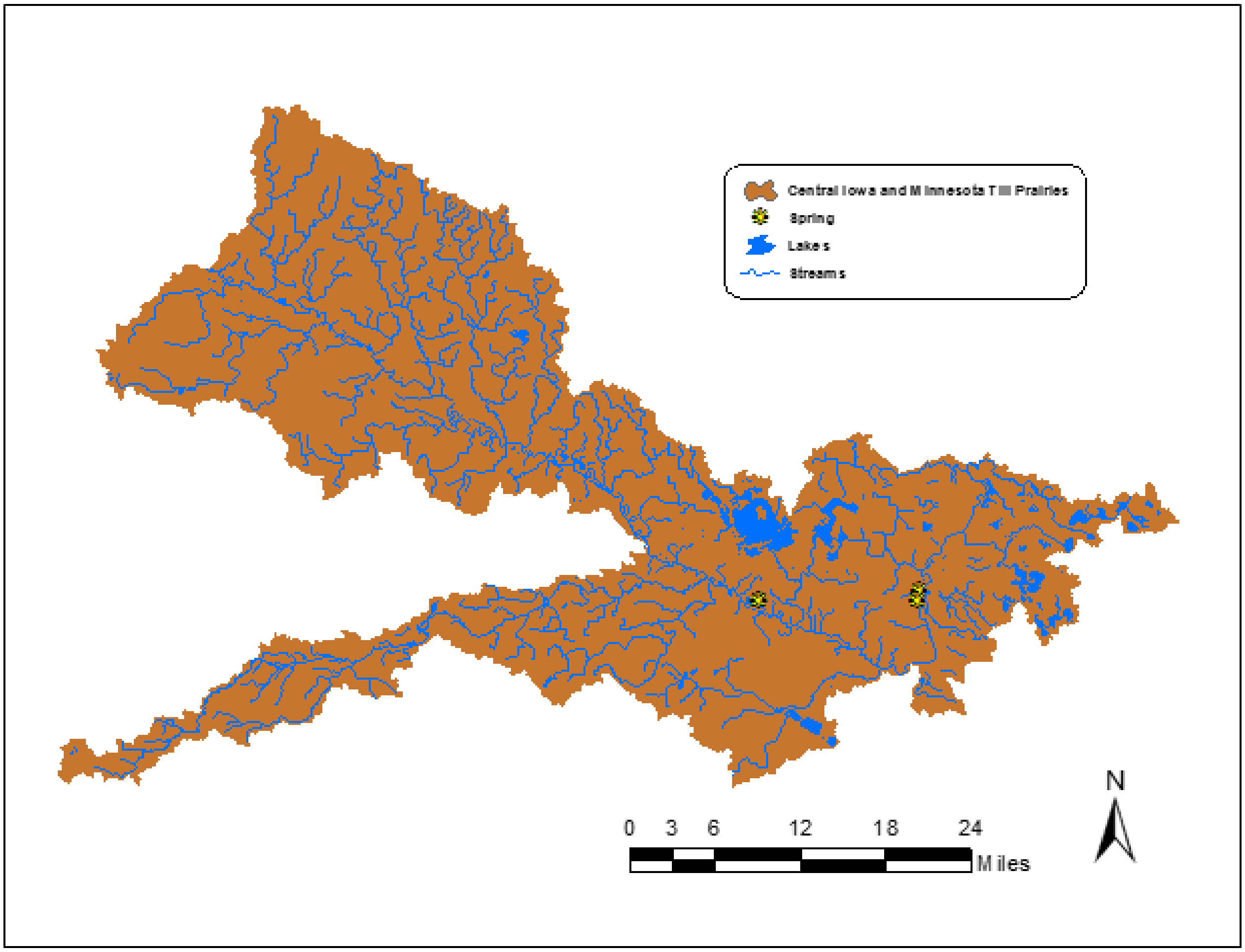


Figure 9. NRCS Major Land Resource Areas (MLRA) and springs in the Minnesota River – Mankato Watershed.

Land use summary

A dominant component of the land use in the Minnesota River – Mankato Watershed is agriculture. With nearly level to gently rolling terrain, and typically loam or silt loam soils (NRCS 2009) well suited for crops, crop production is an important contributor to the economy in the watershed. Cropland utilizes about 76% (655,366 acres) of the watershed (Figure 10). In 2013, the majority of the cropland is used to produce corn (56%) and soybeans (34%) (USDA 2013). For that year, other crops include: sweet corn (1.6%), sugar beets (1.3%), peas (1.2%), and Alfalfa (1.0%) (USDA 2013). Small grains such as wheat, barley, rye, and oats account for only 0.44% of the cropland use (USDA 2013). Only about 0.02% of the cropland was idle or fallow in 2013 (USDA 2013). Artificial drainage is used extensively in this watershed to remove ponded water from flat or depressional areas and greatly boasts the productivity of much of the cropland in this watershed. There are 2,043 farms in the watershed (NRCS 2009). Of these, 31% of the farms are less than 180 acres, 51% of the farms are 180 acres to 1,000 acres, and the remaining 18% of the farms are over 1,000 acres (NRCS 2009).

Another important component of the agricultural economy in this watershed is the production of livestock and poultry. Approximately 3.38% (29,180 acres) of the watershed is rangeland consisting of grasses (Figure 10). Up to 65% (18,956 acres) of the rangeland is used as pasture for livestock, or hay for feeding livestock (USDA 2013). The remaining rangeland is likely grass cover. With the steep nature of the bluffs along the river valley, and ravines of the tributaries, pasture for livestock is a common agricultural use for these areas that are not suitable for crops. There are approximately 878,432 animals and 939 permitted Animal Feeding Operations (AFOs) within the watershed (NRCS 2009). Swine make up the largest percentage of animals at 57% (502,812), while the second largest number of animals consists of Turkeys at 40% (351,574) (NRCS 2009). Dairy cattle account for 1% (8,839), and beef cattle account for 0.5% (4,029) of the animal production (NRCS 2009). Chickens account for 5,667 animals, or 0.6% of the total number of animals (NRCS 2009).

Approximately 62,615 acres, or 7.2%, of the watershed is developed (Figure 10). The population of the watershed is 95,035 people as of the 2010 census (MNDNR 2015). The majority of the watershed is rural, with the largest city being Mankato, with a population of 39,305 (MNDNR 2015). The other larger cities include: New Ulm (13,522), North Mankato (13,394), Saint Peter, (11,196), and Lake Crystal (2,549) (MNDNR 2015). These towns account for 84% of the population, with the remaining people living in the smaller towns and rural areas throughout the watershed.

Aggregate mining and quarries are also present within the watershed, roughly encompassing 3201 acres of land classified as Barren, or 0.4% of the watershed area (Figure 10). Many of the aggregate mines can be found in the Minnesota River valley, where large deposits of alluvial materials occur. Other areas of glacial till are also utilized. There are notable outcrops of bedrock throughout the watershed, with many of these areas quarried in the past, with some quarry activity going on to this day. In the western part of the watershed, Gneiss quarried near Morton is considered some of the oldest bedrock in the United States, at approximately 3.6 billion years old (Lore 2015). In the eastern part of the watershed, sedimentary rock outcroppings are more prevalent. Near the town of Kasota, the area is renowned for the beautiful salmon pink limestone quarried there (Waters 1977).

The remaining land cover types for the Minnesota River – Mankato Watershed are as follows: forest 3.9% (34,390 acres), wetland 5.2% (45,513 acres), and open water 3.7% (31,984 acres) (Figure 10). Much of the western portion of the watershed was tallgrass prairie before settlement. Much of the forest at that time occurred along the stream corridors, and in the Minnesota River valley along the bluffs and in the floodplain. The most significant change after settlement was the prairie was converted to cropland. Some of the forested corridors were cleared due to logging, and eventually became pasture for livestock. In the eastern portion of the watershed that is a part of the North Central Hardwood Forests ecoregion, pre-settlement forests were more prevalent. Much of those forests were cleared for cropland and pastures after settlement. Currently, the majority of the woodland areas occur along the steeper and lowland areas of the Minnesota River valley, as well as the steeper ravines of the tributaries, as they get closer to the main river valley. In pre-settlement times, wetland areas were quite common due to imperfect drainage on the landscape as a result of the glaciation in the region. With settlement, and the employment of drainage systems (ditching, and subsurface tiling) on the landscape, wetlands are far less prevalent on the landscape. Present day wetland areas are often found in areas that the drainage system failed to drain the land due to topography or other factors, or in some cases the wetland areas were restored, or sometimes not drained in the first place. The Minnesota River floodplain contains a significant portion of the wetlands in this watershed. For lands classified as open water, the western portion of the watershed contains fewer lakes and open water areas. The eastern portion of the watershed consists of more glacial moraines, and consequentially, more lakes and open water wetlands. The Minnesota River itself, as well as the backwaters and sloughs in floodplain contribute a significant portion to the percentage of open water in the watershed. The Minnesota River valley is a significant natural corridor within the watershed, primarily because of the difficulties with utilizing the land due to the steepness of the terrain along the bluffs, or the problems associated with the flood prone lowlands of the valley floor.

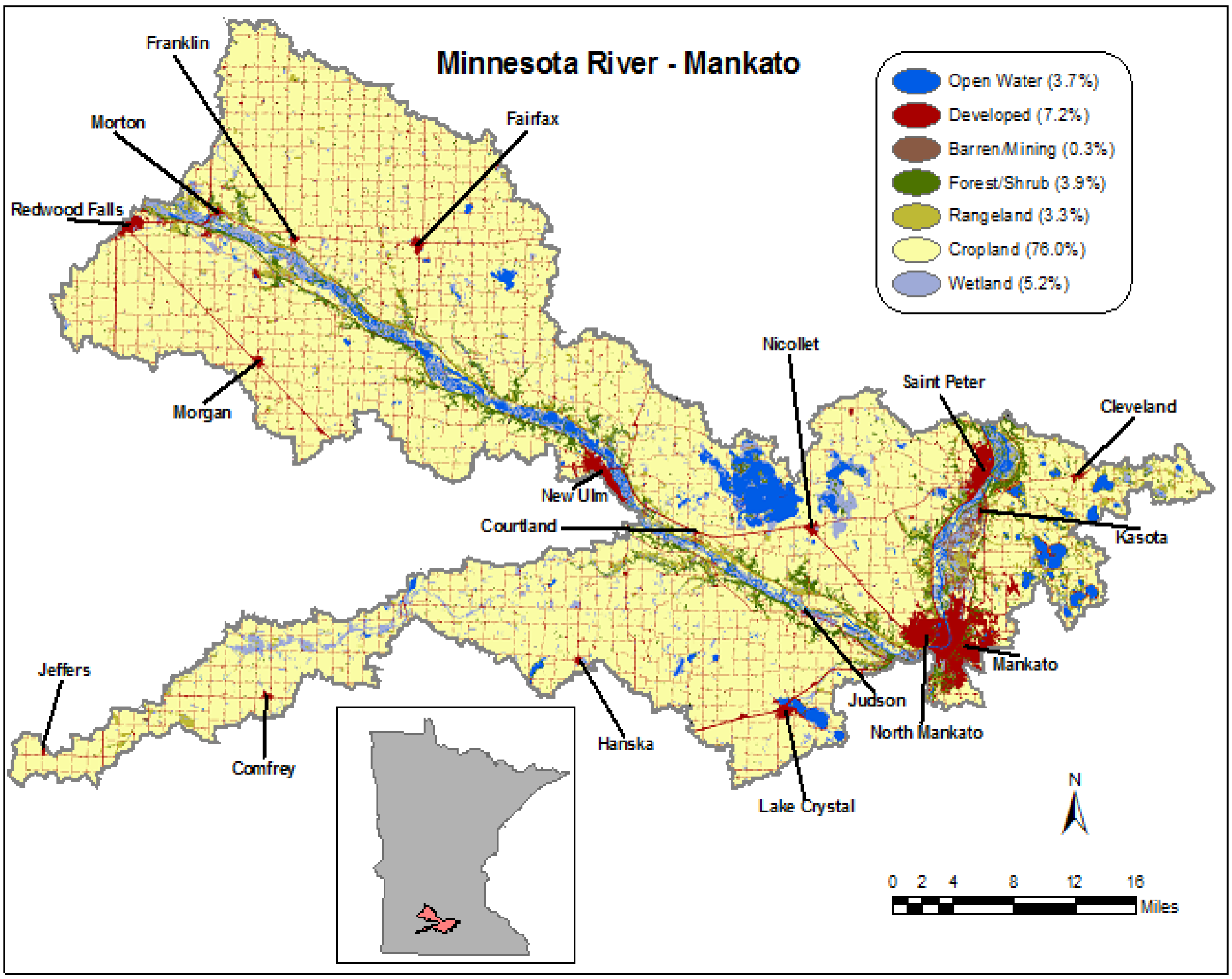


Figure 10. Land use in the Minnesota River – Mankato Watershed.

Surface water hydrology

Although it is not included in the results of this report, the primary watercourse within this watershed is the Minnesota River, which is the final receiving water for the all of the waterbodies present in this watershed. Within the watershed, the Minnesota River flows southeast roughly 60 miles to Mankato, then turns northeast roughly 15 miles to the point where it enters the Minnesota River – Shakopee HUC 8 watershed. The watershed consists wholly of tributaries to the Minnesota River, which typically have their headwaters near the boundaries of the watershed and flow inward towards the bisecting mainstem river. Tributaries in approximately the western three quarters of the watershed roughly flow north or south, depending on which side of the river they are located. Tributaries in approximately the eastern quarter of the watershed may flow roughly east or west in conjunction with the side of the river they are located. Listed west to east, significant tributaries on the North side of the Minnesota River include: Birch Coulee Creek, Fort Ridgley Creek, Little Rock Creek, Swan Lake Outlet (Nicollet Creek), Seven Mile Creek, and Rogers Creek. The wetland complex of Swan Lake, which is the largest lake in the watershed, is present on the north side of the river. Listed west to east, significant tributaries on the south side of the Minnesota River include: Wabasha Creek, Spring Creek, Little Cottonwood River (the watersheds largest tributary), Morgan Creek, Minneopa Creek, Cherry Creek, and Shanaska Creek. On the south side, in the eastern portion of the watershed lakes are more prevalent. Some of those lakes include: Washington, Crystal, Loon, Scotch, Wita, Ballantyne, and Henry.

The majority of the streams in the Minnesota River – Mankato Watershed are considered warmwater. With the topography along the Minnesota River valley, springs are present, and several coldwater streams are found in the watershed. Figure 9 shows the presence of some known springs in the watershed, with many springs present that are not depicted on the map. Significant coldwater streams in the watershed include Seven Mile Creek, Spring Creek (Hindeman Cr.), and County Ditch 10 (Johns Cr.).

With the dominance of agriculture in watershed, many of the tributaries to the Minnesota River have been altered by channelization (ditched) to promote drainage of some areas in the watershed to increase crop productivity (Figure 11). Although alteration is not as severe as in some watersheds of the state, drainage ditches are a pervasive feature in this watershed. Based on the MPCA's statewide Altered Watercourse Project, 64.5% of the tributaries have been channelized, while 33.3% remain natural (Figure 12). Percentages in Figure 11 are slightly lower than percentages found in Figure 12 primarily because the statewide figure includes the mainstem Minnesota River, which is predominately a natural channel. Due to the relatively flat nature of the watershed, and the extensive cropland, the majority of the tributaries are channelized from their headwaters (Figure 12) to the point in the watercourse where the stream gradient increases closer to the Minnesota River valley. Drastic elevation changes are noted of up to 250 feet difference between upland bluff and river valley floor (Waters 1977), many tributaries have formed steep walled ravines in the higher gradient portions, before they join the Minnesota River. Because of the steep terrain along these ravines, these areas are not suitable for cropland and have largely remained natural channels (Figure 12). The watersheds largest tributary, the Little Cottonwood River, is unusual compared to other streams in the watershed because 77% of its 83 mile length is still considered natural channel based on the Altered Watercourse Project. A mere 17% of the Little Cottonwood is considered channelized, and 5% of the stream in the uppermost headwaters is considered No Definable Channel. Lack of channelization along this stream may be attributed to a portion of the stream occupying lowlands that are more suitable for pasture and hay. Other streams that resist the channelization trend slightly more are typically found in the rolling glacial moraines of the North Central Hardwood Forest Ecoregion portion of the watershed.

Along with channelizing streams to promote drainage, another major component of agricultural drainage systems incorporates subsurface tiling to convey ponded surface water and excess water in the soil to nearby drainage ditches, streams, and other water bodies. Drain tile is extensively used in the watershed to increase cropland productivity and has a significant effect on stream hydrology.

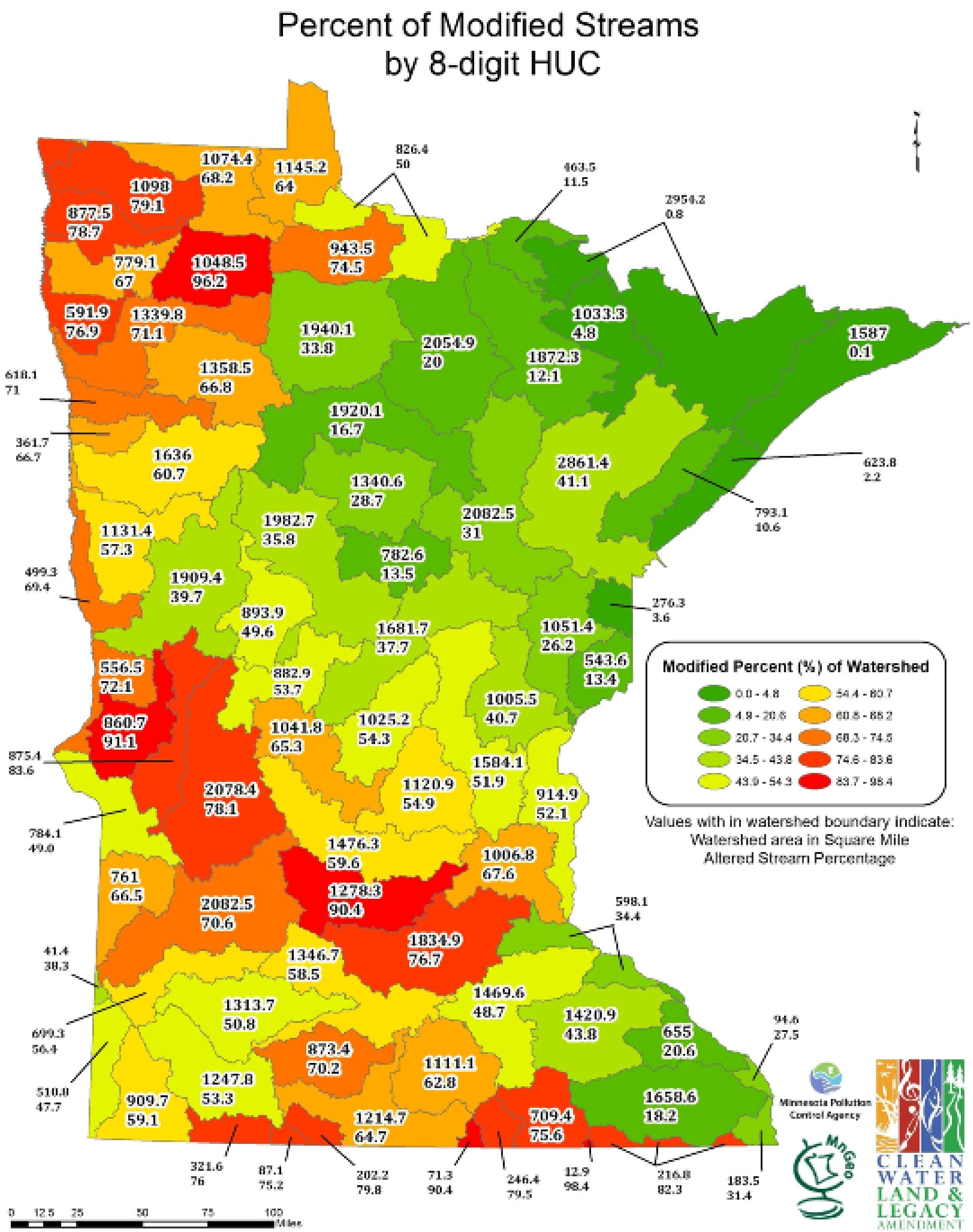


Figure 11. Map of Percent Modified Streams by Major Watershed (8-HUC).

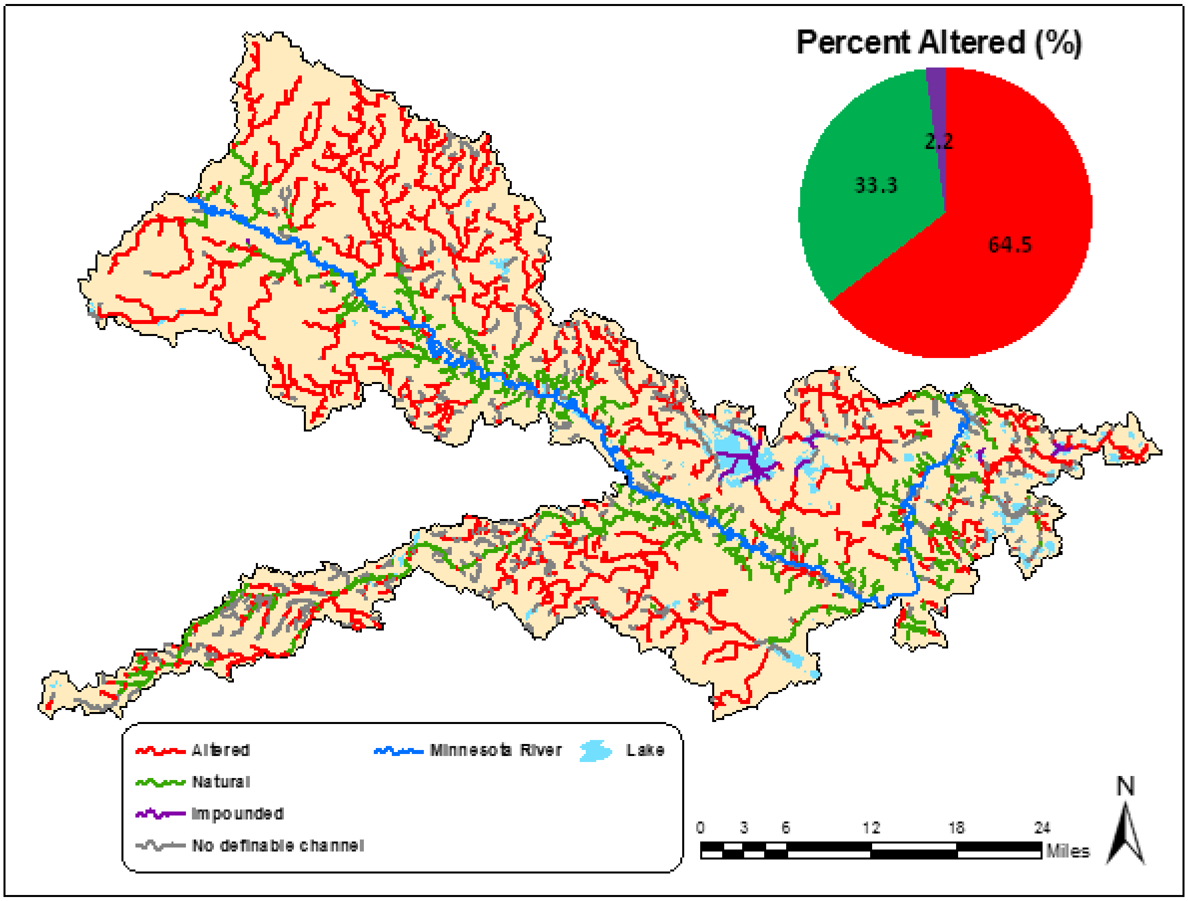


Figure 12. Comparison of natural to altered streams in the Minnesota River – Mankato Watershed, not including the mainstem Minnesota River and watercourses categorized as No Definable Channel (percentages derived from the State-wide Altered Water Course project).

With the unique topography and geology of the Minnesota River - Mankato watershed, there are numerous features that impede the movement of the fish along many of the streams (Figure 13). In particular, in areas around Mankato where the streams have down cut to Jordan Sandstone bedrock, many natural waterfalls occur. In the watershed, there are 11 natural waterfalls (Lore 2015). The largest of the waterfalls in the watershed, with a drop of approximately 52 feet, can be found on Minneopa Creek within Minneopa State Park. Other streams in the watershed that were monitored in 2013 that have waterfalls include Rogers Creek, and Swan Lake Outlet (Nicollet Cr.), as well as two unnamed streams. Four small dams exist in the watershed, which are present on Cherry Creek, Fort Ridgley Creek, Seven Mile Creek, and Shanaska Creek (Lore 2015). These small dams typically only drop approximately five to six feet (Lore 2015). There are also four streams that have perched culverts at road crossings that are considered barriers to fish movement within the watershed (Lore 2015). These streams include Eight Mile Creek, Spring Creek, Wabasha, and Unnamed Creek.4 road crossings that can be barriers to fish passage. There are also eight lake outlet structures within the watershed that would impede fish movement from the stream into lake. Of these, the outlet dam for Mud Lake, has a considerable effect on upstream portions of Little Rock Creek (Lore 2015). Often times, the fish community is affected by these barriers, depending on various factors such the characteristics of the barrier itself, presence of upstream refuge, and the overwintering capability of the stream.

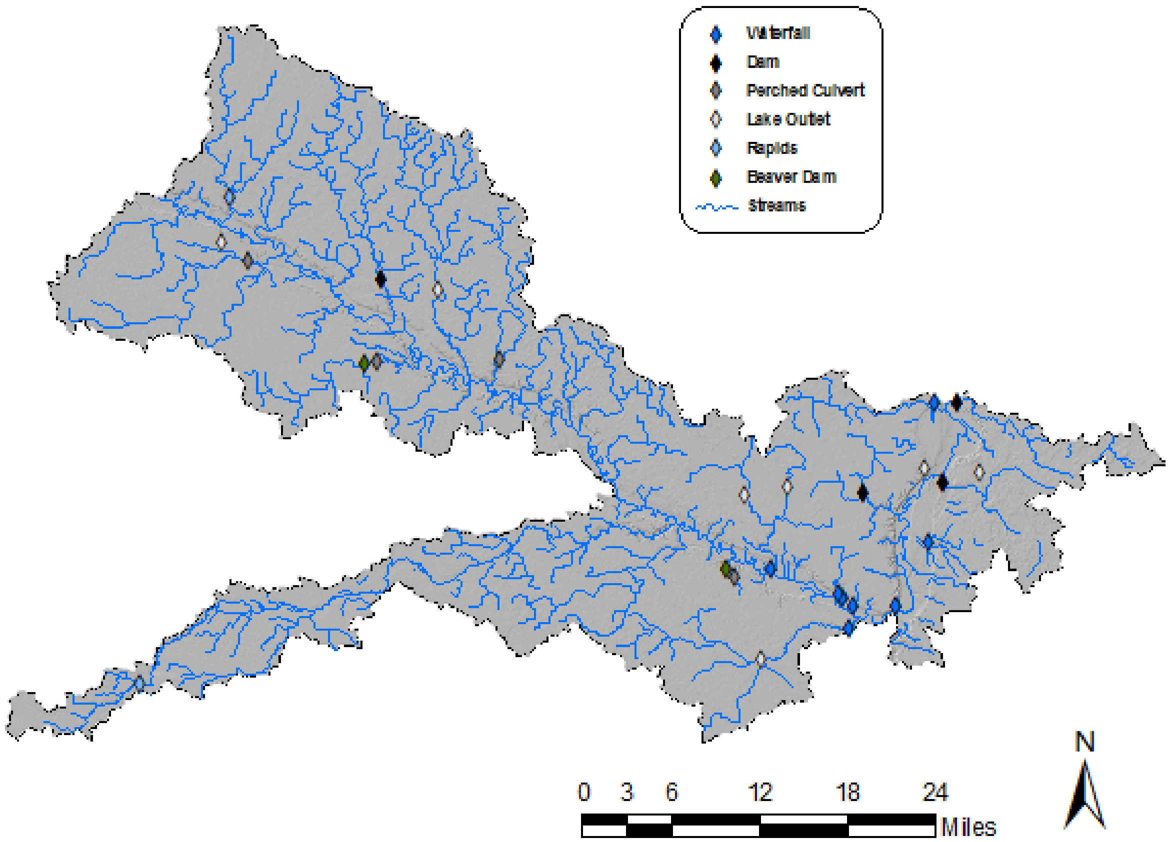


Figure 13. Locations of waterfalls, dams, lake outlet dams, and rapids in the Minnesota River – Mankato Watershed (Locations courtesy of Jon Lore, MNDNR).

Climate and precipitation

Precipitation is an important source of water input to a watershed. Figure 11 shows two representations of precipitation for calendar year 2013. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this figure, the Minnesota River - Mankato Watershed area received anywhere from 20-28 inches of precipitation in 2013. The display on the right shows the amount those precipitation levels departed from normal. For the Minnesota River - Mankato Watershed, the map shows that precipitation ranged from two to six inches below normal (MNDNR 2015).

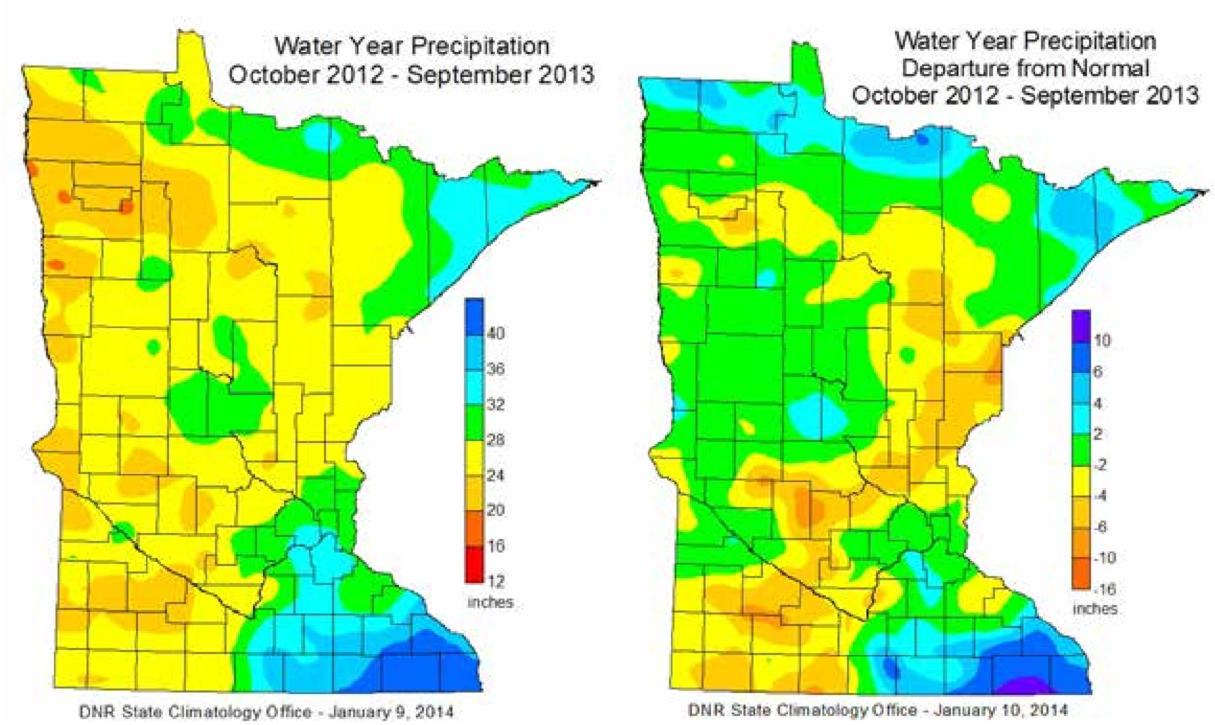


Figure 14. State-wide precipitation levels during the 2013 water year.

Figure 15 displays the areal average representation of precipitation in South Central Minnesota over the past 20 years and the past 100 years. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset.

Rainfall in the Central region has not risen at a statistically significant rate over the last 20 years. This contrasts with a state-wide spatial average showing a statistically significant rising trend for the same time period. Though rainfall can vary in intensity and time of year, it would appear that south central Minnesota precipitation has not changed dramatically over this time period. The past 100 years of precipitation, though have shown a significant rising trend (p=0.001) that matches similar trends throughout Minnesota for the same period.

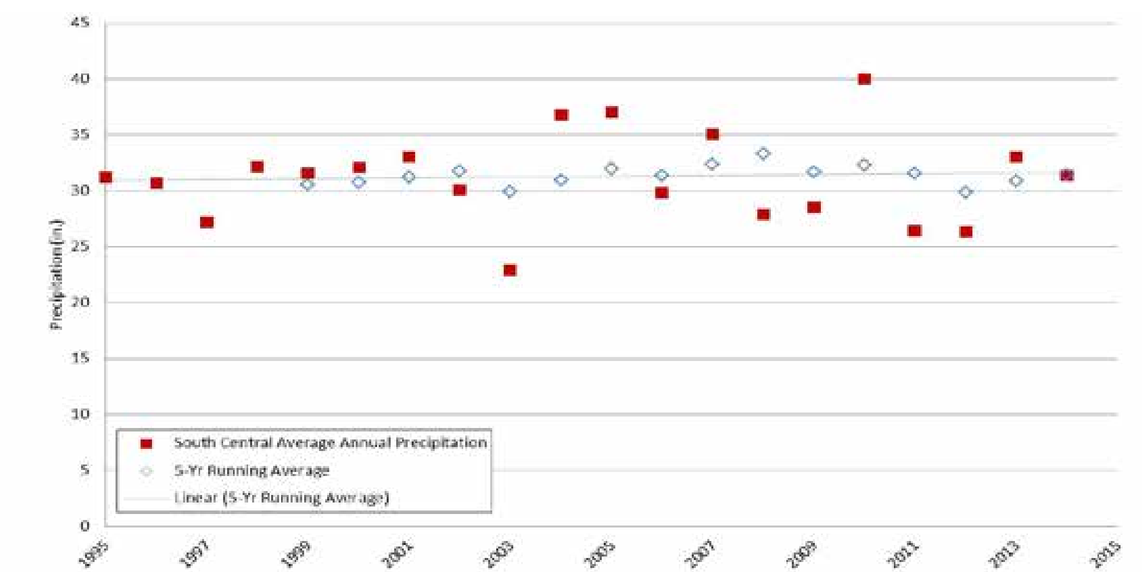


Figure 15. Precipitation trends in in South Central Minnesota (1995-2014) with five-year running average.

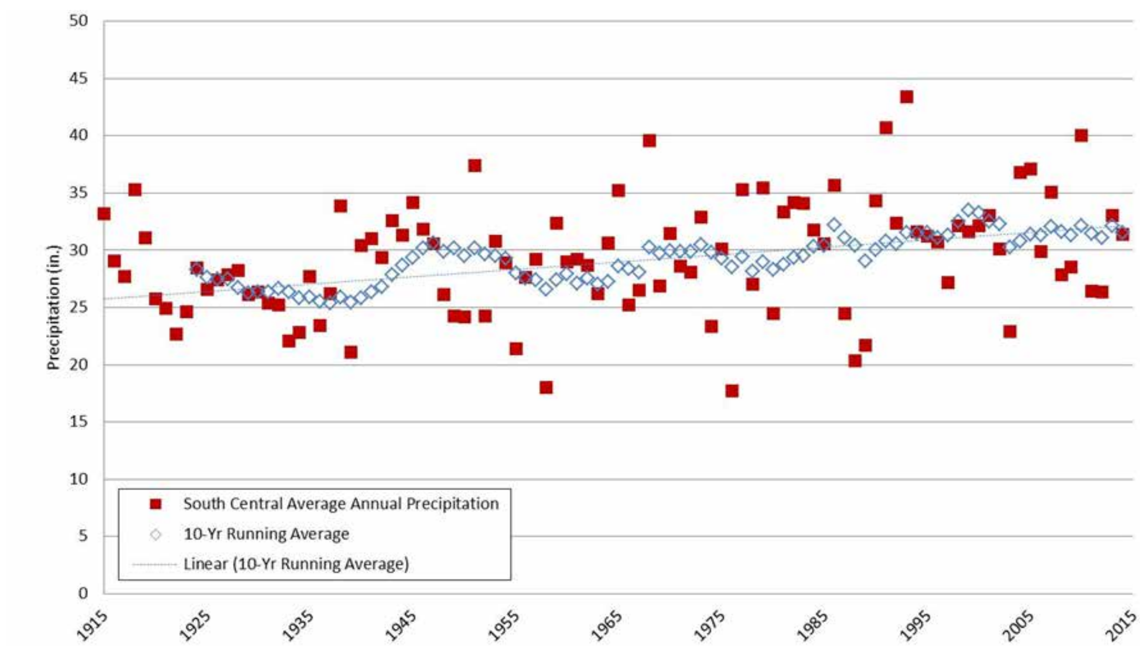


Figure 16. Precipitation trends in South Central Minnesota (1915-2014) with ten-year running average.

Hydrogeology

The Minnesota River - Mankato Watershed lies within the MMNDNR's defined Western and South-Central Groundwater Provinces ([Figure 17](#)). The bulk of the watershed is within the Western Province; characterized by clayey glacial drift overtop Cretaceous and Precambrian bedrock. Aquifers are typically sand in glacial drift or sandstone and are of limited extent. (MNDNR, 2001)

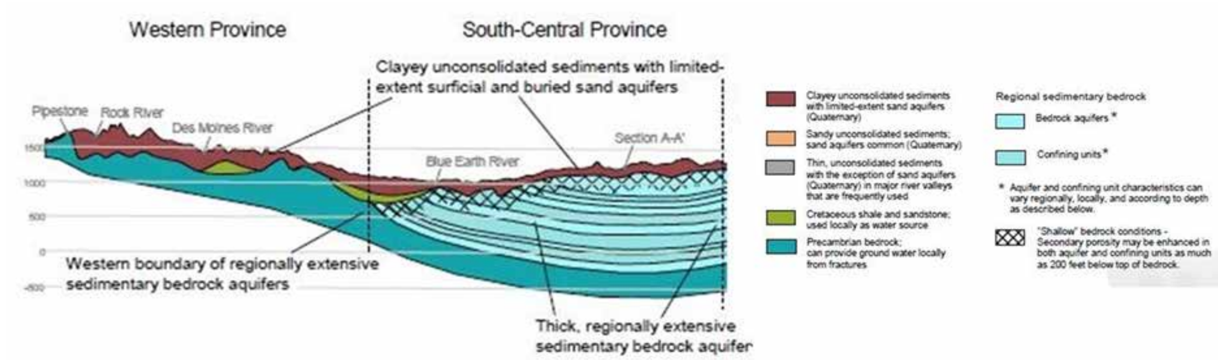


Figure 17. West/East Cross Section of MNDNR's Groundwater Provinces – Western and South-Central.

Wetlands

Excluding the open water portions of lakes, ponds, and rivers, the Minnesota River – Mankato Watershed has approximately 63,240 acres of wetlands, which is equivalent to 7.34% of the watershed area. Wetlands with herbaceous emergent vegetation are the most common wetland type in this watershed ([Figure 18](#)). Wetlands are fairly well distributed throughout the watershed, much of which is characterized as ground or stagnation moraine originating from the Des Moines lobe of the last glaciation. Many of the wetlands are associated with the Minnesota River floodplain, along the Little Cottonwood River and in the northeastern quarter of the watershed. The coarse till and fine grained well drained soils in this region were historically conductive to supporting wetlands of various types. The Swan Lake Outlet (Nicollet Creek) sub watershed currently supports the highest percentage of wetland

(21%) area with the next highest area Morgan Creek – Minnesota River supporting about 12.5% wetland. These estimates and distribution observations represent a snapshot of the location, type, and extent of wetlands from the recently updated state wetland inventory (NWI) based primarily on 2011 spring imagery.

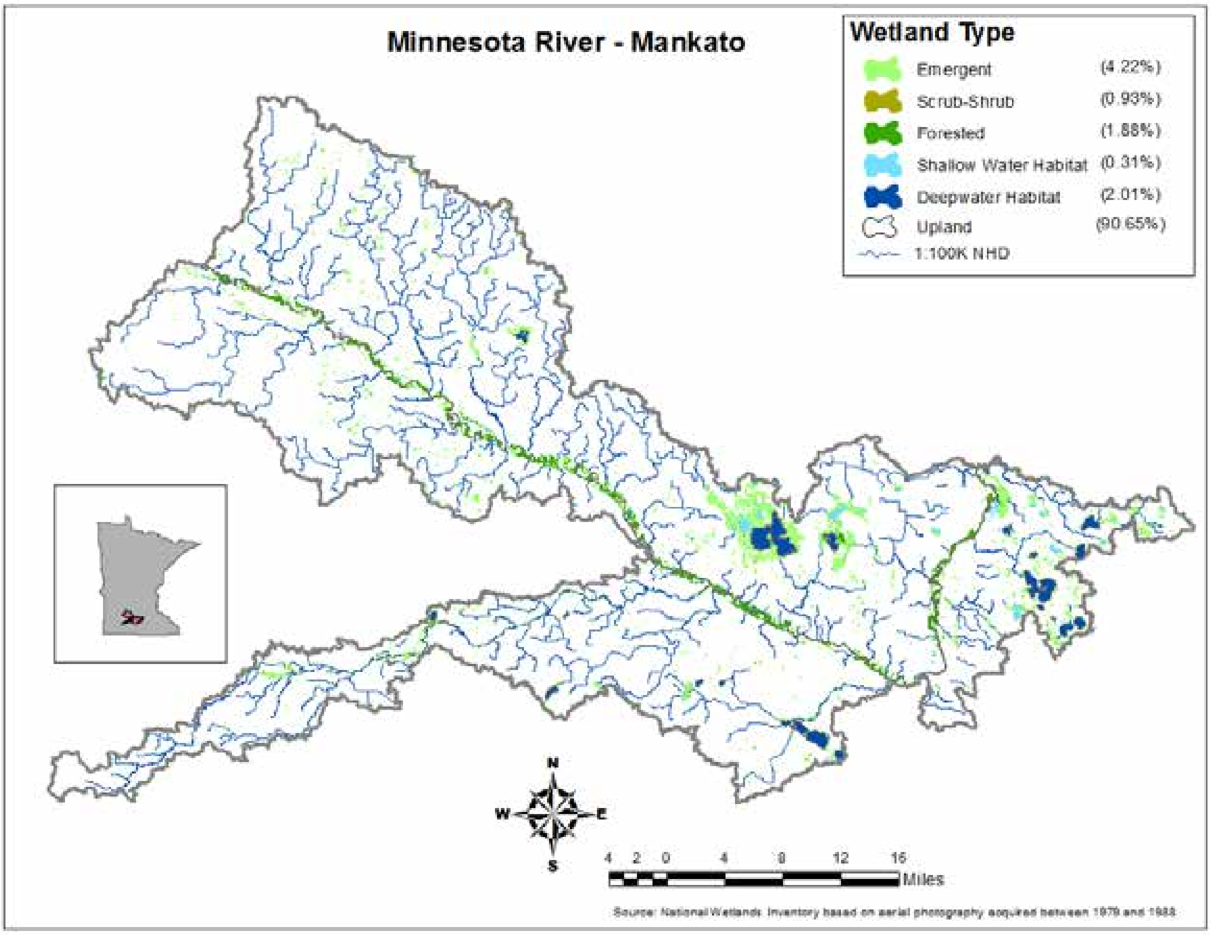


Figure 18. Distribution of wetlands by National Wetland Inventory type within the Minnesota River – Mankato watershed.

Soils data can be used to estimate historical wetland extent prior to European settlement which initiated significant drainage of wetlands. Analysis of Natural Resources Conservation Service digital soil survey (SSURGO) soil map units with drainage classes of either Poorly Drained or Very Poorly Drained suggest approximately 446,180 acres of wetland or 52% of the Minnesota River - Mankato Watershed occurred prior to settlement. Figure 19 presents estimates of the percent wetland loss in the Minnesota River - Mankato HUC 12 sub watersheds. These estimates were derived by subtracting estimated contemporary (primarily 2011 spring imagery) wetland area from estimated historical wetland area based on SSURGO analysis divided by 12HUC watershed area. This analysis finds that historically wetlands comprised over 70% of the subwatershed area in the Morgan Creek and Fort Ridgely Creek sub watersheds, both of which occur in the middle region of the Minnesota River – Mankato (Figure 19). In five nearby HUC12 watersheds located in the upper end as well as the southern portion of the watershed most have lost 45% to 65% of their historic wetlands to drainage or filling activities. The remaining Minnesota River – Mankato 12HUC watersheds have lost between 30.1% and 45% of their historic wetlands, except for Shanaska Creek subwatershed which is estimated to have lost less than 30% of the wetlands historically occurring there (Figure 19).

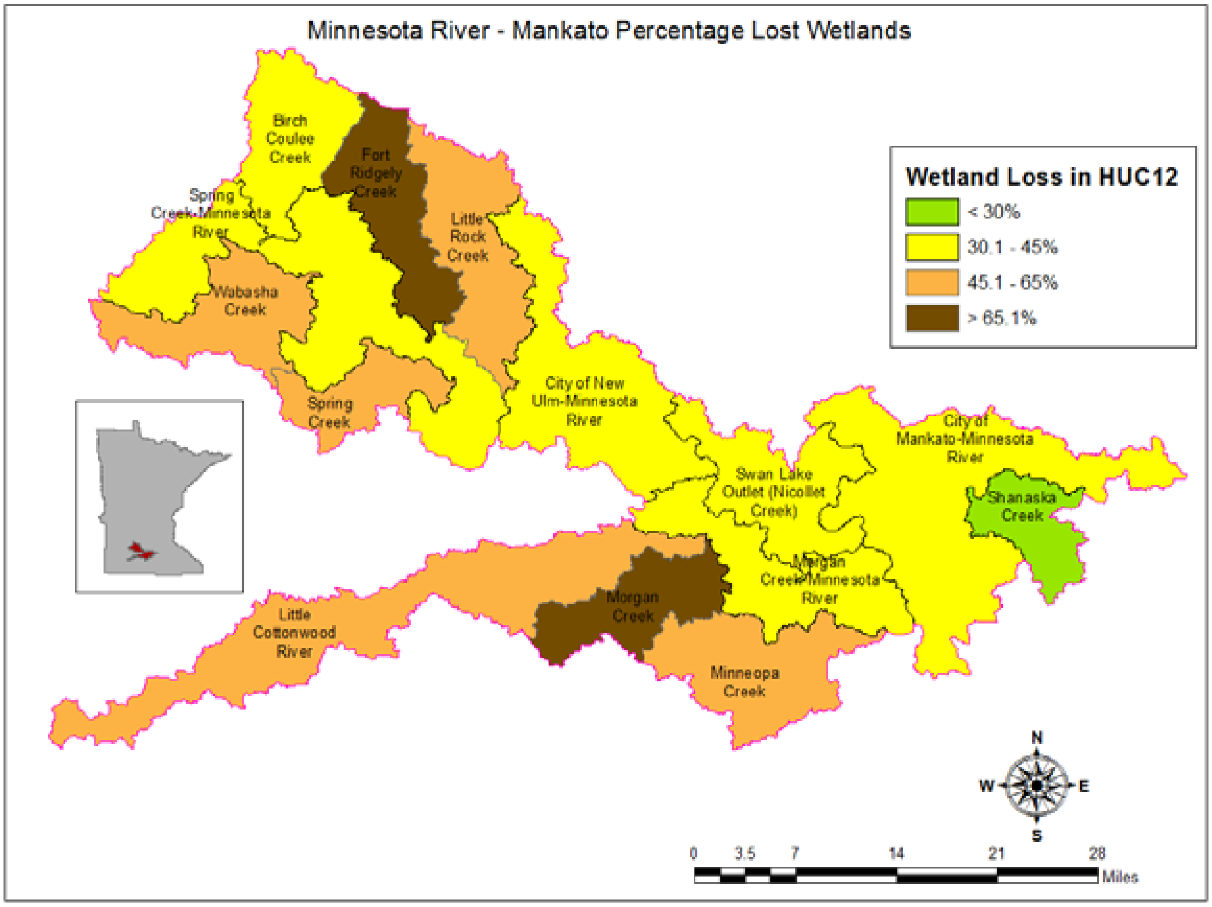


Figure 19. Percentage of wetland area lost in the Minnesota River-Mankato Watershed.

Wetland hydrogeomorphic classification

Not all wetlands provide the same functions, e.g. human benefits or ecological services. Position in the watershed and hydrologic connectivity between the wetland and the associated stream network determines many of the functions provided by individual wetlands. Plant community types, water source, duration, frequency and magnitude of inundation or saturation and soil properties are also significant determinants of wetland function. Hydrogeomorphic (HGM) classification of wetlands characterizes the wetland landform, hydrologic regime and expected primary water flow paths of individual wetlands (Tiner 2011). The HGM approach is a hierarchical classification based on physical attributes including **Landscape** (River, Stream; Lake and Inland [terrene]; **Major Land Form** (Fringe, Island, Basin, Floodplain, Flat, Slope, Pond, Lake); **Water Flow Path** (bi-directional, throughflow, outflow, inflow, isolated, paludified - organic material deposition as in peatlands) and waterbody type. Several dozen possible combinations occur when the landscape, major land form, and water flow path descriptors are combined hierarchically. Using this hierarchical approach thirty-six unique HGM descriptor combinations ("classes") occur in the Minnesota River - Mankato Watershed. Twenty-seven of these classes make up less than 2% of the total wetland area in this watershed and are not specified here. The remaining nine HGM classes each comprise at least 2% of the Minnesota River - Mankato wetland area presented in Table 2. Five of these wetland HGM classes represent discharging hydrology as either "flow through discharge" or outflows, three of them have bi-directional flows, and one has isolated hydrology. This range of predominant hydrology demonstrates the richness and complexity of wetland hydrology in the Minnesota River – Mankato. In a major watershed dominated by a large river it is surprising that several of the dominant wetland HGM classes are not associated with the river and stream drainage system.

Table 2. Predominant (> 2.0%) simplified hydrogeomorphic (HGM) wetland functional classes present in the Minnesota River-Mankato Watershed along with percent of the total watershed area (38,300 acres) and the number of polygons of each respective HGM class and the types of simplified plant communities present in each respective HGM class.

HGM Class Code	Wetland HGM landform description	Predominant simplified wetland plant classes (in order by predominance)	Percent occurance	Number of Polygons	General Distribution in the MN River - Mankato	HGM Class area (ac)
LRFPTH	Large river floodplain with throughflow hydrology	Emergent; Shrub-carr; Forested	33.8%	3283	Along MN & main tribs	21405.5
TEFLOU	Inland wetlands in level landscape "flats" with outflow hydrology	Emergent; Shrub-carr	21.1%	4178	Scattered throughout	13340.8
TEBAOU	Inland wetland basins with outflow hydrology	Emergent; Shrub-carr; Forested	8.7%	1564	Scattered throughout	5486.3
LEFRBI	Lake or reservoir fringing wetland with flucuating water levels where water flows into and out of depending on stage	Emergent	8.3%	193	Mostly near Swan Lake	5247.1
TESLOU	Inland wetland on a >2% grade slope with outflow hydrology	Emergent; Forested; Shrub-carr	5.4%	991	Scattered, eastern	3392.0
LEBABI	Wetland basin adjacent to a lake or reservoir with flucuating water where water flows into and out of the wetland depending on stage	Emergent; Forested; Shrub-carr	5.0%	138	Eastern, lower	3186.9
LSFLTH	Wetland adjacent to a stream in level landscape "flats" with outflow hydrology	Emergent; Forested; Shrub-carr	3.4%	365	Tribs, throughout	2130.3
TEFLIS	Inland wetlands in level landscape "flats" with isolated hydrology	Emergent; Shrub-carr	2.4%	753	Scattered throughout	1506.6
LEFLBI	Lake or reservoir fringing wetland in level landscape "flats" with flucuating water levels where water flows into and out of the wetland depending on stage	Forested; Emergent; Shrub-carr	2.0%	325	Eastern, NE, Lower	1252.3

However, the LRFPTH (Large river floodplain with throughflow hydrology) wetland class which is associated primarily with the Minnesota River and Little Cottonwood River was the most dominant wetland class. Based on results presented in Table 2 several of the predominant wetland HGM classes could be expected to exhibit long retention times during high flow periods. This would be particularly true of the classes with bi-directional and isolated hydrology. In general, these wetland classes could be expected to have high pollutant assimilative and flood storage capacities, which benefit downstream waters.

Watershed-wide data collection methodology

Load monitoring

Intensive water quality sampling occurs at all WPLMN sites. Thirty-five samples per year are allocated for basin and major watershed sites and 25 samples per season (ice out through October 31) for subwatershed sites. Because of relationships that can exist between concentration and flow for many of the monitored analytes, sampling frequency is greatest during periods of moderate to high flow (Figure 20). Because these relationships can also shift with storm type or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

Annual water quality and daily average flow data are coupled in the "FLUX32," pollutant load model to estimate the transport of nutrients or other water quality constituents past a tributary sampling station over a given period of time (pollutant load). Flux uses paired concentration/flow observations to develop one or more discharge or seasonally constrained relationships to estimate daily pollutant concentrations from the daily flow record. Most WPLMN load estimates use the "Time series"calculation method in FLUX32. This method applies an "adjustment" to the regressed estimates based on adjacent sample concentrations and when sample collection frequency is high, results in the determination of more accurate daily as well as annual/seasonal pollutant loads than the regressed estimates alone. Loads and flow weighted mean concentrations are calculated for TSS, TP, dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO3+NO2-N), and total Kjeldahl nitrogen (TKN).

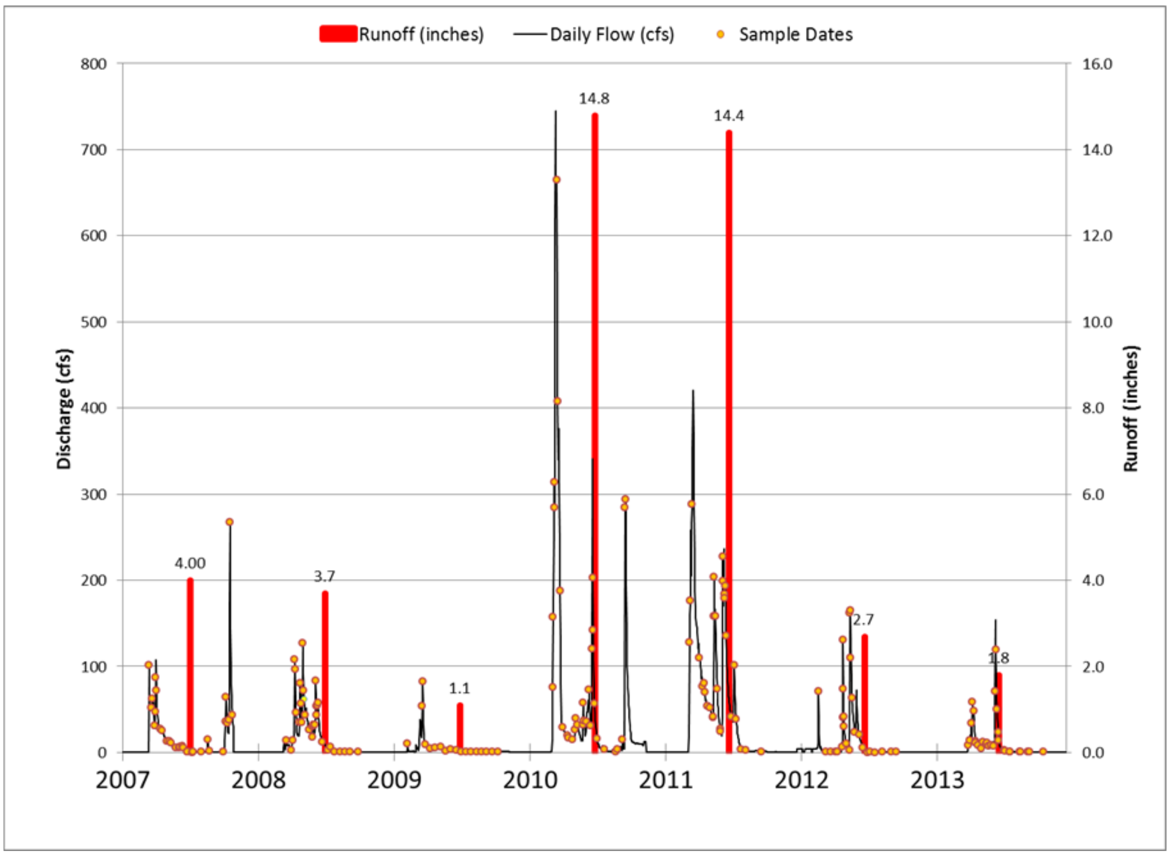


Figure 20. 2007-2013 Hydrograph, Sampling Regime and Annual Runoff for Seven Mile Creek near St. Peter, Minnesota

Stream water sampling

Thirteen water chemistry stations were sampled from May through September in 2013, and again June through August of 2014, to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12 HUC subwatershed that was >40 square miles in area (purple circles and green circles in (Figure 4). A Surface Water Assessment Grant (SWAG) to conduct water chemistry monitoring was awarded to Great River Greening at six stations, Redwood-Cottonwood River Control Area (RCRCA) at four stations, and MPCA staff monitored the remaining three stations. (See Appendix 2.1 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study). Due to the small drainage area (<40 mi2) of the Shanaska Creek aggregated 12-HUC subwatershed an intensive water chemistry station was not placed at the outlet; however, a biological station was placed at the outlet. Morgan Creek-Minnesota River aggregated 12-HUC subwatershed lacks a perennial tributary to the Minnesota River which meets the intensive water chemistry monitoring criteria, therefore, no intensive chemistry station was established in the subwatershed. The City of Mankato-Minnesota River aggregated 12-HUC subwatershed had two tributaries which met intensive water chemistry criteria (Seven Mile and Rogers Creek). Eight Mile Creek outlet represents the intensive water chemistry monitoring location for the City of New Ulm-Minnesota River aggregated 12-HUC subwatershed. An intensive water chemistry monitoring station was placed at the outlet of Crow Creek within the Spring Creek-Minnesota River aggregated 12-HUC subwatershed.

Stream flow methodology

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

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Minnesota River – Mankato Watershed was completed during the summer of 2013. A total of 77 sites were newly established and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, 19 previously established biological monitoring stations were revisited in 2013. These monitoring stations were initially established as part of the Minnesota River Assessment Project (MRAP) in 1991, as part of a 2003, effort to develop and refine IBI's, or as part of a 2007, survey which investigated 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 2015 assessment was collected in 2013. A total of 79 AUID's were sampled for biology in the Minnesota River – Mankato Watershed. Waterbody assessments to determine aquatic life use support were conducted for 66 AUID's. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

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

Fish contaminants

The MNDNR fisheries staff collected fish for the Fish Contaminant Monitoring Program. When fish are collected as part of the MPCA's intensive watershed monitoring, the MPCA biomonitoring staff attempt to collect up to five piscivorous (top predator) fish and five forage fish. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish are analyzed for polychlorinated biphenyls (PCBs). Monitoring of fish contaminants in the 1970s and 1980s showed high concentrations of PCBs were primarily a concern downstream of large urban areas in large rivers, such as the Mississippi River, and in Lake Superior. Therefore, PCBs are now tested where high concentrations in fish were measured in the past and the major watersheds are screened for PCBs in the watershed monitoring collections.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzed the samples for mercury and PCBs. If fish were tested for perfluorochemicals (PFCs), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFCs. Of the measured PFCs, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.

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

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

Lake water sampling

MPCA sampled nine lakes in 2013 and 2014; Ballantyne, Emily, George, Henry, Mills, Scotch, Swan, Washington and Wita. This was part of the Clean Water Legacy Surface Water Monitoring project for the purpose of enhancing the dataset for lake assessment of aquatic recreation. There are currently six volunteers enrolled in the MPCA's Citizens Lake Monitoring Program (CLMP) that are conducting lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period for phosphorus, chlorophyll-a and Secchi depth.

Groundwater monitoring

Groundwater quality

The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These Ambient wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

Groundwater / surface water withdrawals

The MNDNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or 1 million gallons/year. Permit holders are required to track water use and report back to the MNDNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html. The changes in withdrawal volume detailed in this report are a representation of water use and demand in the watershed and are taken into consideration when the MNDNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

Groundwater quantity

Monitoring wells from the MNDNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. Data from these wells and others are available at:
http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html.

Wetland monitoring

The MPCA began developing biological monitoring methods for wetlands in the early 1990s, focusing on wetlands with emergent vegetation (i.e., marshes) in a depressional geomorphic setting. This work has resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, and crustaceans) IBIs for the Temperate Prairies (TP), Mixed Wood Plains (MWP) and the Mixed Wood Shield (MWS) level II ecoregions in Minnesota. These IBIs are suitable for evaluating the ecological condition or health of depressional wetland habitats. All of the wetland IBIs are scored on a 0 to 100 scale with higher scores indicating better condition. Wetland sampling protocols can be viewed at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html. Today, these indicators are used in a statewide survey of wetland condition where results can be summarized statewide and for each of Minnesota's three level II ecoregions (Genet 2012).

Individual Aggregated 12-HUC subwatershed results

Aggregated 12-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each Aggregated HUC-12 subwatershed within the Minnesota River- Mankato Watershed. The primary objective is to portray all the full support and impairment listings within an aggregated 12-HUC subwatershed resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire 8-HUC watershed including aquatic consumption, and drinking water assessments (where applicable) is included in Appendix 3.1). This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated HUC-12 subwatersheds, the assessment results from the 2015 Assessment Cycle, as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2013, intensive watershed monitoring effort, but also considers available data from the last 10 years.

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

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the aggregated HUC-12 subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2015 assessment process 2016 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 6). Assessment of aquatic life is derived from the analysis of biological (fish and invert IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli or fecal coliform) 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 3.1. Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated HUC-12 subwatershed as well as in the Watershed-wide results and discussion section.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each aggregated HUC-12 subwatershed 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 aggregated HUC-12 subwatershed.

Stream stability results

Stream channel stability information evaluated during each invert sampling visit is provided in each aggregated HUC-12 subwatershed section. These tables display the results of the Channel Condition and Stability Index (CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates three regions of the stream channel (upper banks, lower banks, and bottom) which may provide an indication of stream channel geomorphic changes and loss of habitat quality which may be related to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2008, and is collected once at each biological station. Consequently, the CCSI ratings are only available for biological visits sampled in 2010 or later. The final row in each table displays the average CCSI scores and a rating for the aggregated HUC-12 subwatershed.

Aggregated HUC-12 subwatershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the aggregated HUC-12 subwatershed. 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. While not all of the water chemistry parameters of interest have established water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of parameters that provide a basis for evaluating stream water quality data and estimating attainable conditions for an ecoregion. For comparative purposes, water chemistry results for the Minnesota River – Mankato Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams within each ecoregion.

Lake assessments

A summary of lake water quality is provided in the aggregated HUC-12 subwatershed sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for all lakes in the watershed are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 5.2.

Birch Coulee Creek Aggregated 12-HUC

HUC 0702000701-01

The Birch Coulee Creek (0702000701-01) aggregated 12-HUC is located on the north side of the Minnesota River at the western margin of the major watershed (Figure 21). This subwatershed drains 68 square miles (43,725 acres), and is entirely within Renville County. The Birch Coulee Creek subwatershed primarily consists of County Ditch 124/Birch Coulee Creek and its tributaries, and is a direct tributary to the Minnesota River. The main tributaries to Birch Coulee Creek are County Ditch 85A and Judicial Ditch 12. This stream system primarily flows south to its confluence with the Minnesota River near Morton, and is represented by the pour point biological monitoring site 13MN008, which was sampled for water chemistry. All of the streams within this subwatershed are considered warmwater. Within this watershed, 71% of the reaches have been altered, primarily in the headwater reaches, while 28% remain natural. No definable channel accounts for 1% of the reaches in the watershed. There are no lakes within the watershed. One of the unique features along Birch Coulee Creek is a substantial rapids at biological monitoring site 14MN210, formed by an outcrop of gneiss. The rapids are not considered a barrier to fish movement (Lore 2015).

The Birch Coulee Creek subwatershed is predominately rural, with no towns present. The dominant land use in the watershed is cropland, with 90% of the watershed area used for this purpose. This subwatershed has the highest percentage of cropland than the other subwatersheds within the major watershed, although several others come close to this percentage. Approximately 4% of the watershed is developed, while the more natural portions consist of 2% forest, 1.4% rangeland. There is very little water storage potential on the landscape, with open water accounting for 0.01% and wetlands account for 1.53% of the landscape.

Table 3. Aquatic life and recreation assessments on stream reaches: Birch Coulee Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**									**Eutrophication**		**Aquatic Life**	**Aquatic Rec. (Bacteria)**
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-670 **County Ditch 124** *Headwaters to CD 85A*	13MN004	8.26	WWm	-	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-711 **County Ditch 124** *CD 85A to T113 R34W S5, west line*	07MN080	1.69	WWm	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
07020007-588 **Birch Coulee Creek** *Unnamed ditch to JD 12*	90MN053	3.71	WWg	EXS	EXS	IF	IF	MTS	-	IF	IF	-	IF	-	IMP	-
07020007-707 **Judicial Ditch 12** *CSAH 2 to CD 136*	13MN007	2.34	WWg	MTS	-	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-587 **Birch Coulee Creek** *JD 12 to Minnesota R*	13MN008, 14MN210	3.76	WWg	EXS	EXS	MTS	MTS	MTS	MTS	MTS	MTS	-	MTS	-	IMP	IMP

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

Table 4. Minnesota Stream Habitat Assessment (MSHA): Birch Coulee Creek Aggregated 12-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	13MN004	County Ditch 124	0	7.5	12	9	5	33.5	Poor
1	13MN005	County Ditch 85A	0	9	12.7	7	13	41.7	Poor
3	07MN080	County Ditch 124	0	8	12.3	5	7.3	32.7	Poor
2	90MN053	Birch Coulee Creek	2.5	11	21.1	12	29	75.6	Good
1	13MN006	Judicial Ditch 12	0	7	20.0	11	12	50.0	Fair
2	13MN007	Judicial Ditch 12	0	10.5	20.2	9.5	22.5	62.7	Fair
2	13MN008	Birch Coulee Creek	3.3	12.5	18.4	12	24.5	70.7	Good
1	14MN210	Birch Coulee Creek	2.5	5	21.6	15	29	73.1	Good
Average Habitat Results: Birch Coulee Creek *Aggregated 12 HUC*			1.1	9.3	17.1	9.5	17.9	54.9	**Fair**

Qualitative habitat ratings

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

Table 5. Channel Condition and Stability Assessment (CCSI): Birch Coulee Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN004	County Ditch 124	36	21	24	5	86	Severely Unstable
2	07MN080	Birch Coulee Creek	30	14	17.5	4	65.5	Moderately Unstable
1	90MN053	Birch Coulee Creek	18	26	11	3	58	Moderately Unstable
2	13MN008	Birch Coulee Creek	24	26.5	31.5	9	91	Severely Unstable
Average Stream Stability Results: *Birch Coulee Cr. Aggregeted 12 HUC*			27	21.3	22.2	5.7	76.2	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 6. Outlet water chemistry results: Birch Coulee Creek Aggregated 12-HUC.

Station location:	Birch Coulee Creek, At Minnesota Highway 19, 1.5 miles Southeast of Morton						
STORET/EQuIS ID:	S005-662						
Station #:	13MN008						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	13	0.27	17.2	2.6	40	0
Chloride	mg/L	10	7.5	23.1	14.62	230	0
Dissolved Oxygen (DO)	mg/L	20	6.9	14	8.67	5	0
pH		20	7.8	8.6	8.18	6.5 - 9	0
Secchi Tube	100 cm	44	1	100	65.92	10	3
Total suspended solids*	mg/L	25	2	186	19.76	65	2
Phosphorus	ug/L	26	20	1000	90	150	5
Escherichia coli (geometric mean)	MPN/100ml	3	363	638	-	126	3
Escherichia coli	MPN/100ml	41	33.1	2419.6	764.1	1260	3
Inorganic nitrogen (nitrate and nitrite)*	mg/L	26	0.2	23	6.8	-	-
Kjeldahl nitrogen*	mg/L	10	0.5	2	1	-	-
Specific Conductance	uS/cm	20	460	868	761.4	-	-
Temperature, water	deg °C	20	5.5	23	17.7	-	-
Sulfate*	mg/L	10	44.1	179	132.1	-	-
Hardness	mg/L	10	270	476	404.8	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Birch Coulee Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

For the Birch Coulee aggregated (0702000701-01) 12-HUC, five AUID's were assessed for Aquatic Life (AQL) using data from six biological monitoring sites sampled in 2013 and 2014, (Table 3, Figure 21). Of these, only County Ditch 12 (07020007-707) was found to be supporting for aquatic life. The F-IBI score for this reach was above the General Use threshold and the upper confidence interval. This portion of County Ditch 12 enters a high gradient ravine before it joins with Birch Coulee Creek where habitat was considered fair. For the AUID's making up County Ditch 124 (-670 and -711), the upstream most AUID (-670) had no assessable fish community data, while the downstream reach (-711) met the F-IBI standard for the Modified Use class. Both reaches will be listed for Aquatic life based on M-IBI exceedances. The fish community for the downstream reach of County Ditch 124 (-711) may have benefited from better habitat conditions downstream. The downstream AUID's for Birch Coulee Creek (-588, -587) are designated General Use and show impairments for both the fish community (F-IBI) and macroinvertebrate community (M-IBI). Despite MSHA scores showing good habitat conditions for stations on these lower AUID'S, the biological communities are degraded. The F-IBI scores suffered from the presence numerous tolerant species. The biological communities also likely suffers from the effects of altered hydrology as stream stability results for many of the monitoring stations were found to be moderately to severely unstable. Data from fish sampling visits for 13MN004, 13MN005, and 13MN006 were not used for assessment due to the visits occurring earlier in the season before the fish community had a chance to recolonize following a drought and a late spring.

Stream water chemistry

Assessable water chemistry data was available on the two downstream reaches of Birch Coulee Creek. Birch Coulee Creek (-588) had only secchi tube (STUBE) data available from four years, with no violations over that time. More supporting water chemistry data would be needed to make a complete aquatic life use assessment on this reach. The outlet reach (-587) of Birch Coulee Creek had large datasets available for all assessment parameters. Aquatic life use parameters easily met their respective standards, with only TSS and STUBE datasets revealing a few event based exceedances.

E. coli data used for aquatic recreation use assessment was collected between 2009 and 2014. Individually three violations occurred, three months meeting the minimum criteria for geometric mean calculations all violated the 126 MPN/100 mL standard, indicating a persistent problem of elevated bacteria concentrations, which will trigger an aquatic recreation use listing.

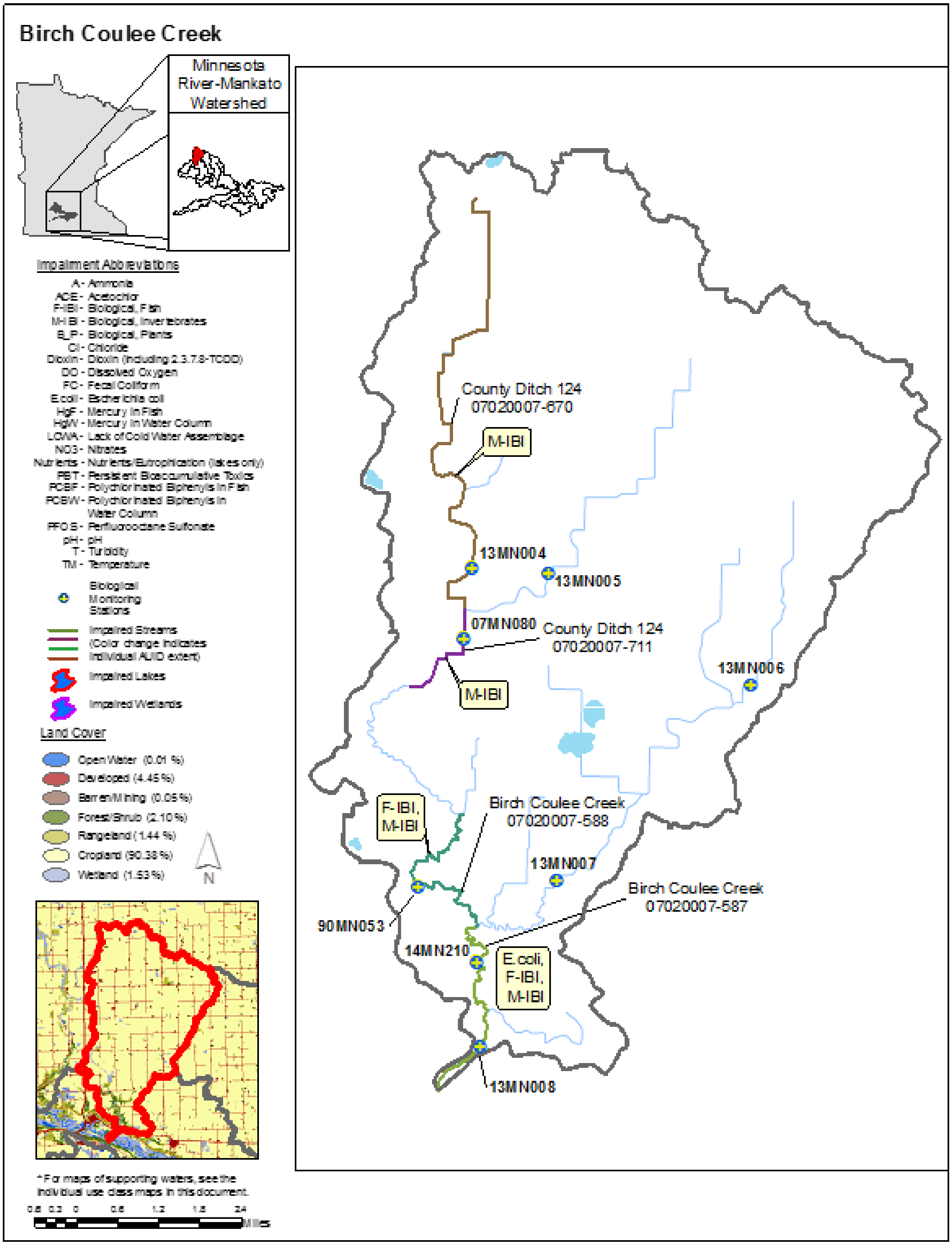


Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Birch Coulee Creek Aggregated 12-HUC.

Fort Ridgley Creek Aggregated 12-HUC HUC 0702000703-01

The Fort Ridgley Creek (0702000703-01) aggregated 12-HUC subwatershed drains 70 square miles on the north side of the Minnesota River in the western half of the major watershed (Figure 22). This subwatershed falls entirely within Renville County. The primary watercourse, County Ditch 106A/Fort Ridgley Creek, and its tributaries are a direct tributary to the Minnesota River. The main tributaries to Fort Ridgley Creek include: County Ditch 115, County Ditch 3, and an Unnamed Creek. The primary direction of the flow for this system is south to the Minnesota River. The subwatershed is represented by the pour point sampling site 05MN013. All of the streams within the subwatershed are considered warmwater. Channelization is prevalent in the headwater portions of the streams with 81% of the streams altered. Nearer the confluence with the Minnesota River, 11% of the streams remain natural. Streams with no definable channel account for 8% of total river miles. There are no lakes within the watershed. A fish barrier created by a six-foot dam is found on Fort Ridgley Creek near the Mayflower Golf Course approximately five miles upstream of the confluence with the Minnesota River (Lore 2015). There are eight biological monitoring sites upstream of the dam. Despite the barrier, there appears to be a negligible effect on the fish community at these stations.

The town of Fairfax lies on the eastern boundary of this predominantly rural subwatershed. Land use within the watershed is dominated by cropland, occupying 89% of the area. Developed areas account for 6% of the area within the watershed. The natural component of the subwatershed consists of 1.9% forest, 1.7% rangeland, and 1.4% wetland. Water storage capacity in the watershed is minimal with the small percentage of wetlands, and open water only accounting for 0.17% of the watershed area.

Table 7. Aquatic life and recreation assessments on stream reaches: Fort Ridgley Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name*****,** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-688 **County Ditch 106A (Fort Ridgley Creek)** *Headwaters to T112 R33W S13, south line*	13MN017, 13MN019, 91MN054	20.70	WWm	MTS	EXS	IF	IF	IF	-	MTS	MTS	-	MTS	-	IMP	-
AUID ***Reach Name*****,** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**											**Aquat ic Life**	**Aquat ic**

				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication			
													Phosphorous	Response Indicator		
07020007-673 **County Ditch 115** *Unnamed cr to Unnamed cr*	13MN018	7.16	WWm	-	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-664 **County Ditch 115** *Unnamed cr to CD 106A*	13MN020	2.71	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-525 **County Ditch 3** *Headwaters to Fort Ridgley Cr*	13MN022	4.86	WWm	NA	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-663 **Unnamed creek** *MN Hwy 4 to Fort Ridgely Cr*	13MN023	0.96	WWg	-	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-689 **Fort Ridgley Creek** *T112 R33W S24, north line to Minnesota R*	05MN013, 05MN014, 05MN015, 13MN021	7.58	WWg	EXS	EXS	MTS	MTS	MTS	MTS	MTS	IF	-	MTS	-	IMP	IMP

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

Table 8. Minnesota Stream Habitat Assessment (MSHA): Fort Ridgley Creek Aggregated 12-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
2	13MN017	County Ditch 106A (Fort	0	7.8	10.1	6	8.5	32.3	Poor
2	13MN019	County Ditch 106A (Fort	0	7.3	16.7	6	7.5	37.5	Poor
1	91MN054	County Ditch 106A (Fort	0	7	12	9	4	32	Poor
1	13MN018	County Ditch 115	0	7.5	12	9	4	32.5	Poor
1	13MN020	County Ditch 115	0	6	15.9	6	11	38.9	Poor
2	13MN022	County Ditch 3	0	8	18.0	10.5	11	47.5	Fair
1	13MN023	Unnamed creek	2.5	12	17.8	12	25	69.3	Good
1	05MN013	Fort Ridgley Creek	5	14.5	21.3	13	28	81.8	Good
1	05MN014	Fort Ridgley Creek	3	8.5	21.1	11	21	64.6	Fair
1	05MN015	Fort Ridgley Creek	5	14	17.8	12	27	75.8	Good
1	13MN021	Fort Ridgley Creek	0	11.5	18.7	13	24	67.2	Good
Average Habitat Results: Fort Ridgley Creek *Aggregated 12-HUC*			1.1	9.1	16.2	9.3	14.1	49.8	**Fair**

Qualitative habitat ratings

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

Table 9. Channel Condition and Stability Assessment (CCSI): Fort Ridgley Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN017	Fort Ridgley Creek	33	21	8	5	67	Moderately Unstable
1	13MN018	County Ditch 115	33	15	9	5	62	Moderately Unstable
1	05MN013	Fort Ridgely Creek	11	20	12	3	46	Moderately Unstable
Average Stream Stability Results: *Fort Ridgley Cr. Aggregated 12-HUC*			25.7	18.7	9.7	4.3	58.3	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 10. Outlet water chemistry results: Fort Ridgely Creek Aggregated 12-HUC.

Station location:	Fort Ridgely Creek, At CSAH 21, 5.5 miles South of Fairfax						
STORET/EQuIS ID:	S005-665						
Station #:	05MN013						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	6	2.1	42	12.32	40	1
Chloride	mg/L	9	22	37.4	26.8	230	0
Dissolved Oxygen (DO)	mg/L	16	6.4	14.5	8.3	5	0
pH		8	8.1	10.5	8.6	6.5 - 9	1
Secchi Tube	100 cm	37	7	100	68.9	10	8
Total Suspended Solids	mg/L	25	2	248	25.2	65	2
Phosphorus	ug/L	24	19	1329	119	150	2
Escherichia coli (geometric mean)	MPN/100 ml	3	203	517	-	126	3
Escherichia coli	MPN/100 ml	32	14.6	2419.6	266.7	1260	1
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	25	0.6	27	8.2	-	-
Kjeldahl Nitrogen	mg/L	9	0.5	3.3	1.2	-	-
Specific Conductance	uS/cm	16	540	882	663.9	-	-
Water Temperature	deg °C	16	8.7	24.2	17.8	-	-
Sulfate*	mg/L	9	68.9	111	94.2	-	-
Hardness	mg/L	9	290	444	390.3	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Fort Ridgely Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Six AUID's were assessed for Aquatic Life (AQL) using data from 11 biological monitoring stations within the Fort Ridgley Creek aggregated (0702000703-01) 12-HUC (Table 7, Figure 22). Three AUID'S' were found to be supporting of AQL. County Ditch 3 (07020007-525) and Unnamed Creek (-663) met the Modified Use class criteria for the macroinvertebrate community. Fish community data was not assessed primarily due to drought conditions over winter and a late spring that inhibited fish movement within the system. Habitat conditions for these stream reaches were considered fair to good. County Ditch 115 consists of two reaches (-673, -664), both designated as Modified Use. The upstream reach on County Ditch 115 (-673) did not have assessable fish community data, but will be listed for AQL based on the M-IBI exceeding the criteria. The downstream reach (-664) met both the F-IBI and M-IBI criteria for AQL. Fort Ridgley Creek consists of two reaches, County Ditch 106A (-688) which is the headwaters reach and is designated as Modified Use, and a downstream reach (-689) designated as General Use. All three monitoring sites in the headwaters reach had poor habitat associated with low MSHA scores. Despite low MSHA scores the fish community met AQL standards while the macroinvertebrate community failed to meet the AQL standards. Accordingly, this reach will be listed as impaired for AQL based on low M-IBI scores. The dam downstream of the reach, had minimal impact on the fish community (Lore 2015). The downstream reach of Fort Ridgley Creek (-689) had improved habitat conditions at most of the sampling sites, in spite of this both the fish and macroinvertebrate communities failed to meet the General Use standards for AQL, and will be listed as Impaired. This downstream reach on Fort Ridgley Creek supports a seasonal put-and-take trout fishery within Fort Ridgley State Park. There is enough groundwater entering the stream in the lower portion of this reach to support a seasonal, put-and-take trout fishery. Brown trout are stocked in the spring to provide a recreational activity for visitors to the park throughout the spring and summer months. Cold water conditions usually do not persist later in the summer so overwintering of trout rarely occurs. Altered hydrology and poor water quality conditions within the watershed can have an adverse impact on biological communities; these conditions may be event based, and not present at the time of monitoring.

Stream water chemistry

County Ditch 106A (-688), considered the headwaters reach of Fort Ridgely Creek had limited water chemistry available within the assessment window primarily collected at biological monitoring visits across four years. All parameters would meet the respective standard although minimum data requirements were not met. The exception is dissolved oxygen (DO), which indicated one severe exceedance (0.5 mg/L) out of four sample points, not enough data to confidently list but it is clear that wide swings in DO concentrations are occurring on this reach of Fort Ridgely Creek which could potentially be a stressor to aquatic communities. The downstream portion of Fort Ridgely Creek (-689) had more complete datasets for water chemistry assessment. TSS and Secchi tube revealed minor exceedance rates in large datasets which would not trigger a listing at this time. Unionized ammonia and pH had a single exceedance, both linked to an abnormally high pH value (10.4 SU) in May 2013, which could be the result of a short term change in water quality conditions or potentially equipment malfunction. All DO values met the applicable standard. Bacteria data was available on this reach (-689) from four years between 2009 and 2014, with one individual and three monthly geometric mean violations over that time, indicating persistently high bacteria levels across all months and years, which will trigger an aquatic recreation use impairment.

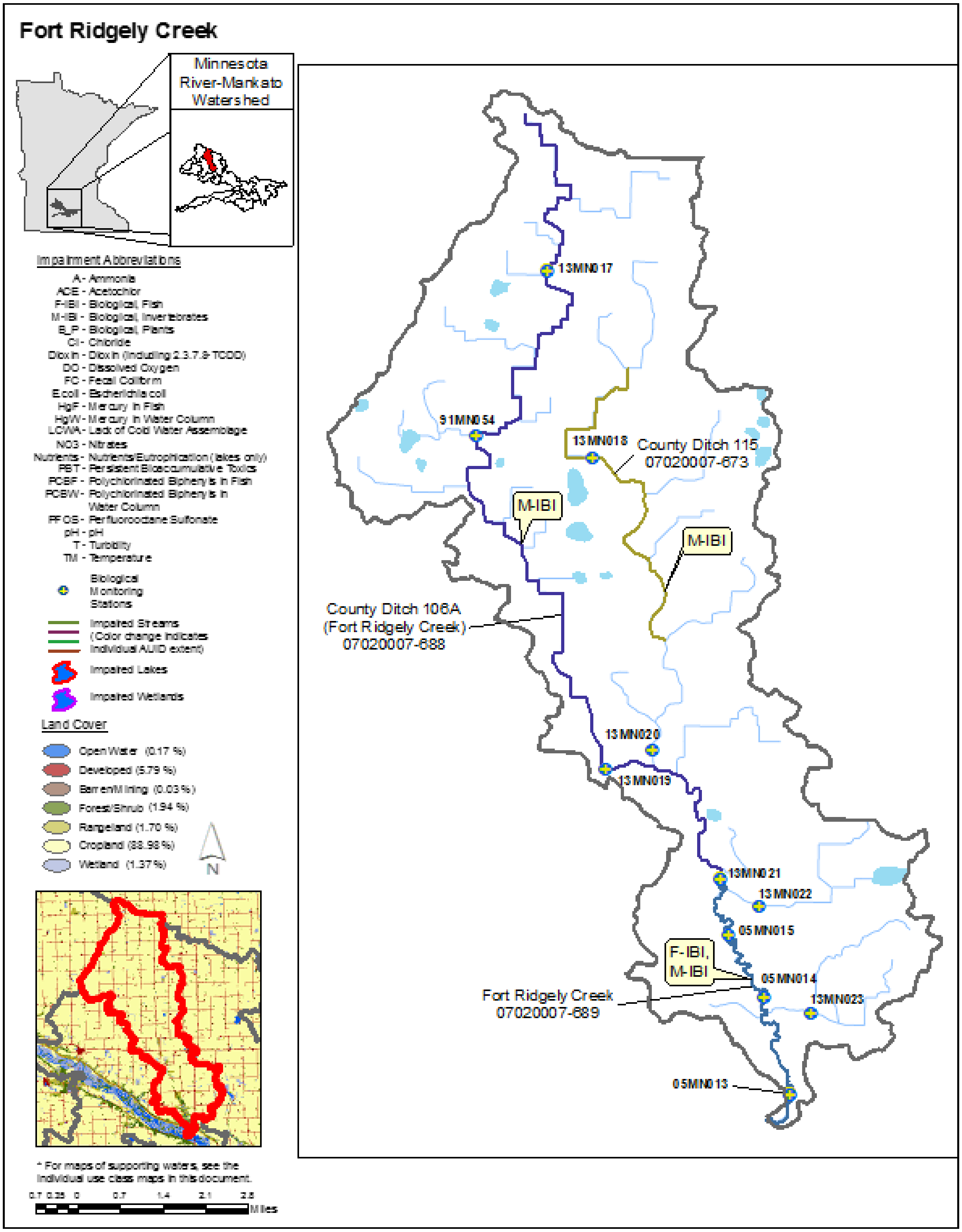


Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Fort Ridgely Creek Aggregated 12-HUC.

Little Rock Creek Aggregated 12-HUC HUC 0702000705-01

The Little Rock Creek (0702000705-01) aggregated 12-HUC is located in the western half of the major watershed, on the north side of the Minnesota River (Figure 23). This subwatershed drains 85 square miles (54,140 acres), and has a large proportion within Renville County. A southern portion of the subwatershed is in Nicollet County, and in the eastern edge of the watershed is in Sibley County. The Little Rock Creek subwatershed generally flows south to its confluence with the Minnesota River, and consists of Little Rock Creek/Judicial Ditch 31, and its tributaries. The main tributaries to Little Rock Creek from north to south include: County Ditch 34, Judicial Ditch 8, County Ditch 100, and Judicial Ditch 31. All of the streams within the watershed are warmwater. The pour point biological monitoring site that represents the subwatershed is 13MN032. Altered stream channels are common within the watershed, representing 75% of the total river miles. Natural stream channels account for 12% of the river miles, while 13% of the stream reaches are considered to have No Definable Channel. Channel alterations to promote drainage typically occur in the headwater reaches, while natural channels occur closer to the Minnesota River valley. Three lakes are present in the watershed, Swan Lake (560 acres), Mud Lake (139 acres), and Round Lake (97 acres). Little Rock Creek flows thru Mud Lake, which also has a 5-foot high dam at its outlet (Lore 2015). The outlet dam appears to have an effect on the five biological monitoring stations present upstream of the structure (Lore 2015).

A portion of the town of Fairfax is present on the western boundary of the watershed. This rural subwatershed consists of 88% cropland, and about 5% developed. Forest accounts for about 2% of the watershed area while, rangeland a mere 0.6%. About 2% of the watershed consists of wetland, and about 1% is open water. With a small percentage of wetland and open water, water storage is minimal on the landscape.

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

AUID *Reach Name,* *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-686 **Little Rock Creek (Judicial Ditch 31)** *Headwaters thru Mud Lk*	13MN026, 13MN027, 13MN029	13.84	WWm	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-666 **Judicial Ditch 8** *Unnamed cr to JD 31*	13MN028	3.11	WWm	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-665 **County Ditch 100** *CD 28 to JD 31*	13MN030	4.17	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-716 **Judicial Ditch 13** *Unnamed ditch to CSAH 5*	13MN031	2.07	WWm	EXS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-717 **Judicial Ditch 13** *CSAH 5 to Little Rock Cr*	10EM083	2.18	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-687 **Little Rock Creek (Judicial Ditch 31)** *Mud Lk to Minnesota R*	03MN019, 03MN020, 13MN032	13.18	WWg	EXS	EXS	MTS	IF	MTS	MTS	MTS	IF	-	IF	-	IMP	IMP

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

Table 12. Minnesota Stream Habitat Assessment (MSHA): Little Rock Creek Aggregated 12-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	10EM019	Unnamed ditch	0	6	3	12	9	30	Poor
1	13MN026	Little Rock Creek (Judicial Ditch	0	7.5	17.9	8	13	46.4	Fair
1	13MN027	Little Rock Creek (Judicial Ditch	0	7	14	6	4	31	Poor
1	13MN029	Little Rock Creek (Judicial Ditch	0	7	18	7	12	44	Poor
2	13MN028	Judicial Ditch 8	0.6	7.5	17	4.5	6	35.6	Poor
2	13MN030	County Ditch 100	0	7	11	8	6	32	Poor
1	13MN031	Judicial Ditch 13	0	6.5	16	10	4	36.5	Poor
1	10EM083	Judicial Ditch 13	0	9	18.6	13	28	68.6	Good
3	03MN019	Little Rock Creek (Judicial Ditch	1.3	7.5	17.8	13.7	23.7	63.9	Fair
1	03MN020	Little Rock Creek (Judicial Ditch	0.5	7.5	18.2	12	18	56.2	Fair
3	13MN032	Little Rock Creek (Judicial Ditch	2.1	9.3	19	12.7	25.3	68.4	Good
Average Habitat Results: *Little Rock Creek Aggregated 12-HUC*			0.7	7.6	16.0	10.1	15.2	49.7	**Fair**

Qualitative habitat ratings

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

Table 13. Channel Condition and Stability Assessment (CCSI): Little Rock Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	10EM019	Unnamed ditch	27	15	9	3	54	Moderately Unstable
1	10EM083	Trib. to Little Rock Creek	20	15	12	5	52	Moderately Unstable
1	03MN019	Little Rock Creek	15	17	13	11	56	Moderately Unstable
Average Stream Stability Results: *Little Rock Cr. Aggregated 12-HUC*			20.7	15.7	11.3	6.3	54	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 14. Outlet water chemistry results: Little Rock Creek Aggregated 12-HUC.

Station location:	Little Rock Creek, At Newton Township Road 40, 7 miles Southeast of Fairfax						
STORET/EQuIS ID:	S007-569						
Station #:	13MN032						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	10	2.4	121.8	22.86	40	1
Chloride	mg/L	10	21.3	33.8	25.3	230	0
Dissolved Oxygen (DO)	mg/L	16	6.2	13.2	8.4	5	0
pH		10	8.3	8.8	8.5	6.5 - 9	1
Secchi Tube	100 cm	16	12	100	67	10	3
Total Suspended Solids	mg/L	10	3.6	31	9.8	65	5
Phosphorus	ug/L	9	45	198	105	150	2
Escherichia coli (geometric mean)	MPN/100ml	3	675	1346	-	126	3
Escherichia coli	MPN/100ml	14	75	2613	1037.3	1260	5
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	10	3.8	26.2	12.5	-	-
Kjeldahl Nitrogen	mg/L	10	0.8	2.3	1.6	-	-
Specific Conductance	uS/cm	16	347	684	570.4	-	-
Water Temperature	deg °C	16	8.3	25.9	18.8	-	-
Sulfate*	mg/L	10	33.7	81.5	58.4	-	-
Hardness	mg/L	10	294	401	345.4	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Little Rock Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Six AUID's were assessed for Aquatic Life (AQL) within the Little Rock Creek aggregated 12-HUC, utilizing data from 10 monitoring sites (Table 11, Figure 23). Of these, only one was found to be supporting of AQL. County Ditch 100 (07020007-665) was found to be fully supporting of AQL for the Modified Use class. Judicial Ditch 8 (-666) exceeded the criteria for Modified Use (MU) for both the fish and macroinvertebrate community and will be listed as impaired for AQL. Judicial Ditch 13 consists of two reaches, which was the result of an AUID split according to Tiered Aquatic Life Use (TALU) criteria. The upstream reach (-716) is channelized and falls under the Modified Use class. The downstream reach (-717) consists of a natural channel, and will be held to General Use (GU) standards. Despite the macroinvertebrate community meeting standards, the fish community exceeded the MU threshold, prompting a listing for AQL. Both the fish and macroinvertebrate communities failed to meet the GU criteria for the downstream reach of Judicial Ditch 13 (-717), which will also list this reach for AQL. The headwater reach for Little Rock Creek (Judicial Ditch 31) (-686) exceed the MU use standards for both the fish and macroinvertebrate community, consequentially this reach will be Impaired for AQL. Most of this reach is channelized with poor habitat conditions based on MSHA scores at the monitored stations, which likely contributes to the poor biological communities for this reach. The outlet dam at Mud Lake is also a factor contributing to the poor condition of the fish community of this reach (-686), as well as the fish community for Judicial Ditch 8 (-666). For an unknown reason, the fish community for County Ditch 100 (-665) seemed to fair better despite being upstream of the barrier. Mud Lake provides a refuge for tolerant fish species during times of drought (Lore 2015), while the outlet dam prevents recolonization after drought of other fish species that may be favorable for the fish community. In contrast with the poor habitat conditions and channelization found in the upper portions of the watershed, habitat conditions are considered fair to good in the natural channel lower reach of Little Rock Creek (-687). Despite habitat slightly more suitable for biological communities, both the fish and macroinvertebrate communities exceeded the GU standard, resulting in an AQL Impairment for the reach. Overall land use within the watershed, as well as altered hydrology exasperated by drainage systems throughout the watershed are likely factors in the poor condition biological communities exhibit within the watershed.

Stream water chemistry

Assessable water chemistry data was available from two different stations on the downstream reach of Little Rock Creek (-687). TSS and secchi tube datasets had a small number of exceedances mainly at the downstream station. The majority of these violations were related to large rain and flow events at a time when sediment loads are predictably high. Unionized ammonia and pH indicates a violation in August 2013, the resulting exceedance rates are minimal and will not trigger a listing at this time. Bacteria data reveals a clear pattern of elevated *E. coli* concentrations across all months and years, with five individual and three monthly geometric mean violations, this will result in new listing for bacteria. Runoff from concentrated animal activity within the floodplain can often lead to increase bacteria levels.

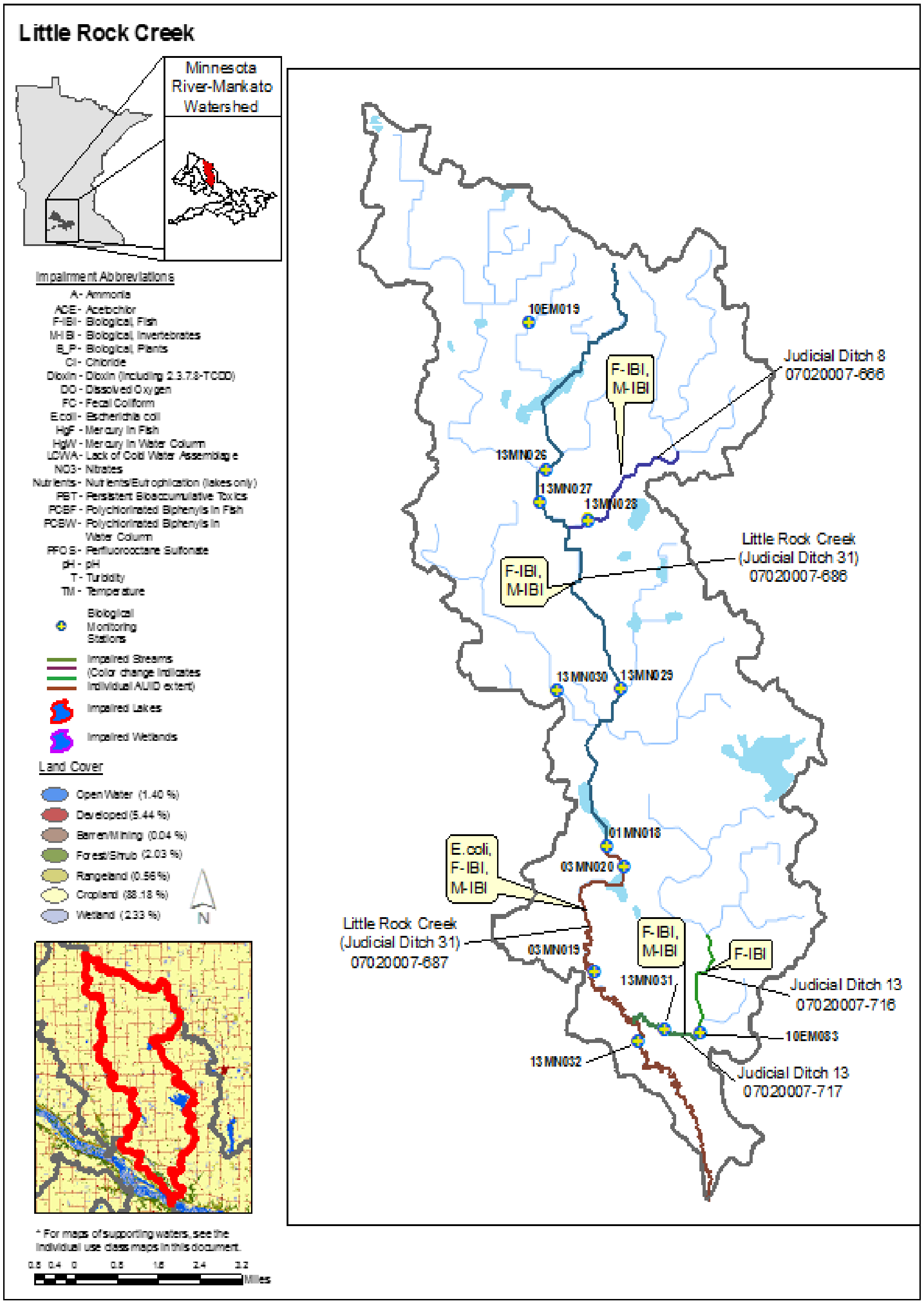


Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Little Rock Creek Aggregated 12-HUC.

Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC HUC 0702000708-01

The Swan Lake Outlet (Nicollet Creek) (0702000708-01) aggregated 12-HUC is located on the north side of the Minnesota River in the central region of the major watershed (Figure 24). This subwatershed drains 79 square miles (50,539 acres), and is entirely within Nicollet County. The most significant waterbodies within the subwatershed are Swan Lake, an 8,884-acre shallow lake and wetland complex, and Swan Lake Outlet (Nicollet Creek). Swan Lake Outlet (NIcollet Creek) and its associated tributaries flow south to join the Minnesota River. County Ditch 11 and County Ditch 4/County Ditch 39 are the main tributaries to Swan Lake Outlet (Nicollet Creek). Streams within the subwatershed fall under the warmwater use class. The biological monitoring station that represents the pour point of the subwatershed is 03MN069. Channelization of the stream within this subwatershed is slightly less prevalent with only 33% of the stream reaches altered. Natural stream channels represent 10% of the stream reaches. With the presence of Swan Lake, there is a higher percentage of impounded (25%) reaches and no definable channel (32%) reaches. Some of the reaches that are considered no definable channel occur in the smallest of the headwater streams, and may have been converted to tile lines, or consist of intermittent grass waterways in fields. Natural channels typically occur in the streams nearest to the Minnesota River valley. Besides Swan Lake, other lakes include Middle Lake (1,152 acres) Petersen Lake (57 acres), and Horseshoe Lake (42 acres). Numerous barriers to fish movement occur within the watershed. Most notable of these is an 11-foot natural waterfall on Swan Lake Outlet (Nicollet Creek) 0.3 miles upstream of the confluence with the Minnesota River, which has a noticeable effect on the fish communities at five biological monitoring stations upstream of the barrier (Lore 2015). Besides the waterfall, a perched culvert exists between the biological monitoring stations 03MN069 and 13MN086 (Lore 2015). There are also dams at the outlets to Swan Lake and Middle Lake (Lore 2015).

The town of Nicollet is the only town within the subwatershed. The presence of Swan Lake and its associated wetlands has a significant effect on the land use within the subwatershed. Cropland (60%) is still a dominant component of the land use in the watershed. With the lakes, 14% of the watershed is open water, and 17% is wetland, the highest percentages of the subwatersheds in the Minnesota River – Mankato watershed. Developed areas comprise 4% of the watershed area. Forest and rangeland occupy 4% and 1% of the watershed area respectively. With the presence of the lakes and wetlands, water storage capacity in the watershed is more significant than in other subwatersheds within the Minnesota River – Mankato major watershed.

Table 15. Aquatic life and recreation assessments on stream reaches: Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-682 **Swan Lake Outlet (Nicollet Creek)** *Swan Lk to CD 39*		3.47	WWg	-	-	-	-	MTS	-	-	-	-	-	-	IF	-
07020007-661 **County Ditch 11** *Headwaters to CD 39*	13MN058	4.69	WWm	NA	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-545 **County Ditch 4/County Ditch 39** *Middle Lk to Swan Lk outlet*	13MN056, 13MN057	3.77	WWm	-	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-683 **Swan Lake Outlet (Nicollet Creek)** *CD 39 to Minnesota R*	03MN069, 13MN086	7.23	WWg	NA	EXS	MTS	MTS	MTS	MTS	MTS	MTS	-	IF	-	IMP	IMP

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

Table 16. Minnesota Stream Habitat Assessment (MSHA): Swan Lake Outlet (Nicollet Creek) Aggregated 12-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
2	13MN058	County Ditch 11	0	10	6.5	5	5.5	27	Poor
1	13MN056	County Ditch 4/County Ditch	0.5	8	9	9	8	34.5	Poor
1	13MN057	County Ditch 4/County Ditch	0	8.5	11	9	13	41.5	Poor
2	03MN069	Swan Lake Outlet (Nicollet	5	12.5	19.1	12.5	27.5	76.6	Good
2	13MN086	Swan Lake Outlet (Nicollet	4.8	13.3	21.3	13	26	78.3	Good
Average Habitat Results: *Swan Lake Outlet (Nicollet Cr.) Aggregated 12-HUC*			2.5	11	14.2	9.9	17.4	55.0	**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 17. Channel Condition and Stability Assessment (CCSI): Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN058	County Ditch 11	13	7	13	1	34	Fairly Stable
1	13MN056	County Ditch 4 (39)	13	5	17	1	36	Fairly Stable
1	13MN057	County Ditch 4	13	4	17	1	35	Fairly Stable
1	13MN086	Swan Lake Outlet (Nicolet Creek)	12	15	6	3	36	Fairly Stable
Average Stream Stability Results: *Swan Lake Outlet (Nicollet Cr.) Agg. 12-HUC*			12.8	7.8	13.3	1.5	35.3	**Fairly Stable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 18. Outlet water chemistry results: Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC.

Station location:	Nicollet Creek, At County Road 62, 4.5 miles Northwest of Mankato						
STORET/EQuIS ID:	S007-571						
Station #:	03MN069						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia	ug/L	7	1.3	14.3	4.3	40	0
Chloride	mg/L	10	20.8	39.7	29.2	230	0
Dissolved Oxygen (DO)	mg/L	17	6.1	16.7	8.6	5	0
pH		9	8.2	8.6	8.4	6.5 - 9	0
Secchi Tube	100 cm	17	23	100	74	10	0
Total Suspended Solids	mg/L	9	2	28	8.1	65	0
Phosphorus	ug/L	9	33	135	83	150	0
Escherichia coli (geometric mean)	MPN/100 ml	3	404	479	-	126	3
Escherichia coli	MPN/100 ml	16	134	1299.7	491.8	1260	7
Inorganic Nitrogen (Nitrate and Nitrite)	mg/L	10	0.28	14.3	4.4	-	-
Kjeldahl Nitrogen	mg/L	10	0.41	2	1.2	-	-
Specific Conductance	uS/cm	16	414.4	685	525.2	-	-
Water Temperature	deg °C	17	12.4	21	17.7	-	-
Sulfate	mg/L	10	11.3	67.5	40.9	-	-
Hardness	mg/L	10	265	415	344.4	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Swan Lake Outlet Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 19. Lake assessments: Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Swan	52-0034-00	10095	E	100	2.4	0.6	-	75.5	9.3	1.2	IF	IF

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

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

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use

Summary

Stream biology

Assessments of stream condition were determined for three AUID's, using data from five biological monitoring stations, within the Swan Lake Outlet (Nicollet Creek)(070200708-01) aggregated 12-HUC (Table 15, Figure 24). None of the stream reaches assessed were found to support Aquatic Life (AQL) use. The uppermost AUID on Swan Lake Outlet (Nicollet Creek) (07020007-682) consisted only of secchi tube data. Insufficient data exists to assess for AQL on this AUID. A substantial natural barrier (Nicollet Creek falls) exists downstream of all biological monitoring stations within this subwatershed. Consequentially, recolonization of fish species from the Minnesota River after a period of drought is prevented by this barrier. Upstream refuge within the watershed is also inhibited due to dams at the outlets to Swan Lake and Middle Lake, preventing any movement of fish from the stream to the lakes. The general characteristics of the lakes also prove to be unsuitable for most stream fish species, since the lakes are shallow, wetland complex lakes, prone to the dissolved oxygen issues associated with wetlands, and actively managed for wildlife. Because of the unique situation of the natural barrier, and the lack up upstream refugia, no fish community data was used to asses for AQL on any of the AUID's (-661, -545, -683) upstream of the barrier. The macroinvertebrate community is not affected by the barrier, resulting in AQL assessments being primarily based on macroinvertebrate data in this watershed. County Ditch 11 (-661) and County Ditch 4/County Ditch 39 (-545) consist of channelized reaches, and were determined to use Modified Use class standards. Despite the lower IBI threshold for this use class, the macroinvertebrate communities did not meet the lower standards for AQL. Both AUID's (-661, -545) will be Impaired for AQL M-IBI. The lowest AUID on Swan Lake Outlet (Nicollet Creek) (-383) was previously listed for fish based on an assessment in 2008, and subsequently corrected based on the presence of the barrier falls, no fish data was used for this assessment of this reach. The macroinvertebrate community for this reach failed to meet the General Use threshold for this predominantly natural reach, resulting in an AQL Impairment for M-IBI. Despite the poor condition of the macroinvertebrate community, habitat conditions in this natural reach are considered good, and the CCSI results exhibit fairly stable channels conditions. With the substantial presence of lakes and wetland within this subwatershed, note fairly stable channels are noted throughout the reaches in this watershed, which is likely attributed to the increased capacity of water storage on the landscape.

Stream water chemistry

Assessable water chemistry data in this subwatershed was limited to Swan Lake Outlet (Nicollet Creek). Data was collected at S007-571 approximately eight miles downstream of Swan Lake. Aquatic life use parameters were collected up to four years, with all parameters meeting their applicable standard. Considering water quality on this reach is likely representative of the upstream Swan lake, careful consideration would be needed if an aquatic life use assessment was made based on the water chemistry data. Bacteria data was collected at two stations (S007-671 & S007-571) between 2009 and 2014, with seven individual and three of three monthly geometric mean violations over that time. Concentrated animal activity within the floodplain and stream bed can often lead to elevated concentrations of bacteria. At this time, this reach will be listed impaired for aquatic recreation use base on the bacteria data exceedances.

Lake water chemistry

Swan Lake is a very large, shallow lake. Water chemistry data was available on Swan Lake from 2006 through 2013. With the exception of three elevated sampling events in June and August 2006, Swan shows a pattern of easily meeting the Western Corn Belt Plains shallow lake standard for phosphorus (90 ug/L). It should be noted that concentrations in 2010 and 2013 were significantly lower than 2006; investigation could be pursued to see if lake manipulation was occurring during that time period between 2006 and 2010. Secchi and Chlorophyll-a measurements do not meet the minimum data points for assessment, although both parameters appear to be meeting standards. At this time, it would be beneficial to have the complete eight sample dataset for both response variables to make a confident aquatic recreation use assessment. Management strategies on this lake do not necessarily target swimmable conditions, but more so to provide excellent feeding and nesting habitat for various types of animals and waterfowl.

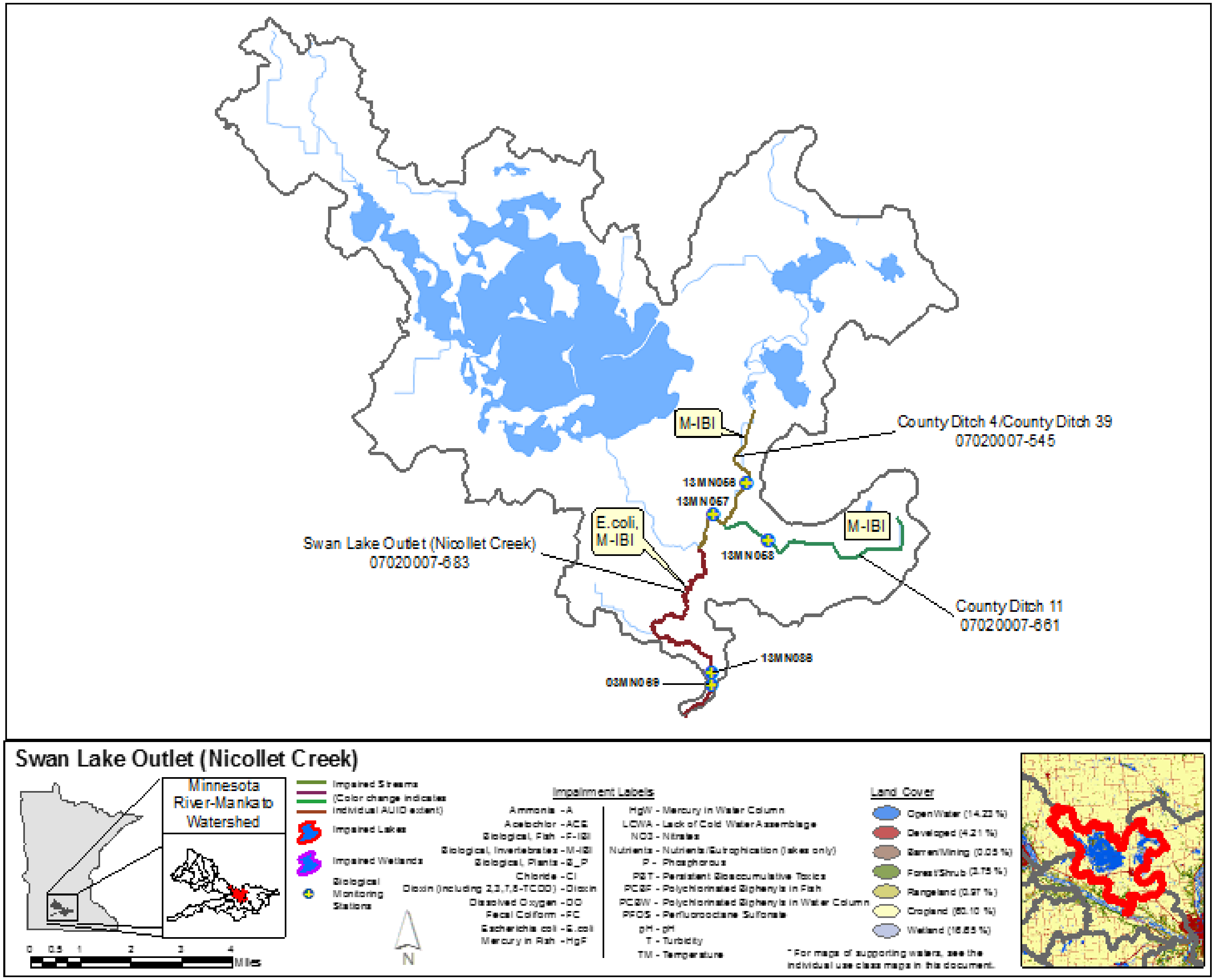


Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Swan Lake Outlet (Nicollet Creek) Aggregated 12-HUC.

Spring Creek-Minnesota River Aggregated 12-HUC HUC 0702000704-01

The Spring Creek – Minnesota River (0702000704-01) aggregated 12-HUC straddles the Minnesota River at the western margin of the major watershed (Figure 25). This subwatershed drains 172 square miles (110,375 acres), and consists of numerous small tributaries that directly flow into the Minnesota River on both the north and south sides of the river. The second largest subwatershed in the major watershed encompasses parts of four counties: Renville, Nicollet, Redwood, and Brown. Numerous streams are present in the watershed. On the north side of the river, an Unnamed Creek, Purgatory Creek, County Ditch 111, Threemile Creek, and County Ditch 140 were monitored as part of the 2013 effort. On the South side of the river, Crow Creek, County Ditch 52, County Ditch 22, an Unnamed Creek, County Ditch 13, and County Ditch 10 (John's Creek) were monitored as part of the intensive watershed monitoring effort. The most significant tributary in the subwatershed is Crow Creek, so the pour point station 13MN002 on that stream was selected to represent the water chemistry for this subwatershed. The majority of the streams within this subwatershed are considered warmwater. A portion of County Ditch 10 (John's Creek) is designated as coldwater, and a small Unnamed Creek on the side of the river is proposed to change from warmwater to coldwater. Many of the streams in this subwatershed are smaller direct tributaries to the Minnesota River so the prevalence of stream alterations is slightly less than the subwatersheds that contain more substantial systems. Altered stream reaches account for 54% of the reaches, while natural streams account for 32% of the reaches. No definable channel comprises 14% of the reaches. There are no lakes within the watershed.

The Spring Creek – Minnesota River subwatershed is predominantly rural with a few towns present. Portions of Redwood Falls, and Morgan are present within the watershed. Other towns wholly within the watershed are Morton and Franklin. Cropland (72%) is a dominant component of the land use within the watershed. With the watersheds proximity to the Minnesota River valley and its associated bluff and ravines, forest accounts for 6% of the watershed area, while rangeland accounts for 4%. Developed areas utilize 6% of the watershed area. Wetland and open water account for 9% and 2% of the acreage within the watershed. The Minnesota River and its floodplain areas contribute significantly to those percentages.

Table 20. Aquatic life and recreation assessments on stream reaches: Spring Creek-Minnesota River Aggregated 12-HUC. Reaches are organized upstream to downstream on the North side of the Minnesota River, followed by the South side of the Minnesota River in the table.

AUID **Reach Name**, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-668 **Unnamed creek** *Headwaters to Minnesota R*	13MN003	2.71	CWg*	NA	MTS	IF	-	-	-	IF	IF	-	IF	-	SUP	-
07020007-672 **County Ditch 111** *Unnamed cr to Purgatory Cr*	13MN016	1.09	WWg	MTS	-	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-645 **Purgatory Creek** *Unnamed cr to Minnesota R*		2.29	WWg	-	-	-	IF	MTS	-	-	-	-	IF	-	IF	IMP
07020007-704 **Threemile Creek** *CD 140 to Minnesota R*	13MN014	2.25	WWg	EXS	MTS	IF	MTS	MTS	-	IF	IF	-	MTS	-	IMP	IMP
07020007-636 **County Ditch 52** *Unnamed ditch to CD 22*	07MN074	1.51	WWm	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-671 **County Ditch 22** *Headwaters to Crow Cr*	13MN001	7.49	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-569 **Crow Creek** *CD 52 to T112 R35W S2, north line*	13MN002	3.45	WWg	EXS	EXS	EXS	MTS	MTS	MTS	MTS	MTS	-	EXS	-	IMP	IMP
07020007-715 **Unnamed creek** *T111 R33W S8, east line to Unnamed cr*	13MN013	2.59	WWg	EXS	-	IF	MTS	IF	-	IF	IF	-	IF	-	IMP	IF

AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**									**Eutrophication**		**Aquatic Life**	**Aquatic Rec. (Bacteria)**
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-651 **Unnamed creek** *Headwaters to Unnamed cr*		2.72	WWg	-	-	MTS	-	-	-	MTS	-	-	IF	-	IF	-
07020007-644 **Unnamed creek** *Unnamed cr to Minnesota R*		1.76	WWg	-	-	IF	MTS	MTS	-	MTS	MTS	-	EXS	-	IF	IMP
07020007-712 **County Ditch 13** *245th Ave to Minnesota R*	13MN025	2.69	WWg	EXS	EXS	IF	MTS	MTS	-	MTS	MTS	-	EXS	-	IMP	IMP
07020007-650 **County Ditch 10 (John's Creek)** *Unnamed ditch to T110 R32W S2, east line*		2.10	WWg	-	-	MTS	MTS	MTS	-	MTS	MTS	-	EXS	N	IF	IF
07020007-571 **County Ditch 10 (John's Creek)** *T110 R32W S1, west line to Minnesota R*	05MN011	3.77	CWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	EXS	-	IMP	IMP

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

Table 21. Minnesota Stream Habitat Assessment (MSHA): Spring Creek-Minnesota River Aggregated 12-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
2	13MN003	Unnamed creek	2.5	13.8	17.5	11	23.5	68.3	Good
1	13MN016	County Ditch 111	0	10	8	12	7	37	Poor
1	13MN014	Threemile Creek	0	15	20.9	16	27	78.9	Good
3	07MN074	County Ditch 52	0.8	8	14	9.3	9.3	41.5	Poor
1	13MN001	County Ditch 22	0	8	18.1	10	8	44.1	Poor
1	13MN002	Crow Creek	0	10	17.2	12	26	65.2	Fair
1	13MN013	Unnamed creek	0	1.5	14.9	13	16	45.4	Fair
1	13MN025	County Ditch 13	0	9.5	18.4	11	22	60.9	Fair
1	05MN011	County Ditch 10 (John's Creek)	2.5	13.5	20.9	11	25	72.9	Good
Average Habitat Results: *Spring Cr.-Minnesota R. Aggregated 12-HUC*			0.8	9.9	16.3	11.3	17.2	55.4	Fair

Qualitative habitat ratings

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

Table 22. Channel Condition and Stability Assessment (CCSI): Spring Creek-Minnesota River Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN003	Trib. to Minnesota R.	18	30	17	5	70	Moderately Unstable
1	07MN074	County Ditch 52	36	17	13	5	71	Moderately Unstable
1	13MN001	County Ditch 22	33	15	9	5	62	Moderately Unstable
1	13MN002	Crow Creek	36	27	15	7	85	Severely Unstable
1	13MN025	County Ditch 13	37	40	17	7	101	Severely Unstable
1	05MN011	County Ditch 10 (John's Creek)	15	26	4	3	48	Moderately Unstable
Average Stream Stability Results: *Spring Cr.-Minnesota R. Aggregated 12-HUC*			29.2	25.8	12.5	5.3	72.8	Moderately Unstable

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 23. Outlet water chemistry results: Spring Creek-Minnesota River Aggregated 12-HUC.

Station location:	Crow Creek, At Noble Avenue, 3 miles East of Redwood Falls						
STORET/EQuIS ID:	S005-628						
Station #:	13MN002						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	41	0.1	24.7	5.3	40	0
Chloride	mg/L	11	11.3	53.4	34.7	230	0
Dissolved Oxygen (DO)	mg/L	41	2.6	15.2	7.7	5	5
pH		50	7.1	8.8	8.	6.5 - 9	0
Secchi Tube	100 cm	56	7	100	59	10	3
Total suspended solids*	mg/L	42	2	236	30.3	65	4
Phosphorus	ug/L	42	22	465	200	150	18
Escherichia coli (geometric mean)	MPN/100ml	6	179	1544	-	126	5
Escherichia coli	MPN/100ml	41	33.1	2419.6	764.1	1260	7
Inorganic nitrogen (nitrate and nitrite)*	mg/L	42	0.2	21.9	8.7	-	-
Kjeldahl nitrogen	mg/L	42	0.5	2.7	1.4	-	-
Specific Conductance	uS/cm	21	284	925	700	-	-
Temperature, water	deg °C	45	4.6	21.1	16.1	-	-
Sulfate*	mg/L	11	30.3	94.9	64.3	-	-
Hardness	mg/L	10	122	412	319.1	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Spring Creek-Minnesota River Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Nine AUID's were assessed for Aquatic Life (AQL) use based on data from nine individual biological monitoring stations within the Spring Creek – Minnesota River (0702000704-01) aggregated 12-HUC (Table 20, Figure 25). Four other AUID's had insufficient data for AQL assessments. Three AUID's were determined to be fully supporting of Aquatic Life, while six AUID's are impaired.

One such AUID that supports AQL is Unnamed Creek (07020007-668), on the north side of the river near the western margin. This reach was initially designated as a warmwater reach, it is now proposed to change to cold water general use based on the monitoring results from 2013, and a coldwater review that included MNDNR participation. This exceptionally small tributary to the Minnesota River exhibited a predominantly warmwater fish community. With the coldwater review, the fish community was determined to be not assessable because there will not likely be any coldwater fishery management activities on this stream, and since there are no nearby coldwater fish communities, colonization by any coldwater fish is highly unlikely. With this, F-IBI data was not used in the assessment of this reach. Macroinvertebrate sampling in 2013, collected a sensitive, coldwater obligate caddisfly that has been rarely collected which indicates a high quality coldwater invertebrate community. M-IBI results scored above the coldwater general use threshold and above the confidence interval, indicating full support for M-IBI AQL. Water temperatures recorded at the sampling visits also suggested a coldwater thermal regime, suggesting inputs from groundwater contribute to stream flow. Ground water protection strategies would certainly benefit this stream. CCSI results indicated moderate stream instability. One of the threats to this high quality stream may potentially be altered hydrology, with an increase in magnitude and frequency of high flow events, conditions in this stream could be degraded. This small stream system exhibit's good habitat quality, as well as other beneficial characteristics within the watershed, making it a worthy resource to implement protection strategies.

Another AUID fully supporting of Aquatic Life, is County Ditch 111 (-672). Designated general use, the fish community sampled at the one monitoring station (13MN016) representing the reach met the AQL standards, while macroinvertebrates were not sampled due to insufficient flow at the time of the sampling visit. The habitat was rated as poor based on the MSHA score for the monitoring site on this reach.

Threemile Creek (-704), on the north side of the Minnesota River, exhibited a macroinvertebrate community the met general use standards, while the fish community failed, despite a good MSHA habitat rating. As result of the degraded fish community, this AUID will be listed as Impaired for AQL F-IBI.

Within the Crow Creek catchment, County Ditch 52 (-636) consists of a channelized reach designated as modified use. The fish community present in the stream meets the AQL standards for modified use, while the invertebrate community exceeded the modified use standards resulting in a listing for AQL M-IBI. Habitat for this reach scored poorly and the stream channel exhibited moderate instability. Proximity to the city of Redwood Falls likely impacts the biological communities of County Ditch 52. In contrast within the Crow Creek catchment, County Ditch 22 (-671) was found to be fully supporting of modified use AQL standards. Both the M-IBI and F-IBI results scored above the modified use threshold. Habitat was still considered poor, and the stream channel moderately unstable. Downstream of County Ditch 22 and 52 lies Crow Creek (-569). Because this reach consists of a natural channel, this AUID has been designated as general use. Both the fish and macroinvertebrate communities performed poorly, failing to meet the general use criteria for AQL. Impairment for Aquatic Life is further supported by DO standard exceedance. The nutrient phosphorus is likely a problem, with and exceedance of the eutrophication standard. But with the lack of a response indicator, this standard could not be listed. Habitat was considered fair, despite the natural condition of the stream. CCSI results indicate severe instability of the stream channel. Besides the contribution from the surrounding agricultural land use, the proximity of the headwaters to Redwood Falls likely adds to issues facing the condition of this stream.

On the south side of the river, Unnamed Creek (-715) will be listed as impaired for Aquatic Life Fish-IBI. The fish community within this reach failed to meet the general use standard for AQL. Macroinvertebrates were not sampled for this reach in 2013. From MSHA results, fair habitat conditions exist on this reach. Another AUID located on the south side of the Minnesota River is County Ditch 13 (-712). Exceedances under general use criteria include F-IBI and M-IBI, prompting a listing for AQL. Habitat conditions for this reach were considered fair, and the channel showed signs of severe instability.

County Ditch 10 (John's Creek) (-571) is a coldwater, general use stream reach on the south side of the river near the eastern margin of the subwatershed. Both the fish and macroinvertebrate assemblages failed to score higher than the coldwater general use threshold, indicating impairment for Aquatic Life. The stream itself exhibits good habitat, but moderate instability. The MNDNR classifies the stream as a 1D marginal trout stream, and the stream has had a history of coldwater fishery management. According the MNDNR, the stream does support a small self-sustaining population of brown trout. Numerous issues threaten to degrade this stream. Dominant agricultural land uses can be a source of excessive nutrients, increased flow due to drainage systems upstream, and groundwater withdrawals could reduce cold water inputs. This AUID was listed in 2013, for a Drinking Water impairment based on exceedance of the Nitrate standard, supporting nutrient issues within this stream system.

Stream water chemistry

Numerous stream reaches in this subwatershed had water chemistry data within the 10-year assessment window. A large water chemistry dataset was available from station S005-628 on the downstream portion of Crow Creek (07020007-569). TSS and STUBE data collected across four years reveals minor exceedance rates below 10%, the majority of these violations were associated with high precipitation events during summer 2010. DO data collected across four years indicated five violations, which result in an exceedance rate near 12%. Reviewing raw data reveals all violations occurred in 2009; as the result of a malfunctioning DO probe. This problem occurred across the entire summer 2009 throughout the Minnesota River Mankato Watershed. TP data showed a consistent pattern of exceedance, with an average over four years of collection being 187 ug/L easily violating the 150 ug/L standard. Chlorophyll-a data is needed to pair with the total phosphorus data to make a complete river eutrophication assessment. All other aquatic life water chemistry parameters in Crow Creek easily met their respective standard.

Purgatory Creek had small TSS, STUBE, and TP datasets collected between 2009 and 2010. TSS dataset revealed a minor violation rate triggered by rainfall biased values, STUBE did not confirm the violations, so this data will not trigger a listing at this time. The TP average was elevated but would need more supporting data to make a complete river eutrophication assessment on this reach. County Ditch 13 (-712) had DO data available with three exceedances of the standard over 19 samples. This would normally result in a listing for DO based on the 16% exceedances rate, but the violations occurred during 2009, when known equipment issues resulted in poor data accuracy and reliability, therefore will not be listed based on this data. Other assessment parameters in County Ditch 13 met standards. Tributary to Minnesota River (-644) indicated the same pattern of potentially false DO violations from 2009, as mentioned above, and will not be listed on this data. The TP dataset exceeds river nutrient standards, but needs supporting data for a complete assessment. The remaining parameters for Unnamed Creek reveal minor exceedance rates, some are biased flow events so a listing was not recommended. Three Mile Creek (-704) had small datasets available for TSS and STUBE from three years of sampling, with no exceedances occurring over that time.

County Ditch 10 (John's Creek) had two reaches with assessment data available. Upstream reach (-650) had small datasets for all parameters, most of which met standard, with the exception of grossly exceeding TP data from 2010 and 2011, the chlorophyll-a data does not exhibit a response (i.e. algae or periphyton are not growing as a result of the elevated nutrients), therefore will not trigger a listing based on the river nutrient standard. Downstream County Ditch 10(John's Creek) reach (-571) had 3 years of assessment data available. Initial review indicates nearly all parameters are violating standard on this 2A coldwater designated reach, but uncertainty surrounding accuracy needs to be considered during the assessment. Beginning with the violating DO data from 2009 and 2010, this is a known period of equipment malfunction and will not be used in this assessment. The pH dataset reveals very minor exceedances, and again limited to just one timeframe in 2009, strongly suggesting equipment error and/or sampling inaccuracies, these details will prevent pH from being assessed at this time. The questionable pH data results in inflated unionized ammonia calculations as well, resulting in five questionable violations which cannot be confidently assessed. The majority of violations surrounding TSS and STUBE data is biased to storm events in June and September 2010, and will not trigger a listing at this time.

Bacteria data was available on Crow Creek (-569), Purgatory Creek (-645), County Ditch 13 (-712) and Unnamed Creek (-644). This subwatershed has a consistent pattern of high bacteria concentrations for all reaches. *E. coli* sampling on Crow Creek occurring across four years showed a persistent pattern of elevated bacteria levels easily violating both the monthly geometric mean and individual standard. Five of six months meeting minimum data requirements for geometric mean calculation exceeded the 126 MPN/100mL standard, with a September value of 1330 MPN/100mL, this alone would trigger a listing for aquatic recreation on this reach. Individual violations occurred across all months and years, with the highest outliers being 2419 MPN/100mL, which was the lab reporting limit. Purgatory Creek just meets the minimum bacteria data requirements for assessment, with eighteen samples in 2009 and 2010. Two individual exceedances occurred during that time along with another falling just below the 1260 MPN/mL standard. Two months had enough data available for geometric mean calculations, both violated the standard; this paired with the individual exceedances will trigger a *E.coli* listing on this reach. Unnamed Creek (-644) had bacteria data from 2009 and 2010, five individual violations paired with four of six monthly geometric mean exceedances will trigger a listing. Three Mile Creek (-704) had bacteria data from 2009 and 2010, which revealed one monthly geometric violation and another month that would exceed but falls just short of minimum data requirements for geometric calculation. Based on this information, this will trigger a listing for aquatic recreation based on the bacteria data. The downstream reach of County Ditch 10 (John's Creek) had both individual and monthly geometric violations that strongly indicating non-support conditions for aquatic recreation and will be listed on this data. Nine individual and four of five monthly geometric violations reveal persistently high bacteria concentrations across all months and years.

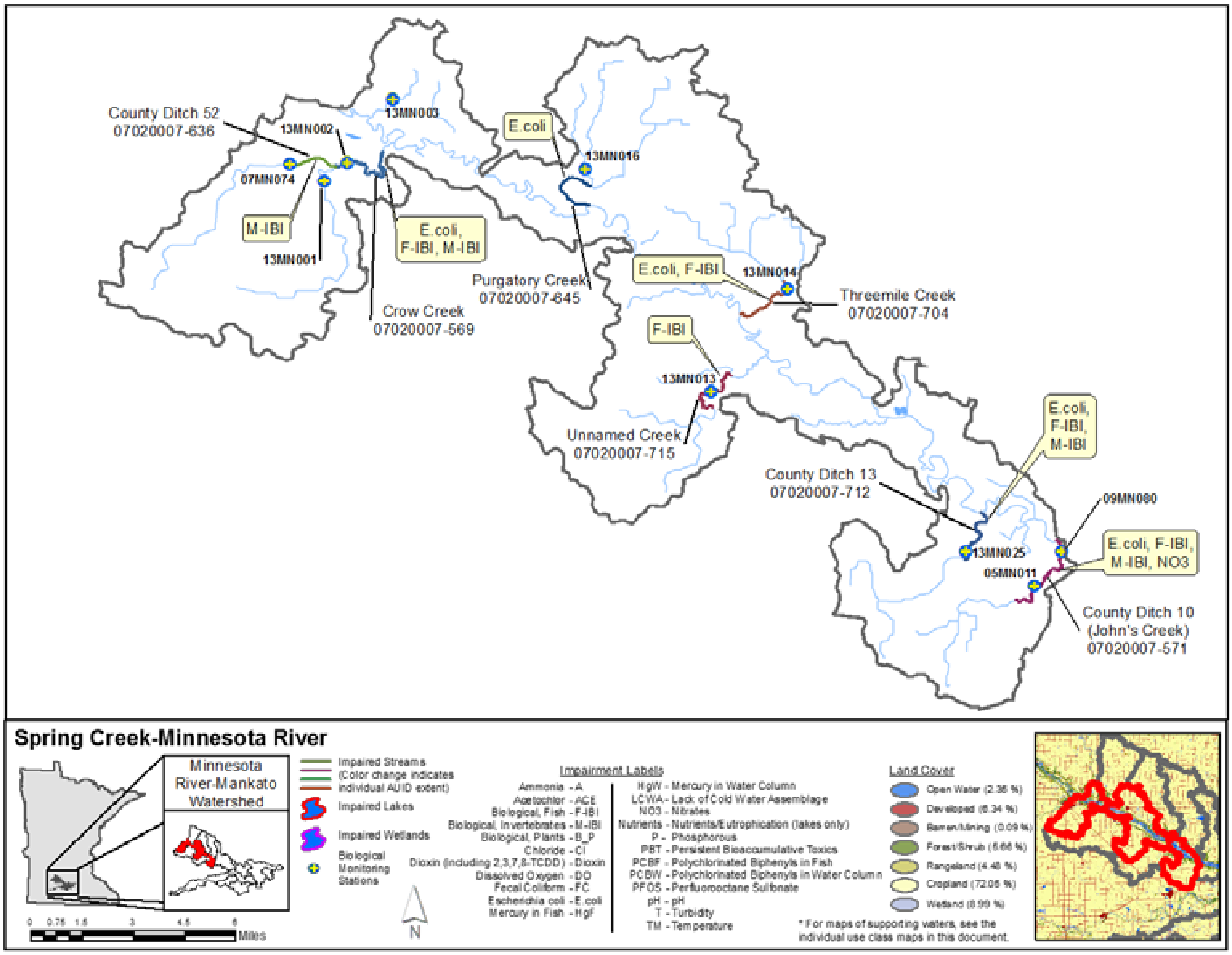


Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Spring Creek-Minnesota River Aggregated 12-HUC.

City of New Ulm-Minnesota River Aggregated 12-HUC HUC 0702000706-01

The City of New Ulm – Minnesota River (0702000706-01) aggregated 12-HUC straddles the Minnesota River in the central portion of the major watershed (Figure 26). This subwatershed drains 129 square miles (82,887 acres), and consists of numerous small tributaries that directly flow into the Minnesota River on both the north and south sides of the river. The watershed is part of Nicollet and Sibley Counties on the north side of the river, while the south side of the river falls entirely in Brown County. The majority of the tributaries to the Minnesota River that were sampled in 2013, occur on the North side of the river and predominantly flow south to their confluences with the Minnesota River. The largest of these tributaries is Eightmile Creek, of which the pour point station 13MN033 was selected to represent the subwatershed. Other monitored streams include Huelskamp Creek, Fritsche Creek (County Ditch 77), and Heyman's Creek. There are no coldwater stream reaches within this subwatershed. The presence of stream alteration in this subwatershed is similar to the Spring Creek – Minnesota River subwatershed. Channelized streams make up 53% of the stream reaches and natural channels make up 28% of the reaches. No definable channel is found for 19% of the stream reaches. A significant barrier to fish movement occurs on Eightmile Creek consisting of a perched culvert with about a six foot drop at a road crossing (Lore 2015). One biological monitoring station exists upstream of the barrier, and seems to be impacted by the barrier (Lore 2015).

A large portion of New Ulm is found within the subwatershed. Cropland utilizes the largest acreage within the watershed, with 77% of the area. Developed areas account for 7% of the area. Five percent of the land area is forest, while 2% is considered rangeland. The Minnesota River and its floodplain likely contribute to the 6% of wetlands, and 3% of the open water found in the subwatershed.

Table 24. Aquatic life and recreation assessments on stream reaches: City of New Ulm-Minnesota River Aggregated 12-HUC. Reaches are organized upstream to downstream on the North side of the Minnesota River, followed by the South side of the Minnesota River in the table.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
07020007-685 **Eightmile Creek** *Headwaters to 366th St/T-39*		13.02	WWg	-	-	-	-	MTS	-	-	-	-	-	-	NA	-
07020007-684 **Eightmile Creek** *366th St/T-39 to Minnesota R*	13MN033, 13MN087	5.85	WWg	EXS	EXS	MTS	MTS	MTS	MTS	MTS	IF	-	MTS	-	IMP	IMP
07020007-641 **Huelskamp Creek** *Unnamed cr to Minnesota R*		2.71	WWg	-	-	-	IF	MTS	-	-	-	-	EXS	-	IF	IMP
07020007-709 **Fritsche Creek (County Ditch 77)** *-94.4172 44.3557 to Minnesota R*	05MN012	5.16	WWg	MTS	EXS	IF	IF	MTS	-	IF	IF	-	EXS	-	IMP	IMP
07020007-675 **Heyman's Creek** *T110 R30W S22, north line to Unnamed cr*	13MN040	2.87	WWg	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-640 **Heyman's Creek** *Unnamed cr to Minnesota R*		1.14	WWg	-	-	-	MTS	MTS	-	-	-	-	MTS	-	IF	IMP

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

Table 25. Minnesota Stream Habitat Assessment (MSHA): City of New Ulm-Minnesota River Aggregated 12-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
3	13MN033	Eightmile Creek	2.5	9.7	20.1	14.7	23.7	70.6	Good
3	13MN087	Eightmile Creek	2.5	10	18.6	13	22.3	66.5	Good
1	13MN035	Unnamed creek	2.5	13	21.8	9	29	75.3	Good
1	05MN012	Fritsche Creek (County Ditch 77)	2.5	12	20.5	14	30	79	Good
1	13MN040	Heyman's Creek	2.5	7	17.4	10	25	61.9	Fair
Average Habitat Results: *New Ulm-Minnesota R. Aggregated 12-HUC*			2.5	10.1	19.6	12.9	24.7	69.7	**Good**

Qualitative habitat ratings

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

Table 26. Channel Condition and Stability Assessment (CCSI): City of New Ulm-Minnesota River Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	05MN012	Fritsche Creek	20	22	13	5	60	Moderately Unstable
1	13MN040	Heymans Creek	32	38	17	6	93	Severely Unstable
Average Stream Stability Results: *New Ulm-Minnesota R. Aggregated 12-HUC*			26	30	15	5.5	76.5	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 27. Outlet water chemistry results: City of New Ulm-Minnesota River Aggregated 12-HUC.

Station location:	Eight Mile Creek, At CSAH 5, 8 miles Northwest of New Ulm						
STORET/EQuIS ID:	S004-348						
Station #:	13MN033						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	6	2.2	14.2	7.1	40	0
Chloride	mg/L	10	20	40.8	29.4	230	0
Dissolved Oxygen (DO)	mg/L	17	5.4	11.9	8	5	0
pH		9	8.3	9.3	8.5	6.5 - 9	1
Secchi Tube	100 cm	99	1	100	61	10	3
Total Suspended Solids	mg/L	10	2	149	24	65	5
Phosphorus	ug/L	9	40	250	122	150	3
Escherichia coli (geometric mean)	MPN/100ml	3	534.6	1003	-	126	3
Escherichia coli	MPN/100ml	16	90.6	2419.6	632	1260	4
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	10	2	30.4	17.3	-	-
Kjeldahl Nitrogen	mg/L	10	0.4	2.4	1.5	-	-
Specific Conductance	uS/cm	16	8.1	801	635.6	-	-
Water Temperature	deg °C	17	7.1	25.9	18.1	-	-
Sulfate*	mg/L	10	57.7	128	82.7	-	-
Hardness	mg/L	10	356	454	404.1	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the City of New Ulm-Minnesota River Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Aquatic Life assessments were conducted for three AUID's, using data from four biological monitoring stations, within the City of Mankato – Minnesota River (0702000706-01) aggregated 12-HUC (Table 24, Figure 26). Three AUID's will be listed as impaired for Aquatic Life (AQL). No AUID's were supporting of AQL, while three other AUID's lacked sufficient data for AQL assessment.

Eightmile Creek (07020007-684) consists of a natural channel with good habitat based on MSHA scores. Despite these beneficial qualities, both the fish and macroinvertebrate communities failed the meet General Use (GU) criteria, with IBI's scoring below the threshold for both communities. One feature affecting the fish community for a portion of this reach is a six foot perched culvert at the County Road 5 crossing which separates the two monitoring stations that were sampled (13MN033 and 13MN087). The culvert had a significant impact on the fish community for the AUID after considering that the station (13MN033) downstream of the reach consistently had as many as 19 species and higher numbers of fish, while the station (13MN087) upstream of the road had only 4 species at most, as well as lower numbers. With no refuge upstream of the barrier, the likelihood of replenishment after a severe drought, or other event is highly unlikely (Lore 2015). This barrier greatly contributes to the AQL impairment for this stream. Without the affect of the barrier, the biological communities at the downstream station should have faired better given the natural condition and the associated habitat. One likely factor degrading the biological communities at this stream is altered hydrology, which significantly contributes to poor biological communities. Field notes from sampling crews visiting these two stations commented on evidence of high flow events contributing to erosion and drastic changes in channel morphology.

Fritsche Creek (County Ditch 77) (-709) is another example of a stream exhibiting relatively good habitat, but poor biological condition. For this stream, the fish assemblage faired better, with the IBI scoring above the GU threshold. The stream will be listed for AQL based on the macroinvertebrate community failing to meet the GU criteria.

Another instance of the fish community meeting the standard, while the macroinvertebrate community exceeds the standard is Heyman's Creek (-672). Designated as General Use, this stream will be listed for AQL M-IBI. Habitat quality as indicated by MSHA scores, is slightly lower than other AUID'S within this subwatershed, with a Fair rating.

Stream water chemistry

Assessable water chemistry data was available on reaches of Eight Mile Creek, Huelskamp Creek, Fritsche Creek and Heyman's Creek. The upstream segment of Eight Mile Creek (-685) had only a large Secchi tube (STUBE) dataset at S004-509 collected across five years, only two violations occurred over one hundred and forty samples, reflecting consistently low sediment loads in this reach. The downstream reach of Eight Mile Creek (-684) had varying amounts of water chemistry data from S004-348 and S005-664, with the total suspended solid (TSS) and STUBE datasets being the most complete. TSS had only two violations across thirty-two samples over four years while STUBE had no violations over one hundred and thirty-three samples over seven years, indicating sediment loads should not be a stressor within this reach. Other aquatic life use parameters meet their respective standards. Bacteria data indicates a persistent pattern of high *E. coli* concentrations across all months and years of data collection, with four individual and three monthly geometric mean violations. This bacteria data will trigger an aquatic recreation use listing for this reach.

Huelskamp Creek (-641) had limited water chemistry data available from S005-667 near the downstream end of the reach. Bacteria data indicated one individual and one monthly geometric mean violations, with another month just missing the minimum requirements for calculation, this will result in an aquatic recreation use listing. The TSS and STUBE data was collected during 2009 and 2010, with only a few violations in the TSS dataset correlating directly to large flow events when high sediment loads are anticipated, these will not result in a listing do to the biased nature of the collection. TP data exceeds the river nutrient standard but would need supporting chlorophyll-a data to determine if eutrophication is present along the reach.

Fritsche Creek (-709) had water chemistry available from S005-430 near the downstream end of this reach. TSS and STUBE had the most complete datasets, with a few event driven exceedances that will not result in an aquatic life use listing at this time. Bacteria data collected during 2009 and 2010, revealed a pattern of persistently high concentrations across all months and years, with one individual and two monthly geometric mean violations which will trigger a listing for aquatic recreation use. Heyman's Creek (-640) had limited water chemistry data, notably a bacteria dataset from 2009 and 2010 at S005-666 indicating elevated *E. coli* concentrations, with two individual and two monthly geometric mean violations. This data will trigger an aquatic recreation use listing on this reach. TSS had a single violation from June 2010, a known period of high flow which typically correlates with higher sediment loads.

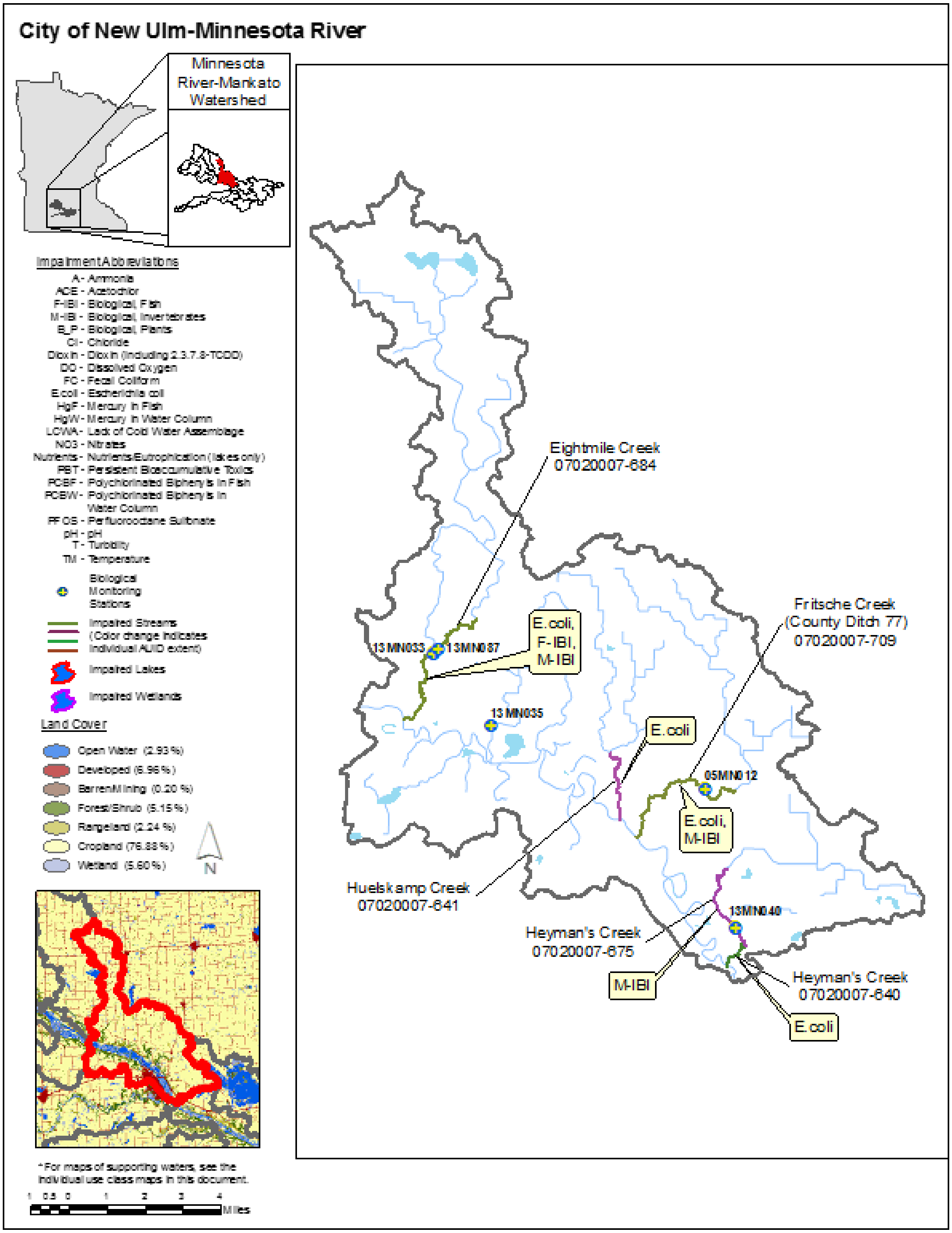


Figure 26. Currently listed impaired waters by parameter and land use characteristics in the City of New Ulm-Minnesota River Aggregated 12-HUC.

Morgan Creek-Minnesota River Aggregated 12-HUC HUC 0702000710-01

The Morgan Creek – Minnesota River (0702000710-01) aggregated 12-HUC is adjacent to the Minnesota River in the central region of the major watershed (Figure 27). This subwatershed drains 85 square miles (54,572 acres). Brown, Blue Earth, and Nicollet Counties are present within the watershed. Several different streams are present on both the north and south sides of the river, and they all are direct tributaries to the Minnesota River. Two significant tributaries are in this subwatershed. On the north side of the river, a County Ditch 3 was monitored as part of the Intensive Watershed Monitoring effort. On the south side of the Minnesota River an Unnamed Creek was monitored. No monitoring stations where picked for water chemistry sampling within this subwatershed. Of the monitored reaches within the watershed, County Ditch 3 is designated warmwater, while the monitored Unnamed Creek on the south side of the Minnesota river is designated as a coldwater reach. Lakes are absent from this watershed. Because this subwatershed contains mostly smaller tributaries within the topography of the Minnesota River valley, natural stream channels (60%) are dominant. In the headwater reaches of the larger stream systems some channelization occurs, with 19% of the reaches in the watershed are altered. Twenty-one percent of the reaches are considered no definable channel. Three natural waterfalls occur in the watershed, Minnewaukon Falls, Minnemeshiona Falls, and an unknown fall's (Lore 2015). Minnwaukon falls has a drop of approximately 17 feet and occurs below the monitoring station (13MN067) on County Ditch 3 (Lore 2015). This barrier has a significant impact on the upstream fish community. The two other falls occur on unmonitored streams. A barrier consisting of a perched culvert is also present on the monitored Unnamed Creek on the south side of the river (Lore 2015). This perched culvert and a significant beaver dam (~9 feet high) seems to have significant recolonization effects on the fish community at station 09MN094, upstream of the barriers (Lore 2015).

The town of Courtland is the only town present within the Morgan Creek – Minnesota River subwatershed. Sixty-two percent of the landscape within the watershed is cropland, while 8% is developed. Forest (10%) and rangeland (8%) utilizes a slightly higher percentage of the landscape than is seen in other subwatersheds within the Minnesota River – Mankato major watershed. Ten percent and 3% of the watershed is classified as wetlands and open water, respectively. The Minnesota River floodplain contributes to those percentages.

Table 28. Aquatic life and recreation assessments on stream reaches: Morgan Creek-Minnesota River Aggregated 12-HUC. Reaches are organized upstream to downstream on the North side of the Minnesota River, followed by the South side of the Minnesota River in the table.

AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	**Eutrophication** Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-660 **County Ditch 3** *-94.1041 44.1989 to Minnesota R*	13MN067	2.69	WWg	-	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-577 **Unnamed creek** *T108 R28W S6, south line to T108 R28W S6, north line*	09MN094	1.46	CWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-

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

Table 29. Minnesota Stream Habitat Assessment (MSHA): Morgan Creek-Minnesota River Aggregated 12-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	13MN067	County Ditch 3	0	10.5	12.9	12	22	57.4	Fair
2	09MN094	Unnamed creek	1.3	12	18.0	15	27.5	73.7	Good
Average Habitat Results: *Morgan Cr.-Minnesota R. Aggregated 12-HUC*			0.8	11.5	16.3	14	25.7	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 30. Channel Condition and Stability Assessment (CCSI): Morgan Creek-Minnesota River Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN067	County Ditch 3	30	32	22	5	89	Severely Unstable
1	09MN094	Unnamed creek (Trib. to Minnesota River)	29	34	15	7	85	Severely Unstable
Average Stream Stability Results: *Morgan Cr.-Minnesota R. Aggregated 12-HUC*			29.5	33	18.5	6	87	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

Stream biology

Two AUID's were assessed for Aquatic Life use using data from two monitoring sites within the Morgan Creek – Minnesota River (0702000710-01) aggregated 12-HUC subwatershed (Table 28, Figure 27). County Ditch 3 (07020007-660) will be listed for Aquatic Life (AQL) due to the macroinvertebrate community exceeding the General Use criteria. Data for the fish community was not used for assessment of this AUID due to the presence of Minnewaukon Falls downstream of the biological monitoring site (13MN067). The presence of this natural barrier in such a small minor watershed severely limits the fish movement and recolonization, as a result, no fish were collected when sampling occurred in 2013. The other AUID in this subwatershed assessed for AQL occurs on Unnamed Creek (-577) on the south side of the Minnesota River. This reach is designated as coldwater General Use. Both biological communities failed to meet coldwater general use AQL standards, resulting in an impairment listing. The stream lacked a coldwater fish community, but had a sufficient thermal regime to potentially support such an assemblage. With only two fish species collected at the monitoring station (09MN094) on this reach, one factor contributing to the impaired status of this reach is the existence of two barriers, a perched culvert and a substantial beaver dam downstream of the site. Both features severely limit any fish movement within the stream. Currently, no coldwater fishery management activities occur on this stream. Future management may be possible after further investigation. Maintaining coldwater designation ensures some level of protection for a minor watershed that exhibits beneficial characteristics like very little channelization, less extensive tiling, and intake riparian areas, in a region that has been substantially altered by humans.

Stream water chemistry

Water chemistry data on small tributaries in this subwatershed is limited, with the majority of reaches only having single grab sample datasets from biological monitoring visits. All single data points would meet standard more water chemistry data would be needed on all reaches to make complete assessments based on water chemistry.

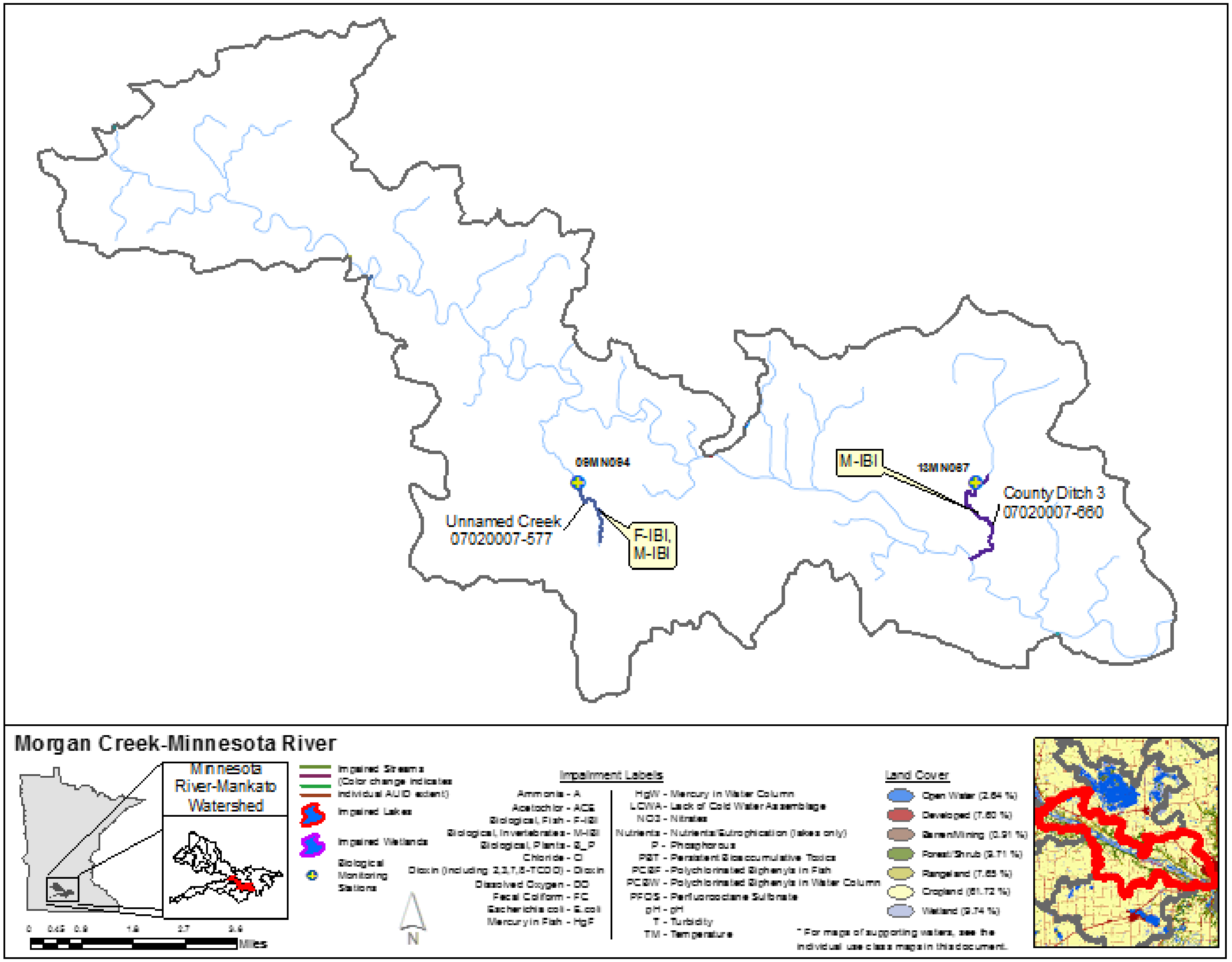


Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Morgan Creek-Minnesota River Aggregated 12-HUC.

City of Mankato-Minnesota River Aggregated 12-HUC HUC 0702000711-01

The City of Mankato - Minnesota River (0702000711-01) aggregated 12-HUC consists of numerous direct tributaries to the Minnesota River, and makes up the majority of the eastern portion of the major watershed (Figure 28). This subwatershed is the largest within the Minnesota River – Mankato major watershed, with a drainage area of 187 square miles (119,501 acres). Three counties make up the watershed: Nicollet, Blue Earth, and Le Sueur. For its length within the watershed, the Minnesota River mostly flows to the Northeast so the tributaries within the watershed generally flow east or west, depending on the side of the river that they are located on. The primary watercourses in the watershed include: Cherry Creek, Seven Mile Creek, Roger's Creek/County Ditch 78, and County Ditch 46A. Numerous unnamed streams are present within the watershed. Several lakes also occur within the watershed, with Scotch Lake (598 acres) the largest. Other lakes include: Rice (317), Wita (362), Savidge (149), Little (345), Mud (297), and Oak Leaf (138), as well as numerous other unnamed ponds and small lakes. The majority of the streams are designated as warmwater. A coldwater reach is present on a large portion of Seven Mile Creek. Two pour point monitoring stations were selected for water chemistry to represent the subwatershed, 91MN061 on Roger's creek, and 09MN090 on the coldwater reach on Seven Mile Creek. A slightly higher percentage of natural stream channels (33%) occur within this watershed when compared to other watersheds within the major watershed. This is likely due to the proximity of the streams to the Minnesota River valley and the characteristics of the North Central Hardwood Forest ecoregion. Altered streams channels are still dominant, with 47% of the reaches being channelized. Other reach types include 19% no definable channel, and 1 % impounded. Numerous barriers that affect upstream fish communities are present within this subwatershed. Kasota Prairie falls, which has a drop of about 16 feet is found on Unnamed Creek on the East side of the Minnesota River (Lore 2015). Another natural waterfall, with a drop of about six feet, occurs on Roger's Creek. Two dams also are present on streams within the watershed. The dam on Seven Mile Creek has a drop of approximately 5-feet, and occurs roughly 4.6 miles upstream of the confluence with the Minnesota River (Lore 2015). The dam on Cherry Creek occurs approximately 0.6 miles upstream of the confluence with the Minnesota River, and has a drop of approximately 6-feet (Lore 2015).

The City of Mankato – Minnesota River subwatershed contains most of the development, and the highest percentage of the population within the Minnesota River – Mankato major watershed. The largest city within the major watershed, Mankato, is found within the subwatershed, as well as North Mankato, Saint Peter, Kasota, and Cleveland. Consequentially, this subwatershed has the highest percentage of area developed (15%). Quarry and sand mining is also prevalent with 2% of the land classified as barren. With a portion of the watershed in the North Central Hardwood Forest Ecoregion, 8% of the watershed is forested and 7% is rangeland, which is slightly higher than most subwatershed within the major watershed. Despite the other land uses in the watershed, cropland (59%) still accounts for the highest percentage of land use within the watershed. Wetland and open water make up 7% and 3% of the landscape respectively. With the slightly higher percentage of lakes and wetlands within the watershed, the water storage capacity of the watershed is slightly increased.

Table 31. Aquatic life and recreation assessments on stream reaches: City of Mankato-Minnesota River Aggregated 12-HUC. Reaches are organized upstream to downstream on the North side of the Minnesota River, followed by the South side of the Minnesota River in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-703 **Seven Mile Creek** *MN Hwy 99 to CD 46A*	13MN068	0.72	WWg	-	EXS	MTS	MTS	MTS	-	MTS	IF	-	EXS	-	IMP	IMP
07020007-678 **County Ditch 46A** *Headwaters to -94.0803 44.2762*	91MN059	5.38	WWm	EXS	EXS	IF	IF	MTS	-	IF	IF	-	IF	-	IMP	IMP
07020007-679 **County Ditch 46A** *-94.0803 44.2762 to Seven Mile Cr*	13MN069	0.88	WWg	-	EXS	IF	EXS	MTS	-	IF	IF	-	EXS	-	IMP	IMP
07020007-562 **Seven Mile Creek** *T109 R27W S4, north line to Minnesota R*	09MN090	5.20	CWg	EXS	EXS	MTS	EXS	EXS	MTS	IF	MTS	-	MTS	-	IMP	IMP
07020007-637 **Unnamed creek (Seven Mile Creek Tributary)** *Headwaters to T109 R27W S15, north line*		2.36	WWg	-	-	MTS	MTS	MTS	-	MTS	-	-	EXS	-	IF	IMP
07020007-613 **Rogers Creek (County Ditch 78)** *CD 21 to Unnamed cr*		7.59	WWg	-	-	MTS	IF	MTS	MTS	MTS	IF	-	EXS	-	IF	IMP
07020007-547 **Rogers Creek** *Unnamed cr to Minnesota R*	13MN094, 91MN061	1.62	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-598 **Unnamed ditch** *Unnamed cr to underground pipe*		1.06	WWg	-	-	-	-	EXS	-	-	-	-	-	-	NA	-

AUID ***Reach Name,*** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	**Eutrophication** Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-558 **Unnamed creek (Glenwood Ave Creek)** *Headwaters to Division St*		1.36	WWg	-	-	-	-	MTS	-	-	-	-	-	-	IF	-
07020007-694 **Unnamed creek** *CSAH 5/3rd Ave to Minnesota R*	13MN073	1.62	WWg	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-696 **Unnamed creek** *Unnamed cr to -93.9413 44.228*	01MN020	2.05	WWm	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-550 **Unnamed creek** *Unnamed cr to Unnamed ditch*	03MN072	2.05	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-541 **Cherry Creek** *Headwaters (Mud Lk 40-0110-00) to T110 R25W S21, north line*	13MN088	4.19	WWm	EXS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-543 **Cherry Creek** *T110 R26W S1, south line to Minnesota R*	13MN081, 13MN083	7.01	WWg	NA	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	IF

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

Table 32. Minnesota Stream Habitat Assessment (MSHA): City of Mankato-Minnesota River Aggregated 12-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
2	13MN068	Seven Mile Creek	0	11.3	13.6	13.5	21	59.4	Fair
1	91MN059	County Ditch 46A	0	8	9	13	5	35	Poor
2	13MN069	County Ditch 46A	0	12.3	15.2	12	25	64.5	Fair
4	09MN090	Seven Mile Creek	2.5	11.6	22.7	12	28	76.8	Good
1	13MN094	Rogers Creek	2.5	15	21.1	13	31	82.6	Good
2	91MN061	Rogers Creek	3.8	11.5	19.2	12	22.5	68.9	Good
1	13MN073	Unnamed creek	1	15	18.4	12	28	74.4	Good
2	01MN020	Unnamed creek	0	9	12.9	7	10.5	39.4	Poor
1	03MN072	Unnamed creek	2.5	14	22	8	29	75.5	Good
1	13MN074	Unnamed creek	0	10	16.2	13	16	55.2	Fair
1	13MN075	Unnamed creek	5	13	21.6	12	31	82.6	Good
2	13MN088	Cherry Creek	0	8	7.5	7	5.5	28	Poor
2	13MN080	Cherry Creek	0	8.5	12.5	5	4.5	30.5	Poor
2	13MN081	Cherry Creek	0	13.5	19.5	14	31.5	78.5	Good
1	13MN083	Cherry Creek	0	10.5	18.0	10	23	61.5	Fair
Average Habitat Results: *Mankato-Minnesota R. Aggregated 12-HUC*			1.1	11.2	16.7	10.8	20.6	60.5	**Fair**

Qualitative habitat ratings

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

Table 33. Channel Condition and Stability Assessment (CCSI): City of Mankato-Minnesota River Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN068	Seven Mile Creek	36	28	34	11	109	Severely Unstable
1	13MN069	Co. Ditch 46 Branch A	27	34	22	11	94	Severely Unstable
2	09MN090	Seven Mile Creek	12	13	6	1	32	Fairly Stable
1	13MN073	Unnamed creek	19	20	22	7	68	Moderately Unstable
1	01MN020	Unnamed trib. to Minnesota River	26	15	28	7	76	Moderately Unstable
1	03MN072	Unnamed trib. to Minnesota River	6	20	6	5	37	Fairly Stable
1	13MN074	Unnamed ditch	26	27	15	7	75	Moderately Unstable
1	13MN075	Unnamed ditch	14	19	18	5	56	Moderately Unstable
1	13MN088	Cherry Creek	15	9	17	1	42	Fairly Stable
1	13MN080	Cherry Creek	16	13	13	1	43	Fairly Stable
1	13MN081	Cherry Creek	13	21	8	3	45	Moderately Unstable
Average Stream Stability Results: *Mankato-Minnesota R. Aggregated 12-HUC*			17.5	18.1	14.5	4.5	54.6	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 34. Outlet water chemistry results: Seven Mile Creek, City of Mankato-Minnesota River Aggregated 12-HUC.

Station location:	Seven Mile Creek, Upstream of US Highway 169, Seven Mile Creek County Park(Second foot bridge), 5.5 miles West of St. Peter						
STORET/EQuIS ID:	S002-937						
Station #:	09MN090						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	19	0.2	11.5	2.5	16	0
Chloride	mg/L	9	18.5	35.8	24.7	230	0
Dissolved Oxygen (DO)	mg/L	106	6.2	15.5	10.3	7	5
pH		88	5.2	11.5	8.2	6.5 – 8.5	14
Secchi Tube	100 cm	217	1	100	59.2	55	75
Total Suspended Solids	mg/L	210	1	5970	143.2	10	108
Phosphorus	ug/L	152	5	2840	140	150	90
Escherichia coli (geometric mean)	MPN/100ml	5	331	1002	-	126	2
Escherichia coli	MPN/100ml	129	1	48000	1028.5	1260	20
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	210	0.2	39.5	16.3	-	-
Kjeldahl Nitrogen	mg/L	42	0.5	14.4	2.2	-	-
Orthophosphate*	ug/L	199	0	0.5	0.1	-	-
Specific Conductance	uS/cm	131	135.3	1251	715.8	-	-
Water Temperature	deg °C	170	3.5	24.4	16	-	-
Sulfate*	mg/L	9	45.9	101	80.1	-	-
Hardness	mg/L	9	361	448	411.2	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station on Seven Mile Creek, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 35. Outlet water chemistry results: Rogers Creek, City of Mankato-Minnesota River Aggregated 12-HUC.

Station location:	Rogers Creek, At County Road 20, 1 mile North of St. Peter						
STORET/EQuIS ID:	S007-570						
Station #:	91MN061						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	3	2.9	17.4	9.4	40	0
Chloride	mg/L	9	28.2	42.7	35.1	230	0
Dissolved Oxygen (DO)	mg/L	15	6.5	9.7	8.2	5	0
pH		9	7.7	8.8	8.4	6.5 – 9	0
Secchi Tube	100 cm	15	11	100	52	10	0
Total Suspended Solids	mg/L	9	3	148	28.9	65	1
Phosphorus	ug/L	8	91	2600	696	150	7
Escherichia coli (geometric mean)	MPN/100ml	3	525	759	-	126	1
Escherichia coli	MPN/100ml	14	119.8	1553.1	614.9	1260	2
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	9	1.9	44.2	20.6	-	-
Kjeldahl Nitrogen	mg/L	9	1.1	7	2.6	-	-
Specific Conductance	uS/cm	14	485.2	959	737.5	-	-
Water Temperature	deg °C	15	12.9	23.8	18.2	-	-
Sulfate*	mg/L	9	56.2	135	81.6	-	-
Hardness	mg/L	9	374	567	453.3	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Rogers Creek, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 36. Lake assessments: City of Mankato-Minnesota River Aggregated 12-HUC.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Wita	07-0077-00	338	H	100	6	-	-	152.2	164.9	0.2	NS	IF
Savidge	40-0107-00	119	E	100	4	-	-	32	78.4	0.3	IF	IF
Scotch	40-0109-00	574	H	100	11	-	D	139.3	184.5	0.7	NS	IF
Unnamed	52-0001-00	9	M	-	23	-	D	12.1	5.8	3.1	IF	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

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

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use

Summary

Stream biology

The City of Mankato – Minnesota River (0702000711-01) aggregated 12-HUC consists of 10 AUID's assessed for Aquatic Life during the 2013, monitoring and 2015 assessments (Table 31, Figure 28). Data from 12 stations within the subwatershed was utilized to assess stream condition. Results of the assessments indicated 1 AUID supporting for Aquatic Life (AQL) and nine AUID's impaired for AQL. Of the nine impairments, five were existing AQL impairments. In some cases, new AQL impairment parameters were added for some AUID's as the result of the Intensive Watershed Monitoring effort. Two AUID's were determined to have insufficient information for AQL assessments, while one AUID was determined to be not assessable.

Within the Seven Mile Creek minor watershed, five AUID's were monitored and assessed during the recent effort. County Ditch 46A is one of the primary tributaries to Seven Mile Creek, and consists of two monitored reaches. These two AUID's were the result of a TALU split based on differing channel and habitat conditions. The upstream AUID on County Ditch 46A (07020007-678) falls in the channelized headwater portion of the minor watershed, and exhibits poor habitat conditions based on MSHA scores. This reach was determined to be a Modified Use (MU) class. Both biological communities failed to meet MU criteria for AQL, and will be listed for both communities. Downstream of this reach, County Ditch 46A consists of a more natural channel and fair habitat as rated by MSHA. For these improved conditions, this reach was determined to fall under the General Use (GU) class. Fish community data was not utilized for assessment of this reach due to below normal flow conditions at the time of the sample. Macroinvertebrate data for this reach indicated that this assemblage did not meet GU criteria, further supporting the existing AQL impairment. This reach was rated as severely unstable for channel condition based on CCSI scores. Similar conditions exist for the upstream most monitored reach on Seven Mile Creek (-703). This AUID was from a TALU split based on differences shown between the upstream and the downstream portions. The monitored reach fell on the downstream AUID from the split. From the upstream channelized network, the stream at this point has started to enter the wooded ravine leading to the Minnesota River, and consists of a natural channel and fair habitat conditions. These conditions fall under the General Use (GU) class for TALU. Fish community data was not assessed due to lower than normal flow at the time of the sampling activity. Macroinvertebrates failed to meet GU standards, which results in a new parameter that supports the existing AQL impairment. Channel condition for this reach was rated severely unstable according to CCSI scores. These AUID's (-678, -679, -703) that make up the upper portion of the Seven Mile Creek are significantly impacted by a dam just downstream of these reaches. Sampling of the fish community on these reaches collected very low numbers of fish, and only two tolerant species (Brook Stickleback, Fathead Minnow), resulting in very low F-IBI scores. Removal of this dam would likely greatly improve fish movement and the composition of the community. Various stressors would still impact the biological communities in this portion of the watershed. Severely unstable stream channels are are often the result of altered hydrology and lack of water storage within the watershed. Nutrients can also pose a problem for biological communites, both -679 and -703 showed exceedances for phosphorus, but lacked the response indicators needed for a listing. The downstream most reach on Seven Mile Creek (-562) consists of a coldwater, General Use reach. Both biological communities, fish and macroinvertebrates, exceeded coldwater GU criteria, supporting the existing AQL impairment with two parameters. This reach is predominantly a natural channel, rated as fairly stable according to CCSI scores, and as good habitat according to MSHA scores. One contributing factor for lower than the threshold Fish IBI scores is the presence of warmwater fish species. A higher abundance of warmwater fish species would negatively affect the coldwater F-IBI used to score this reach. Seven Mile Creek is a MNDNR designated trout stream and is actively managed as a put-grow-take fishery for brown trout. MNDNR surveys have shown evidence of carryover, but with active stocking, natural reproduction is hard to document. Significant factors affecting the condition of this coldwater stream include excess nutrients and altered hydrology. Much of the headwaters for this stream system consists of an agricultural landscape. Drainage ditches, underground tile networks, and the loss of wetlands all contribute hydrologic issues that stress biological communities. Management of agricultural lands can also contribute excess nutrients to aquatic systems.

Rogers Creek (-547) was previously listed as impaired for the fish community in 2004. Current fish community data further supports this listing. With the recent sampling effort, the macroinvertebrate community also did not meet the designated General Use criteria, again further supporting the previous impaired status of this reach. This reach consists of a natural channel with good habitat. Two stations were sampled on this reach, a station (91MN061) upstream of the natural waterfall, and a station below the fish barrier (13MN094). Both stations showed low fish IBI scores due to the presence of the 6-foot barrier falls inhibiting fish movement to the upstream station. Most of the fish collected on this reach at both stations are considered tolerant species. The falls has limited the fish community is the species composition of the fish community. Only three tolerant species were present upstream of the falls, while up to 11 species are present downstream of the falls. Despite the relatively good stream habitat attributes, the downstream reach had low F-IBI scores, indicating that there are also other stressors likely affecting the fish community.

Located on the east side of the Minnesota River, just north of Mankato, Unnamed Creek (-694) exhibited biological communities in good condition. With habitat considered to be good according to MSHA, this reach was designated General Use. Both the fish and macroinvertebrate communities met GU criteria for AQL, resulting in full support. Up to 21 species of fish, of which 2 species are considered sensitive, were collected at the monitoring site (13MN075) representing the reach. The resulting F-IBI score from the one fish sampling visit scored above the GU threshold, and just slightly over the upper confidence limit.

The original AUID for Unnamed Creek (-549) was split for TALU based on differences in channel and habitat characteristics. The resulting AUID's, -696 and -550 are now designated for different TALU use classes based on these differences. The upstream reach of Unnamed Creek (-696), designated Modified Use, has been mostly altered by channelization and exhibits poor habitat conditions. The fish and macroinvertebrate communities failed to meet MU standards. This reach will be listed as impaired for AQL for both communities. The next downstream reach is substantially different, with a natural channel and good habitat conditions. Designated General Use, the fish community data still did not support AQL standards for this use class. This current assessment supports the existing listing (2006) for AQL F-IBI. The macroinvertebrate community also exhibited non-support for AQL for this use class, prompting an additional listing for macroinvertebrate community as well.

Three AUID's make up the length of Cherry Creek. The upstream most reach on Cherry Creek (-541) is mostly channelized and designated as Modified Use. The fish community at the monitoring station (13MN088) consisted of only 1 species, and an F-IBI score below the MU threshold, indicating non-support for AQL for this assemblage. The macroinvertebrate community performed better, meeting MU standards for AQL. Habitat for the monitoring station was rated poor according to MSHA results, but the channel condition was rated fairly stable according to CCSI results. The next reach downstream on Cherry Creek (-542) is a limited resource value water with no aquatic life expectation, so it was not assessed for AQL support using biological assemblage data. The last reach on Cherry Creek (-543) before the stream joins the Minnesota River features improved habitat, with fair and good MSHA habitat ratings, and a predominantly natural channel. As a result, this reach was classified as General Use. Despite a more natural condition for the streams, the macroinvertebrate community still failed to meet

GU criteria for AQL, and will subsequently be listed as impaired for this biological community. Fish community data for this reach was considered non-assessable data due to insufficient effort at the sampling visits. One this reach, one dominant species was collected at the two monitoring sites on this reach, with a second species collected at the downstream most site (13MN083). Very low numbers of fish are present. With assessable fish data, this reach would likely be impaired for the fish assemblage. A dam closer to the Minnesota River likely limits diversity in the fish community found on this stream.

Stream water chemistry

Assessable water chemistry data was available on reaches of Seven Mile Creek, Rogers Creek and small tributaries within this subwatershed.

Unnamed Creek (-637) which is a tributary of Seven Mile Creek has data collected between 2006 and 2009, at S002-464 near the downstream end of this reach. Dissolved oxygen (DO) had no violations over the four-year period. TSS and STUBE had three and zero violations respectively, resulting in a low exceedance rate below 10%. The pH dataset had minor exceedance rate but they do not trigger an impairment at this time. TP is grossly exceeding the river nutrient standard, but no data exists to determine if eutrophication indicators is resulting from the excess phosphorus. This reach was previously listed impaired for aquatic recreation use in 2010, based on bacteria data collected between 2006 and 2009.

During this assessment, the original County Ditch 46A parent reach -516 exhibited discrepancies in habitat and biological communities, resulting in a split to assess each reach in the appropriate tiered aquatic life class. County Ditch 46A (-678) is the upstream child reach resulting from a split of the parent reach -516 which had existing impairments for turbidity and bacteria. The station from which the existing impairments arose is not on this reach; limited chemistry data is available on the reach. County Ditch 46A (-679) is the downstream child reach resulting from a split of now retired parent reach -516 which had existing impairments for both turbidity and bacteria based on data from S002-936, which falls on the downstream portion of this new child reach. Recent data confirms the existing impairments for both TSS and bacteria. Dissolved oxygen easily meets standard with a relatively large dataset. The pH data reveals a number of very borderline violations (9.3, 9.1, 9.1, 6.3, 6.4 SU) across a large dataset collected over seven years. Considering there are few moderate to severe exceedances over such a large timeframe and dataset it would be hard to confidently list this reach for pH without observing a stronger pattern of significant violation. TP has a large dataset with an average grossly exceeding river nutrient standard, however, response data is needed to determine if eutrophication is resulting from the excess phosphorus.

Seven Mile Creek parent reach -564 was split during this assessment cycle due to habitat and biological differences across the reach, ensuring biological data were compared to the appropriate standard. Seven Mile Creek (-703) is the downstream child reach of the split parent reach -564, which had been previously listed impaired for turbidity and bacteria based on data from S002-934 which falls on this child reach. Recent TSS and bacteria data confirm the existing impairments on this reach. DO and pH datasets have a few minor exceedances that do not result in a rate above 10%. TP is grossly exceeding river nutrient standard but no response data is available to determine if eutrophication is present. Seven Mile Creek (-562) has extensive amounts of water chemistry data available for all water chemistry parameters. Four previous impairments are active, turbidity and bacteria listed in 2006, drinking water use in 2010, based on nitrate data, and a pesticide listing from 2012. TSS and STUBE data collected since the initial listing indicated an ongoing problem with sediment loading, with nearly 50% violation rate for TSS and 25% for STUBE, confirming the existing impairment. Bacteria data continues to indicate a persistent pattern of high concentrations across all months and years, violating both individual and geometric standards. Recently collected nitrate data since the initial listing confirms concentrations are still consistently violating standard. The existing impairment for pesticides will also remain. DO, TP, and toxics data all met respective standards. A cursory review of the pH dataset indicates impairment, reviewing raw data reveals contradicting violations during similar time periods. This unusual pattern triggered further review of data collection methods, the local sampler at the time of the violations could not provide calibration records and staff collecting samples are no longer available. Considering this uncertainty, a listing based on questionable pH dataset and will not be pursued.

Rogers Creek (-613) had small datasets available. High bacteria concentrations were evident, with two individual and one monthly geometric mean violations throughout two years of data collection, this will result in an aquatic recreation use listing. TP data was limited but the average was exceeding the river nutrient standard; however, no response data was available to determine if algae growth was resulting from the excess phosphorus. All other parameters would meet their respective standards.

Lake water chemistry

Two lakes within this subwatershed had enough data within the 10-year window to make a complete aquatic recreation or aquatic life use assessment during this cycle. Wita and Scotch lakes are located near the North Central Hardwood and Western Corn Belt Plains ecoregion boundaries, therefore to assess against the appropriate standards individual watershed land use reviews were completed. Land use reviews for both lakes revealed agriculture dominates the contributing watersheds, indicating that assessment would be best completed using the Western Corn Belt Plains ecoregion standards.

Scotch Lake fits into the shallow lake criteria (11 feet maximum depth and 100% littoral zone), total phosphorus(TP) and chlorophyll-a(chl-a) had data from 2013 and 2014 grossly exceeding standard, algae blooms were apparent in both years, TP data was noticeably higher in 2014 possibly reflecting an increased inflow during that summer or more frequent internal loading. Secchi data was right at the standard, with a long term trend indicating water clarity is decreasing. Wita Lake was assessed on the shallow lake standard using data from 2013 and 2014, all three lake eutrophication parameters severely exceed standard across both years revealing a persistent pattern of high TP concentrations and frequent heavy algae blooms, which will result in a new aquatic recreation use impairment listing. Unnamed (Hallet) Lake located within the city of St. Peter receives a significant amount of local recreational use throughout the summer months. TP and Chl-a data is limited, indicating this waterbody would meet recreational use standard if minimum data requirements were met. For example, a more extensive Secchi dataset easily has the best clarity of the entire watershed. However, a trend has been detected in the Secchi dataset indicating a decreasing clarity over the course of the dataset and local monitors have noted increased nuisance algae blooms in recent years. Additional monitoring occurred starting in 2015 to better characterize more recent conditions. Considering the contributing watershed is nearly all urban land use, Hallet Lake is a pollutant sink to much of the city’s surface water runoff, and would benefit greatly from local restoration and protection strategies to ensure an impaired status is never reached and continued public use is possible for the long term future.

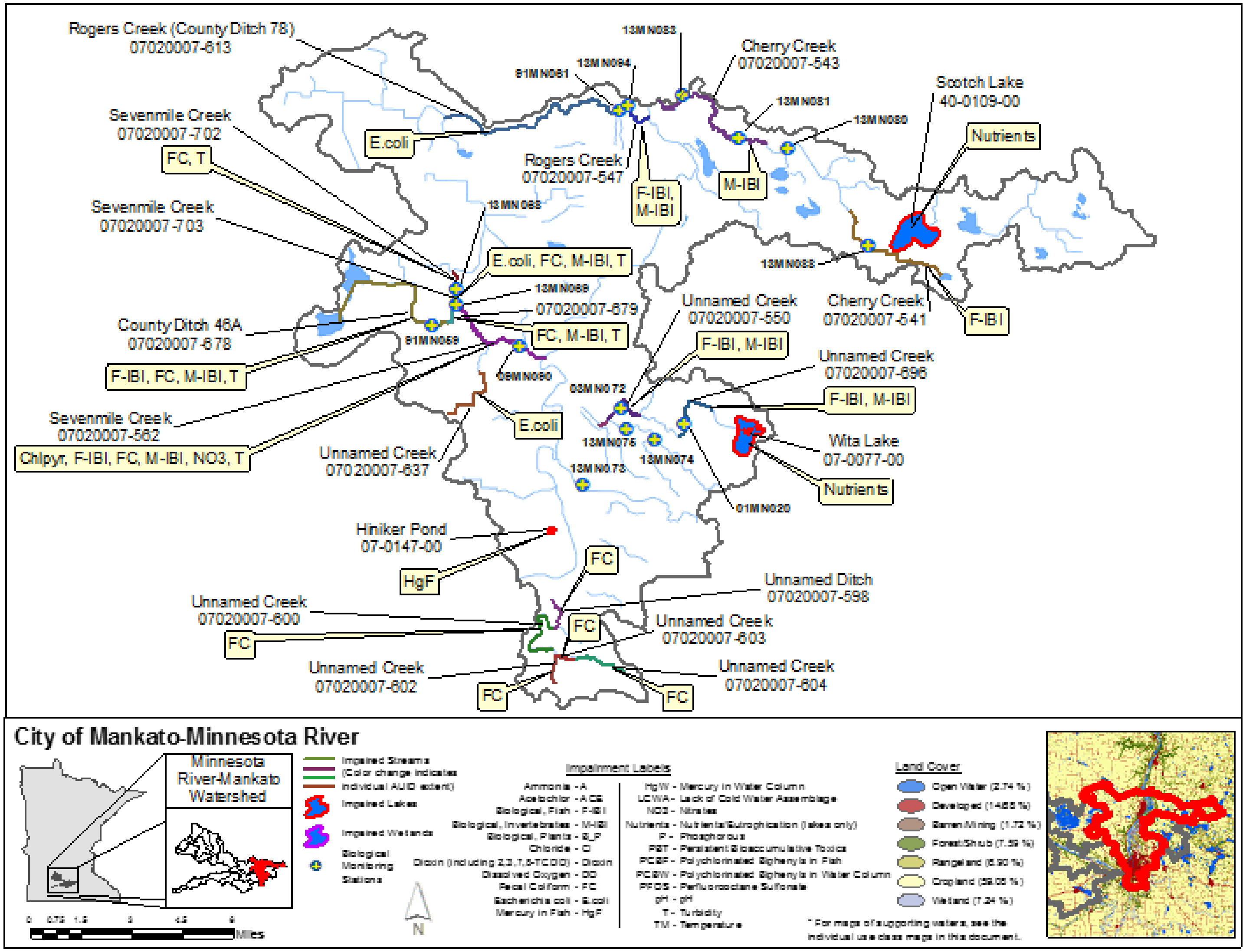


Figure 28. Currently listed impaired waters by parameter and land use characteristics in the City of Mankato-Minnesota River Aggregated 12-HUC.

Wabasha Creek Aggregated 12-HUC HUC 0702000702-01

The Wabasha Creek (0702000702-01) aggregated 12-HUC is located on the south side of the Minnesota River at the western margin of the major watershed (Figure 29). This subwatershed drains 72 square miles (46,013 acres), and is entirely within Redwood County. The Wabasha Creek subwatershed primarily consists of Wabasha Creek and its tributaries, and is a direct tributary to the Minnesota River. The main tributaries to Wabasha Creek are County Ditch 105 and County Ditch 109. This stream system primarily flows north and east to its confluence with the Minnesota River near Franklin, and is represented by the pour point biological monitoring site 13MN012, which was sampled for water chemistry. All of the streams within this subwatershed are considered warmwater. Within this watershed, 71% of the streams have been altered, primarily in the headwater reaches, while 24% remain natural. No definable channel accounts for 5% of the reaches in the watershed. There are no lakes within the watershed. There is a perched culvert on Wabasha Creek that may be a barrier to fish movement at most flows (Lore 2015). The fish community upstream of this barrier may be only slightly impacted by this barrier (Lore 2015).

The Wabasha Creek subwatershed is predominately rural, with only the town of Morgan present. The dominant land use in the watershed is cropland, encompassing 87% of the watershed area. Approximately 6% of the watershed is developed, while the more natural portions consist of 1% forest, 2% rangeland. There is very little water storage potential on the landscape, with open water accounting for 0.3% and wetlands account for 3% of the landscape.

Table 37. Aquatic life and recreation assessments on stream reaches: Wabasha Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name*,** *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-699 **Wabasha Creek** *T111 R35W S11, west line to T112 R35W S24, east line*	13MN010	6.93	WWm	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-667 **County Ditch 105** *CD 106 to Wabasha Cr*	13MN009	1.13	WWm	EXS	-	IF	IF	IF	-	IF	IF	-	IF	-	IF	-
07020007-527 **Wabasha Creek** *T112 R34W S19, west line to Minnesota R*	13MN012	8.41	WWg	EXS	EXS	IF	IF	MTS	MTS	MTS	MTS	-	EXS	-	IMP	IMP

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

Table 38. Minnesota Stream Habitat Assessment (MSHA): Wabasha Creek Aggregated 12-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	13MN010	Wabasha Creek	0	6	9	9	5	29	Poor
2	13MN009	County Ditch 105	0	7	4	6.5	4	21.5	Poor
1	13MN011	County Ditch 109	0	13.5	19	14	28	74.5	Good
1	13MN092	County Ditch 109	0	6.5	4	10	4	24.5	Poor
1	13MN012	Wabasha Creek	0	8	17.4	12	25	62.4	Fair
Average Habitat Results: *Wabasha Creek Aggregated 12-HUC*			0	8	9.6	9.7	11.7	38.9	**Poor**

Qualitative habitat ratings

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

Table 39. Channel Condition and Stability Assessment (CCSI): Wabasha Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN010	Wabasha Creek	36	21	9	3	69	Moderately Unstable
Average Stream Stability Results: *Wabasha Creek Aggregated 12-HUC*			36	21	9	3	69	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 40. Outlet water chemistry results: Wabasha Creek Aggregated 12-HUC.

Station location:	Wabasha Creek, At CSAH 11, 1.5 miles South of Franklin						
STORET/EQuIS ID:	S005-627						
Station #:	13MN012						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	44	0.53	55.3	10.3	40	2
Chloride	mg/L	10	14.7	146	60.4	230	0
Dissolved Oxygen (DO)	mg/L	35	3.3	14.4	8.1	5	4
pH		44	7.5	9.1	8.3	6.5 - 9	2
Secchi Tube	100 cm	50	3	100	59	10	4
Total Suspended Solids	mg/L	41	2	1040	81	65	6
Phosphorus	ug/L	41	41	1310	272	150	29
Escherichia coli (geometric mean)	MPN/100ml	5	604	2117	-	126	5
Escherichia coli	MPN/100ml	34	95.9	8664	1247.4	1260	12
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	41	0.2	18.9	6.7	-	-
Kjeldahl Nitrogen	mg/L	41	0.2	4.9	1.6	-	-
Orthophosphate*	ug/L	37	0.01	0.5	0.2	-	-
Specific Conductance	uS/cm	15	561	1245	881.3	-	-
Water Temperature	deg °C	39	5.7	22.9	17	-	-
Sulfate*	mg/L	10	127	166	141.7	-	-
Hardness	mg/L	10	324	480	412.3	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Wabasha Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Water quality criteria for Aquatic Life (AQL) was used to assess two AUID's, using data from two monitoring sites within the Wabasha Creek (0702000702-01) aggregated 12-HUC (Table 37, Figure 29). One AUID, County Ditch 105 (0702007-667) was determined to have insufficient data to determine Aquatic Life use support, based on a lack of a macroinvertebrate sample. Macroinvertebrates were not sampled in 2013, due to insufficient flow at the time of the sampling visit. The fish community for this AUID exceeded AQL standards for warm water, Modified Use using a Low Gradient fish class IBI. Another reach utilizing the Low Gradient fish class is the upstream AUID segment on Wabasha Creek (-699). Due to channelization, and a lack of habitat (MSHA rating of Poor), this reach was designated as warm water, Modified Use (MU). The fish community met MU criteria for this reach while the macroinvertebrate community did not meet the MU criteria which results in this AUID being listed as impaired. Aquatic Life criteria for the Modified Use class in the Low Gradient fish class, constitutes the lowest F-IBI impaired threshold used to assess the condition of fish communities in Minnesota because of natural limitations. The lowest AUID on Wabasha Creek (-527), designated General Use, consisted of very poor biological communities after considering both the macroinvertebrate community and fish community failed to meet AQL standards. Habitat was considered fair, although the fish community consisted of only one sensitive and five tolerant fish species. Tolerant individuals made up 89% of the individuals collected at the monitoring station (13MN012) on this reach. The upstream reach (-699) on Wabasha Creek meet AQL standards for fish and the downstream reach (-527) fails to meet standards, with a fish barrier consisting of a perched culvert between the two reaches (Lore 2015). The effect of this barrier is likely minimal since only six species were collected upstream of the barrier compared to only ten species downstream of the barrier (Lore 2015). The condition of the biological communities within the watershed is more likely the result of other stressors within the watershed. Wabasha Creek (-527) did have an exceedance for Phosphorus (P), but lacked a response indicator which inhibited listing for this parameter. Excess nutrients can have a considerable effect on the biological community, often contributing to algae growth that can exasperate daily swings in DO (i.e. 3.3 to 14.4 mg/L), which results in biological communities composed of low oxygen tolerant species.

Stream water chemistry

Water chemistry data was available on the outlet reach of Wabasha Creek (-527). The DO dataset indicates a common pattern that has been noted throughout the watershed, the few violations occurred during the summer 2009, when sampling equipment malfunctioned. Unionized ammonia, total suspended solids, secchi tube and pH all have violations but below 10% exceedance rate overall, a few violations could be correlated to flow events. Considering that these parameters are all showing some stressor related response, this could cause a future impairment if degradation persists.

E. coli data on this reach reveals consistently elevated levels of bacteria across different months and years. Individual bacteria violations occurred at a rate of 30%, monthly geometric mean calculations violated the standard for five of the six months available, both confirm a new listing for aquatic recreation.

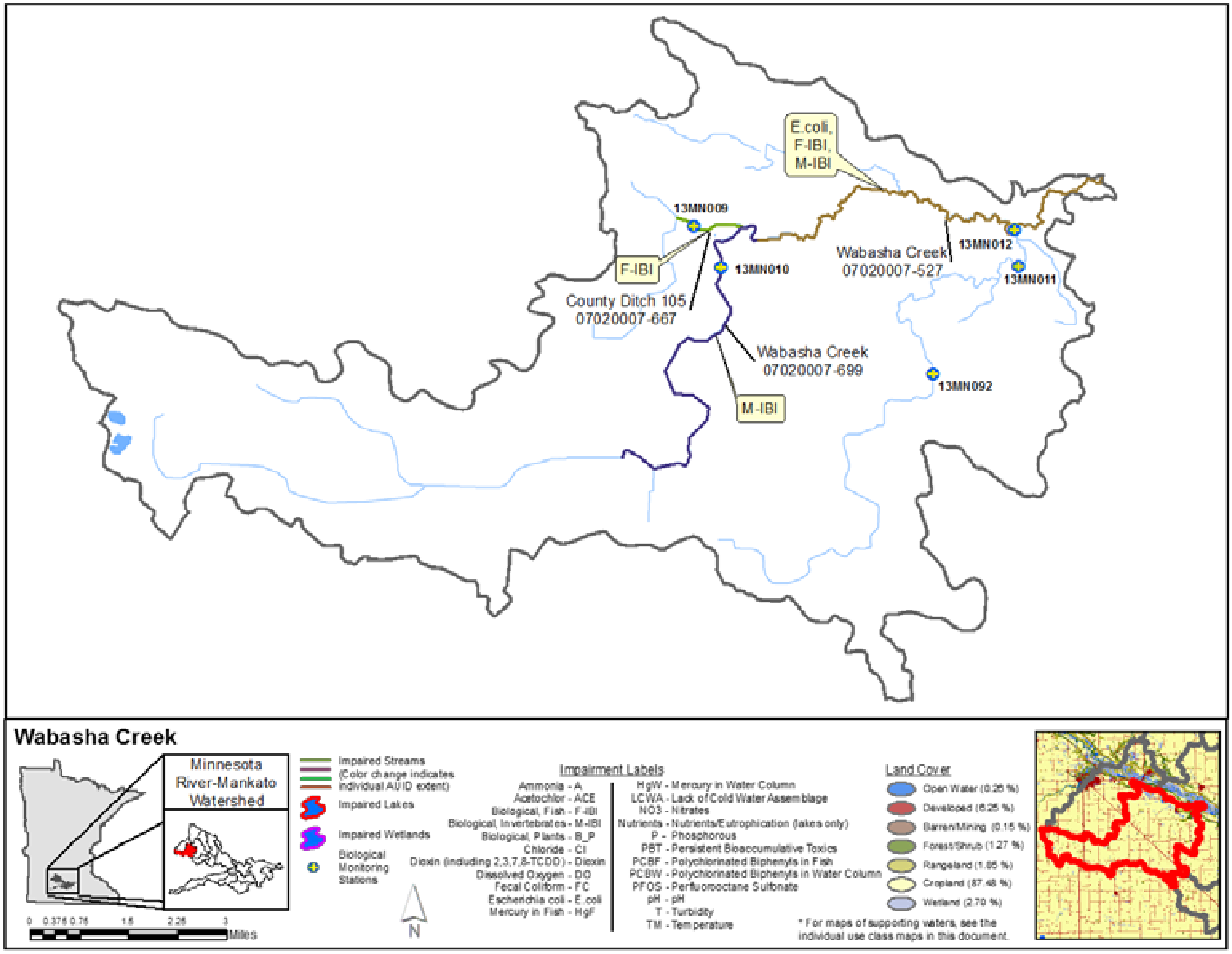


Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Wabasha Creek Aggregated 12-HUC.

Spring Creek Aggregated 12-HUC HUC 0702000704-02

The Spring Creek (0702000704-02) aggregated 12-HUC is located on the south side of the Minnesota River in the western half of the major watershed (Figure 30). This subwatershed drains 45 square miles (28,503 acres). The western portion of the watershed lies in Redwood County, while the rest is a part of Brown County. The Spring Creek subwatershed is a direct tributary to the Minnesota River, and primarily consists of Spring Creek (Hindeman Creek), also known as Judicial Ditch 29 in its headwaters, and its small tributaries. The most significant tributary is Judicial Ditch 29 Lateral Branch in the headwaters. The rest of the tributaries are unnamed. Flow direction for this stream system is to the north and east. The monitoring site at the pour point, 13MN090, was sampled for water chemistry. Most of the stream reaches within this subwatershed are considered warmwater, with the exception of a coldwater reach on Spring Creek (Hindeman Creek) that starts approximately 6.25 miles upstream of the creeks confluence with the Minnesota River, and ends approximately 1.5 miles upstream of the confluence. The majority of the streams in the watershed have been altered (76%). Natural channels represent 22% of the reaches in the watershed and only occur on the portions of the stream and tributaries as they near the Minnesota River Valley. Lone Tree Lake is the only lake present within the subwatershed. A perched culvert affecting one monitoring station is present on Spring Creek (Lore 2015).

The small town of Evan is the only town within this rural subwatershed. Land in the watershed consists of 89% cropland, 6% developed, 2% forest, 1% rangeland, 1% wetland, and a mere 0.4% open water. The majority of the forest and rangeland occurs near the Minnesota River valley. With the small percentage of wetland and open water, water storage within the watershed is minimal.

Table 41. Aquatic life and recreation assessments on stream reaches: Spring Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-622 **Spring Creek (Judicial Ditch 29)** *T111 R33W S23, west line to T111 R33W S23, east line*	13MN024	1.40	WWg	EXS	EXS	MTS	IF	MTS	-	MTS	IF	-	EXS	N	IMP	IMP
07020007-574 **Spring Creek (Hindeman Creek)** *T111 R33W S24, west line to T111 R32W S20, east line*	91MN055	4.72	CWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-649 **County Ditch 57** *Headwaters to T111 R32W S18, south line*		3.93	WWg	-	-	IF	IF	IF	-	MTS	MTS	-	EXS	N	IF	-
07020007-573 **Spring Creek** *T111 R32W S21, west line to Minnesota R*	13MN090	2.18	WWg	EXS	EXS	MTS	MTS	MTS	MTS	MTS	MTS	-	EXS	-	IMP	IMP

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

Table 42. Minnesota Stream Habitat Assessment (MSHA): Spring Creek Aggregated 12-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
2	13MN024	Spring Creek (J D 29)	0	7.8	15.1	8	12	42.8	Poor
1	91MN055	Spring C. (Hindeman Cr.)	2.5	9.5	20.3	14	34	80.3	Good
1	13MN090	Spring Creek	2.5	11	16.1	11	24	64.6	Fair
Average Habitat Results: Spring Creek *Aggregated 12-HUC*			1.3	9	16.6	10.3	20.5	57.6	**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 43. Channel Condition and Stability Assessment (CCSI): Spring Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	91MN055	Spring Creek	10	11	5	3	29	Fairly Stable
1	13MN090	Spring Creek	42	36	20	11	109	Severely Unstable
Average Stream Stability Results: *Spring Cr. Aggregated 12-HUC*			26	23.5	12.5	7	69	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 44. Outlet water chemistry results: Spring Creek Aggregated 12-HUC.

Station location:	Spring Creek, At CSAH 10, 5.5 miles Northwest of Essig						
STORET/EQuIS ID:	S005-625						
Station #:	13MN090						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	44	0.11	58	11.18	40	2
Chloride	mg/L	10	7.7	28.2	15.7	230	0
Dissolved Oxygen (DO)	mg/L	42	4	17.5	9.2	5	4
pH		50	7.7	9.2	8.4	6.5 - 9	3
Secchi Tube	100 cm	56	2	100	61.9	10	6
Total suspended Solids	mg/L	41	2	1380	110.4	65	5
Phosphorus	ug/L	41	22	1200	175	150	10
Escherichia coli (geometric mean)	MPN/100ml	5	73	1275	-	126	5
Escherichia coli	MPN/100ml	32	14.6	2419.6	266.7	1260	8
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	41	1	22	7	-	-
Kjeldahl Nitrogen	mg/L	41	0.2	6.7	1.5	-	-
Orthophosphate*	ug/L	39	0.005	0.678	0.115	-	-
Specific Conductance	uS/cm	21	413	959	803	-	-
Water Temperature	deg °C	45	6.1	23.5	17.1	-	-
Sulfate*	mg/L	10	36.4	237	164	-	-
Hardness	mg/L	10	378	544	437.9	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Spring Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 45. Lake assessments: Spring Creek Aggregated 12-HUC.

Name	DNR Lake ID	Area (acres)	Trophic Status		Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Lone Tree	08-0073-00	19	H		100	1.5	-	-	202.4	83.8	1	IF	NA

Abbreviations:

D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

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

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use

Summary

Stream biology

Within the Spring Creek (0702000704-02) aggregate 12-HUC, three AUID's were assessed for Aquatic Life based on data from three monitoring stations (Table 41, Figure 30). One AUID within the subwatershed lacked a sufficient dataset to assess for Aquatic Life (AQL). The three AUID's all fall on Spring Creek with the upstream most AUID consisting of Spring Creek (Judicial Ditch 29) (07020007-622) which was determined to be General Use (GU) for warmwater streams. The macroinvertebrate and fish communities both failed to meet General Use AQL standards resulting in a listing. Habitat was considered poor at the monitoring station on this reach, as well as the fish species collected consisted of tolerant species. Besides other fish community stressors, a perched culvert downstream of the reach may significantly impact the fish community present on this reach, further contributing to the impairment on this reach. The next AUID downstream, Spring Creek (HIndeman Creek) (-574) is a coldwater General Use reach on Spring Creek. Both communities failed to meet AQL standards for GU and will be listed as impaired. For two fish sampling visits to the monitoring site (91MN055) on the reach, both visits resulted in F-IBI's that fell below the GU threshold and lower confidence interval. Despite good habitat as based on MSHA scores and a fairly stable channel based on CCSI score, no coldwater species were collected and only one coolwater fish species was collected. The stream has been a designated trout stream since 1952 and the MNDNR has actively managed the stream as a put and take fishery. Previous MNDNR surveys have found suspected carry over and potential natural reproduction for brown trout. Downstream of the coldwater reach, the AUID on Spring Creek (-573) consists of a warmwater, General Use class reach that flows for 2.18 miles before the confluence with the Minnesota River. Similar to the upstream reaches, both macroinvertebrate and fish assemblages failed exceeded the GU AGL standards and will be listed as impaired for Aquatic Life M-IBI and F-IBI. Aquatic habitat was considered fair from MSHA. One difference between this reach and the upstream two reaches was that CCSI rated the stream as Severely Unstable. With this AUID being the lowest in the watershed, all of the accumulated flow moves thru this reach, changes to the hydrology within this watershed would affect this reach the most. Unstable stream channels can negatively impact the fish community. Phosphorus was also a potential problem, with an exceedance of the standard, but with the lack of a response indicator, a listing would not be possibly for this parameter. The fish community at the monitoring site for this reach consisted of three sensitive species, seven tolerant species, and three very tolerant species, with over 80% of the individuals consisting of tolerant/very tolerant fish.

Stream water chemistry

Assessable water chemistry data is available on multiple reaches of Spring Creek and County Ditch 57. The midpoint reach of Spring Creek (-622) had DOSTUBE, pH and river eutrophication datasets. The majority of parameters would meet applicable standard on this reach with the exception of grossly exceeding TP data, insufficient data existed to determine if algae grew within the reach as a result of excess nutrients. Bacteria data on this reach indicates an aquatic recreation use impairment, with three months exceeding the monthly geometric mean standard of 126 MPN/ 100mL, which will trigger a listing during this assessment cycle. The downstream reach of Spring Creek (-573) had substantial datasets for all water chemistry parameters. A cursory review of the DO data would indicate impairment, but all violations within the dataset occurred in a previously mentioned timeframe in 2009, which faulty collection equipment skewed DO values to false violations. TSS and STUBE data had minor exceedances rates, further review reveals the few violations occurred during high flow events which are expected to carry higher sediment loads. Unionized ammonia and pH had few violations, not at a scale that would trigger a listing for aquatic life. The TP dataset exceeds river nutrient standard but would need supporting Chlorophyll-a data to make a complete assessment. Bacteria data on this reach indicated a clear pattern of high concentrations across different months and years, with 8 of 45 individual and 4 of 6 monthly geometric mean violations which will result in an impairment for aquatic recreation use.

County Ditch 57 had various water chemistry datasets available. The DO dataset had a violation rate just above 10%, although three of the four exceeding data points are very minor, at this time a listing will not be pursued based on the borderline nature of the data. The TP data was grossly violating the river nutrient standard, the Chlorophyll-a dataset does not indicate a response (i.e. excessive algal growth). Other remaining parameters would meet the respective standard.

Lake water chemistry

Lone Tree Lake had limited aquatic recreation use data available, none of the three water chemistry parameters used for lake nutrient assessment met minimum data requirements to make a complete assessment. At this time, total phosphorus and chlorophyll-a datasets grossly exceed standard, while secchi disk data would just meet the standard. More phosphorus and chlorophyll-a data would be needed to meet data requirements and make a confident assessment of Lone Tree Lake.

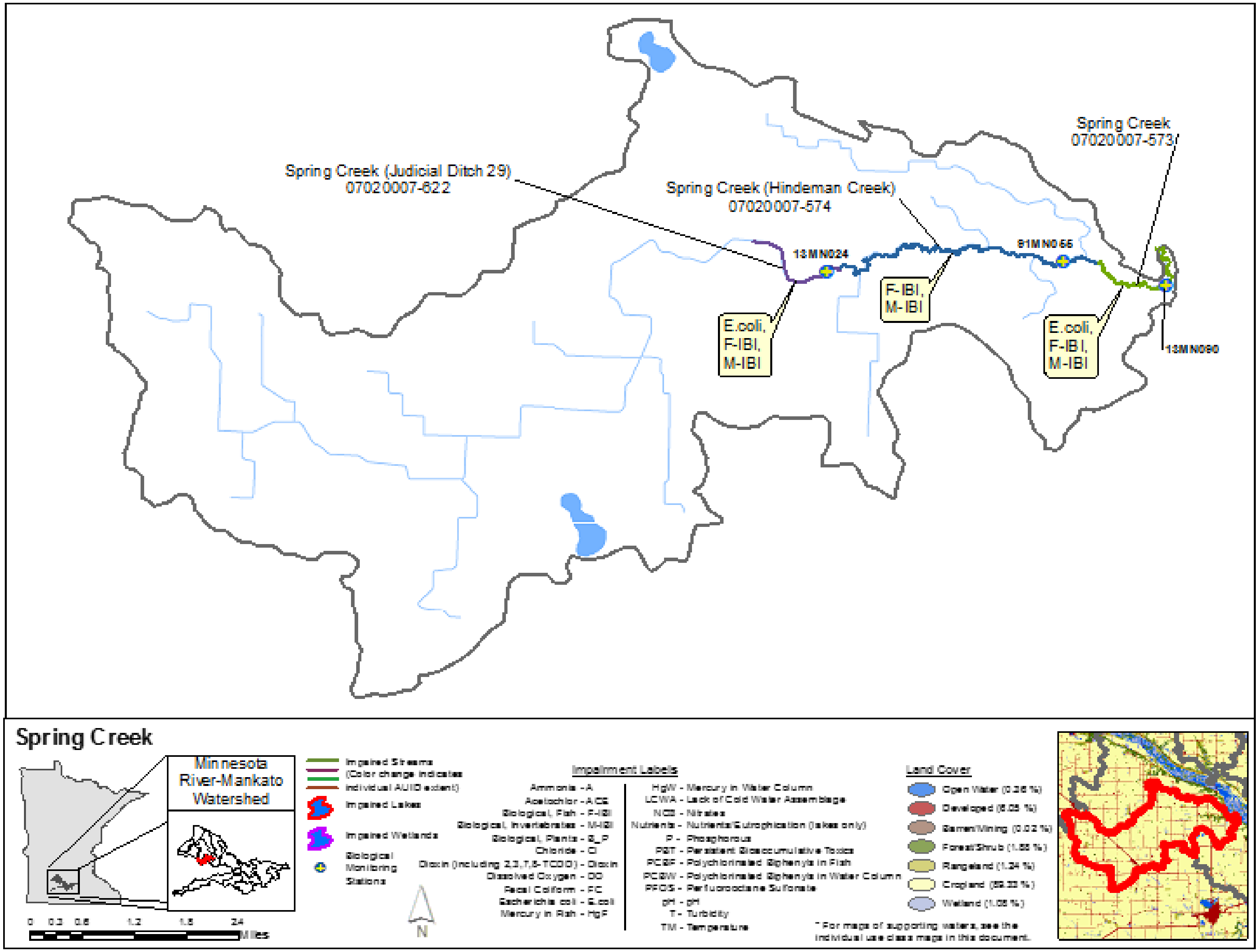


Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Spring Creek Aggregated 12-HUC

Little Cottonwood River Aggregated 12-HUC HUC 0702000707-01

The Little Cottonwood River (0702000707-01) aggregated 12-HUC is the third largest subwatershed, and the longest tributary within the Minnesota River – Mankato major watershed (Figure 31). This river flows for 83 miles before it joins the Minnesota River. It is located on the south side of the Minnesota River and starts at the western margin of the major watershed, and flows east and slightly north to its confluence with the Minnesota River near Courtland. This subwatershed drains 169 square miles (108,293 acres), and falls within Cottonwood County in the west, and Brown County in the east. The Little Cottonwood River is the primary watercourse for this subwatershed. Main tributaries to the Little Cottonwood include: Altermatts Creek, County Ditch 11, County Ditch 67, County Ditch 28-1, Judicial Ditch 9, and numerous unnamed tributaries. The subwatershed is represented by water chemistry sampling at the pour point biological monitoring site 13MN052. All of the streams in the subwatershed are designated warmwater. The Little Cottonwood is unique in that ¾'s of the stream has remained natural. Within the subwatershed, 37% of the streams have been altered, while 32% remain natural. No definable channel accounts for 31% of the reaches in the watershed. The Little Cottonwood River contributes the majority of reaches that make up the natural percentage. Gilman Lake is the largest lake in watershed at 164 acres. Juni Lake (57) and an Unnamed Lake (51) make up the only other lakes within the watershed.

The Little Cottonwood River subwatershed has only a portion of Jeffers, and Comfrey for towns within the watershed. Cropland dominates the landscape with 84% of the watershed area, while 5% is developed. Forest consists of 1% of the watershed, rangeland 3%, and wetland 7% of the subwatershed area. Most of the rangeland and wetland occurs in the lowlands present along the Little Cottonwood River for part of its length. The forested portion of the watershed is also found adjacent to the Little Cottonwood as it nears the Minnesota River valley.

Table 46. Aquatic life and recreation assessments on stream reaches: Little Cottonwood River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:												
													Eutrophication			
AUID ***Reach Name*****,** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-676 **Little Cottonwood River** *Headwaters to T109 R31W S22, north line*	13MN041, 13MN044, 13MN048, 13MN089, 91MN056	63.27	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	IMP
07020007-681 **Altermatts Creek** *Unnamed cr to T107 R34W S3, east line*	13MN043	3.50	WWm	-	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-656 **County Ditch 28-1** *Headwaters to Altermatts Cr*	13MN046	4.29	WWm	MTS	MTS	IF	IF	IF		IF	IF	-	IF	-	SUP	-
07020007-518 **Altermatts Creek** *T108 R34W S35, south line to Little Cottonwood R*	13MN045	7.02	LRVW	-	-	MTS	-	-	-	MTS	IF	-	-	-	-	IMP
07020007-548 **Unnamed creek** *Unnamed ditch to Little Cottonwood R*	91MN057	1.74	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-657 **County Ditch 11** *Unnamed ditch to Unnamed cr*	13MN049	2.88	WWm	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-646 **Unnamed creek (County Ditch 11)** *CD 11 to Little Cottonwood R*	10EM115	0.99	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-658 **County Ditch 67** *CD 58 to Little Cottonwood R*	13MN051	1.17	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-

AUID ***Reach Name*****,** *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
07020007-677 **Little Cottonwood River** *T109 R31W S15, south line to Minnesota R*	13MN050, 13MN052, 90MN058, 97MN009	19.88	WWg	MTS	EXS	MTS	EXS	EXS	MTS	MTS	MTS	-	EXS	-	IMP	IMP

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

Table 47. Minnesota Stream Habitat Assessment (MSHA): Little Cottonwood River Aggregated 12-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	13MN041	Little Cottonwood River	0	7	11.2	10	17	45.2	Fair
1	13MN044	Little Cottonwood River	2.5	10.5	5	13	5	36	Poor
2	13MN048	Little Cottonwood River	1.3	7.5	15.3	8.5	19.5	52.0	Fair
1	13MN089	Little Cottonwood River	2.5	10	14.7	7	15	49.2	Fair
1	91MN056	Little Cottonwood River	0	11.5	17.5	13	31	73	Good
1	13MN043	Altermatts Creek	0	9	4	5	5	23	Poor
1	13MN046	County Ditch 28-1	0	7	4	1	4	16	Poor
1	13MN045	Altermatts Creek	0	8	13.9	12	11	44.9	Poor
1	13MN047	Unnamed creek	0	12	14	10	6	42	Poor
2	91MN057	Unnamed creek	0	7.5	8.5	6	9.5	31.5	Poor
1	13MN049	County Ditch 11	0	6	16	5	5	32	Poor
1	10EM115	Unnamed creek (County Ditch 11)	0	12.5	8	14	13	47.5	Fair
1	13MN051	County Ditch 67	0	11	18.3	14	21	64.3	Fair
2	13MN050	Little Cottonwood River	2.5	3.25	17	13.5	20.5	56.75	Fair
2	13MN052	Little Cottonwood River	3.75	7.5	17	12.5	25	65.75	Fair
2	97MN009	Little Cottonwood River	2.5	10.25	17.675	13	25	68.425	Good
Average Habitat Results: *Little Cottonwood River Aggregated 12-HUC*			1.2	8.4	13.2	10.0	15.8	48.7	**Fair**

Qualitative habitat ratings

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

Table 48. Channel Condition and Stability Assessment (CCSI): Little Cottonwood River Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN041	Little Cottonwood River	37	36	26	5	104	Severely Unstable
1	13MN044	Little Cottonwood River	24	38	34	5	101	Severely Unstable
1	13MN048	Little Cottonwood River	13	19	17	5	54	Moderately Unstable
1	13MN089	Little Cottonwood River	16	15	21	5	57	Moderately Unstable
1	91MN056	Little Cottonwood River	4	4	4	1	13	Stable
1	13MN043	Altermatt Creek	15	13	17	1	46	Moderately Unstable
1	13MN046	County Ditch 28-1	13	7	21	1	42	Fairly Stable
1	13MN045	Altermatt Creek	19	18	19	3	59	Moderately Unstable
2	91MN057	Little Cottonwood River trib	21	10	22.5	2	55.5	Moderately Unstable
1	13MN049	County Ditch 11	13	11	6	1	31	Fairly Stable
1	10EM115	Unnamed ditch	24	10	10	7	51	Moderately Unstable
1	13MN050	Little Cottonwood River	23	27	9	7	66	Moderately Unstable
1	13MN052	Little Cottonwood River	23	23	20	3	69	Moderately Unstable
1	97MN009	Little Cottonwood River	10	15	9	3	37	Fairly Stable
Average Stream Stability Results: *Little Cottonwood R. Aggregated 12-HUC*			18.4	17.1	17.2	3.4	56.1	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27   = fairly stable: 27 < CCSI < 45   = moderately unstable: 45 < CCSI < 80   = severely unstable: 80 < CCSI < 115   = extremely unstable: CCSI > 115

Table 49. Outlet water chemistry results: Little Cottonwood River Aggregated 12-HUC.

Station location:	Little Cottonwood River, At Apple Road, 1.6 miles South of Cortland						
STORET/EQuIS ID:	S004-609						
Station #:	13MN052						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	31	0.4	21.6	6	40	0
Chloride	mg/L	16	17.9	28.9	23.4	230	0
Dissolved Oxygen (DO)	mg/L	96	6.5	12.1	9.2	5	0
pH		106	6.8	8.7	8	6.5 - 9	0
Secchi Tube	100 cm	248	1	100	35.4	10	35
Total suspended solids	mg/L	127	2	1520	110.5	65	75
Phosphorus	ug/L	115	22	1230	193	150	50
Escherichia coli (geometric mean)	MPN/100 ml	6	375.5	1835.2	-	126	6
Escherichia coli	MPN/100 ml	84	10	20000	869.8	1260	14
Inorganic nitrogen (nitrate and nitrite)*	mg/L	125	0.1	20.4	7.7	-	-
Kjeldahl nitrogen	mg/L	62	0.4	5.3	1.6	-	-
Orthophosphate*	ug/L	111	0.005	0.416	0.09	-	-
Specific Conductance	uS/cm	114	408	910	726.8	-	-
Temperature, water	deg °C	125	6.4	29.9	20.2	-	-
Sulfate*	mg/L	16	66.6	167	124.5	-	-
Hardness	mg/L	17	191	470	371.9	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Little Cottonwood River Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

For the Little Cottonwood River (0702000707-01) aggregated 12-HUC, nine AUID's, utilizing data from 16 biological monitoring stations, were assessed for Aquatic Life (AQL) (Table 46, Figure 31). Results of these assessments indicated 4 AUID's were fully supporting of AQL, while 4 AUID's were impaired for AQL use. One reach on Altermatts Creek (07020007-518) is a reach classified as a Limited Resource Value Water (LRVW) and was not assessed for Aquatic Life.

The headwater reach on Altermatts Creek (-681) is predominantly channelized, with poor habitat attributes, and a moderately unstable channel. Consequentially, this reach was determined as a Modified Use (MU) class. Fish were sampled in early June of 2013, and it was determined that the sample had been affected by fall drought conditions, and a late spring, so data from that visit was not used for assessment. The Macroinvertebrate community did meet AQL standards for Modified Use, so the reach is considered supporting of AQL. The following reach on Altermatts Creek is a Class 7, LRVW, which was not assessed using biological community data. A tributary to this portion of the reach is County Ditch 28-1 (-656). Like the headwater reach on Altermatts Creek, this reach was determined to fall under the MU category due to poor habitat conditions and an altered stream channel. According to CCSI score for the site (13MN046), the channel exhibits signs of being fairly stable. Despite the channelized condition and poor aquatic habitat, both the macroinvertebrate and fish communities met standards for Aquatic Life, Modified Use, resulting in a fully supporting of AQL determination.

Unnamed Creek (-548) was also determined to be full supporting of AQL. The reach was classified as MU due to its channelized nature and poor habitat. Channel condition was rated as moderately unstable from the CCSI score for the reach. The macroinvertebrate and fish assemblages both met AQL criteria for the Modified Use class.

County Ditch 11 (-657), designated as Modified Use, showed a fish community that met AQL criteria and a macroinvertebrate community that did not meet AQL criteria, subsequently this reach will be listed for AQL M-IBI. This reach can be characterized by extensive channelization, poor habitat conditions, and a fairly stable channel. Just downstream of this AUID, lies Unnamed Creek (County Ditch 11) (-646). Similar to the upstream reach, this reach was designated Modified Use due to the channelized condition, and had shown a habitat limitation. Habitat scored slightly better with a fair rating based on MSHA. Unlike the upstream reach, channel condition was rated moderately unstable based on CCSI. Both biological communities met AQL Modified Use criteria, indicating full support for AQL.

Unlike the other tributaries to the Little Cottonwood River that were predominantly channelized, the monitored reach on County Ditch 67 (-658) consists of a mostly natural channel, and showed fair habitat according to MSHA results. This reach is located closer to the Little Cottonwood Rivers confluence with the Minnesota River, and is likely demonstrating the higher gradient, natural channel characteristics that is commonly found as streams near the Minnesota River Valley. This AUID was designated General use based on the natural channel and improved habitat. Despite more favorable stream characteristics for biological communities, both biological communities, macroinvertebrates and fish, failed to meet AQL criteria for General Use, and will subsequently be listed as impaired for AQL for both communities.

The Little Cottonwood River is the largest tributary to the Minnesota River within the Minnesota River – Mankato major watershed. Originally the AUID (-515) representing the Little Cottonwood River consisted of the entire 83-mile length of this stream. Prior to assessments, AUID's were classified for Tiered Aquatic Life Uses (TALU) by Use Attainability Analysis (UAA). Upon review, it was determined that although the majority of the prior AUID was similar, there were geographic and biological differences between the upper portion and lower portion of the Little Cottonwood River. Based on these differences, as well as the unsuitable nature long AUID's present for assessment purposes, the original AUID was split into a 63.27-mile upper reach (-676) which consists of lower gradient, poorer biological communities, and a 19.88 mile lower reach (-677) that exhibited higher gradient and an improved fish community. Both reaches qualify for the General Use (GU) class. The headwater reach of the Little Cottonwood River (-676) utilized biological data from five monitoring stations along its length. Throughout this reach, the macroinvertebrate and fish communities failed to meet AQL criteria for General Use, resulting in a listing for both communities. Much of this reach consists of a natural channel, although some channelized portions exist. Habitat ranged from poor to good, with the majority of the monitoring sites exhibiting fair habitat ratings based on MSHA results. Channel stability for this reach ranged from stable to severely unstable according to CCSI results. One monitoring location (91MN056) exhibited stable conditions, which was located the furthest upstream of all the monitoring locations. Stability at this location may benefit from an outcropping of Sioux Quartzite bedrock at this location, which serves as a durable substrate for the stream channel. Unlike the stability at the uppermost site, the next two monitoring stations downstream exhibit severe channel instability. The lowest two monitoring locations on this reach were rated as moderately unstable. The lower reach of the Little Cottonwood River (-677) demonstrates many of the qualities of streams as they enter higher gradient, wooded ravines near the Minnesota River valley. Habitat ranges from fair to good as seen in the MSHA results from the four biological monitoring stations representing the reach. Channel stability ratings ranged from moderately unstable to fairly stable for the monitoring locations. The second monitoring site (97MN009) upstream from the confluence with the Minnesota River represented the best conditions of the reach with a good habitat rating, and a fairly stable channel rating. With the slightly improved conditions on this lower reach, the fish assemblage met AQL criteria for General Use, while the macroinvertebrate assemblage failed to meet the criteria, further supporting the existing AQL impairment on this reach.

Stream water chemistry

Assessable water chemistry data was available on reaches of Little Cottonwood River and smaller tributaries within this subwatershed. The original 83-mile Little Cottonwood River reach (-515) was split during this cycle into two smaller reaches (-676 & -677), extremely long reaches are typically not ideal for assessment purposes. The headwaters of the Little Cottonwood River (-676) is one of the child reaches resulting from a split of now retired parent reach -515. The parent reach -515 was initially listed impaired for turbidity and fecal coliform bacteria based on four stations across the entire parent reach, three of these stations fall on this new child reach -676. Reviewing the old turbidity listing data collected at these three stations between 1997 and 2002, 34 violations occurred across 142 samples when compared to the new TSS standard of 65 mg/L, confirming that the initial turbidity listing should carry forward to this child reach. A similar statement can be for the bacteria data, three stations which fall on this new child reach (-676) still have two individual and one monthly geometric mean violations, therefore the bacteria listing from retired parent -515 should carry forward to this new child -676. The downstream reach of Little Cottonwood River (-677) is the second child reach resulting in a split of parent -515, which had existing impairments for turbidity and fecal coliform. One of the original four listing stations (S004-609) is located on this child reach (-677) near the outlet, recalculating assessment strings for both parameters indicates that total suspended solids and bacteria data from S004-609 alone would have triggered impairments during the initial listing cycle, therefore previous listings for both should carry forward to -677. Other water chemistry parameters would all meet their respective standards with the exception of TP data, which violations the river nutrient standard, however, response data is not available to determine if the reach is experiencing eutrophication as a result.

Altermatts Creek (-518) is a designated Class 7 limited resource value water. Bacteria data from 2009 and 2010, indicates two individual and one monthly geometric mean violations, indicating elevated concentrations of bacteria across different months and years which will result in a new listing.

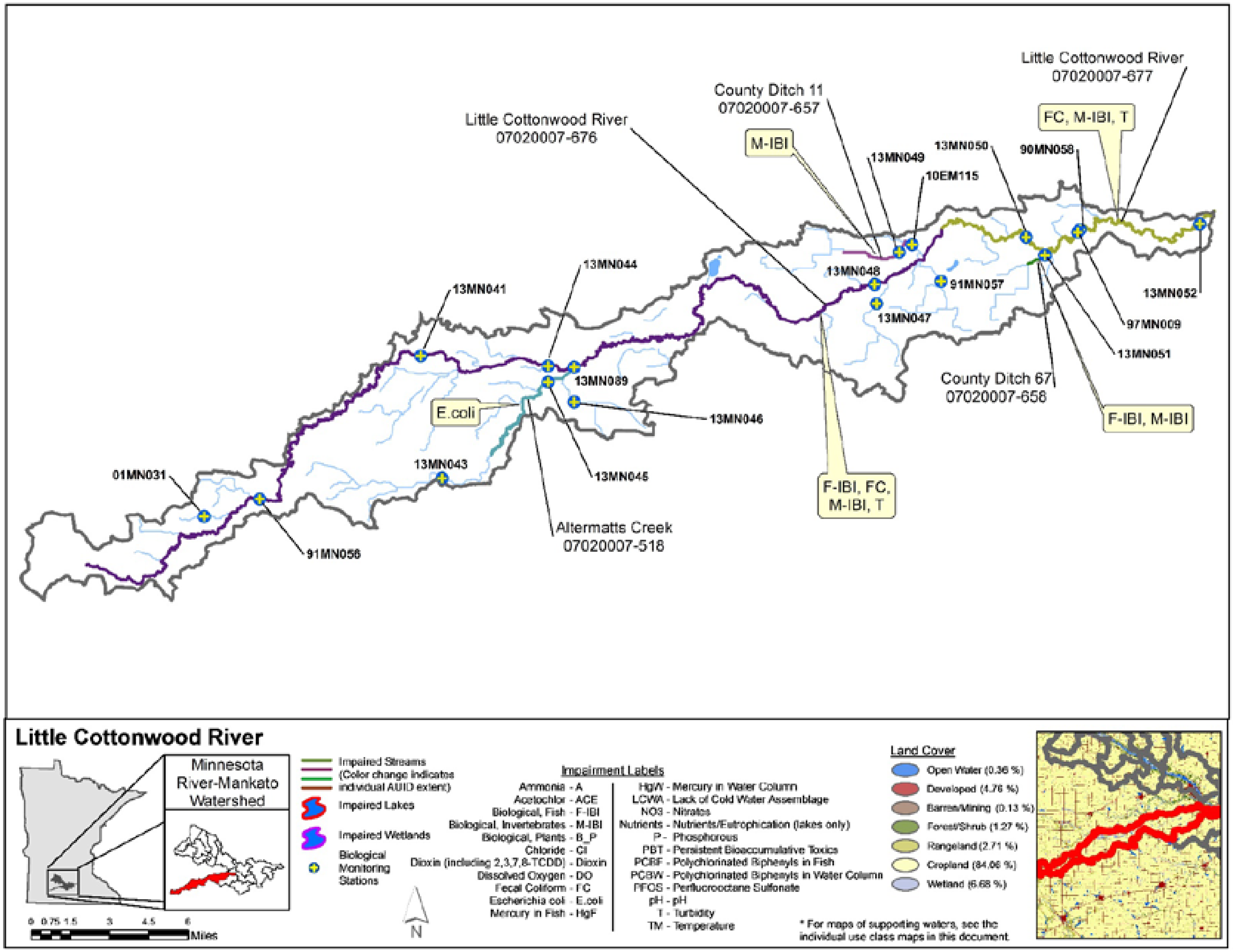


Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Little Cottonwood River Aggregated 12-HUC.

Morgan Creek Aggregated 12-HUC HUC 0702000710-02

The Morgan Creek (0702000710-02) aggregated 12-HUC is located in the central region of the major watershed, on the south side of the Minnesota River (Figure 32). This subwatershed drains 59 square miles (37,790 acres), with the largest proportion within Brown County, and the rest of the watershed within Blue Earth County. The primary water course Morgan Creek/Judicial Ditch 10, and the watersheds largest tributary, County Ditch 63, flow north and east to the subwatersheds confluence with the Minnesota River. All of the streams within the watershed are warmwater. The pour point biological monitoring site that represents the watershed is 13MN055. Altered stream channels are common within the watershed, representing 73% of the stream reaches. Natural stream channels account for 15% of the reaches, while 12% of the stream reaches are considered No Definable Channel. Channelization is most common in the headwaters, while natural channels are found nearer the confluence and the Minnesota River valley. Only two lakes are present in the watershed, the largest being Omsrud at 298 acres, and the 29 acre Ouren in Hanska.

The only town present in the Morgan Creek subwatershed is Hanska. This rural subwatershed consists of 89% cropland, and about 5% developed. Forest accounts for about 2% of the watershed area while, rangeland a mere 1%. About 2% of the watershed consists of wetland.

Table 50. Aquatic life and recreation assessments on stream reaches: Morgan Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-701 **Judicial Ditch 10** *Unnamed cr to T108 R30W S2, east line*	13MN053	6.73	WWm	MTS	EXS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-691 **Morgan Creek** *T109 R29W S30, south line to Minnesota R*	13MN055	6.96	WWg	EXS	EXS	IF	MTS	MTS	IF	MTS	IF	-	MTS	-	IMP	IMP

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

Table 51. Minnesota Stream Habitat Assessment (MSHA): Morgan Creek Aggregated 12-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
2	13MN053	Judicial Ditch 10	0	8.5	9.5	9	5.5	32.5	Poor
2	13MN054	County Ditch 63	0	7.5	9.5	7.5	7	31.5	Poor
1	13MN055	Morgan Creek	0	2	14.6	12	19	47.6	Fair
Average Habitat Results: Morgan Creek *Aggregated 12-HUC*			0	6.8	10.5	9	8.8	35.1	**Poor**

Qualitative habitat ratings

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

Table 52. Channel Condition and Stability Assessment (CCSI): Morgan Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN053	Judicial Ditch 10	24	7	30	7	68	Moderately Unstable
1	13MN054	County Ditch 63	23	7	26	11	67	Moderately Unstable
1	13MN055	Morgan Creek	24	17	8	5	54	Moderately Unstable
Average Stream Stability Results: *Morgan Cr. Aggregated 12-HUC*			23.7	10.3	21.3	7.7	63	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 53. Outlet water chemistry results: Morgan Creek Aggregated 12-HUC.

Station location:	Morgan Creek, At County Road 47, 0.5 miles South of Cambria						
STORET/EQuIS ID:	S007-339						
Station #:	13MN055						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	13	2	10	4.6	40	0
Chloride	mg/L	11	27.7	53.7	34.7	230	0
Dissolved Oxygen (DO)	mg/L	20	7.6	13.9	9.9	5	0
pH		20	7.3	9	8.3	6.5 - 9	0
Secchi Tube	100 cm	20	10	100	76.3	10	0
Total Suspended Solids	mg/L	11	2.4	290	30.9	65	3
Phosphorus	ug/L	12	17	368	79.25	150	1
Escherichia coli (geometric mean)	MPN/100ml	3	331	1002	-	126	3
Escherichia coli	MPN/100ml	16	120	4400	591.9	1260	1
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	12	0.3	29	9.4	-	-
Kjeldahl Nitrogen	mg/L	12	0.3	1.6	0.8	-	-
Specific Conductance	uS/cm	20	373	894	744.3	-	-
Water Temperature	deg °C	20	12.6	24.4	19.1	-	-
Sulfate*	mg/L	11	55.5	117	89.6	-	-
Hardness	mg/L	12	350	440	385.8	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.
***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Morgan Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Stream biology

Two AUID's were assessed for Aquatic Life (AQL) use, resulting in two impairments, within the Morgan Creek (0702000710-02) aggregated 12-HUC (Table 50, Figure 32). Data used for the assessment consisted of a monitoring station on each reach. The upstream most reach, Judicial Ditch 10 (07020007-701) consists of a predominantly channelized reach with limited habitat, with a poor rating from MSHA, which was subsequently determined to be Modified Use. Despite the slightly lower threshold associated with the Modified Use (MU) class, the macroinvertebrate assemblages exceeded AQL criteria, prompting a listing. The fish assemblage scored better by meeting the AQL criteria for MU, but still consisted of all tolerant fish species. Downstream of Judicial Ditch 10, Wabasha Creek (-691) consists of a more natural channel, and slightly better habitat with a Fair MSHA rating. Consequentially, this reach was designated for General Use (GU). Despite the slightly improved habitat and channel conditions, both the macroinvertebrate and fish assemblages did not meet higher AQL standards for GU. This reach will be listed for AQL, both M-IBI and F-IBI. The fish community at the monitoring site 13MN055, representing the AUID (-691), consisted of only 2 sensitive fish species, 13 tolerant species, and 6 specie considered very tolerant. Tolerant and very tolerant individuals made up 75% of fish collected. Multiple stressors within the watershed are likely affecting the biological communities within the watershed.

Stream water chemistry

Assessable water chemistry data existed on Morgan Creek collected between 2009 and 2014, at S004-281 and S007-339 near the downstream end of this reach. DO, toxics, and pH datasets had no exceedances of the respective standard. TSS and secchi tube had a couple violations resulting in an exceedance rate well below 10%, the exceedances were tied to higher flow events. Bacteria data revealed persistently elevated concentrations of *E. coli* across different months and years in the dataset, with three of three monthly geometric mean violations triggering an aquatic recreation use listing. High bacteria levels are often linked to concentrated animal activity within the waterway and adjacent floodplain.

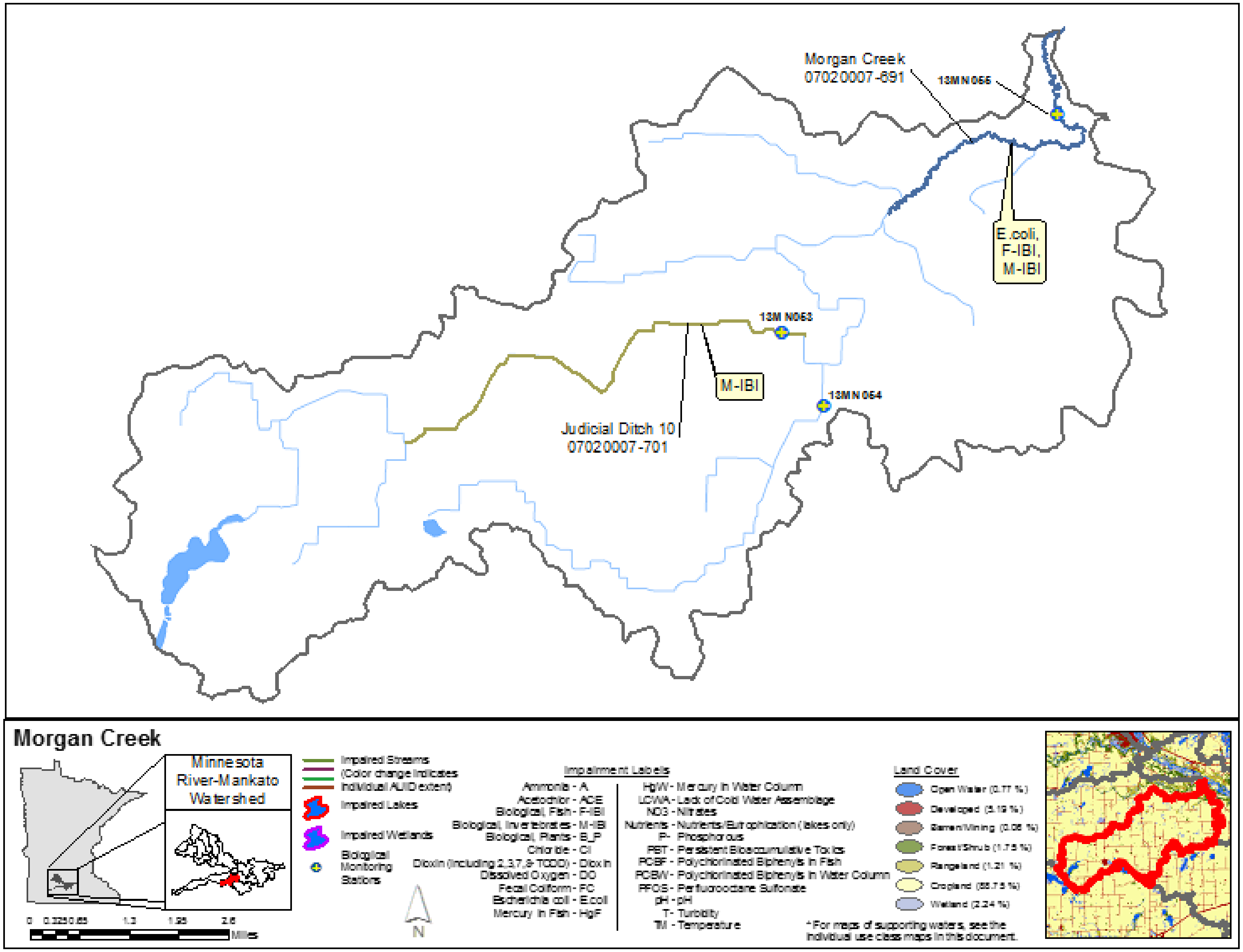


Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Morgan Creek Aggregated 12-HUC.

Minneopa Creek Aggregated 12-HUC HUC 0702000709-01

The Minneopa Creek (0702000709-01) aggregated 12-HUC is located on the south side of the Minnesota River in the eastern portion of the major watershed (Figure 33). This subwatershed drains 85 square miles (54,564 acres), and is mostly within Blue Earth County. A small portion on the western part of the watershed lies in Brown County, and a very small portion is a part of Watonwan County. The Minneopa Creek subwatershed primarily consists of Minneopa Creek and its tributaries. The main tributaries to Minneopa Creek are County Ditch 56 (Lake Crystal Inlet), County Ditch 27, and Judicial Ditch 48. The watershed confluence with the Minnesota River is near Mankato. The pour point biological monitoring site 13MN066, which was sampled for water chemistry, represents the subwatershed. All of the streams within this subwatershed are considered warmwater. Numerous lakes can be found within the watershed. The largest of these is Loon Lake, comprising 808 acres, near the town of Lake Crystal. Other lakes near the town of Lake Crystal, include Lake Crystal (379 acres), and Lily Lake (134 acres). Other lakes in the watershed include Strom (124), Mills (237), Lieberg (73), and Armstrong (114). Channelization is extensive in the watershed, accounting for 66% of the streams. Natural stream channels account for 20% of the streams, and primarily consists of Minneopa Creek from Lake Crystal downstream to the confluence. No definable channel makes up 14% of the streams. The highest (~52 feet) natural waterfall in the Minnesota River – Mankato watershed occurs where Minneopa Creek is undercutting a layer of Jordan Sandstone in Minneopa State Park (Lore 2015).

Developed areas within the Minneopa Creek subwatershed account for 7% of the land area, with Lake Crystal being the only town found in the watershed. Eighty-four of the land area is used as cropland. Forest comprises 1% of the land area, while rangeland is found on less than 1% of the land within the watershed. With the presence of lakes, open water accounts for 4% of the watershed area, and wetland accounts for 3%. The watershed has increased water storage potential with the presence of the numerous lakes within the watershed.

Table 54. Aquatic life and recreation assessments on stream reaches: Minneopa Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07020007-531 **Minneopa Creek** *Headwaters to Lily Lk*	13MN060, 13MN061	7.19	WWm	EXS	MTS	IF	IF	MTS	-	IF	IF	-	IF	-	IMP	-
07020007-593 **Judicial Ditch 48** *Unnamed ditch to Minneopa Cr*	13MN059	3.32	WWm	EXP	MTS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-535 **County Ditch 27** *Headwaters to Lily Lk*	13MN062	4.75	WWm	EXS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	IMP	-
07020007-557 **County Ditch 56 (Lake Crystal Inlet)** *Headwaters to Lk Crystal*	13MN063	8.29	WWm	EXS	MTS	IF	MTS	MTS	-	IF	IF	-	EXS	-	IMP	IMP
07020007-534 **Minneopa Creek** *T108 R28W S23, south line to Minnesota R*	13MN065, 13MN066	7.48	WWg	EXS	EXS	MTS	EXS	MTS	MTS	EXS	MTS	-	IF	-	IMP	IMP

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

Table 55. Minnesota Stream Habitat Assessment (MSHA): Minneopa Creek Aggregated 12-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	13MN060	Minneopa Creek	0	8	3	9	7	27	Poor
1	13MN061	Minneopa Creek	0	8	8	1	4	21	Poor
1	13MN059	Judicial Ditch 48	0	8.5	4	1	4	17.5	Poor
2	13MN062	County Ditch 27	0	7	6	9.5	5.5	28	Poor
1	13MN063	County Ditch 56 (Lake Crystal	0	5.5	10.9	11	15	42.4	Poor
1	13MN064	Minneopa Creek	1	11.5	16.4	12	27	67.9	Good
1	13MN065	Minneopa Creek	0	8	20.15	14	24	66.15	Good
1	13MN066	Minneopa Creek	5	13.5	17.7	12	23	71.2	Good
Average Habitat Results: Minneopa Creek *Aggregated 12-HUC*			0.7	8.6	10.2	8.8	12.8	41.0	**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 56. Channel Condition and Stability Assessment (CCSI): Minneopa Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN060	Minneopa Creek	23	11	32	7	73	Moderately Unstable
1	13MN061	Minneopa Creek	24	11	30	7	72	Moderately Unstable
1	13MN062	County Ditch 27	28	9	32	7	76	Moderately Unstable
1	13MN063	County Ditch 56	21	12	26	11	70	Moderately Unstable
1	13MN065	Minneopa Creek	18	17	8	3	46	Moderately Unstable
1	13MN066	Minneopa Creek	13	21	5	3	42	Fairly Stable
Average Stream Stability Results: *Minneopa Cr. Aggregated 12-HUC*			21.2	13.5	22.2	6.3	63.2	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 57. Outlet water chemistry results: Minneopa Creek Aggregated 12-HUC.

Station location:	Minneopa Creek, At State Park Road 7, in Minneopa State Park, 4 miles West of Mankato						
STORET/EQuIS ID:	S001-985						
Station #:	13MN066						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Unionized Ammonia*	ug/L	14	0.6	27.3	10.4	40	0
Chloride	mg/L	11	21.2	105	51.6	230	0
Dissolved Oxygen (DO)	mg/L	19	4.6	14.8	8.8	5	1
pH		19	7.4	9.2	8.3	6.5 - 9	4
Secchi Tube	100 cm	333	1	100	37.1	10	14
Total Suspended Solids	mg/L	11	6.8	520	77.4	65	5
Phosphorus	ug/L	12	28	300	137.6	150	5
Chlorophyll-a, Corrected	ug/L	1	682	682	682	35	1-
Escherichia coli (geometric mean)	MPN/100ml	3	921	1740	-	126	3
Escherichia coli	MPN/100ml	15	110	7700	1309	1260	4
Inorganic Nitrogen (Nitrate and Nitrite)*	mg/L	12	0.2	14	3.2	-	-
Kjeldahl Nitrogen	mg/L	12	0.4	4.5	2.5	-	-
Specific Conductance	uS/cm	19	369	753	559.3	-	-
Water Temperature	deg °C	19	13.2	25.9	20.2	-	-
Sulfate*	mg/L	11	20.1	52.8	34.8	-	-
Hardness	mg/L	12	195	340	244.6	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 65 mg/L.

***Minimum, Maximum, and Mean values for this parameter may have been calculated using non detect values, non-detect limits vary between parameters**

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Minneopa Creek Aggregated 12-HUC, a component of the IWM work conducted between May and September from 2004 through 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 58. Lake assessments: Minneopa Creek Aggregated 12-HUC.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Loon	07-0096-00	782	H	100	2.2	1.2	-	144.8	77	0.3	NS	IF
Mills	07-0097-00	231	H	100	2.2	1.5	-	213	97	0.3	NS	IF
Crystal	07-0098-00	368	H	100	10.5	2.1	NT	251.6	87.1	0.3	NS	NS
Lieberg	07-0124-00	73	E	-	-	-	-	82	71	0.4	IF	IF

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

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

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use

Summary

Stream biology

Aquatic Life was assessed for five AUID's, using data from seven biological monitoring stations, within the Minneopa Creek (0702000709-01) aggregated 12-HUC (Table 54, Figure 33). Of these assessed AUID's, none met the Aquatic Life Standards (AQL), resulting in impairments for each of the AUID's. Judicial Ditch 48 (07020007-593) consisted of a channelized reach and poor habitat, as based on MSHA scores, which prompted a Modified Use class for this reach. With the lower thresholds of this use class, the macroinvertebrate community met AQL standards despite the poor habitat conditions. The fish community for this reach failed to meet AQL standards, resulting in an impairment listing for AQL F-IBI. The headwaters of Minneopa Creek (-531), which was also determined as a Modified Use (MU) class, will also be listed for AQL F-IBI as the result of the macroinvertebrate community meeting standards, while the fish community failed to meet standards. Like other reaches in this area of the watershed, channelization is prevalent, habitat conditions are poor, and the stream channels are considered moderately unstable based on CCSI scores from the monitoring locations. Another stream reach exhibiting these trends is County Ditch 27 (-535). This reach was also classified as MU, and consists of a channelized stream channel, poor habitat, and moderately unstable channel. Likewise, the macroinvertebrate met AQL standards, while the fish assemblage failed to meet AQL standards resulting in an impairment based on the fish community. County Ditch 56 (Lake Crystal Inlet) (-557), like the other reaches in the upper portion of Minneopa Creek subwatershed was designated MU based on poor habitat and an altered stream channel. Similar to the other reaches, the AUID will be listed for AQL F-IBI since the macroinvertebrate community met AQL criteria and the fish community failed to meet AQL criteria for the MU class. Another factor that may influence the fish community could be the presence of excess nutrients. From the data collected on this reach, phosphorus showed an exceedance of the standard, but lacked the presence of a response indicator, which doesn't allow this parameter to be listed as impaired. Likely, more data could document a response. County Ditch 56 is likely a significant contributor of excess nutrients to Lake Crystal, which is well known to have nutrient issues. The downstream most reach on Minneopa Creek (-534) is designated warmwater, General Use (GU). This reach primarily consists of a natural channel, with good habitat characteristics, as based on MSHA scores. The channel is also considered fairly stable according to CCSI scores. For the biological communities, both macroinvertebrates and fish failed to meet GU Aquatic Life criteria. pH also exceeds AQL standards. The current TSS, ph, F-IBI, and M-IBI exceedances build upon the original turbidity impairment, further supporting the existing listing as impaired for AQL. One factor impacting the streams in the upper portions of this subwatershed is the presence of Minneopa Falls in Minneopa State park. At ~52 feet, the falls is a barrier to fish movement at all water levels and inhibits any fish re colonization from the Minnesota River. Sufficient refuge exists for fish recolonization with the presence of significant lakes, but the water quality issues facing the lakes favor more tolerant species. Fish communities upstream of the barrier falls were dominated by tolerant and very tolerant species, most were also associated with lacustrine environments.

Stream water chemistry

Assessable water chemistry data exists on reaches of Minneopa Creek and County Ditch 56 (Lake Crystal Inlet). County Ditch 56 (-557) had large datasets for total phosphorus, bacteria, total suspended solids and Secchi tube. TSS and STUBE data indicated minor exceedances rates approaching the standard, with some extremely elevated sediment load periods in June and July 2008, that do not appear to be tied to high flow events after reviewing hydrograph and precipitation records. TP concentrations are grossly exceeding river nutrient standard response data is not available to determine if eutrophication is occurring as a result. It should be noted that downstream Lake Crystal is severely exceeding all lake nutrient standards and is currently listed impaired for aquatic recreation use. Bacteria data collected between 2007 and 2009 reveals a clear pattern of consistently high concentrations, with five individual and four of six monthly geometric mean violations, resulting in an existing recreational use impairment that was listed in 2010. No new bacteria data has been collect since, therefore the existing impairment will remain.

The headwater Minneopa Creek (-531) reach had extensive Secchi tube data from nine years of monitoring, with five violations in 168 samples, resulting in a minor exceedance rate on this reach upstream of Lake Crystal. Minneopa Creek (-534) downstream of Lake Crystal has an existing turbidity impairment listed in 2006, based on turbidity, transparency tube and TSS data collected prior to 2005. Newer TSS data collected in 2013, revealed five violations over thirteen samples, the majority of which cannot be link to high flow events, confirming the initial listing. DO and toxics data met their respective standards. The pH dataset did reveal four violations across 23 samples, further analysis of the raw data shows the exceedances are very borderline (9, 9.1, 9.3 SU), considering the severity a listing for pH will not be pursued. Although TP does meet river nutrient standards, Lake Crystal is having a significant impact on algae levels in Minneopa Creek, chlorophyll-a growth of this magnitude is not typical in riverine situations. Bacteria data was collected in 2013 and 2014, at S001-985 near the downstream outlet of Minneopa Creek, both individual (five) and monthly geometric mean (three of three) violate the standard, which will trigger an aquatic recreation use listing during the assessment cycle.

Lake water chemistry

Four lakes in the Minneopa Creek subwatershed had assessment data available. Loon Lake was previously listed impaired for aquatic recreation use in 2010, based on nutrient data collected between 2006 and 2009. Aquatic life data is limited to chloride, which reveals no violations of the standard but would need supporting biological community data to make a complete aquatic life use decision. Mills Lake has aquatic recreation use assessment data collected during 2008, 2009, and 2013, due to the characteristics of the basin it will be assessed as a shallow lake. TP, chlorophyll-a (Chl-a), and Secchi disk averages all grossly exceeded standards, indicating a persistent problem across different months and years, resulting in a new listing for aquatic recreation use. Lake Crystal was previously listed impaired in 2006 for aquatic recreation use based on nutrient data collected 2008 and 2009, data for all parameters during that time severely violations lake nutrient standards. Only secchi disk data has been collected since the initial listing, a pattern of violation still exists in recent years. Lake Crystal is notorious for dense, persistent summer algae blooms which can prevent recreational enjoyment on lakes in most cases; contributing factors to this situation are watershed land use practices, watershed to lake ratio, inputs from waterways entering the lake basin and internal loading from historical inputs. Biological data was available on Lake Crystal, tolerant species such as fathead minnow, common carp, bigmouth buffalo, black bullhead and green sunfish dominated the near shore community. Black bullhead, common carp, and stocked walleye made up the off shore samples. Due to the dominance of tolerant species throughout the lake, the resulting fish IBI score was ten, well below the threshold of thirty-six, Lake Crystal is considered impaired for aquatic life use. Lieberg Lake had only a single water quality data point for all three assessment parameters and will not be assessed at this time.

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Minneopa Creek Aggregated 12-HUC.

Shanaska Creek Aggregated 12-HUC HUC 0702000711-02

The Shanaska Creek (0702000711-02) aggregated 12-HUC subwatershed drains 42 square miles on the east side of the Minnesota River on the eastern margin of the major watershed (Figure 34). This watershed is the smallest of the subwatershed within the Minnesota River – Mankato watershed. This subwatershed falls entirely within Le Sueur and Blue Earth Counties. The primary watercourse, Shanaska Creek and its tributaries are a direct tributary to the Minnesota River. The main tributaries to Shanaska Creek include Dog Creek and several unnamed streams. The primary direction of the flow for this system is west to the Minnesota River, and the subwatershed is represented by the pour point water chemistry site 13MN079. All of the streams within the subwatershed are considered warmwater. Channelization is less prevalent in the watershed with 35% of the stream reaches altered, while 24% of the stream reaches are natural channels. No definable channel accounts for 39% of the reaches, which consists of the lakes in the watershed. Impounded reaches comprise 2% of the stream reaches. Of the subwatershed within the Minnesota River Mankato major watershed, the Shanaska Creek sub watershed is especially rich with lakes. Numerous lakes dot the watershed. The largest is Lake Washington, covering 1478 acres. Other lakes include: Gilfillin (220), George (87), Dog (195), Mud (59), Duck (279), Ballantyne (354), Henry (351) Emily (263), as well as another Emily Lake (112). An approximately 5-foot dam on Shanaska Creek is present within the town of Kasota (Lore 2015).

The portion of the town of Kasota lies within the Shanaska Creek subwatershed. Development can be found on 5% of the watershed area while 59% of watershed area is used as cropland. Forested areas cover 7% of the land, and rangeland covers 12% of the watershed area. With the numerous lakes, 13% of the watershed is open water, along with 3% of the area is classified as wetland. The Shanaska Creek watershed differs from other subwatersheds in the Minnesota River –Mankato watershed by having the lowest percentage of cropland, the highest percentage of lands classified as rangeland, and especially the highest percentage of watershed area covered by open water. This subwatershed has perhaps the greatest capacity to store water within the watershed.

Table 59. Aquatic life and recreation assessments on stream reaches: Shanaska Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	**Eutrophication** Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07020007-902 **Unnamed creek (Duck Lake Inlet)** *to Duck Lk*		0.42	WWg	-	-	-	-	EXS	-	-	-	-	-	-	NA	-
07020007-607 **Unnamed creek** *Mud Lk (07-0049-00) to Lk Washington*	91MN060	2.57	WWg	-	-	IF	IF	MTS	-	IF	IF	-	EXS	-	IF	-
07020007-610 **Unnamed creek** *Headwaters to Lk Washington*		1.05	WWg	-	-	-	-	MTS	-	-	-	-	EXS	-	IF	-
07020007-609 **Unnamed creek** *Unnamed lk (40-0097-00) to Lk Washington*		0.43	WWg	-	-	-	-	MTS	-	-	-	-	EXS	-	IF	-
07020007-692 **Shanaska Creek** *Dog Cr to Shanaska Cr Rd*	13MN077	0.15	WWm	MTS	MTS	IF	IF	IF	-	IF	IF	-	IF	-	SUP	-
07020007-693 **Shanaska Creek** *Shanaska Cr Rd to Minnesota R*	13MN079	5.64	WWg	EXS	EXS	IF	MTS	MTS	-	IF	IF	-	IF	-	IMP	IMP

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

Table 60. Minnesota Stream Habitat Assessment (MSHA): Shanaska Creek Aggregated 12-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	13MN077	Shanaska Creek	0	8	16	12	7	43	Poor
1	13MN079	Shanaska Creek	0.5	12.5	25.5	14	30	82.5	Good
Average Habitat Results: Shanaska Creek *Aggregated 12-HUC*			0.3	10.3	20.8	13	18.5	62.8	**Fair**

Qualitative habitat ratings

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

Table 61. Channel Condition and Stability Assessment (CCSI): Shanaska Creek Aggregated 12-HUC.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	13MN077	Shanaska Creek	18	11	24	7	60	Moderately Unstable
1	13MN079	Shanaska Creek	21	14	13	5	53	Moderately Unstable
Average Stream Stability Results: *Shanaska Cr. Aggregated 12-HUC*			19.5	12.5	18.5	6	56.5	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 62. Lake assessments: Shanaska Creek Aggregated 12-HUC.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Gilfillin	07-0045-00	220	H	100	1	-	-	442.3	20.3	0.4	IF	NA
George	07-0047-00	87	E	75.9	8.5	2.7	-	69.5	57.2	0.9	NS	IF
Duck	07-0053-00	279	E	-	7.6	-	D	80.9	52.6	0.8	NS	FS
Ballantyne	07-0054-00	354	E	86.3	17.7	2.1	NT	30.6	24.6	0.9	FS	FS
Unnamed	40-0098-00	4	H	-	-	-	-	123	55.4	0.3	IF	IF
Henry	40-0104-00	351	H	100	1.8	-	-	400.9	154.5	0.9	NS	IF
Washington	40-0117-00	1478	E	74.2	14.9	3.4	I	67.1	51.7	1.5	NS	NS
Emily	40-0124-00	263	E	70	11.2	3	NT	24.8	24.3	0.9	FS	IF

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

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use

Summary

Stream biology

Two AUID's were assessed for Aquatic Life based on data from two monitoring stations within the Shanaska Creek (0702000711-02) aggregated 12-HUC (Table 59, Figure 34). Assessment of these two AUID's resulted in one AUID fully supporting AQL, while the other one failed to meet AQL standards. Three other AUID's within the subwatershed were determined to lack sufficient data for Aquatic Life (AQL) assessments, while data from another AUID was determined to be not assessable. Monitoring data for Shanaska Creek (07020007-692) indicated both the macroinvertebrate and fish communities met AQL standards for the Modified Use class, resulting in a reach fully supporting of AQL. Despite the biological communities meeting standards, habitat was shown to poor based on the MSHA score, and the channel showed signs of moderate instability according to the CCSI scores. Closer to the Minnesota River, Shanaska Creek showed improved habitat conditions with a good MSHA rating, a predominantly natural channel, but still was considered moderately unstable for channel condition. Based on the natural channel and good habitat, this reach was classified for a General Use class. Despite the more favorable conditions, both the macroinvertebrate and fish communities failed to meet the higher AQL standards for General Use, resulting in impairments for both communities on this reach. On factor likely affecting the fish community is the existence of a dam downstream of the monitoring site that inhibits fish migration from the Minnesota River. Sufficient refuge exists with several upstream lakes, but the fish community on Shanaska Creek is dominated by tolerant fish more closely associated with lake environments.

Stream water chemistry

Water chemistry data was available on Shanaska Creek (-693) and Unnamed Creek (-607) to Lake Washington. The downstream reach of Shanaska Creek (-693) had limited data available from 2009 and 2010, collected at S005-670, near the outlet of this reach to the Minnesota River. Bacteria data reveals three individual and two monthly geometric mean violations in the dataset, with some high values at the lab reporting limit of 2419 MPN/ 100 mL. The geometric mean calculations show a persistent problem of high concentrations across two years, which will trigger an aquatic recreation use listing. TSS and Secchi tube data indicate a trend of light sediment loading, with only two violations from June 2010, a known time of high precipitation and flows. TP exceeds the river nutrient standard of 100 ug/L, supporting chlorophyll-a data would be needed to make a complete assessment based on river nutrient data. Unnamed Creek (-607) to Lake Washington had limited data available from S006-975 just upstream of Lake Washington. Secchi tube data collected between 2012 and 2013, showed few violations, resulting in a very low exceedance rate. TP was limited to seven samples the average grossly violates the river nutrient standard; response data would be necessary to determine if algae is growing as a result.

Lake water chemistry

Six lakes within this subwatershed had enough data within the 10-year window to make a complete aquatic recreation or aquatic life use assessment during this cycle. The majority of these lakes are located nearby the North Central Hardwood and Western Corn Belt Plains (WCBP) ecoregion boundaries, therefore to assess against the appropriate standards individual watershed land use reviews were completed. Land use reviews for all lakes revealed agriculture dominates the contributing watersheds, indicating that assessment would be best completed using the less restrictive WCBP ecoregion standards.

Emily Lake was assessed against the deep lake standard using data from 2013 and 2014, TP concentrations over that time were consistently low and Secchi average meets standard. Chlorophyll-a(chl-a) concentrations fluctuate widely both years not clearly matching the TP and Secchi signal. A few high values in the dataset pushed up the average in violation of standard when otherwise multiple samples met the 22 ug/L standard. Based on the meeting TP and Secchi datasets, Emily will be considered fully supporting aquatic recreation use, noting that it is vulnerable to additional nutrients and could benefit from watershed restoration and protection strategies to prevent a future impairment. Duck and Washington were previously listed impaired for aquatic recreation use in 2008, newer data confirms conditions are still not meeting standards. Duck and Washington both had biological indicator data available for aquatic life use assessment. Washington had a fish community survey in 2013, with a biological index score not meeting the threshold. Two tolerant species (common carp and black bullhead) were present but not completely dominating the community, only one intolerant taxa was observed, which potentially indicates subpar habitat to support stronger biological diversity, resulting in a new listing for aquatic life use based on the biological indicators. Duck was surveyed in 2013, just meeting biological index threshold, eight insectivore taxa were observed potentially indicating fair water quality and complex habitat available for aquatic communities to thrive, three tolerant taxa were observed in relatively low abundance. Based on the relatively strong diversity of biological communities in Duck, it will be listed as full support for aquatic life use. Henry Lake was assessed using the shallow lake criteria based on data from 2013 and 2014, TP and chl-a severely violated standard indicating a strong signal of impairment and will result in being listed not supporting for aquatic recreation use. George Lake was assessed using deep water criteria based on three years of data, TP and chl-a datasets violated the standard, high concentrations across different months and years revealed a persistent pattern of poor recreation water quality, resulting in a new listing for aquatic recreation use. Ballantyne Lake was assessed for aquatic recreation using the deep lake criteria based on data from three years. The TP concentration over that time easily met the standard of 65 ug/L, however chl-a data is just over the standard and Secchi is at the standard. Considering TP and Secchi are both meeting standard, Ballantyne will be assessed as full support for aquatic recreation use and should be considered vulnerable to additional inputs of phosphorus. Two biological community surveys were conducted in 2014, meeting thresholds for both surveys. Relatively diverse fish communities were evident, although common carp seem to be dominating the biomass of the system. Considering the biological index data, Ballantyne is fully supporting aquatic life use. It is recommended that Lake Ballantyne be a high priority for development of local protection strategies to prevent degradation into an impaired state in the future. Land use throughout this subwatershed as a whole is continuing to change rapidly from the pressure of urban sprawl and agricultural production, finding a healthy balance using responsible land and water management practices will be vital to curbing future degradation of water quality.

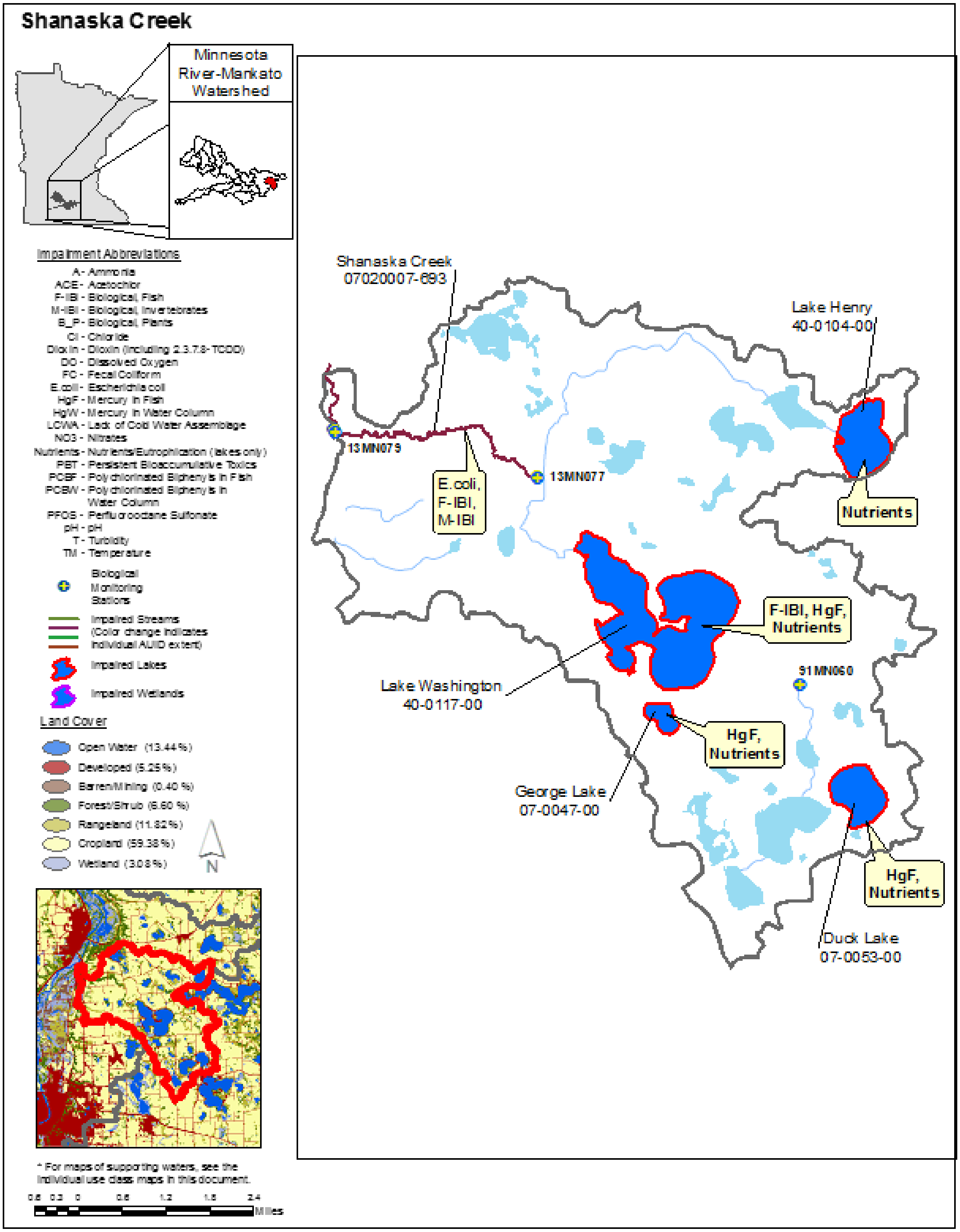


Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Shanaska Creek Aggregated 12-HUC.

Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Minnesota River - Mankato watershed], grouped by sample type. Summaries are provided for load monitoring data results near the mouth of the river, aquatic life and recreation uses in streams and lakes throughout the watershed, and for aquatic consumption results at select river and lake locations along the watershed. Additionally, groundwater monitoring results and long-term monitoring trends are included where applicable.

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

Pollutant load monitoring

Because of the recent establishment and lack of data from the Little Cottonwood River subwatershed site and the inclusion of data from the Minnesota River basin sites in the upcoming Minnesota River Large River Report, analysis and results within this report are limited to a general overview of the Minnesota River-Mankato Watershed and data from the Seven Mile Creek subwatershed.

Water quality and discharge data have been collected and loads calculated for the Minnesota River basin sites and Seven Mile Creek near St. Peter, US169 beginning in 2007. The Seven Mile Creek site was added as a subwatershed site to the WPLMN in 2013. Data collected prior to 2013, was collected by other water monitoring projects, pollutant loads were recalculated according to WPLMN protocols.

Table 63. WPLMN Stream Monitoring Sites for the Minnesota River-Mankato Watershed

Site Type	Stream Name	USGS	DNR/MPCA	EQuIS
Basin	Minnesota River at Morton	05316580	28012001	S000-145
Basin	Minnesota River at Judson	NA	28054001	S001-759
Basin	Minnesota River at St Peter, MN 22	05325300	28038002	S000-041
Subwatershed	Little Cottonwood River nr Courtland, MN68	05317200	28057001	S000-377
Subwatershed	Seven Mile Creek nr St. Peter, US169	NA	28063001	S002-937

Pollutant loads are influenced by land use, land management, watershed size, hydrology, climate, and other factors. Watershed size and differences in flow volume greatly influences pollutant loads; therefore, when comparing watersheds across a region or state, it is often useful to normalize the results for these differences. The flow weighted mean concentration (FWMC) is calculated by dividing the total load (mass) by the total flow volume, which normalizes load data for both spatial differences in watershed size and volumetric difference in discharge between watersheds. The FWMC is an estimate of the average concentration (mg/L) of a pollutant for the entire flow volume that passed the monitoring location over the monitoring season. This allows for the direct comparison of water quality between watersheds regardless of watershed size or annual discharge volume. In this report, nutrient and sediment data will be expressed in loads and FWMCs.

Many years of water quality data from throughout Minnesota combined with the previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA, 2013). Of the state's three RNRs (Northern, Central, Southern), the majority of the Minnesota River-Mankato Watershed is contained in the Southern RNR with the far south eastern corner of watershed in the Central RNR. Seven Mile Creek near St Peter, US169 and the Minnesota River at St Peter, MN22 drain landscapes located in the Southern RNR.

Annual flow weighed mean concentrations for Seven Mile Creek near St. Peter were calculated for 2007-2013 and compared with South RNR standards (only TP and TSS river standards exist for Minnesota at this time) to give an indication of the overall water quality of the watershed and contrast year to year variability. See below for specific parameter results and discussion. It should be noted that while a FWMC exceeding a water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule may not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent 10-year period (MPCA, 2014) 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% of the individual samples collected over the assessment period exceeded the standard.

Pollutant sources and source contributions affecting rivers can be diverse from one watershed to the next depending on land use, climate, soils, slopes, and other factors. Regional correlations between landuse, percent land disturbance, and water quality can be observed with Figure 35 and Figure 36. Elevated nutrient and sediment levels in streams and rivers can occur naturally in landscapes composed of young glacial soils, steep slopes or other natural factors; however, landuse, percent disturbance and other anthropogenic influences also strongly influence measured water quality. As a general rule, elevated levels of TSS and nitrate plus nitrite-nitrogen (NO3+NO2-N) are regarded as “non-point” source derived pollutants originating from many diffuse sources such as urban or agricultural runoff. Excess TP and dissolved orthophosphate (DOP) can be attributed to both non-point as well as point sources such as industrial or waste water treatment plants. Major “non-point” sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

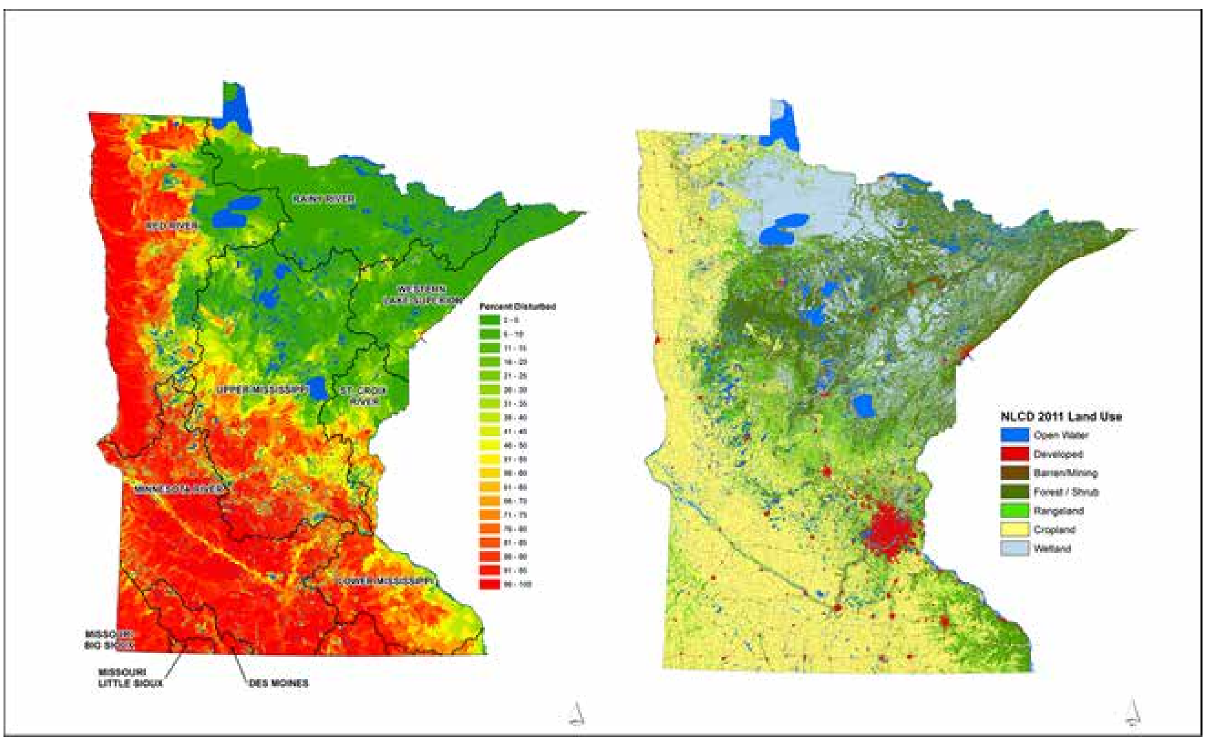


Figure 35. Percent land disturbance and NLCD 2011 landuse for the state of Minnesota

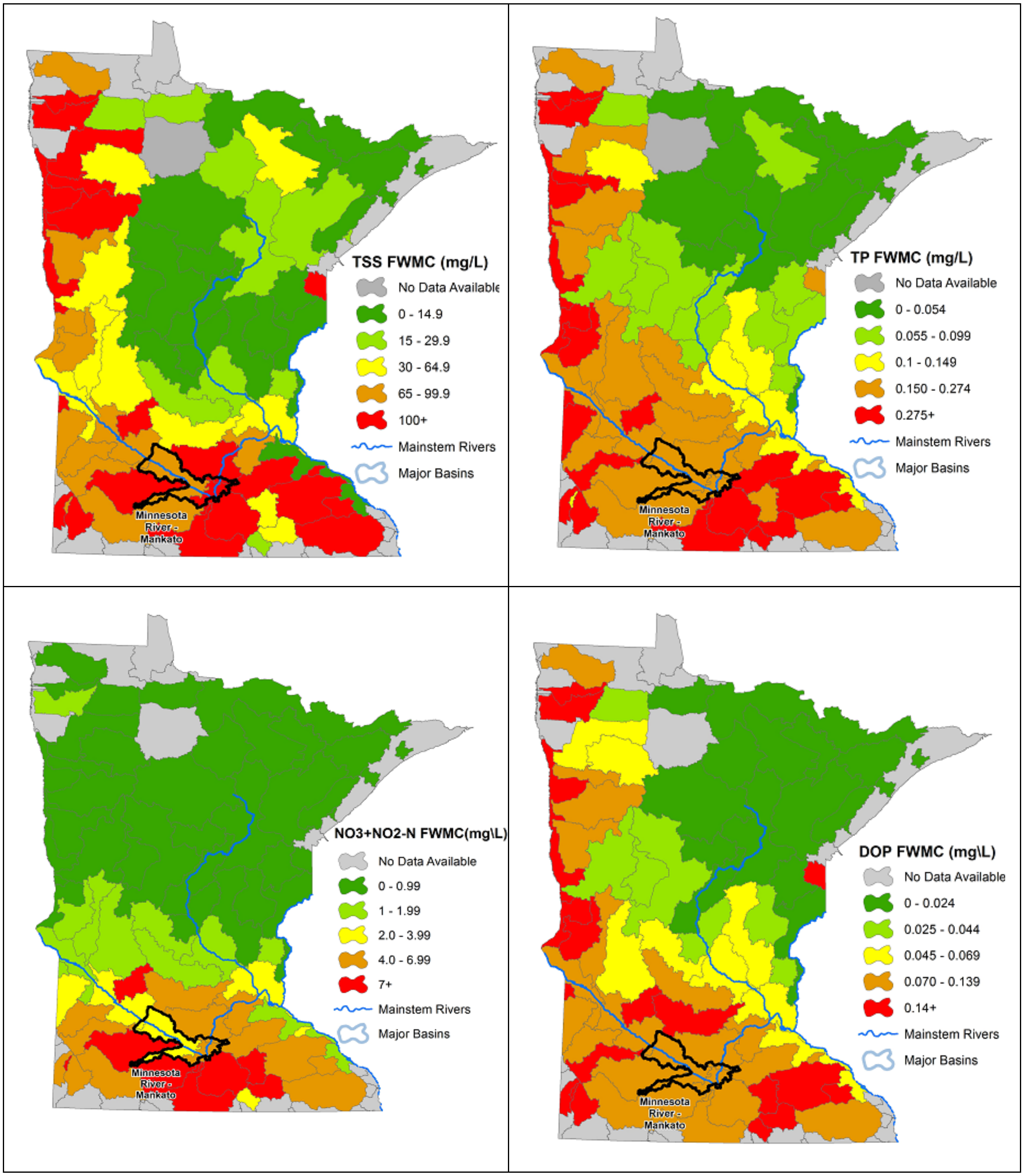


Figure 36. WPLMN average annual TSS, TP, NO3-NO2-N and DOP flow weighted mean concentrations by major watershed.

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: vegetative canopy development, soil conditions (frozen/unfrozen saturation level, etc.), and precipitation type, intensity, and amount. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development when compared to post-canopy events where soils are more protected and less surface runoff and more infiltration occur. Precipitation type and intensity can influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, or through artificial agricultural and urban drainage networks. 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 in-stream pollutant concentrations. Pollutant loads, the product of concentration and flow, are influenced not only by in-stream pollutant concentrations but also the volume of runoff delivered to the stream. During years when high intensity rain events provide the greatest proportion of total annual runoff, FWMCs of TSS and TP tend to be higher and DOP and NO_3+NO_2-N concentrations tend to be lower in many watersheds. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS FWMCs tend to be lower while TP, DOP, and NO_3+NO_2-N levels tend to be elevated. Years with larger runoff volumes will typically have larger loads when compared to years with lesser runoff volumes. Table 64 for example, shows the 2010 TSS load for Seven Mile Creek. to be over 30 times larger than the 2009 load, largely because of differences in runoff volume: 14.8” and 1.1” respectively.

Table 64. Annual Pollutant Loads (kg) for Seven Mile Creek near ST. Peter, Minnesota.

Parameter	2007	2008		2009	2010	2011	2012	2013
TSS	1074301	779525		506132	17312640	7012254	1045361	204552
TP	2291	1539		830	19309	8975	2260	870
DOP	1425	801		463	5336	2472	1088	506
NO_3+NO_2-N	184578	170914		25842	598832	629087	133902	103812

Total Suspended Solids (TSS)

Water clarity refers to the transparency of water. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter, and plankton or other microscopic organisms. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

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

Minnesota’s water quality standards for river eutrophication and total suspended solids were adopted into State R. ch 7050 in 2014 and approved by the EPA in January 2015. Within the South RNR, a river is considered impaired when greater than 10% of the individual samples exceed the TSS standard of 65 mg/L. (MPCA, 2011). From 2007 through 2013, nearly 30% of the 199 water quality samples collected at the Seven Mile Creek near St Peter monitoring site exceeded this standard. TSS FWMCs for this site also exceeded the 65 mg/L standard six out of seven years as shown in Figure 37.

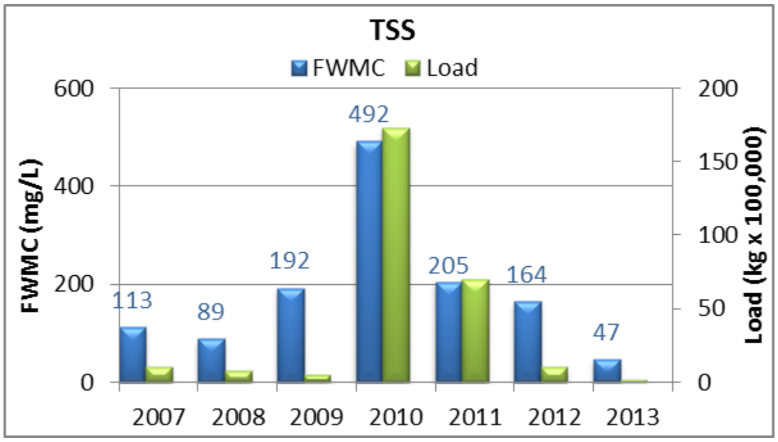


Figure 37. TSS Flow Weighted Mean Concentrations and Loads for Seven Mile Creek near St Peter, Minnesota.

When compared with other 8-digit HUC watersheds throughout the state, Figure 36 shows the average annual TSS FWMC to be several times higher for the Minnesota River-Mankato Watershed than watersheds in north central and northeast Minnesota, but in line with the agriculturally rich watersheds found in northwest, north central, and southern regions of the state. The TSS and TP maps also show an increase in FWMCs within the Minnesota River-Mankato Watershed following inputs from the Blue Earth River. It should be noted, for major river mainstem sites like the Minnesota River at St Peter, the FWMCs presented are computed from the load and total flow volume received from the total drainage area above the site, not just additional inputs to the 8 digit HUC nestled within the drainage area.

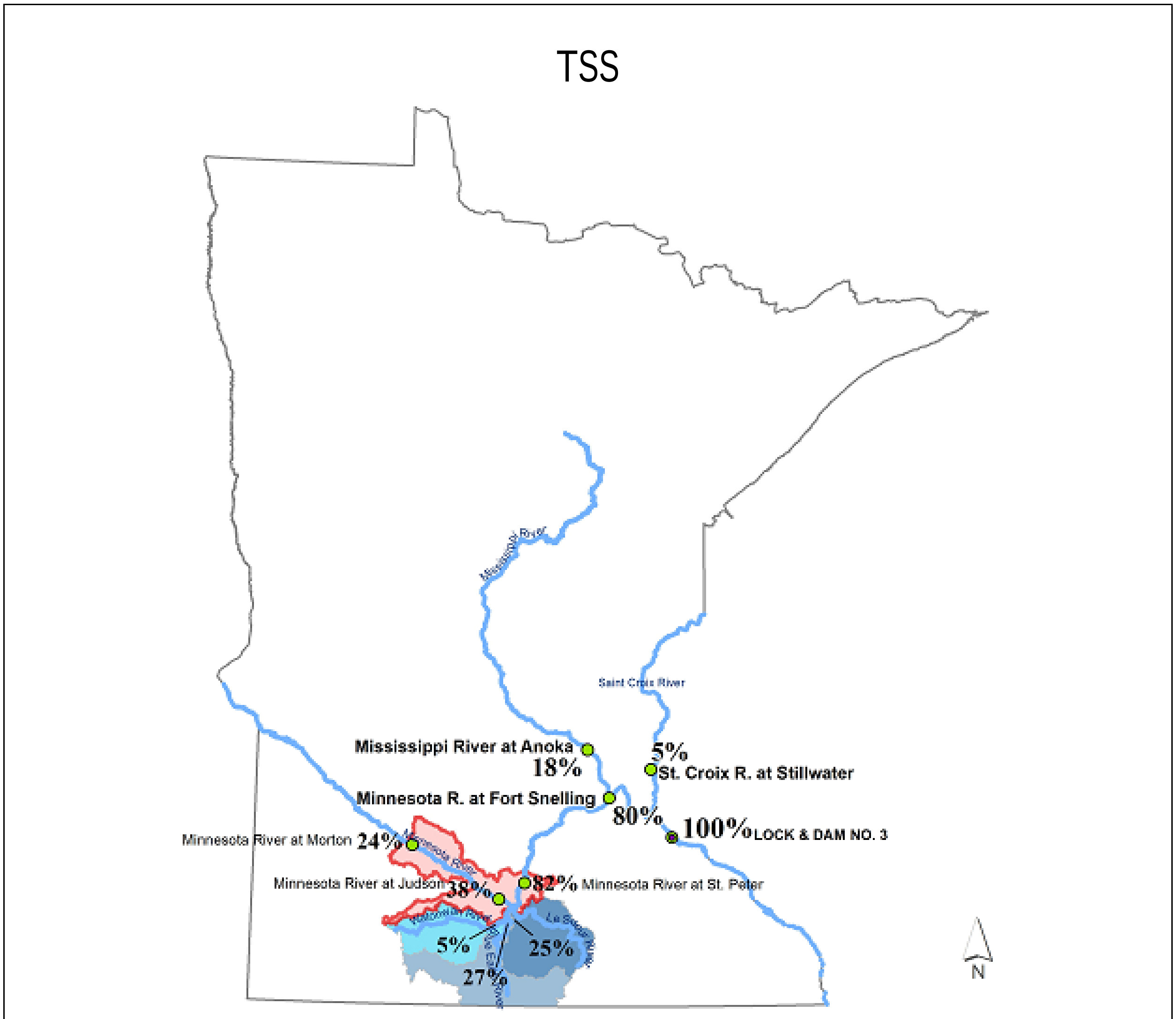
Figure 38 illustrates the how the Minnesota River, in particular, the Blue earth River and its major tributaries, the Watonwan and Le Sueur rivers, contribute a disproportionate amount to the Mississippi River sediment load. The diagram presents 2008-2013 average TSS loads at sites along the Mississippi, St. Croix, and Minnesota rivers expressed as a percentage of the average load measured at Lock and Dam #3 (site load/Lock and Dam #3 load). Lock and Dam #3 (LD#3) is the first downstream monitoring location below the Twin Cities Metropolitan Area (TCMA) and includes inputs from the upper Mississippi, St. Croix and Minnesota rivers and the TCMA.

It should be noted pollutant loads may not always be cumulative as one moves downstream. Some river reaches gain additional sediment from added discharge or increased bank erosion along the reach. Others, with perhaps lakes, wetlands, or extensive floodplain between sites, may be losing reaches with a net loss of sediment between upstream and downstream monitoring sites.

A comparison of average annual pollutant loads from the Upper Mississippi, St. Croix, and Minnesota rivers as they enter the metropolitan area show the average annual load for the St. Croix River near Stillwater to be the equivalent of 5% of the average annual load measured at LD#3, 18% for the Mississippi River at Anoka, and a disproportionate 80% equivalent for the Minnesota River at Fort Snelling. The map illustrates the summation and comparison of loading inputs into the TCMA are the near equivalent to the average TSS load leaving the Twin Cities as measured at LD#3. The data show the TCMA, on average, has more sediment entering than leaving the area. Sediment inputs from storm runoff and other sources should add to and result in a net gain to TSS loads as the rivers pass through the TCMA. However, sediment entering and being deposited within local backwater areas and on flood plains result in a net loss of sediment from the major rivers passing through the TCMA.

Within the Minnesota River basin, pollutant loads from the Blue Earth River and its major tributaries, the Watonwan and Le Sueur rivers, account for a disproportionate amount of the average TSS, TP, and NO3+NO2–N loads (Table in Figure 38) originating from the basin and those measured at LD#3. The Le

Sueur and Blue Earth rivers alone, for example, have a combined average TSS load equivalent of 52% of the average load measured at LD#3 yet only account for 5% of the total drainage area above LD#3.



	St Croix R at Stillwater	Mississippi R. at Anoka	Minnesota R. at Ft. Snelling	Watonwan R. Watershed	Blue Earth R. Watershed	Le Sueur R. Watershed
TSS	5%	18%	80%	5%	27%	25%
TP	8%	34%	57%	4%	10%	10%
NO3+NO2 -N	2%	19%	74%	6%	11%	14%

Figure 38. 2008-2013 average annual TSS, TP and NO_3+NO_2-N loads for Mississippi River Basin mainstem sites and select watersheds, expressed as a percentage of the average load measured at Lock and Dam #3.

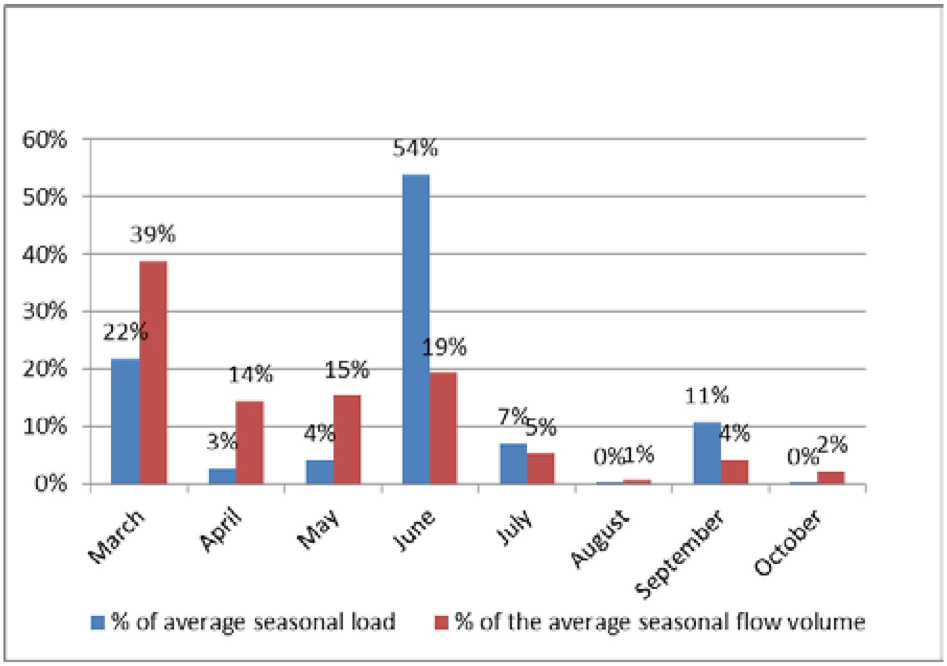


Figure 39. Monthly percentages of the average seasonal TSS load and flow volume for Seven Mile Creek near St. Peter, Minnesota, 2007-2013.

Seasonality and climate influence the timing and size of TSS loads. The majority of the average annual flow volume and average annual TSS load typically pass through Southern Minnesota's watersheds beginning in March and running through the end of June, a period when vegetative canopy is lacking or in the early stages of development. Figure **39** illustrates this seasonal variability in TSS loads and flow for Seven Mile Creek near St Peter, Minnesota. While monthly flow volumes are more evenly distributed during the March-June time period, monthly TSS loads are largely skewed to the two months of March and June when 76% of average seasonal TSS load passed through the system.

Analysis of daily loads shows most of the loading that occurs each season can be attributed to two to four major runoff/storm events, often during the months of March and June. In addition, within these large runoff events, most of the loading occurs during the day of and the day or days immediately preceding the event suggesting strong ties to overland flow related sediment sources. The turbidity and stage plot, Figure 40, illustrates this dramatic but short lived rise in turbidity during two different rain events in 2016.

During the rising limb of major runoff events, instream TSS concentrations can rise in excess of twenty times the concentration of samples collected at similar flows during the recession period of these events (see Figure 40). As a result, TSS loading can be very biased in relation to flow with often, a handful of days accounting for the majority of the seasonal TSS load. During 2012 for example, 86% of the seasonal TSS load passed through Seven Mile Creek in 5 days while only 24% of the total seasonal flow was recorded during the same period. During 2011, 12 days accounted for 59% of the seasonal TSS load but only 18% of the seasonal flow volume. In 2010, 71% of the TSS load came through in 8 days, carried by 13% of the seasonal flow volume. Keuhner, 2001, identified the flat, cultivated, upland portion of Seven Mile Creek watershed as being responsible for 23% of the watersheds average TSS load while the steep, incised" lower portion of the watershed is responsible for 77% of the load. Based on the substantial difference in load contributions from the two watershed areas and the fast response time between the beginning of these events and peak turbidity and measured TSS concentrations, it appears gully erosion is largely responsible for the bulk of the TSS load during many years, especially those with a strong overland flow footprint.

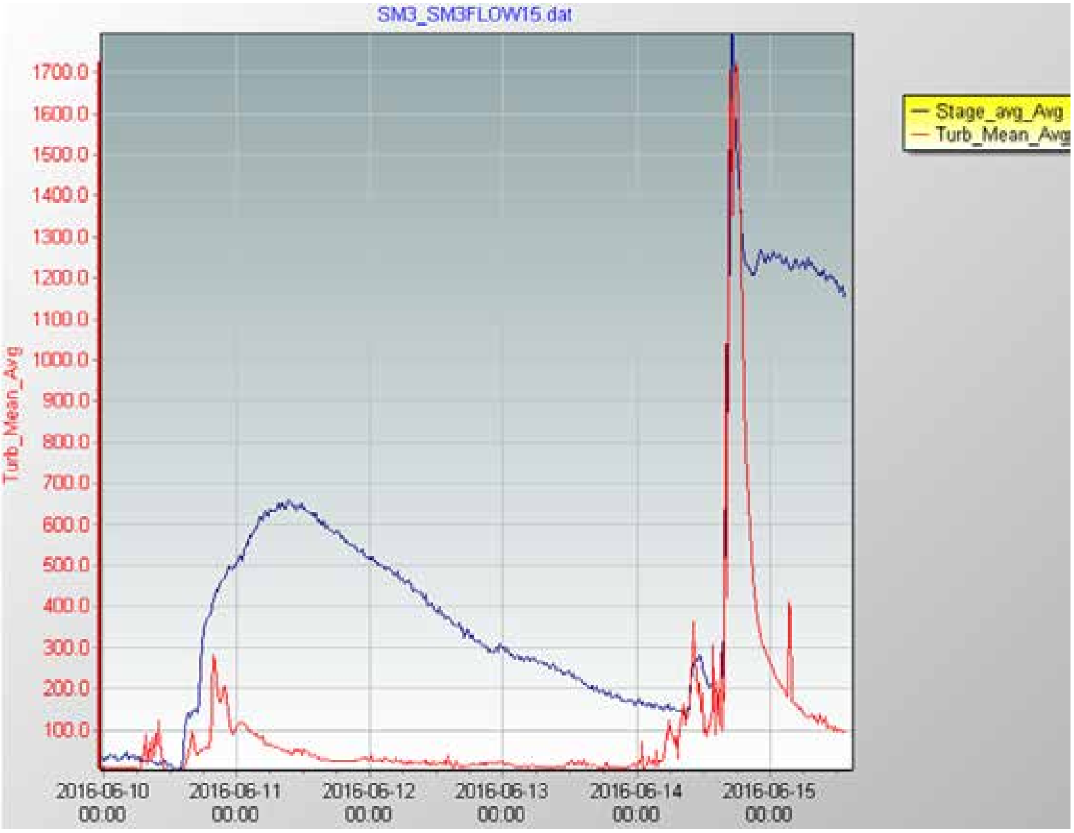


Figure 40. Stage and turbidity plot from Seven Mile Creek near St Peter, June 2016. Graph courtesy on Minnesota Department of Agriculture.

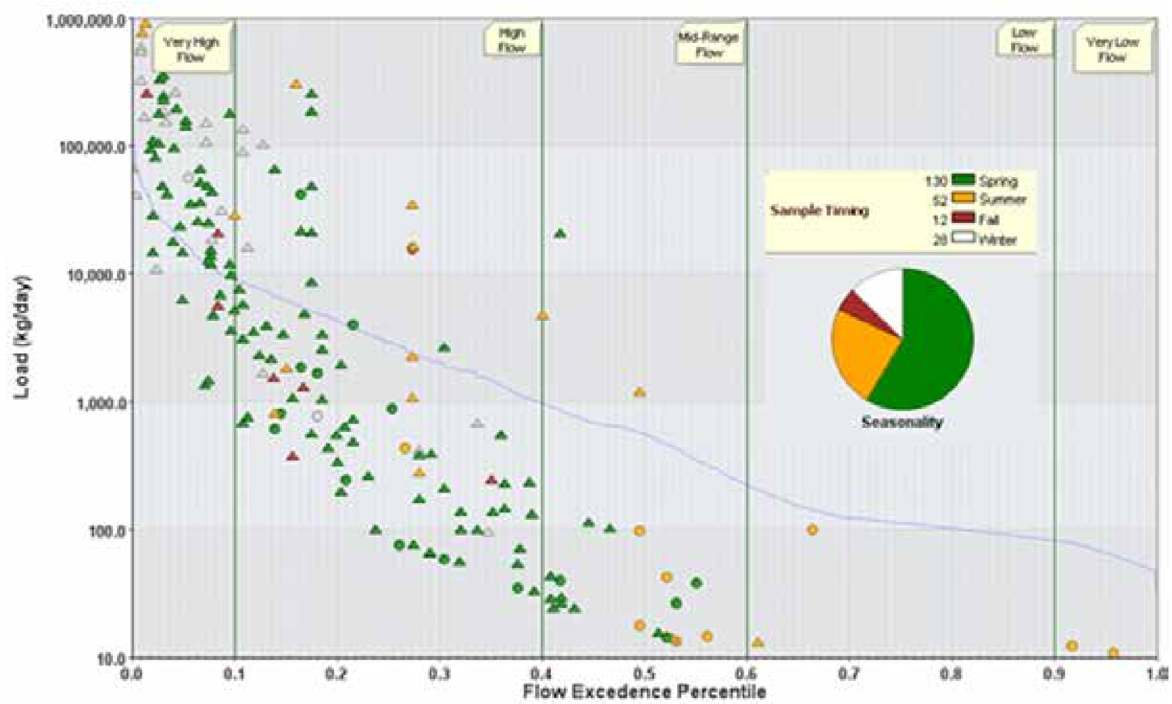


Figure 41. TSS load duration curve for Seven Mile Creek near St. Peter, Minnesota, 2007-2015.

Flow conditions under which violations in Minnesota's TSS standard are most likely to occur for Seven Mile Creek is best illustrated with the TSS load duration curve for the Seven Mile Creek near St Peter (Figure 41). A load duration curve of is a plot of daily loads computed from TSS sample concentrations plotted against the exceedance curve, above which daily loads are considered non-compliant with TSS water quality standards for the South RNR. Figure 40 shows most exceedances of the TSS standard occur under "moist" to "high flow" conditions and during the spring and summer seasons.

Total Phosphorus

Nitrogen, phosphorus, and potassium are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension, 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels overstimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality from overstimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension, 1999). Elevated levels of phosphorus in rivers and streams can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries, and toxins from cyanobacteria (blue green algae) which can affect human and animal health (University of Missouri Extension, 1999).

Within the south RNR, a violation of Minnesota's water quality standard for river eutrophication occurs when the TP summer mean concentration (June through September) is at or above 0.150 mg/L along with a summer average violation of one or more "response" variables (pH, biological oxygen demand, DO flux, chlorophyll-a). A comparison of all 2007 through 2013 total phosphorus data collected for Seven Mile Creek near St. Peter show TP concentrations at or above the 0.150 mg/L south RNR TP standard 41% of the time. The summer TP averages were above the standard in two out of seven years with the average sample flow largely driving this statistic. If average summer sample flows were below 25 cfs, summer average TP concentrations were well below the 0.150 mg/L standard. The two years when the summer standard was exceeded, 2010 and 2011, had large summer rain events that drove the average sample TP concentrations well over the standard (0.92 and 0.276 mg/L respectively). Seasonal TP flow weighted mean concentrations exceeded the standard in all years (Figure 42) signifying elevated phosphorus levels go through the system when elevated flows go through the system. In many years, between mid-summer and fall, Seven Mile Creek become an ephemeral system as one moves up in elevation from the outlet. The outlet during these dry time periods will have often have slight discharge from groundwater inputs. Samples collected during these very low flows have very little in the way of sediment and nutrient concentrations.

When compared with other 8-digit HUC watersheds, Figure 36 shows the average annual TP FWMC for The Middle Minnesota-Mankato and Seven Mile Creek to be several times higher than watersheds in north central and northeast Minnesota, but in line with the agriculturally rich watersheds found in the remainder of the state.

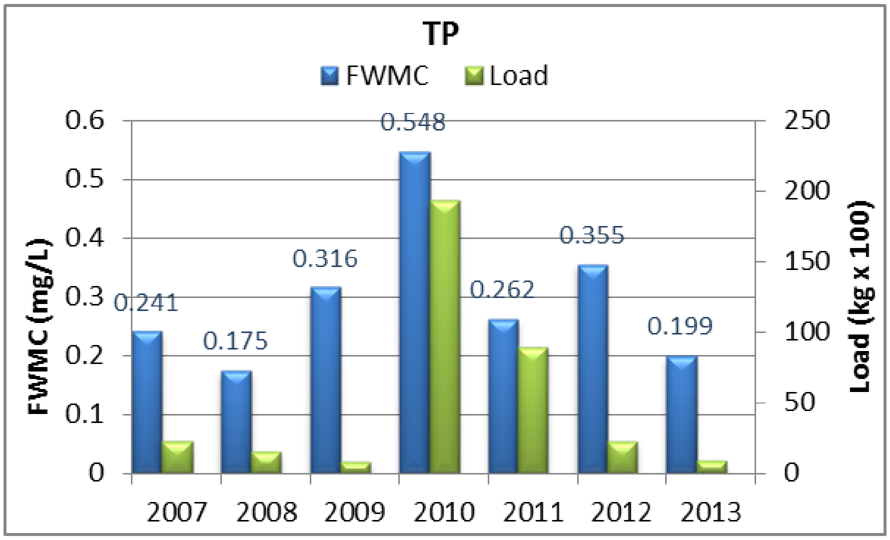


Figure 42. TP Flow Weighted Mean Concentrations and Loads for Seven Mile Creek near St Peter, Minnesota.

Similar to TSS, Figure 43 illustrates the majority of the average annual TP load (68%) passes through the system during the months of March and June. Interestingly, 40% of the average annual TP load is carried through the system during the month of March alone, a month largely dominated by snowmelt runoff.

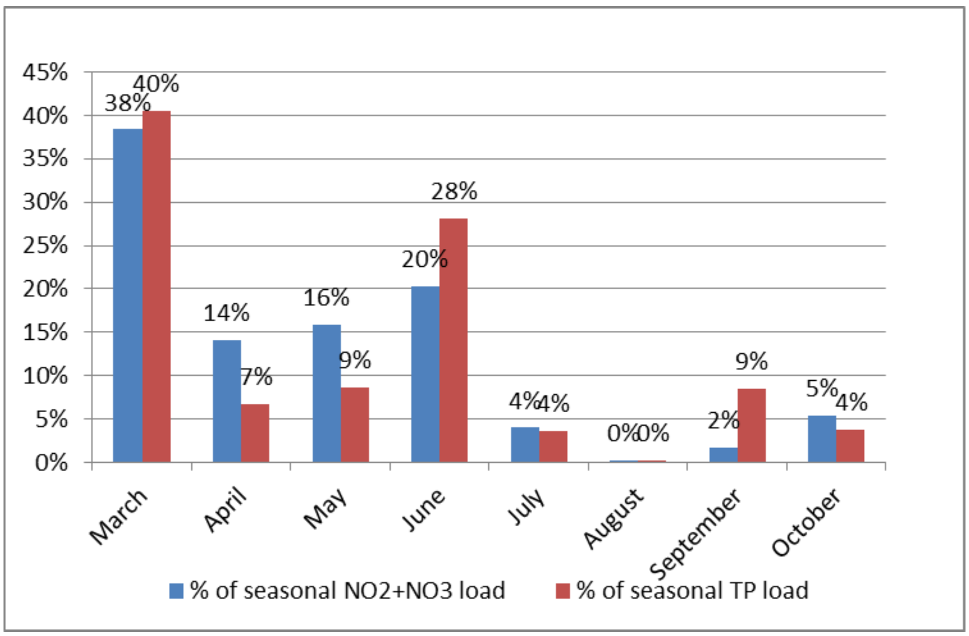


Figure 43. Monthly percentages of the seasonal NO3-NO2-N and TP loads for Seven Mile Creek near St. Peter, Minnesota, 2007-2013.

Due to soil frost and snow packed ditches, melt water can be trapped on the landscape for days or weeks at a time allowing for desorption of phosphorus from agricultural soils and plant residue resulting in elevated dissolved orthophosphate concentrations. During years with sudden spring thaws, surface soils can also be eroded when surface frost lets go, allowing the transport of sediment bound phosphorus to receiving streams.

The ephemeral nature of Seven Mile Creek, makes loading of all pollutants during the month of August insignificant when compared to the other months of the monitoring season.

The table in Figure 38 shows the impact the Minnesota River, in particular the Blue Earth River and its major tributaries, the Watonwan and Le Sueur rivers, have on the average phosphorus load measured at LD#3. Proportionally, the Minnesota River's impact on the Mississippi River with regard to phosphorus is less than both TSS and NO3+ NO2-N but still significant at an equivalent of 56% of the LD#3 load. Within the Minnesota River Basin, the Watonwan, Blue Earth and Le Sueur rivers alone accounted for a combined equivalent of 23% of the LD#3 TP load.

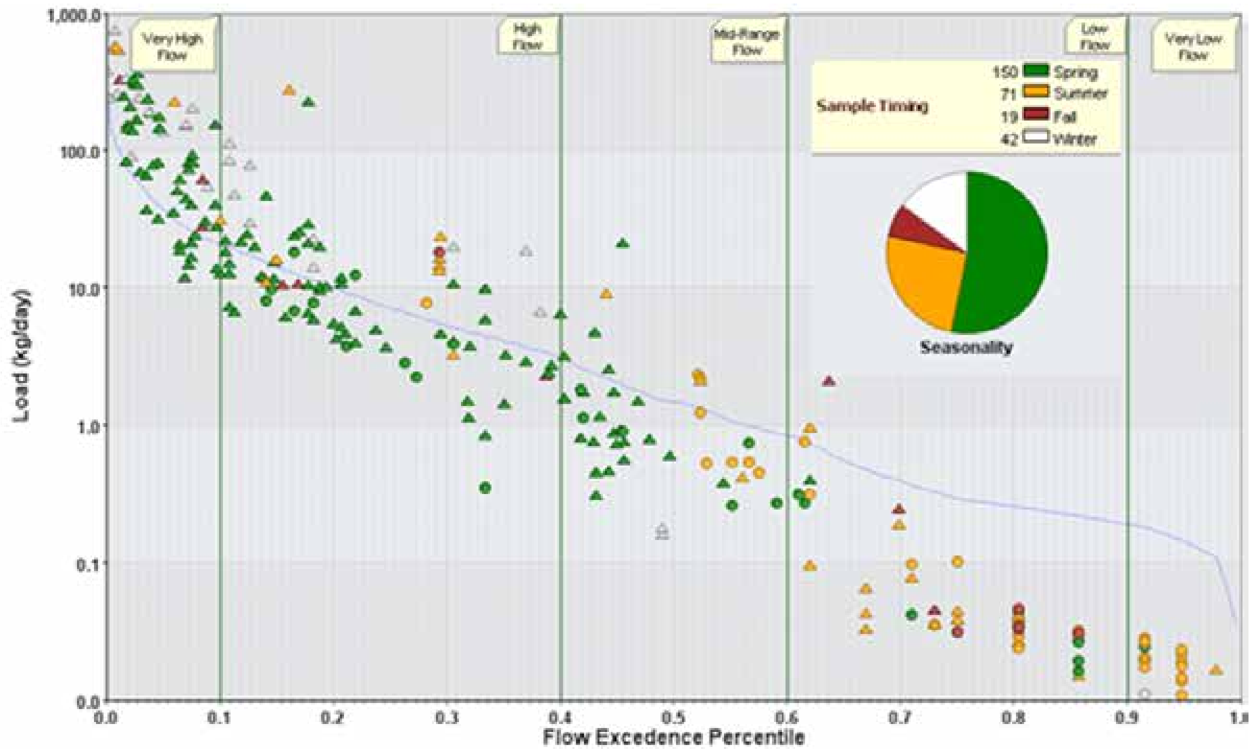


Figure 44. TP load duration curve for Seven Mile Creek near St Peter, Minnesota, 2007-2015.

The 2007 through 2015 TP load duration curve for Seven Mile Creek near St. Peter (Figure 44) shows daily load exceedances occur primarily under high to very high flow conditions. Flow exceedance percentiles within these categories further show great variability in daily loads, indicating factors other than flow alone responsible for measured loads.

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, 2013). 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. Environmentally, studies have shown that the elevated nitrate-nitrogen levels in the Minnesota River Basin contribute to hypoxia (low levels of DO) in the Gulf of Mexico. 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 for the protection of aquatic life in lakes and streams. A 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 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate- N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA 2010f).

Infants less than six months old who drink water with high levels of nitrate can become critically ill and develop methemoglobinemia, which is also known as "Blue Baby Syndrome". As such, the Minnesota Department of Health (MDH) has set a standard of 10 mg/L for nitrate in drinking water. For means of this discussion, data comparisons will be limited to MDH Drinking Water Standard.

From a statewide perspective, Figure 36 shows the average annual NO3+NO2-N FWMCs to be highest from rivers within the southern part of the state. These FWMCs are several times higher than watersheds north of the Twin Cities metropolitan area. Watersheds with low to medium NO3+NO2-N FWMCs levels generally have more land in forest or grasses, more in wetlands, more in small grains, and less land in row crops and tile drainage (MPCA 2013-2).

Figure 45 shows the NO3+ NO2-N FWMCs over the seven year period for Seven Mile Creek near St. Peter, Minnesota. Flow weighted mean concentrations for the site ranged from 9.8 to 24 mg/L over the monitoring period with a seven-year average of 18.3 mg/L: one of the highest averages measured of all 199 WPLMN monitoring sites. Of the 233 individual samples collected between 2007 and 2013, 59% exceeded the nitrate drinking water standard of 10 mg/L.

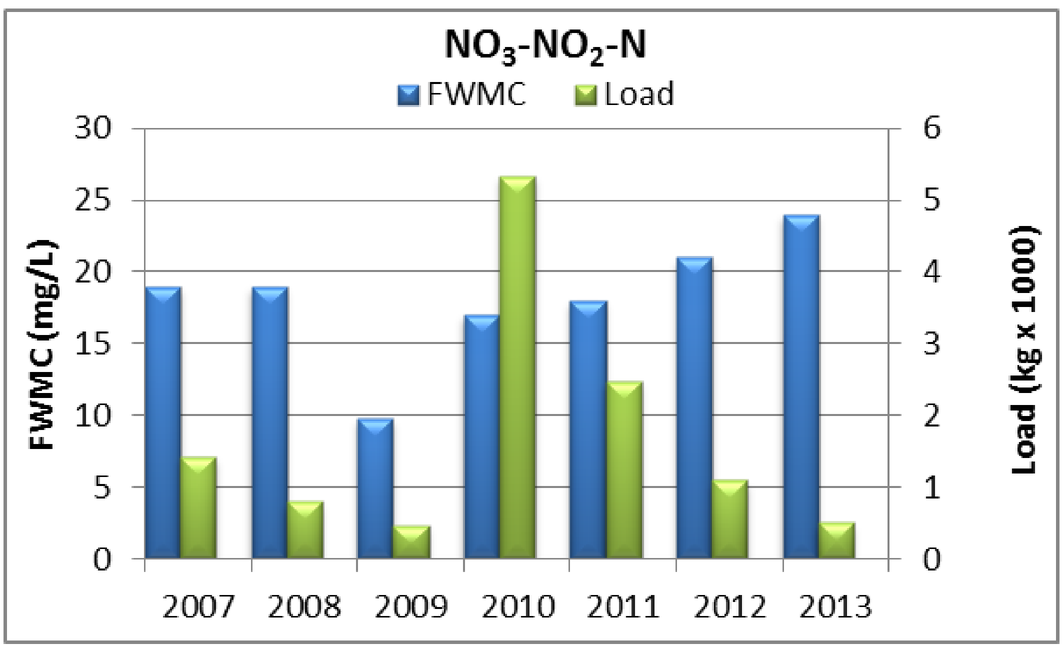


Figure 45. NO3+NO2-N Flow Weighted Mean Concentrations and Loads for Seven Mile Creek near St. Peter, Minnesota.

Seasonal NO3+ NO2-N load dynamics for Seven Mile Creek are similar to TSS and TP in that the months of March and June are the heaviest loading months (Figure 43). However, monthly loads within the March through June time period for NO3+ NO2-N appear less dependent upon the source of runoff than the proportion of the total seasonal runoff delivered during the given month (Figure **39** and Figure 43). In other words, the amount of NO3+ NO2-N going through Seven Mile Creek at any given time is largely a function of the flow volume going through the creek at that time. Years with the greatest runoff volume are therefore going to be the heaviest loading years. 70% of the 2007-2013, total runoff volume, for example, passed through Seven Mile Creek during the years of 2010 and 2011, along with 66% of the NO3+ NO2-N load recorded over the same time period.

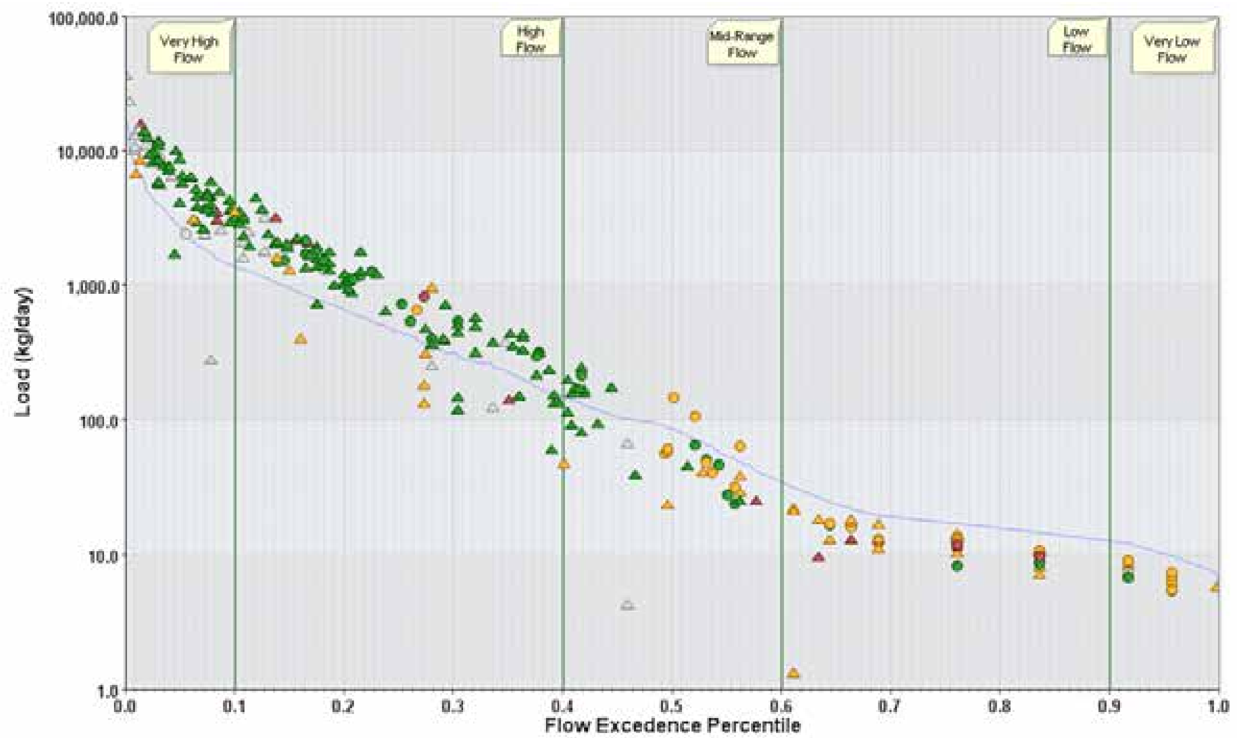


Figure 46. NO3+ NO2-N load duration curve for the Seven Mile Creek near St Peter, Minnesota.

A review of the NO3+ NO2-N load duration curve of the 10 mg/L drinking water standard for Seven Mile Creek near St Peter, MN (Figure 46) shows the standard is exceeded under most flow conditions with the exception of low and very low flows when groundwater largely dominates the system. Seven Mile Creek is rarely in compliance with the 10 mg/L nitrate drinking water standard under high and very high flow conditions.

Switching to the Minnesota River–Mankato Watershed, the table within Figure 38 shows the significance the Minnesota River has on the Mississippi River with regard to NO3+ NO2-N loads. Average inputs from the Minnesota River are the equivalent of 74% of the load measured at Mississippi River Lock and Dam #3, with inputs from the Greater blue Earth River watershed the equivalent of 31% of this total.

Stream water quality

Eighty-six of the 97 stream AUID's sampled were assessed (Table 65) within the Minnesota River Mankato Watershed. Of the assessed streams, 14 were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Six reaches were not assessed due to their classification as limited resource waters. Sixty reaches are non-supporting for aquatic life and/or recreation. Of those reaches, 54 are non-supporting for aquatic life and 27 are non-supporting for aquatic recreation.

Twenty-three reaches within the watershed were split during this assessment cycle resulting in 44 child reaches. Of these split parent reaches, three had previous impairments for turbidity (aquatic life) and fecal coliform (aquatic recreation). These existing impairments were carried forward by one or more of the resulting child reaches in each case based on the location of previous listing data and data collected since the initial listing.

Two existing drinking water impairments based on nitrate data were confirmed by newer data. An existing pesticide impairment from 2012, on Seven Mile Creek also remains.

Table 65. Assessment summary for stream water quality in the Minnesota River – Mankato River Watershed.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total AUID's**	**# Assessed AUID's**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
Minnesota River-Mankato **HUC 8**	**859,440**	97	86	14	0	54	27	20	0
Birch Coulee Creek	43,520	9	7	1	0	4	1	2	0
Fort Ridgely Creek	44,160	6	6	3	0	3	1	0	0
Little Rock Creek	53,760	7	7	1	0	5	1	1	0
Spring Creek-Minnesota River	110,080	13	13	3	0	6	5	6	0
Wabasha Creek	46,080	4	3	0	0	3	1	0	0
Spring Creek	28,800	4	4	0	0	3	2	1	0
City of New Ulm-Minnesota River	82,560	6	6	0	0	3	4	3	0
Little Cottonwood River	108,160	10	9	4	0	5	2	0	0
Morgan Creek	37,360	4	4	0	0	3	1	0	0
Minneopa Creek	54,400	7	5	0	0	5	2	0	0
Morgan Cr.-Minnesota R.	54,460	2	1	0	0	1	0	0	0
Swan Lake Outlet (Nicollet Creek)	50,560	4	3	0	0	3	1	0	0
City of Mankato-Minnesota River	118,560	16	13	1	0	10	6	3	0
Shanaska Creek	26,880	5	5	1	0	0	0	4	0

Lake water quality

Of the lakes within the Minnesota River-Mankato Watershed 38 greater than 10 acres had some type of assessment data available (Table 66). The availability of biological index data allowed during this assessment cycle provided an opportunity to make complete aquatic life use assessments on lakes. Ballantyne and Emily lakes were full support for aquatic recreation use, while Ballantyne and Duck lakes were full support for aquatic life use. Four lakes were previously listed impaired prior to this assessment cycle for aquatic recreation use based on nutrient data, five new lake impairments for aquatic recreation will be added. More recent data collected on these previously listed lakes confirm initial impairments. Crystal and Washington lakes will be listed impairment for aquatic life use assessment based on biological index data. Insufficient data was available for Aquatic Life or Aquatic Recreation use assessments on 23 lakes.

Table 66. Assessment summary for lake water chemistry in the Minnesota River – Mankato River Watershed.

			Supporting		Non-supporting			
Watershed	**Area (acres)**	**Lakes >10 Acres**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delisting's**
Minnesota River-Mankato **HUC 8**	**859,440**	**68**	**2**	**2**	**2**	**9**	**23**	**0**
Birch Coulee Creek	43,520	0	0	0	0	0	0	0
Fort Ridgely Creek	44,160	0	0	0	0	0	0	0
Little Rock Creek	53,760	3	0	0	0	0	0	0
Spring Creek-Minnesota River	110,080	0	0	0	0	0	0	0
Wabasha Creek	46,080	0	0	0	0	0	0	0
Spring Creek	28,800	0	0	0	0	0	0	0
City of New Ulm-Minnesota River	82,560	5	0	0	0	0	0	0
Little Cottonwood River	108,160	3	0	0	0	0	0	0
Morgan Creek	37,360	2	0	0	0	0	0	0
Minneopa Creek	54,400	7	0	0	1	3	5	0
Morgan Cr.-Minnesota River	54,460	4	0	0	0	0	0	0
Swan Lake Outlet (Nicollet Creek)	50,560	7	0	0	0	0	1	0
City of Mankato-Minnesota River	118,560	19	0	0	0	2	11	0
Shanaska Creek	26,880	14	2	2	1	4	6	0

Remote sensing transparency data

Remote sensing data was used to describe lake transparency in areas where water chemistry data has not been collected (Figure 47) or were difficult to access. With remote sensing data, comparisons can be made at the state and watershed scale. Remote sensing provides insight into water quality by estimating transparency values for lakes void of total phosphorus, chlorophyll-a, or Secchi data. Satellite imagery is used with Secchi transparency measurements to form a relationship that allows for predictions of transparency values across the state. This provides a snap shot of lake transparency during the time of satellite pass over.

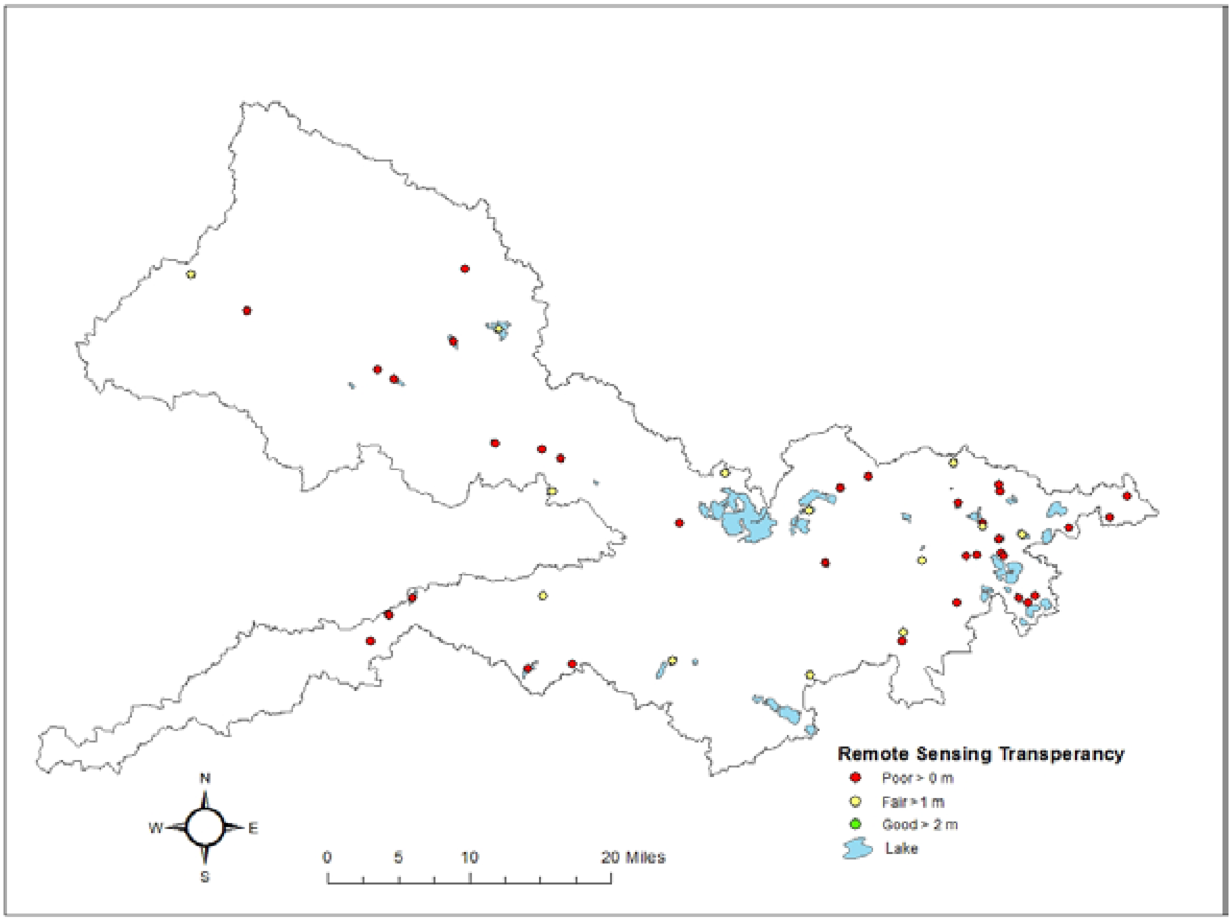


Figure 47. Remote Sensing Transparency Data on lakes without observed water chemistry data within the Minnesota River-Mankato Watershed.

Currently, remote sensing data has been analyzed on approximately a five-year basis from 1975 to 2008, with seven years of remote sensing data available. At this frequency the data allows for a simple average lake transparency value to be calculated at the state or watershed scale. Comparisons of lake transparencies may also be made between individual lakes during any single year. This data does not allow for trends analysis due to the small number of remote sensing data points available at this time.

Remote sensing data was used to describe lake transparencies on 50 lakes without water chemistry data in the Minnesota River Mankato Watershed, of those, 15 had estimated transparencies greater than the Western Corn Belt Plains Ecoregion Eutrophication Standard of 0.9 m. Forty lakes had estimates of transparencies that fell below the 0.9 m eutrophication standard. These lakes may warrant further investigation into water quality conditions. However, other variables must be taken into account as well, such as lake depth, presence of heavy vegetation and color or sediment present, which may impact the remote sensing transparency data. Overall, transparencies appear to be in poor to fair condition for the majority of lakes without water chemistry data. Lakes with fair remote sensing lake transparency data may be considered candidates for protection strategies given their relatively good water clarity.

Fish contaminant results

Mercury was analyzed in fish tissue samples collected from nine Minnesota River - Mankato watershed lakes. During the 2013 monitoring effort, two sites were selected for fish contaminant samples in the watershed. One site at the outlet of the watersheds largest tributary, the Little Cottonwood River (13MN052), as well as a site on a coldwater stream, Seven Mile Creek (09MN090). Sampling crews were unable to collect a sufficient sample for fish contaminant analysis at these sites. Contaminant data for the Minnesota River is not included in this watershed report; it will be included later in a large rivers report. Polychlorinated biphenyls (PCBs) were measured in fish from seven lakes. Thirteen fish species were tested for contaminants. Fish species are identified by codes that are defined by their common and scientific names (Table 68). A total of 442 fish were collected for contaminant analysis between 1969 and 2014.

Contaminant concentrations are summarized by waterway, fish species, and year (Table 67). "Total Fish" indicates the total number of fish analyzed and "N" indicates the number of samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish (BGS) and yellow perch (YP). "Anat." refers to the sample anatomy. Since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET). Occasionally whole fish (WHORG) are analyzed.

Of the nine lakes tested for fish contaminants within the Minnesota River - Mankato watershed, five are impaired for mercury in fish tissue and none are impaired for PCBs in tissue (MPCA's 2014 draft Impaired Waters List). The impaired waters are identified in Table 67 with a red asterisk (*). Four of the impaired lakes are covered under the Statewide Mercury TMDL and do not need additional TMDLs for mercury in fish tissue. Lake George (07004700) had mercury levels too high to be included in the Statewide Mercury TMDL and is identified with a double red asterisk.

Most of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 - 0.05 mg/kg). The highest PCB concentration was 0.077 mg/kg in a white bass (WHB) collected from Hiniker Pond (07014700) in 1990. The next highest PCB concentration was 0.064 mg/kg in a gizzard shad (GSH) from same pond and same year.

Overall, mercury remains the dominant fish contaminant in the watershed. The Fish Contaminant Monitoring Program will continue to retest the fish from impaired waters to assess if mercury levels are changing.

Table 67. Summary statistics of fish length, mercury, and PCBs, by waterway-species-year

AUID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
07004700	GEORGE**	BGS	2000	FILSK	10	1	6.6	6.6	6.6	0.040	0.040	0.040				
			2005	FILSK	15	1	6.0	6.0	6.0	0.063	0.063	0.063				
			2010	FILSK	10	2	6.5	6.2	6.7	0.043	0.038	0.047				
		BKS	2010	FILSK	10	2	7.5	7.1	7.8	0.046	0.046	0.046				
		LMB	2010	FILSK	1	1	17.4	17.4	17.4	0.643	0.643	0.643				
		NP	2000	FILSK	3	3	24.6	24.1	25.2	0.180	0.120	0.290				
			2005	FILSK	8	8	26.6	20.1	32.2	0.513	0.172	0.862				
			2010	FILSK	5	5	20.7	19.6	21.8	0.115	0.091	0.170				
07005300	DUCK*	BGS	2000	FILSK	9	1	6.7	6.7	6.7	0.013	0.013	0.013				
			2011	FILSK	10	2	6.8	6.6	7.0	0.021	0.016	0.026				
		BKS	2011	FILSK	10	2	8.0	7.6	8.3	0.039	0.039	0.039				
		NP	2000	FILSK	7	7	21.2	17.3	24.1	0.034	0.020	0.040				
			2006	FILSK	20	20	23.8	17.9	33.2	0.123	0.058	0.230				
			2011	FILSK	4	4	24.5	22.2	28.5	0.083	0.052	0.111				
07009600	LOON*	BKS	1996	FILSK	9	1	6.9	6.9	6.9	0.011	0.011	0.011				

AUID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WE	1996	FILSK	13	4	17.2	13.0	22.1	0.095	0.011	0.310	1	0.01	0.01	
07009700	MILLS	BGS	1990	FILSK	10	1	6.6	6.6	6.6	0.020	0.020	0.020	1	0.01	0.01	Y
		BKB	1990	FILET	8	1	8.3	8.3	8.3	0.084	0.084	0.084	1	0.01	0.01	Y
		C	1990	FILSK	5	1	15.9	15.9	15.9	0.020	0.020	0.020	1	0.01	0.01	Y
		NP	1990	FILSK	4	2	25.8	22.4	29.1	0.125	0.110	0.140	2	0.01	0.01	Y
		YP	1990	FILSK	6	1	8.3	8.3	8.3	0.075	0.075	0.075	1	0.01	0.01	Y
07009800	CRYSTAL	BKS	1996	FILSK	7	1	8.3	8.3	8.3	0.021	0.021	0.021				
			2011	FILSK	3	1	11.2	11.2	11.2	0.044	0.044	0.044				
		CHC	2011	FILSK	1	1	21.3	21.3	21.3	0.036	0.036	0.036	1	0.025	0.025	Y
		NP	2011	FILSK	6	6	19.3	17.6	21.9	0.018	0.013	0.027				
		WE	1996	FILSK	9	3	18.5	15.2	22.5	0.074	0.052	0.100	1	0.01	0.01	Y
			2011	FILSK	5	5	19.1	18.0	22.4	0.044	0.039	0.050				
		YP	2011	FILSK	5	1	9.4	9.4	9.4	0.013	0.013	0.013				
07014700	HINIKER POND*	BGS	1990	FILSK	4	1	5.2	5.2	5.2	0.064	0.064	0.064	1	0.01	0.01	Y
		GSH	1990	FILSK	6	1	15.2	15.2	15.2	0.029	0.029	0.029	1	0.064	0.064	
		NP	1990	FILSK	1	1	28.5	28.5	28.5	0.100	0.100	0.100	1	0.043	0.043	
		WHB	1990	FILSK	7	2	13.2	10.9	15.4	0.255	0.180	0.330	2	0.046	0.077	
		YP	1990	FILSK	9	1	6.4	6.4	6.4	0.061	0.061	0.061	1	0.01	0.01	Y
40011700	WASHINGTON*	BGS	1996	FILSK	10	1	7.8	7.8	7.8	0.080	0.080	0.080				
			1997	FILSK	6	1	6.8	6.8	6.8	0.024	0.024	0.024	1	0.01	0.01	Y
			2013	FILSK	5	1	7.9	7.9	7.9	0.048	0.048	0.048				
		BKS	1997	FILSK	5	1	7.7	7.7	7.7	0.026	0.026	0.026	1	0.01	0.01	Y
			2013	FILSK	8	2	9.1	8.6	9.5	0.043	0.040	0.046				
		C	1996	FILSK	14	5	19.3	14.3	25.3	0.034	0.020	0.060	1	0.015	0.015	
			1997	FILSK	5	2	21.0	19.1	22.8	0.047	0.032	0.062	2	0.01	0.01	Y
		NP	1997	FILSK	7	7	26.7	24.7	28.5	0.087	0.064	0.140	2	0.01	0.01	Y
			2008	FILSK	8	8	28.0	21.2	38.4	0.071	0.026	0.201				
			2013	FILSK	6	6	23.5	21.1	25.2	0.076	0.052	0.096				
		WE	1996	FILSK	6	3	20.0	15.8	23.4	0.187	0.080	0.400	1	0.01	0.01	
			1997	FILSK	10	10	20.0	16.1	24.2	0.226	0.067	0.510	2	0.01	0.01	Y
			2013	FILSK	11	11	15.8	13.0	25.6	0.100	0.052	0.197				
		WHS	1997	FILSK	2	1	8.6	8.6	8.6	0.032	0.032	0.032	1	0.01	0.01	Y
40012400	EMILY	BBU	2012	FILSK	3	1	23.2	23.2	23.2	0.044	0.044	0.044				
		BGS	1993	FILSK	10	1	5.8	5.8	5.8	0.048	0.048	0.048				
			2012	FILSK	9	2	7.5	7.1	7.9	0.046	0.042	0.050				
		BKS	2012	FILSK	10	2	8.8	8.6	9.0	0.039	0.037	0.040				
		C	1993	FILSK	21	3	16.6	12.8	21.5	0.042	0.023	0.078	1	0.01	0.01	Y
			2012	FILSK	5	1	19.3	19.3	19.3	0.041	0.041	0.041				
		NP	2012	FILSK	6	6	25.9	21.7	29.8	0.065	0.051	0.077				

AUID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in) Mean	Length (in) Min	Length (in) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	PCBs (mg/kg) N	PCBs (mg/kg) Mean	PCBs (mg/kg) Max	PCBs (mg/kg) < RL
52000100	HALLETT	BGS	1999	FILSK	8	1	7.9	7.9	7.9	0.050	0.050	0.050	1	0.015	0.015	
		YP	1999	FILSK	7	1	6.7	6.7	6.7	0.060	0.060	0.060	1	0.02	0.02	

* Impaired for mercury in fish tissue as of 2014 Draft Impaired Waters List; categorized as EPA Class 4a for waters covered by the Statewide Mercury TMDL.
** Impaired for mercury in fish tissue as of 2014 Draft Impaired Waters List; categorized as EPA Class 5 for waters needing a TMDL.
1 Species codes are defined in Table 76
2 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism

Table 68. Fish species codes, common names, and scientific names

SPECIES	COMMON NAME	SCIENTIFIC NAME
BBU	Bigmouth buffalo	Ictiobus cyprinellus
BGS	Bluegill sunfish	Lepomis macrochirus
BKB	Black bullhead	Ameiurus melas
BKS	Black crappie	Pomoxis nigromaculatis
C	Carp	Cyprinus carpio
CHC	Channel catfish	Ictalurus punctatus
GSH	Gizzard shad	Dorosoma cepedianum
LMB	Largemouth bass	Micropterus salmoides
NP	Northern pike	Esox lucius
WE	Walleye	Sander vitreus
WHB	White bass	Morone chrysops
WHS	White crappie	Pomoxis annularis
YP	Yellow perch	Perca flavescens

Groundwater monitoring

Groundwater quality

There are no current MPCA Ambient Groundwater monitoring sites within the Minnesota River – Mankato Watershed. From 1992 to 1996, the MPCA conducted a statewide baseline water quality study of Minnesota's principal aquifers based on dividing Minnesota into six hydrogeologic regions: Northwest, Northeast, Southwest, Southeast, North Central and Twin Cities Metropolitan Regions.

The regional assessment of southwest Minnesota, including the area around the Minnesota River – Mankato Watershed, concluded the deeper aquifers produced water with high mineral content making it difficult to use as drinking water and the more productive surficial aquifers are very susceptible to nitrate contamination. (MPCA 1998)

The MDA monitors pesticides and nitrate on an annual basis in groundwater across agricultural areas in the state. The MDA also separates the state into regions, which consist of 10 regional water quality monitoring networks that are referred to as Pesticide Monitoring Regions (PMRs). The Minnesota River - Mankato Watershed lies within the regional water quality monitoring networks Region 8 (PMR 8), referred to as the South Central Region. For PMR 8, nitrate-nitrogen was detected in 67% of samples with a median of 1.00 mg/L, 22% were at or below background level of 3.00 mg/L, 14% were within 3.01 and 10.00 mg/L, and 25% were above drinking water standard of 10.00 mg/L (MDA, 2015).

Another source of information on groundwater quality comes from the MDH. Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells statewide has found that 10.7% of all wells installed from 2008 to 2015 have arsenic levels above the maximum contaminant level (MCL) for drinking water of 10 micrograms per liter. The percent of new wells exceeding that same threshold in counties within the Minnesota River – Mankato Watershed ranges from 13.9% and 17.4% in Cottonwood and Nicollet Counties to above 20% in Blue Earth, Redwood, Brown and Renville Counties. (MDH, 2015).

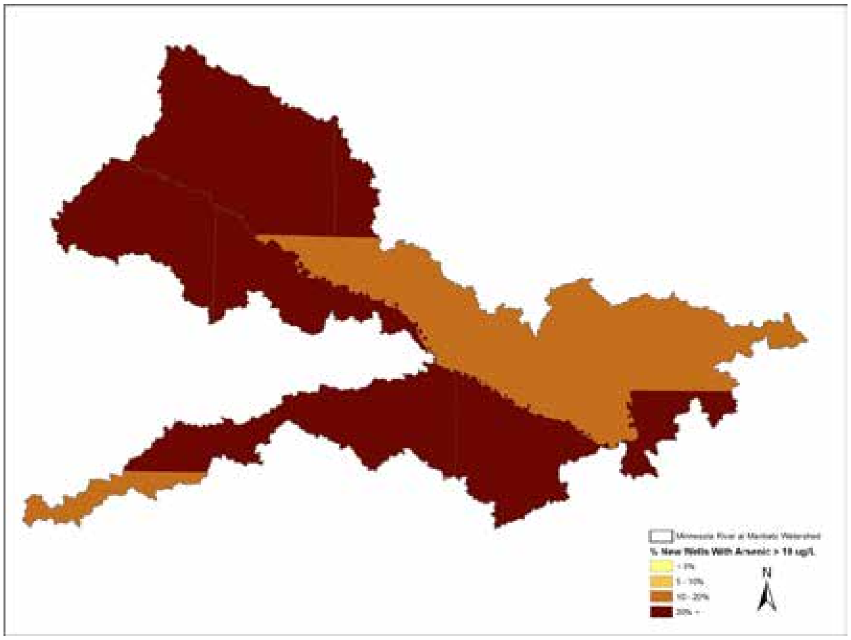


Figure 48. Percentage of New Private Wells with arsenic concentrations greater than 10 micrograms/Liter (2008-2015)

Groundwater quantity

Monitoring wells from the MNDNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. To access the MNDNR Observation Well Network, please visit http://www.dnr.state.mn.us/waters/cgm/index.html.

There are no currently-monitored DNR observation wells within the Minnesota River – Mankato Watershed.

High-capacity withdrawals

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

Total annual permitted high-capacity surface water and groundwater withdrawals are displayed in Figure 49 and Figure 50, respectively, from 1993-2013. Surface water withdrawals have increased at a statistically significant rate (p=0.10) and groundwater withdrawals have increased at a very significant rate (p=0.001).

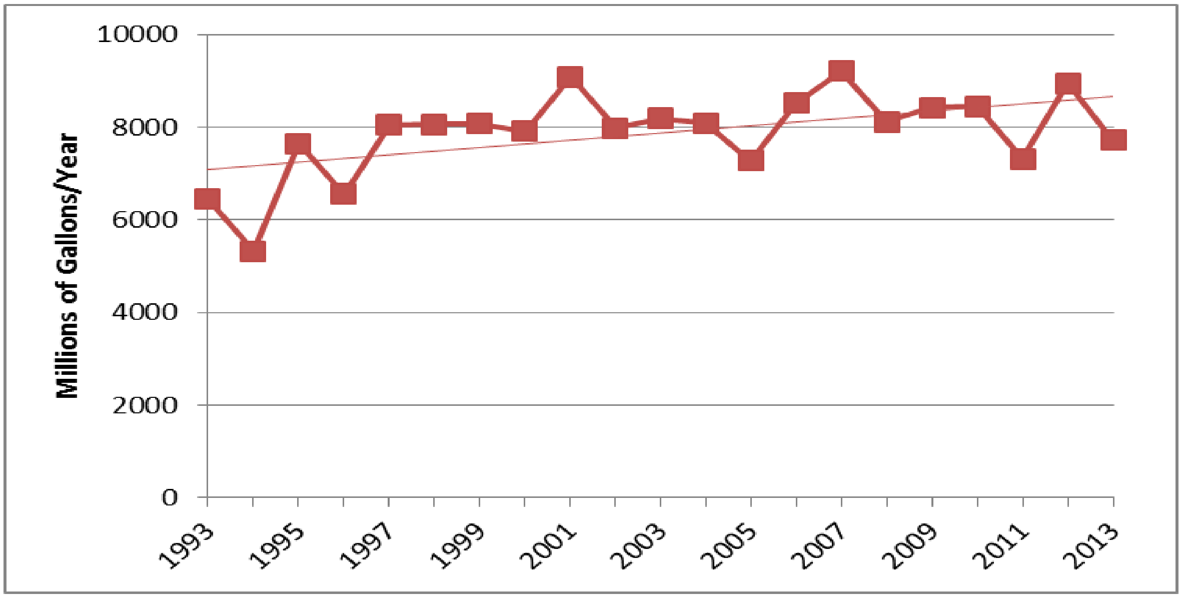


Figure 49. Total annual high-capacity surface water withdrawals, Minnesota River – Mankato Watershed (1993-2013)

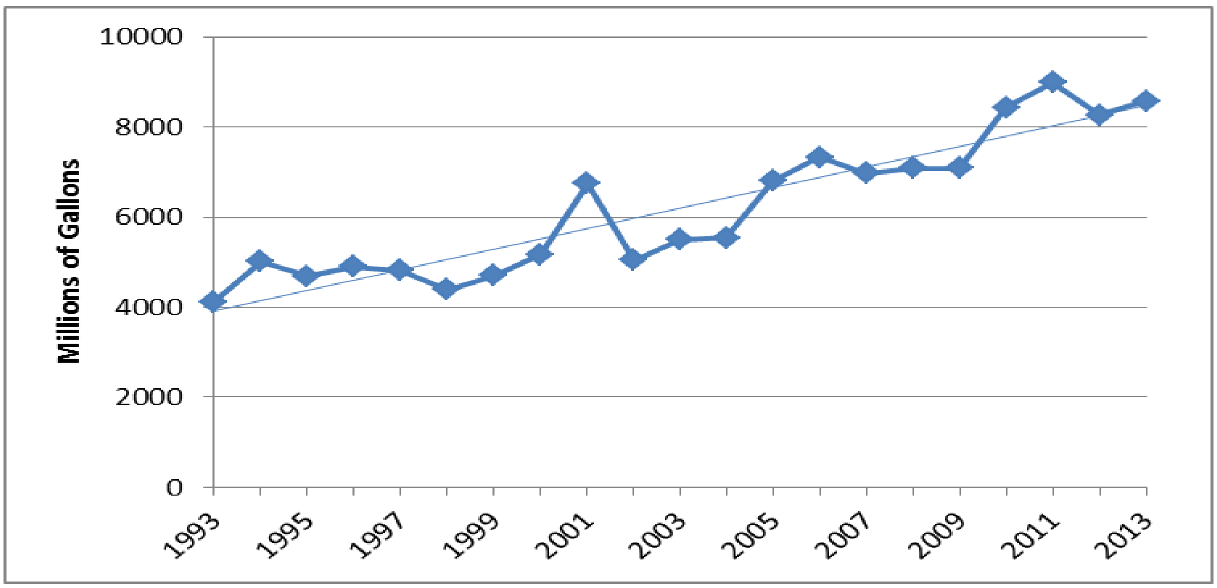


Figure 50. Total annual high-capacity groundwater withdrawals, Minnesota River – Mankato Watershed (1993-2013)

Furthermore, groundwater withdrawals from the shallow quaternary water table aquifer (QWTA) have also increased over the same time period. One specific withdrawal began in 2008, and increased the total annual amount. This increase is apparent in Figure 51 (below). With so few measurements after the new withdrawal, it is too soon to determine any statistical significance due to this change.

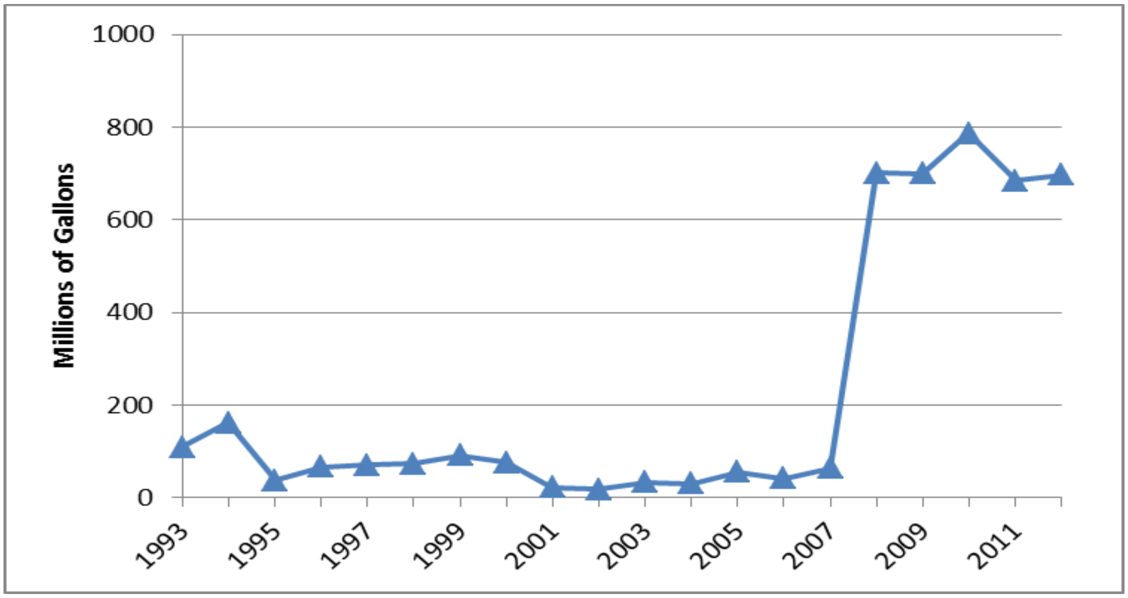


Figure 51. Total annual high-capacity QWTA withdrawals, Minnesota River – Mankato Watershed (1993-2013).

Stream flow

Figure 52 and Figure 53 displays mean annual discharge for the Little Cottonwood River from 1993-2009 and mean monthly discharge for the months of July and August over the same time period. Annual discharge appears to be declining but does not show a significant trend. Both summer months, though, show a significant decreasing flow trend; July has a p-value of 0.001 and August, 0.01.

When taking into consideration the anomaly of 1993 being a significant flood year (Larson, 1996) and calculating from 1994-2009, the declining trend for both months is still significant at p=0.01.

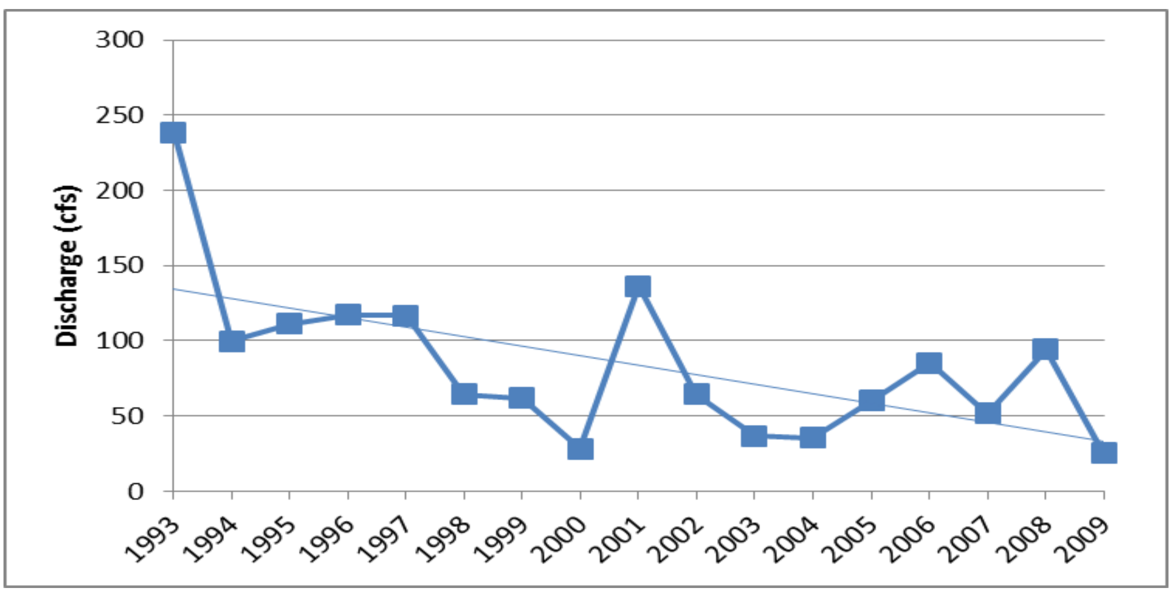


Figure 52. Mean annual discharge, Little Cottonwood River (1993-2009).

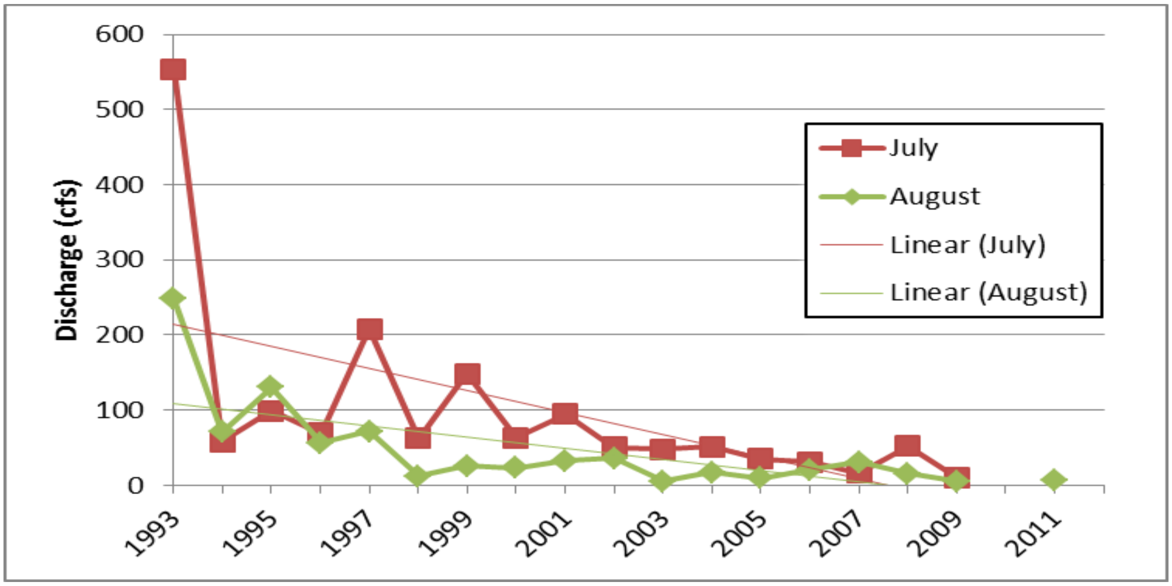


Figure 53. Little Cottonwood River - mean Annual and July/August discharge measurements (1993-2009, 2011).

Figure 54 shows discharge for the Minnesota River measured at Mankato from 1993-2013. Figure 55 shows mean flows in July and August over the same time period. High-flow peaks during flood periods are visible, but the declining trends are not significant for the mean annual or mean July flow. August mean flow has declined at a slightly significant rate (p=0.1).

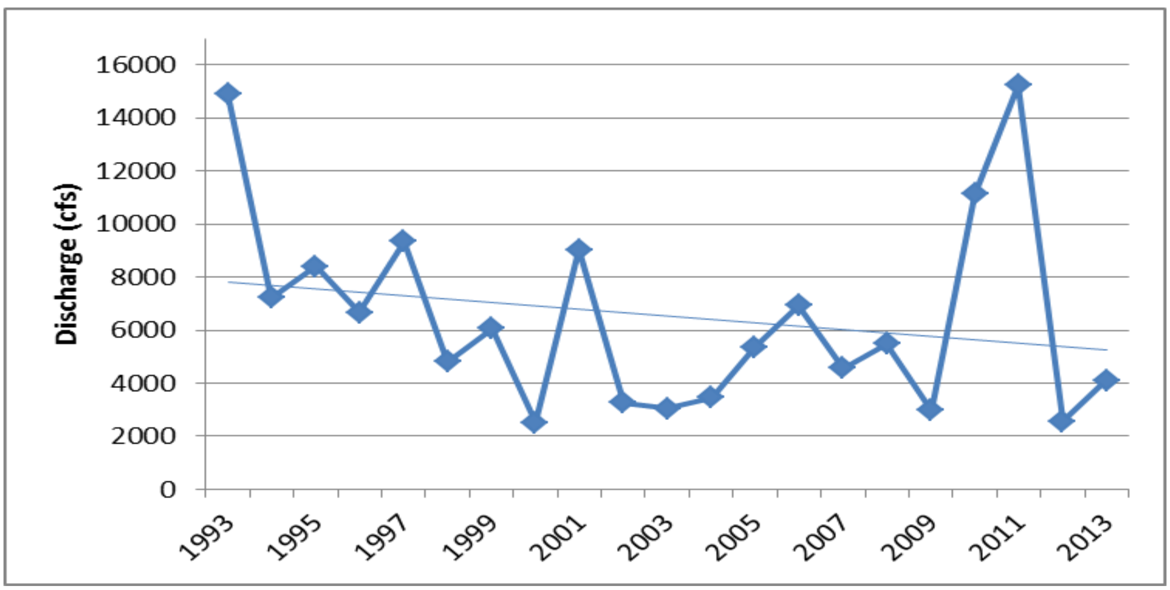


Figure 54. Mean annual discharge, Minnesota River at Mankato (1993-2009).

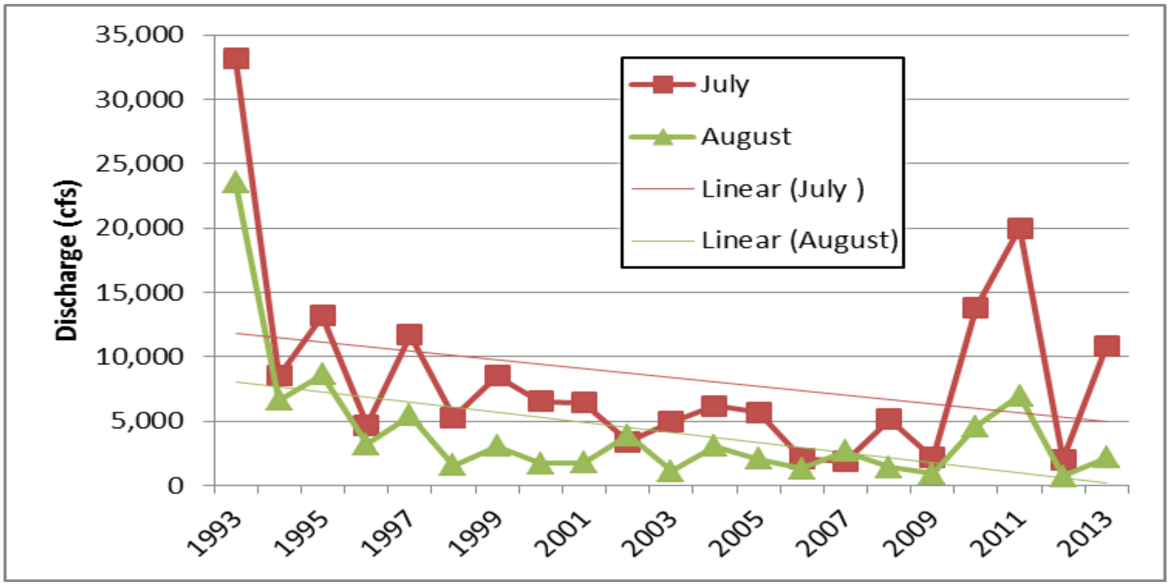


Figure 55. Mean July/August discharge, Minnesota River at Mankato (1993-2013).

Wetland condition

The MPCA began biological monitoring of wetlands in the early 1990s, focusing on wetlands with emergent vegetation (i.e., marshes) in a depressional geomorphic setting. This work resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, & crustaceans) IBIs for evaluating the ecological condition or health of this type of wetland habitat. Both IBIs are on a 0 to 100 scale with higher scores indicating better condition. Today, these indicators are used to survey wetland condition where results can be summarized regionally for Minnesota's ecoregions (Genet 2012). Most of the Minnesota River – Mankato Watershed occurs in the Temperate Prairies Ecoregion, whereas the east half of the City of Mankato Minnesota River and the all of the Shanaska Creek subwatersheds occur in the Mixed Wood Plains Ecoregion (Figure 56). Wetland condition in the Temperate Prairies Ecoregion is among the worst in the state and the Mixed Wood Plains Ecoregion is not much better. Wetland invertebrate index results in the Temperate Prairies found 47% of depressional wetlands are in poor condition while 33% of these marsh-type wetlands are in good condition (Genet 2012). Plant index results show 17% of the depressional wetlands are estimated to be in good condition and 54% in poor condition. Invasive plants, particularly narrow-leaf (*Typha angustifolia*) and hybrid cattails (*Typha* X *glauca*) and also reed canary grass (*Phalaris arundinacea*) are believed to contribute to the difference between invertebrate and plant results as their ubiquity in this region of the state is likely more detrimental to plant communities. These invasive plants readily often dominate wetland habitats outcompeting native species (Genet 2012). Their invasiveness is aided by their tolerance of nutrient enrichment, hydrologic alterations and toxic pollutants such as chlorides (Galatowitsch 2012).

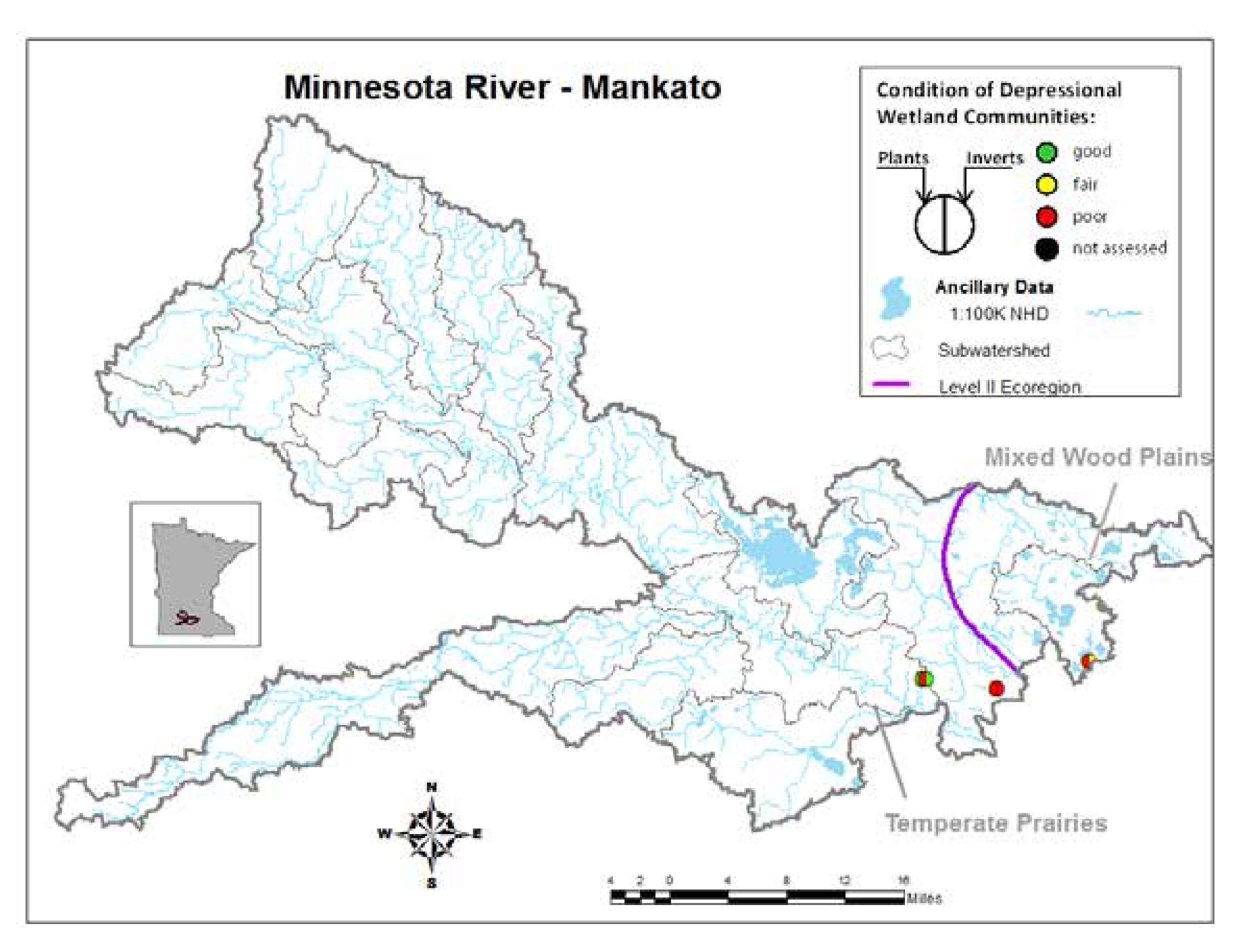


Figure 56. Depressional wetland IBI results (invertebrate and plant community indices) for the four MPCA wetland biological study sites located in the Minnesota River – Mankato Watershed.

MPCA ambient wetland condition data is available for four depressional wetlands in the Minnesota River – Mankato Watershed. Invertebrate and plant condition results for these sites are presented in Figure 56. All four of these wetland study sites were randomly selected to estimate wetland quality in the Temperate Prairie Ecoregion. The invertebrate community IBI results found two of the wetlands in 'poor' condition, one in 'fair' and one in 'good' condition. Plant community results were similar, three of the wetlands were found to be in 'poor' condition and one in 'good' condition. The one wetland which the invertebrate community result was 'good' was found to be 'poor' by the plant community index. In contrast, one of the wetlands found to be in 'poor' condition using the invertebrate community index scored 'good' in the plant community index. Overall no watershed pattern is evident in this small set of wetland condition study sites. Three of the wetlands were privately owned and one of the wetlands rated as 'poor' by both invertebrates and plants was publicly owned. The City of Mankato managed this wetland as one of their storm water ponds.

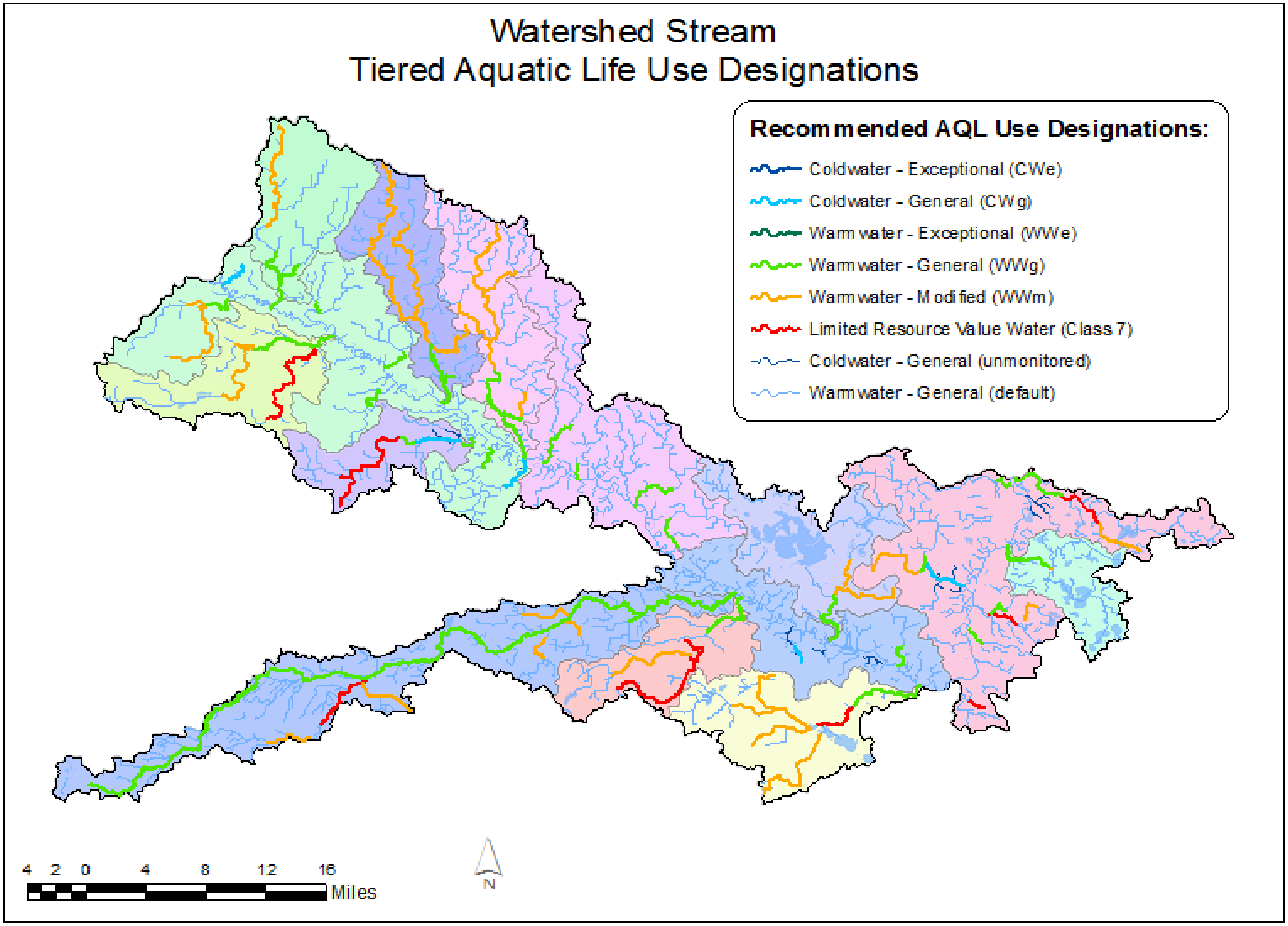


Figure 57. Stream Tiered Aquatic Life Use Designations in the Minnesota River – Mankato Watershed

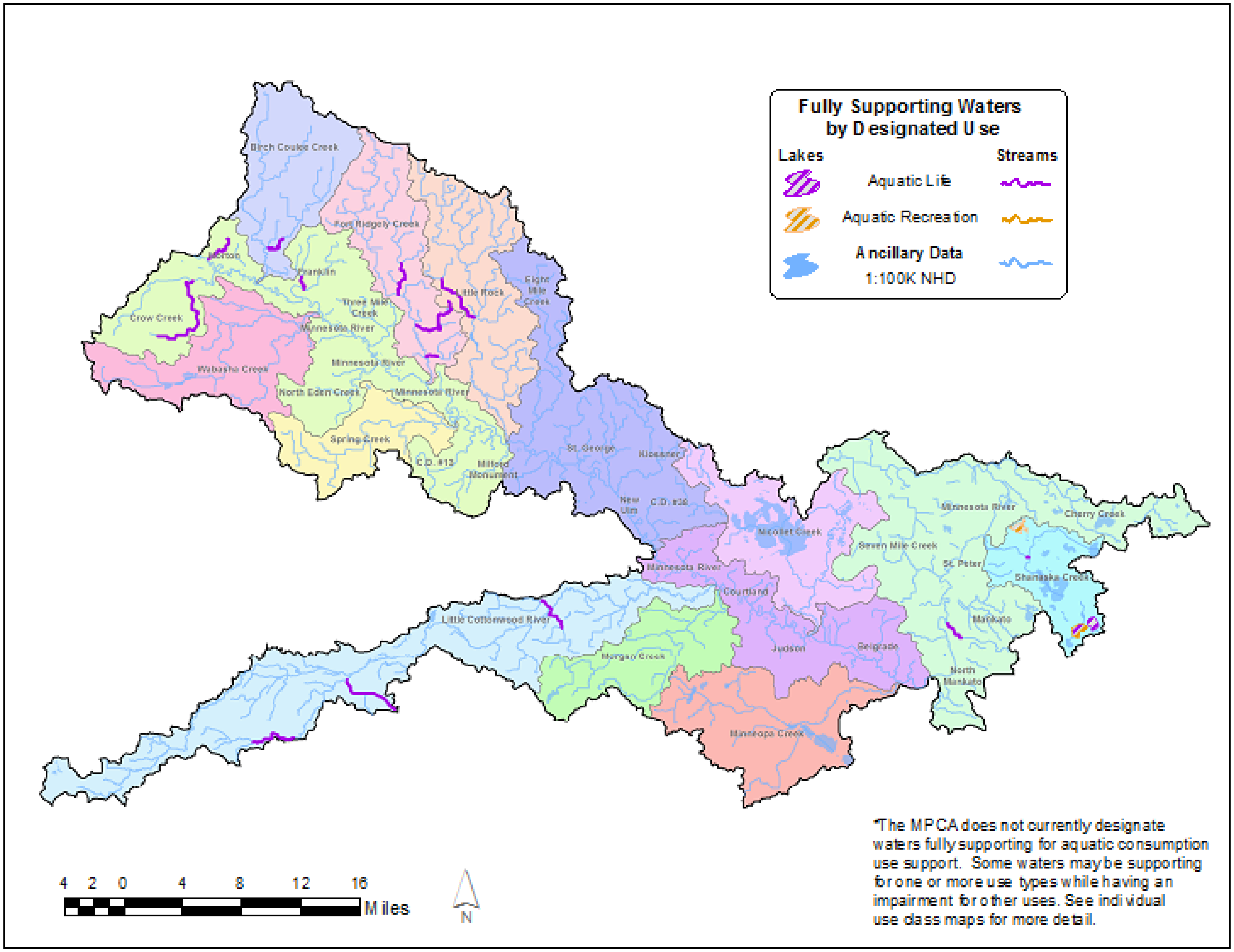


Figure 58. Fully supporting waters by designated use in the Minnesota River – Mankato Watershed

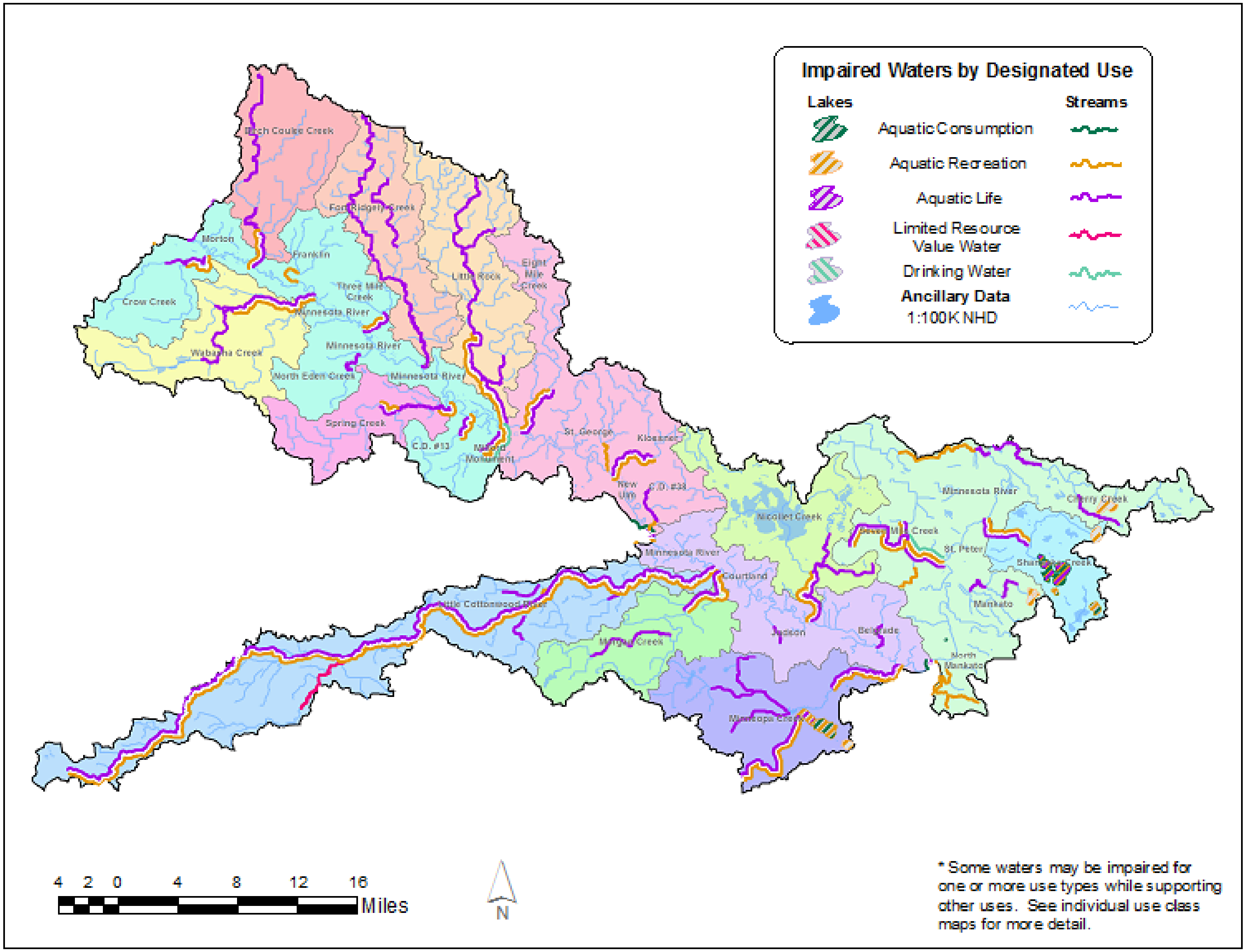


Figure 59. Impaired waters by designated use in the Minnesota River – Mankato Watershed.

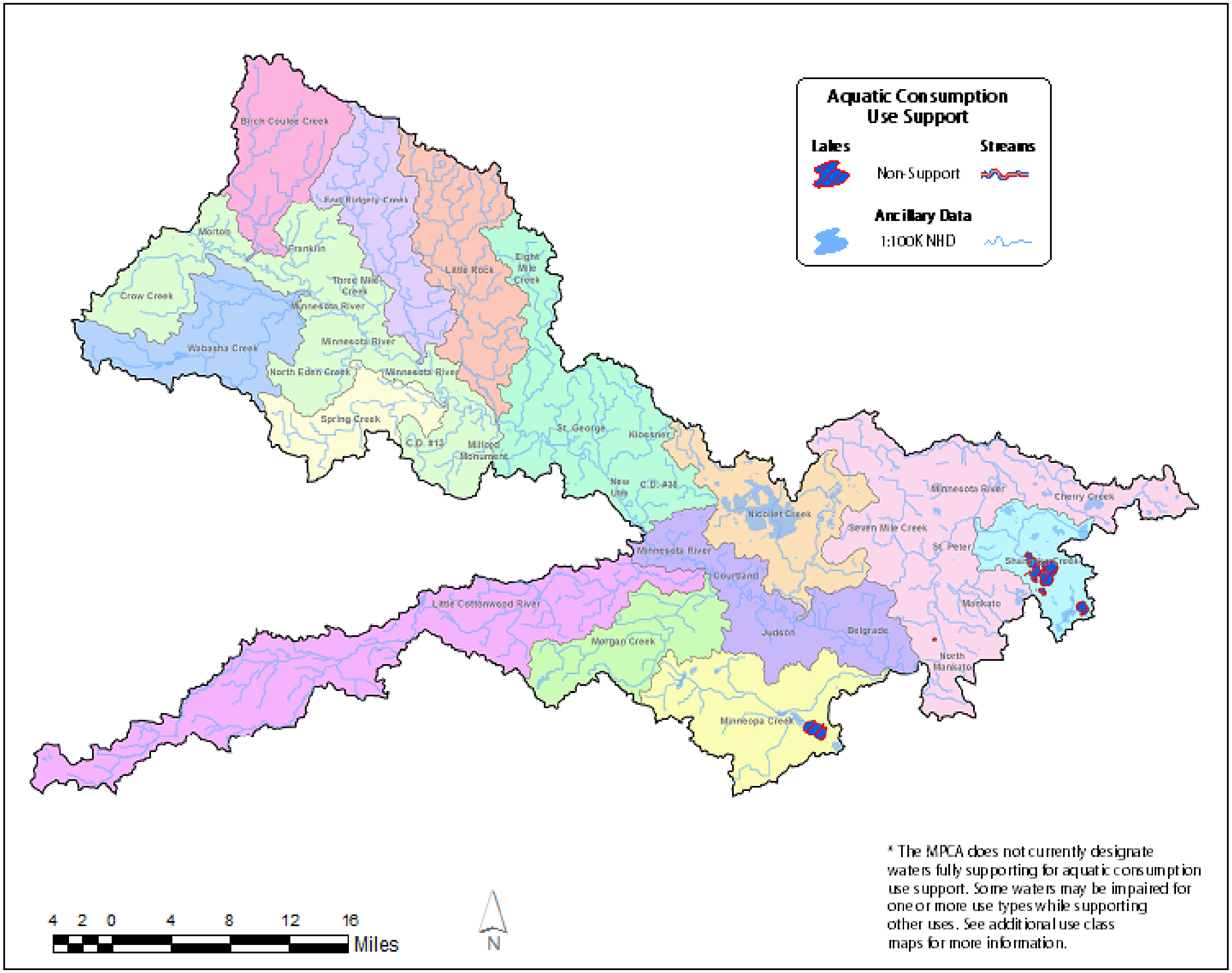


Figure 60. Aquatic consumption use support in the Minnesota River – Mankato Watershed

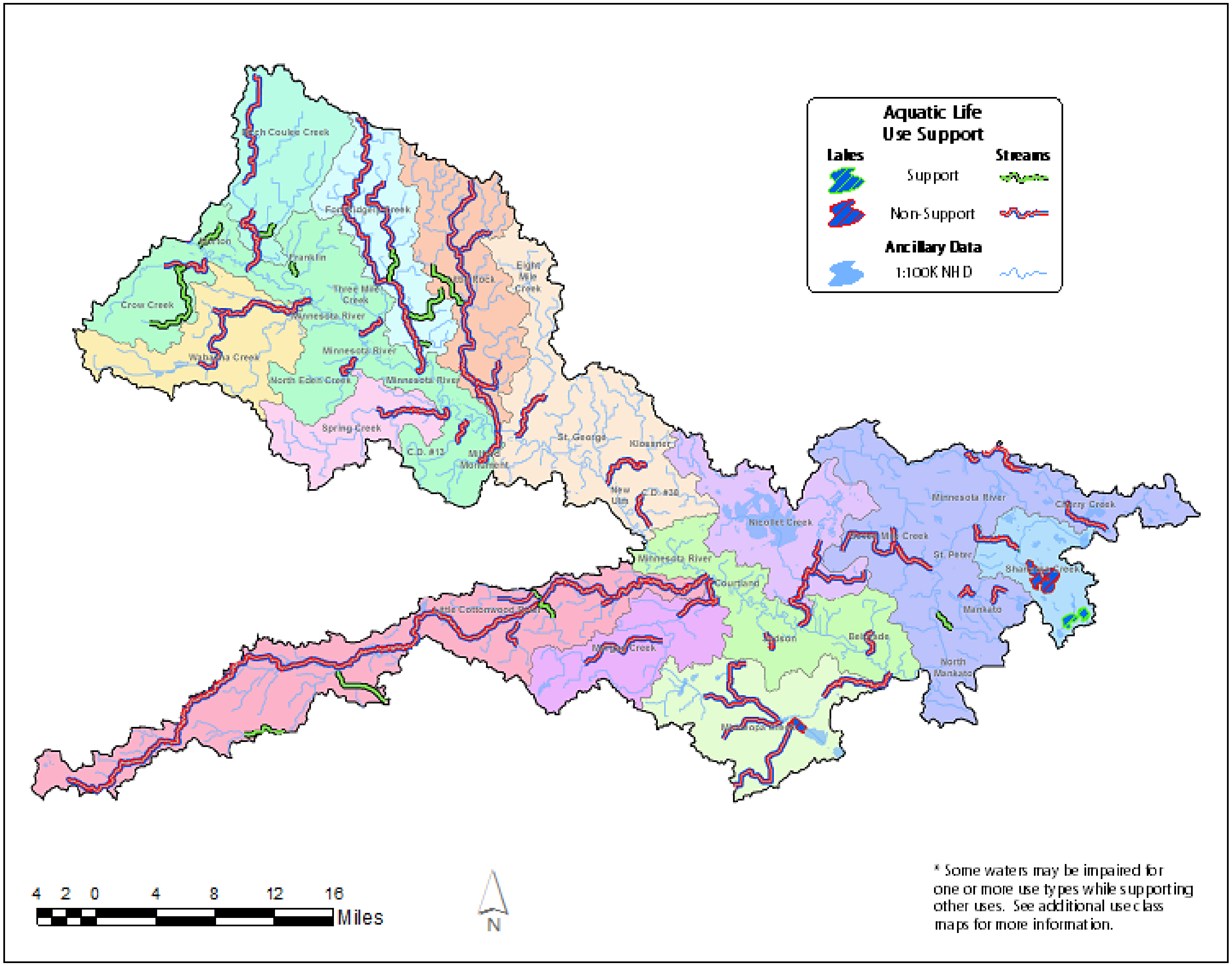


Figure 61. Aquatic life use support in the Minnesota River – Mankato Watershed

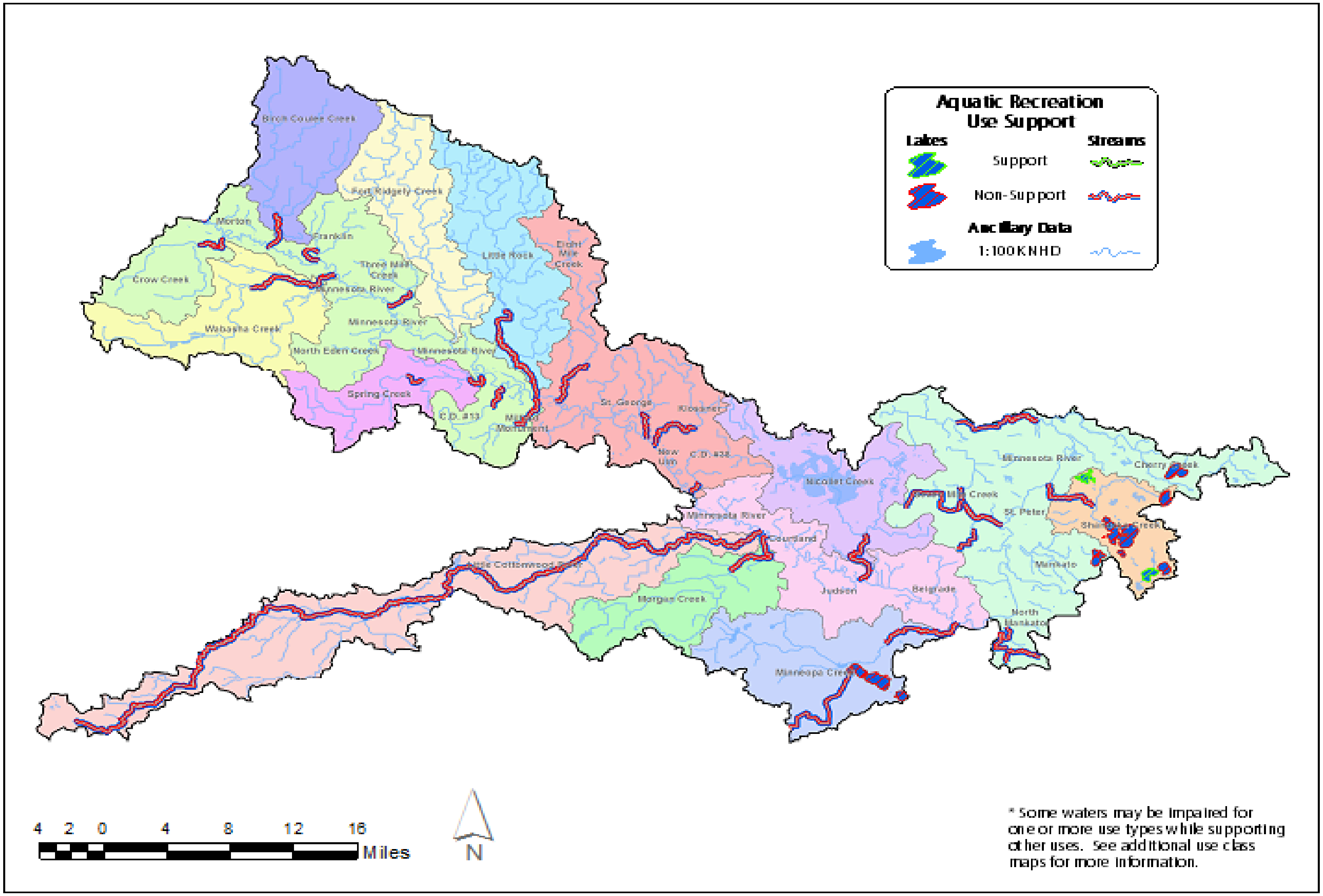


Figure 62. Aquatic recreation use support in the Minnesota River – Mankato Watershed.

Pollutant trends for the Minnesota River – Mankato Watershed

Water clarity trends at citizen monitoring sites

Volunteer citizen monitoring is being conducted at nineteen stream and seven lake locations in the Minnesota River-Mankato Watershed (Table 69). Trend analysis was conducted where sufficient long term clarity datasets were available, at this time; no clarity trend is detectable at locations where citizen stream data was collected. Trend analysis on citizen monitored lake locations indicated that water clarity is increasing on Lake Washington, while decreasing on Duck and Hallet lakes. Continued citizen data collection at these locations is vital to strengthen long term datasets, local advocacy is key to recruiting new volunteer monitors within the watershed potentially filling in data gaps between intensive watershed monitoring years.

Table 69. Water Clarity Trends at Citizen Stream Monitoring Sites.

Minnesota River-Mankato HUC 07020007	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/ increasing trend	0	1
number of sites w/ decreasing trend	0	2
number of sites w/ no trend	7	2

Summaries and recommendations

Biological monitoring

Biological communities within the Minnesota River –Mankato major watershed are significantly affected by the magnitude of human activity within that watershed. Within the watershed, extensive cropland, the dominance of ditching in the upstream reaches, urban areas with stormwater runoff and waste water treatment facilities, manmade barriers, livestock grazing and manure management, and many other aspects of human activity exhibit a cumulative effect on the biological communities present with the watershed.

Fish

Fish community data was used to assess for Aquatic Life (AQL) use on 54 AUID's within the Minnesota River-Mankato watershed. Of those assessments, F-IBI's were supporting of Aquatic Life for 18 AUID's (6 General Use, 12 Modified Use), while 36 AUID's were not supporting of Aquatic Life (4 Coldwater General Use, 20 General Use, 12 Modified Use). Two AUID's had previously listed impairments for the Fish Community, Rogers Creek (07020007-547), and Unnamed Creek (-550). For the General Use class, 23% of the AUID's were supporting of Aquatic Life based on F-IBI scores, while 76% demonstrated non-support. With lower IBI thresholds, AUID's designated as Modified Use, exhibited 50% to be supporting and 50% to be not supporting. All four of the reaches assessed that are designated coldwater, General Use were found to be not supporting of AQL.

Fifty species of fish were collected during the period of record at 106 biological monitoring stations. In a watershed dominated by intensive agricultural land use, the most common species of fish consisted of tolerant species that are not inhibited by degraded stream conditions. Of these tolerant species, Creek Chubs were found at 78% of the monitoring stations. Other common tolerant species include: fathead minnow (66% of the stations), blacknose dace (61% of stations), white sucker (44% of stations), and central stoneroller (43% of stations). Fathead minnows are also considered very tolerant and can survive a wide range of degraded conditions. Many of these same tolerant species were also found to be the most abundant, which consequently contributed to lower F-IBI scores for many of the stream reaches. Abundant populations of tolerant species typically are indicative of degraded natural conditions, often caused by human activity. Presence of urban areas, intensive agricultural land use, landscape drainage systems all contribute to fish communities composed of primarily of tolerant species.

The most common sensitive fish species was the hornyhead chub, found at 30% of the monitoring stations. Other sensitive species collected include: fantail darter (18% of the stations), northern hogsucker (7%), slenderhead darter (6%), and stonecats (5%). Sensitive fish species will be less abundant in streams that are unsuitable due to altered hydrology, lack of habitat, excess nutrients, and other factors.

Macroinvertebrates

Macroinvertebrate community data was used to assess aquatic life use support on 63 stream and river AUIDs in the watershed. Or the 63 AUIDs assessed, 44 (70%) were determined to have impaired aquatic macroinvertebrate communities, and 19 (30%) were determined to be supporting of the designated aquatic life use. Of the 44 reaches determined to be impaired, 14 were designated as modified use, 26 as general use, and 4 as coldwater. Of the 19 assessment units that were determined to have supporting macroinvertebrate communities, 15 were designated as modified use, three as general use (Unnamed Creek, -694, Threemile Creek, -704, and Unnamed Creek, -663), and one was a stream being proposed to be designated as coldwater (Unnamed Creek, -668).

Overall, a total of 210 genera in 43 families of macroinvertebrates were collected in the Minnesota Mankato watershed based on 91 qualitative multi-habitat samples collected primarily in 2013. The most commonly collected macroinvertebrates in this watershed included: midges in the genera Polypedilum, Thienemannimyia, Tanytarsus and Cricotopus; oligochaete worms; aquatic mites; snails in the genus Physa; mayflies in the genera Caenis and Baetis; and caddisflies in the genus Cheumatopsyche. As with other similar, agricultural watersheds, the majority of the commonly encountered taxa are considered tolerant. When these tolerant taxa are also collected in relatively high proportions in the samples, the typical result is a depressed IBI score, which is what was encountered throughout this watershed.

A total of 142 macroinvertebrate genera were collected from low gradient (i.e., glide/pool) streams, the most common of which were: oligochaete worms; midges in the genera Polypedilum, Paratanytarsus, Thienemannimyia, Ablabesmyia, and Dicrotendipes; snails in the genus Physa; and mayflies in the genus Caenis. In high gradient (i.e., riffle/run habitat) streams 181 macroinvertebrate genera were collected, the most common of which were: caddisflies in the genera Cheumatopsyche and Hydroptila; mayflies in the genera Baetis and Caenis; blackflies in the genus Simulium; midges Polypedilum, Rheotanytarsus, and Thienemannimyia; and snails in the genus Physa.

Very few sensitive taxa were collected in abundance in the watershed. The most commonly encountered intolerant taxa included: the caddisfly Helicopsyche (13% of sites), the riffle beetle Optioservus (17% of sites), the true fly Atherix (9% of sites), and the stonefly Acroneuria (5% sites). One very rare and sensitive taxon, the caddisfly Diplectrona, was collected at a single location: Unnamed Creek, the stream reach being recommended to change to coldwater use.

Stream water quality

Historical water chemistry data collection in the Minnesota River Mankato watershed indicates the deep interest in addressing water quality issues on tributaries to the Minnesota River. The Little Cottonwood

River, Minneopa Creek and Seven Mile Creek had previous impairment listings prior to this assessment cycle based on historical data. Chemistry data collected since those initial listings reveal we are still working to understand and develop strategies to curb these long term issues that lead to exponentially larger problems in downstream waterways (e.g. Lake Pepin). Sediment loads carried by many of these tributaries on a consistent basis are not typical of good water quality, drastically impacting natural hydrology and aquatic communities. Preserving upland surface water storage areas can reduce severity of high flow events, bank instability, channel incision and surface water runoff which typically elevate sediment loading to these tributaries. Stream buffers on many occasions provide a source for water to infiltrate naturally. A one size fits all approach will not be the long term solution to noticeable improvement to these situations mentioned above. Investing time and financial resources now will help target high priority areas to focus protection and restoration efforts. Dissolved oxygen data for many streams was skewed by faulty equipment used for collection in 2009, this data will be removed from the water quality database to ensure is not a future problem during assessment.

Bacteria concentrations are a persistent problem seen in almost every tributary in this watershed, degrading aquatic recreational use potential of these waterbodies. Concentrated animal activity within stream or immediately adjacent to the flood plain is typically associated with high bacteria levels. Limiting concentrated domesticated and wildlife access to these areas could potentially lower bacteria levels. Investigation into the compliance of private septic systems and water treatment plants could potentially be used address elevated bacteria concentrations.

Lakes

Many lakes included in this assessment show signs of human-induced disturbed land use within their contributing watershed, which often leads to excessive nutrient loading to downstream waterbodies. Newly impaired lakes are concentrated geographically on eastern side of the watershed, which is the lake-rich portion of the watershed and is impacted by increased land use conversion. Crystal, Loon, Duck, and Washington all had historical datasets which resulted in aquatic recreation use listings prior to this current assessment cycle, all will remain impaired for aquatic recreation use at this time based on new data available. Recreational enjoyment is severely impacted when lakes have frequent heavy algae blooms throughout the summer months which typically are fueled by unnaturally elevated nutrient concentrations. Poor recreational use potential can result in reduced economic benefits to local businesses that rely on healthy recreational opportunities in the area. Controlling the nutrient inputs to these lakes can engage citizens at a local level. Keeping native shoreline buffers intact, preventing yard waste input, maintaining complaint septic systems, and reducing or eliminating fertilizer use are all potential practices to investigate locally. Addressing larger scale issues such as altered surface hydrology, overland runoff, and water treatment plant compliance would be potential areas for improvement as well. In some cases, internal loading on shallow lake basins can be difficult to manage. Devoting time and financial resources to develop long term restoration and protection strategies will be required for these lakes to see water quality improvements.

During this assessment cycle, an effort was made to model priority lakes that are the most sensitive to elevated nutrient loading. This effort identified Ballantyne, Emily, Swan and Hallet lakes as the most responsive to small changes in nutrient loading, which indicates they could potentially benefit from prioritizing protection work in their contributing watershed.

Aquatic biology index data now available for lakes allows for assessment of aquatic life use not possible in previous assessments. Habitat limitations in some cases linked directly to poor water quality can be a lynchpin to thriving aquatic communities. In other cases, such as Duck Lake, aquatic recreation impairment does not directly relate to struggling aquatic communities. Tolerant taxa such as common carp, black bullhead and fathead minnow were abundant and dominated the biomass in some lakes, resulting in low biological index scores. Protecting and improving aquatic habitat both in-lake and on adjacent shoreline is key to promoting strong natural reproduction and a healthy food web to provide the building blocks for diverse aquatic communities.

Pollutant load monitoring

The Minnesota River, in particular the Blue Earth River and its tributaries, contributes a significant portion of Total Suspended Solids, Total Phosphorus, and Nitrate and Nitrite load to the Mississippi River. From 57-80% of the average load for these parameters measured at Lock and Dam Three on the Mississippi River near Hastings can be attributed to the input from the Minnesota River Basin. The Minnesota River-Mankato watershed also contributes to these inputs from the Minnesota to the Mississippi River. Pollutant loads from the various tributaries within this major watershed may be represented by data collected at the MN PCA's Load Monitoring Network station on Seven Mile Creek near St Peter. Total Suspended Solid (TSS) data from this station collected between 2007 and 2013 showed 30% of 199 samples exceeded the South River Nutrient Standard of 65mg/L, while the flow weighted mean concentration exceeded the TSS standard 6 out of the 7 years. For Total Phosphorus (TP) at this WPLMN station, 41% of the samples exceeded the South River Nutrient Region standard of 0.150 mg/L, and summer average concentrations of TP were higher than the standard for 2 of the 7 years that data was collected. Likewise, Nitrate and Nitrite Nitrogen concentrations during the same timeframe, totaling 233 samples, exceeded the drinking water standard of 10 mg/L for 59% of the samples. The seven-year Nitrate and Nitrite Nitrogen average for that time frame is 18.3 mg/L, which is the highest average among 199 stations in the WPLMN. Cover crops, improved riparian buffers, increasing water storage potential on the landscape can all help reduce some of the erosion that leads to increased suspended solids within waterways. Expanding the acreage utilizing better nutrient management practices could greatly improve the pollutant loads exhibited within the Minnesota River-Mankato watershed, and consequently, would improve the nutrient loads for downstream waters.

Fish contaminants

Nine lakes within the Minnesota River-Mankato major watershed were tested for mercury, while seven lakes were tested for polychlorinated biphenyls (PCB's). No tributary streams within the watershed were tested for mercury or PCB's due to difficulty collecting a sufficient sample of targeted gamefish and rough fish. Five lakes are impaired for mercury, which include: George, Duck, Loon, Hiniker Pond, and Washington. Of these lakes, all are included under the Statewide Mercury TMDL except for Lake George, which had high enough mercury levels to warrant a TMDL specific to this waterbody. No lakes were impaired for PCB's, with most of the data falling at or below the reporting limit (0.01-0.05 mg/kg). Mercury is considered the fish contaminant of greatest concern within the Minnesota River-Mankato major watershed. Continued monitoring for fish contaminants can determine if the concentrations of contaminates in fish in Impaired waterbodies are increasing, or declining. Also waterbodies that have not been previously monitored would benefit from continued monitoring to determine if contaminants are a problem.

Groundwater

The primary concerns for groundwater within the watershed are naturally-occurring arsenic in drinking water and groundwater quantity in the heavily agricultural areas of the watershed. With regard to arsenic, the Minnesota Department of Health is continually monitoring arsenic in drinking water supplies and in all new wells. Regarding groundwater quantity, increasing withdrawals and a slight decrease in flow suggest continued attention. Groundwater supply and its potential impacts on surface water bodies can be tracked by two Minnesota DNR efforts; the cooperative stream gauging effort to define trends in flow, and annual reporting of high-capacity withdrawals to determine how they, too, change over time

Wetlands

Historically, wetlands were estimated to cover approximately 52% of the watershed area, or 446,180 acres within the Minnesota River-Mankato Watershed. Currently, only about 7.34% (63,240 acres) of wetlands remain, which accounts for a loss of approximately 44% within the major watershed. Among the Aggregated 12-HUC's within the major watershed, Swan Lake Outlet (Nicollet Creek) (0702000708-01) currently has the highest percentage of wetland cover (12% of the sub-watershed area). Depending on the location within the major watershed, most subwatersheds have lost between 30-65% of historical wetlands. Many of the present day wetlands are found along the Minnesota River floodplain. Within the major watershed, four sites were randomly located and sampled for wetland condition. Based on macroinvertebrate IBI's, two of those sites were considered in poor condition, one site was considered in fair condition, and one site was considered in good condition. For the same wetland sites, plant IBI's rated three of the sites in poor condition, and 1 site in good condition. With only four sites sampled within the major watershed, no trend was apparent. Most of the western three quarters of the major watershed fall within the Temperate Prairies Level II Ecoregion, where the condition of wetlands is considered significantly degraded compared to other parts of the state. Invasive species such as narrow-leafed cattail and reed canary grass, aided by nutrient enrichment, hydrologic alterations, and toxic contaminates continue to pose a threat to existing wetlands within the major watershed. Management practices designed to curb these threats would greatly benefit condition of wetlands, as well as the condition of other waterbodies within the major watershed. Restoration of historical wetlands that have been lost would also benefit the watershed with increased ecological and hydrologic functions such as water storage, nutrient sinks, carbon sequestering, and many others.

Literature cited

Galatowitsch, S.A. 2012. Why invasive species stymie wetland restoration; Society of Wetland Scientists Research Brief, No. 2012-0001. 4 pp. http://www.sws.org/category/sws-research-briefs.html

Genet, J. A. 2012. Status and Trends of wetland s in Minnesota: Depressional Wetland Quality Baseline. Minnesota Pollution Control Agency, Biological Monitoring Program, St. Paul, Minnesota. 80 pp. http://www.pca.state.mn.us/index.php/view-document.html?gid=17741

Kevin Kuehner. 2001. Seven-Mile Creek Watershed Project, A Resource Investigation within the Middle Minnesota Major Watershed.

Larson, Lee W. 1996. The Great USA Flood of 1993. http://www.nwrfc.noaa.gov/floods/papers/oh_2/great.htm

Lore, Jon. 2015. Minnesota River, Mankato Watershed Characterization Report. Division of Ecological and Water Resources, Minnesota Department of Natural Resources, St Paul, Minnesota. 99 pp.

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

Minnesota Department of Agriculture (MDA). 2009. 2009 Water Quality Monitoring Report. Pesticide and Fertilizer Management Division, Minnesota Department of Agriculture, St. Paul, Minnesota. http://www.mda.state.mn.us/~/media/Files/chemicals/reports/2009waterqualitymonrpt.ashx

Minnesota Department of Agriculture (MDA). 2010. 2010 Water Quality Monitoring Report. Pesticide and Fertilizer Management Division, Minnesota Department of Agriculture, St. Paul, Minnesota. http://www.mda.state.mn.us/chemicals/pesticides/~/media/Files/chemicals/maace/2010wqmreport.ashx.

Minnesota Department of Natural Resources (2001), Figure 1: Minnesota Ground Water Provinces. Retrieved from http://files.dnr.state.mn.us/natural_resources/water/groundwater/provinces/gwprov.pdf

Minnesota Department of Natural Resources: State Climatology Office (2015), Annual Precipitation Maps. Retrieved from http://climate.umn.edu/doc/annual_pre_maps.htm

Minnesota Department of Natural Resources (MDNR). 2015. Watershed Health Assessment Framework (WHAF). Watershed Report Card: Minn R-Mankato. Division of Ecological and Water Resources, Minnesota Department of Natural Resources, St. Paul, MN. http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_28.pdf

Minnesota Pollution Control Agency (1998). Baseline Water Quality of Minnesota's Principal Aquifers: Region 4, Southwest Minnesota.

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

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

Minnesota Pollution Control Agency (MPCA). 2008a. Watershed Approach to Condition Monitoring and Assessment. Appendix 7 *in* Biennial Report of the Clean Water Council. Minnesota Pollution Control Agency, St. Paul, Minnesota.

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

Minnesota Pollution Control Agency (MPCA). 2010c. Guidance Manual for Assessing the Quality of Minnesota Surface Water for the Determination of Impairment: 305(b) Report and 303(d) List. Environmental Outcomes Division, Minnesota Pollution Control Agency, St. Paul, Minnesota.

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

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

Minnesota Pollution Control Agency (MPCA). 2010f. Aquatic Life Water Quality Standards Technical Support Document for Nitrate. http://www.pca.state.mn.us/index.php/view-document.html?gid=14949

Minnesota Pollution Control Agency (MPCA). 2011. Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity). http://www.pca.state.mn.us/index.php/view-document.html?gid=14922

Minnesota Pollution Control Agency (MPCA). 2013. Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria. http://www.pca.state.mn.us/index.php/view-document.html?gid=14948

Minnesota Pollution Control Agency (MPCA). 2013-2. Nitrogen in Minnesota's Waters. Conditions, trends, sources, and reductions. https://www.pca.state.mn.us/sites/default/files/wq-s6-26a.pdf

Minnesota Pollution Control Agency and Minnesota State University Mankato (MPCA and MSUM). 2009. State of the Minnesota River, Summary of Surface Water Quality Monitoring 2000-2008. http://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/reports/basin/state_08/2008_fullreport1109.pdf?field_pubtitle_value=State+of+the+Minnesota+River&field_pubauthor_value=&body_value=&taxonomy_vocabulary_1_tid%255B%255D=1258&=Apply

Minnesota Pollution Control Agency (MPCA). 2014. Guidance Manual for Assessing the Quality of Minnesota Surface Water for the Determination of Impairment: 305(b) Report and 303(d) List. http://www.pca.state.mn.us/index.php/view-document.html?gid=16988

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

Natural Resource Conservation Service. 2006. Major Land Resource Regions Custom Report. USDA Agriculture Handbook 296. NRCS. USDA. http://apps.cei.psu.edu/mlra/.

Natural Resource Conservation Service (NRCS). 2009. Rapid Watershed Assessment: Middle Minnesota Watershed (MN) HUC: 07020007. NRCS. USDA. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022269.pdf

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the Upper Midwest States. EPA/600/3-88/037. Corvallis, OR: United States Environmental Protection Agency. 56 p.

State Climatology Office- MDNR Division of Ecological and Water Resources. 2014. http://www.dnr.state.mn.us/climate/historical/water_year_maps.html

Tiner, R. 2011 Dichotomous Keys and Mapping Codes for Wetland Landscape Position: Landform, Water Flow Path, and Waterbody Type Descriptors (vers. 2.0) http://www.fws.gov/northeast/wetlands/publications/dichotomousKeys_090611wcover.pdf

United States Department of Agriculture (USDA). National Agricultural Statistics Service Cropland Data Layer. 2013. Published crop-specific data layer [Online]. https://nassgeodata.gmu.edu/CropScape/ USDA-NASS, Washington, DC.

University of Missouri Extension. 1999. Agricultural Phosphorus and Water Quality. Pub. G9181. http://extension.missouri.edu/publications/DisplayPub.aspx?P=G9181.

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

Wiken, Ed, Francisco Jiménez Nava, and Glenn Griffith. 2011. North American Terrestrial Ecoregions—Level III. Commission for Environmental Cooperation, Montreal, Canada.

Appendix 1 - Water chemistry definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix 2.1 – Intensive watershed monitoring water chemistry stations in the Minnesota River-Mankato Watershed

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	12-digit HUC
13MN008	S005-662	Birch Coulee Creek	At MN 19, 1.5 mi. SE of Morton	Birch Coulee Creek
13MN002	S005-628	Crow Creek	At Noble Ave, 3 mi. E of Redwood Falls	Spring Creek-Minnesota River
13MN091*	S005-627	Wabasha Creek	At CSAH 11, 1.5 mi. S of Franklin	Wabasha Creek
05MN013	S005-665	Fort Ridgely Creek	At CSAH 21, 5.5 mi. S of Farifax	Fort Ridgely Creek
13MN032	S007-569	Little Rock Creek	At Newton Twp Rd 40, 7 mi. SE of Fairfax	Little Rock Creek
13MN087*	S005-625	Spring Creek	At CSAH 10, 5.5 mi. NW of Essig	Spring Creek
13MN033	S004-348	Eight Mile Creek	At CSAH 5, 8 mi. NW of New Ulm	City of New Ulm-Minnesota River
13MN052	S004-609	Little Cottonwood River	At Apple Rd, 1.6 mi. S of Courtland	Little Cottonwood River
13MN055	S007-339	Morgan Creek	At CR 47, 0.5 mi. S of Cambria	Morgan Creek
13MN066	S001-985	Minneopa Creek	At State Park Rd 7, Minneopa State Park, 4 mi. W of Mankato	Minneopa Creek
03MN069	S007-571	Swan Lake Outlet (Nicollet Creek)	At CR 62, 4.5 mi. NW of Mankato	Swan Lake Outlet(Nicollet Creek)
09MN090	S002-937	Seven Mile Creek	Upstream of Hwy 169, Seven Mile Creek City Park (Second Foot Bridge), 5.5 mi. W of St. Peter	City of Mankato-Minnesota River
91MN061	S007-570	Rogers Creek	At CR 20, 1 mi. N of Saint Peter	City of Mankato-Minnesota River

*Biological Monitoring stations in the Spring Creek and Wabasha Creek Aggregated 12-HUC subwatersheds were not collocated with intensive water chemistry stations as outlet sites failed to meet the biological monitoring location criteria (proximity to larger body of water).

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Minnesota River-Mankato Watershed

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07020007-518	13MN045	Altermatts Creek	Upstream of 330th Ave., 4 mi. NE of Comfrey	Brown	0702000707-01
07020007-525	13MN022	County Ditch 3	Upstream of 465th St., 2 mi. SW of Fairfax	Renville	0702000703-01
07020007-527	13MN012	Wabasha Creek	Upstream of 305th St., 3 mi. S of Franklin	Redwood	0702000702-01
07020007-528	13MN011	County Ditch 109	Upstream of 300th St., 4.5 mi. N of Morgan	Redwood	0702000702-01
07020007-528	13MN092	County Ditch 109	Off of driveway near CSAH 2, 2 mi. N of Morgan	Redwood	0702000702-01
07020007-531	13MN061	Minneopa Creek	Upstream of CR 111, 1 mi. NW of Lake Crystal	Blue Earth	0702000709-01
07020007-531	13MN060	Minneopa Creek	Upstream of CR 108, 3 mi. NW of Lake Crystal	Blue Earth	0702000709-01
07020007-533	13MN064	Minneopa Creek	Downstream of Hwy 60, 1 mi. N of Lake Crystal	Blue Earth	0702000709-01
07020007-534	13MN066	Minneopa Creek	Upstream of State Park Rd. 7 in Minneopa State Park, 4 mi. W of Mankato	Blue Earth	0702000709-01
07020007-534	13MN065	Minneopa Creek	Upstream of 280th St., 3.5 mi. NE of Lake Crystal	Blue Earth	0702000709-01
07020007-535	13MN062	County Ditch 27	Upstream of 505th Ave, 1 mi. W of Lake Crystal	Blue Earth	0702000709-01
07020007-541	13MN088	Cherry Creek	Downstream of CR 15, 0.25 mi. S of Cleveland	Le Sueur	0702000711-01
07020007-542	13MN080	Cherry Creek	Upstream of 307th Ave, 2 mi. NW of Cleveland	Le Sueur	0702000711-01
07020007-543	13MN081	Cherry Creek	Upstream of 321st Ave., 1.5 mi NE of St. Peter	Le Sueur	0702000711-01
07020007-543	13MN083	Cherry Creek	Off of private Drive bridge East of CR 23, 1 mi. S of Ottawa	Le Sueur	0702000711-01
07020007-544	13MN054	County Ditch 63	Upstream of 145th Ave., 2 mi. E of Linden	Brown	0702000710-02
07020007-545	13MN056	County Ditch 4/County Ditch 39	Upstream of Hwy 14 SE of Nicollet	Nicollet	0702000708-01
07020007-545	13MN057	County Ditch 4/County Ditch 39	Downstream of CR 23, 1 mi. S of Nicollet	Nicollet	0702000708-01
07020007-547	91MN061	Rogers Creek	Downstream from CSAH 20, 3 mi N of St. Peter	Nicollet	0702000711-01
07020007-547	13MN094	Rogers Creek	Downstream of CR 20, 1 mi. N of St. Peter	Nicollet	0702000711-01
07020007-548	91MN057	Unnamed creek	Upstream of 170th St, 5 mi. NW of Hanska	Brown	0702000707-01
07020007-550	03MN072	Unnamed creek	Upstream of CR 5, 4 mi N of Mankato	Blue Earth	0702000711-01

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07020007-557	13MN063	County Ditch 56 (Lake Crystal Inlet)	Upstream of CR 20, 1 mi. S of Lake Crystal	Blue Earth	0702000709-01
07020007-562	09MN090	Seven Mile Creek	Upstream of Hwy 169, 4.5 mi. SW of St Peter	Nicollet	0702000711-01
07020007-566	13MN075	Unnamed creek	Upstream of Lime Valley Rd, 2 mi. N of Mankato	Blue Earth	0702000711-01
07020007-566	13MN074	Unnamed creek	Downstream of 238th St, 2 mi. N of Mankato	Blue Earth	0702000711-01
07020007-569	13MN002	Crow Creek	Downstream of Noble Ave., 3 mi. E of Redwood Falls	Redwood	0702000704-01
07020007-571	05MN011	County Ditch 10 (John's Creek)	30 meters upstream of CR 29, ~3 miles NW of Essig. (DNR site: Johns Creek site #1)	Brown	0702000704-01
07020007-571	09MN080	County Ditch 10 (John's Creek)	Downstream of Hwy 29, 7 mi. NE of Sleepy Eye	Brown	0702000704-01
07020007-573	13MN090	Spring Creek	Upstream of CR 10, 5 mi. S of Fairfax	Brown	0702000704-02
07020007-574	91MN055	Spring Creek (Hindeman Creek)	Upstream of Golden Gate Road, 7 mi. N of Sleepy Eye	Brown	0702000704-02
07020007-577	09MN094	Unnamed creek	Upstream of Hwy 68, 2.5 mi. W of Judson	Blue Earth	0702000710-01
07020007-582	13MN006	Judicial Ditch 12	Downstream of CR 73, 5.5 mi. N of Franklin	Renville	0702000701-01
07020007-587	13MN008	Birch Coulee Creek	Upstream of MN 19, 1.5 mi. SE of Morton	Renville	0702000701-01
07020007-587	14MN210	Birch Coulee Creek	0.3 mi. SW of 675th Ave, 1.5 mi. NE of Morton	Renville	0702000701-01
07020007-588	90MN053	Birch Coulee Creek	Upstream of Unnamed road, in Birch Coulee Battlefield park, 2 mi. N of Morton	Renville	0702000701-01
07020007-593	13MN059	Judicial Ditch 48	Upstream of CR 6 near Butternut	Blue Earth	0702000709-01
07020007-607	91MN060	Unnamed creek	downstream from Co Rd 16, 2.5 mi. N of Madison Lake	Le Sueur	0702000711-02
07020007-622	13MN024	Spring Creek (Judicial Ditch 29)	Downstream of 300th St., 7 mi. E of Morgan	Brown	0702000704-02
07020007-636	07MN074	County Ditch 52	Upstream of CR 1, 1 mi. E of Redwood Falls	Redwood	0702000704-01
07020007-646	10EM115	Unnamed creek (County Ditch 11)	0.5 mi. W of Grandview Rd, 6.5 mi. SW of New Ulm	Brown	0702000707-01
07020007-647	10EM019	Unnamed ditch	Downstream of 490th St, 5 mi. N of Fairfax	Renville	0702000705-01
07020007-656	13MN046	County Ditch 28-1	Downstream of 320th Ave., 4.5 mi. NE of Comfrey	Brown	0702000707-01
07020007-657	13MN049	County Ditch 11	Downstream of 200th Ave., 4 mi. of Stark	Brown	0702000707-01

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07020007-658	13MN051	County Ditch 67	Downstream of CR 24, 1 mi. W of Searles	Brown	0702000707-01
07020007-660	13MN067	County Ditch 3	Upstream of CR 6, 2 mi. W of Mankato	Nicollet	0702000710-01
07020007-661	13MN058	County Ditch 11	Upstream of 451st Ave, 1 mi. S of Nicollet	Nicollet	0702000708-01
07020007-662	13MN035	Unnamed creek	Upstream of CR 21, 1 mi. S of Saint George	Nicollet	0702000706-01
07020007-663	13MN023	Unnamed creek	Downstream of CR 4, 3 mi. S of Fairfax	Renville	0702000703-01
07020007-664	13MN020	County Ditch 115	Upstream of Hwy 19, 2 mi. W of Fairfax	Renville	0702000703-01
07020007-665	13MN030	County Ditch 100	Upstream of 640th Ave, 1.5 mi E of Fairfax	Renville	0702000705-01
07020007-666	13MN028	Judicial Ditch 8	Downstream of CR 27, 3 mi. NE of Fairfax	Renville	0702000705-01
07020007-667	13MN009	County Ditch 105	Downstream of Omega Ave, 4 mi. S of Morton	Redwood	0702000702-01
07020007-668	13MN003	Unnamed creek	Upstream of CR 15, 1.5 mi. NW of Morton	Renville	0702000704-01
07020007-669	13MN005	County Ditch 85A	Downstream of CR 69, 6.5 mi. NE of Franklin	Renville	0702000701-01
07020007-670	13MN004	County Ditch 124	Downstream of CR 50, 6 mi. N of Morton	Renville	0702000701-01
07020007-671	13MN001	County Ditch 22	Upstream of CR 24, 2 mi. E of Redwood Falls	Redwood	0702000704-01
07020007-672	13MN016	County Ditch 111	Upstream of Hwy 19, 1 mi. W of Franklin	Renville	0702000704-01
07020007-673	13MN018	County Ditch 115	Upstream of 440th St., 7 mi. NW of Fairfax	Renville	0702000703-01
07020007-675	13MN040	Heyman's Creek	Downstream of 446th St., 1 mi. E of New Ulm	Nicollet	0702000706-01
07020007-676	13MN048	Little Cottonwood River	Downstream of CR 11, 4 mi. NW of Hanska	Brown	0702000707-01
07020007-676	13MN041	Little Cottonwood River	Downstream of 380th Ave., 3 mi. E of Dotson	Brown	0702000707-01
07020007-676	91MN056	Little Cottonwood River	Upstream of CR 2, 7 mi. E of Jeffers	Cottonwood	0702000707-01
07020007-676	13MN089	Little Cottonwood River	Upstream of 320th Ave., 5 mi. NE of Comfrey	Brown	0702000707-01
07020007-676	13MN044	Little Cottonwood River	Upstream of 330th Ave., 4.5 mi. NE of Comfrey	Brown	0702000707-01
07020007-677	13MN052	Little Cottonwood River	Downstream of Apple Rd., 1.6 mi. S of Courtland	Blue Earth	0702000707-01

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07020007-677	97MN009	Little Cottonwood River	near Searles, MN	Brown	0702000707-01
07020007-677	13MN050	Little Cottonwood River	Upstream of 150th Ave, 2 mi. W of Searles	Brown	0702000707-01
07020007-677	90MN058	Little Cottonwood River	Downstream of Hwy 15, 4 mi S of New Ulm	Brown	0702000707-01
07020007-678	91MN059	County Ditch 46A	Upstream of township road 186/411th Ave, 6.5 mi W of Kasota	Nicollet	0702000711-01
07020007-679	13MN069	County Ditch 46A	Downstream of CR 13, 6 mi. SW of Saint Peter	Nicollet	0702000711-01
07020007-681	13MN043	Altermatts Creek	Upstream of CR 1, 1 mi. W of Comfrey	Cottonwood	0702000707-01
07020007-683	13MN086	Swan Lake Outlet (Nicollet Creek)	Upstream of CR 62, 4.5 mi. NW of Mankato	Nicollet	0702000708-01
07020007-683	03MN069	Swan Lake Outlet (Nicollet Creek)	4 mi. S. of Nicollet on S. side of CR 61	Nicollet	0702000708-01
07020007-684	13MN033	Eightmile Creek	Downstream of CSAH 5, 3 mi. W of St. George	Nicollet	0702000706-01
07020007-684	13MN087	Eightmile Creek	Upstream of CR 5, 3 mi. W of Saint George	Nicollet	0702000706-01
07020007-686	13MN026	Little Rock Creek (Judicial Ditch 31)	Downstream of CR 75, 2.5 mi NE of Fairfax	Renville	0702000705-01
07020007-686	13MN027	Little Rock Creek (Judicial Ditch 31)	Downstream of 490th St, 2 mi NE of Fairfax	Renville	0702000705-01
07020007-686	13MN029	Little Rock Creek (Judicial Ditch 31)	Upstream of 640th Ave., 2.5 mi. E of Fairfax	Renville	0702000705-01
07020007-687	13MN032	Little Rock Creek (Judicial Ditch 31)	Upstream of 362nd St., 7 mi. SE of Fairfax	Nicollet	0702000705-01
07020007-687	03MN020	Little Rock Creek (Judicial Ditch 31)	About 4 mi. SE of Fairfax, downstream of CR 77	Renville	0702000705-01
07020007-687	03MN019	Little Rock Creek (Judicial Ditch 31)	6 mi. SE of Fairfax, upstream of CR 5	Nicollet	0702000705-01
07020007-688	13MN017	County Ditch 106A (Fort Ridgley Creek)	Upstream of 730th Ave, 6.5 mi. N of Franklin	Renville	0702000703-01

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07020007-688	13MN019	County Ditch 106A (Fort Ridgley Creek)	Upstream of 440th St, 3 mi. W of Fairfax	Renville	0702000703-01
07020007-688	91MN054	County Ditch 106A (Fort Ridgley Creek)	Along 420th St, 5 mi. NE of Franklin	Renville	0702000703-01
07020007-689	05MN013	Fort Ridgley Creek	~900 meters upstream of CR 21, in Fort Ridgely State Park (DNR site #1, began at the upstream end of the park picnic area)	Nicollet	0702000703-01
07020007-689	13MN021	Fort Ridgley Creek	Downstream of 630th Ave., 2 mi. S of Farifax	Renville	0702000703-01
07020007-689	05MN015	Fort Ridgley Creek	upstream of CR 39, 3 miles SW of Fairfax (DNR site #3)	Renville	0702000703-01
07020007-689	05MN014	Fort Ridgley Creek	~1.5 mi. upstream of the Nicollet/Renville county line, in Fort Ridgely State Park (DNR site #2, at the downstream of the horse camp)	Renville	0702000703-01
07020007-691	13MN055	Morgan Creek	Downstream of CR 47, 0.5 mi. S of Cambria	Blue Earth	0702000710-02
07020007-692	13MN077	Shanaska Creek	Upstream of CR 19, 2 mi. E of Kasota	Le Sueur	0702000711-02
07020007-693	13MN079	Shanaska Creek	Downstream of Pearl St, in Kasota	Le Sueur	0702000711-02
07020007-694	13MN073	Unnamed creek	Downstream of CR 5, 1 mi. E of Benning	Blue Earth	0702000711-01
07020007-696	01MN020	Unnamed creek	Upstream of 240th St., 4.5 mi. NE of Mankato	Blue Earth	0702000711-01
07020007-699	13MN010	Wabasha Creek	Upstream of 300th St., 4.5 mi. S of Morton	Redwood	0702000702-01
07020007-701	13MN053	Judicial Ditch 10	Upstream of 112th Ave, 2 mi E of Linden	Brown	0702000710-02
07020007-703	13MN068	Seven Mile Creek	Downstream of Hwy 99, 5 mi. E of Nicollet	Nicollet	0702000711-01
07020007-704	13MN014	Threemile Creek	Downstream of 623rd Ave, 4 mi. SW of Fairfax	Renville	0702000704-01
07020007-707	13MN007	Judicial Ditch 12	Downstream of CR 2, 2.5 mi. NE of Morton	Renville	0702000701-01
07020007-709	05MN012	Fritsche Creek (County Ditch 77)	3 miles N of New Ulm (DNR site Fritsche Creek site #1)	Nicollet	0702000706-01
07020007-711	07MN080	County Ditch 124	Downstream of 720th Ave, 6 mi. N of Morton	Renville	0702000701-01
07020007-712	13MN025	County Ditch 13	Downstream of CR 10, 5.5 mi. N of Sleepy Eye	Brown	0702000704-01
07020007-715	13MN013	Unnamed creek	Upstream of CR 8, 6 mi. NE of Morgan	Brown	0702000704-01
07020007-716	13MN031	Judicial Ditch 13	Upstream of CR 5, 7 mi. SE of Fairfax	Nicollet	0702000705-01
07020007-717	10EM083	Judicial Ditch 13	Adjacent to CSAH 5, 7 mi. SE of Fairfax	Nicollet	0702000705-01
07020007-718	13MN047	Unnamed creek	Downstream of CR 22, 3.5 mi. NW of Hanska	Brown	0702000707-01

Appendix 3.1 – AUID table of stream assessment results (by parameter and beneficial use)

AUID DESCRIPTIONS		USES						Aquatic Life Indicators:									
Assessment Unit ID (AUID), Stream Reach Name, Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014	Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A
HUC 12 Agg: 0702000701-01 Birch Coulee Creek																	
07020007-582, Judicial Ditch 12, Headwaters to Unnamed ditch	3.50	2Bg, 3C	IF							IF	IF	IF		IF	IF	IF	
07020007-587, Birch Coulee Creek, JD 12 to Minnesota R	3.76	2Bg, 3C	NS	NS				EXS	EXS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	
07020007-588, Birch Coulee Creek, Unnamed ditch to JD 12	3.71	2Bg, 3C	NS					EXP	EXS	IF	IF	MTS		IF	IF	IF	
07020007-669, County Ditch 85A, Headwaters to CD 124	6.77	2Bg, 3C	IF							IF	IF	IF		IF	IF	IF	
07020007-670, County Ditch 124, Headwaters to CD 85A	8.26	2Bm, 3C	NS						EXS	IF	IF	IF		IF	IF	IF	
07020007-707, Judicial Ditch 12, CSAH 2 to CD 136	2.34	2Bg, 3C	FS					MTS		IF	IF	IF		IF	IF	IF	
07020007-711, County Ditch 124, CD 85A to T113 R34W S5, west line	1.69	2Bm, 3C	NS					MTS	EXS	IF	IF	IF		IF	IF	IF	
HUC 12 Agg: 0702000702-01 Wabasha Creek																	
07020007-527, Wabasha Creek, T112 R34W S19, west line to Minnesota R	8.41	2Bg, 3C	NS	NS				EXS	EXS	IF	IF	MTS	MTS	MTS	MTS	EX	
07020007-528, County Ditch 109, T111 R34W S17, west line to Wabasha Cr	10.58	7								IF				IF	IF		
07020007-667, County Ditch 105, CD 106 to Wabasha Cr	1.13	2Bm, 3C	IF					EXP		IF	IF	IF		IF	IF	IF	
07020007-699, Wabasha Creek, T111 R35W S11, west line to T112 R35W S24, east line	6.93	2Bm, 3C	NS					MTS	EXS	IF	IF	IF		IF	IF	IF	

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES						Aquatic Life Indicators:									
Assessment Unit ID (AUID), Stream Reach Name. Reach Description	**Reach Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Consumption**	**Drinking Water**	**303d listed impairments 2014**	**Fish**	**Macroinvertebrates**	**Dissolved Oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**AmmoniaNH3**	**Phosphorous**	**Chlorophyl A**
HUC 12 Agg: 0702000703-01 Fort Ridgely Creek																	
07020007-525, County Ditch 3, Headwaters to Fort Ridgley Cr	4.86	2Bm, 3C	FS					NA	MTS	IF	IF	IF		IF	IF	IF	
07020007-663, Unnamed creek, MN Hwy 4 to Fort Ridgely Cr	0.96	2Bg, 3C	FS						MTS	IF	IF	IF		IF	IF	IF	
07020007-664, County Ditch 115, Unnamed cr to CD 106A	2.71	2Bm, 3C	FS					MTS	MTS	IF	IF	IF		IF	IF	IF	
07020007-673, County Ditch 115, Unnamed cr to Unnamed cr	7.16	2Bm, 3C	NS						EXS	IF	IF	IF		IF	IF	IF	
07020007-688, County Ditch 106A (Fort Ridgley Creek), Headwaters to T112 R33W S13, south line	20.70	2Bm, 3C	NS					MTS	EXS	IF	IF	IF		MTS	MTS	MTS	
07020007-689, Fort Ridgley Creek, T112 R33W S24, north line to Minnesota R	7.58	2Bg, 3C	NS	NS				EXP	EXS	MTS	MTS	MTS	MTS	MTS	IF	MTS	
HUC 12 Agg: 0702000704-01 Spring Creek-Minnesota River																	
07020007-569, Crow Creek, CD 52 to T112 R35W S2, north line	3.45	2Bg, 3C	NS	NS				EXS	EXS	EX	MTS	MTS	MTS	MTS	MTS	EX	
07020007-571, County Ditch 10 (John's Creek), T110 R32W S1, west line to Minnesota R	3.77	1B, 2Ag, 3B	NS	NS		NS	NO3	EXS	EXS	IF	IF	IF		IF	IF	EX	
07020007-636, County Ditch 52, Unnamed ditch to CD 22	1.51	2Bm, 3C	NS					MTS	EXS	IF	IF	IF		IF	IF	IF	
07020007-644, Unnamed creek, Unnamed cr to Minnesota R	1.76	2Bg, 3C	IF	NS						IF	MTS	MTS		MTS	MTS	EX	
07020007-645, Purgatory Creek, Unnamed cr to Minnesota R	2.29	2Bg, 3C	IF	NS							IF	MTS				IF	
07020007-650, County Ditch 10 (John's Creek), Unnamed ditch to T110 R32W S2, east line	2.10	2Bg, 3C	IF	IF						MTS	MTS	MTS		MTS	MTS	EX	MTS

AUID DESCRIPTIONS		USES						Aquatic Life Indicators:									
Assessment Unit ID (AUID), Stream Reach Name, Reach Description	**Reach Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Consumption**	**Drinking Water**	**303d listed impairments 2014**	**Fish**	**Macroinvertebrates**	**Dissolved Oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**AmmoniaNH3**	**Phosphorous**	**Chlorophyl A**
07020007-651, Unnamed creek, Headwaters to Unnamed cr	2.72	2Bg, 3C	IF							MTS				MTS		IF	IF
07020007-668, Unnamed creek, Headwaters to Minnesota R	2.71	1B, 2Ag, 3B	FS					NA	MTS	IF				IF	IF	IF	
07020007-671, County Ditch 22, Headwaters to Crow Cr	7.49	2Bm, 3C	FS					MTS	MTS	IF	IF	IF		IF	IF	IF	
07020007-672, County Ditch 111, Unnamed cr to Purgatory Cr	1.09	2Bg, 3C	FS					MTS		IF	IF	IF		IF	IF	IF	
07020007-704, Threemile Creek, CD 140 to Minnesota R	2.25	2Bg, 3C	NS	NS				EXP	MTS	IF	MTS	MTS		IF	IF	MTS	
07020007-712, County Ditch 13, 245th Ave to Minnesota R	2.69	2Bg, 3C	NS	NS				EXP	EXS	IF	MTS	MTS		MTS	MTS	EX	
07020007-715, Unnamed creek, T111 R33W S8, east line to Unnamed cr	2.59	2Bg, 3C	NS	IF				EXP		IF	MTS	IF		IF	IF	IF	
HUC 12 Agg: 0702000704-02 Spring Creek																	
07020007-573, Spring Creek, T111 R32W S21, west line to Minnesota R	2.18	2Bg, 3C	NS	NS				EXS	EXS	MTS	MTS	MTS	MTS	MTS	MTS	EX	
07020007-574, Spring Creek (Hindeman Creek), T111 R33W S24, west line to T111 R32W S20, east line	4.72	1B, 2Ag, 3B	NS					EXS	EXS	IF	IF	IF		IF	IF	IF	
07020007-622, Spring Creek (Judicial Ditch 29), T111 R33W S23, west line to T111 R33W S23, east line	1.40	2Bg, 3C	NS	NS				EXS	EXS	MTS	IF	MTS		MTS	IF	EX	MTS
07020007-649, County Ditch 57, Headwaters to T111 R32W S18, south line	3.93	2Bg, 3C	IF							IF	IF	IF		MTS	MTS	EX	MTS

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES						Aquatic Life Indicators:									
Assessment Unit ID (AUID), Stream Reach Name, Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014	Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A
HUC 12 Agg: 0702000710-02 Morgan Creek																	
07020007-544, County Ditch 63, Headwaters to JD 10	9.45	7								IF				IF	IF		
07020007-691, Morgan Creek, T109 R29W S30, south line to Minnesota R	6.96	2Bg, 3C	NS	NS				EXS	EXS	IF	MTS	MTS	IF	MTS	IF	MTS	
07020007-701, Judicial Ditch 10, Unnamed cr to T108 R30W S2, east line	6.73	2Bm, 3C	NS					MTS	EXS	IF	IF	IF		IF	IF	IF	
HUC 12 Agg: 0702000711-01 City of Mankato-Minnesota River																	
07020007-541, Cherry Creek, Headwaters (Mud Lk 40-0110-00) to T110 R25W S21, north line	4.19	2Bm, 3C	NS					EXS	MTS	IF	IF	IF		IF	IF	IF	
07020007-542, Cherry Creek, T110 R25W S16, south line to T110 R26W S12, north line	4.29	7	NA							IF				IF	IF		
07020007-543, Cherry Creek, T110 R26W S1, south line to Minnesota R	7.01	2Bg, 3C	NS	IF				NA	EXS	IF	IF	IF		IF	IF	IF	
07020007-547, Rogers Creek, Unnamed cr to Minnesota R	1.62	2Bg, 3C	NS				F-IBI	EXS	EXS	IF	IF	IF		IF	IF	IF	
07020007-550, Unnamed creek, Unnamed cr to Unnamed ditch	2.05	2Bg, 3C	NS				F-IBI	EXS	EXS	IF	IF	IF		IF	IF	IF	
07020007-556, Thompson Ravine, Unnamed pond to Minnesota R	2.95	2Bg, 3C	IF									IF					
07020007-558, Unnamed creek (Glenwood Ave Creek), Headwaters to Division St	1.36	2Bg, 3C	IF									MTS					
07020007-562, Seven Mile Creek, T109 R27W S4, north line to Minnesota R	5.20	1B, 2Ag, 3B	NS	NS		NS	Chl, FC, NO	EXS	EXS	MTS	EX	EX	MTS	IF	MTS	MTS	IF
07020007-566, Unnamed creek, T109 R26W S28, east line to Unnamed ditch	2.43	7								IF				IF	IF		
07020007-598, Unnamed ditch, Unnamed cr to underground pipe	1.06	2Bg, 3C	NA				FC					EX					
07020007-613, Rogers Creek (County Ditch 78), CD 21 to Unnamed cr	7.59	2Bg, 3C	IF	NS						MTS	IF	MTS	MTS	MTS	IF	EX	

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES						Aquatic Life Indicators:									
Assessment Unit ID (AUID), **Stream Reach Name,** **Reach Description**	**Reach Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Consumption**	**Drinking Water**	**303d listed impairments 2014**	**Fish**	**Macroinvertebrates**	**Dissolved Oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**AmmoniaNH3**	**Phosphorous**	**Chlorophyl A**
07020007-637, Unnamed creek (Seven Mile Creek Tributary), Headwaters to T109 R27W S15, north line	2.36	2Bg, 3C	IF	NS			E.coli			MTS	MTS	MTS		MTS		EX	
07020007-678, County Ditch 46A, Headwaters to -94.0803 44.2762	5.38	2Bm, 3C	NS	NA				EXS	EXS	IF	IF	MTS		IF	IF	IF	
07020007-679, County Ditch 46A, -94.0803 44.2762 to Seven Mile Cr	0.88	2Bg, 3C	NS	NS			FC, T		EXS	IF	EX	MTS		IF	IF	EX	
07020007-694, Unnamed creek, CSAH 5/3rd Ave to Minnesota R	1.62	2Bg, 3C	FS					MTS	MTS	IF	IF	IF		IF	IF	IF	
07020007-696, Unnamed creek, Unnamed cr to -93.9413 44.228	2.05	2Bm, 3C	NS					EXS	EXS	IF	IF	IF		IF	IF	IF	
07020007-702, Seven Mile Creek, CD 13A to to MN Hwy 99	0.55	2Bg, 3C	NA	NA						NA	NA	NA		NA		NA	
07020007-703, Seven Mile Creek, MN Hwy 99 to CD 46A	0.72	2Bg, 3C	NS	NS			FC, T		EXS	MTS	MTS	MTS		MTS	IF	EX	
HUC 12 Agg: 0702000711-02 Shanaska Creek																	
07020007-607, Unnamed creek, Mud Lk (07-0049-00) to Lk Washington	2.57	2Bg, 3C	IF							IF	IF	MTS		IF	IF	EX	
07020007-609, Unnamed creek, Unnamed lk (40-0097-00) to Lk Washington	0.43	2Bg, 3C	IF									MTS				EX	
07020007-610, Unnamed creek, Headwaters to Lk Washington	1.05	2Bg, 3C	IF									MTS				EX	
07020007-652, Unnamed creek, Gilfillin Lk to Ballantyne Lk	0.44	2Bg, 3C	IF													NA	NA
07020007-692, Shanaska Creek, Dog Cr to Shanaska Cr Rd	0.15	2Bm, 3C	FS					MTS	MTS	IF	IF	IF		IF	IF	IF	
07020007-693, Shanaska Creek, Shanaska Cr Rd to Minnesota R	5.64	2Bg, 3C	NS	NS				EXS	EXS	IF	MTS	MTS		IF	IF	IF	
07020007-902, Unnamed creek (Duck Lake Inlet), to Duck Lk	0.42	2Bg, 3C	NA									EX					

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

Appendix 3.2 – Assessment results for lakes in the Minnesota River-Mankato Watershed

HUC12 Name	Lake Name	Lake ID	County	Eco Region*	Lake Type	Lake Area (acres)	Watershed Area (acres)	Max Depth (m)	Mean Depth (m)	Littoral %	CLMP Secchi Trend	Mean TP (ug/L)	Mean Chl-a (ug/L)	Mean Secchi (m)	2008 Remote Sensing Clarity	AQR Use Support Status	AQL Use Support Status
Shanaska Creek	Gilfillin	07-0045-00	Blue Earth	WCBP	Shallow Lake	220	1,406	2	-	-	-	442.3	20.3	0.4	0.64	IF	NA
Shanaska Creek	George	07-0047-00	Blue Earth	WCBP	Lake	87	826	28	9	75.9	-	69.5	57.2	0.9	0.36	NS	IF
Shanaska Creek	Duck	07-0053-00	Blue Earth	WCBP	Lake	279	1,020	25	-	-	D	80.9	52.5	0.8	0.36	NS	FS
Shanaska Creek	Ballantyne	07-0054-00	Blue Earth	WCBP	Lake	354	3,608	58	7	86.3	NT	30.6	24.5	0.9	0.82	FS	FS
City of Mankato	Wita	07-0077-00	Blue Earth	WCBP	Shallow Lake	338	1,324	6	-	-	-	152.2	164.8	0.2	0.33	NS	IF
Minneopa Creek	Loon	07-0096-00	Blue Earth	WCBP	Shallow Lake	782	3,707	7	4	100	-	144.8	77.1	0.3	0.27	NS	IF
Minneopa Creek	Mills	07-0097-00	Blue Earth	WCBP	Shallow Lake	231	772	7	5	100	-	211.3	97.7	0.3	0.25	NS	IF
Minneopa Creek	Crystal	07-0098-00	Blue Earth	WCBP	Shallow Lake	368	13,979	10.5	7	100	NT	251.6	87.1	0.3	0.26	NS	NS
Minneopa Creek	Lieberg	07-0124-00	Blue Earth	WCBP	Shallow Lake	73	1,367	-	-	-	-	82	71	0.4	0.35	IF	IF
Minneopa Creek	Strom	07-0126-00	Blue Earth	WCBP	Shallow Lake	261	5,206	2.3	-	-	-	143	-	0.6	0.8	IF	NA
Spring Creek	Lone Tree	08-0073-00	Brown	WCBP	Shallow Lake	19	560	5	-	-	-	202.4	83.8	1	0.5	IF	NA
Shanaska Creek	Unnamed	40-0098-00	Le Sueur	WCBP	Shallow Lake	4	247	-	-	-	-	123	55.4	0.3	-	IF	IF
Shanaska Creek	Henry	40-0104-00	Le Sueur	WCBP	Shallow Lake	351	836	6	-	-	-	400.8	154.5	0.9	1.29	NS	IF
City of Mankato	Savidge	40-0107-00	Le Sueur	WCBP	Shallow Lake	119	1,219	4	-	-	-	32	78.4	0.3	1.03	IF	IF
City of Mankato	Scotch	40-0109-00	Le Sueur	WCBP	Shallow Lake	574	10,716	11	-	-	D	139.2	184.4	0.7	0.8	NS	IF
Shanaska Creek	Washington	40-0117-00	Le Sueur	WCBP	Lake	1478	14,421	49	11	74.2	I	67.1	51.6	1.5	0.6	NS	NS
Shanaska Creek	Emily	40-0124-00	Le Sueur	WCBP	Lake	263	1,092	37	10	70	NT	24.7	24.3	0.9	0.55	FS	IF
City of Mankato	Unnamed	52-0001-00	Nicollet	NCHF	Lake	9	3,397	23	-	-	D	12.1	5.8	3.1	2.07	IF	NA

HUC12 Name	Lake Name	Lake ID	County	Eco Region*	Lake Type	Lake Area (acres)	Watershed Area (acres)	Max Depth (m)	Mean Depth (m)	Littoral %	CLMP Secchi Trend	Mean TP (ug/L)	Mean Chl-a (ug/L)	Mean Secchi (m)	2008 Remote Sensing Clarity	AQR Use Support Status	AQL Use Support Status
Swan Lake Outlet	Swan	52-0034-00	Nicollet	WCBP	Shallow Lake	10095	26,881	8	1	-	-	75.5	9.2	1.2	1.28	IF	IF

Abbreviations: **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information; **NA** – Not Assessed

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

*Lake Eco region used AQR asessments does not necessarily reflect the Eco region in which the lake physically is within, in some cases where lakes may fall near or on the borderline of an Eco region boundary a land use analysis is conducted to determine which Eco region standard describes the lakes contributing watershed.

Appendix 4.1 – Minnesota statewide IBI thresholds and confidence limits

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

Appendix 4.2 – Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
HUC 12 Agg: 0702000701-01 (Birch Coulee Creek)							
07020007-582	13MN006	Judicial Ditch 12	10.7	3	55	48.9	6/19/2013
07020007-587	13MN008	Birch Coulee Creek	68.16	2	50	38.09	7/15/2013
07020007-587	13MN008	Birch Coulee Creek	68.16	2	50	44.53	8/27/2014
07020007-587	14MN210	Birch Coulee Creek	65.06	2	50	44.94	8/27/2014
07020007-588	90MN053	Birch Coulee Creek	36.94	2	50	42.14	7/15/2013
07020007-588	90MN053	Birch Coulee Creek	36.94	2	50	55.32	8/14/2013
07020007-669	13MN005	County Ditch 85A	9.54	3	55	0	6/19/2013
07020007-670	13MN004	County Ditch 124	16.32	3	55	0	6/19/2013
07020007-707	13MN007	Judicial Ditch 12	22.99	3	55	43.33	6/19/2013
07020007-707	13MN007	Judicial Ditch 12	22.99	3	55	71.44	8/14/2013
07020007-711	07MN080	County Ditch 124	28.66	7	42	27.31	8/29/2007
07020007-711	07MN080	County Ditch 124	28.66	7	42	0	6/18/2013
07020007-711	07MN080	County Ditch 124	28.66	7	42	20.19	8/28/2013
HUC 12 Agg: 0702000702-01 (Wabasha Creek)							
07020007-527	13MN012	Wabasha Creek	71.06	2	50	40.54	6/11/2013
07020007-528	13MN011	County Ditch 109	17.99	3	55	41.96	6/11/2013
07020007-528	13MN092	County Ditch 109	13.92	7	42	8.33	6/11/2013
07020007-667	13MN009	County Ditch 105	5.36	7	42	10	8/13/2013
07020007-699	13MN010	Wabasha Creek	27.54	7	42	20.09	6/18/2013
HUC 12 Agg: 0702000703-01 (Fort Ridgely Creek)							
07020007-525	13MN022	County Ditch 3	3.78	3	55	0	6/19/2013
07020007-525	13MN022	County Ditch 3	3.78	3	55	23.93	8/14/2013
07020007-663	13MN023	Unnamed creek	4.17	3	55	0	6/19/2013
07020007-664	13MN020	County Ditch 115	20.31	3	55	41.94	7/10/2013
07020007-673	13MN018	County Ditch 115	7.18	3	55	0	6/20/2013
07020007-688	13MN017	County Ditch 106A (Fort Ridgley Creek)	5.57	3	55	0	6/19/2013
07020007-688	13MN017	Cty Ditch 106A (Fort Ridgley Cr)	5.57	3	55	36.62	8/29/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07020007-688	13MN019	County Ditch 106A (Fort Ridgley Creek)	26.37	3	55	20.76	6/19/2013
07020007-688	13MN019	County Ditch 106A (Fort Ridgley Creek)	26.37	3	55	47.55	8/29/2013
07020007-688	91MN054	County Ditch 106A (Fort Ridgley Creek)	13.3	3	55	0	6/20/2013
07020007-689	05MN013	Fort Ridgley Creek	69.4	2	50	30.31	9/9/2005
07020007-689	05MN013	Fort Ridgley Creek	69.4	2	50	40.85	7/16/2013
07020007-689	05MN014	Fort Ridgley Creek	62.2	2	50	38.57	9/12/2005
07020007-689	05MN014	Fort Ridgley Creek	62.2	2	50	46.38	7/17/2013
07020007-689	05MN015	Fort Ridgley Creek	59.47	2	50	36.09	9/20/2005
07020007-689	05MN015	Fort Ridgley Creek	59.47	2	50	50.23	7/17/2013
07020007-689	13MN021	Fort Ridgley Creek	54.85	2	50	40.5	7/17/2013
Huc 12 Agg: 0702000704-01 (Spring Creek-Minnesota River)							
07020007-569	13MN002	Crow Creek	31.27	2	50	41.17	6/18/2013
07020007-571	05MN011	County Ditch 10 (John's Creek)	11.87	10	50	38.3	7/17/2013
07020007-571	09MN080	County Ditch 10 (John's Creek)	13.16	10	50	37.04	9/1/2009
07020007-636	07MN074	County Ditch 52	14.36	3	55	55.65	8/29/2007
07020007-636	07MN074	County Ditch 52	14.36	3	55	43.93	6/17/2013
07020007-636	07MN074	County Ditch 52	14.36	3	55	60.96	8/13/2013
07020007-668	13MN003	Unnamed creek	3.3	10	50	35.59	6/18/2013
07020007-668	13MN003	Unnamed creek	3.3	10	50	22.36	8/13/2013
07020007-671	13MN001	County Ditch 22	15.48	3	55	57.22	6/17/2013
07020007-672	13MN016	County Ditch 111	6.83	3	55	73.51	7/10/2013
07020007-704	13MN014	Threemile Creek	9.96	3	55	40.88	7/15/2013
07020007-712	13MN025	County Ditch 13	9.91	3	55	36.13	7/9/2013
07020007-715	13MN013	Unnamed creek	16.73	3	55	50	7/9/2013
Huc 12 Agg: 0702000704-02 (Spring Creek)							
07020007-573	13MN090	Spring Creek	44.5	2	50	37.93	7/9/2013
07020007-574	91MN055	Spring Creek (Hindeman Creek)	36.16	10	50	30.39	8/9/2010
07020007-622	13MN024	Spring Creek (Judicial Ditch 29)	28.62	3	55	0	6/12/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07020007-622	13MN024	Spring Creek (Judicial Ditch 29)	28.62	3	55	40.94	8/12/2013
Huc 12 Agg: 0702000705-01 (Little Rock Creek)							
07020007-665	13MN030	County Ditch 100	8.59	3	55	0	6/19/2013
07020007-665	13MN030	County Ditch 100	8.59	3	55	34.43	8/14/2013
07020007-666	13MN028	Judicial Ditch 8	10.31	3	55	0	6/20/2013
07020007-666	13MN028	Judicial Ditch 8	10.31	3	55	0.83	8/14/2013
07020007-686	13MN026	Little Rock Creek (Judicial Ditch 31)	7.39	3	55	0	6/20/2013
07020007-686	13MN027	Little Rock Creek (Judicial Ditch 31)	22.27	3	55	0	7/10/2013
07020007-686	13MN029	Little Rock Creek (Judicial Ditch 31)	39.82	2	50	0	7/10/2013
07020007-687	03MN019	Little Rock Creek (Judicial Ditch 31)	62.4	2	50	47.05	7/16/2013
07020007-687	03MN019	Little Rock Creek (Judicial Ditch 31)	62.4	2	50	24.12	8/14/2014
07020007-687	03MN020	Little Rock Creek (Judicial Ditch 31)	57.43	2	50	35.86	7/10/2013
07020007-687	13MN032	Little Rock Creek (Judicial Ditch 31)	81.48	2	50	44.76	7/17/2013
07020007-687	13MN032	Little Rock Creek (Judicial Ditch 31)	81.48	2	50	41.62	8/27/2014
07020007-716	13MN031	Judicial Ditch 13	15.56	3	55	29.68	7/10/2013
07020007-717	10EM083	Judicial Ditch 13	15.94	3	55	48.44	6/15/2010
Huc 12 Agg: 0702000706-01 (City of New Ulm-Minnesota River)							
07020007-662	13MN035	Unnamed creek	7.65	3	55	0	7/16/2013
07020007-675	13MN040	Heyman's Creek	15.57	3	55	60.1	6/11/2013
07020007-684	13MN033	Eightmile Creek	33.02	2	50	15.29	7/16/2013
07020007-684	13MN033	Eightmile Creek	33.02	2	50	29.97	8/27/2014
07020007-684	13MN087	Eightmile Creek	29.41	3	55	21.57	7/16/2013
07020007-684	13MN087	Eightmile Creek	29.41	3	55	24.37	8/27/2014
07020007-709	05MN012	Fritsche Creek (County Ditch 77)	16.34	3	55	58.49	8/30/2005
07020007-709	05MN012	Fritsche Creek (County Ditch 77)	16.34	3	55	59.56	7/16/2013
Huc 12 Agg: 0702000707-01 (Little Cottonwood River)							

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07020007-518	13MN045	Altermatts Creek	19.82	3	55	39.3	6/11/2013
07020007-548	91MN057	Unnamed creek	6.4	3	55	57.76	7/28/2010
07020007-548	91MN057	Unnamed creek	6.4	3	55	37.9	6/12/2013
07020007-646	10EM115	Unnamed creek (County Ditch 11)	9.62	3	55	70.14	8/4/2010
07020007-656	13MN046	County Ditch 28-1	5.14	7	42	29.69	7/8/2013
07020007-657	13MN049	County Ditch 11	8.22	3	55	44.6	7/9/2013
07020007-658	13MN051	County Ditch 67	7.47	3	55	49.67	6/12/2013
07020007-676	13MN041	Little Cottonwood River	31.72	2	50	23.92	7/8/2013
07020007-676	13MN044	Little Cottonwood River	54.18	2	50	37.25	7/18/2013
07020007-676	13MN048	Little Cottonwood River	113.74	2	50	44.32	7/15/2013
07020007-676	13MN048	Little Cottonwood River	113.74	2	50	47.98	8/7/2013
07020007-676	13MN089	Little Cottonwood River	81.09	2	50	43.9	7/16/2013
07020007-676	91MN056	Little Cottonwood River	21.26	3	55	52.78	7/29/2010
07020007-677	13MN050	Little Cottonwood River	147.98	2	50	64.09	8/6/2013
07020007-677	13MN052	Little Cottonwood River	168.96	2	50	57.85	7/16/2013
07020007-677	13MN052	Little Cottonwood River	168.96	2	50	46.82	8/7/2013
07020007-677	97MN009	Little Cottonwood River	161.32	2	50	61.66	8/6/2013
07020007-681	13MN043	Altermatts Creek	8.39	3	55	26.78	6/11/2013
07020007-718	13MN047	Unnamed creek	6.85	3	55	0	7/9/2013
Huc 12 Agg: 0702000708-01 (Swan Lake Outlet (Nicollet Creek))							
07020007-545	13MN056	County Ditch 4/County Ditch 39	18.75	7	42	0	6/10/2013
07020007-545	13MN057	County Ditch 4/County Ditch 39	26.84	3	55	18.79	6/10/2013
07020007-661	13MN058	County Ditch 11	6.36	3	55	0	6/10/2013
07020007-661	13MN058	County Ditch 11	6.36	3	55	0	8/15/2013
07020007-683	03MN069	Swan Lake Outlet (Nicollet Creek)	78.78	2	50	2.85	6/11/2013
07020007-683	03MN069	Swan Lake Outlet (Nicollet Creek)	78.78	2	50	20.29	8/8/2013
07020007-683	13MN086	Swan Lake Outlet (Nicollet Creek)	78.72	2	50	0	6/11/2013
07020007-683	13MN086	Swan Lake Outlet (Nicollet Creek)	78.72	2	50	0	8/8/2013
Huc 12 Agg: 0702000709-01 (Minneopa Creek)							
07020007-531	13MN060	Minneopa Creek	6.16	3	55	38.54	7/11/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07020007-531	13MN061	Minneopa Creek	31.1	2	50	15.95	7/11/2013
07020007-533	13MN064	Minneopa Creek	69.62	2	50	26.95	7/25/2013
07020007-534	13MN065	Minneopa Creek	78.15	2	50	28.53	7/24/2013
07020007-534	13MN066	Minneopa Creek	84.74	2	50	1.48	7/29/2013
07020007-535	13MN062	County Ditch 27	11.52	7	42	0	6/12/2013
07020007-535	13MN062	County Ditch 27	11.52	7	42	11.23	8/12/2013
07020007-557	13MN063	County Ditch 56 (Lake Crystal Inlet)	8.98	3	55	11.4	7/11/2013
07020007-593	13MN059	Judicial Ditch 48	17.46	3	55	27.52	7/11/2013
Huc 12 Agg: 0702000710-01 (Morgan Creek-Minnesota River)							
07020007-577	09MN094	Unnamed creek	6	10	50	37.78	7/21/2010
07020007-577	09MN094	Unnamed creek	6	10	50	48.07	7/17/2013
07020007-660	13MN067	County Ditch 3	6.41	3	55	0	6/10/2013
Huc 12 Agg: 0702000710-02 (Morgan Creek)							
07020007-544	13MN054	County Ditch 63	11.14	3	55	18.51	6/12/2013
07020007-544	13MN054	County Ditch 63	11.14	3	55	14.35	8/8/2013
07020007-691	13MN055	Morgan Creek	58.52	2	50	27.26	7/29/2013
07020007-701	13MN053	Judicial Ditch 10	22.2	3	55	16.48	6/12/2013
07020007-701	13MN053	Judicial Ditch 10	22.2	3	55	47.68	8/8/2013
Huc 12 Agg: 0702000711-01 (City of Mankato-Minnesota River)							
07020007-541	13MN088	Cherry Creek	19.71	3	55	23.4	6/10/2013
07020007-541	13MN088	Cherry Creek	19.71	3	55	33.4	7/23/2013
07020007-542	13MN080	Cherry Creek	26.07	3	55	0	6/10/2013
07020007-542	13MN080	Cherry Creek	26.07	3	55	0	7/23/2013
07020007-543	13MN081	Cherry Creek	31.3	2	50	0	6/10/2013
07020007-547	13MN094	Rogers Creek	26.51	3	55	8.61	6/11/2013
07020007-547	91MN061	Rogers Creek	26.34	3	55	20.81	7/21/2010
07020007-547	91MN061	Rogers Creek	26.34	3	55	0	6/11/2013
07020007-550	03MN072	Unnamed creek	7.9	3	55	41.38	7/18/2013
07020007-562	09MN090	Seven Mile Creek	34.04	10	50	19.54	7/21/2010
07020007-562	09MN090	Seven Mile Creek	34.04	10	50	23.92	8/29/2011

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07020007-562	09MN090	Seven Mile Creek	34.04	10	50	57.1	6/13/2013
07020007-562	09MN090	Seven Mile Creek	34.04	10	50	46.18	8/13/2013
07020007-566	13MN074	Unnamed creek	3.27	3	55	0	6/13/2013
07020007-566	13MN075	Unnamed creek	4.87	3	55	0	6/13/2013
07020007-678	91MN059	County Ditch 46A	9.8	3	55	16.7	7/27/2010
07020007-679	13MN069	County Ditch 46A	14.25	3	55	0	6/13/2013
07020007-679	13MN069	County Ditch 46A	14.25	3	55	0	8/15/2013
07020007-694	13MN073	Unnamed creek	5.27	3	55	62.75	7/17/2013
07020007-696	01MN020	Unnamed creek	4.67	3	55	0	6/13/2013
07020007-696	01MN020	Unnamed creek	4.67	3	55	0	8/8/2013
07020007-703	13MN068	Seven Mile Creek	14.97	3	55	0	6/13/2013
07020007-703	13MN068	Seven Mile Creek	14.97	3	55	13.42	8/13/2013
Huc 12 Agg: 0702000711-02 (Shanaska Creek)							
07020007-692	13MN077	Shanaska Creek	34.86	2	50	43.72	7/18/2013
07020007-693	13MN079	Shanaska Creek	41.52	2	50	0	7/18/2013

Appendix 4.3 – Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
HUC 12 Agg: 0702000701-01 (Birch Coulee Creek)							
07020007-587	13MN008	Birch Coulee Creek	68.16	5	37	45.62	8/21/2013
07020007-587	13MN008	Birch Coulee Creek	68.16	5	37	26.37	8/20/2014
07020007-587	14MN210	Birch Coulee Creek	65.06	5	37	30.48	8/20/2014
07020007-588	90MN053	Birch Coulee Creek	36.94	5	37	32.75	8/20/2013
07020007-670	13MN004	County Ditch 124	16.32	7	41	16.82	8/20/2013
07020007-711	07MN080	County Ditch 124	28.66	7	41	23.31	8/27/2007
07020007-711	07MN080	County Ditch 124	28.66	7	41	11.74	8/20/2013
HUC 12 Agg: 0702000702-01 (Wabasha Creek)							
07020007-527	13MN012	Wabasha Creek	71.06	5	37	31.14	8/21/2013
07020007-528	13MN011	County Ditch 109	17.99	5	37	28.94	8/21/2013
07020007-528	13MN092	County Ditch 109	13.92	7	41	21.25	8/21/2013
07020007-699	13MN010	Wabasha Creek	27.54	7	41	18.07	8/19/2013
HUC 12 Agg: 0702000703-01 (Fort Ridgely Creek)							
07020007-525	13MN022	County Ditch 3	3.78	7	41	23.19	8/20/2013
07020007-663	13MN023	Unnamed creek	4.17	5	37	41.45	8/20/2013
07020007-664	13MN020	County Ditch 115	20.31	7	41	27.84	8/20/2013
07020007-673	13MN018	County Ditch 115	7.18	7	41	12.83	8/19/2013
07020007-688	13MN017	County Ditch 106A (Fort Ridgley Creek)	5.57	7	41	13.86	8/20/2013
07020007-688	13MN019	County Ditch 106A (Fort Ridgley Creek)	26.37	7	41	28.49	8/20/2013
07020007-688	91MN054	County Ditch 106A (Fort Ridgley Creek)	13.3	7	41	29.24	8/19/2013
07020007-689	05MN013	Fort Ridgley Creek	69.4	5	37	21.23	8/15/2013
07020007-689	05MN013	Fort Ridgley Creek	69.4	5	37	42.04	8/15/2013
07020007-689	05MN014	Fort Ridgley Creek	62.2	5	37	28.98	8/14/2013
07020007-689	13MN021	Fort Ridgley Creek	54.85	5	37	13.78	8/20/2013
HUC 12 Agg: 0702000704-01 (Spring Creek-Minnesota River)							
07020007-569	13MN002	Crow Creek	31.27	5	37	26.39	8/19/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
07020007-571	05MN011	County Ditch 10 (John's Creek)	11.87	9	43	22.63	8/15/2013
07020007-636	07MN074	County Ditch 52	14.36	7	41	14.51	8/27/2007
07020007-636	07MN074	County Ditch 52	14.36	7	41	17.79	8/19/2013
07020007-668	13MN003	Unnamed creek	3.3	9	43	58	8/19/2013
07020007-671	13MN001	County Ditch 22	15.48	7	41	26.78	8/19/2013
07020007-704	13MN014	Threemile Creek	9.96	5	37	37.03	8/21/2013
07020007-712	13MN025	County Ditch 13	9.91	5	37	15.74	8/14/2013
07020007-569	13MN002	Crow Creek	31.27	5	37	26.39	8/19/2013
HUC 12 Agg: 0702000704-02 (Spring Creek)							
07020007-573	13MN090	Spring Creek	44.5	5	37	34.93	8/15/2013
07020007-574	91MN055	Spring Creek (Hindeman Creek)	36.16	9	43	13.04	8/16/2010
07020007-622	13MN024	Spring Creek (Judicial Ditch 29)	28.62	5	37	21.3	8/15/2013
HUC 12 Agg: 0702000705-01 (Little Rock Creek)							
07020007-647	10EM019	Unnamed ditch	0.99	7	41	0.79	8/9/2010
07020007-665	13MN030	County Ditch 100	8.59	7	41	26.39	8/14/2013
07020007-666	13MN028	Judicial Ditch 8	10.31	7	41	13.93	8/20/2013
07020007-686	13MN027	Little Rock Creek (Judicial Ditch 31)	22.27	7	41	5.73	8/20/2013
07020007-687	03MN019	Little Rock Creek (Judicial Ditch 31)	62.4	7	41	42.64	8/14/2013
07020007-687	03MN019	Little Rock Creek (Judicial Ditch 31)	62.4	7	41	34.9	8/20/2014
07020007-687	03MN020	Little Rock Creek (Judicial Ditch 31)	57.43	5	37	19.58	8/14/2013
07020007-687	13MN032	Little Rock Creek (Judicial Ditch 31)	81.48	5	37	15.04	8/20/2014
07020007-687	13MN032	Little Rock Creek (Judicial Ditch 31)	81.48	5	37	20.68	8/20/2014
07020007-716	13MN031	Judicial Ditch 13	15.56	7	41	39.02	8/14/2013
07020007-717	10EM083	Judicial Ditch 13	15.94	5	37	25.54	8/16/2010
07020007-647	10EM019	Unnamed ditch	0.99	7	41	0.79	8/9/2010
HUC 12 Agg: 0702000706-01 (City of New Ulm-Minnesota River)							
07020007-675	13MN040	Heyman's Creek	15.57	5	37	32.89	8/14/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
07020007-684	13MN033	Eightmile Creek	33.02	5	37	33.47	8/14/2013
07020007-684	13MN033	Eightmile Creek	33.02	5	37	21.51	8/20/2014
07020007-684	13MN087	Eightmile Creek	29.41	5	37	21.85	8/20/2014
07020007-709	05MN012	Fritsche Creek (County Ditch 77)	16.34	5	37	19.04	8/14/2013
HUC 12 Agg: 0702000707-01 (Little Cottonwood River)							
07020007-518	13MN045	Altermatts Creek	19.82	5	37	26.4	8/12/2013
07020007-548	91MN057	Unnamed creek	6.4	7	41	28.1	8/17/2010
07020007-548	91MN057	Unnamed creek	6.4	7	41	39.42	8/15/2013
07020007-548	91MN057	Unnamed creek	6.4	7	41	42.42	8/15/2013
07020007-646	10EM115	Unnamed creek (County Ditch 11)	9.62	7	41	35.32	8/17/2010
07020007-656	13MN046	County Ditch 28-1	5.14	7	41	26.73	8/12/2013
07020007-657	13MN049	County Ditch 11	8.22	5	37	21.28	8/15/2013
07020007-658	13MN051	County Ditch 67	7.47	5	37	31.04	8/7/2013
07020007-676	13MN041	Little Cottonwood River	31.72	7	41	45.06	8/13/2013
07020007-676	13MN044	Little Cottonwood River	54.18	7	41	35.86	8/12/2013
07020007-676	13MN048	Little Cottonwood River	113.74	7	41	41.82	8/15/2013
07020007-676	13MN089	Little Cottonwood River	81.09	7	41	40.52	8/13/2013
07020007-676	91MN056	Little Cottonwood River	21.26	5	37	32.98	8/17/2010
07020007-677	13MN050	Little Cottonwood River	147.98	5	37	35.82	8/7/2013
07020007-677	13MN052	Little Cottonwood River	168.96	5	37	30.76	8/7/2013
07020007-677	97MN009	Little Cottonwood River	161.32	5	37	37.25	8/7/2013
07020007-681	13MN043	Altermatts Creek	8.39	7	41	20.08	8/13/2013
HUC 12 Agg: 0702000708-01 (Swan Lake Outlet (Nicollet Creek))							
07020007-545	13MN056	County Ditch 4/County Ditch 39	18.75	7	41	18.49	8/7/2013
07020007-545	13MN057	County Ditch 4/County Ditch 39	26.84	7	41	12.96	8/7/2013
07020007-661	13MN058	County Ditch 11	6.36	7	41	14.7	8/7/2013
07020007-683	03MN069	Swan Lake Outlet (Nicollet Creek)	78.78	5	37	45.64	8/12/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
07020007-683	13MN086	Swan Lake Outlet (Nicollet Creek)	78.72	5	37	26.94	8/7/2013
HUC 12 Agg: 0702000709-01 (Minneopa Creek)							
07020007-531	13MN060	Minneopa Creek	6.16	7	41	23.79	8/6/2013
07020007-531	13MN061	Minneopa Creek	31.1	7	41	29.34	8/6/2013
07020007-533	13MN064	Minneopa Creek	69.62	5	37	23.17	8/6/2013
07020007-534	13MN065	Minneopa Creek	78.15	5	37	38.56	8/6/2013
07020007-534	13MN066	Minneopa Creek	84.74	5	37	28.86	8/6/2013
07020007-535	13MN062	County Ditch 27	11.52	7	41	26.92	8/6/2013
07020007-557	13MN063	County Ditch 56 (Lake Crystal Inlet)	8.98	7	41	34.83	8/6/2013
07020007-593	13MN059	Judicial Ditch 48	17.46	7	41	34.51	8/6/2013
HUC 12 Agg: 0702000710-01 (Morgan Creek-Minnesota River)							
07020007-577	09MN094	Unnamed creek	6	9	43	30.86	9/16/2009
07020007-577	09MN094	Unnamed creek	6	9	43	3.34	8/7/2013
07020007-660	13MN067	County Ditch 3	6.41	5	37	18.04	8/7/2013
HUC 12 Agg: 0702000710-02 (Morgan Creek)							
07020007-544	13MN054	County Ditch 63	11.14	7	41	5.56	8/7/2013
07020007-691	13MN055	Morgan Creek	58.52	5	37	23.84	8/7/2013
07020007-701	13MN053	Judicial Ditch 10	22.2	7	41	8.97	8/7/2013
HUC 12 Agg: 0702000711-01 (City of Mankato-Minnesota River)							
07020007-541	13MN088	Cherry Creek	19.71	6	43	47.27	8/5/2013
07020007-542	13MN080	Cherry Creek	26.07	6	43	39.11	8/5/2013
07020007-543	13MN081	Cherry Creek	31.3	5	37	18.81	8/5/2013
07020007-547	91MN061	Rogers Creek	26.34	5	37	28.5	8/16/2010
07020007-547	91MN061	Rogers Creek	26.34	5	37	32.26	8/21/2013
07020007-550	03MN072	Unnamed creek	7.9	5	37	19.57	8/6/2013
07020007-562	09MN090	Seven Mile Creek	34.04	9	43	23.1	9/16/2009
07020007-562	09MN090	Seven Mile Creek	34.04	9	43	49.9	8/15/2011
07020007-562	09MN090	Seven Mile Creek	34.04	9	43	32	8/6/2013
07020007-566	13MN074	Unnamed creek	3.27	5	37	18.64	8/5/2013

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
07020007-566	13MN075	Unnamed creek	4.87	5	37	32.17	8/6/2013
07020007-678	91MN059	County Ditch 46A	9.8	7	41	9.55	8/16/2010
07020007-679	13MN069	County Ditch 46A	14.25	7	41	29.96	8/6/2013
07020007-694	13MN073	Unnamed creek	5.27	5	37	37.98	8/6/2013
07020007-696	01MN020	Unnamed creek	4.67	5	37	16.13	8/5/2013
07020007-703	13MN068	Seven Mile Creek	14.97	7	41	29.76	8/6/2013
HUC 12 Agg: 0702000711-02 (Shanaska Creek)							
07020007-692	13MN077	Shanaska Creek	34.86	6	43	36.18	8/5/2013
07020007-693	13MN079	Shanaska Creek	41.52	5	37	22.66	8/5/2013

Appendix 5.1 – Minnesota's ecoregion-based lake eutrophication standards

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

Appendix 5.2 – MINLEAP model estimates of phosphorus loads for lakes in the Minnesota River – Mankato Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
07-0045-00	Gilfillin	442	136	20	87	0.4	0.6	565	448	76	0.79	1.1	0.89	H
07-0047-00	George	70	100	57	55	0.9	0.7	567	258	82	0.46	2.3	1.29	E
07-0053-00	Duck	81	110	53	63	0.8	0.7	562	340	81	0.6	1.9	0.54	E
07-0054-00	Ballantyne	31	123	25	74	0.9	0.6	567	1,125	78	1.98	1.4	1.38	E
07-0077-00	Wita	152	113	165	65	0.2	0.7	563	438	80	0.78	1.8	0.57	H
07-0096-00	Loon	145	121	77	73	0.3	0.6	564	1,207	78	2.14	1.5	0.68	H
07-0097-00	Mills	211	77	98	38	0.3	0.9	562	260	86	0.46	4	0.49	H
07-0098-00	Crystal	261	203	181	155	0.3	0.4	569	4,237	64	7.44	0.4	5	H
07-0124-00	Lieberg	82	203	71	154	0.4	0.4	568	419	64	0.74	0.4	2.49	E
08-0073-00	Lone Tree	202	235	84	192	1	0.3	569	170	59	0.3	0.3	3.89	H
40-0098-00	Unnamed	123	291	55	262	0.3	0.3	569	75	49	0.13	0.1	8.09	H
40-0104-00	Henry	401	93	155	49	0.9	0.8	559	293	83	0.53	2.7	0.37	H
40-0107-00	Savidge	32	163	78	113	0.3	0.5	567	380	71	0.67	0.7	1.39	E
40-0109-00	Scotch	139	203	184	154	0.7	0.4	568	3,283	64	5.78	0.4	2.49	H
40-0117-00	Washington	67	101	52	56	1.5	0.7	567	4,504	82	7.95	2.3	1.33	E
40-0124-00	Emily	25	70	24	33	0.9	1	563	359	88	0.64	5	0.6	E
52-0001-00	Unnamed (Hallet)	12	124	6	76	3.1	0.3	148	266	16	1.79	0	49.11	M
52-0034-00	Swan	76	97	9	52	1.2	0.8	560	9,286	83	16.59	2.5	0.41	E

Abbreviations: **H** – Hypereutrophic **M** – Mesotrophic --- No data
E – Eutrophic **O** – Oligotrophic

Appendix 6 – Fish species found during biological monitoring surveys

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
banded darter	4	84
bigmouth buffalo	11	115
bigmouth shiner	36	784
black bullhead	29	279
black crappie	4	7
blacknose dace	65	4592
blackside darter	13	178
bluegill	1	1
bluntnose minnow	35	983
brassy minnow	22	495
brook stickleback	43	679
brown trout	1	282
central mudminnow	6	45
central stoneroller	46	4505
channel catfish	5	29
common carp	24	2645
common shiner	52	5577
creek chub	83	4689
emerald shiner	2	5
fantail darter	19	408
fathead minnow	71	2620
flathead catfish	1	1
golden redhorse	5	101
golden shiner	4	7
goldfish	1	1
green sunfish	25	263
hornyhead chub	32	655
hybrid minnow	1	1
hybrid sunfish	1	1
Iowa darter	4	10
johnny darter	50	1725
largemouth bass	12	45
largescale stoneroller	1	2
northern hogsucker	7	213
northern pike	15	46
orangespotted sunfish	12	29
sand shiner	22	1979

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
shorthead redhorse	9	111
shortnose gar	1	2
silver redhorse	2	4
slenderhead darter	6	32
smallmouth bass	2	2
spotfin shiner	16	894
stonecat	5	27
tadpole madtom	1	6
walleye	5	19
white crappie	1	1
white sucker	47	1344
yellow bullhead	8	23
yellow perch	7	26

Appendix 7 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Ablabesmyia	64	254
Acari	73	734
Acentrella	11	83
Acerpenna	2	4
Acricotopus	2	2
Acroneuria	5	6
Aeshna	22	54
Aeshnidae	49	143
Agabus	3	5
Amercaenis	3	7
Amnicola	1	1
Amphipoda	2	4
Anafroptilum	2	2
Anax	16	18
Ancylidae	14	75
Anisoptera	7	9
Anopheles	9	21
Anthopotamus	1	1
Antocha	1	1
Argia	2	4
Asellidae	11	82
Asellus	1	14
Athericidae	9	18

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Atherix	9	18
Atrichopogon	18	44
Baetidae	81	2817
Baetis	59	2317
Baetisca	2	2
Baetiscidae	2	2
Belostoma	22	27
Belostomatidae	23	28
Berosus	3	26
Bezzia	1	1
Bezzia/Palpomyia	8	40
Bithyniidae	1	1
Boyeria	14	30
Brachycentridae	1	1
Brachycentrus	1	1
Branchiobdellida	7	34
Brillia	29	95
Caecidotea	10	68
Caenidae	76	1954
Caenis	74	1907
Callibaetis	16	40
Caloparyphus	1	1
Calopterygidae	17	69
Calopteryx	8	21
Cambaridae	71	145
Cambarus	3	3
Cardiocladius	1	1
Centroptilum	1	2
Ceraclea	1	5
Ceratopogon	1	1
Ceratopogonidae	36	136
Ceratopsyche	17	217
Chaetocladius	1	1
Cheumatopsyche	56	2039
Chironomidae	100	11678
Chironomus	18	82
Cladopelma	5	27
Cladotanytarsus	14	34
Clinocera	1	1
Coenagrionidae	47	361
Concha/Thiene	87	781

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Conchapelopia	14	22
Corduliidae	11	13
Corixidae	36	217
Corydalidae	1	1
Corynoneura	35	124
Cricotopus	68	738
Cryptochironomus	38	61
Culex	2	5
Culicidae	12	38
Cymbiodyta	1	1
Dasyhelea	4	6
Decapoda	1	1
Desmopachria	1	1
Diamesa	1	1
Dicranota	6	8
Dicrotendipes	57	575
Diplectrona	1	23
Dolichopodidae	1	1
Doncricotopus	1	1
Dryopidae	9	15
Dubiraphia	45	452
Dytiscidae	24	47
Dytiscus	1	1
Elmidae	62	964
Empididae	39	158
Enallagma	7	82
Enchytraeidae	2	2
Endochironomus	12	38
Enochrus	3	3
Ephemeridae	2	2
Ephoron	3	9
Ephydridae	42	121
Epitheca	3	3
Eukiefferiella	11	41
Fallceon	6	71
Ferrissia	14	75
Forcipomyia	1	1
Fossaria	24	94
Gammaridae	12	592
Gammarus	12	592
Gerridae	12	34

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Glossosomatidae	1	1
Glyptotendipes	27	204
Gomphidae	6	8
Gomphus	1	1
Gyraulus	20	394
Gyrinidae	4	7
Gyrinus	4	7
Haliplidae	23	59
Haliplus	17	47
Helichus	9	15
Helicopsyche	13	179
Helicopsychidae	13	179
Helisoma	4	37
Helophorus	2	2
Hemerodromia	36	110
Heptagenia	37	268
Heptageniidae	57	861
Hesperophylax	1	1
Hetaerina	5	16
Hexagenia	2	2
Hirudinea	46	143
Hyalella	61	2249
Hyalellidae	61	2249
Hydatophylax	1	1
Hydraenidae	1	2
Hydrobaenus	2	2
Hydrochara	2	2
Hydrochus	3	5
Hydrophilidae	29	59
Hydropsyche	38	698
Hydropsychidae	64	3692
Hydroptila	55	517
Hydroptilidae	63	621
Hydrozoa	1	1
Ilybius	1	1
Ischnura	3	6
Isonychia	15	48
Isonychiidae	15	48
Kribiodorum	2	2
Labiobaetis	13	135
Labrundinia	60	465

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Laccobius	1	1
Laccophilus	5	6
Larsia	4	8
Leptoceridae	52	322
Leptophlebiidae	7	77
Lethocerus	1	1
Leucrocuta	13	129
Libellulidae	5	6
Limnephilidae	3	6
Limnophyes	18	27
Limnoporus	3	3
Limonia	3	3
Liodessus	6	8
Lopescladius	1	4
Lymnaea	1	3
Lymnaeidae	57	428
Maccaffertium	13	117
Macronychus	13	83
Mayatrichia	6	8
Micropsectra	37	241
Microtendipes	21	134
Microvelia	3	6
Muscidae	4	10
Naididae	8	33
Nanocladius	30	49
Natarsia	2	15
Nectopsyche	40	271
Nemata	18	40
Nematoda	2	13
Nematomorpha	2	3
Neoplasta	4	9
Neoplea	5	12
Neoporus	3	7
Nepidae	1	1
Neurocordulia	1	1
Nigronia	1	1
Nilotanypus	13	16
Nixe	2	23
Notonectidae	2	2
Ochrotrichia	1	4
Ochthebius	1	2

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Odontomesa	1	1
Odontomyia	2	2
Odontomyia/Hedriodiscus	3	3
Oecetis	16	29
Oligochaeta	73	919
Optioservus	17	115
Orconectes	60	128
Orthocladius	17	54
Orthotrichia	1	1
Palmacorixa	3	5
Parachaetocladius	1	1
Parachironomus	11	22
Paracladopelma	4	4
Paracloeodes	3	8
Parakiefferiella	13	85
Paraleptophlebia	4	59
Paramerina	40	349
Parametriocnemus	25	183
Paraphaenocladius	2	2
Paratanytarsus	67	825
Paratendipes	43	532
Peltodytes	7	12
Pentaneura	3	9
Pericoma	1	1
Perlesta	6	11
Perlidae	13	21
Phaenopsectra	53	211
Phryganeidae	6	8
Physa	79	4740
Physella	10	189
Physidae	85	4930
Pisidiidae	53	328
Planorbella	27	159
Planorbidae	40	676
Planorbula	3	26
Plauditus	5	40
Pleidae	5	12
Polycentropodidae	2	2
Polymitarcyidae	3	9
Polypedilum	93	2765
Potamanthidae	1	1

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Potamyia	5	113
Procladius	45	179
Procloeon	1	4
Prodiamesa	1	1
Promenetus	1	2
Pseudochironomus	1	1
Pseudocloeon	4	28
Pseudosmittia	1	1
Pseudosuccinea	1	1
Psychoda	3	8
Psychodidae	6	12
Pteronarcidae	8	10
Pteronarcys	8	10
Ptilostomis	4	5
Pycnopsyche	1	4
Ranatra	1	1
Rheocricotopus	14	28
Rheotanytarsus	53	1034
Roederiodes	1	2
Saetheria	7	11
Sciomyzidae	10	14
Scirtes	2	2
Scirtidae	4	4
Sigara	16	44
Simuliidae	56	2663
Simulium	56	2658
Sisyra	1	1
Sisyridae	1	1
Smittia	1	1
Somatochlora	2	2
Stagnicola	35	244
Stempellinella	2	2
Stenacron	20	106
Stenelmis	31	306
Stenochironomus	25	76
Stenonema	6	118
Stictochironomus	15	91
Stilocladius	1	5
Stratiomyidae	10	13
Sublettea	2	2
Sympetrum	2	2

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Syrphidae	1	1
Tabanidae	5	7
Tanypus	2	2
Tanytarsus	70	483
Thienemanniella	29	85
Thienemannimyia	8	102
Tipula	20	82
Tipulidae	25	95
Trepaxonemata	1	1
Triaenodes	1	2
Tribelos	1	1
Trichocorixa	3	5
Trichoptera	2	2
Tricorythidae	30	506
Tricorythodes	30	506
Tropisternus	5	5
Turbellaria	8	55
Tvetenia	26	169
Veliidae	3	6
Xenochironomus	6	8
Zavreliella	3	4
Zavrelimyia	6	25