Watershed health

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Cottonwood River Watershed Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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List of acronyms

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DNR Minnesota Department of Natural Resources

DOP Dissolved Orthophosphate

E Eutrophic

EQuIS Environmental Quality Information System

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

FS Full Support

FWMC Flow Weighted Mean Concentration

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

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

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

WID Waterbody Identification Number

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The Cottonwood River watershed drains an area of 1,312 square miles (840,000 acres) and sits within the Minnesota River Basin, which is located in the Prairie Parkland Ecological Province. The watershed is located in the southwest corner of Minnesota. The headwaters of the Cottonwood River begins its journey in the southwest corner of the watershed, just north of Balaton, from there it travels west across the watershed where it exists the subwatershed, about two miles south east of New Ulm, and flows into the Minnesota River. The watershed includes the Cottonwood River and main tributaries including Dutch Charlie Creek, Mound Creek, Sleepy Eye Creek, and Plum Creek. Plum Creek is of historical interest for being the subject of some of Laura Ingalls Wilder's writings.

The Minnesota Pollution Control Agency (MPCA) conducted a two-year intensive watershed monitoring (IWM) project in the Cottonwood River watershed. During this two-year sampling period, 81 stations across 59 stream reaches were monitored for fish, macroinvertebrates, and water chemistry. The biological data that was collected was used to determine the health of the streams and lakes by assessing the health of the aquatic community (fish and macroinvertebrates in streams, fish and plants in lakes). Of the reaches assessed, 20% were found to fully support aquatic life and 22% of the reaches did not support aquatic life. This watershed has had a significant amount of hydrological alterations in the form of drain tile, straightening of streams and the addition of ditches. These alterations have negative effects on the stream communities due to the lack of habitat, increased sedimentation, and increased large flow events. The presence of hybridization between fish species and the large number tolerant species are signs of unhealthy stream communities, directly linked to habitat degradation. Even though a majority of the watershed has had a significant amount of hydrological alterations there are still streams that have not been straightened and still provide good habitat for the fish and macroinvertebrate communities. In these streams, sensitive fish were present and the habitat was considered good. There were only nine stations that had habitat classified as good and no stations exhibited excellent habitat.

As part of the Intensive Water Monitoring effort, MPCA staff joined with local partners to complete stream water chemistry sampling at the outlets of the sixteen subwatersheds. New data on these reaches confirms poor water quality persists throughout the watershed making it difficult for healthy aquatic communities to thrive. Excessive suspended sediment in river systems is typically tied to poor surface water storage through altered hydrology, massive bank sloughing, channel incision and erosion. Increased sedimentation can cover vital spawning habitat for aquatic communities and decrease feeding success while changing the natural hydrology. Turbidity impairments already existed throughout the watershed, and three additional reaches now have total suspended solid impairments, including Highwater Creek, and two segments of the Cottonwood River. Numerous stream reaches were previously listed for fecal coliform bacteria. Sampling during this assessment period has found elevated levels of *E. coli* bacteria and added 13 more impairments for aquatic recreation. Elevated levels of bacteria can indicate conditions that are unsafe for swimming or wading, and secondary body contact such as fishing from a boat or shore.

Water chemistry sampling was also done on seven lakes in the watershed. Rock, Bean and Double lakes were all previously listed as impaired for aquatic recreation. New data confirms the existing impairments. Clear lake has a new impairment for nutrients. The impairments are for elevated levels of total phosphorus and chlorophyll-a, and low clarity. Sleepy Eye Lake was removed from impaired waters list. There was were several dredging and reclamation events on the lake that likely contributed to reduced phosphorous levels.

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 total maximum daily loads (TMDLs). 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 Cottonwood River Watershed beginning in the summer of 2017. This report provides a summary of all water quality assessment results in the Cottonwood River Watershed 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

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term statewide river monitoring network initiated in 2007 and designed to obtain pollutant load information from 199 river monitoring sites throughout Minnesota. Monitoring sites span three ranges of scale:

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

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

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

The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads.

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 1). 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 1). 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 2) 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 2) 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 2)

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Figure 1. The Intensive Watershed Monitoring Design.

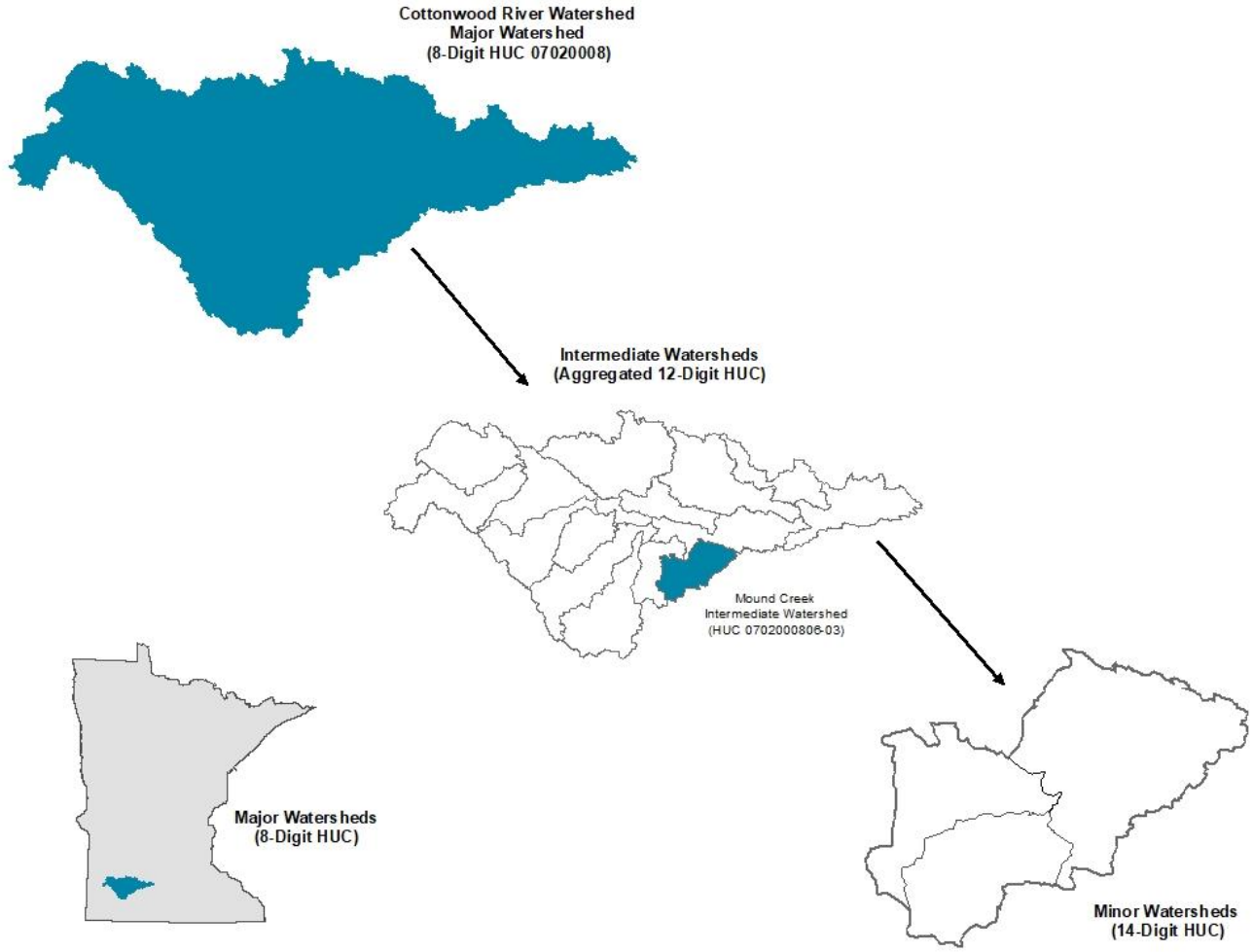
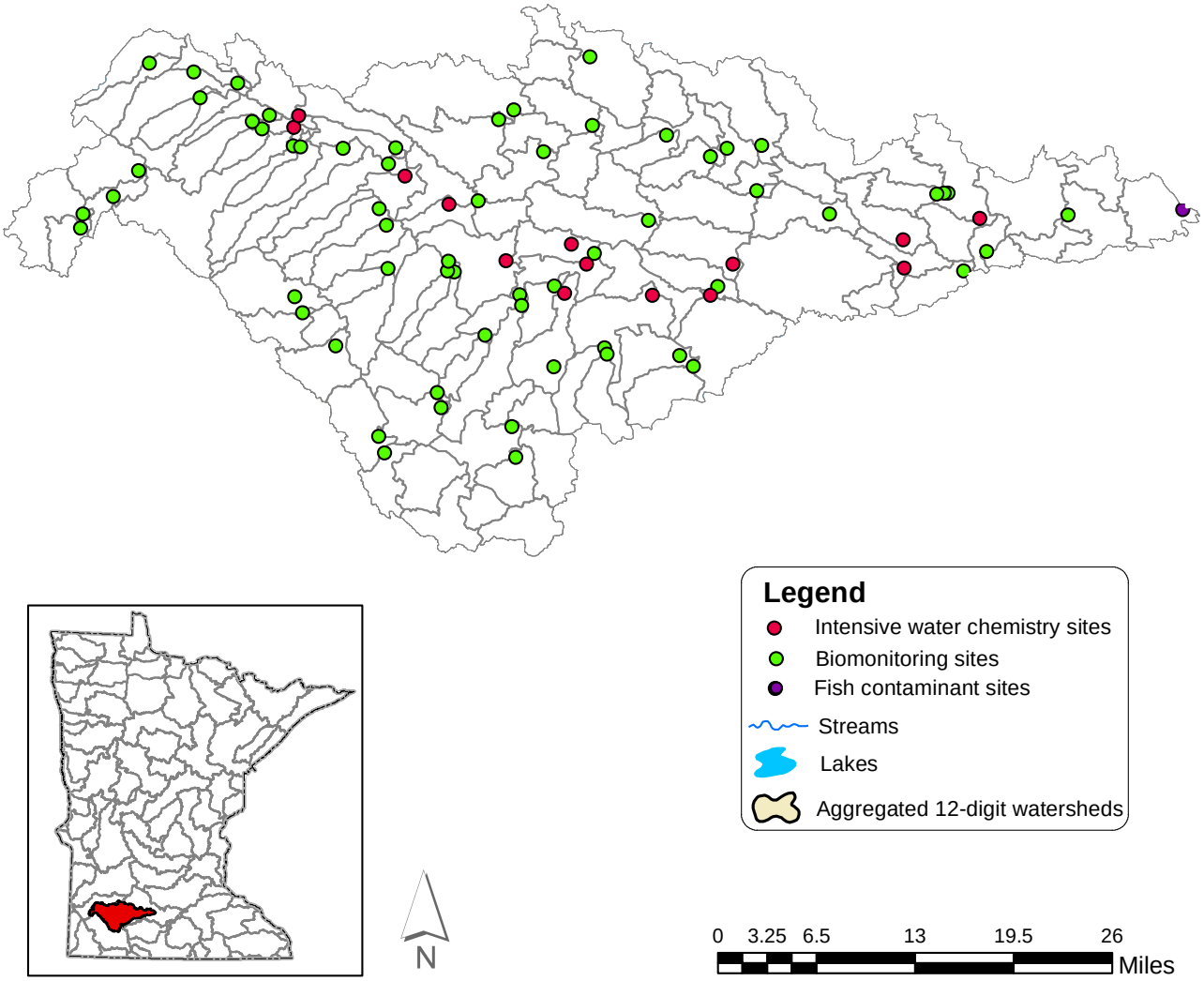


Figure 2. Intensive watershed monitoring sites for streams in the Cottonwood River watershed.



Lake monitoring

Lakes are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported and where applicable, where fish community health can be determined. Lakes are prioritized by size (greater than 100 acres), accessibility (can the public access the lakes), and presence of recreational use.

Lakes sampled as part of the intensive monitoring effort in the Cottonwood River watershed are shown in and are listed in Appendices 2.1 and 2.2.

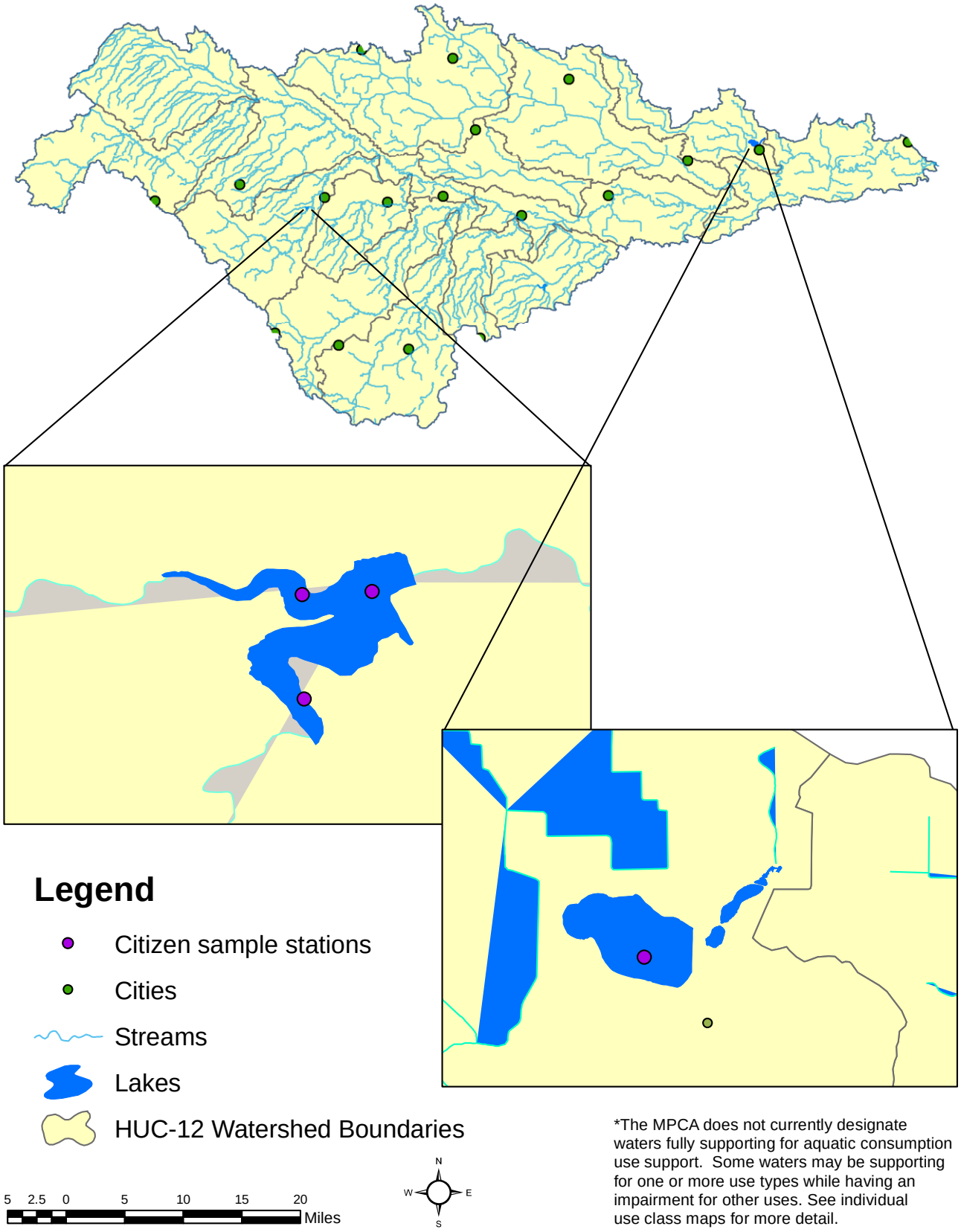
Citizen and local monitoring

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 3 provides an illustration of the locations where citizen monitoring data were used for assessment in the Cottonwood River watershed.

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Cottonwood River watershed.



*The MPCA does not currently designate waters fully supporting for aquatic consumption use support. Some waters may be supporting for one or more use types while having an impairment for other uses. See individual use class maps for more detail.

Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses 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)*. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

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 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.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, macroinvertebrates, and plants. Biological monitoring, the sampling of aquatic organisms, 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 stream IBIs for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. The MPCA also uses a lake fish IBI developed by the Minnesota Department of Natural Resources (DNR) to

determine if lakes are meeting aquatic life use. Because the lakes, rivers, and streams in Minnesota are physically, chemically, and biologically diverse, IBI's are developed separately for different stream classes and lake class groups 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. For streams these include pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride, total suspended solids, pesticides, and river eutrophication. For lakes, pesticides and chlorides contribute to the overall aquatic life use assessment.

Protection for aquatic life uses in streams and rivers 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 streams with channels that have been directly altered by humans (e.g., maintained for drainage). These tiered aquatic life uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat (MPCA 2015). 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. Tiered aquatic life use standards.

Tiered aquatic life use	Acronym	Use class code	Description
Warm water General	WWg	2Bg	Warm water 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.
Warm water Modified	WWm	2Bm	Warm water 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
Warm water Exceptional	WWe	2Be	Warm water 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.

Tiered aquatic life use	Acronym	Use class code	Description
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.

A small percentage of stream miles in the state (~1% 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, dissolved oxygen 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 WID), 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 DNR. The Protected Waters Inventory (PWI) provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the WID and are composed of an eight-digit number indicating county, lake and bay for each basin.

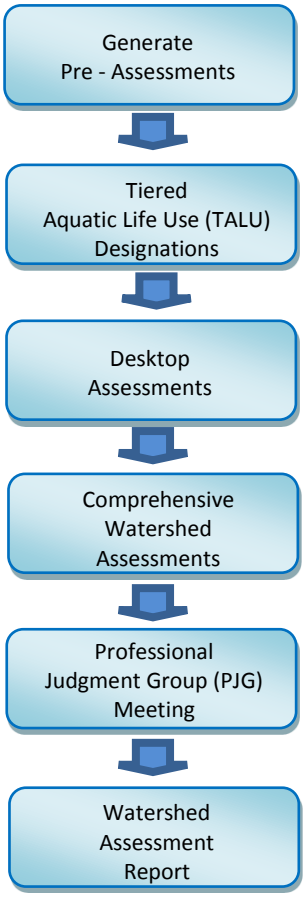
It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). 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 4.

Figure 4. Flowchart of aquatic life use assessment process.



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 aquatic life 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).

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. Iimplementing 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 2016) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04j.pdf 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 WID). 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.

Watershed overview

The Cottonwood River watershed drains an area of 840,000 acres and sits within the Minnesota River Basin which is located in the Prairie Parkland Ecological Province of Southwestern Minnesota. The watershed occurs within two ecoregions: Western Corn Belt Plains and Northern Glaciated Plains of Southwest Minnesota (figure 6). The watershed contains 15 12-HUC subwatersheds and 108 minor subwatersheds. The watershed consists of five counties: Brown, Cottonwood, Lyon, Murray and Redwood.

The southwestern section of the watershed has greater elevation than the northeastern section due to the Coteau Moraines (see figure 5). The Coteau Moraines is an area of higher elevation created by large amounts of pre-Wisconsin age glacial till deposits, up to 800 feet deep in some areas. Due to these glacial till deposits, this region is dominated by gentle rolling hills with steep ravines cut into the till by streams and rivers. The majority of the natural streams are south of the Cottonwood River in the Northern Glaciated Plains. Thirty seven percent of the Cottonwood River watershed is in the Coteau Moraines. The headwaters of the Cottonwood River is in the most westerly tip of the watershed which also lies in the Coteau Moraines. The Cottonwood River then travels east across the watershed for approximately 144 miles where it flows into the Minnesota River.

Figure 5. Elevation Map

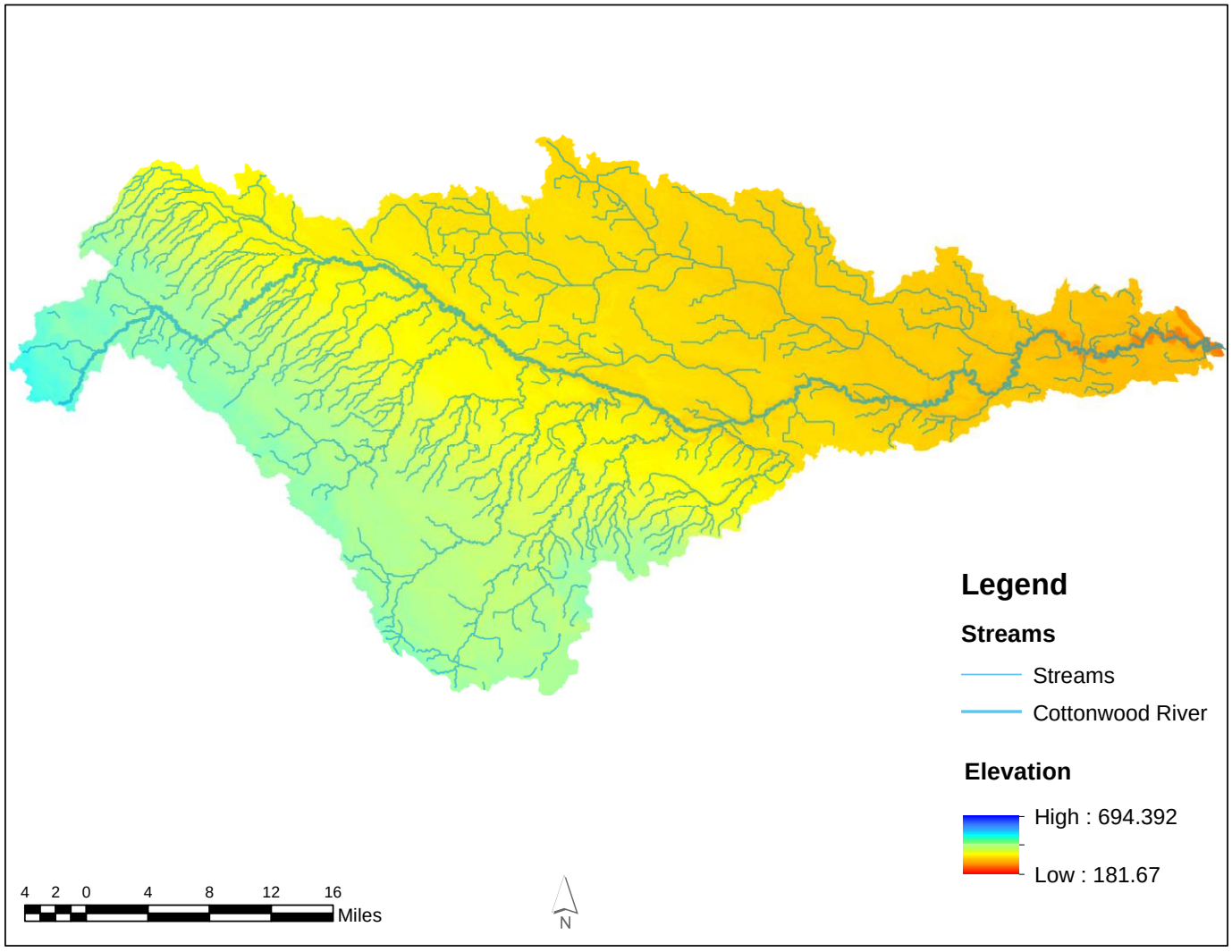
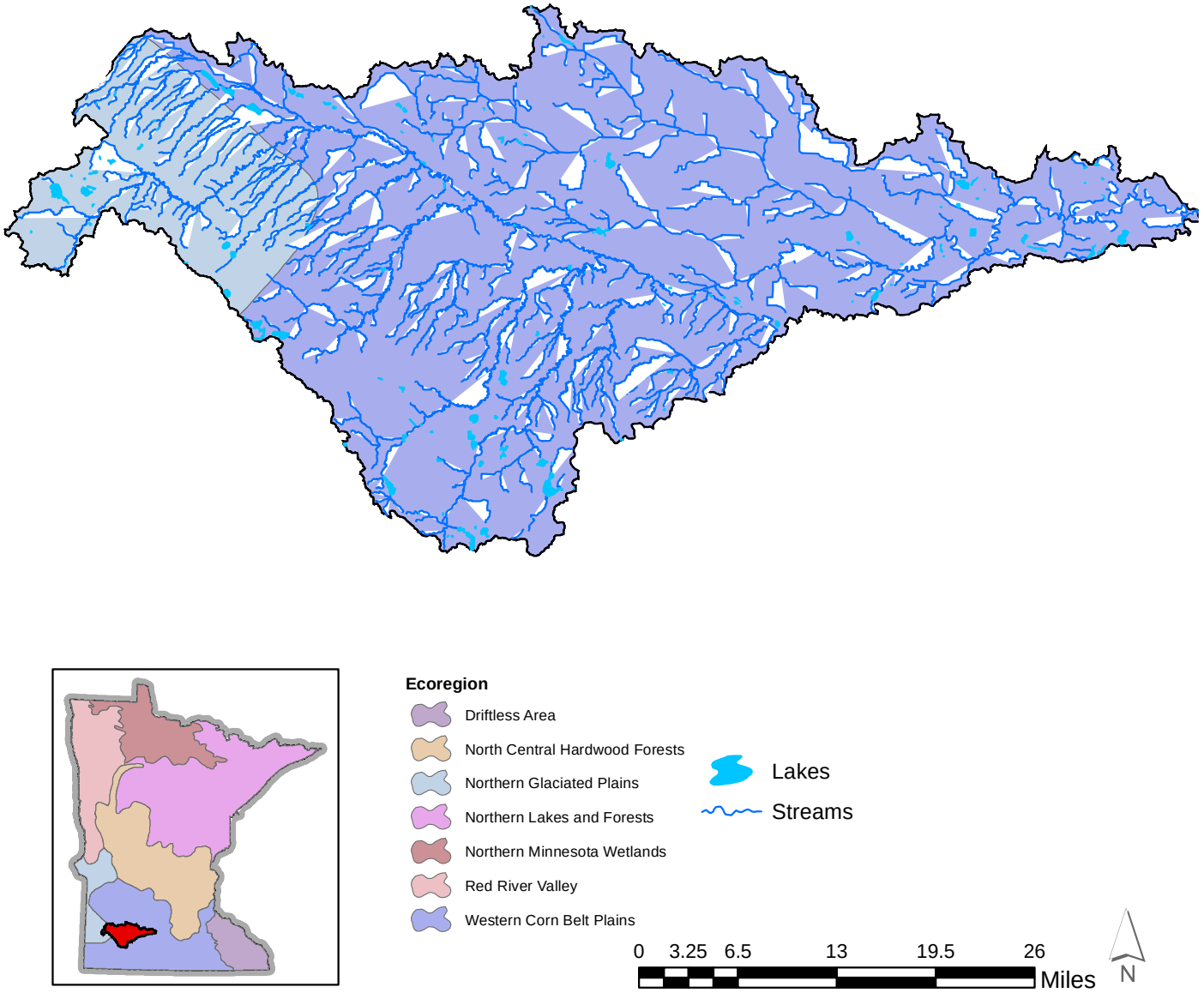


Figure 6. The Cottonwood River watershed within the Western Corn Belt Plains and Northern Glaciated Plains ecoregion of Southwest Minnesota.



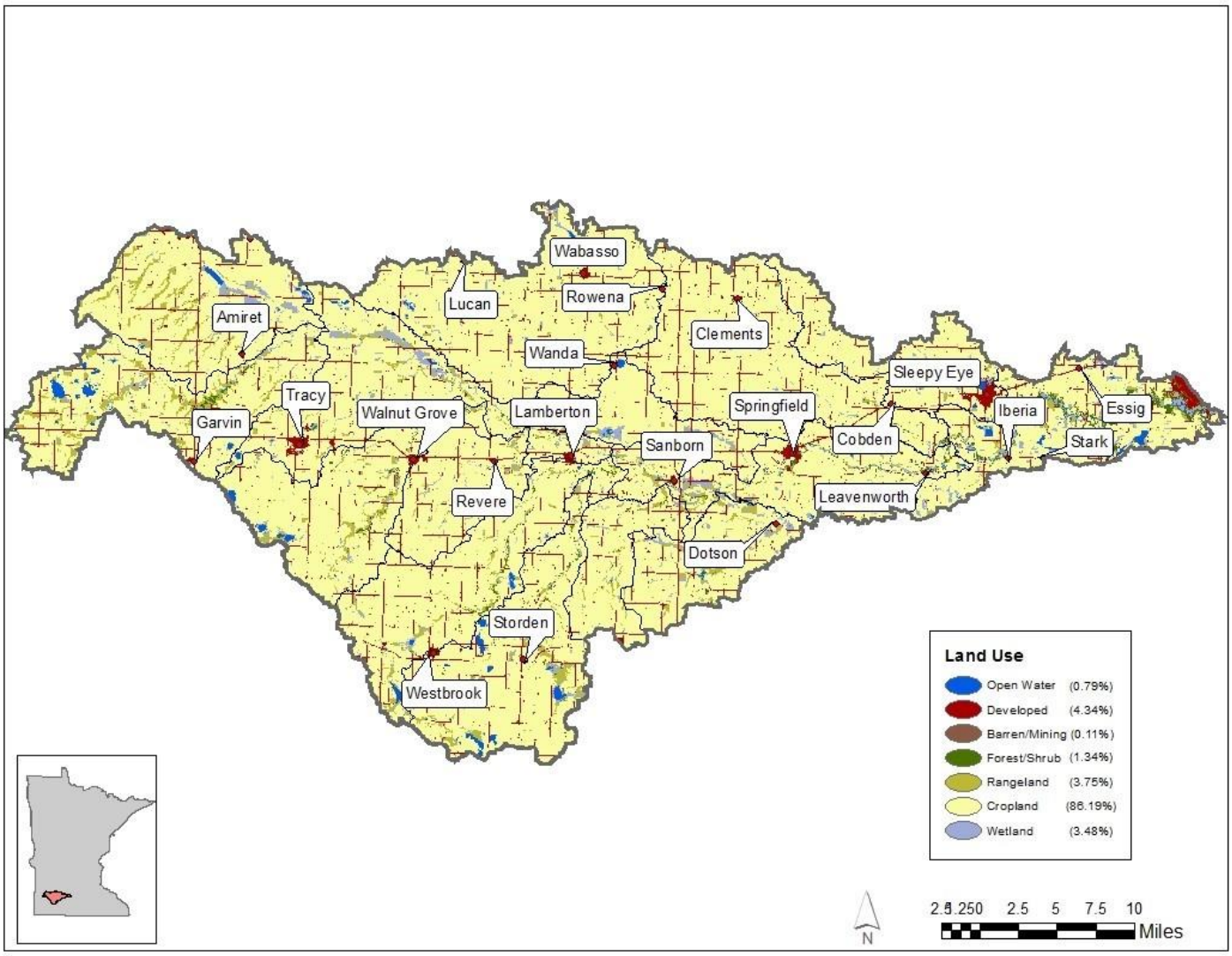
Land use summary

The Cottonwood River watershed is in the Prairie Pothole region. Before European settlers moved to the area, the land had an abundance of wetlands and prairies. Once European settlers moved to the area in the late 1800s, they began draining wetlands and tilling up the prairies to farm the land. The settlers also began to create ditches and straighten streams to move water off the land faster, making it easier to farm and the soil more productive. These alterations drastically changed the landscape and altered how water moved through the area. It is estimated that at least 70% of the wetlands in this region have been drained.

Today, the primary land use in the Cottonwood River watershed is agricultural. Approximately 84% of the land is cropland with 92% of that dedicated to corn and soybeans.

The other major uses of the land within the Cottonwood River watershed is rangeland (3.7%), human development (4.3%), and wetlands (3.5%).

Figure 7. Land use in the Cottonwood River watershed.



Surface water hydrology

The Cottonwood River watershed contains 460 named streams, totaling about 1,932 miles, 26 named lakes, and about 135 lakes/ponds in total. Approximately 18% of the lakes/ponds are over 100 acres while the remainder are as small as 1.5 acres.

All streams with the watershed drain into the Cottonwood River which eventually drains into the Minnesota River just southeast of New Ulm. Upper Sleepy Eye Creek is the largest tributary in the Cottonwood River watershed draining an area of 98 square miles while the smallest is Dry Creek draining an area of 41 square miles. Approximately 50% of the streams and rivers in the watershed are channelized.

The Cottonwood River does not have any large power producing dams on it but there are a few small dams that were constructed in the mid to late 1900. The DNR started a dam removal project and has been removing dams to help improve aquatic life. In 2016, the DNR began the process of removing three dams along the Cottonwood River located at Kuhar Park north of Lamberton, the Sanborn golf course and at the Sanborn community park. The dams will be replaced with more natural structures such as riffles to improve the rivers health. By removing the dams native fish will be able to migrate back into the upstream portions of the river that were previously blocked due to the dam. Construction on Kuhar Park dam began this January 2020 and will continue until all three dams have been removed.

Figure 8. Map of percent altered streams by major watershed (8-HUC)

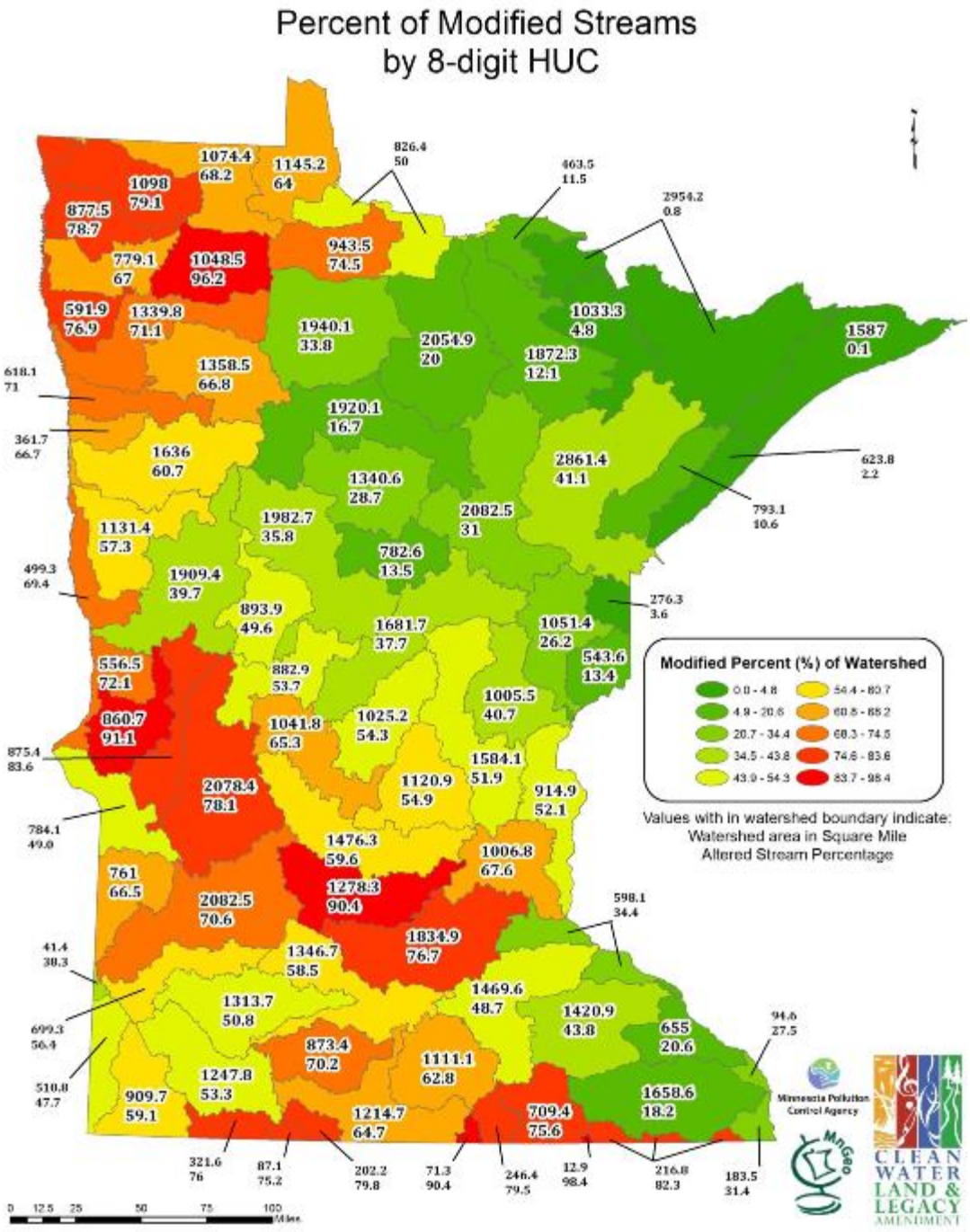
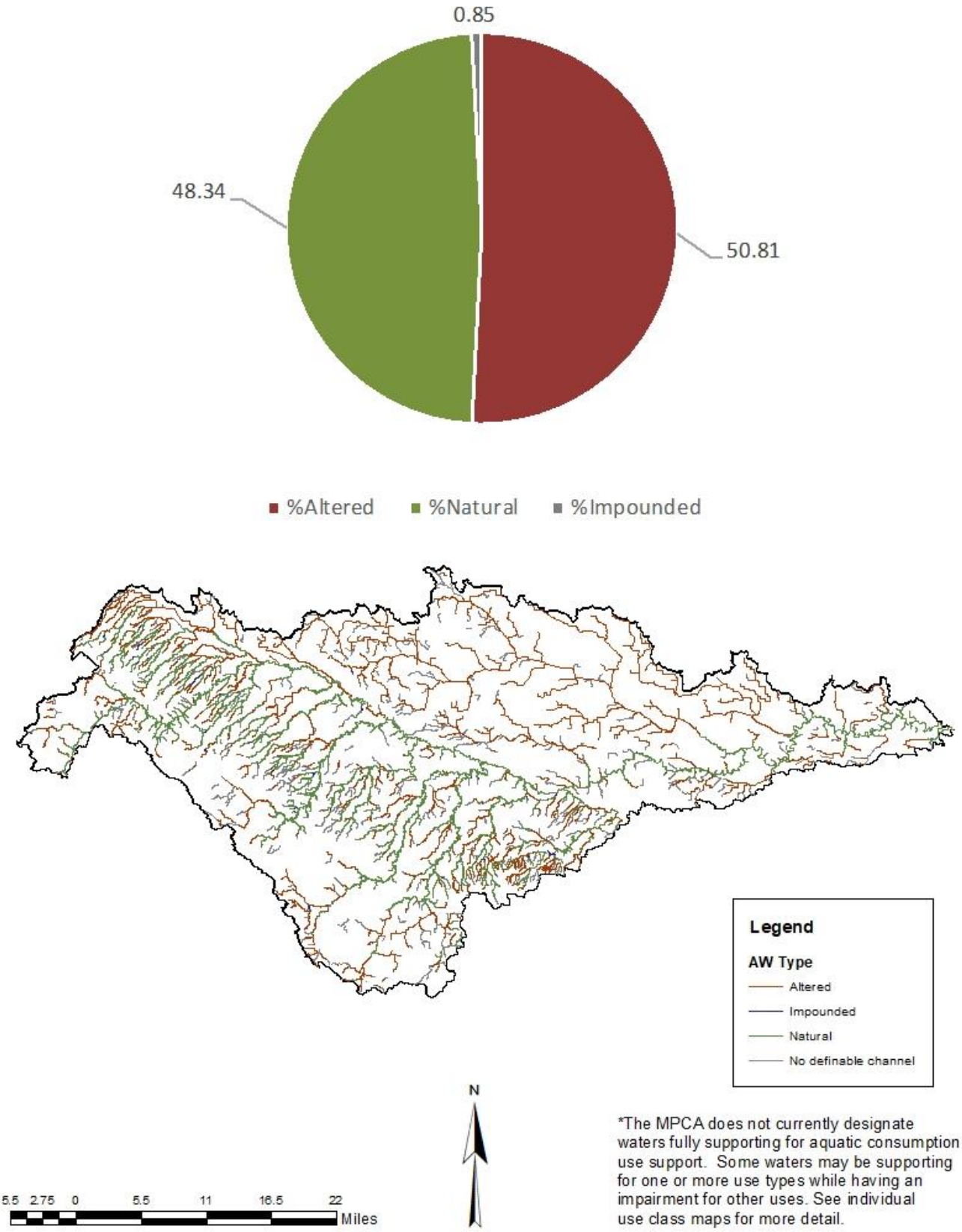


Figure 9. Comparison of natural to altered streams in the Cottonwood River watershed (percentages derived from the Statewide Altered Water Course project.

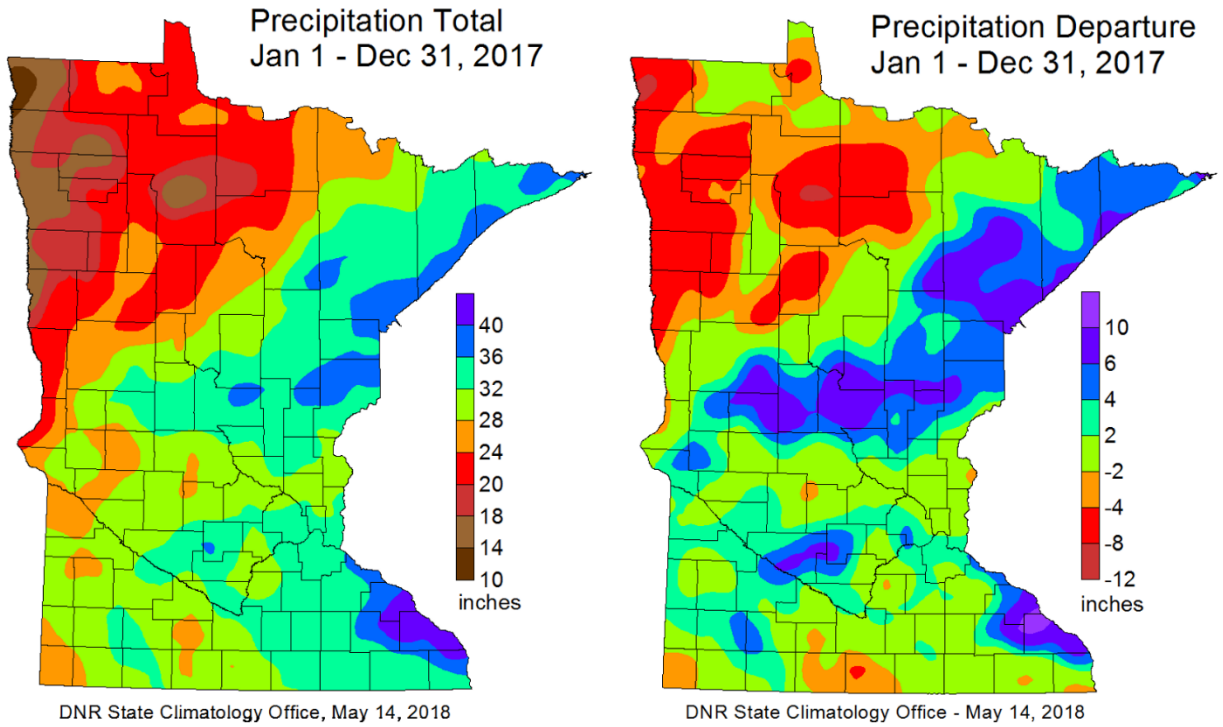


Climate and precipitation

The average annual temperature for the State of Minnesota is 41.6˚F. For the Cottonwood River watershed, the annual average is 45.0 ˚F, the average summer (June-August) temperature is 70.4˚F and the average winter (December-February) temperature is 17.2˚F (DNR: Minnesota State Climatology Office, 2020).

Precipitation is an important source of water input to a watershed. Figure 10 displays two representations of precipitation for calendar year 2017. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the southeastern portion of the state. The Cottonwood River watershed received 29.5 inches of precipitation in 2017. The display on the right shows the amount that precipitation levels departed from normal. The watershed experienced total precipitation about four inches above normal that year.

Figure 10. Statewide precipitation total (left) and precipitation departure (right) during 2017 (Source: DNR State Climatology Office, 2019a)



The Cottonwood River watershed is located within the Southwest precipitation region. Figure 11 and 12 display the areal average representation of precipitation in Southwest Minnesota for 20 and 100 years, respectively. An aerial average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. Though rainfall can vary in intensity and time of year, rainfall totals in the Southwest region display no significant trend over the last 20 years. However, precipitation in Southwest Minnesota exhibits a significant rising trend over the past 100 years ($p<0.01$). This is a strong trend and matches similar trends throughout Minnesota.

Figure 11. Precipitation trends in Southwest Minnesota (1997-2017) with five-year running average (Source: WRCC, 2020)

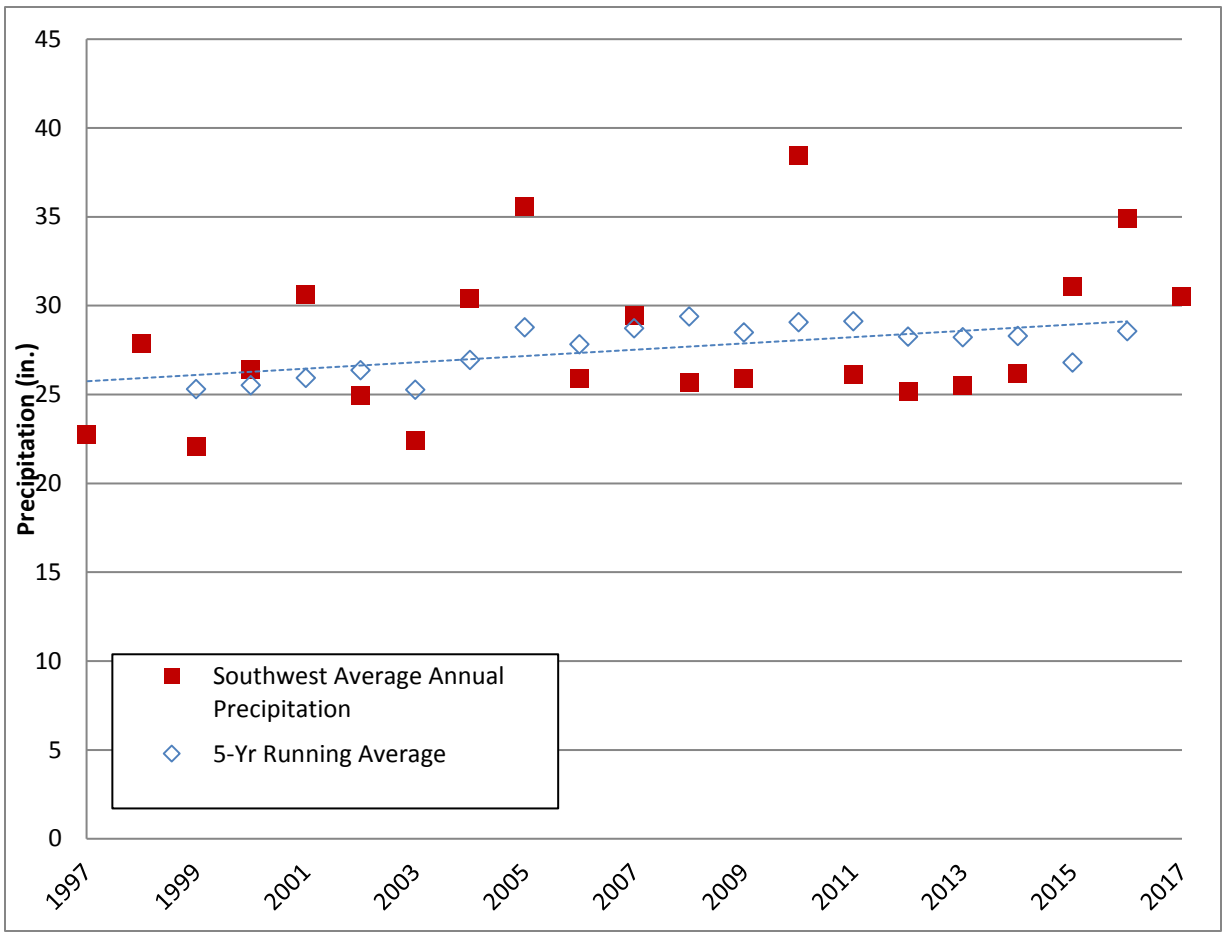
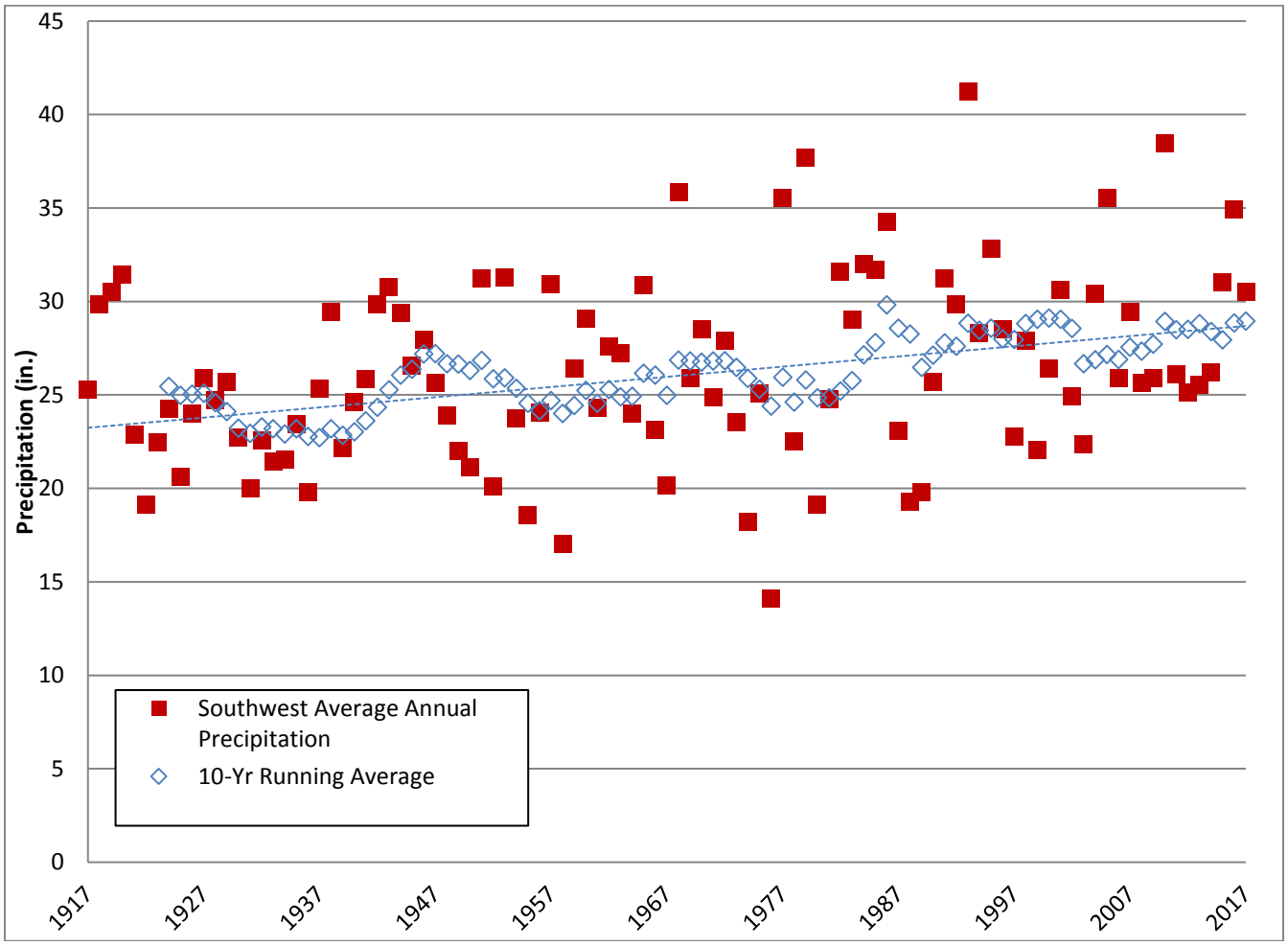


Figure 12. Precipitation trends in East-Central Minnesota (1917-2017) with ten-year running average (Source: WRCC, 2020)



Hydrogeology

Hydrogeology is the study of the interaction, distribution and movement of groundwater through the rocks and soil of the earth. The geology of a region strongly influences the quantity of groundwater available, the quality of the water, the sensitivity of the water to pollution, and how quickly the water will be able to recharge and replenish the source aquifer. This branch of geology is important to understand as it indicates how to manage groundwater withdrawal and land use and can determine if mitigation is necessary.

The Cottonwood River watershed contains features of Minnesota's Western groundwater province. The Western Province is characterized by clayey drift overlying Cretaceous and Precambrian bedrock. The drift and Cretaceous bedrock contain sand and sandstone aquifers of limited extent. (DNR, 2017)

Groundwater potential recharge

Groundwater recharge is one of the most important parameters in the calculation of water budgets, which are used in general hydrologic assessments, aquifer recharge studies, groundwater models, and water quality protection. Recharge is a highly variable parameter, both spatially and temporally, making accurate estimates at a regional scale difficult to produce. The MPCA contracted the US Geological Survey to develop a statewide estimate of recharge using the SWB – Soil-Water-Balance Code. The result is a gridded data structure of spatially distributed recharge estimates that can be easily integrated

into regional groundwater studies. The full report of the project as well as the gridded data files are available at: https://gisdata.mn.gov/dataset/geos-gw-recharge-1996-2010-mean.

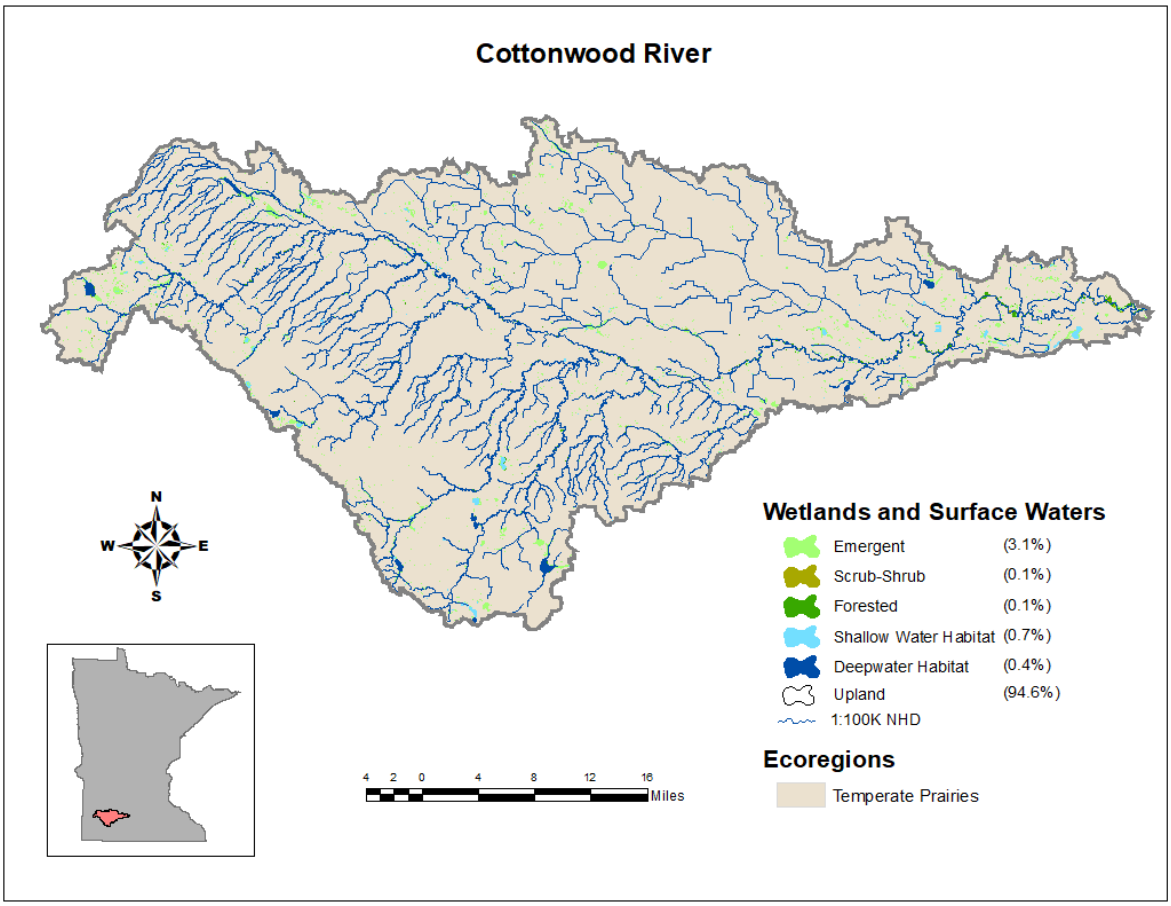
Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock-surficial deposit interface. Typically, recharge rates in unconfined aquifers are estimated at 20 to 25 percent of precipitation received, but can be less than 10 percent of precipitation where glacial clays or till are present (USGS, 2007). For the Cottonwood River watershed, the average annual potential recharge rate to surficial materials ranges from 1.35 to 8.05 inches per year, with a mean of 3.42 inches per year. The statewide average potential recharge is estimated to be four inches per year with 85 percent of all recharge ranging from three to eight inches per year (USGS, 2015)

Wetlands

Excluding open water portions of lakes and rivers, the Cottonwood River watershed supports an estimated 38,887 acres of wetland, which is equivalent to 5% of the total watershed area (Figure 13). Emergent wetlands are the most common type, making up over half (62%) of the total wetland area. The second most extensive wetland type is shallow open water habitat (ponds and deep marshes) which comprise (14.2%) of the total wetland area and only 0.7% of the total watershed area. Forested wetlands make up about 13.9% and shrub dominated wetlands (1.8%) of the total wetland area. An estimated 7.9% of wetland area is comprised of typically smaller wetlands with temporary hydrology which are routinely farmed in dry years. These estimates of wetland extent and distribution observations come from the recently updated Minnesota National Wetland Inventory (NWI). Using the Minnesota NWI Kloiber et al (2019) present a summary of wetland extent by county or major watershed as reported here. For more information about Minnesota's NWI update, visit: http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html.

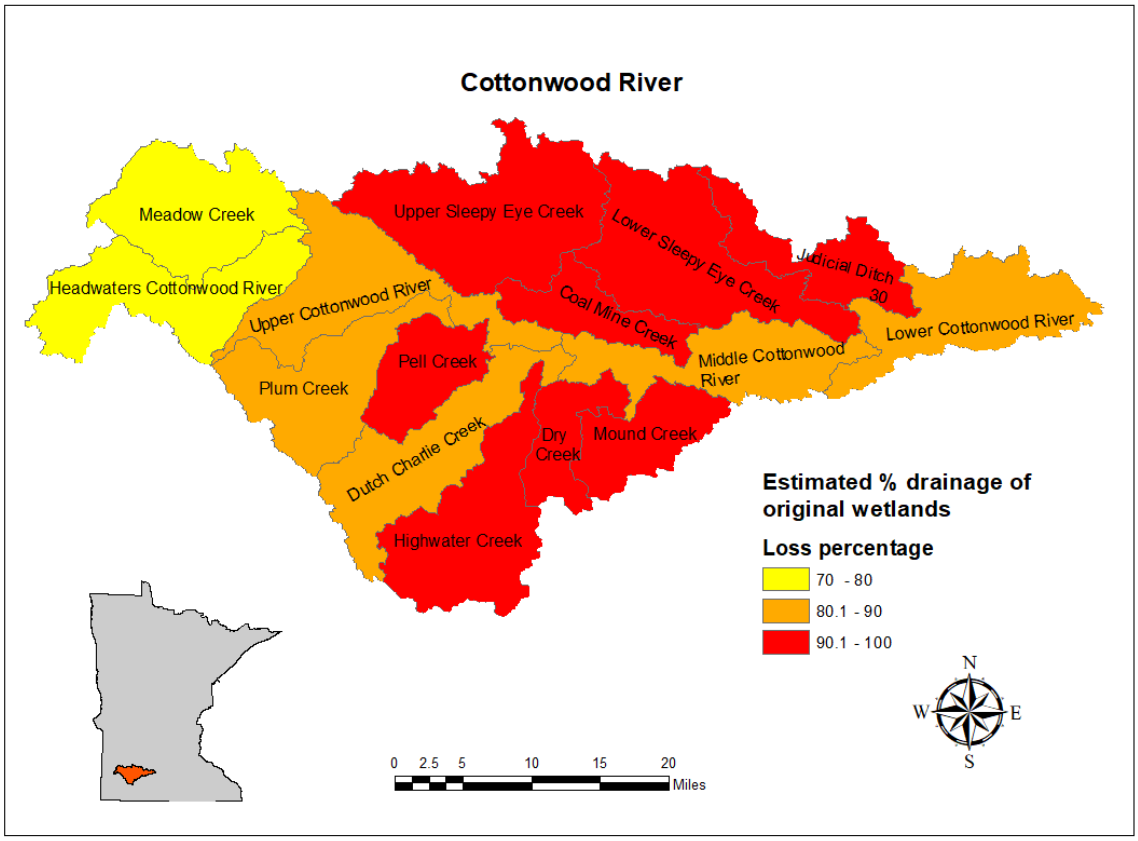
Headwaters of the Cottonwood watershed drain a portion of the eastern edge of the Coteau des Prairies. The coteau rising to over 800 feet in elevation compared to the surrounding landscape is a significant landscape feature in Southwest MN and extends northwest into South Dakota and to the southeast into Iowa. Topography in much of the Cottonwood watershed is gently rolling to flat. Recent geology of the watershed is dominated by ground moraine derived from the Des Moines glaciation lobe. Ground moraine typically results in extensive networks of isolated and often interconnected shallow wetlands. Much of Minnesota's portion of the prairie pothole region is characterized by ground moraine. All of Cottonwood River watershed is within the prairie pothole region. The watershed also occurs entirely within the Temperate Prairies Ecoregion (Figure 6).

Figure 13. Wetlands and surface water in the Cottonwood River watershed. Wetland data are from the updated MN National Wetlands Inventory (circa 2011 data).



Conversion of wetlands by drainage and filling activities over the past century and a half has resulted in extensive portions of the Cottonwood River watershed becoming one of the most productive row cropping agricultural areas of Minnesota. At the same time this extensive drainage has greatly altered the historic hydrology of the watershed. Estimates of historic wetland extent can be derived using drainage class assignments from the soil survey. SSURGO soil polygon map units (MU) classed as 'Poorly Drained' or 'Very-Poorly Drained' were used as proxies for historic wetland extent. These results were then compared to contemporary wetland extent estimates from Minnesota's updated NWI to produce wetland loss estimates as a percentage at the 12-HUC subwatershed scale. Figure 7 illustrates the relative amount of wetland conversion that has occurred across the Cottonwood watershed. Findings from this analysis show all fifteen of the Cottonwood subwatersheds have experienced significant wetland drainage, impacting at least 70% of historical wetlands. The least amount of wetland conversion exists in the westernmost two subwatersheds – Meadow Creek and Headwaters of the Cottonwood River. Subwatersheds further down the Coteau and along the Cottonwood River corridor have experienced slightly more extensive amounts of wetland conversion. Subwatersheds in the flatter regions of the Cottonwood River watershed, particularly to the north and south of the main river corridor have less than 10% of their original wetland extent remaining today. Wetland drainage reduces the amount of water storage in the watershed, contributing to short but often more intense flooding (Blann et al 2009).

Figure 14. Estimated wetland conversion (loss) rates between historic extent based on SSURGO soil data and ca. 2011 wetland data presented at 12-HUC subwatershed scale.



Special wetland features in the Cottonwood River watershed

Calcareous fens are one of the rarest wetland communities in Minnesota. Calcareous fens are wetlands characterized by saturated soils with ground water discharges which are high in alkaline ions, particularly calcium and magnesium. The constant water supply and rich mineral supply characteristic of calcareous fens supports a diverse assemblage of rare and unique plants. Calcareous fens are dominated by narrow-leafed grass-like plants including sedges, grasses and specially adapted forbs. Because of their rareness and sensitivity to disturbance, calcareous fens in Minnesota are specially designated in State Water Quality Standards to be protected from impacts to water quality.

Three calcareous fens are located in the Cottonwood River watershed. All three of them (Storden 21, Storden 34 and Amo 2) occur in the Highwater Creek subwatershed and are recognized as unlisted, restricted discharge Outstanding Resource Value Waters (ORVWs) in accord with Minn. R ch. 7050.0335 subp 2.

The Cottonwood River watershed also supports three Scientific and Natural Areas (SNAs). Two of these, Cottonwood River Prairie SNA located in the Middle Cottonwood River subwatershed and Glynn Prairie SNA in the Headwaters Cottonwood River subwatershed, support extensive wetlands. All surface waters, including wetlands, located within state designated Scientific and Natural Areas are designated as unlisted prohibited discharge ORVWs in accord with Minn. R. ch. 7050 033 subp 4.

Watershed-wide data collection methodology

Lake water sampling

Local partners with Redwood-Cottonwood Rivers Control Area (RCRCA) monitored seven lakes in the Cottonwood watershed through grant agreements with the MPCA in 2016 and 2017. They sampled Clear, Sleepy Eye, Bean, Double, Rock, and Laura lakes, and Wellner-Hageman Reservoir for assessment of aquatic recreation. There are currently three volunteers enrolled in the MPCA's 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 recreation use assessment requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth.

Stream water sampling

Sixteen water chemistry stations were sampled from May through September in 2017, and again June through August of 2018, to provide sufficient water chemistry data to assess 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/triangles in Figure 2). A SWAG was awarded to the Redwood-Cottonwood Rivers Control Area (RCRCA) to conduct this monitoring (See Appendix 2.1 for locations of stream water chemistry monitoring sites & Appendix 1 for definitions of stream chemistry analytes monitored in this study).

Stream flow methodology

The MPCA and the DNR jointly monitor stream discharge at dozens of sites across the state on major rivers, at the outlets of most of the state's major watersheds, and at the mouths of some aggregated 12-HUC subwatersheds. These data are available at the DNR/MPCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Lake biological sampling

A total of five lakes were monitored for fish community health in the Cottonwood River watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2019 assessment was collected in 2011-2015.

To measure the health of aquatic life at each lake, a fish IBI was calculated based on monitoring data collected in the lake. A fish classification framework was developed to account for natural variation in community structure which is attributed to area, maximum depth, alkalinity, shoreline complexity, and geographic location. As a result, an IBI is available for four different groups of lake classes (Schupp Lake Classification, DNR). Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs). IBI scores higher than the impairment threshold and upper CI indicate that the lake supports aquatic life. Scores below the impairment threshold and lower CI indicate that the lake 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, plant surveys, and observations of local land use activities).

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Cottonwood River watershed was completed during the summer of 2017. A total of 84 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor 14-HUC

watersheds. In addition, 14 existing biological monitoring stations within the watershed were revisited in 2017. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2019 assessment was collected in 2017. A total of 60 WIDs were sampled for biology in the Cottonwood River watershed. Waterbody assessments to determine aquatic life use support were conducted for 59 WIDs. Older biological information that was not used in the assessment process will be used in 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 macroinvertebrate 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 macroinvertebrate 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 3.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, 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). For IBI results for each individual biological monitoring station, see Appendices 4.1 and 4.2.

Fish contaminants

Minnesota Department of Natural Resource (DNR) fisheries staff collect most of the fish for the Interagency Fish Contaminant Monitoring Program. In addition, MPCA's biomonitoring staff collect up to five piscivorous (top predator) fish and five forage fish near the 8-HUC pour point, as part of the Intensive Watershed Monitoring. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish of each species are analyzed for polychlorinated biphenyls (PCBs).
Captured fish are wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets are placed in 60 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzes the samples for mercury and PCBs. Fish tested for poly- and perfluoroalkyl substances (PFAS) are shipped to SGS-AXYS Analytical Laboratory, which analyze homogenized fish fillets for 13 PFAS. Of the measured PFAS, only perfluorooctane sulfonate (PFOS) is reported here because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.
From the fish contaminant analyses, MPCA determines which waters exceed impairment thresholds. The Impaired Waters List is prepared by the MPCA and submitted every even year to the U.S. 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 (minimum concentration for 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.

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.

Before 2008, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory, the same as PCBs. With the adoption of a water quality standard for mercury in edible fish tissue, a waterbody is classified as impaired for mercury in fish tissue if ten percent of the fish samples (measured as the 90th percentile) exceed 0.2 mg/kg of mercury. At least five fish samples of the same species are required to make this assessment for a single year.

Pollutant 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 concentrations typically rise with streamflow for many of the monitored pollutants, and because of the added influence elevated flows have on pollutant load estimates, sampling frequency is greatest during periods of moderate to high flow. All major snowmelt and rainfall events are sampled. Low flow periods are also sampled although sampling frequency is reduced as pollutant concentrations are generally more stable when compared to periods of elevated flow.

Water sample results and daily average flow data are coupled in the $FLUX_{32}$ pollutant load model to estimate the transport (load) of nutrients and other water quality constituents past a sampling station over a given period of time. Loads and flow weighted mean concentrations (FWMCs) are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website.

Groundwater monitoring methodology

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 quantity

Monitoring wells from the DNR 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

Groundwater/Surface water withdrawals

The DNR 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 DNR yearly. Information on the program and the program database are found at:
http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Stream flow

The MPCA and the DNR jointly monitor stream water quantity and quality at 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. Information and data on these sites are available at the DNR/PCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Wetland monitoring

The MPCA is actively developing methods and building capacity to conduct wetland quality monitoring and assessment. Our primary approach is biological monitoring—where changes in biological communities may indicate a response to human-caused impacts. The MPCA has developed Indices of Biological Integrity (IBIs) to monitor the macroinvertebrate condition of depressional wetlands with open water. MPCA is also using Floristic Quality Assessment (FQA) to assess vegetation condition in all of Minnesota's wetland types. For more information about the wetland monitoring (including technical background reports and sampling procedures), please visit the MPCA Wetland monitoring and assessment webpage at: https://www.pca.state.mn.us/water/wetland-monitoring.

The MPCA currently does not monitor wetlands systematically by watershed. Rather, the MPCA is using probabilistic monitoring to assess status and trends of wetland quality in the state and by major ecoregion. Probabilistic monitoring refers to the process of randomly selecting sites to monitor and achieve an unbiased estimate of the resource. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

Individual aggregated 12-HUC subwatershed results

Aggregated 12-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each Aggregated 12-HUC subwatershed within the Cottonwood River 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. 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 12-HUC subwatersheds contain the assessment results from the 2019 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2017 intensive watershed monitoring effort, but also considers available data from the last ten years.

The proceeding pages provide an account of each aggregated 12-HUC subwatershed. Each account includes a brief description of the aggregated 12-HUC subwatershed, and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, and b) lake aquatic life and recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the aggregated 12-HUC 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 12-HUC subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2019 assessment process (2020 U.S. Environmental Protection Agency [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 4). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), dissolved oxygen, total suspended solids, chloride, pH, total phosphorus, chlorophyll-a, biochemical oxygen demand and un-ionized ammonia (NH3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*Escherichia coli*) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (CW) or cool or warm water community (WW). 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 12-HUC subwatershed as well as in the watershed-wide results and discussion section.

Lake assessments

A summary of lake water quality is provided in the aggregated 12-HUC subwatershed sections where available data exists. This includes aquatic recreation (phosphorus, chlorophyll-a, and Secchi) and aquatic life, where available (chloride and fish IBI). Similar to streams, parameter level and over all use decisions are included in the table.

Headwaters Cottonwood River Aggregated 12-HUC HUC 0702000801-01

The Headwaters Cottonwood River subwatershed drains an area of 100 square miles of mostly natural streams. It is located in the northwest corner of the Cottonwood River watershed and almost exclusively within Lyon County. The Cottonwood River travels approximately 42 miles through Lyon County starting just north of Balaton in the southernmost tip of the subwatershed. From there it heads northeast where it leaves the subwatershed, approximately 20 miles southeast of Marshall. A majority of the Cottonwood River is natural channel with only few small sections, less than one mile, being channelized. About 50% of the streams flowing into the Cottonwood River are natural and the other 50% channelized. The majority of land use is row crop farming (74%) and cattle ranching (10%) with only 4% of land developed.

Table 2. Aquatic life and recreation assessments on stream reaches: Headwaters Cottonwood River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators:									Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication		
07020008-502 Cottonwood River, Headwaters to Meadow Creek	01MN042, 14MN150, 17MN160, 17MN162	42.42	WWg	EXS	EXS	IF	EXS	IF	MTS	MTS	MTS	IF	IMP	IMP
07020008-581 Unnamed creek, Unnamed cr to Cottonwood River	17MN158	3.82	WWg	MTS	EXS	IF	IF	IF		IF	IF	IF	IMP	--
07020008-619 Unnamed creek, T110 R42W S24, west line to Cottonwood River	17MN159	3.76	WWg	EXS	EXS	IF	IF	IF		IF	IF	IF	IMP	--
07020008-621 Unnamed creek, -95.902 44.256 to Cottonwood River	17MN161	1.12	WWg	EXS	EXS	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 2016 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 3. Lake assessments: Headwaters Cottonwood River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
North Twin	42-0003-00	48	--	--	NGP	--	--	--	--	IF	IF	--	--	IF
McKay	42-0043-00	218	--	--	NGP	--	--	--	--	IF	--	IF	--	IF
Rock	42-0052-00	392	7	Shallow lake	NGP	--	EXS		--	EXS	IF	IF	NS	NS
Mahlke Marsh	42-0060-00	63	--	--	NGP	--	--	--	--	IF	--	--	**NA**	IF

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

One of the stations sampled on the mainstem Cottonwood River is a long term biological monitoring station (14MN150) located in Garvin Park. This station was selected specifically for its "least impacted" condition based on surrounding stream conditions so it would be expected that the habitat and fish community would score higher than surrounding stations. This site was monitored in 2014, 2016, and 2017, with macroinvertebrates failing to meet general use expectations in 2014 and 2017 despite the relatively high quality habitat in this stretch of the river. The fish data tells a slightly different story as the fish scored above the general use expectations but only by a very small margin. The other three stations indicate poor fish communities with little diversity and a majority of the fish species being tolerant.

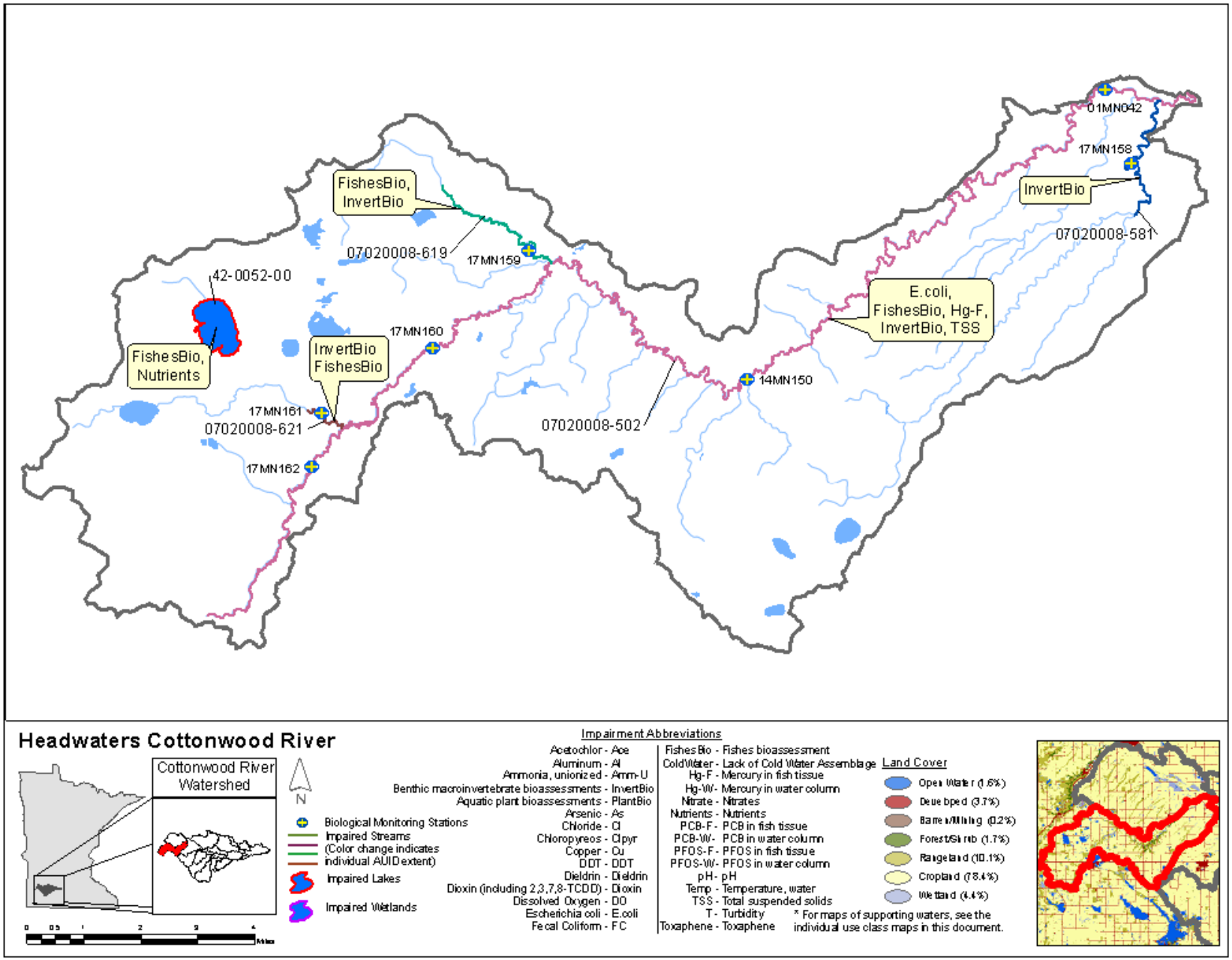
Biological station 17MN157, on one of the unnamed tributaries, was not assessable due to the low number (21) of individual fish captured at the site and low water level. Low waterlevels also prohibited a macroinvertebrate sample from being collected. The data collected from the

remaining unnamed creeks indicated poor fish communities with little diversity and a majority of tolerant species. Biological stations 17MN159 and 17MN158 had relatively low habitat scores which could be due to the fact that their reach is within an open pasture with animal access to stream channel. Biological station 17MN161 had good habitat but still had low fish diversity and mostly tolerant fish species. Macroinvertebrate data was collected on four stream assessment units that are within this subwatershed. All four of these stream segments exhibited impaired macroinvertebrate communities and were dominated by tolerant taxa such as *Physella* (snail) and *Polypedilum* (midge).

Chemistry data was available on the downstream reach of the Cottonwood River. The river exceeds the standard for bacteria and is impaired for aquatic recreation use. The river carries excess sediment and does not support aquatic life use.

Rock Lake was previously listed for nutrients in 2010. One year of data was collected in 2017 and still shows elevated levels of phosphorus. Additionally, the lake exceeds the standard for aquatic life using the FIBI. The most common species captured by backpack electrofishing and seining was Black Crappie (i.e. 96% of catch). Common carp comprised the most biomass in both gill nets and trap nets. The remaining lakes in the subwatershed do not have sufficient data to make assessments.

Figure 15. Currently listed impaired waters by parameter and land use characteristics in the Headwaters Cottonwood River Aggregated 12-HUC.



Meadow Creek Aggregated 12-HUC HUC 0702000802-01

The Meadow Creek subwatershed is located in the northwestern corner of the Cottonwood River watershed in Lyon County. The subwatershed drains an area of 98 square miles. The headwaters of Meadow Creek is in the southern part of the subwatershed, about 6 miles southwest of Marshall. From its source, the creek travels north then southeast for about 25 miles to the eastern most point of the subwatershed where it leaves the Meadow Creek subwatershed and Lyon County. The streams including Meadow Creek are a combination of natural and ditched. The majority of the land in Meadow Creek is 83% cropland, with only 5% developed. Marshall Lake is the only lake of any significant size in the subwatershed, about 250 acres.

Table 4. Aquatic life and recreation assessments on stream reaches: Meadow Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators:									Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication		
07020008-601, Meadow Creek, Unnamed creek to Cottonwood River	17MN163	1.77	WWg	MTS	MTS	IF	MTS	MTS	MTS	IF	IF	MTS	SUP	IMP
07020008-615, Unnamed creek, T1110 R40W S9, south line to Unnamed creek	17MN165	0.57	WWm	MTS	EXS	IF	IF	IF		IF	IF	IF	IMP	--
07020008-576, Unnamed creek, Heck Slough to Unnamed creek	17MN164	2.33	WWm	IC	EXS	IF	IF	IF		IF	IF	IF	IMP	--
07020008-578, Unnamed creek, Unnamed creek to Unnamed creek	17MN166	2.1	WWg	MTS	MTS	IF	IF	IF		IF	IF	IF	SUP	--
07020008-569, Unnamed ditch, Unnamed ditch to CD 44	17MN171	5.88	WWm	MTS	EXS	IF	IF	IF		IF	IF		IMP	--
07020008-613, Unnamed creek, T110 R40W S6, west line to Meadow Creek	17MN168	1.46	WWm		NA	IF		IF		IF			NA	--

07020008-574, Unnamed creek, Unnamed creek to Lk Marshall	17MN169	2.92	WWg	MTS	EXS	IF	IF	IF		IF	IF		IMP	--
07020008-573, Unnamed creek, Unnamed creek to Lk Marshall	17MN170	0.57	WWm	NA	EXS	IF		IF		IF			IMP	--
07020008-593, Unnamed creek, Unnamed creek to Unnamed ditch	17MN172	6.53	WWg	IC	MTS	IF	IF	IF		IF	IF	IF	SUP	--
07020008-600, Meadow Creek, Headwaters to Unnamed creek		7.79	WWg										--	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 2016 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 5. Lake water aquatic recreation assessments: Meadow Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Jackson Marsh	42-0009-00	58	--	--	WCBP	--	--	--		IF	IF	--	--	IF
Jacobsons Marsh	42-0036-00	28	--	--	NGP	--	--	IF		IF	IF	IF	IF	IF

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Fish were sampled at ten stations in this subwatershed: three stations on Meadow Creek (17MN172, 17MN171 and 17MN163) the remaining stations are located on tributaries that flow into Meadow Creek.

The fish captured in the subwatershed indicate the subwatershed is doing well as all the stations assessed, except two (17MN164

17MN172), support general or modified aquatic life. The data collected at stations 17MN164 and 17MN172 was considered inconclusive due to outside factors such as a perched culvert or proximity to a lake that could have adverse effects on the fish population.

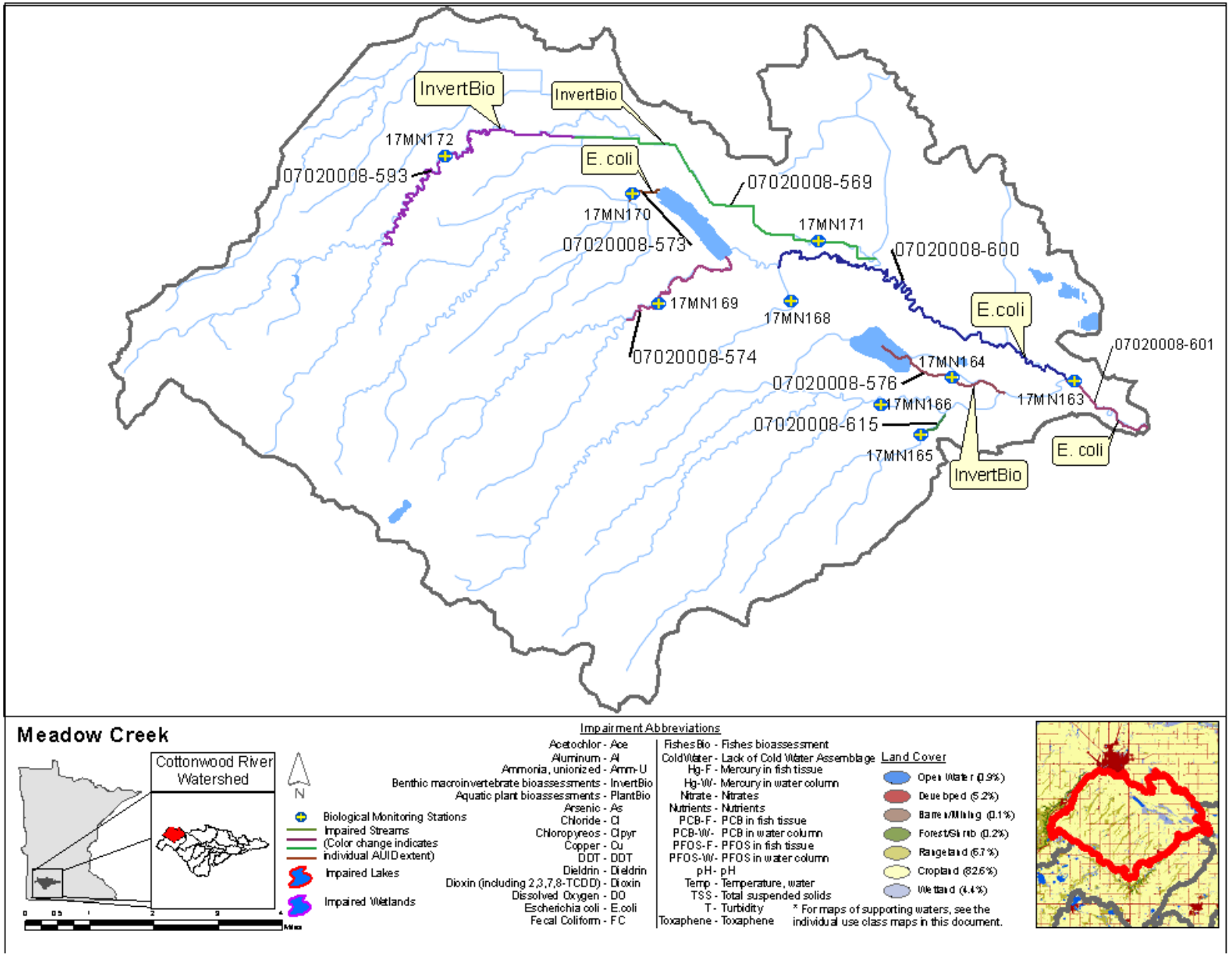
Station 17MN171 is a headwater low gradient stream which usually do not support a diverse fish community (low number of fish species). Conversely, this station had 19 fish species collected, demonstrating a stream with rich taxa. There were also two stations that were classified as full support for macroinvertebrate and fish IBI scores; 17MN166 that is supporting a general aquatic life use and 17MN163 that is supporting a modified aquatic life.

The majority of streams in this subwatershed were impaired for aquatic life based on the macroinvertebrate community. The macroinvertebrate communities of impaired streams within this subwatershed were typified by low numbers of species and a predominance of taxa that can tolerate low dissolved oxygen concentrations such as midges, physid snails, and amphipods.

Chemistry data was available on the downstream reach of Meadow Creek. Based on available data, water quality in the subwatershed is good and does not seem to be negatively impacting the biology. Meadow Creek was previously listed for bacteria, as one reach, from the headwaters to the outlet at the Cottonwood River. The creek was split into two reaches (from 07020008-515 to 07020008-600 and 07020008-601) and it was determined that the bacteria impairment will carry forward to both reaches. Additionally, new data was collected on the downstream reach of the creek and confirms the previous bacteria listing for aquatic recreation.

Of the two lakes looked at in the subwatershed, Jackson and Jacobson's marshes do not have sufficient data to make lake assessments. Based on available data, Jackson's Marsh is highly eutrophic, with nuisance algal blooms likely. Jacobson's Marsh has relatively clear water and much lower phosphorus.

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Meadow Creek Aggregated 12-HUC.



Plum Creek Aggregated 12-HUC HUC 0702000803-01

The Plum Creek subwatershed drains an area of approximately 90 square miles in the southwestern potion of the Cottonwood River watershed. Plum Creek subwatershed spans three counties: Lyon, Murray and Redwood. The majority of the streams are natural and eventually feed into Plum Creek (Judicial Ditch 20A) which travels north through the subwatershed. Roughly, 3 miles of Plum Creek is channelized while 30 miles is natural. Approximately 85% of the land is cropland, 6.3% is rangeland and 3.6% is human development.

Table 6. Aquatic life and recreation assessments on stream reaches: Plum Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:									Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication		
07020008-603, Plum Creek (Judicial Ditch 20A), -95.576 44.177 to Cottonwood River	17MN145, 90MN062	30.31	WWg	MTS	MTS	IF	EXS	MTS	MTS	MTS	MTS	IF	IMP	IMP
07020008-623, Unnamed creek, T109 R39W S14, west line to Plum Creek	17MN146	3.35	WWg	MTS	MTS	IF	IF	IF		IF	IF	IF	SUP	--
07020008-551, Willow Creek, Unnamed creek to Plum Creek	17MN147	4.38	WWg	MTS	EXS	IF	IF	IF		IF	IF	IF	IMP	--
07020008-586, Unnamed creek, Robbins Slough to Plum Creek	17MN148	3.61	WWm	MTS	MTS	IF	IF	IF		IF	IF	IF	SUP	--
07020008-602, Plum Creek (Judicial Ditch 20A), Headwaters to -95.576 44.177	07MN085	3.6	WWm	MTS	MTS	NA	NA	NA		NA		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 2016 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 7. Lake assessments: Plum Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Round	51-0038-00	166	7	--	WCBP	--	--	--		IF	IF	IF	--	IF
Clear	51-0047-00	104	--	--	WCBP	--	--	--		IF	--	IF	--	IF
Laura	64-0150-00	24	21.5	Deep lake	WCBP	NT	--	IF		IF	MTS	EXS	IF	IF

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

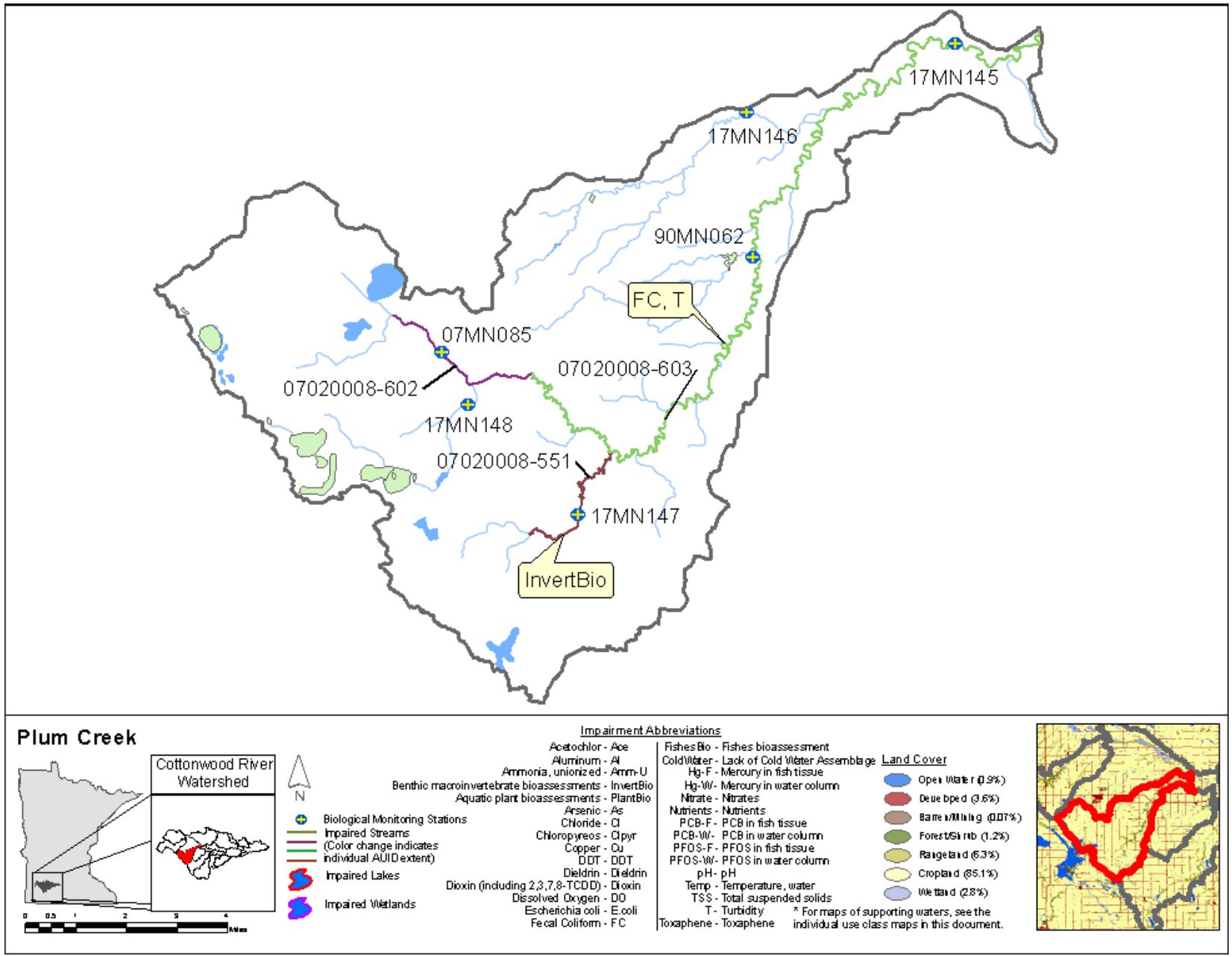
There were six biological stations sampled in this subwatershed. Two stations are located on the Plum Creek (17MN145 and 90MN062) and the rest of the stations are on tributaries to Plum Creek. All of the stations sampled in this subwatershed had relatively high IBI and habitat scores. The two stations located on Plum Creek are on natural segments of the stream while the remaining sites are on channelized streams.

Macroinvertebrates in this subwatershed were largely attaining aquatic life use goals. Three channelized streams met the modified use based on macroinvertebrate IBI scores, while a section of Plum Creek (Judicial Ditch 20A) met the general use. The number of mayfly, stonefly, and caddisfly (EPT) taxa collected at both stations on Plum Creek (-603) was relatively high, ranging from 14-17, despite indications of erosion and sedimentation issues in this creek.

Plum Creek was previously listed for fecal coliform and turbidity, from the headwaters to the outlet at the Cottonwood River. The creek was split into two reaches (from 07020008-516 to 07020008-602 and 07020008-603) and it was determined that the impairments will carry forward to both reaches. New data was collected on the downstream reach of the creek; E. coli and sediment exceed their impairment thresholds and confirm previous impairments for aquatic recreation and aquatic life, respectively.

Laura Lake is a reservoir within the subwatershed. One data point drove the phosphorous average to be above the standard. Sampling notes from this date notes that the lake was up ten feet due to recent rains. Chl-a is easily meeting and Secchi is just below the standard. It is possible that although phosphorous is elevated, large rain events such as this do not allow water to remain in the basin long enough to foster algal growth. Overall, data was inconclusive for aquatic recreation. Round and Clear lakes do not have sufficient data to make assessments.

Figure 17. Currently listed impaired waters by parameter and land use characteristics in the Plum Creek Aggregated 12-HUC.



Upper Cottonwood River Aggregated 12-HUC HUC 0702000804-01

The Upper Cottonwood River subwatershed is located in the northwest region of the Cottonwood watershed, in Lyon and Redwood counties and has a drainage area of 110 square miles. About 35 miles of the Cottonwood River flows south through the subwatershed with smaller tributaries flowing in to it. This subwatershed is mostly dominated by cropland (84%) while a small amount of land cover is developed (5%). As the Cottonwood River flows south out of the Upper Cottonwood subwatershed, it passes just north of the city of Lamberton. About 80% of the Cottonwood River is a natural channel, while 20% is channelized. As a whole, the streams in the Upper Cottonwood subwatershed are about 60% channelized and 40% natural.

Table 8. Aquatic life and recreation assessments on stream reaches: Upper Cottonwood River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-503, Cottonwood River, Meadow Creek to Plum Creek	17MN156	21.64	WWg	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-617, Judicial Ditch 22 -95.566 to Cottonwood River	17MN155	2.35	WWg	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-548, Judicial Ditch 9, Unnamed creek to Cottonwood River	17MN154	6.92	WWg	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-584, Unnamed Creek, Unnamed Creek to Lone Tree Creek	17MN151	3.89	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-504, Cottonwood River, Plum Creek to Dutch Charley Creek	17MN144, 17MN181, 10EM094	13.37	WWg	MTS	MTS	IF	EXS	IF	MTS	MTS	MTS		IF	IMP	IMP
07020008-524, Lone Tree Creek, T109 R39W S7, west line to Cottonwood River		17.22	7							IF	MTS			--	IMP
07020008-547, Judicial Ditch 9, Unnamed creek to Unnamed creek		3.99	WWg					IF						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 2016 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 9. Lake assessments: Upper Cottonwood River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
South Twin	42-0005-00	58	--	--	NGP	--	--	--		IF	IF	IF	--	IF
Unnamed	64-0116-00	42	--	--	WCBP	--	--	--		IF	--	--	--	IF

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains

Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data

Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)

Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Fish were sampled at seven biological stations in this subwatershed: four on the Cottonwood River (17MN156, 17MN144, 17MN181 and 10EM094) the remaining three stations are located on tributaries of the Cottonwood River. The four stations sampled on the Cottonwood River are located on natural sections of the river.

The upstream reach of the Cottonwood River (-503) was impaired based on macroinvertebrate and fish community data. At monitoring station 17MN156 the river exhibited severe bank erosion, heavy siltation, and poor habitat diversity. These are all indications of altered hydrology further upstream (e.g., stream channelization, pattern tiling, wetland drainage), which may be a major source of stress to macroinvertebrate communities. The most abundant macroinvertebrate taxa collected at 17MN156 was *Tricorythodes*, a mayfly specially adapted to survive in streams with high sediment transport. The fish community also reflects the poor habitat at this station and was dominated by tolerant species with no sensitive species captured.

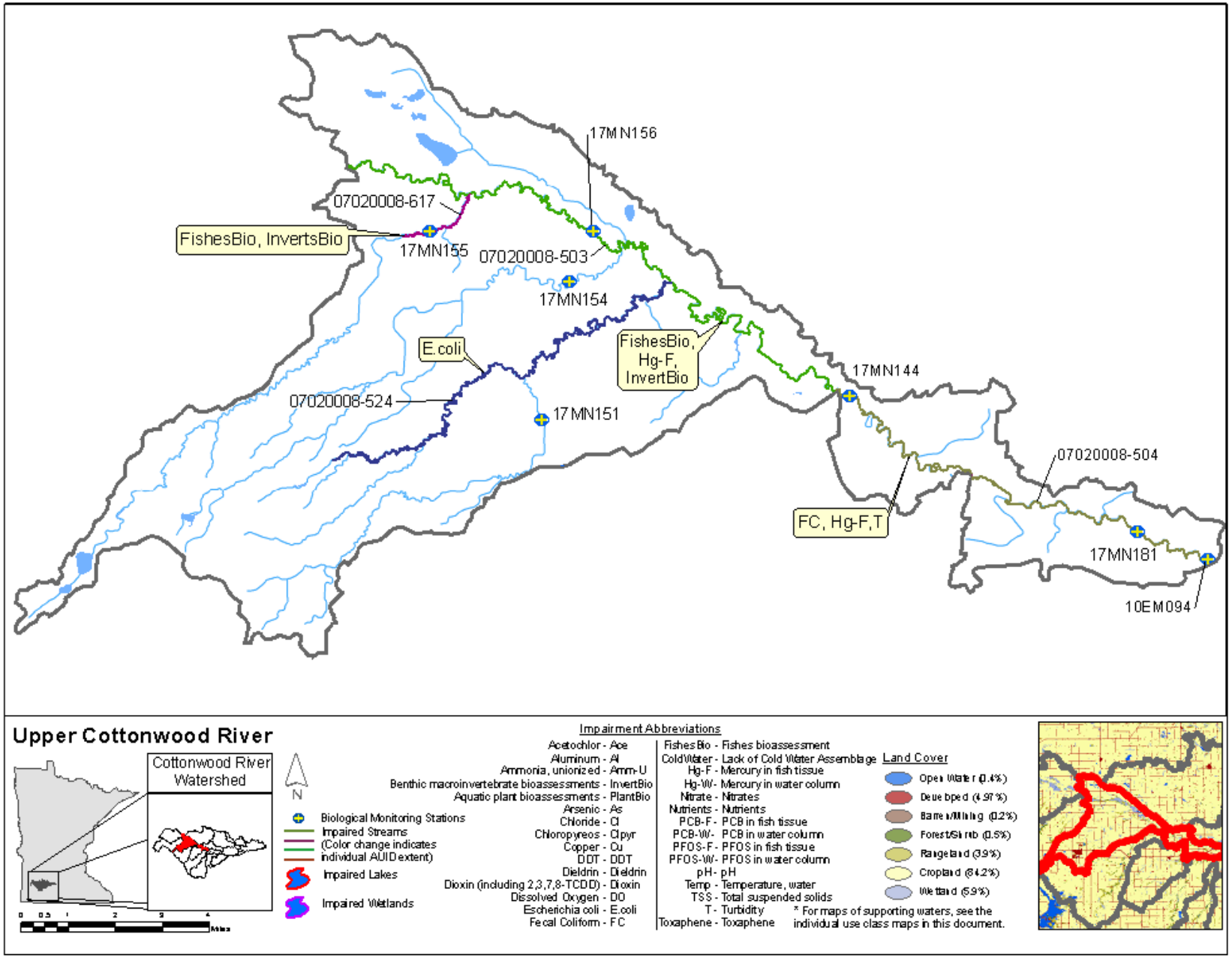
Station 17MN155, on Judicial Ditch 22 (-617), was also impaired based on macroinvertebrate and fish community data and had similar stream degradation characteristic with severe bank erosion and moderate to heavy siltation. The fish community consisted of 86% tolerant individuals and no sensitive taxa which are all signs of an unhealthy fish community.

The downstream reach of the Cottonwood River had three stations sampled but only two were sampled in 2017, 17MN144 and 17MN181, while the third station, 10EM094, was sampled in 2010. Based on the fish data collected from these stations, the downstream (-504) reach of the Cottonwood River has a healthier fish community than the upstream reach (-503). Sensitive species, 25% of the taxa, were present and the river exhibited suitable habitat characteristics such as good sinuosity and good channel development. Based on the macroinvertebrate and fish community data the stream supports general aquatic life use.

New chemistry data was collected on the downstream reach of the Cottonwood River (-504). Both *E. coli* and sediment exceed their impairment thresholds and confirm previous impairments for aquatic recreation and aquatic life, respectively. Lone Tree Creek, a limited resource value stream, was previously determined to be impaired; more recent data confirms the bacteria exceeds standards.

The two lakes in the subwatershed do not have sufficient data to make assessments. Both are shallow, plant dominated systems not likely used for swimming or fishing.

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Upper Cottonwood River Aggregated 12-HUC.



Pell Creek Aggregated 12-HUC HUC 0702000804-02

Pell Creek subwatershed is located in the center of the Cottonwood River watershed with a drainage area of 51 square miles and spans three counties; Redwood, Murray and Cottonwood. The main stream that flows through this subwatershed is Pell Creek. The headwaters of Pell Creek start 5 miles south of Walnut Grove in the southwestern corner of the subwatershed, from there it travels northeast for about 20 miles where it leaves the Pell Creek subwatershed and flows into the Cottonwood River. This confluence is located at the northeastern corner of the subwatershed. The majority of streams in this subwatershed are categorized as natural, specifically, Pell Creek which is 98% natural. In this subwatershed, 90% of the land is used for farming. A portion of this subwatershed is in the Coteau Moraines which may contribute to the larger number of natural streams. The streams in the Coteau Moraines usually cut through the deep glacier deposits, creating steep ravines which are difficult to channelize.

Table 10. Aquatic life and recreation assessments on stream reaches: Pell Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach Description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-523, Pell Creek, T109 R37W S30, west line to Cottonwood River	17MN140	6.59	WWg	MTS		IF	IF	MTS	MTS	IF	MTS		IF	SUP	IMP
07020008-545, Unnamed creek, unnamed creek to unnamed creek	17MN141	4.36	WWg	EXS	MTS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-592, Unnamed creek, unnamed creek to unnamed creek	17MN142	0.39	WWg	IF	IF	IF	IF	IF		IF	IF		IF	IF	--
07020008-536, Pell Creek, T109 R38W S28, west line to T109 R38W S25, east line		6.75	7							IF	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)
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*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

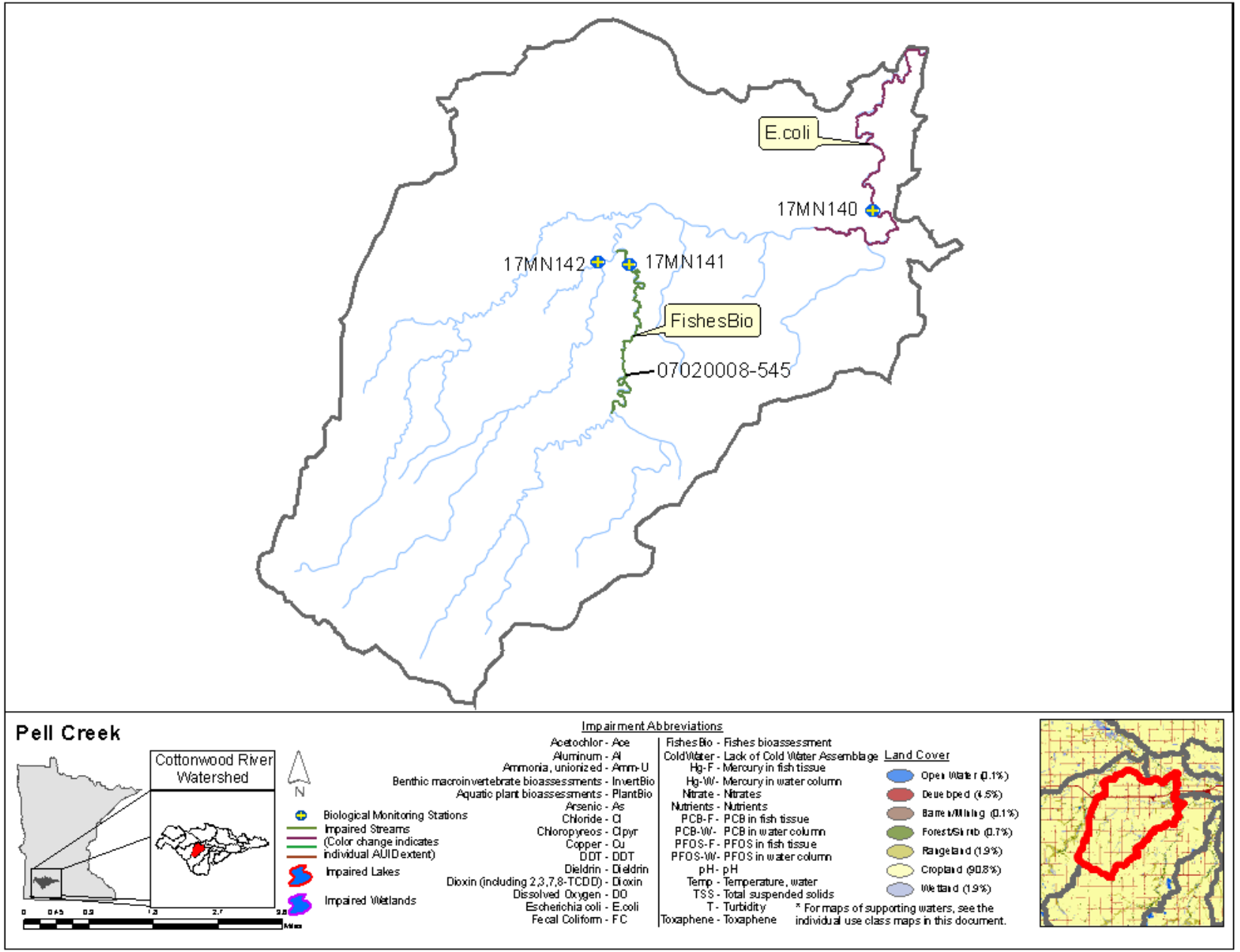
Fish were sampled at three stations on Pell Creek and two on tributaries to Pell Creek. All three stations are on natural sections of stream and all had relatively good habitat. Station 17MN140 on Pell Creek had suitable habitat for a healthy fish community and had no physical barriers that would affect fish mobility. This station scored well and was determined to support aquatic life.

A conclusive assessment of the macroinvertebrate and fish data could not be reached on Unnamed Creek (-592) given concerns about the potential that this stream may have gone dry sometime before the monitoring visit. Evidence in support of this idea was the sampler's notes about 'barely any water to sample', the region being abnormally dry during the week of 7/18/17 according to the US Drought Monitor website, and the relatively small drainage area of this creek (~6 sq mi). However, an adjacent creek (-545) with a slightly larger drainage area was able to attain general aquatic life use goals based on the macroinvertebrate data during a similar timeframe.

Station 17MN141 had a culvert which could act as a physical or a hydraulic barrier preventing fish from entering the stream from that direction. In addition to the culvert, this reach also exhibited hydrological stressors in the form of channel incision and bank erosion. All of these factors are reflected in the fish community; no sensitive taxa were present and 94% of the fish captured were tolerant species. The fish community does not support aquatic life use.

Chemistry data was available on the downstream reach of Pell Creek. Based on available data, water quality in the subwatershed is good, with low nutrients and sediment concentrations, and does not seem to be negatively impacting the biology. However, bacteria concentrations do not support recreation use of this reach. Persistent elevated concentrations exist over the summer months. A new impairment was added for aquatic recreation use.

Figure 19. Currently listed impaired waters by parameter and land use characteristics in the Pell Creek Aggregated 12-HUC.



Dutch Charlie Creek Aggregated 12-HUC HUC 0702000805-01

Dutch Charlie Creek is located in the southwest region of the Cottonwood River watershed with a drainage area of 100 square miles and spans 3 counties: Murray, Cottonwood and Redwood. Dutch Charlie Creek begins its journey in the southern most region of the subwatershed, about 3 miles southwest of Westbrook. It then travels northeast for about 41 miles at which point it exits the subwatershed, about 2.5 east of Lamberton, and flows directly into the Cottonwood River. Dutch Charlie Creek is about 90% natural channel while the whole subwatershed consist of about 50% channelized and 50% natural. The land use in this subwatershed is dominated by cropland, 86.7%, with only 3.9% developed.

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

WID *Reach name*, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-518, Dutch Charley Creek, Headwaters to Highwater Creek	03MN035, 17MN138, 17MN136	39.49	WWg	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-589, County Ditch 19, Headwaters to Dutch Charley Creek	17MN139	6.1	WWm	MTS	MTS	IF	IF	IF		IF			IF	SUP	--
07020008-588, Judicial Ditch 3, Headwaters to Dutch Charley Creek	17MN137	4.05	WWg	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-587, Unnamed creek, Unnamed creek to Unnamed creek	17MN134	5.41	WWg	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-529, Unnamed creek, Unnamed creek to Dutch Charley Creek	01MN006	1.63	WWg	MTS	EXS	IF	IF	IF		IF	IF		IF	IMP	--

07020008-591, Unnamed creek, Unnamed ditch to Dutch Charley Creek	17MN135	3.82	WWg	IF	IF	IF	IF	IF		IF	IF		IF	IF	--
07020008-517, Dutch Charley Creek, Highwater Creek to Cottonwood River	17MN130	7.29	WWg	IF	MTS	IF	EXS	IF	MTS	IF	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 2016 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. Lake assessments: Dutch Charlie Creek Aggregated 12-HUC.

							Aquatic life indicators:			Aquatic recreation indicators:				
Lake name	**DNR ID**	**Area (acres)**	**Max depth (ft)**	**Assessment method**	**Ecoregion**	**Secchi Trend**	**Fish IBI**	**Chloride**	**Pesticides *****	**Total Phosphorus**	**Chlorophyll-a**	**Secchi**	**Aquatic life use**	**Aquatic recreation Use**
Hurricane	17-0037-00	158	5.5	Shallow	WCBP	--	--	--		IF	IF	IF	--	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient informatio

Summary

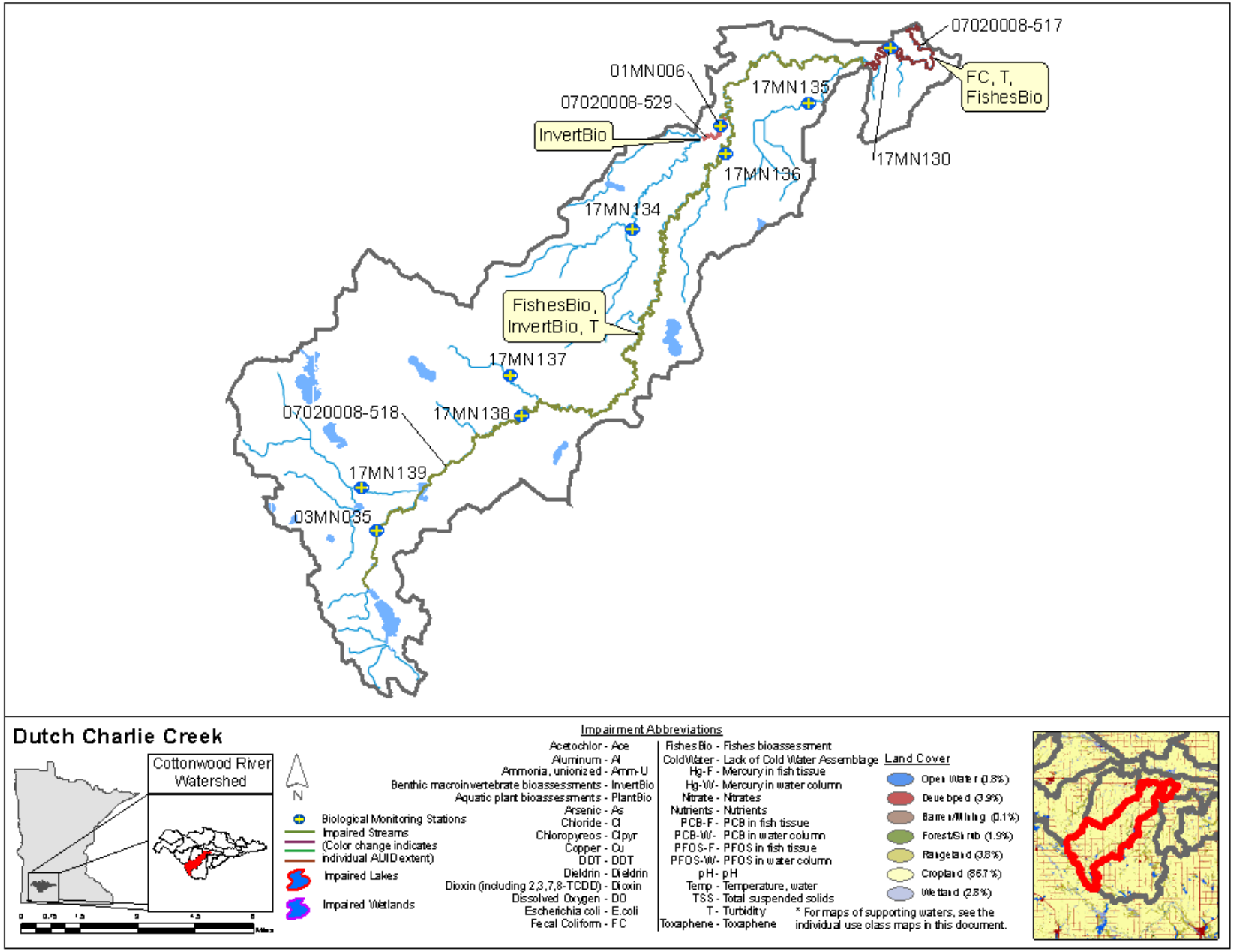
Fish and macroinvertebrates were sampled at nine stations in this subwatershed: four stations are on Dutch Charley Creek and five stations on tributaries of Dutch Charley Creek. Along the four stations where macroinvertebrates were monitored on Dutch Charley Creek (-517 & 518) in 2017, MIBI scores increased in the downstream direction. The upper reach (-518) was determined to be impaired for invertebrates while the lower reach (-517) was not. Most stations on this creek showed signs of watershed disturbance/habitat degradation (e.g., over-widening

channel, embedded substrates), so it is somewhat surprising that the macroinvertebrate community is attaining general aquatic life use goals in the lower section of the creek. Both reaches of Dutch Charley Creek were previously listed as impaired for fish. In the upstream reach, all three stations had poor habitat conditions with the dominate substrate as sand. The fish community had a low percentage of sensitive species and a low number of species captured. The furthest downstream station on Dutch Charley Creek had low habitat score and high percentage of tolerant fish captured during sampling.

The lower reach of Dutch Charlie Creek was previously listed for fecal coliform and turbidity. New data was collected on the downstream reach of the river; *E. coli* and sediment exceed their impairment thresholds and confirm previous impairments for aquatic recreation and aquatic life, respectively.

Hurricane Lake does not have sufficient data to make assessments; the lake is very shallow and plant dominated.

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Dutch Charlie Creek Aggregated 12-HUC.



Highwater Creek Aggregated 12-HUC HUC 0702000805-02

The Highwater Creek subwatershed located in the southernmost part of Cottonwood watershed and drains an area of 108 square miles. The Highwater Creek subwatershed sits almost completely in the Cottonwood County, about 5% is in the Redwood and 5% in Murray County. The headwaters of Highwater Creek starts approximately four miles south of Westbrook and travels northeast for about 39 miles where it leaves the subwatershed and flows into Dutch Charley Creek. Highwater Creek is a combination of natural and ditched sections, approximately 70% is natural while the smaller tributaries are about 50% natural. The majority of the land use in the Highwater Creek subwatershed is cropland and cattle pasture, 90%, while only 4% is developed for human use.

Table 13. Aquatic life and recreation assessments on stream reaches: Highwater Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-519, Highwater Creek, Double LK outlet to Dutch Charley Creek	17MN131, 17MN182, 90MN063, 17MN133	33.05	WWg	IC	MTS	IF	EXS	IF	MTS	MTS	MTS		IF	IMP	IMP
07020008-527, County Ditch 38, Unnamed Creek to Highwater Creek	17MN132	1.98	WWg	MTS	IC	IF	IF	IF		IF	IF		IF	SUP	--
07020008-537, County Ditch 38, Headwaters to T107 R37W S32, north line	17MN176	1.66	WWm	MTS	EXS									IMP	--
07020008-528, Unnamed ditch, Headwaters to Highwater Creek		1.31	7							IF	IF			--	--
07020008-538, County Ditch 38, T107 R37W S29, south line to Unnamed creek		1.19	7							IF	IF			--	--

07020008-610, Highwater Creek, Headwaters to -95.395 43.99		2.85	WWg											NA	--	

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 2016 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 14. Lake assessments: Highwater Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Augusta	17-0033-00	441	4.5	Shallow	WCBP	--	--	--		EXS	IF	IF	--	IF
Round	17-0048-01	64	--	--	WCBP	--	--	--		IF	IF	IF	--	IF
Long	17-0048-02	197	--	--	WCBP	--	--	IF		IF	IF	IF	IF	IF
Bean	17-0054-00	123	12	Shallow	WCBP	--	--	IF		IF	IF	IF	IF	IF
Double (North Portion)	17-0056-01	129	7	Shallow	WCBP	--	EXS	IF		EXS	EXS	MTS	NS	NS
Double (South Portion)	17-0056-02	102	--	--	WCBP	--		--		--	--	--	--	--

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

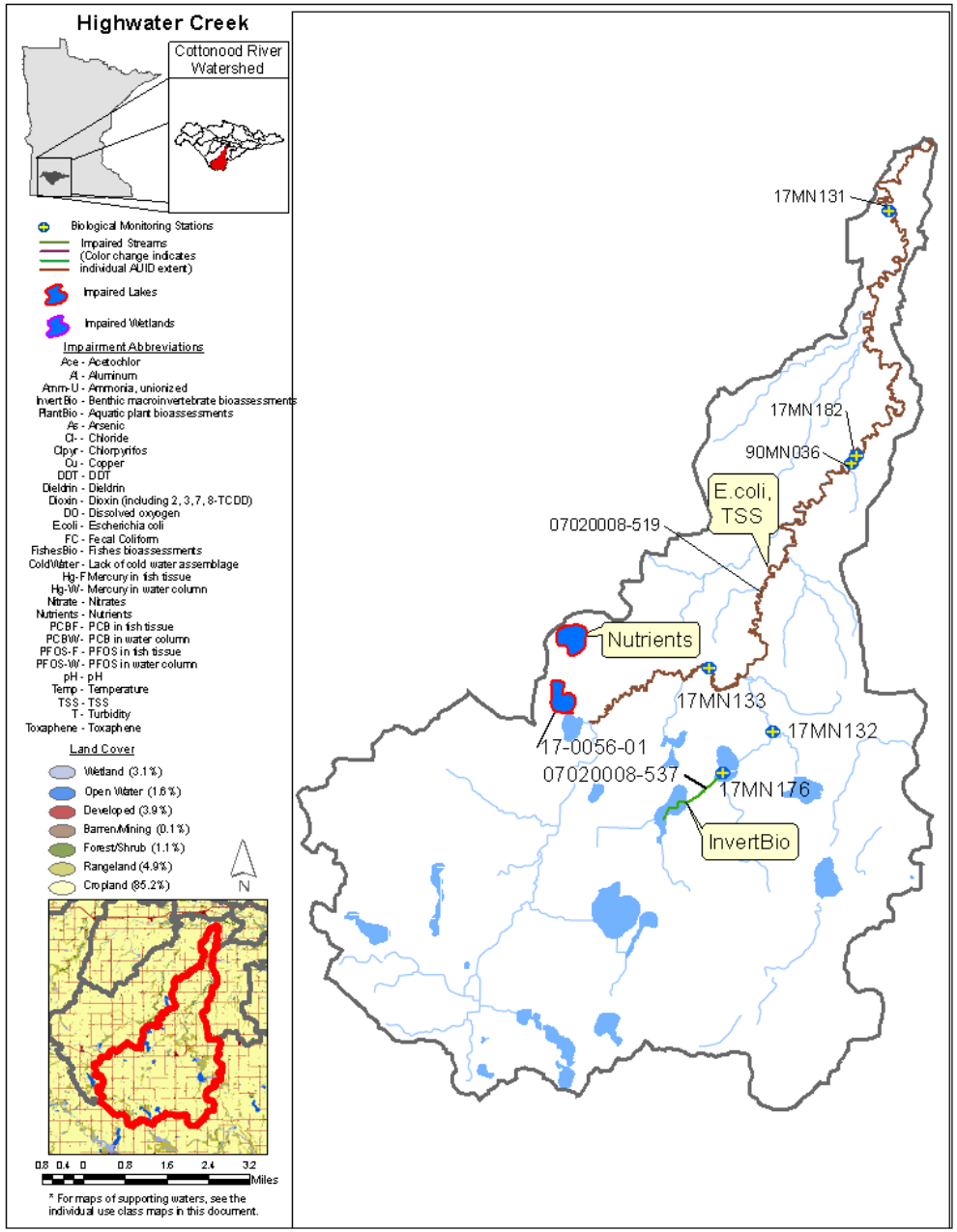
The data collected from the four stations on reach Highwater Creek (-519) were considered inconclusive due to the mixed and marginal results amongst stations' FIBI scores. All of the stations sampled fell within the confidence intervals, just above or just below the threshold with the exception of station 17MN133 which fell below the threshold and confidence interval. The fish communities in the three upstream stations (90MN063, 17MN182 and 17MN131) had sensitive taxa present but were dominated by tolerant species with an average of 21 species captured during sampling at each station. They had good to excellent habitat scores ranging from 61 to 75. Station 17MN133 had the lowest habitat score, 54, with heavy bank erosion present. The fish IBI scores decrease in a downstream direction.

Similar to the other stream in this watershed, Highwater Creek demonstrates an improving trend in macroinvertebrate condition in the downstream direction based on 2017 monitoring results. With MIBI scores consistently meeting general use expectations—six samples going back to 2001—Highwater Creek is one of the healthiest tributaries in the watershed in terms of macroinvertebrate condition.

Chemistry data was available on the downstream reach of Highwater Creek. Elevated levels of *E. coli* and sediment were found and the creek is impaired for aquatic recreation and aquatic life, respectively.

Bean and Double lakes were previously listed for nutrients. New data collected confirms the previous listings. Lake Augusta also has elevated levels of nutrients but there was not enough data in order to make an assessment. Double Lake was impaired for aquatic life using the FIBI. The most common species captured by backpack electrofishing and seining were yellow perch, green sunfish, and orangespotted sunfish. Walleye and white sucker comprised the most biomass in the gill nets and common carp and black bullhead comprised the most biomass in the trap nets. The remaining lakes in the subwatershed do not have sufficient data to make assessments.

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



Middle Cottonwood River Aggregated 12-HUC HUC 0702000806-01

The Middle Cottonwood River subwatershed is located on the eastern region of the Cottonwood River watershed in Brown, Redwood and Cottonwood counties and drains an area of 87 square miles. The Middle Cottonwood River subwatershed streams are a combination of approximately 60% natural and 40% channelized reaches. The Cottonwood River has a natural channel and nearly all the tributaries in the subwatershed are channelized. The Cottonwood River starts about 4 miles west of Sanborn and travels about 38 miles through the subwatershed then exits the subwatershed just over two miles north west of Leavenworth. The majority of land use is crop farming, 85%, and 5.5% of land is developed for human use.

Table 15. Aquatic life and recreation assessments on stream reaches: Middle Cottonwood River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-505, Cottonwood River, Dutch Charley Creek to Dry Creek		5.86	WWg			IF	IF	IF		IF	IF		IF	IF	--
07020008-507, Cottonwood River, Mound Creek to Coal Mine Creek	17MN110	2.91	WWg	MTS	MTS	IF	IF	IF		IF			IF	SUP	--
07020008-508, Cottonwood River, Coal Mine Creek to Sleepy Eye Creek	17MN105	23.9	WWg	MTS	MTS	IF	EXS	EXS	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 2016 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. Lake assessments: Middle Cottonwood River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic Recreation Indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Altermatt	08-0054-00	125	6	Shallow	WCBP	--	--	--		EXS	EXS	EXS	--	NS
Boise	08-0096-00	152	6.5	Shallow	WCBP	--	--	--		EXS	EXS	IF	--	NS

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

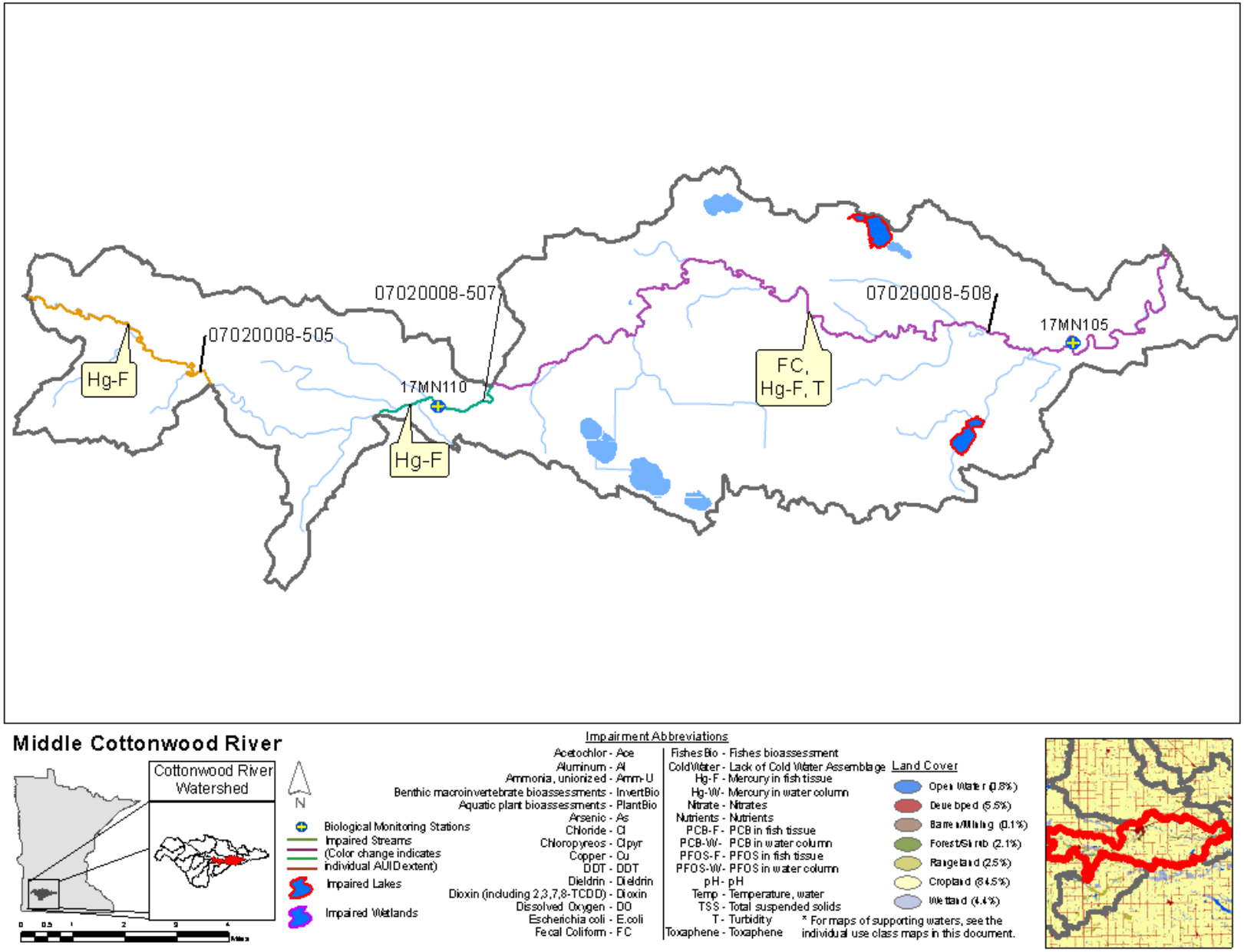
Summary

Fish were sampled at two stations on the Cottonwood River. The upstream station had a diverse and balanced fish community with 27% of the fish sampled being sensitive. The downstream station also had a healthy fish community with sensitive species present and had a higher habitat score than the upstream station. Both stations support aquatic life use for biology.

The lower reach of the Cottonwood River was previously listed for fecal coliform and turbidity. New data was collected on the downstream reach of the river with *E. coli* and sediment concentrations exceeding water quality standards and confirming the existing impairments.

Two lakes in this subwatershed have data available for assessment, Altermatt and Boise. These lakes are shallow and have limited ability to deal with excess nutrients. Based on available data, both lakes do not support aquatic recreation use due to elevated levels of phosphorous and nuisance algal blooms.

Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Middle Cottonwood River Aggregated 12-HUC.



Coal Mine Creek Aggregated 12-HUC HUC 0702000806-02

Coal Mine Creek subwatershed is located in the center of the Cottonwood River watershed in Redwood and Brown counties and drains an area of 47 square miles. Coal Mine Creek is about 98% channelized. Coal Mine Creek headwaters starts about 5.5 miles southwest of Wanda and travels southwest across the subwatershed for about 18 miles where it leaves the subwatershed. The majority of land use in this subwatershed is cropland, 88%, with wetland comprising 6%, and developed land at 3.5%.

Table 17. Aquatic life and recreation assessments on stream reaches: Coal Mine Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***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	Aquatic life	Aquatic rec. (Bacteria)
07020008-604, Coal Mine Creek, Headwaters to T109 R35W S22, south line	17MN126, 17MN109	17.33	WWm	MTS	EXS	IF	IF	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 2016 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.

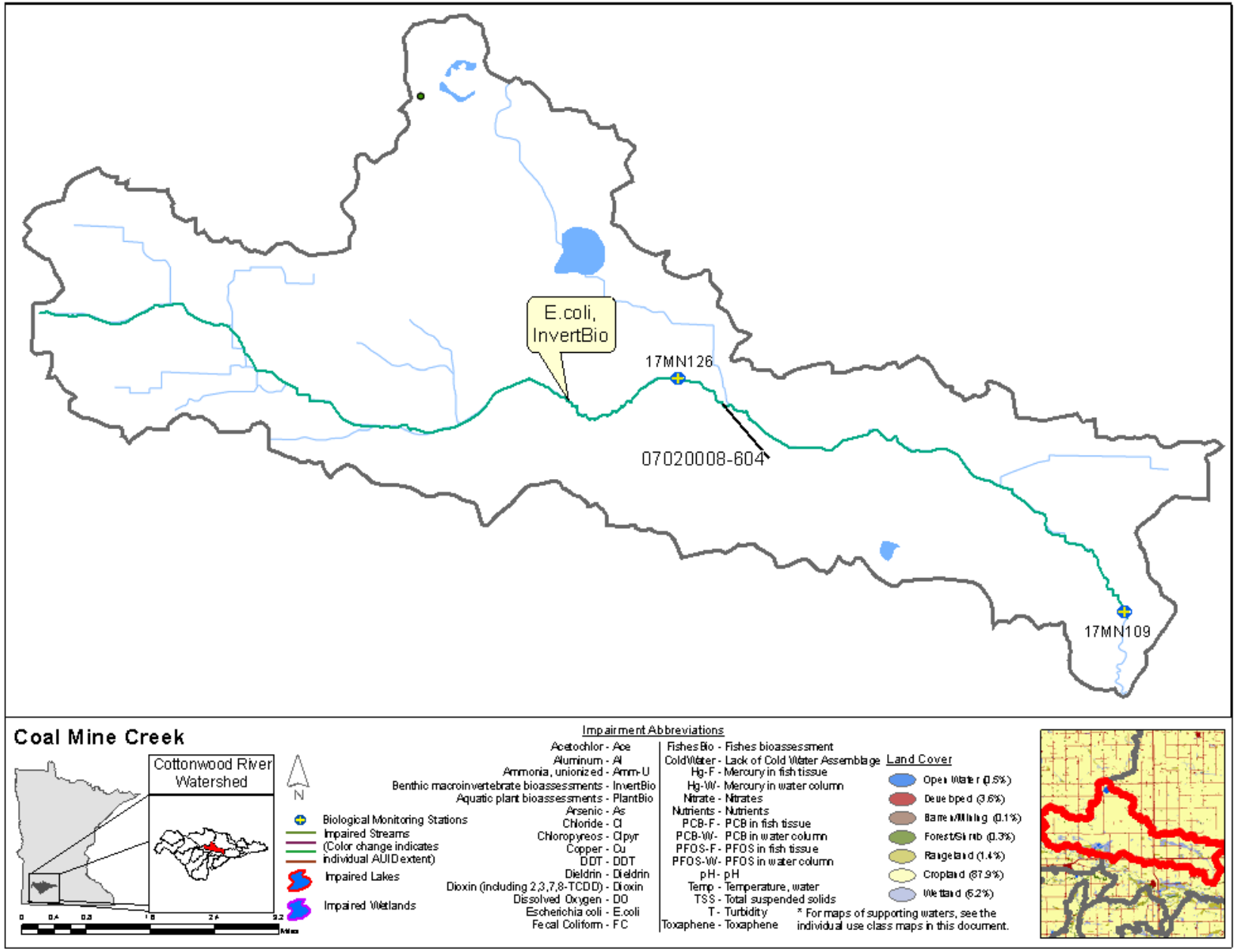
Summary

In 2017, fish were sampled at two stations in Coal Mine Creek. The upstream station is on a channelized section while the downstream station is on a natural section of the stream. Both stations had low IBIs, with poor habitat and a fish community dominated by tolerant fish species. Both stations were determined to support modified aquatic life use.

Macroinvertebrates were monitored at two stations on Coal Mine Creek with widely varying results. The upstream station failed to meet modified aquatic life use expectations while the downstream station exceeded those expectations. Despite similar habitat conditions at each station, the community at the upstream site was dominated by macroinvertebrates that prefer lentic (i.e., lake-like) conditions with 80% of the sample represented by two tolerant taxa, *Physella* (snail) and *Hyalella* (freshwater shrimp), while the lower station had an invertebrate community that was more typical of a stream. Considering that the upper station showed signs of limited flow and excess nutrients, the overall decision for this reach was to list aquatic macroinvertebrates as an impairment.

Chemistry data was available on the downstream reach of Coal Mine Creek. Phosphorous is elevated, but other available data, including sediment, chloride and un-ionized ammonia met water quality standards. Elevated levels of bacteria were found and the stream does not support aquatic recreation use.

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



Mound Creek Aggregated 12-HUC HUC 0702000806-03

Mound Creek subwatershed is located on the southwest region of the Cottonwood River watershed in Cottonwood and Brown counties and drains an area of 55 square miles. Mound Creek beings its journey in the southwest corner of the subwatershed and travels northeast where it exits the subwatershed about six miles southwest of Springfield. The streams in this subwatershed are a combination of channelized and natural streams, about 50% are channelized and 50% is natural. The majority of the land use is cropland, 81.4%, and the second largest land use is wetlands, 6%.

Table 18. Aquatic life and recreation assessments on stream reaches: Mound Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID *Reach name*, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-606, Unnamed creek, Unnamed creek to -95.095 44.134	91MN065	0.61	WWm	MTS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-521, Mound Creek, Headwaters to Cottonwood River	17MN111, 91MN067, 17MN112	24.85	WWg	MTS	EXS	IF	IF	IF	MTS	MTS	MTS		IF	IMP	IMP
07020008-544, Unnamed creek, Unnamed creek to Mound Creek		2.44	WWg			IF		IF		IF				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 2016 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 19. Lake assessments: Mound Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Wellner-Hageman Reservoir	08-0129-00	75	24	Deep lake	WCBP	--	--	IF		EXS	MTS	MTS	IF	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Five macroinvertebrate samples collected between 2001 and 2017 all indicate that Mound Creek (-521) is not attaining general aquatic life expectations. Limited water chemistry data collected at the lowermost biological station indicate that this stream may have high nutrients/low dissolved oxygen concentrations.

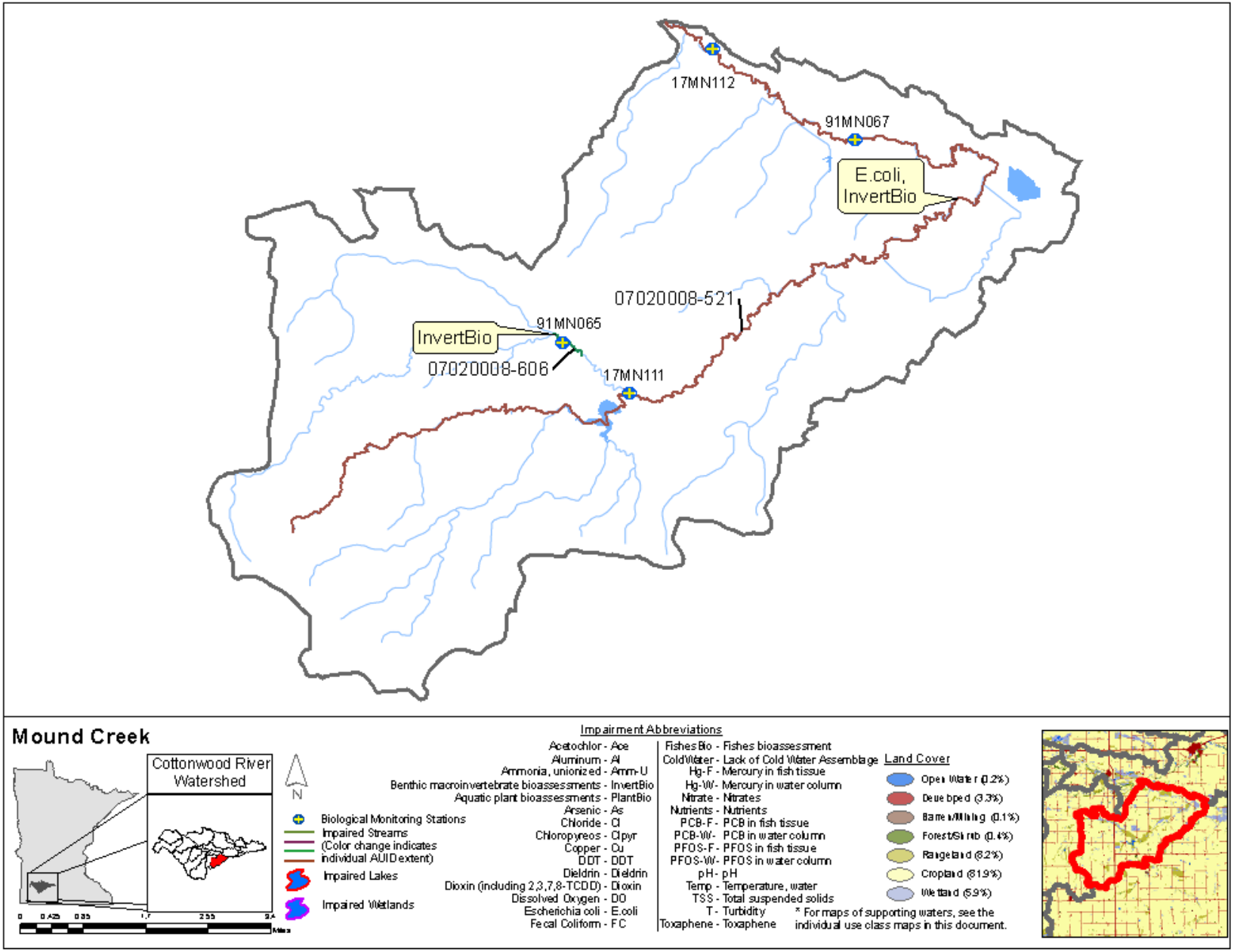
All three stations on Mound Creek demonstrated healthy fish communities with sensitive species present. Stations 17MN112 and 17MN111 habitat are suitable to support a relatively healthy fish community (no habitat data for station 91MN067). Based on the data from these three stations, Mound Creek supports aquatic life use.

Station 91MN065, on Unnamed Creek, was sampled once in 2010 and once in 2017 for fish, both visits had very low habitat scores but had relatively high IBI scores. This station is classified as modified due to the limiting habitat and channelization present. Based on the fish data, the stream supports aquatic life use.

Chemistry data was available on the downstream reach of Mound Creek. Phosphorous is elevated, but response variables (pH and chl-a) meet. Sediment is a potential concern; elevated concentrations were found, but not enough samples were collected to make an assessment for aquatic life use. Elevated levels of bacteria were found and the creek does not meet the standards for aquatic recreation.

Wellner-Hageman is a man-made reservoir within the subwatershed. Phosphorous is elevated but algae concentrations are low and the water is clear. Land use upstream of the basin will impact the water quality and increased nutrients will likely lead to algae blooms.

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Mound Creek Aggregated 12-HUC.



Dry Creek Aggregated 12-HUC HUC 0702000806-04

Dry Creek subwatershed is located in the southeastern region of the Cottonwood watershed and is almost completely in Cottonwood County, only 2% of the subwatershed is in the Redwood County. This subwatershed drains an area of 41 square miles. Dry Creek headwaters are in the southern most region of the subwatershed, from there the river travels north where it leaves the subwatershed, about a half mile west of Sanborn. The streams in Dry Creek subwatershed are about 60% natural and 40% channelized, Dry Creek itself is about 90% natural and 10% channelized. The subwatershed land use is made up of mostly cropland, 90%, and only 4% is developed. Dry Creek subwatershed has the least amount of wetlands in the Cottonwood River watershed with only 2%.

Table 20. Aquatic life and recreation assessments on stream reaches: Dry Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-520, Dry Creek, T108 R36W S31, south line to Cottonwood River	17MN127, 17MN129	17.8	WWg	EXS	EXS	IF	IF	MTS	MTS	IF	MTS		IF	IMP	IMP
07020008-590, Unnamed Creek, Unnamed creek to Dry Creek	17MN128	1.05	WWg	IF	EXS	IF	IF	IF		IF	IF		IF	IMP	--

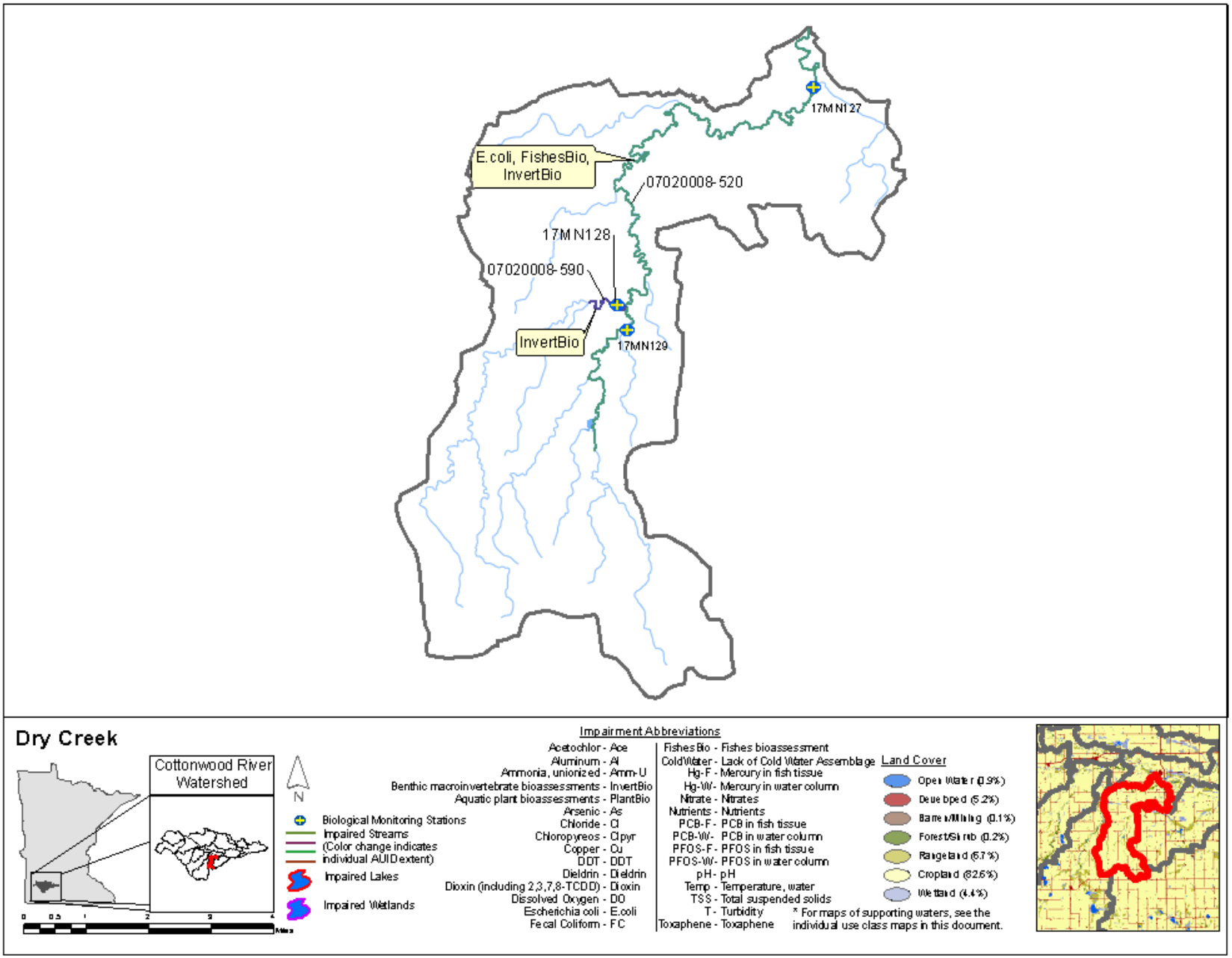
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 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.

Summary

Based on the data collected at the two stations on Dry Creek in 2017, the stream is considered impaired for fish. The fish community is unbalanced and dominated by tolerant fish species with only two sensitive species present. Similarly, the two stations on Dry Creek were sampled for macroinvertebrates with neither one attaining general aquatic life use expectations. Despite having better habitat, the lower station had a lower MIBI score and a community that was dominated by tolerant, filter-feeding caddisflies.

Chemistry data was available on the downstream reach of Dry Creek. Based on available data, nutrient and sediment concentrations are low. However, persistently elevated bacteria concentrations exist in the lower reach of Dry Creek. A new impairment was added and the reach does not support aquatic recreation use.

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



Lower Sleepy Eye Creek Aggregated 12-HUC HUC 0702000807-01

Lower Sleepy Eye Creek subwatershed is located in the northeast region in the Cottonwood River watershed in Redwood and Brown counties. It drains an area of 129 square miles. Sleepy Eye Creek enters the subwatershed on the western side about 5.5 miles west of Clements and flows southeast, it exits in the southeastern region of the subwatershed where it flows into the Cottonwood River. Lower Sleepy Eye Creek is 95% channelized and only 5% is natural. The land use is 93% cropland with 4% developed. Lower Sleepy Eye Creek subwatershed has the least amount of open water in the Cottonwood River watershed with 13.8 acres.

Table 21. Aquatic life and recreation assessments on stream reaches: Lower Sleepy Eye Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-598, Sleepy Eye Creek, Headwaters to T109 R33W S6, east line	17MN115, 17MN119	45.92	WWg	EXS	MTS	IF	MTS	MTS	MTS	MTS	MTS		MTS	IMP	IMP
07020008-597, County Ditch 26, Headwaters to Sleepy Eye Creek	17MN118	3.12	WWm		EXS	IF		IF		IF				IMP	--
07020008-561, County Ditch 68, Headwaters to Sleepy Eye Creek	15EM071, 17MN117	5.34	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-557, County Ditch 38, Headwaters to CD 85	10EM007, 17MN116	5.2	WWm	MTS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-550, County Ditch 24, Unnamed creek to Sleepy Eye Creek	17MN114	5.51	WWm	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-596, Judicial Ditch 35, Unnamed ditch to Sleepy Eye Creek	17MN113	2.97	WWm	MTS	MTS	IF	IF	IF		IF			IF	SUP	--

07020008-599, Sleepy Eye Creek, T109 R33W S5, west line to Cottonwood River	03MN032	6	WWg	MTS	EXS	IF	EXS	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 2016 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.

Summary

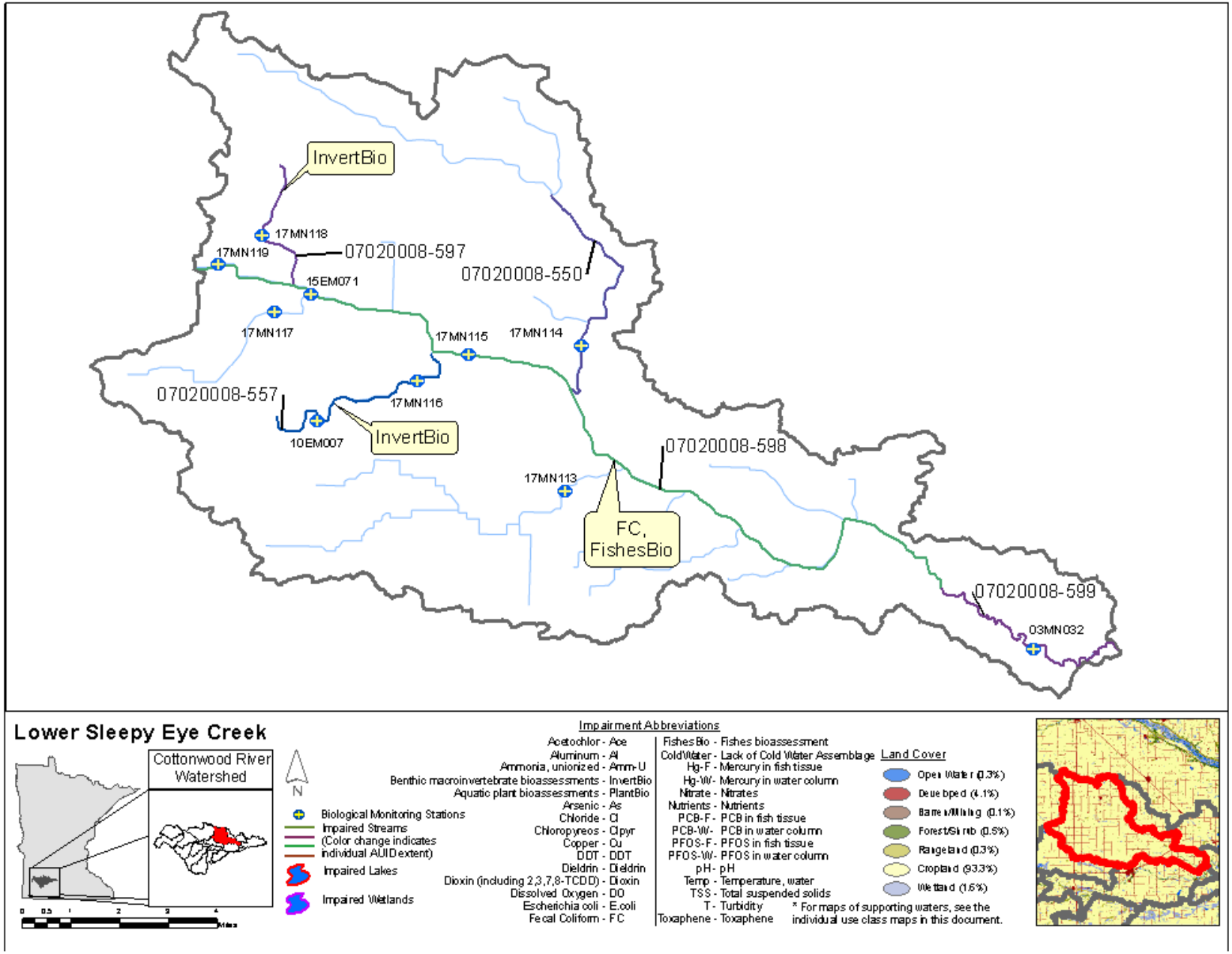
An extensive MIBI data set on Sleepy Eye Creek indicate that the modified use, upstream section of this stream is supporting while the general use portion is impaired for aquatic macroinvertebrates. Throughout the stream a pattern of high DO readings and elevated nitrate concentrations suggest DO flux issues, potentially related to nutrient and/or flow conditions.

There are four stations sampled for fish within the 10-year data window on the upstream reach of Sleepy Eye Creek, -598. Based on the fish collected at all the stations, it was determined that reach currently does not support a modified aquatic life use determination. There is a noticeable trend of improving conditions progressing from upstream to downstream in the fish community.

Station 17MN114 is considered impaired for fish. It had very poor habitat with little fish diversity, ten species were captured and none of them were sensitive species. The reach also had a large number of aquatic plants which could be affecting the oxygen levels in the stream, limiting the types of species that can inhabit the reach.

Sleepy Eye Creek was previously listed for fecal coliform and turbidity as one reach from the headwaters to the outlet at the Cottonwood River. The creek was split into two reaches from 07020008-512 to 07020008-598 (within the Upper Sleepy Eye Creek subwatershed) and 07020008-599 (within the Lower Sleepy Eye Creek subwatershed) and it was determined that the impairments will carry forward to both reaches. Additionally, new data was collected on Lower Sleepy Eye Creek and supports the previous listings for aquatic recreation and aquatic life, respectively. A few very severe bacteria exceedances were reported, including one sample with a reported value of 14,136 colonies.

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Lower Sleepy Eye Creek Aggregated 12-HUC.



Upper Sleepy Eye Creek Aggregated 12-HUC HUC 0702000807-02

The Upper Sleepy Eye Creek subwatershed is in the northern region of the Cottonwood watershed. The subwatershed is within Redwood County and drains an area of 144 square miles. Sleepy Eye Creek headwaters starts on the west side of the subwatershed, about 5.5 miles southwest of Lucan. From there it travels southeast where it leaves the subwatershed, about 5.5 miles southeast of Wabasso. The streams in the subwatershed are about 70% channelized and 30% natural, Sleepy Eye Creek is 100% natural meaning all the tributaries are channelized. The land use is 93% cropland and 4% developed.

Table 22. Aquatic life and recreation assessments on stream reaches: Upper Sleepy Eye Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-598, Sleepy Eye Creek, Headwaters to T109 R33W S6, east line	17MN123	45.92	WWm	EXS	MTS	IF	MTS	MTS	MTS	MTS	MTS		MTS	IMP	IMP
07020008-595, Unnamed creek, Unnamed creek to Sleepy Eye Creek	17MN124	2.42	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	
07020008-594, Unnamed ditch, Unnamed ditch to Sleepy Eye Creek	17MN122	0.98	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	
07020008-543, County Ditch 54, Headwaters to Sleepy Eye Creek	91MN068	4.81	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	
07020008-513, Unnamed ditch, Unnamed ditch to Sleepy Eye Creek		6.52	7							IF	IF			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 2016 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 23. Lake assessments: Upper Sleepy Eye Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Unnamed	64-0096-00	38	--	--	WCBP	--	--	IF		IF	IF	IF	IF	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

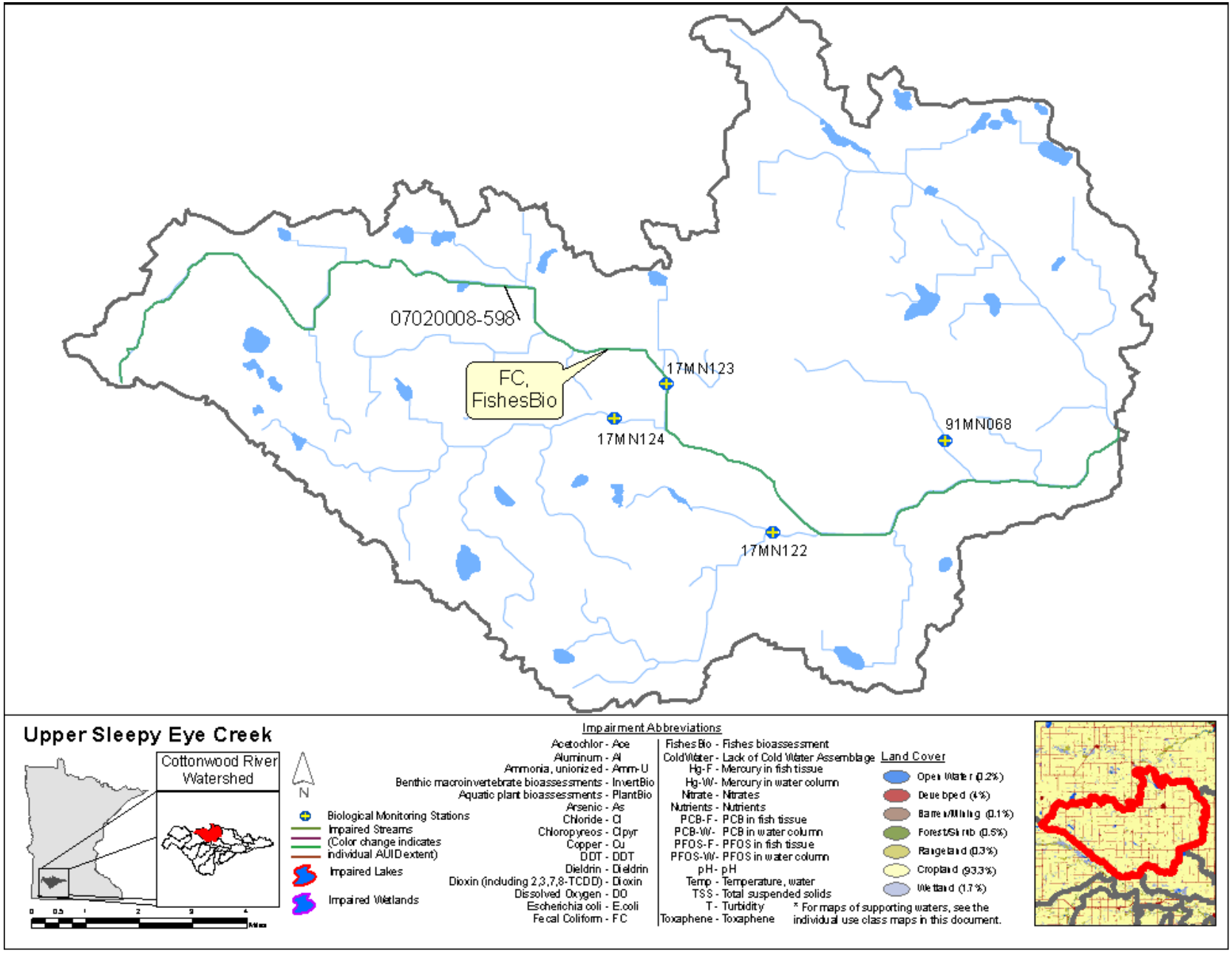
Station 17MN123 had the lowest habitat score (26) and the lowest FIBI in the subwatershed. This station received a FIBI score of 0 due to the low number of fish (5 individuals) caught during sampling.

The other three stations located on tributaries of Upper Sleepy Creek, were determined to support modified aquatic life. These stations scored surprisingly well for being on a channelized stream. During sampling, 300 individuals representing 8 taxa where captured at station 17MN12 which is a significant number of fish for a southern headwater stream.

Sleepy Eye Creek was previously listed for fecal coliform and turbidity as one reach from the headwaters to the outlet at the Cottonwood River. The creek was split into two reaches from 0702008-512 to 07020008-598 (within the Upper Sleepy Eye Creek subwatershed) and 0702008-599 (within the Lower Sleepy Eye Creek subwatershed). New data was collected on Upper Sleepy Eye Creek and supports the previous listings for aquatic recreation. A few very severe bacteria exceedances were reported, including one sample with a reported value of 2,000 colonies. The previous turbidity impairment will not carry-forward to this reach due to new chemistry data indicating full support of aquatic life. The reach has low nutrient and sediment concentrations.

The only lake with data in this subwatershed is a small basin in the Johnsonville Wildlife Management Area. Little data is available; the lake is likely not used for traditional recreation such as swimming or fishing.

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Upper Sleepy Eye Creek Aggregated 12-HUC.



Lower Cottonwood River Aggregated 12-HUC HUC 0702000808-01

The Lower Cottonwood River subwatershed is located on the eastern most region of the Cottonwood Watershed in Brown County and drains an area of 96 square miles. The Cottonwood River enters the subwatershed on the western side of the subwatershed, about 3.5 miles south west of Sleepy Eye, from there it travels east for about 36 miles where it leaves the subwatershed, about 2 miles southeast of New Ulm. The streams in the Lower Cottonwood River subwatershed are about 60% natural and 40% channelized. The Cottonwood River is all natural channel in this part of the watershed. The Lower Cottonwood River subwatershed has the largest amount of wetlands and open water in the Cottonwood River watershed with 4,845 and 1,357 acres respectively.

Table 24. Aquatic life and recreation assessments on stream reaches: Lower Cottonwood River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-501, Cottonwood River, JD 30 to Minnesota River	12MN003, 17MN103, 17MN179	23.97	WWg	MTS	MTS	IF	EXS	EXS	MTS	MTS	MTS		IF	IMP	IMP
07020008-509, Cottonwood River, Sleepy Eye Creekr to JD 30	90MN069	11.97	WWg	MTS	MTS	IF	IF	EXS		IF	IF		IF	IMP	--
07020008-563, Unnamed creek, Unnamed ditch to Cottonwood River	17MN104	3.77	WWg	MTS	EXS	IF	IF	IF		IF	IF		IF	IMP	--
07020008-558, County Ditch 3, Headwaters to Unnamed creek		1.29	WWg			IF	IF	IF		IF	IF		IF	IF	IF
07020008-562, Judicial Ditch 4, Headwaters to Cottonwood River		3.45	WWg					IF						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 2016 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. Lake assessments: Lower Cottonwood River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Clear	08-0011-00	237	8	Shallow lake	WCBP	--	--	IF		EXS	EXS	EXS	IF	NS
Bachelor	08-0029-00	92	4	Shallow lake	WCBP	--	--	--		EXS	EXS	IF	--	NS

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains

Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data

Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)

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

Summary

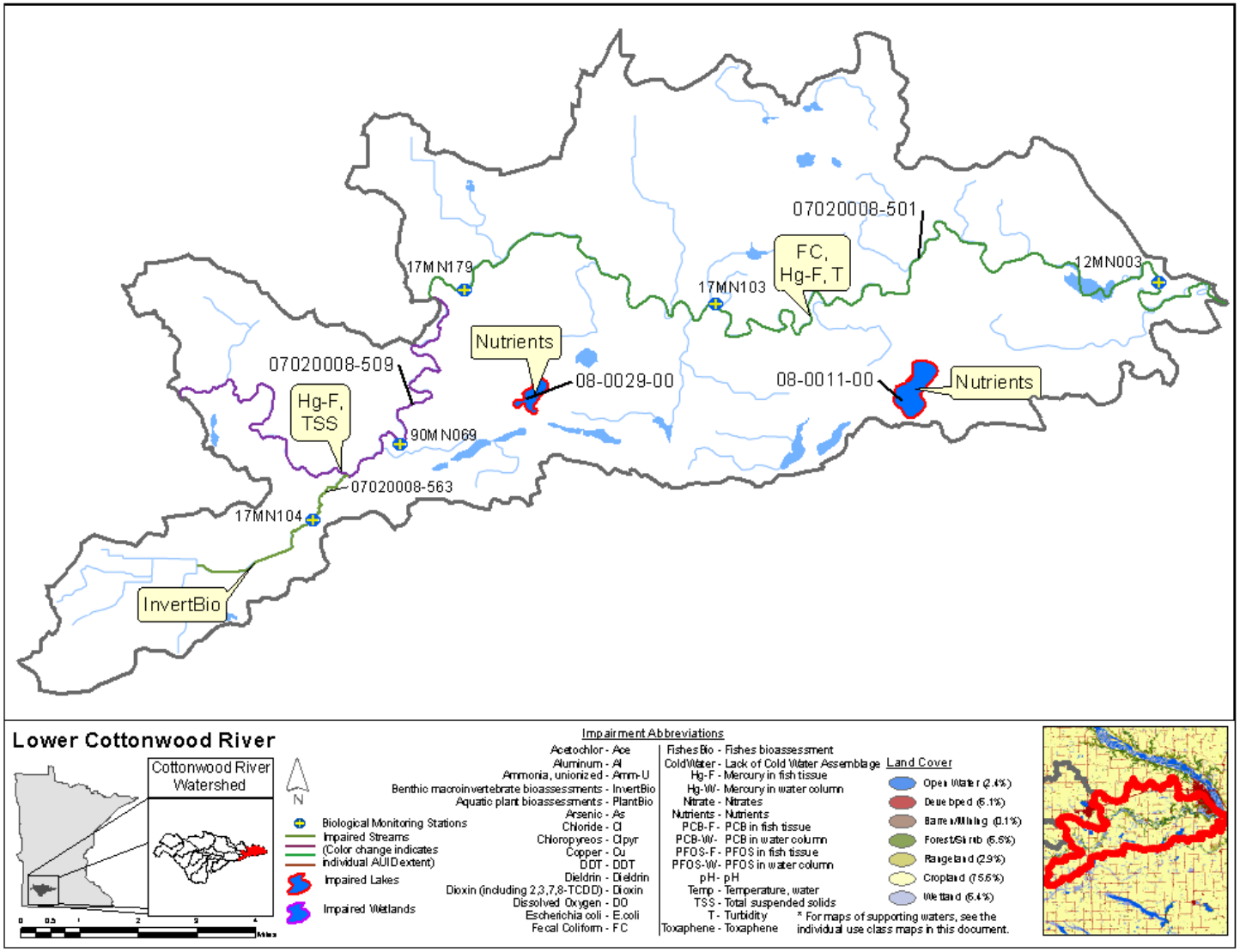
Fish were sampled at five stations in the Lower Cottonwood River subwatershed: four stations are located on the Cottonwood River and one is located on a tributary to the Cottonwood River. All the stations on the Cottonwood River are on natural segments of river while the station located on the tributary is on a channelized segment of stream. All of the stations sampled had suitable habitat to support a healthy fish community which was evident by the fish species captured. Stations 90MN069 fish community was not dominated by tolerant taxa which is common in many reaches within the Cottonwood River watershed. There were nine sensitive species present during sampling, comprising 25% of taxa captured. The habitat at this station was good with coarse substrate, pool-riffle-run sequence, and diverse and abundant cover present. Due to the habitat present, simple lithophilic species that were captured that require clean, coarse substrate to reproduce. The other two reaches had similar habitat similar habitat scores and were determined to support general aquatic life.

The lower reach of the Cottonwood River was previously listed for fecal coliform and turbidity. Recent *E. coli* and sediment data exceed their impairment thresholds and confirm the previous impairments for aquatic recreation and aquatic life, respectively. Additionally, CSMP volunteers are active on the Cottonwood River between Sleepy Eye Creek and Judicial Ditch 30. The robust dataset does not meet the standard for S-tube and indicate sediment is an issue.

Two lakes in this subwatershed have data available for assessment, Clear and Bachelor. These lakes are shallow and have limited ability to deal with excess nutrients. Based on available data, both lakes do not support aquatic recreation use due to elevated levels of phosphorous and

resulting nuisance algal blooms. Clear Lake was sampled for aquatic life using the FIBI. Due to an established history of winterkill events, the lake was not able to be assessed.

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Lower Cottonwood River Aggregated 12-HUC.



Judicial Ditch 30 Aggregated 12-HUC HUC 0702000808-02

Judicial Ditch 30 subwatershed is located on the northeastern region of the Cottonwood watershed in Brown and Redwood counties and drains an area of 58 square miles. Judicial Ditch 30 headwater is located in the northern corner of the subwatershed, about 3.5 miles northeast of Clements, from there is travels southeast though the subwatershed. It exits the subwatershed in the southeast region, 2 miles southeast of Sleepy Eye. The streams in this subwatershed are 99% channelized, the small section of Judicial Ditch 30 that is natural is at the southernmost point and right before its confluence with the Cottonwood River. Land use consists of 87.5% cropland while 7.6% of the subwatershed is developed. Judicial Ditch 30 subwatershed has 734 acres of wetlands which is one of the smallest amounts in the Cottonwood River watershed.

Table 26. Aquatic life and recreation assessments on stream reaches: Judicial Ditch 30 Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07020008-564, County Ditch 60, Unnamed ditch to JD 30	17MN108	1.62	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	--
07020008-609, Judicial Ditch 30, T110 R33W S15, west line to T110 R33W S36, east line	17MN107	5.78	WWm	EXS	MTS	IF		MTS		MTS			IF	IMP	IMP
07020008-565, County Ditch 5, CD 5 to JD 30	17MN106	1.92	WWm	MTS		IF	IF	IF		IF	IF		IF	SUP	--
07020008-511, Judicial Ditch 30, T110 R32W S31, west line to Cottonwood River		4.15	7							MTS	MTS			--	IMP
07020008-530, Judicial Ditch 30, West Branch, Unnamed creek to E Br JD 30		5.67	WWg											NA	--

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 2016 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 27. Lake assessments: Judicial Ditch 30 Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Sleepy Eye	08-0045-00	230	20	Shallow lake	WCBP	NT	--	IF		MTS	MTS	MTS	IF	FS

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

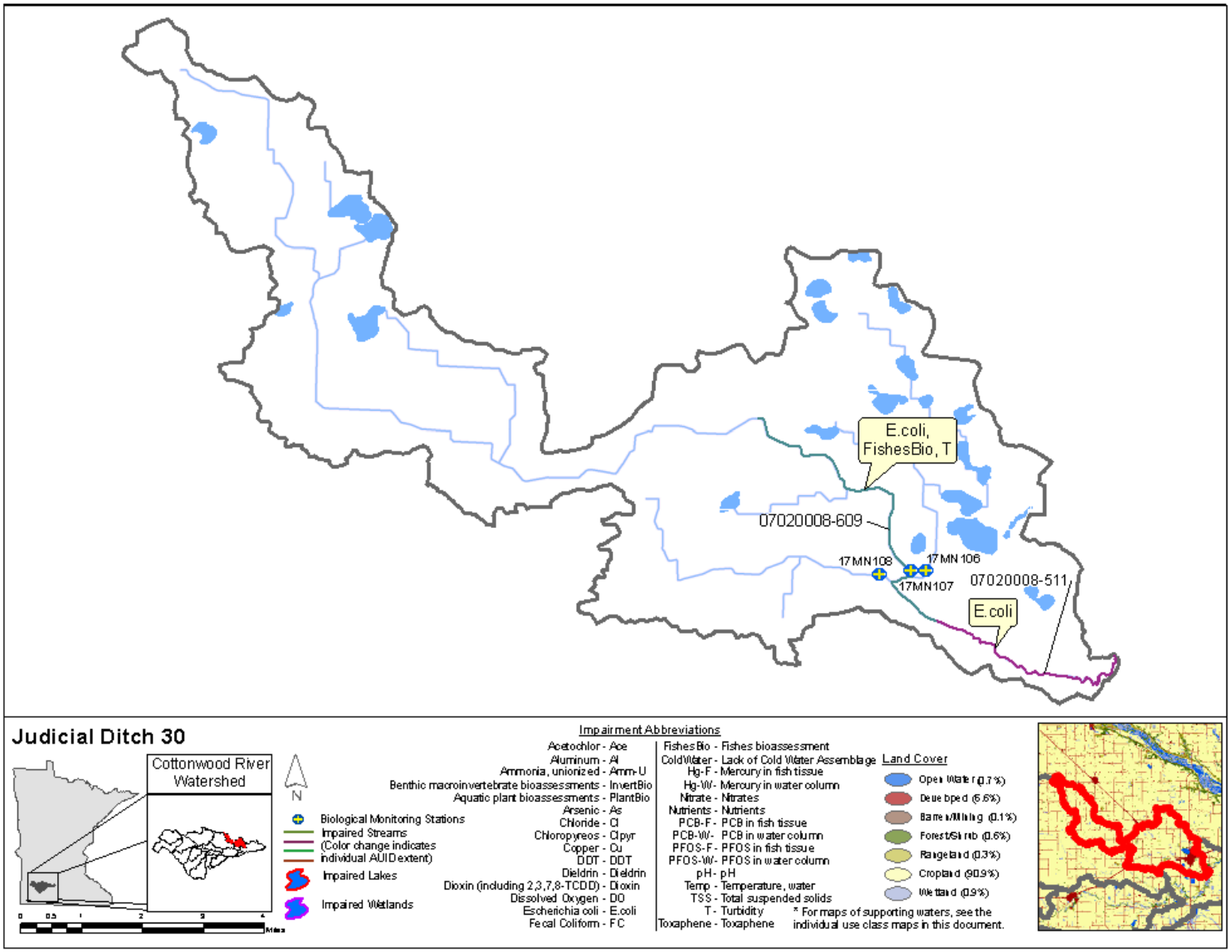
Summary

Stations 17MN108 and 17MN106 are located on tributaries to Judicial Ditch 30, were determined to support modified aquatic life use. The station on Judicial Ditch 30 was determined to not support modified aquatic life due to the very low number of species and individual fish caught when the station was sampled. There was a perched culvert up stream of the reach which may affect the fish population during base flows and could explain why the reach had such a low number of fish caught during sampling.

Chemistry data was available on Judicial Ditch 30, 07020008-609. Elevated concentrations of phosphorous were found but there was not a eutrophication response, with low algae concentrations. Citizen volunteers are active on the same reach, just a mile upstream of the chemistry monitoring site and data shows high transparency measurements indicating sediment is not an issue on that part of the reach. Judicial Ditch 30 stream reaches 07020008-511 and 07020008-609 had elevated concentrations of bacteria; both reaches are impaired for aquatic recreation use.

Sleepy Eye Lake was previously listed for nutrient impairment in 2002. New chemistry data collected shows all parameters well below the standard for the ecoregion and the lake will be removed from the impaired waters list. The lake has been dredged a few times since 1970's. Additionally, the lake was reclaimed with rotenone in 1993 and successfully eliminated common carp. The lake was sampled for aquatic life using the FIBI. Due to the previous dredging and fish reclamation events, the lake was not able to be assessed.

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Judicial Ditch 30 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 Cottonwood River watershed, grouped by sample type. Summaries are provided for lakes, streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption results, load monitoring data results, and transparency trends. Waters identified as priorities for protection or restoration work were also identified. Additionally, groundwater and wetland monitoring results 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 Cottonwood River watershed.

Stream water quality

Seventy of the 75 stream WIDs were assessed (Table 28) Of the assessed streams, only 19 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Six WIDs were classified as limited resource waters and assessed accordingly.

Throughout the watersheds, 40 WIDs are non-supporting for aquatic life and/or recreation. Of those WIDs, 37 are non-supporting for aquatic life and 17 are non-supporting for aquatic recreation.

Table 28. Assessment summary for stream water quality in the Cottonwood River watershed.

				Supporting			Non-supporting			Insufficient data			
Watershed	**Area (acres)**	**# Total WIDs**	**# Assessed WIDs**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Delistings**
Cottonwood **HUC 8**	840782	**75**	**70**	**19**	**0**	**0**	**37**	**17**	**2**	**7**	**1**	**4**	**0**
Headwaters Cottonwood River	64275	5	4	0	0	--	4	1	--	0	0	--	0
Meadow Creek	62978	11	9	2	0	--	6	2	--	0	0	--	0
Plum Creek	57695	5	5	2	0	--	3	2	--	0	0	--	0

				Supporting			Non-supporting			Insufficient data			
Watershed	**Area (acres)**	**# Total WIDs**	**# Assessed WIDs**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Aquatic life**	**# Aquatic recreation**	**# Limited resource**	**# Delistings**
Upper Cottonwood River	67876	7	7	2	0	0	3	1	1	1	0	0	0
Pell Creek	33171	4	4	1	0	0	1	1	0	1	0	1	0
Dutch Charlie Creek	64577	7	7	3	0	--	3	1	--	1	0	--	0
Highwater Creek	69410	6	5	1	0	0	2	1	0	0	0	2	0
Middle Cottonwood River	55469	3	3	1	0	--	1	1	--	1	0	--	0
Coal Mine Creek	29982	1	1	0	0	--	1	1	--	0	0	--	0
Mound Creek	35286	3	3	0	0	--	2	1	--	1	0	--	0
Dry Creek	26273	2	2	0	0	--	2	1	--	0	0	--	0
Lower Sleepy Eye Creek	82298	6	6	2	0	--	4	1	--	0	0	--	0
Upper Sleepy Eye Creek	92359	5	5	3	0	--	1	1	--	0	0	1	0
Lower Cottonwood River	61615	5	5	0	0	--	3	1	--	2	1	--	0
Judicial Ditch 30	37515	5	4	2	0	0	1	1	1	0	0	0	0

Lake water quality

The Cottonwood River watershed has data on 25 lakes greater than 10 acres. Sleepy Eye Lake was previously listed as impaired for aquatic recreation use but new data collected shows the lake is now meeting standards and will be delisted. Five lakes in the watershed do not support aquatic recreation use (Double, Altermatt, Boise, Clear and Bachelor). The remaining lakes had insufficient data to make an aquatic recreation assessment. Two lakes are impaired for aquatic life use (Rock and Double).

Table 29. Assessment summary for lake water chemistry in the Cottonwood River watershed.

			Supporting		Non-supporting		Insufficient data		
Watershed	**Area (acres)**	**Lakes >10 acres**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Delistings**
Cottonwood **HUC 8**	840782	**25**	**0**	**1**	**2**	**5**	**9**	**18**	**1**
Headwaters Cottonwood River	64275	4	0	0	1	0	0	4	0
Meadow Creek	62978	2	0	0	0	0	1	2	0
Plum Creek	57695	3	0	0	0	0	1	3	0
Upper Cottonwood River	67876	2	0	0	0	0	0	2	0
Pell Creek	33171	0	--	--	--	--	--	--	--
Dutch Charlie Creek	64577	1	0	0	0	0	0	1	0
Highwater Creek	69410	6	0	0	1	1	3	4	0
Middle Cottonwood River	55469	2	0	0	0	2	0	0	0
Coal Mine Creek	29982	0	--	--	--	--	--	--	--
Mound Creek	35286	1	0	0	0	0	1	1	0
Dry Creek	26273	0	--	--	--	--	--	--	--

			Supporting		Non-supporting		Insufficient data		
Watershed	**Area (acres)**	**Lakes >10 acres**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Delistings**
Lower Sleepy Eye Creek	82298	0	--	--	--	--	--	--	--
Upper Sleepy Eye Creek	92359	1	0	0	0	0	1	1	0
Lower Cottonwood River	61615	2	0	0	0	2	1	0	0
Judicial Ditch 30	37515	1	0	1	0	0	1	0	1

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Cottonwood River from 1990 to 2017, and from Sleepy Eye Lake in 1999 and Double Lake in 2015 (Table 22). All nine WIDs of the Cottonwood River are listed as impaired for mercury in fish tissue and are covered under the Minnesota Statewide Mercury TMDL. The highest mercury concentrations in the Cottonwood River was a Walleye collected in 1996 (0.640 ppm). Mercury concentrations in the latest year of sampling, 2017, in the Cottonwood River included five Common Carp ranging from 0.171 ppm to 0.202 ppm, 10 Channel Catfish ranging from 0.060 ppm to 0.178 ppm, and 5 Redhorse ranging from 0.063 ppm to 0.098 ppm. The fish from Sleepy Eye and Double lakes had very low mercury levels. The maximum mercury concentration was in a Northern Pike from Sleepy Eye at 0.200 ppm. Consequently, neither of the lakes tested were impaired for mercury in fish tissue.

PCBs had been measured in multiple species in the Cottonwood River and one Northern Pike in Sleepy Eye Lake. The latter was below the reporting limit (0.01 ppm). The highest PCBs concentration in the Cottonwood River was in a Channel Catfish collected in 2017. The 0.122 ppm in that fish was below the threshold for impairment for PCBs in fish tissue (0.22 ppm).

Table 30. Fish contaminants: summary of fish length, mercury, PCBs and PFOS by waterway-species-year

WID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
07020008-501,502, 503, 504, 505, 506, 507, 508, 509	COTTONWOOD R.*	Common Carp	1990	FILSK	1	1	19.2	19.2	19.2	0.220	0.220	0.220	1	0.021	0.021	
			1996	FILSK	10	3	19.1	16.8	22.1	0.120	0.100	0.150	2	0.03	0.05	
			1999	FILSK	10	5	22.2	17.2	25.8	0.174	0.110	0.240	5	0.0126	0.017	
			2017	FILSK	5	5	21.1	19.8	22.9	0.187	0.171	0.202				
		Channel Catfish	1990	FILET	1	1	15.2	15.2	15.2	0.120	0.120	0.120	1	0.12	0.12	
			1999	FILET	5	5	19.5	17.4	24.4	0.216	0.110	0.370	4	0.055	0.114	
			2017	FILSK	10	10	17.2	12.4	25.4	0.120	0.060	0.178	2	0.0842	0.122	
		Freshwater Drum	1990	FILSK	1	1	11.9	11.9	11.9	0.140	0.140	0.140	1	0.068	0.068	
		Redhorse sp.	2017	FILSK	5	5	11.7	10.4	14.1	0.075	0.063	0.098				
		Quillback	1990	FILSK	2	2	10.5	8.3	12.7	0.132	0.024	0.240	2	0.017	0.024	
		Walleye	1990	FILSK	1	1	15.3	15.3	15.3	0.240	0.240	0.240	1	0.027	0.027	
			1996	FILSK	3	2	22.1	18.1	26.1	0.440	0.240	0.640	1	0.01	0.01	Y
			1999	FILSK	15	15	16.2	13.5	19.4	0.241	0.180	0.370	3	0.01	0.01	Y
		White Sucker	1990	FILSK	2	2	14.4	12.3	16.4	0.081	0.051	0.110	2	0.0345	0.045	
08-0045-00	SLEEPY EYE	Northern Pike	1999	FILSK	7	7	21.3	19.9	23.0	0.136	0.110	0.200	1	0.01	0.01	Y
		Yellow Perch	1999	FILSK	8	1	9.0	9.0	9.0	0.090	0.090	0.090				
17-0056-00	DOUBLE	Common Carp	2015	FILSK	5	1	20.4	20.4	20.4	0.015	0.015	0.015				
		Walleye	2015	FILSK	9	9	14.4	12.3	20.1	0.026	0.016	0.051				
		White Crappie	2015	FILSK	10	1	9.1	9.1	9.1	0.015	0.015	0.015				

* Impaired for mercury in fish tissue as of 2020 Draft Impaired Waters Inventory; categorized as EPA Category 4a for waters covered by the Statewide Mercury TMDL.

1 Anatomy codes: FILSK – fillet with skin; FILET—fillet without skin; WHORG—whole organism.

Pollutant load monitoring

The WPLMN has three sites within the Cottonwood River watershed as shown in Table 31.

Table 31. WPLMN Stream Monitoring Sites for the Cottonwood River watershed

Site Type	Stream Name	USGS ID	DNR/MPCA ID	EQuIS ID
Major Watershed	Cottonwood River nr New Ulm, MN68	05317000	E29001001	S001-918
Subwatershed	Sleepy Eye Creek nr Cobden, CR8	05316992	H29011001	S001-919
Subwatershed	Cottonwood River nr Leavenworth, CR8	05316970	H29022001	S001-920

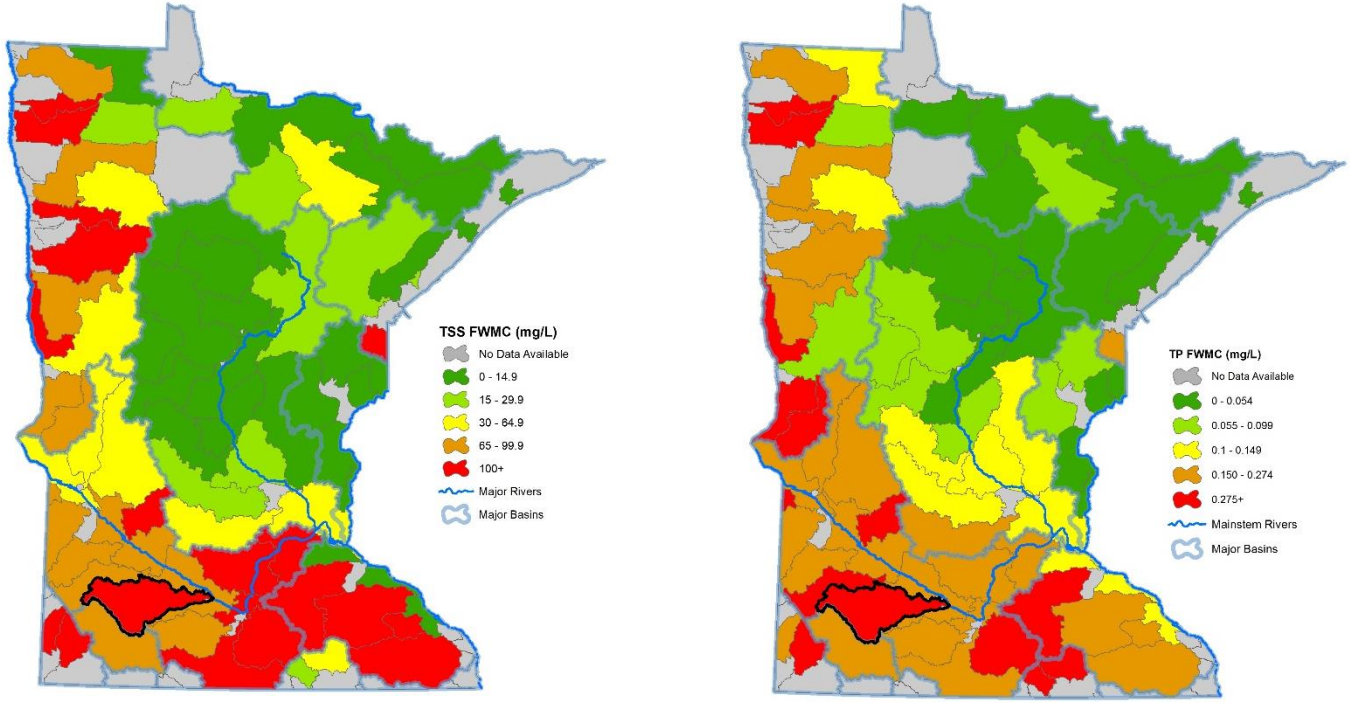
Average annual FWMCs of TSS, TP, and NO3+NO2-N for major watershed stations statewide are presented below, with the Cottonwood River watershed highlighted. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that makes it to a river or stream; this can be expressed in inches.

As a general rule, elevated levels of TSS and NO3+NO2-N are regarded as nonpoint source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess TP can be attributed to both non-point as well as point sources such as industrial or wastewater treatment plants. Major nonpoint sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Excessive TSS, TP, and NO_3+NO_2-N in surface waters impacts fish and other aquatic life, as well as fishing, swimming and other recreational uses. High levels of NO_3+NO_2-N is a concern for drinking water.

When compared with other major watersheds throughout the state, Figure 30 shows the average annual TSS, TP, and NO_3+NO_2-N FWMCs to be several times higher for the Cottonwood River watershed than watersheds in north central and northeast Minnesota, but in line with the agriculturally rich watersheds found in the northwest and southern regions of the state.

Figure 30. 2007-2016 Average annual TSS, TP, and NO3-NO2-N flow weighted mean concentrations, and runoff by major watershed.



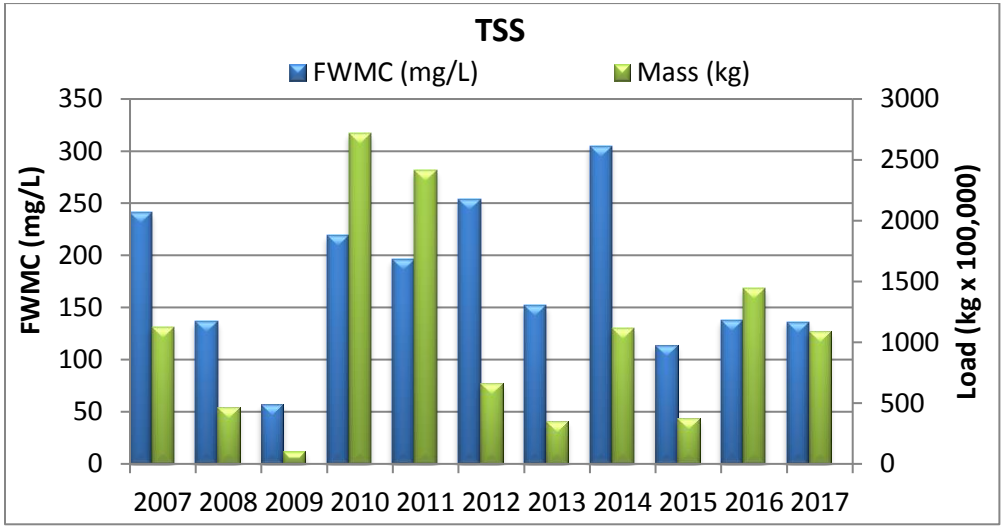
More information, including results for subwatershed stations, can be found at the WPLMN website.

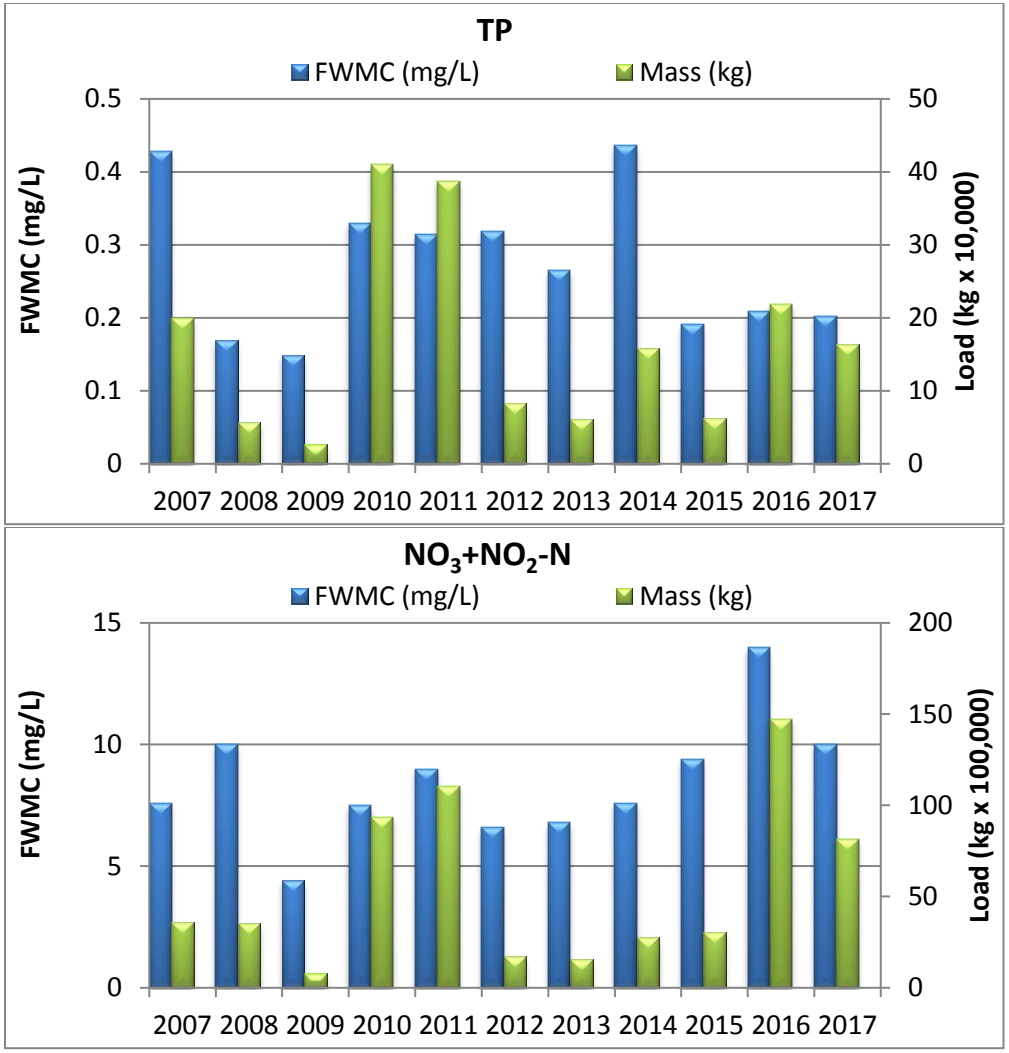
Substantial year-to-year variability in water quality occurs for most rivers and streams, including the Cottonwood River. Results for individual years are shown in the charts below.

Overall, TSS and TP show very similar patterns between FWMCs and loads over the ten-year period. The greatest pollutant loads were measured in 2010 and 2011 and were largely climate driven. The highest annual FWMCs for TSS and TP generally occur during years dominated by intense rain events that occur early in the growing season. High TSS concentrations can also occur during snowmelt when channel ice breaks free, scouring streambanks as it moves downstream. Often the highest total phosphorus concentrations of the year also occur during this period. Phosphorus sources include eroded sediment, dissolved phosphorus leached from: frozen soils, crop residue and other vegetation.

Annual NO_3-NO_2-N flow weighted mean concentrations and loads are complex and variable. Factors influencing year-to-year differences include total annual precipitation, drainage tile density, timing of runoff events and fertilizer application rates.

Figure 31. TSS, TP, and NO3+NO2-N Flow Weighted Mean Concentrations and Loads for the Cottonwood River near New Ulm, MN.





Groundwater Quality

Approximately 75% of Minnesota's population receives their drinking water from groundwater, so clean groundwater is essential to the health of its residents. The Minnesota Pollution Control Agency'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 Groundwater 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.

There is currently just one MPCA Ambient Groundwater Monitoring well actively monitored within the Cottonwood River watershed. Data from this well, and past sampling of other wells, indicate the presence of naturally occurring minerals like boron and manganese. Samples of nitrate collected within the past ten years have been at concentrations at or above the MCL of 10 mg/L.

Another source of information on groundwater quality comes from the Minnesota Department of Health (MDH). Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that an average of 10 percent of all wells installed from 2008 to 2016 have arsenic levels above the MCL for drinking water of 10 micrograms per liter (MDH, 2020a). The Cottonwood River watershed contains portions of five counties: Redwood (makes up 35% of the watershed) Brown (21%) Cottonwood (19%) Lyon (17%) and Murray (8%). The frequency of detections in new wells of arsenic above 2 micrograms per liter was well over 50% in all these counties. The frequency of detections in new wells of arsenic above the MCL of 10 micrograms per liter was 15% in Cottonwood County and above 20% in the other four counties. (MDH 2020b)

Groundwater Quantity

The DNR maintains a statewide network of water level wells to assess groundwater resources, evaluate trends and plan for the future. While there are a number of deep wells within the Cottonwood River watershed, a shallower, water table well is more reactive to recharge and withdrawals. Groundwater elevations from wells #708360 near Sanborn and #689981 near Milroy are displayed below. Fluctuations in water level are common and expected with seasonal change and varied precipitation. Both wells show a significant rising trend over the monitored period.

Figure 32. Water table elevations in Well #708360 near Sanborn 2008-2018

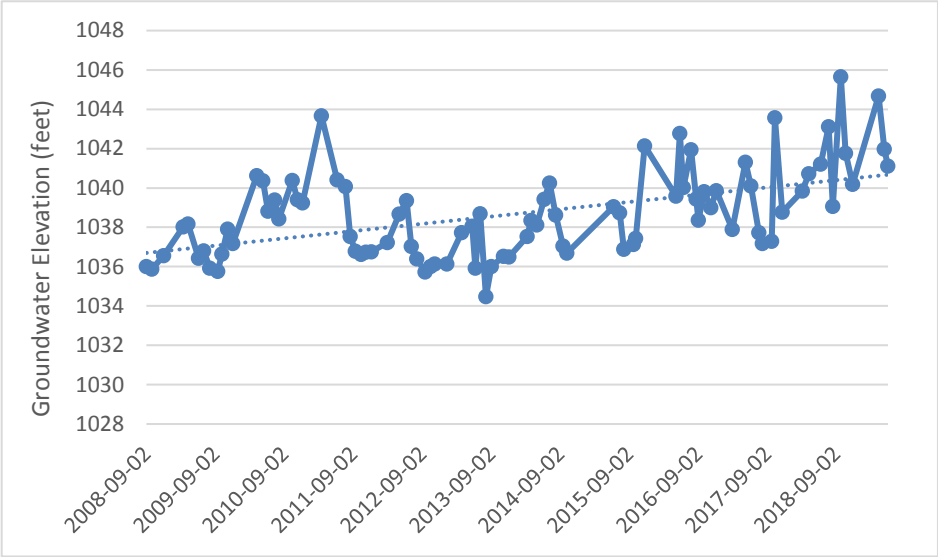
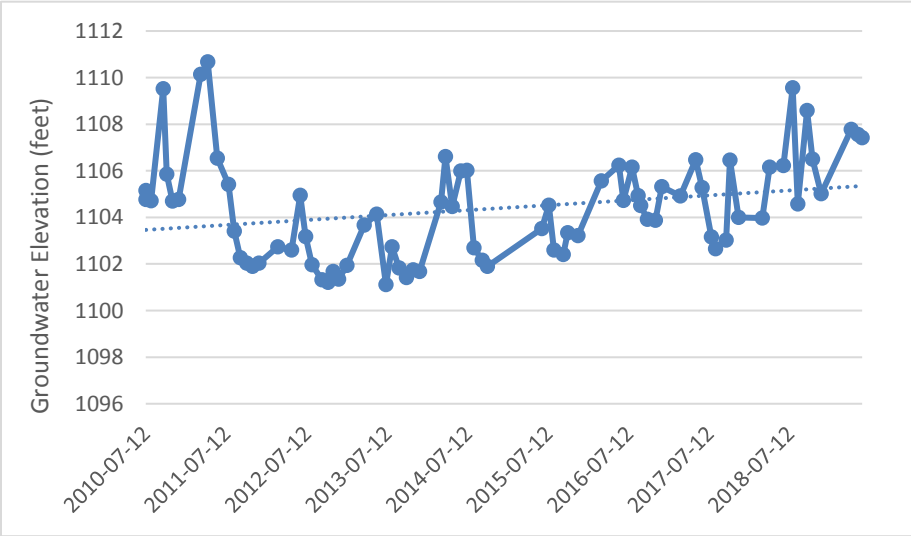


Figure 33. Water table elevations in Well #689981 near Milroy, 2010-2018



The Department of Natural Resources also permits all high capacity water withdrawals where 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 DNR annually. The changes in withdrawal volume detailed in this groundwater report are a representation of water use and demand in the watershed and are taken into consideration when the DNR 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.

The largest permitted consumers of water in the state are (in order) power generation, water supply (DNR, 2019). According to the most recent data from the DNR Permitting and Reporting System (MPARS), the two largest use categories for withdrawals within the Cottonwood River Watershed are water supply (30%) and industrial processing (20%).

Figure 34 displays total high capacity withdrawal locations within the watershed with active permit status in 2017. Permitted groundwater withdrawals are displayed below as blue squares and surface water withdrawals as red triangles. In the Cottonwood River watershed, from 1997 to 2017, groundwater withdrawals surface water withdrawals have both increased significantly ($p<0.01$) (Figure 35).

Figure 34. Locations of active status permitted high capacity withdrawals in the Cottonwood River Watershed (DNR 2020)

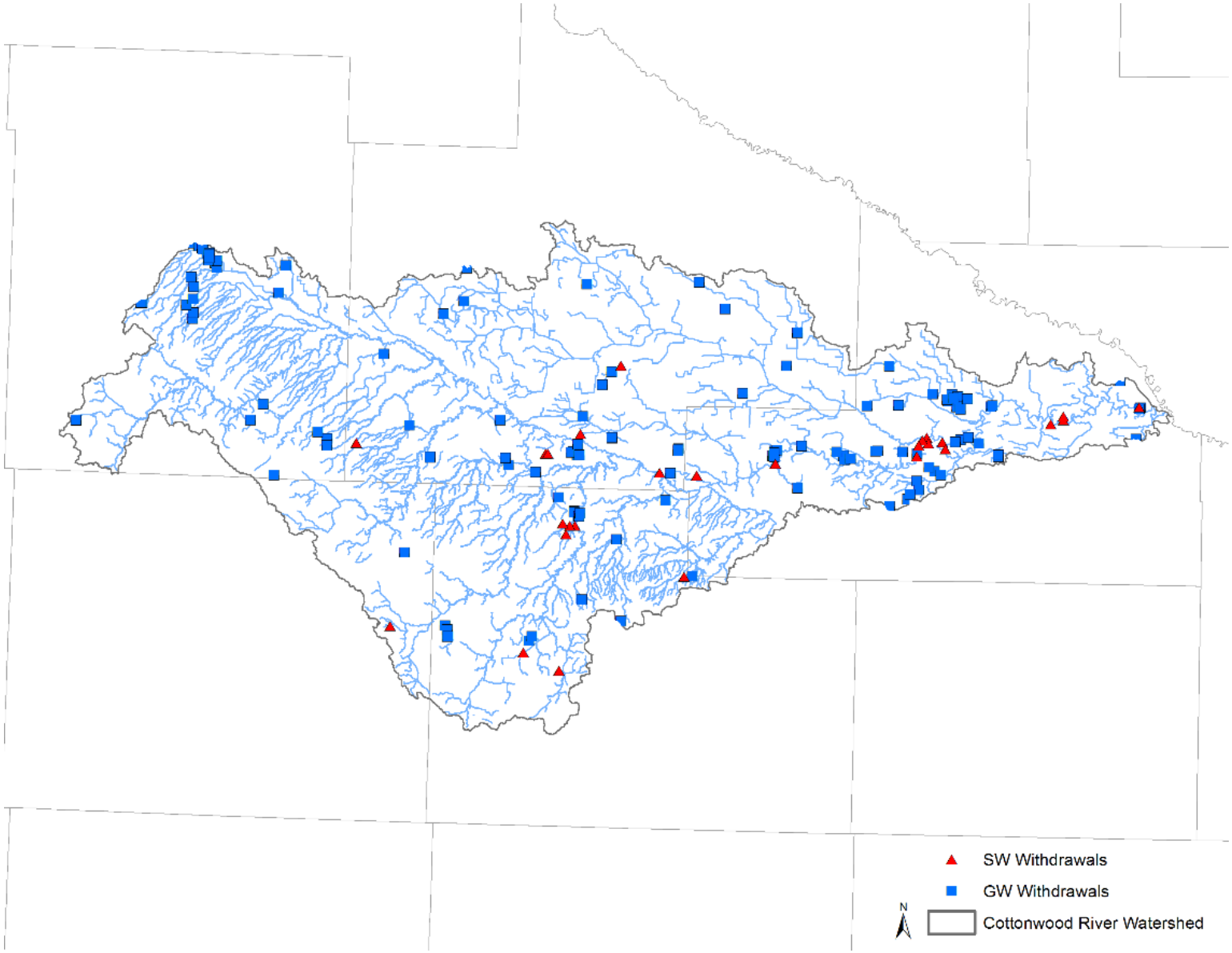
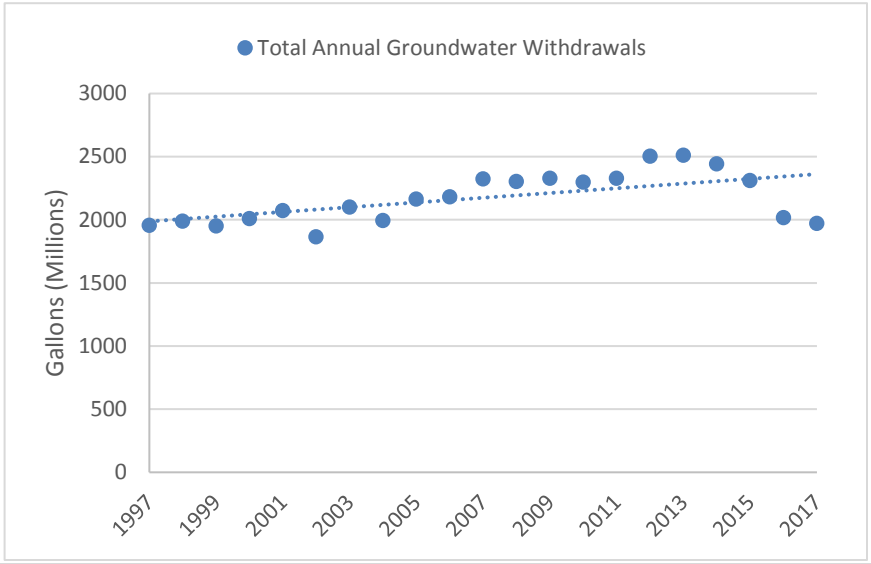
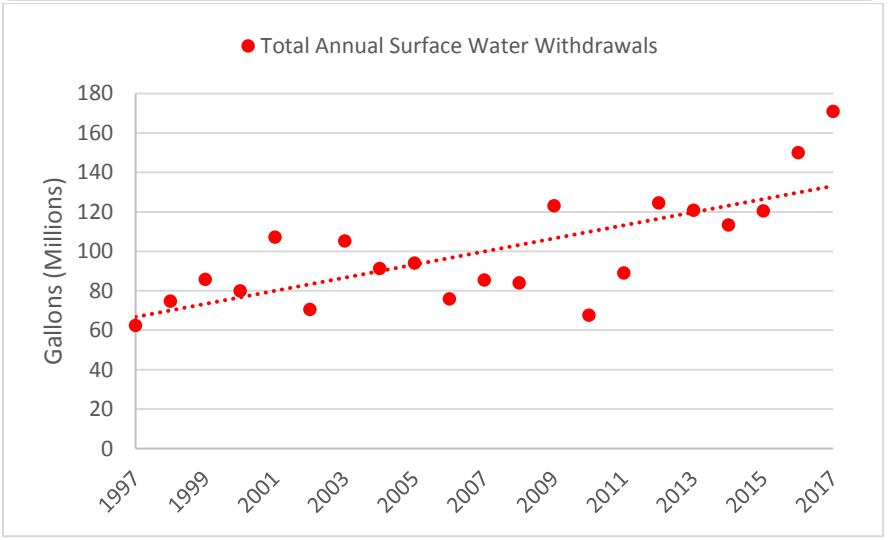


Figure 35. Total annual groundwater (above) and surface water (below) withdrawals in the Cottonwood River watershed (1997-2017)

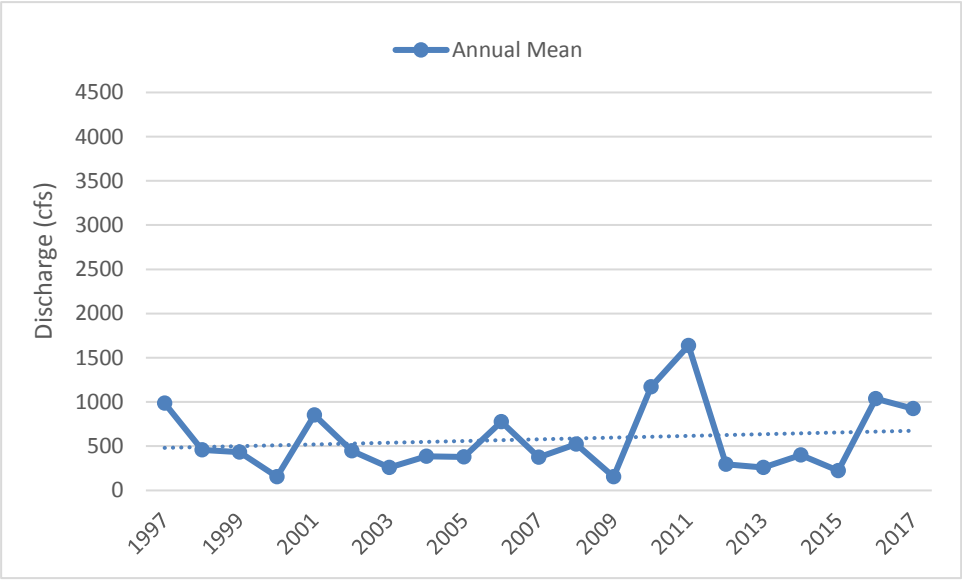


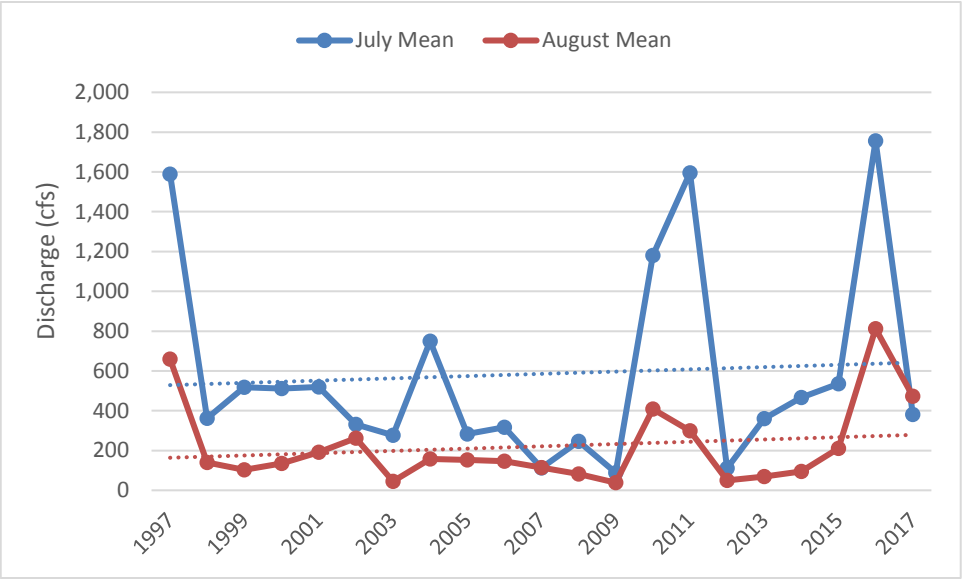


Stream flow

Stream flow data from the United States Geological Survey's real-time streamflow gaging station on the Cottonwood River at New Ulm, MN were analyzed for mean annual discharge and summer (July and August) monthly mean discharge from 1997-2017 (Figure 36). The data fluctuate, but these changes illustrate seasonality of flow and responses to precipitation and are not statistically significant. By way of comparison at a state level, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends (Streitz, 2011).

Figure 36. Average Annual (above) and summer (below) mean discharge for the Cottonwood River at New Ulm (1997-2017) (Source: USGS 2020)





Wetland condition

As noted earlier, the Cottonwood River watershed occurs entirely within the Temperate Prairies ecoregion. As discussed in the methods section the MPCA uses two biological indicators (macroinvertebrates and vegetation) to access wetland quality. Based on plant community floristic quality, 82% of wetlands in the Temperate Prairies ecoregion are estimated to be in fair or poor condition and an estimated 11% are in good condition (Table 32). In contrast the invertebrate condition indicator in the Temperate Prairies ecoregion, found 41% of the wetlands are in good condition and 57% are in either fair or poor condition.

Table 32. Biological wetland condition statewide and by major ecoregions according to vegetation and invertebrate indicators. Vegetation results are expressed by extent (i.e., percentage of wetland acres) and include virtually all wetland types (MPCA 2015). Invertebrate results represent natural depressional wetlands (e.g., prairie potholes) that typically have open water and are expressed as the percentage of wetland basins (Genet 2015). Depressional wetland monitoring is focused in Mixed Wood Plains and Temperate Prairie ecoregions (as opposed to statewide) where it is a more prevalent type.

Vegetation Condition in All Wetland Community Types

Condition Category	Statewide	Mixed Wood Plains	Temperate Prairies
Exceptional	49%	6%	7%
Good	18%	12%	11%
Fair	23%	42%	40%
Poor	10%	40%	42%

Invertebrate Condition in Depressional Wetlands

Condition Category	Mixed Wood Plains & Temperate Prairies	Temperate Prairies
Good	45%	41%
Fair	33%	30%
Poor	22%	27%

Wetlands in the Temperate Prairies are commonly dominated by invasive plants, particularly narrow-leaf cattail (Typha angustifolia), hybrid cattail (Typha X glauca), and reed canary grass (Phalaris arundinacea). These invasive plants often outcompete native species due to their tolerance of nutrient enrichment, hydrologic alterations and toxic pollutants such as chlorides (Galatowisch 2012) and thus strongly influence the composition and structure of the wetland plant community.

Wetlands are an important part of watershed and water quality protection and restoration. Wetlands are affected by many pollutants and related stressors and it is often very difficult and costly to rehabilitate wetlands that are in an impoverished condition. Thus, it will be more cost effective in the Cottonwood River watershed, as well as other HUC-8 watersheds in the prairie region to focus on protecting the few remaining high quality wetlands. Management practices to limit additional wetland hydrologic alternations and efforts to reduce the spread of invasive species promise to be the most cost effective ways to protect and restore water quality in the Cottonwood River watershed.

Figure 37. Stream Tiered Aquatic Life Use Designations in the Cottonwood River watershed.

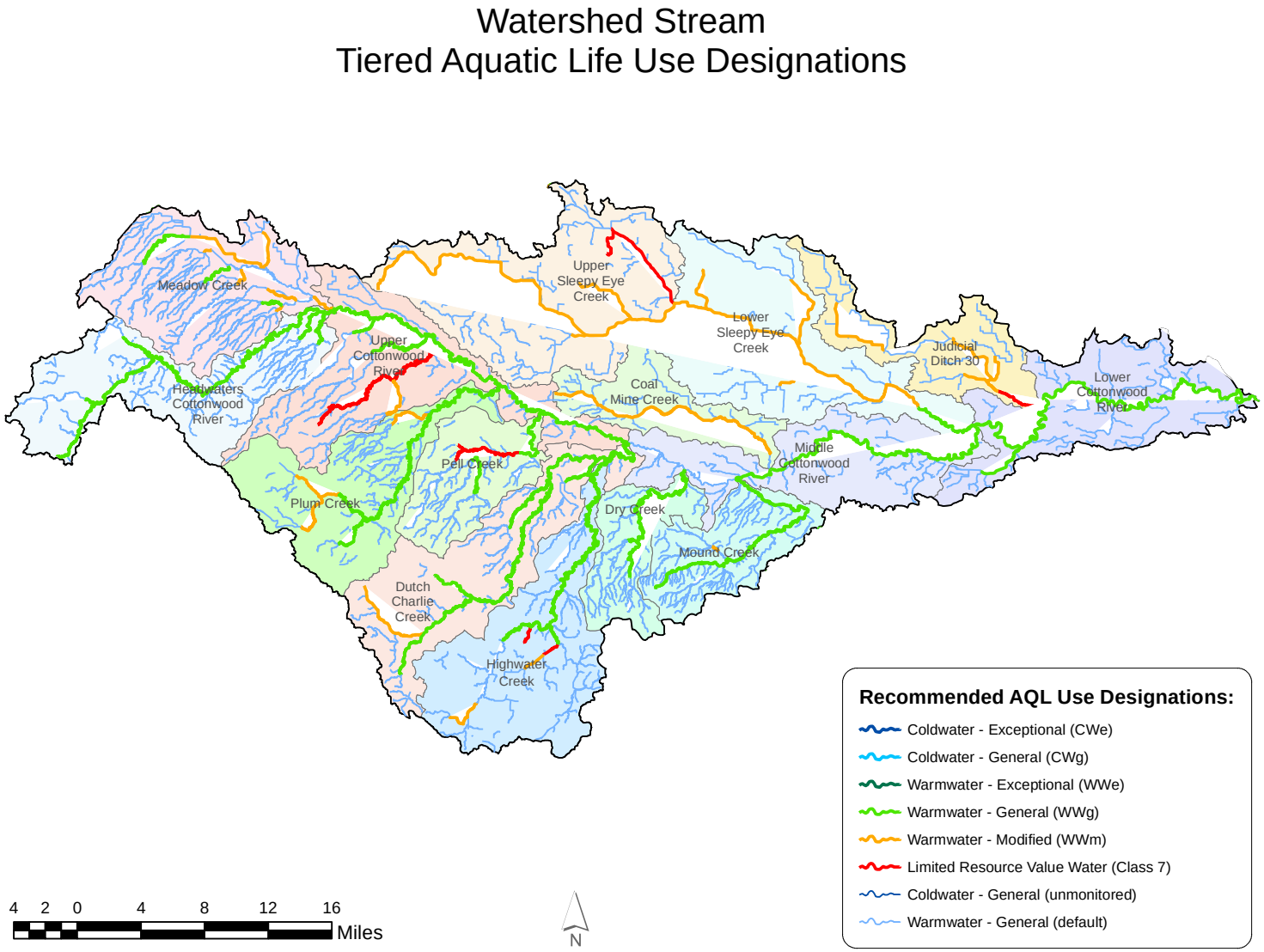
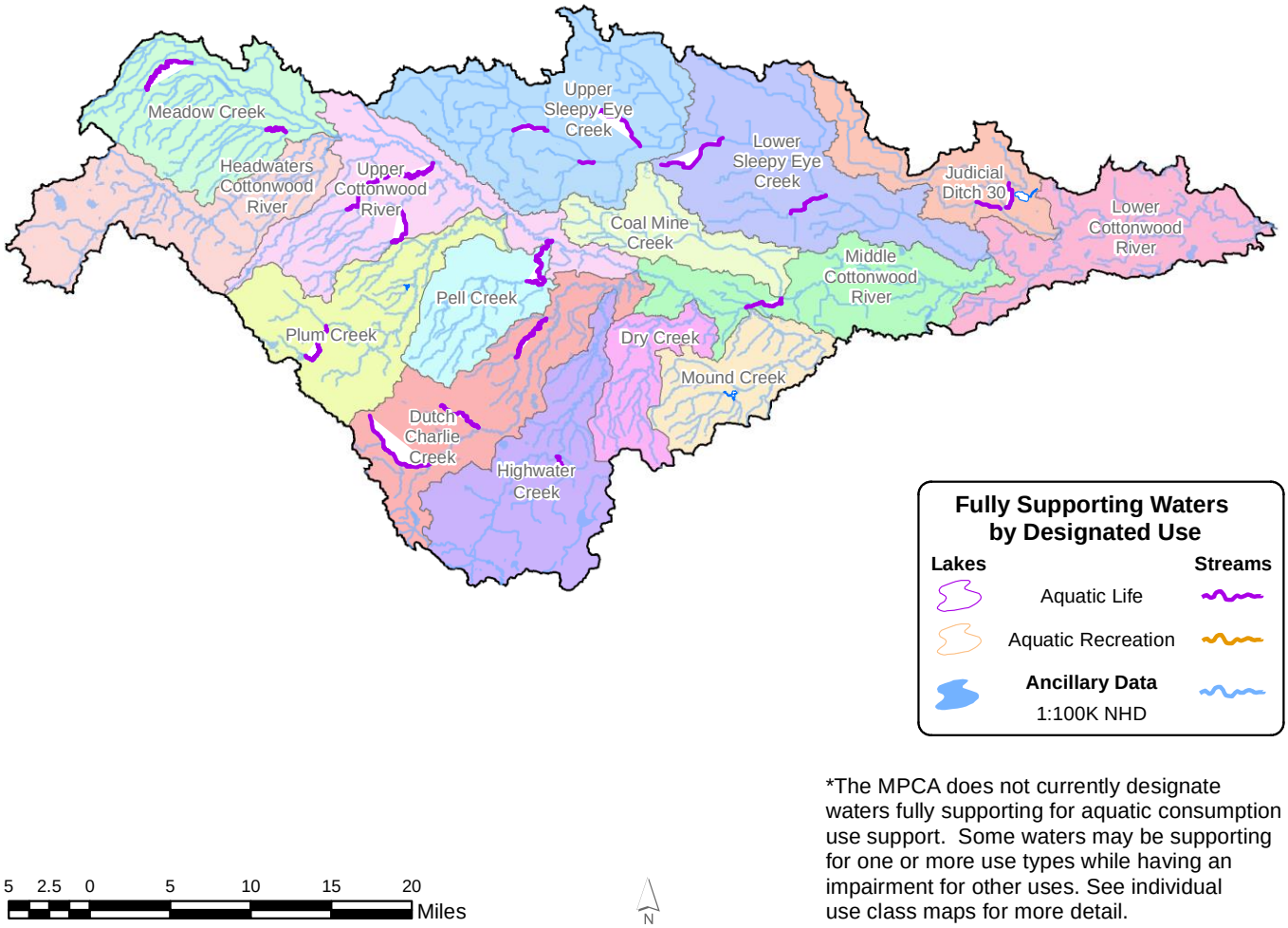


Figure 38. Fully supporting waters by designated use in the Cottonwood River watershed.



*The MPCA does not currently designate waters fully supporting for aquatic consumption use support. Some waters may be supporting for one or more use types while having an impairment for other uses. See individual use class maps for more detail.

Figure 39. Impaired waters by designated use in the Cottonwood River watershed.

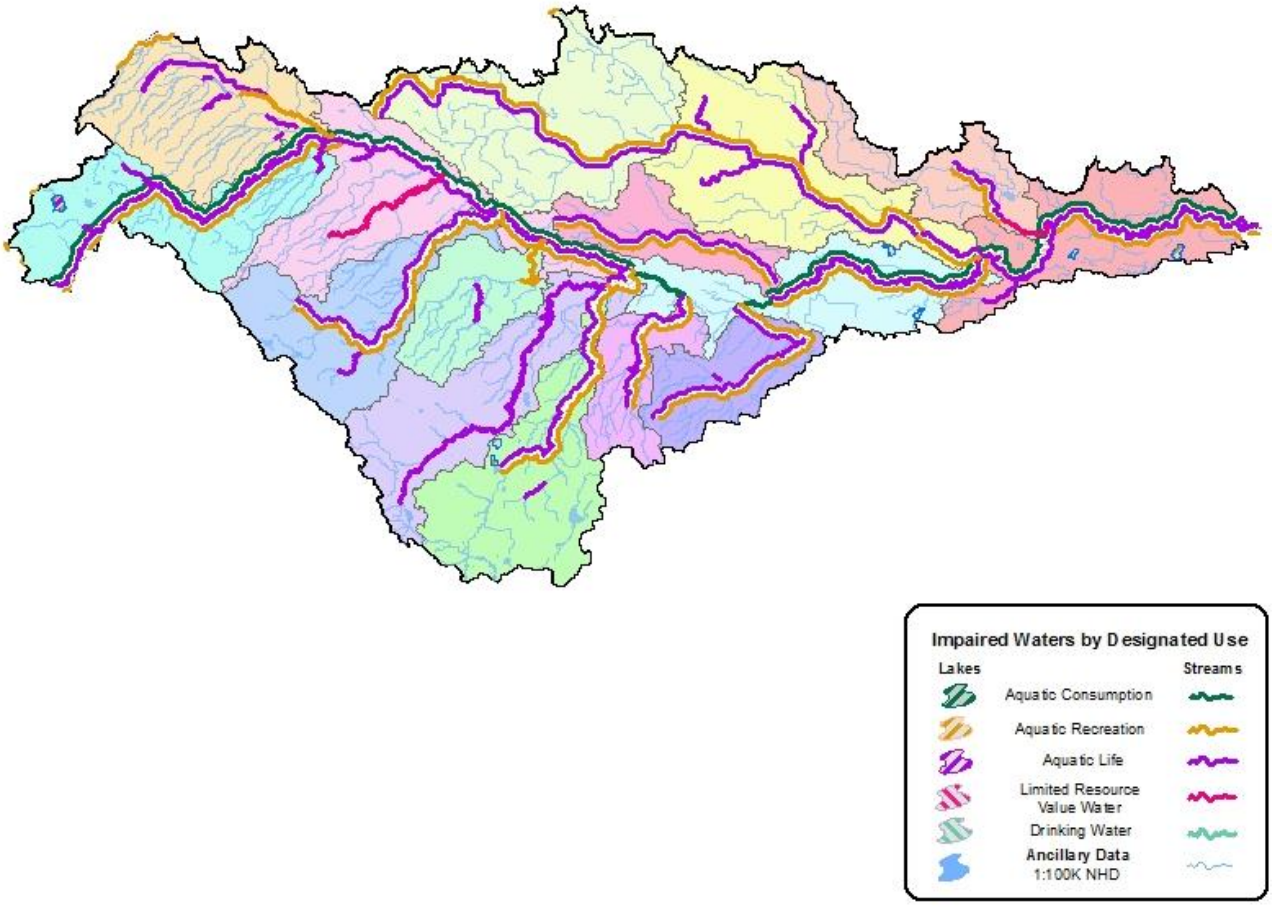
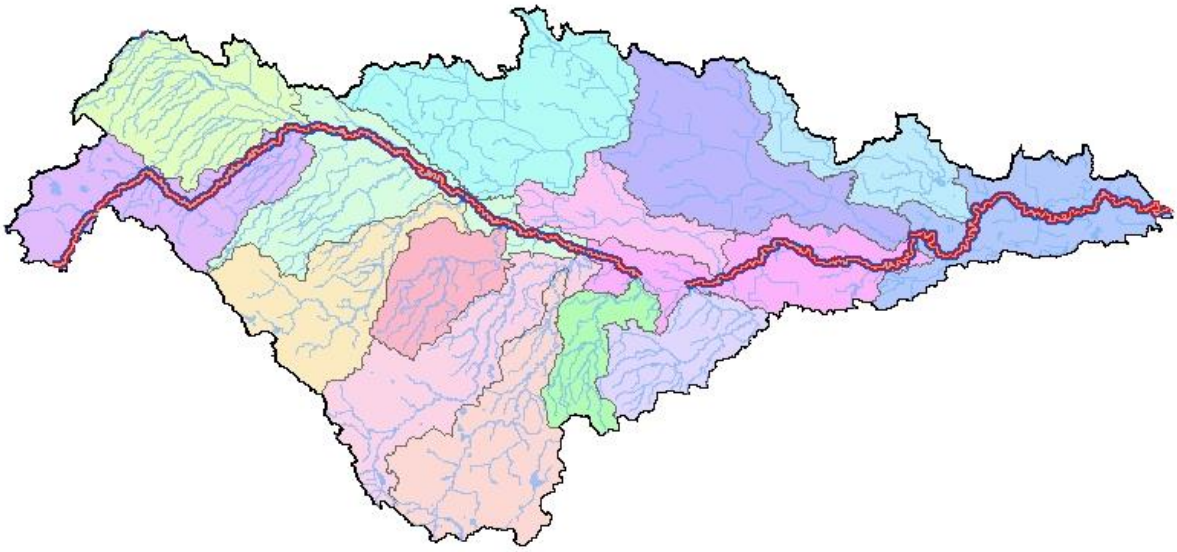
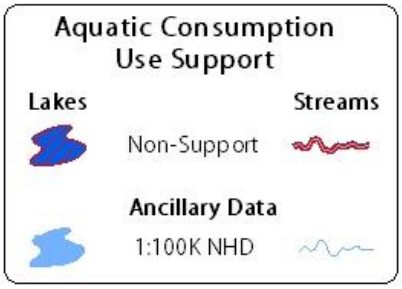


Figure 40. Aquatic consumption use support in the Cottonwood River watershed.





* The MPCA does not currently designate waters fully supporting for aquatic consumption use support. Some waters may be impaired for one or more use types while supporting other uses. See additional use class maps for more information.

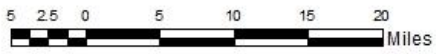


Figure 41. Aquatic life use support in the Cottonwood River watershed.

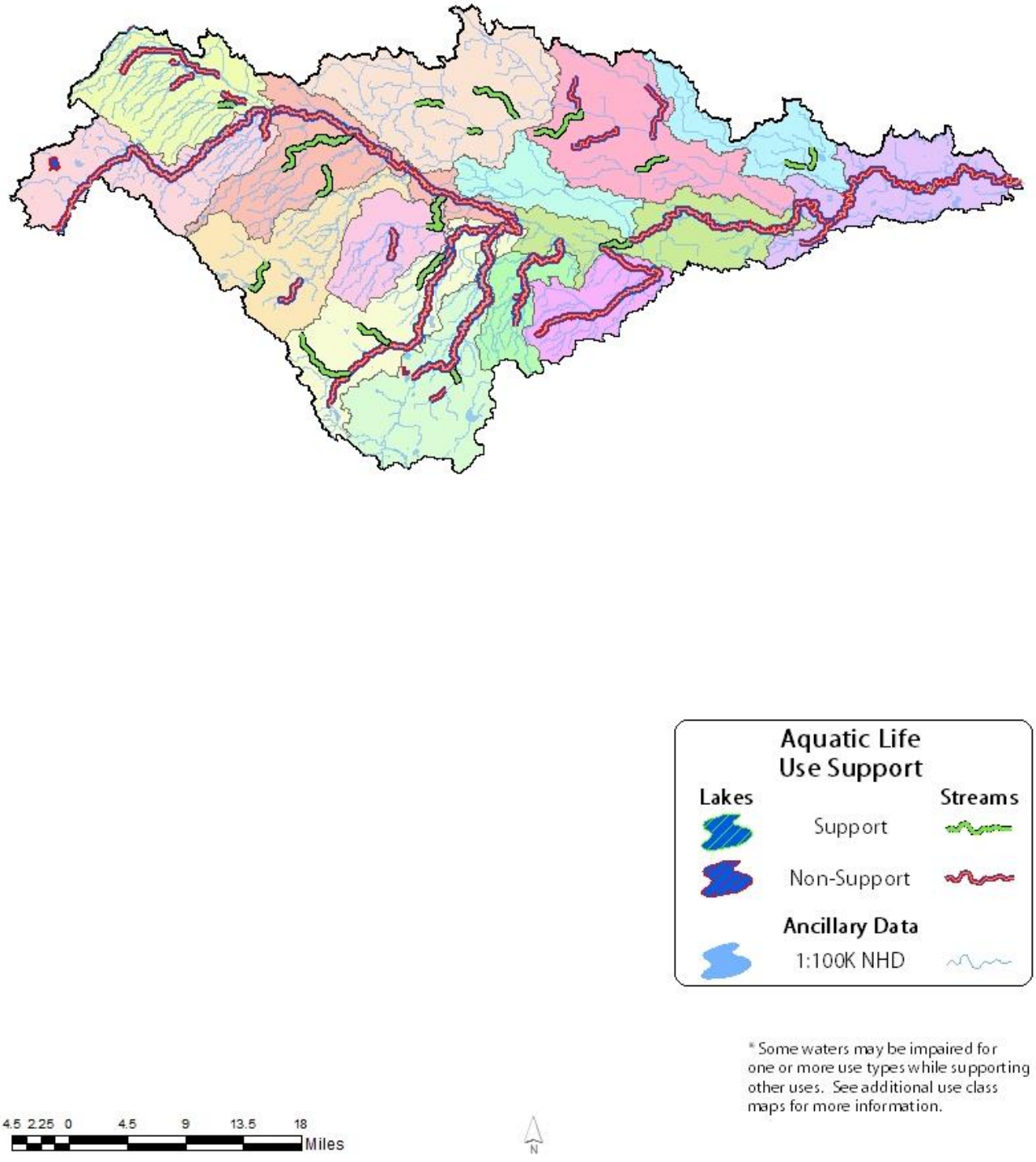
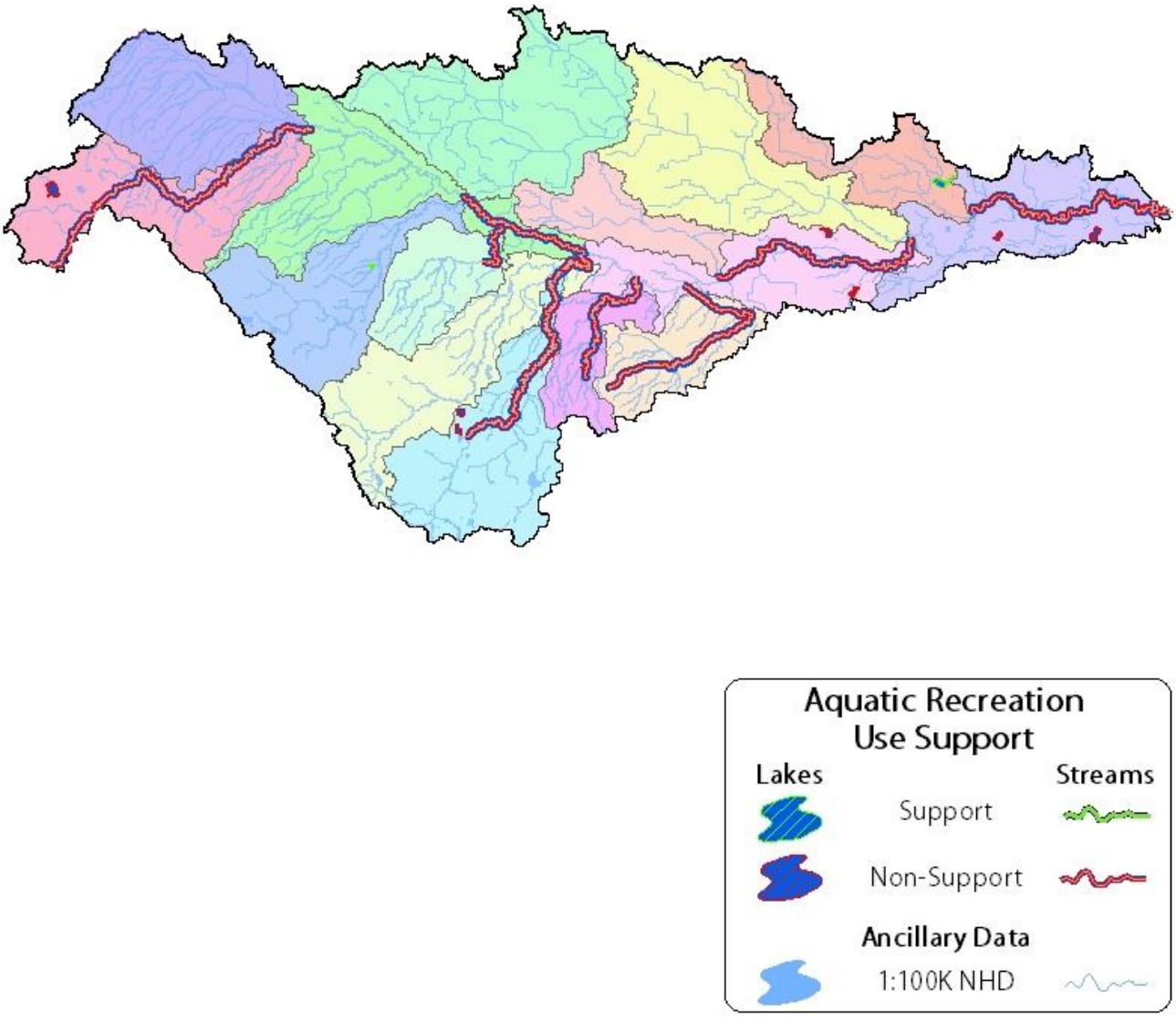


Figure 42. Aquatic recreation use support in the Cottonwood River watershed.



Transparency trends for the Cottonwood River watershed

The MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state and also incorporates any agency and partner data submitted to EQuIS.

The trends are calculated using a Seasonal Kendall statistical test for waters with a minimum of eight years of transparency data; Secchi disk measurements in lakes and Secchi Tube measurements in streams.

Citizen volunteers monitor one stream site and three lakes in the Cottonwood River watershed. The majority of waterbodies had insufficient data for trend analysis. Of those that had enough data, two stream sites have increasing clarity and five have decreasing clarity. The majority of lakes and streams in the watershed had insufficient data to determine a change in transparency.

Table 33. Water Clarity Trends.

Cottonwood HUC 07020008	Streams	Lakes
Number of sites w/increasing trend	2	0
Number of sites w/decreasing trend	5	0
Number of sites w/no trend	2	1

In June 2014, the MPCA published its final trend analysis of river monitoring data located statewide based on the historical Milestones Network. The network is a collection of 80 monitoring locations on rivers and streams across the state with good, long-term water quality data. The period of record is generally more than 30 years, through 2010, with monitoring at some sites going back to the 1950s. While the network of sites is not necessarily representative of Minnesota's rivers and streams as a whole, they do provide a valuable and widespread historical record for many of the state's waters. Starting in 2017, the MPCA will be switching to the Pollutant Load Monitoring Network for long-term trend analysis on rivers and streams. Data from this program has much more robust sampling and will cover over 100 sites across the state.

Priority Waters for Protection and Restoration in the Cottonwood River watershed.

The MPCA, DNR, and BWSR have developed methods to help identify waters that are high priority for protection and restoration activities. Protecting lakes and streams from degradation requires consideration of how human activities impact the lands draining to the water. In addition, helping to determine the risk for degradation allows for prioritization to occur; so limited resources can be directed to waters that would benefit most from implementation efforts.

The results of the analysis are provided to watershed project teams for use during WRAPS and One Watershed One Plan or other local water plan development. The results of the analysis are considered a preliminary sorting of possible protection priorities and should be followed by a discussion and evaluation with other resource agencies, project partners and stakeholders. Other factors that are typically considered during the protection prioritization process include: whether a water has an active lake or river association, is publically accessible, presence of wild rice, presence of invasive, rare or endangered species, as well as land use information and/or threats from proposed development. Opportunities to gain or enhance multiple natural resource benefits ("benefit stacking") is another consideration during the final protection analysis. Waterbodies identified during the assessment process as vulnerable to impairment are also included in the summary below.

The results for selected indicators and the risk priority ranking for each lake are shown in Appendix 6. Protection priority should be given to lakes that are particularly sensitive to an increase in phosphorus with a documented decline in water quality (measured by Secchi transparency), a comparatively high percentage of developed land use in the area, or monitored phosphorus concentrations close to the water quality standard. In the Cottonwood River watershed, highest protection priority is suggested for two lakes: Hurricane and Round. Sleepy Eye Lake was previously listed as impaired, but will be removed from the impaired waters list. Actions need to occur in order to maintain the improved water condition. The entire Cottonwood River watershed has a high percentage of disturbed land use and shallow, small lakes with high concentrations of phosphorous.

The results for selected indicators and risk priority ranking for each stream are shown in Appendix 7. Stream protection is driven by how close the stream is to having an impaired biological community, density of roads and disturbed land use in the immediate and larger drainage area, and how much land is protected in the watershed. In the Cottonwood River watershed, all of the streams on the protection and prioritization list have been identified as high priority for protection efforts, including seven General Use (Pell Creek and Cottonwood River), streams and 12 Modified Use (Meadow Creek) streams. While these streams currently meet standards, work done to maintain current condition is important to prevent impairment in the future.

Summaries and recommendations

The water quality in the Cottonwood River watershed exhibit typical characteristics of a watershed with extreme anthropological alterations to the land and stream systems. The Cottonwood River watershed is dominated by agricultural land and has extensive drain tiling and ditching, replacing wetlands and natural meandering streams. These alterations inhibit the fish and macroinvertebrate communities in the Cottonwood River watershed which was evident in the samples collected during the monitoring process.

The landscape in the Cottonwood River watershed went from prairies and wetlands to cropland and ranchland. It is estimated that 84% of the landuse in the Cottonwood River watershed is cropland and farmland. In order to make the land more productive, wetlands were drained, prairies were replaced with cropland, drainage tiles were installed and ditches were created or natural streams were straightened. These drastic anthropological alterations to the natural systems diminishes the surface water storage capacity of the land causing rapid spikes in discharge flow during rain events and abnormally low flows during dry periods. These rapid spikes in discharge flow wreak havoc on streams, eroding stream banks, destroying habitat for aquatic life and increasing levels of suspended solids in the water column. The increased levels of suspended solids in the water column is a common issue in the Minnesota River Basin and a majority of the watersheds have impairments for suspended solids (TSS or Turbidity) and the Cottonwood River watershed is no exception. The data collected from the IWM monitoring program supports this fact as previous reaches impaired for suspended solids will remain listed. There were also three new reaches listed as impaired for suspended solids. The installation of best management practices can improve water quality by filtering out sediment and reducing the severity of floods. Increasing upland surface water storage capacity reduces the intensity of high flow events reducing bank erosion, channel incision, sediment loading and increasing bank stability. The installation of stream buffers act as natural filters reducing the amount of sediment and excess nutrients entering streams from runoff. The Cottonwood River watershed also has elevated levels of phosphorus concentrations which is similar to other watersheds in the Minnesota River basin. Abnormally high levels of phosphorus can lead to severe fluctuations in dissolved oxygen levels, unsustainable biological use of oxygen, and an increase of aquatic vegetation limiting habitat for other aquatic organisms. In order to reduce these high levels of sediment and phosphorus, restoration projects within the Minnesota Basin must continue. It is vital that water management groups continue conservation efforts as a team and have a singular goal of improving the Minnesota River Basin to reduce sediment and excess nutrient levels in streams.

As a whole, scores of biological communities in this watershed had a combination of good to poor: 19 reaches were determined to fully support aquatic life and 37 were determined impaired for both fish and macroinvertebrate. Of the reaches determined to fully support aquatic life 12 of them were on modified use streams which holds streams to lower standards for biological health than general use. Of the reaches determined impaired, 13 were on modified streams. These impairments reflect the habitat scores. The majority of stations scored poor or fair with only 8% scoring good.

Fish assemblages were collected at 59 stream reaches totaling 81 stations within the Cottonwood River watershed. Of those reaches, 13 failed to meet the aquatic life standards for fish and are listed as impaired with 9 of those as new listings. Macroinvertebrate communities scored far worse than the fish communities.

There was a total of 62 species of fish captured in the Cottonwood River watershed. The most prevalent species, both in number of stations present and individual number of fish caught, were tolerant species that can survive in poor water quality and degraded habitat. One exotic species (Common Carp) was found at 33 stations with a total of 204 individuals. Common Carp are very tolerant species and can thrive in polluted streams. They also cause damage to streams by rooting along the bottom of streams,

dislodging aquatic vegetation and increasing turbidity. Sensitive species were present but in low numbers, approximately 9% of the totally individuals sampled were sensitive.

Macroinvertebrate communities had 26 new impairments and no existing impairments. Of those impaired reaches, 10 are on modified use streams and 16 are on general use streams. This is a significant amount of new impairments but there were only 12 repeat stations (sampled in 2007) and 64 new stations (sampled in 2017) due this increase in stations sampled it is difficult to make a direct comparison between the visit years. It is clear that the macroinvertebrate community in the watershed is negatively affected by the environmental alterations made by humans.

Bacteria impairments persist in the watershed. High bacteria concentrations were found across the summer months resulting in the *E. coli* impairments or confirmation of existing fecal coliform impairments. A possible contributor to the bacteria impairments is the presence of livestock access to the streams. Another cause for elevated bacteria could be from wildlife such as waterfowl and nesting birds. For example, where bridges cross the streams, cliff swallows can congregate and nest in high numbers early in the summer – their leavings can drastically increase bacteria concentrations.

While the Cottonwood River watershed has few lakes, actions to protect those that are in good condition are critical. Sleepy Eye Lake, through dredging activities, was returned to supporting recreation. Reducing nutrient inputs to the system will be necessary to maintain the improved condition.

Some examples of that could assist in the recovery and protection of streams and lakes throughout the watershed consist of:

- Establishment and reintroduction of riparian zones and shorelines using native vegetation, trees, and shrubs
- Protect any current riparian buffer zones, shorelines, and exceptional aquatic habitats
- Institute best management practices to improve reaches with sedimentation and erosion issues and to prevent additional sedimentation
- Restrict livestock access to streams

Groundwater protection should be considered both for quantity and quality. Concerns for quality are possible high levels of naturally-occurring elements like arsenic in drinking water as well as chloride and nitrate from human activities. The concerns for quantity are based on comparing the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater and surface water withdrawals have both increased significantly. Groundwater levels do not appear to have changed significantly in monitored locations across the watershed. Continued mindfulness of water users and additional monitoring of groundwater quantity will provide the information needed to conserve the resource in the watershed. Historical monitoring in the watershed had identified significant water quality issues before monitoring efforts in 2017 and 2018. During this assessment effort, it became obvious past issues related to excess suspended solids, bacteria, and nutrients remain a significant hurdle to improve water quality for aquatic life and recreation. Sediment loads carried by many of the Minnesota River basin tributaries on a consistent basis are not typical of good water quality, drastically impacting natural hydrology and function of aquatic communities.

The Cottonwood River watershed has experienced extreme landscape and hydrological changes that have had significant impacts on the health of the water resources in the watershed. The loss of wetlands, the installation of drain tile, straightening of streams, and the loss of native plants to cropland are major anthropological changes impeding the natural hydrological system. Continued restoration efforts need to be made in order to improve and protect this watershed's resources. Encouraging conservation efforts such as preserving stream buffers, using conservation tilling, planting cover crops and improving riparian corridors are important methods that can be used to protect the overall health

of the watershed. These best management practices may be even more important in the coming years due climate change causing an increase in severity and frequency of floods. Best management practices also reduce the amount of nutrient reaching the streams, another key factor in improving the water resources in the watershed. If the watershed health is to improve, there needs to be collaboration and understanding between all parties involved with conservation and restoration efforts.

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Appendix 1 – Water chemistry definitions

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

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

Nitrate plus Nitrite – Nitrogen - Nitrate and nitrite-nitrogen are in organic 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 wastewater treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

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

Total Kjeldahl 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.

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

Appendix 2.1 – Intensive watershed monitoring water chemistry stations in the Cottonwood River Watershed.

EQuIS ID	Biological station ID	WID	Waterbody name	Location	Aggregated 12-digit HUC
S001-913	17MN145	07020008-603	Plum Creek	At CSAH 10 Br, 4.75 mi. NE of Walnut Grove	0702000803-01
S001-914	17MN149	07020008-524	Lone Tree Creek	At CR 5, 5 mi. N of Walnut Grove	0702000804-01
S001-915	17MN130	07020008-517	Dutch Charley Creek	At CSAH 15 Br, 2 mi. SE of Lamberton	0702000805-01
S001-917	17MN163	07020008-601	Meadow Creek	At CSAH 11 Br, 8 mi. N of Tracy	0702000802-01
S001-918	12MN003	07020008-501	Cottonwood River	At Cottonwood St., .5 mi. S of New Ulm	0702000808-01
S001-919	03MN032	07020008-599	Sleepy Eye Creek	At CSAH 8 Bridge, 2.2 Mi N of Leavenworth	0702000807-01
S001-920	17MN105	07020008-508	Cottonwood River	At CSAH 8 Br, 0.5 mi. N of Leavenworth	0702000806-01
S002-247	17MN181	07020008-504	Cottonwood River	At US HWY 14, 2 mi. E of Lamberton	0702000804-01
S005-690	17MN112	07020008-521	Mound Creek	Mound CK at CSAH-2, 5 MI SW of Springfield	0702000806-03
S009-438	03MN031	07020008-511	Judicial Ditch No. 30	At 260th Ave., 1 mi. SE of Sleepy Eye	0702000808-02
S009-439	17MN109	07020008-604	Coal Mine Creek	At 180th St. W, 2 mi. SW of Springfield	0702000806-02
S009-440	04MN042	07020008-502	Cottonwood River	At CR 11, 4 mi. NE of Amiret	0702000801-01
S009-441	17MN119	07020008-598	Sleepy Eye Creek	At Laser Ave., 4 mi. NE of Wanda	0702000807-02
S009-442	17MN127	07020008-520	Dry Creek	At CR 41/ 100th St., 1 mi. SW of Sanborn	0702000806-04
S009-443	17MN131	07020008-519	Highwater Creek	At Twp. Rd. 98, 1 mi. SE of Lamberton	0702000805-02
S009-444	17MN140	07020008-523	Pell Creek	At Twp. Rd. 142, 4 mi. NW of Lamberton	0702000804-02

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Cottonwood River watershed

WID 07020008	Biological Station ID	Waterbody name	Biological Station Location	County	Subwatershed
-501	12MN003	Cottonwood River	Downstream of Cottonwood St, 0.5 mi. S of New Ulm	Brown	Lower Cottonwood River
-501	17MN103	Cottonwood River	Downstream of CSAH 11, 5.5 mi. E of Sleepy Eye	Brown	Lower Cottonwood River
-501	17MN179	Cottonwood River	Downstream of CSAH 10, 2 mi. SE of Sleepy Eye	Brown	Lower Cottonwood River
-502	01MN042	Cottonwood River	Upstream of CR 11, 7 mi. N of Tracy	Lyon	Headwaters Cottonwood River
-502	17MN160	Cottonwood River	Upstream of CR 220th Ave, 3 NE of Balaton	Lyon	Headwaters Cottonwood River
-502	17MN162	Cottonwood River	Downstream of US Hwy 14, 1 mi. W of Balaton	Lyon	Headwaters Cottonwood River
-502	17MN190	Cottonwood River	Upstream of CR 230th Ave, 4 NE of Balaton	Lyon	Headwaters Cottonwood River
-503	17MN156	Cottonwood River	Upstream of CR 4, 7 mi. N of Walnut Grove	Redwood	Upper Cottonwood River
-504	17MN144	Cottonwood River	Upstream of Frontier Ave, 4 mi. NW of Revere	Redwood	Upper Cottonwood River
-504	17MN181	Cottonwood River	Upstream of US Hwy 14, 2 mi. E of Lamberton	Redwood	Upper Cottonwood River
-507	17MN110	Cottonwood River	Upstream of CR 2, 4 mi. E of Sanborn	Brown	Middle Cottonwood River
-508	17MN105	Cottonwood River	Downtream of CR 8, 4.5 mi. SE of Cobden	Brown	Middle Cottonwood River
-509	90MN069	Cottonwood River	Upstream of CR 78, 4 mi. S of Sleepy Eye	Brown	Lower Cottonwood River
-511	03MN031	Judicial Ditch 30	Upstream of 260th Ave, 1 mi. SE of Sleepy Eye	Brown	Judicial Ditch 30
-513	17MN120	Unnamed Ditch	Upstream of Knox Ave, 3.5 mi. NE of Wanda	Redwood	Upper Sleepy Eye Creek
-513	17MN121	Unnamed Ditch	Upstream of Jade Ave, 1 mi. NE of Wabasso	Redwood	Upper Sleepy Eye Creek
-517	17MN130	Dutch Charley Creek	Downstream of CR 15, 1.5 mi. E of Lamberton	Redwood	Dutch Charlie Creek
-518	03MN035	Dutch Charley Creek	Upstream of 131st St, 2 mi. W of Westbrook	Murray	Dutch Charlie Creek
-518	17MN136	Dutch Charley Creek	Upstream of 210th St, 3.5 mi. SW of Lamberton	Cottonwood	Dutch Charlie Creek
WID 07020008	**Biological Station ID**	**Waterbody name**	**Biological Station Location**	**County**	**Subwatershed**

-518	17MN138	Dutch Charley Creek	Downstream of 280th St, 2.5 mi. N of Westbrook	Cottonwood	Dutch Charlie Creek
-519	17MN131	Highwater Creek	Upstream of Twp Rd 98, 1 mi. SE of Lamberton	Cottonwood	Highwater Creek
-519	17MN133	Highwater Creek	Downstream of CR 53, 2 mi. N of Storden	Cottonwood	Highwater Creek
-519	17MN182	Highwater Creek	Upstream of CR 10, 4 mi. NW of Jeffers	Cottonwood	Highwater Creek
-520	17MN127	Dry Creek	Upstream of CR 41 (100th St.), 1 mi. SW of Sanborn	Cottonwood	Dry Creek
-520	17MN129	Dry Creek	Upstream of 240th St, 5 mi. SW of Sanborn	Cottonwood	Dry Creek
-521	17MN111	Mound Creek	Upstream of 450th Ave, 6 mi. SE of Sanborn	Brown	Mound Creek
-521	17MN112	Mound Creek	Upstream of CR 2, 4 mi. SE of Sanborn	Brown	Mound Creek
-523	17MN140	Pell Creek	Upstream of CR 50 (120th St), 1.5 mi. E of Revere	Redwood	Pell Creek
-524	17MN149	Lone Tree Creek	Downstream of CR 5, 5 mi. N of Walnut Grove	Redwood	Upper Cottonwood River
-524	17MN150	Lone Tree Creek	Upstream of 160th St, 4 mi. NW of Walnut Grove	Redwood	Upper Cottonwood River
-527	17MN132	County Ditch 38	Downstream of MN Hwy 30, 1 mi. NE of Storden	Cottonwood	Highwater Creek
-529	01MN006	Trib. to Dutch Charley Creek	Downstream of CR 62, ~4.5 mi. SW of Lamberton	Cottonwood	Dutch Charlie Creek
-536	17MN143	Pell Creek	Downstream of CR 10, 2.5 mi. E of Walnut Grove	Redwood	Pell Creek
-537	17MN176	County Ditch 38	Upstream of MN Hwy 30, 0.5 mi. E of Storden	Cottonwood	Highwater Creek
-543	91MN068	County Ditch 54	Downstream of 210th St, 2.5 mi. N of Wanda	Redwood	Upper Sleepy Eye Creek
-545	17MN141	Trib. to Pell Creek	Downstream of 110th St, 3 mi. E of Walnut Grove	Redwood	Pell Creek
-548	17MN154	Judicial Ditch 9	Upstream of Crown Ave, 6 mi. NE of Tracy	Redwood	Upper Cottonwood River
-550	17MN114	County Ditch 24	Downstream of CR 4, 3.5 mi. SE of Clements	Redwood	Lower Sleepy Eye Creek
-551	17MN147	Willow Creek	Upstream of 201st St, 5.5 mi. SW of Walnut Grove	Murray	Plum Creek
-555	17MN157	Trib. to Cottonwood River	Upstream of 190th St, 4 mi. E of Amiret	Lyon	Headwaters Cottonwood River
-557	17MN116	County Ditch 38	Downstream of CR 63 (Nature Ave), 1 mi. W of Sundown Twp.	Redwood	Lower Sleepy Eye Creek
-561	17MN117	County Ditch 68	Downstream of Hwy 71, 3.5 mi. NE of Wanda	Redwood	Lower Sleepy Eye Creek
WID 07020008	**Biological Station ID**	**Waterbody name**	**Biological Station Location**	**County**	**Subwatershed**

-563	17MN104	Trib. to Cottonwood River	Upstream of Hwy 4, 4.5 mi. S of Sleepy Eye	Brown	Lower Cottonwood River
-564	17MN108	County Ditch 60	Adjacent to CR 27, 3 mi. W of Sleepy Eye	Brown	Judicial Ditch 30
-565	17MN106	County Ditch 5	Upstream of CR 27, 1 mi. W of Sleepy Eye	Brown	Judicial Ditch 30
-568	17MN167	County Ditch 44	Downstream of 240th St, 5.5 mi. SE of Marshall	Lyon	Meadow Creek
-569	17MN171	Unnamed Ditch to Meadow Creek	Upstream of CR 9, 4 mi. SE of Marshall	Lyon	Meadow Creek
-573	17MN170	Unnamed Ditch	Upstream of US Hwy 59, 2.5 mi. S of Marshall	Lyon	Meadow Creek
-574	17MN169	Trib. to Meadow Creek	Upstream of 220th St, 4 mi. SE of Marshall	Lyon	Meadow Creek
-576	17MN164	Trib. to Meadow Creek	Downstream of CR 78 (320th Ave), 6.5 mi. SE of Marshall	Lyon	Meadow Creek
-578	17MN166	Trib. to Meadow Creek	Upstream of 310th Ave, 6.5 mi. SE of Marshall	Lyon	Meadow Creek
-581	17MN158	Trib. to Cottonwood River	Upstream of 190th St, 4 mi.E of Amiret	Lyon	Headwaters Cottonwood River
-584	17MN151	Trib. to Lone Tree Creek	Downstream of 150th St, 3 mi. N of Walnut Grove	Redwood	Upper Cottonwood River
-586	17MN148	Trib. to Plum Creek	Downstream of 230th Ave, 4.5 mi. S of Tracy	Murray	Plum Creek
-587	17MN134	Trib. to Unnamed Creek	Upstream of CSAH 11, 5 mi. S of Revere	Cottonwood	Dutch Charlie Creek
-588	17MN137	Judicial Ditch 3	Downstream of 270th St, 3.5 mi. N of Westbrook	Cottonwood	Dutch Charlie Creek
-589	17MN139	County Ditch 19	Upstream of 141st St, 2.5 mi. W of Westbrook	Murray	Dutch Charlie Creek
-590	17MN128	Trib. to Dry Creek	Upstream of CSAH 4, 5 mi. SW of Sanborn	Cottonwood	Dry Creek
-591	17MN135	Trib. to Dutch Charlie Creek	Downstream of CSAH 6, 1.5 mi. S of Lamberton	Redwood	Dutch Charlie Creek
-592	17MN142	Trib. to Pell Creek	Downstream of CR 10, 2.5 mi. E of Walnut Grove	Redwood	Pell Creek
-593	17MN172	Trib. to Meadow Creek	Downstream of CR 7, 2 mi. S of Marshall	Lyon	Meadow Creek
-594	17MN122	Trib. to Sleepy Eye Creek	Downstream of Hunter Ave, 4 mi. W of Wanda	Redwood	Upper Sleepy Eye Creek
WID 07020008	**Biological Station ID**	**Waterbody name**	**Biological Station Location**	**County**	**Subwatershed**
-595	17MN124	Trib. to Sleepy Eye Creek	Downstream of CR 7 (Garden Ave), 4 mi. SE of Lucan	Redwood	Upper Sleepy Eye Creek

-596	17MN113	Judicial Ditch 35	Upstream of 170th St, 3.5 mi. N of Springfield	Redwood	Lower Sleepy Eye Creek
-597	17MN118	County Ditch 26	Upstream of 220th St, 3.5 mi. W of Clements	Redwood	Lower Sleepy Eye Creek
-598	17MN115	Sleepey Eye Creek	Downstream of CR 1, 3 mi. S of Clements	Redwood	Lower Sleepy Eye Creek
-598	17MN119	Sleepy Eye Creek	Upstream of Laser Ave, 4 mi. NE of Wanda	Redwood	Lower Sleepy Eye Creek
-598	17MN123	Sleepy Eye Creek	Adjacent to Grandview Ave, 3.5 mi. SW of Wabasso	Redwood	Upper Sleepy Eye Creek
-598	97MN014	Sleepy Eye Creek	near Springfield, MN	Brown	Lower Sleepy Eye Creek
-599	03MN032	Sleepy Eye Creek	Upstream of CR 8, 2 mi. NW of Leavenworth	Brown	Lower Sleepy Eye Creek
-601	17MN163	Meadow Creek	Upstream of CR 11, 4 mi. NE of Amiret	Lyon	Meadow Creek
-602	07MN085	Judicial Ditch 20A	Upstream of CR 22, 4 mi. S of Tracy	Murray	Plum Creek
-603	17MN145	Plum Creek	Upstream of CR 10, 3.5 mi. NE of Walnut Grove	Redwood	Plum Creek
-603	90MN062	Plum Creek	Downstream of CR 78, in Plum Creek Cty Park, 1 mi. SW of Walnut Grove	Redwood	Plum Creek
-604	17MN109	Coal Mine Creek	Upstream of 180th St W, 2 mi. SW of Springfield	Brown	Coal Mine Creek
-604	17MN126	Coal Mine Creek	Downstream of Laser Ave, 4 mi. N of Sanborn	Redwood	Coal Mine Creek
-606	91MN065	Trib. to Mound Creek	Downstream of 460th Ave, 5 mi. S of Sanborn	Brown	Mound Creek
-609	17MN107	Judicial Ditch 30	Upstream of CR 27, 1.5 mi. W of Sleepy Eye	Brown	Judicial Ditch 30
-613	17MN168	Trib. to Meadow Creek	Downstream of 220th St, 3 mi. N of Amiret	Lyon	Meadow Creek
-615	17MN165	Trib. to Meadow Creek	Downstream of 200th St, 2 mi. NE of Amiret	Lyon	Meadow Creek
-617	17MN155	Judicial Ditch 22	Upstream of CR 4, 7 mi. E of Amiret	Redwood	Upper Cottonwood River
-619	17MN159	Trib. to Cottonwood River	Upstream of 170th St, 4 mi. NE of Balaton	Lyon	Headwaters Cottonwood River
-621	17MN161	Trib. to Cottonwood River	Upstream of 140th St, 1 mi. NW of Balaton	Lyon	Headwaters Cottonwood River
-623	17MN146	Trib. to Plum Creek	Upstream of Crown Ave, 2 mi. N of Walnut Grove	Redwood	Plum Creek

Appendix 3.1 – 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	71	49	NA	±11
2	Southern Streams	2B	66	50	35	±9
3	Southern Headwaters	2B	74	55	33	±7
10	Southern Coldwater	2A	82	50	NA	±9
4	Northern Rivers	2B	67	38	NA	±9
5	Northern Streams	2B	61	47	35	±9
6	Northern Headwaters	2B	68	42	23	±16
7	Low Gradient	2B	70	42	15	±10
11	Northern Coldwater	2A	60	35	NA	±10
Invertebrates						
1	Northern Forest Rivers	2B	77	49	NA	±10.8
2	Prairie Forest Rivers	2B	63	31	NA	±10.8
3	Northern Forest Streams RR	2B	82	53	NA	±12.6
4	Northern Forest Streams GP	2B	76	51	37	±13.6
5	Southern Streams RR	2B	62	37	24	±12.6
6	Southern Forest Streams GP	2B	66	43	30	±13.6
7	Prairie Streams GP	2B	69	41	22	±13.6
8	Northern Coldwater	2A	52	32	NA	±12.4
9	Southern Coldwater	2A	72	43	NA	±13.8

Appendix 3.2 – Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
Headwaters Cottonwood River							
07020008-502	17MN162	Cottonwood River	6.78	3	Southern Headwaters	55	26-Jul-17
07020008-581	17MN158	Trib. to Cottonwood River	15.30	3	Southern Headwaters	55	09-Aug-17
07020008-619	17MN159	Trib. to Cottonwood River	10.29	3	Southern Headwaters	55	09-Aug-17
07020008-502	17MN160	Cottonwood River	28.33	3	Southern Headwaters	55	15-Aug-17
07020008-621	17MN161	Trib. to Cottonwood River	17.61	3	Southern Headwaters	55	15-Aug-17
07020008-502	14MN150	Cottonwood River	67.00	2	Southern Streams	50	10-Sep-14
07020008-502	14MN150	Cottonwood River	67.00	2	Southern Streams	50	29-Jun-16
07020008-502	14MN150	Cottonwood River	67.00	2	Southern Streams	50	26-Sep-17
07020008-502	17MN160	Cottonwood River	28.33	3	Southern Headwaters	55	26-Jul-17
07020008-502	01MN042	Cottonwood River	77.62	2	Southern Streams	50	26-Jul-17
Meadow Creek							
07020008-615	17MN165	Trib. to Meadow Creek	4.43	3	Southern Headwaters	33	15-Aug-17
07020008-601	17MN163	Meadow Creek	97.52	2	Southern Streams	35	27-Jun-17
07020008-601	17MN163	Meadow Creek	97.52	2	Southern Streams	35	27-Jul-17
07020008-615	17MN165	Trib. to Meadow Creek	4.43	3	Southern Headwaters	33	20-Jul-17
07020008-578	17MN166	Trib. to Meadow Creek	11.20	3	Southern Headwaters	55	18-Jul-17
07020008-578	17MN166	Trib. to Meadow Creek	11.20	3	Southern Headwaters	55	25-Jul-17
07020008-574	17MN169	Trib. to Meadow Creek	7.16	3	Southern Headwaters	55	09-Aug-17
07020008-569	17MN171	Unnamed Ditch to Meadow Creek	26.30	7	Low Gradient	15	27-Jun-17
07020008-593	17MN172	Trib. to Meadow Creek	8.67	3	Southern Headwaters	55	18-Jul-17
07020008-593	17MN172	Trib. to Meadow Creek	8.67	3	Southern Headwaters	55	25-Jul-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07020008-576	17MN164	Trib. to Meadow Creek	4.71	3	Southern Headwaters	33	20-Jul-17
Plum Creek							
07020008-623	17MN146	Trib. to Plum Creek	9.53	3	Southern Headwaters	33	19-Jul-17
07020008-603	17MN145	Plum Creek	87.34	2	Southern Streams	50	20-Sep-17
07020008-551	17MN147	Willow Creek	12.81	3	Southern Headwaters	55	18-Jul-17
07020008-602	07MN085	Judicial Ditch 20A	17.28	3	Southern Headwaters	33	27-Jul-17
07020008-586	17MN148	Trib. to Plum Creek	7.93	3	Southern Headwaters	33	16-Aug-17
07020008-602	07MN085	Judicial Ditch 20A	17.28	3	Southern Headwaters	33	15-Aug-17
07020008-603	90MN062	Plum Creek	60.67	2	Southern Streams	50	27-Jun-17
07020008-586	17MN148	Trib. to Plum Creek	7.93	3	Southern Headwaters	33	19-Jul-17
07020008-623	17MN146	Trib. to Plum Creek	9.53	3	Southern Headwaters	33	19-Jul-17
07020008-603	17MN145	Plum Creek	87.34	2	Southern Streams	50	20-Sep-17
07020008-551	17MN147	Willow Creek	12.81	3	Southern Headwaters	55	18-Jul-17
Upper Cottonwood River							
07020008-584	17MN151	Trib. to Lone Tree Creek	8.33	3	Southern Headwaters	33	19-Jul-17
07020008-504	17MN144	Cottonwood River	377.63	1	Southern Rivers	49	25-Jul-17
07020008-617	17MN155	Judicial Ditch 22	12.62	3	Southern Headwaters	55	25-Jul-17
07020008-503	17MN156	Cottonwood River	220.11	2	Southern Streams	50	11-Jul-17
07020008-548	17MN154	Judicial Ditch 9	14.81	3	Southern Headwaters	55	09-Aug-17
07020008-504	10EM094	Cottonwood River	446.61	1	Southern Rivers	49	16-Aug-10
07020008-504	17MN181	Cottonwood River	443.82	1	Southern Rivers	49	09-Aug-17
07020008-584	17MN151	Trib. to Lone Tree Creek	8.33	3	Southern Headwaters	33	19-Jul-17
07020008-504	17MN144	Cottonwood River	377.63	1	Southern Rivers	49	25-Jul-17
Pell Creek							
07020008-592	17MN142	Trib. to Pell Creek	6.02	3	Southern Headwaters	55	17-Jul-17
07020008-545	17MN141	Trib. to Pell Creek	10.44	3	Southern Headwaters	55	08-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07020008-523	17MN140	Pell Creek	47.44	2	Southern Streams	50	29-Jun-17
Dutch Charlie Creek							
07020008-517	17MN130	Dutch Charley Creek	206.74	2	Southern Streams	50	10-Jul-17
07020008-587	17MN134	Trib. to Unnamed Creek	10.91	3	Southern Headwaters	55	19-Jul-17
07020008-529	01MN006	Trib. to Dutch Charley Creek	16.91	3	Southern Headwaters	55	10-Aug-17
07020008-518	03MN035	Dutch Charley Creek	7.42	3	Southern Headwaters	55	14-Aug-17
07020008-589	17MN139	County Ditch 19	14.74	3	Southern Headwaters	33	14-Aug-17
07020008-518	17MN138	Dutch Charley Creek	35.70	2	Southern Streams	50	18-Jul-17
07020008-588	17MN137	Judicial Ditch 3	11.23	3	Southern Headwaters	55	18-Jul-17
07020008-518	17MN136	Dutch Charley Creek	65.09	2	Southern Streams	50	28-Jun-17
07020008-591	17MN135	Trib. to Dutch Charlie Creek	7.34	3	Southern Headwaters	55	08-Aug-17
Highwater Creek							
07020008-519	17MN131	Highwater Creek	106.70	2	Southern Streams	50	13-Jul-17
07020008-519	17MN133	Highwater Creek	44.36	2	Southern Streams	50	28-Jun-17
07020008-537	17MN176	County Ditch 38	9.07	7	Low Gradient	15	08-Aug-17
07020008-519	17MN182	Highwater Creek	94.52	2	Southern Streams	50	20-Sep-17
07020008-519	17MN182	Highwater Creek	94.52	2	Southern Streams	50	11-Jul-17
07020008-519	90MN063	Highwater Creek	94.49	2	Southern Streams	50	10-Aug-10
07020008-527	17MN132	County Ditch 38	32.65	2	Southern Streams	50	26-Jul-17
Middle Cottonwood River							
07020008-508	17MN105	Cottonwood River	878.32	1	Southern Rivers	49	08-Aug-17
07020008-507	17MN110	Cottonwood River	776.40	1	Southern Rivers	49	07-Aug-17
Coal Mine Creek							
07020008-604	17MN126	Coal Mine Creek	17.84	7	Low Gradient	15	20-Sep-17
07020008-604	17MN109	Coal Mine Creek	45.82	2	Southern Streams	35	12-Jul-17
Mound Creek							

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07020008-521	17MN112	Mound Creek	52.38	2	Southern Streams	50	12-Jul-17
07020008-521	17MN111	Mound Creek	26.97	7	Low Gradient	42	29-Jun-17
07020008-606	91MN065	Trib. to Mound Creek	12.49	3	Southern Headwaters	33	19-Aug-10
07020008-521	91MN067	Mound Creek	43.62	2	Southern Streams	50	28-Jul-10
07020008-606	91MN065	Trib. to Mound Creek	12.49	3	Southern Headwaters	33	18-Jul-17
Dry Creek							
07020008-520	17MN127	Dry Creek	38.05	2	Southern Streams	50	28-Jun-17
07020008-590	17MN128	Trib. to Dry Creek	8.79	3	Southern Headwaters	55	17-Jul-17
07020008-520	17MN129	Dry Creek	11.62	3	Southern Headwaters	55	17-Jul-17
Lower Sleepy Eye Creek							
07020008-557	10EM007	County Ditch 38	4.64	3	Southern Headwaters	33	05-Aug-15
07020008-561	15EM071	County Ditch 68	6.92	3	Southern Headwaters	33	09-Jun-15
07020008-557	10EM007	County Ditch 38	4.64	3	Southern Headwaters	33	09-Jun-15
07020008-599	03MN032	Sleepy Eye Creek	270.45	2	Southern Streams	50	12-Jul-17
07020008-557	10EM007	County Ditch 38	4.64	3	Southern Headwaters	33	04-Aug-10
07020008-599	03MN032	Sleepy Eye Creek	270.45	2	Southern Streams	50	22-Aug-12
07020008-598	97MN014	Sleepy Eye Creek	248.25	2	Southern Streams	35	11-Jul-17
07020008-596	17MN113	Judicial Ditch 35	18.05	3	Southern Headwaters	33	07-Aug-17
07020008-550	17MN114	County Ditch 24	25.80	3	Southern Headwaters	33	24-Jul-17
07020008-550	17MN114	County Ditch 24	25.80	3	Southern Headwaters	33	15-Aug-17
07020008-598	17MN115	Sleepey Eye Creek	177.54	2	Southern Streams	35	13-Jul-17
07020008-599	03MN032	Sleepy Eye Creek	270.45	2	Southern Streams	50	01-Aug-16
07020008-598	17MN119	Sleepy Eye Creek	144.49	2	Southern Streams	35	26-Jul-17
07020008-557	17MN116	County Ditch 38	7.04	3	Southern Headwaters	33	10-Jul-17
07020008-561	17MN117	County Ditch 68	5.97	3	Southern Headwaters	33	10-Jul-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
Upper Sleepy Creek							
07020008-595	17MN124	Trib. to Sleepy Eye Creek	18.81	3	Southern Headwaters	33	08-Aug-17
07020008-598	17MN123	Sleepy Eye Creek	37.76	2	Southern Streams	35	24-Jul-17
07020008-594	17MN122	Trib. to Sleepy Eye Creek	10.13	3	Southern Headwaters	33	18-Jul-17
07020008-543	91MN068	County Ditch 54	10.47	3	Southern Headwaters	33	10-Aug-17
Lower Cottonwood River							
07020008-501	12MN003	Cottonwood River	1307.63	1	Southern Rivers	49	10-Aug-17
07020008-509	90MN069	Cottonwood River	1183.39	1	Southern Rivers	49	08-Aug-17
07020008-501	12MN003	Cottonwood River	1307.63	1	Southern Rivers	49	22-Aug-12
07020008-501	17MN103	Cottonwood River	1277.34	1	Southern Rivers	49	21-Sep-17
07020008-563	17MN104	Trib. to Cottonwood River	9.37	3	Southern Headwaters	55	09-Aug-17
07020008-563	17MN104	Trib. to Cottonwood River	9.37	3	Southern Headwaters	55	18-Jul-17
07020008-501	12MN003	Cottonwood River	1307.63	1	Southern Rivers	49	25-Sep-17
07020008-501	12MN003	Cottonwood River	1307.63	1	Southern Rivers	49	10-Aug-17
Judicial Ditch 30							
07020008-609	17MN107	Judicial Ditch 30	31.92	2	Southern Streams	35	11-Jul-17
07020008-564	17MN108	County Ditch 60	7.99	3	Southern Headwaters	33	11-Jul-17
07020008-565	17MN106	County Ditch 5	12.76	7	Low Gradient	15	11-Jul-17

Appendix 3.3 – Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
Headwaters Cottonwood River							
07020008-619	17MN159	Trib. to Cottonwood River	10.29	Prairie Streams GP	41	24.95	8/2/2017
07020008-502	17MN190	Cottonwood River	29.64	Prairie Streams GP	41	25.69	8/2/2017
07020008-621	17MN161	Trib. to Cottonwood River	17.61	Southern Streams RR	37	19.73	8/2/2017
07020008-502	01MN042	Cottonwood River	77.62	Prairie Streams GP	41	49.00	8/1/2017
07020008-502	17MN162	Cottonwood River	6.78	Prairie Streams GP	41	34.05	8/2/2017
07020008-502	14MN150	Cottonwood River	67.00	Southern Streams RR	37	34.92	8/5/2014
07020008-502	14MN150	Cottonwood River	67.00	Southern Streams RR	37	42.39	8/2/2016
07020008-502	14MN150	Cottonwood River	67.00	Southern Streams RR	37	29.72	8/2/2017
07020008-581	17MN158	Trib. to Cottonwood River	15.30	Prairie Streams GP	41	34.31	8/1/2017
Meadow Creek							
07020008-615	17MN165	Trib. to Meadow Creek	4.43	Southern Streams RR	24	17.02	8/1/2017
07020008-593	17MN172	Trib. to Meadow Creek	8.67	Southern Streams RR	37	32.01	8/3/2017
07020008-574	17MN169	Trib. to Meadow Creek	7.16	Prairie Streams GP	41	20.63	8/1/2017
07020008-569	17MN171	Unnamed Ditch to Meadow Creek	26.30	Prairie Streams GP	22	12.90	8/1/2017

07020008-601	17MN163	Meadow Creek	97.52	Prairie Streams GP	22	38.54	8/1/2017
National Hydrography Dataset (NHD) Assessment Segment WID	**Biological station ID**	**Stream segment name**	**Drainage area Mi²**	**Invert class**	**Threshold**	**MIBI**	**Visit date**
07020008-613	17MN168	Trib. to Meadow Creek	8.47	Prairie Streams GP	22	9.69	8/1/2017
07020008-573	17MN170	Unnamed Ditch	13.43	Prairie Streams GP	22	15.87	8/3/2017
07020008-578	17MN166	Trib. to Meadow Creek	11.20	Prairie Streams GP	41	42.60	8/1/2017
07020008-576	17MN164	Trib. to Meadow Creek	4.71	Prairie Streams GP	22	5.53	8/1/2017
07020008-573	17MN170	Unnamed Ditch	13.43	Prairie Streams GP	22	10.77	8/3/2017
Plum Creek							
07020008-586	17MN148	Trib. to Plum Creek	7.93	Southern Streams RR	24	20.68	8/2/2017
07020008-551	17MN147	Willow Creek	12.81	Southern Streams RR	37	25.22	8/2/2017
07020008-603	90MN062	Plum Creek	60.67	Southern Streams RR	37	39.45	8/3/2017
07020008-603	90MN062	Plum Creek	60.67	Southern Streams RR	37	39.98	8/3/2017
07020008-602	07MN085	Judicial Ditch 20A	17.28	Prairie Streams GP	22	25.89	8/2/2017
07020008-623	17MN146	Trib. to Plum Creek	9.53	Southern Streams RR	24	29.07	8/3/2017
07020008-603	17MN145	Plum Creek	87.34	Prairie Streams GP	41	52.74	8/8/2017
07020008-586	17MN148	Trib. to Plum Creek	7.93	Southern Streams RR	24	20.68	8/2/2017
Upper Cottonwood River							
07020008-504	10EM094	Cottonwood River	446.61	Prairie Streams GP	41	44.92	8/17/2010

Appendix 4.1 – Fish species found during biological monitoring surveys

Common name	Quantity of stations where present	Quantity of individuals collected
creek chub	77	3307
blacknose dace	70	2178
johnny darter	70	852
white sucker	67	1536
common shiner	65	3928
fathead minnow	65	1407
central stoneroller	55	1379
green sunfish	51	905
bigmouth shiner	50	881
brassy minnow	43	996
bluntnose minnow	40	985
common carp	33	204
sand shiner	33	1693
hornyhead chub	32	805
black bullhead	31	457
blackside darter	30	192
orangespotted sunfish	29	313
brook stickleback	28	335
shorthead redhorse	28	459
spotfin shiner	28	1297
golden redhorse	23	225
northern hogsucker	23	237
tadpole madtom	23	294
banded darter	19	156
rock bass	17	230
stonecat	16	80
Iowa darter	15	215
channel catfish	14	272
silver redhorse	14	64
smallmouth bass	13	140
walleye	12	27
yellow perch	12	35
northern pike	11	18
slenderhead darter	10	110
bluegill	9	53
freshwater drum	9	16
fantail darter	8	476
largemouth bass	8	22
yellow bullhead	8	30
quillback	7	155

Common name	Quantity of stations where present	Quantity of individuals collected
emerald shiner	5	332
Gen: redhorses	5	76
northern redbelly dace	5	29
bigmouth buffalo	4	5
highfin carpsucker	4	4
hybrid sunfish	4	11
black crappie	3	3
flathead catfish	3	11
gizzard shad	3	395
golden shiner	3	8
shortnose gar	3	3
river carpsucker	2	3
smallmouth buffalo	2	3
bullhead minnow	1	3
carmine shiner	1	2
Gen: carpsuckers	1	17
largescale stoneroller	1	1
longnose gar	1	1
mimic shiner	1	13
shoal chub	1	1
shovelnose sturgeon	1	1
silver chub	1	5
white bass	1	5
white crappie	1	1

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Taxonomic name	Quantity of stations where present	Quantity of individuals Collected
Thienemannimyia Gr.	79	713
Polypedilum	78	2553
Oligochaeta	74	787
Physella	72	3115
Acari	66	357
Hydroptila	66	637
Hyalella	63	2575
Cheumatopsyche	59	1513
Caenis diminuta	55	1192
Cricotopus	54	357
Orconectes	54	89
Paratanytarsus	52	781
Dicrotendipes	51	638

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Rheotanytarsus	50	394
Ablabesmyia	48	174
Dubiraphia	48	912
Labrundinia	47	305
Tanytarsus	47	159
Hemerodromia	43	209
Brillia	40	210
Nectopsyche diarina	40	282
Stenelmis	39	406
Coenagrionidae	38	755
Tricorythodes	38	1346
Ceratopsyche morosa	37	960
Simulium	35	434
Pisidiidae	34	81
Baetis intercalaris	33	609
Micropsectra	33	403
Rheocricotopus	33	131
Phaenopsectra	32	116
Heptagenia	31	145
Chironomini	29	43
Tanypodinae	29	67
Fallceon	28	476
Hydropsychidae	28	398
Cryptochironomus	27	42
Thienemanniella	27	58
Empididae	25	50
Hirudinea	25	105
Procladius	25	43
Chironomus	24	204
Ephydridae	23	56
Hydroptilidae	23	118
Paratendipes	23	133
Tanytarsini	23	52
Macronychus glabratus	22	246
Neoplasta	22	84
Parakiefferiella	22	82
Atherix	21	136
Ferrissia	21	200
Orthocladiinae	21	34
Belostoma flumineum	20	24
Maccaffertium	20	144
Orthocladius	20	46
Aeshna	19	41

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Hydropsyche	19	216
Hydropsyche betteni	19	292
Limnophyes	19	50
Pteronarcys	19	50
Zavrelimyia	19	74
Calopterygidae	18	64
Calopteryx	18	71
Nanocladius	18	28
Stenochironomus	18	36
Tvetenia	18	62
Ceratopsyche	17	265
Corynoneura	17	30
Lymnaeidae	17	42
Haliplus	15	29
Isonychia	14	28
Stenacron	14	68
Aeshnidae	13	25
Baetis longipalpus	13	103
Ceratopsyche bronta	13	94
Corixidae	13	57
Mesovelia	13	22
Baetis brunneicolor	12	95
Neoplea striola	12	15
Baetis	11	96
Baetis flavistriga	11	67
Callibaetis	11	47
Helichus	11	17
Hydropsyche simulans	11	137
Leptoceridae	11	12
Optioservus	11	38
Acroneuria	10	17
Glyptotendipes	10	27
Nemata	10	99
Tipula	10	22
Acentrella parvula	9	30
Conchapelopia	9	10
Endochironomus	9	40
Labiobaetis frondalis	9	14
Parametriocnemus	9	17
Plauditus	9	52
Trichocorixa	9	26
Thienemannimyia	8	38
Cambaridae	7	8

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ceratopogoninae	7	14
Cryptotendipes	7	8
Culicidae	7	11
Hetaerina	7	26
Labiobaetis dardanus	7	27
Mayatrichia ayama	7	20
Nectopsyche candida	7	50

Appendix 5 – Minnesota Stream Habitat Assessment results

Habitat information documented during each fish sampling visit is provided. This table 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.

# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
2	17MN109	Coal Mine Creek	0.00	4.50	6.00	9.50	12.00	32.00	Poor
2	17MN126	Coal Mine Creek	0.00	7.75	6.00	5.50	7.50	26.75	Poor
Average Habitat Results: Coal Mine Creek			**0**	**6.13**	**6.00**	**7.50**	**9.75**	**29.38**	**Poor**
2	17MN127	Dry Creek	1.25	9.00	18.82	9.50	18.00	56.58	Fair
2	17MN128	Dry Creek	0.00	6.75	16.03	13.00	18.00	53.77	Fair
2	17MN129	Dry Creek	1.25	11.50	7.15	9.00	17.50	46.40	Fair
Average Habitat Results: Dry Creek			**0.83**	**9.08**	**14.00**	**10.50**	**17.83**	**52.25**	Fair
2	01MN006	Dutch Charlie Creek	0.00	10.50	14.65	6.00	14.00	45.15	Fair
2	03MN035	Dutch Charlie Creek	0.00	11.75	10.10	10.50	17.50	49.85	Fair
2	17MN130	Dutch Charlie Creek	0.00	7.50	15.90	7.50	10.00	40.90	Poor
2	17MN134	Dutch Charlie Creek	0.75	11.25	11.30	9.50	18.50	51.30	Fair
2	17MN135	Dutch Charlie Creek	0.00	8.50	13.30	12.00	18.00	51.80	Fair
2	17MN136	Dutch Charlie Creek	0.00	10.25	11.25	8.00	16.00	45.50	Fair
2	17MN137	Dutch Charlie Creek	0.00	9.25	16.90	7.00	13.00	46.15	Fair
2	17MN138	Dutch Charlie Creek	0.00	4.50	15.50	10.50	22.00	52.50	Fair

# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
2	17MN139	Dutch Charlie Creek	0.88	9.50	8.50	9.50	13.50	41.88	Poor
Average Habitat Results: Dutch Charlie Creek			**0.18**	**9.22**	**13.04**	**8.94**	**15.83**	**47.22**	**Fair**
2	01MN042	Headwaters Cottonwood River	0.00	8.50	16.70	10.50	14.50	50.20	Fair
6	14MN150	Headwaters Cottonwood River	2.54	11.50	18.63	13.00	24.50	70.18	Good
1	17MN157	Headwaters Cottonwood River	0.00	9.50	7.00	12.00	5.00	33.50	Poor
2	17MN158	Headwaters Cottonwood River	0.00	2.25	9.10	9.50	10.50	31.35	Poor
# Visists	**Biological Station ID**	**Reach name**	**Land use**	**Riparian**	**Substrate**	**Fish cover**	**Channel morph.**	**MSHA score**	**MSHA rating**
2	17MN159	Headwaters Cottonwood River	0.00	1.50	8.00	3.50	6.00	19.00	Poor
2	17MN160	Headwaters Cottonwood River	1.25	7.25	11.00	5.50	6.00	31.00	Poor
1	17MN161	Headwaters Cottonwood River	2.50	10.50	14.80	13.00	23.00	63.80	Fair
2	17MN162	Headwaters Cottonwood River	0.00	5.00	16.30	12.00	20.50	53.80	Fair
1	17MN190	Headwaters Cottonwood River	2.50	9.50	6.00	8.00	10.00	36.00	Poor
Average Habitat Results: Headwaters Cottonwood River			**0.98**	**7.28**	**11.95**	**9.67**	**13.33**	**43.20**	**Poor**
2	17MN131	Highwater Creek	0.00	7.75	14.15	12.50	19.00	53.40	Fair
2	17MN132	Highwater Creek	1.00	12.00	20.65	14.50	30.50	78.65	Good
2	17MN133	Highwater Creek	1.25	9.75	15.07	10.00	20.50	56.58	Fair
2	17MN176	Highwater Creek	0.00	7.50	6.50	11.50	4.00	29.50	Poor
3	17MN182	Highwater Creek	0.00	10.00	19.93	13.00	20.33	63.27	Fair
1	90MN063	Highwater Creek	0.00	11.00	20.80	13.00	30.00	74.80	Good
Average Habitat Results: Highwater Creek			**0.38**	**9.67**	**16.18**	**12.42**	**20.72**	**59.37**	**Fair**
2	03MN031	Judicial Ditch 30	0.38	8.75	19.57	13.50	14.00	56.20	Fair
2	17MN106	Judicial Ditch 30	1.25	7.00	5.58	5.00	5.50	24.32	Poor
2	17MN107	Judicial Ditch 30	0.00	7.00	12.00	4.50	7.50	31.00	Poor
2	17MN108	Judicial Ditch 30	0.00	4.25	18.90	7.50	12.00	42.65	Poor
Average Habitat Results: Judicial Ditch 30			**0.41**	**6.75**	**14.01**	**7.63**	**9.75**	**38.54**	**Poor**
3	12MN003	Lower Cottonwood River	1.67	9.17	15.83	8.33	17.33	52.33	Fair
2	17MN103	Lower Cottonwood River	0.63	9.00	18.65	10.50	23.50	62.28	Fair
3	17MN104	Lower Cottonwood River	2.67	11.50	16.13	9.00	17.00	56.30	Fair

# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
1	17MN179	Lower Cottonwood River	0.00	10.50	17.50	12.00	26.00	66.00	Good
2	90MN069	Lower Cottonwood River	1.25	6.25	18.60	12.00	22.00	60.10	Fair
Average Habitat Results: Lower Cottonwood River			**1.24**	**9.28**	**17.34**	**10.37**	**21.17**	**59.40**	**Fair**
5	03MN032	Lower Sleepy Eye Creek	0.00	9.90	20.13	14.20	28.40	72.63	Good
4	10EM007	Lower Sleepy Eye Creek	0.00	7.50	6.75	11.50	8.00	33.75	Poor
3	15EM071	Lower Sleepy Eye Creek	0.00	9.83	16.00	11.33	10.33	47.50	Fair
2	17MN113	Lower Sleepy Eye Creek	0.00	8.25	11.00	7.50	6.00	32.75	Poor
# Visists	**Biological Station ID**	**Reach name**	**Land use**	**Riparian**	**Substrate**	**Fish cover**	**Channel morph.**	**MSHA score**	**MSHA rating**
3	17MN114	Lower Sleepy Eye Creek	0.00	6.33	8.00	6.33	4.33	25.00	Poor
2	17MN115	Lower Sleepy Eye Creek	0.00	8.50	16.23	3.50	8.50	36.73	Poor
2	17MN116	Lower Sleepy Eye Creek	0.00	9.50	8.15	11.00	13.50	42.15	Poor
2	17MN117	Lower Sleepy Eye Creek	0.00	9.25	7.00	6.50	10.50	33.25	Poor
1	17MN118	Lower Sleepy Eye Creek	0.00	9.00	6.00	9.00	7.00	31.00	Poor
2	17MN119	Lower Sleepy Eye Creek	0.00	10.00	17.50	7.00	10.00	44.50	Poor
2	97MN014	Lower Sleepy Eye Creek	0.00	8.00	18.48	3.00	5.00	34.48	Poor
Average Habitat Results: Lower Sleepy Eye Creek			**0.00**	**8.73**	**12.29**	**8.26**	**10.14**	**39.43**	**Poor**
3	17MN163	Meadow Creek	0.00	8.17	10.60	8.67	10.00	37.43	Poor
2	17MN164	Meadow Creek	2.50	10.50	4.00	8.00	7.50	32.50	Poor
3	17MN165	Meadow Creek	0.00	7.67	12.93	10.00	19.33	49.93	Fair
3	17MN166	Meadow Creek	0.00	7.83	12.83	9.00	17.00	46.67	Fair
1	17MN167	Meadow Creek	0.00	8.00	1.00	0.00	5.00	14.00	Poor
1	17MN168	Meadow Creek	0.00	9.50	5.95	2.00	10.00	27.45	Poor
2	17MN169	Meadow Creek	0.00	10.25	8.00	13.00	13.00	44.25	Poor
2	17MN170	Meadow Creek	0.00	6.50	6.50	4.00	7.00	24.00	Poor
2	17MN171	Meadow Creek	0.00	9.00	5.00	8.00	4.50	26.50	Poor
3	17MN172	Meadow Creek	0.00	3.83	11.97	11.00	14.67	41.47	Poor
Average Habitat Results: Meadow Creek			**0.25**	**8.13**	**7.88**	**7.37**	**10.80**	**34.42**	**Poor**
2	17MN105	Middle Cottonwood River	1.25	7.50	17.05	10.00	17.00	52.80	Fair

# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
2	17MN110	Middle Cottonwood River	0.00	6.50	14.35	6.50	12.50	39.85	Poor
Average Habitat Results: Middle Cottonwood River			**0.63**	**7.00**	**15.70**	**8.25**	**14.75**	**46.32**	**Fair**
2	17MN111	Mound Creek	0.00	5.00	20.10	10.50	22.00	57.60	Fair
2	17MN112	Mound Creek	0.00	10.75	18.45	13.50	25.00	67.70	Good
3	91MN065	Mound Creek	1.33	8.50	6.10	7.33	10.33	33.60	Poor
1	91MN067	Mound Creek	0.00	6.50	15.70	7.00	19.00	48.20	Fair
Average Habitat Results: Mound Creek			**0.33**	**7.69**	**15.09**	**9.58**	**19.08**	**51.77**	**Fair**
1	17MN140	Pell Creek	2.50	13.00	15.70	12.00	24.00	67.20	Good
2	17MN141	Pell Creek	0.00	10.50	14.65	9.00	19.00	53.15	Fair
2	17MN142	Pell Creek	0.00	10.75	12.70	8.50	16.00	47.95	Fair
2	17MN143	Pell Creek	0.00	7.75	7.80	10.00	11.00	36.55	Poor
# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
Average Habitat Results: Pell Creek			**0.63**	**10.50**	**12.71**	**9.88**	**17.50**	**51.21**	**Fair**
3	07MN085	Plum Creek	0.42	9.33	14.80	10.67	11.33	46.55	Fair
2	17MN145	Plum Creek	0.00	7.50	13.35	13.00	20.50	54.35	Fair
2	17MN146	Plum Creek	0.00	6.50	17.70	9.00	15.00	48.20	Fair
2	17MN147	Plum Creek	0.38	12.75	17.95	15.00	23.00	69.07	Good
3	17MN148	Plum Creek	0.50	7.00	16.63	10.33	17.00	51.47	Fair
2	90MN062	Plum Creek	2.50	7.50	15.50	13.50	23.50	62.50	Fair
Average Habitat Results: Plum Creek			**0.63**	**8.43**	**15.99**	**11.92**	**18.39**	**55.36**	**Fair**
1	10EM094	Upper Cottonwood River	0.00	7.50	17.60	6.00	21.00	52.10	Fair
2	17MN144	Upper Cottonwood River	1.25	8.50	17.40	14.50	20.00	61.65	Fair
2	17MN149	Upper Cottonwood River	1.25	9.00	13.75	13.00	24.50	61.50	Fair
2	17MN150	Upper Cottonwood River	0.00	5.50	8.95	5.50	18.50	38.45	Poor
2	17MN151	Upper Cottonwood River	0.00	7.50	15.85	7.00	7.50	37.85	Poor
2	17MN154	Upper Cottonwood River	0.00	11.50	20.00	15.50	25.50	72.50	Good
2	17MN155	Upper Cottonwood River	0.00	7.50	11.90	13.00	18.50	50.90	Fair
2	17MN156	Upper Cottonwood River	1.88	7.00	6.50	8.00	9.50	32.88	Poor
2	17MN181	Upper Cottonwood River	1.25	10.25	10.05	6.50	16.00	44.05	Poor
Average Habitat Results: Upper Cottonwood River			**0.63**	**8.25**	**13.56**	**9.89**	**17.89**	**50.21**	**Fair**

# Visists	Biological Station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
2	17MN120	Upper Sleepy Eye Creek	0.00	7.00	8.50	10.00	4.50	30.00	Poor
2	17MN121	Upper Sleepy Eye Creek	0.00	6.75	6.50	1.00	3.50	17.75	Poor
2	17MN122	Upper Sleepy Eye Creek	0.00	5.00	15.40	10.50	13.50	44.40	Poor
2	17MN123	Upper Sleepy Eye Creek	0.00	6.75	9.15	3.50	4.00	23.40	Poor
2	17MN124	Upper Sleepy Eye Creek	0.00	7.75	13.80	9.00	9.50	40.05	Poor
2	91MN068	Upper Sleepy Eye Creek	0.00	10.25	7.00	11.00	4.00	32.25	Poor
Average Habitat Results: Upper Sleepy Eye Creek			**0.00**	**7.25**	**10.06**	**7.50**	**6.50**	**31.31**	**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)

Appendix 6 – Lake protection and prioritization results

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% load reduction goal	Priority
08-0011-00	Clear	163.1		79%	54	C
08-0029-00	Bachelor	400.4		94%	31	C
08-0045-00	Sleepy Eye	85.3	No evidence of trend	80%	16	NA
08-0054-00	Altermatt	402.8		87%	22	C
08-0096-00	Boise	287.0		94%	79	C
17-0033-00	Augusta	158.3		92%	235	C
17-0037-00	Hurricane	48.0		81%	7	B
17-0048-01	Round	544.5		86%	179	C
17-0048-02	Long	330.5		86%	100	C
17-0054-00	Bean	129.4		94%	14	NA
17-0056-00	Double	99.0		93%	26	C
17-0056-01	Double (North Portion)	125.9		93%	36	NA
42-0052-00	Rock	198.5		90%	106	NA
51-0006-00	Louisa	203.0		82%	92	C
51-0038-00	Round	38.0		82%	5	B

Appendix 7 – Stream protection and prioritization results

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
07020008-548	Judicial Ditch 9	General	warm	one	high	high	med/low	A
07020008-578	Unnamed creek	General	warm	one	med/high	high	low	A
07020008-588	Judicial Ditch 3	General	warm	one	med/high	high	low	A
07020008-523	Pell Creek	General	warm	one	med/high	high	med/low	A
07020008-507	Cottonwood River	General	warm	one	medium	high	med/low	A
07020008-527	County Ditch 38	General	warm	one	med/low	high	med/low	A
07020008-587	Unnamed creek	General	warm	neither	med/high	high	low	A
07020008-543	County Ditch 54	Modified	warm	one	high	high	low	A
07020008-589	County Ditch 19	Modified	warm	one	high	high	med/low	A
07020008-586	Unnamed creek	Modified	warm	one	high	high	medium	A
07020008-561	County Ditch 68	Modified	warm	neither	high	high	low	A
07020008-564	County Ditch 60	Modified	warm	neither	high	high	low	A
07020008-565	County Ditch 5	Modified	warm	neither	high	high	low	A
07020008-584	Unnamed creek	Modified	warm	neither	high	high	low	A
07020008-594	Unnamed ditch	Modified	warm	neither	high	high	low	A
07020008-595	Unnamed creek	Modified	warm	neither	high	high	low	A
07020008-596	Judicial Ditch 35	Modified	warm	neither	high	high	low	A
07020008-601	Meadow Creek	Modified	warm	neither	high	high	low	A
07020008-623	Unnamed creek	Modified	warm	neither	high	high	low	A