Watershed health

June 2020

Lower Rainy River and Rapid River Watersheds 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

CR County Road

CSAH County State Aid Highway

CWA Clean Water 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

F-IBI Fish Index of Biological Integrity

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

M-IBI Macroinvertebrate Index of Biological Integrity

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

N Nitrogen

NO_3+NO_2-N Nitrate plus nitrite nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH_3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SNA Scientific Natural Area

SUP Full Support

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 Lower Rainy River and Rapid River watersheds collectively drain approximately 1,765 square miles of Lake of the Woods, Koochiching, and Beltrami counties in north central Minnesota. These neighboring watersheds are largely dominated by extensive wetlands, spruce bogs, and peatlands. Much of the land within these neighboring watersheds is managed in State Forests and Scientific Natural Areas. Beltrami Island, Pine Island, and Lake of the Woods State Forests, collectively encompass 68% of the land within these watersheds. Development and agricultural land use are largely concentrated near the bank of the Rainy River and the cities of Baudette and International Falls. Streams, wetlands, and water resources within the Lower Rainy River and Rapid River watersheds offer ample opportunities for outdoor recreation in a scenic and remote setting and provide valuable riparian habitat for some of Minnesota's most threatened species. Both watersheds contribute to the Rainy River, a widely renowned walleye and lake sturgeon fishery.

In 2017 and 2018, the Minnesota Pollution Control Agency (MPCA) and local partners conducted intensive watershed monitoring (IWM) of surface waters within the Lower Rainy River and Rapid River watersheds. A total of 15 stream reaches were sampled in the Lower Rainy River Watershed while 12 stream reaches were sampled in the Rapid River Watershed. The resulting water chemistry and biological data were used to assess the quality and use support of these waters.

In general, water quality conditions within the Rapid River and Lower Rainy River watersheds are good. While low-flow conditions during the IWM effort in 2017 and 2018 limited sampleability within some reaches, 80% of the stream reaches successfully sampled within the Lower Rainy River Watershed were found to be fully supporting aquatic life. The Rapid River Watershed performed similarly with 92% of its sampled stream reaches scoring above their respective impairment threshold for aquatic life. In many cases (e.g., Winter Road River, Christy Creek) fish or aquatic macroinvertebrate communities performed well and meet standards for exceptional use (MPCA's highest use class designation). Of the subwatersheds sampled, the Winter Road River produced the highest aggregate scores for stream habitat condition (MSHA) and yielded consistently high fish, and aquatic macroinvertebrate Index of Biological Integrity (IBI) scores. Several of these stream had exceptional biological, chemical, and/or physical characteristics that are worthy of additional protection. Pitt Creek, a tributary to Peppermint Creek, represents the only cold water resource within the Rapid and Lower Rainy River watersheds and is popular trout fishery locally.

In cases where macroinvertebrate and/or fish communities were impaired, low dissolved oxygen (DO), and altered hydrology/channelization likely played a role. Much of the wetland and peat bog landscape within these watersheds bears the legacy of extensive ditching and dredging campaigns undertaken at the turn of the 20th century. Today, nearly 100 years after the end of these ditching campaigns, 50% of the total stream length in the Lower Rainy River Watershed and 75% of stream length in the Rapid River Watershed remains altered. Elevated suspended sediment concentration in the downstream reach of the Rapid River represents a threat to the health of aquatic communities and, in the lower reaches of the Black River, high *Escherichia coli* (E.coli) levels impair aquatic recreation.

Given the overall good quality of the water resources within the Rapid River and Lower Rainy River watersheds, protection strategies will be key to preventing future water quality degradation. Restoration and protection strategies should be developed to both improve the condition of degraded resources and ensure that unimpaired waters remain in good condition.

Introduction

Water is one of Minnesota's most abundant and precious resources. The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. The 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 (TMDL). 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 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 both the Lower Rainy River and the Rapid River watersheds beginning in the summer of 2017. This report provides a summary of all water quality assessment results in the Lower Rainy River and Rapid River watersheds 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) https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality.

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 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).

Figure 1. The Intensive Watershed Monitoring Design.

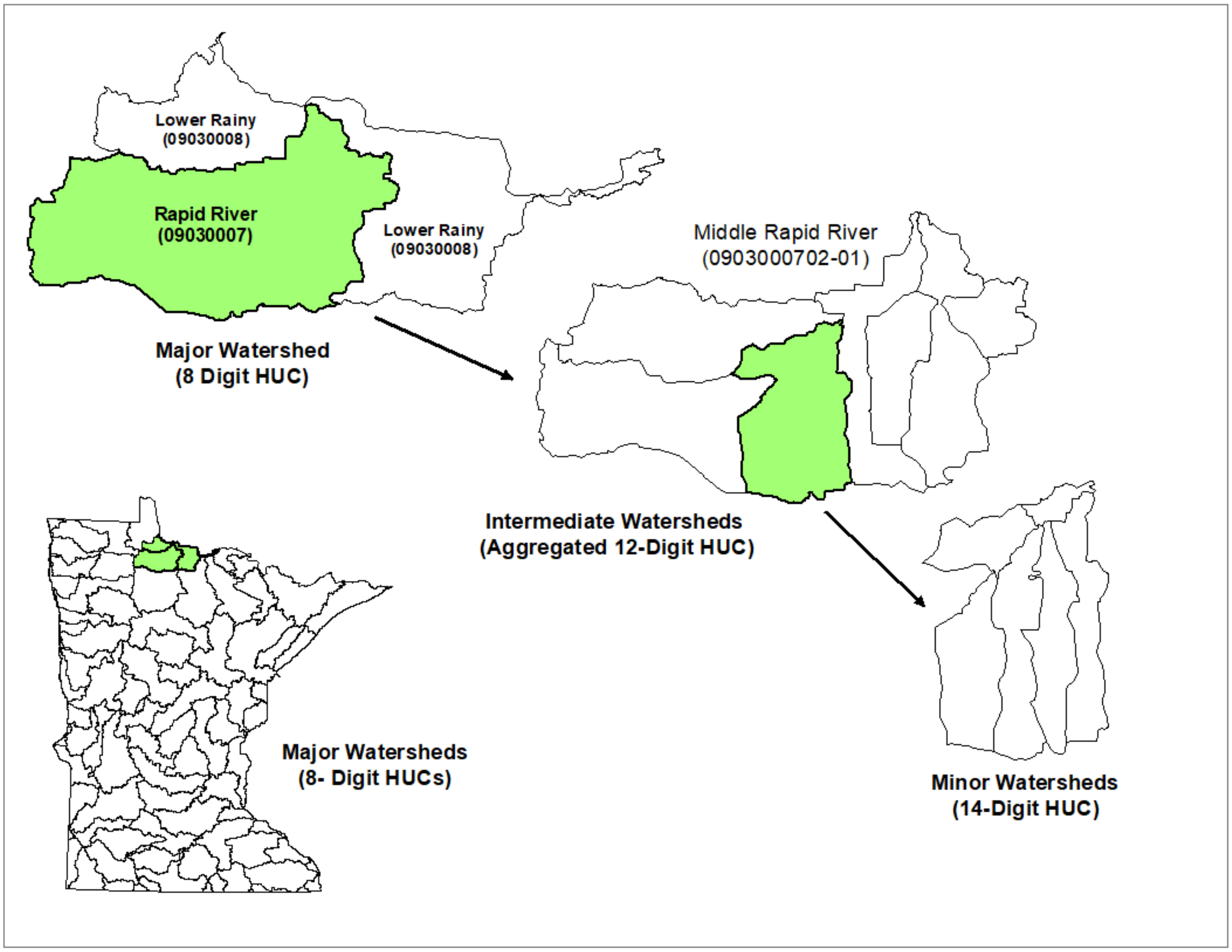
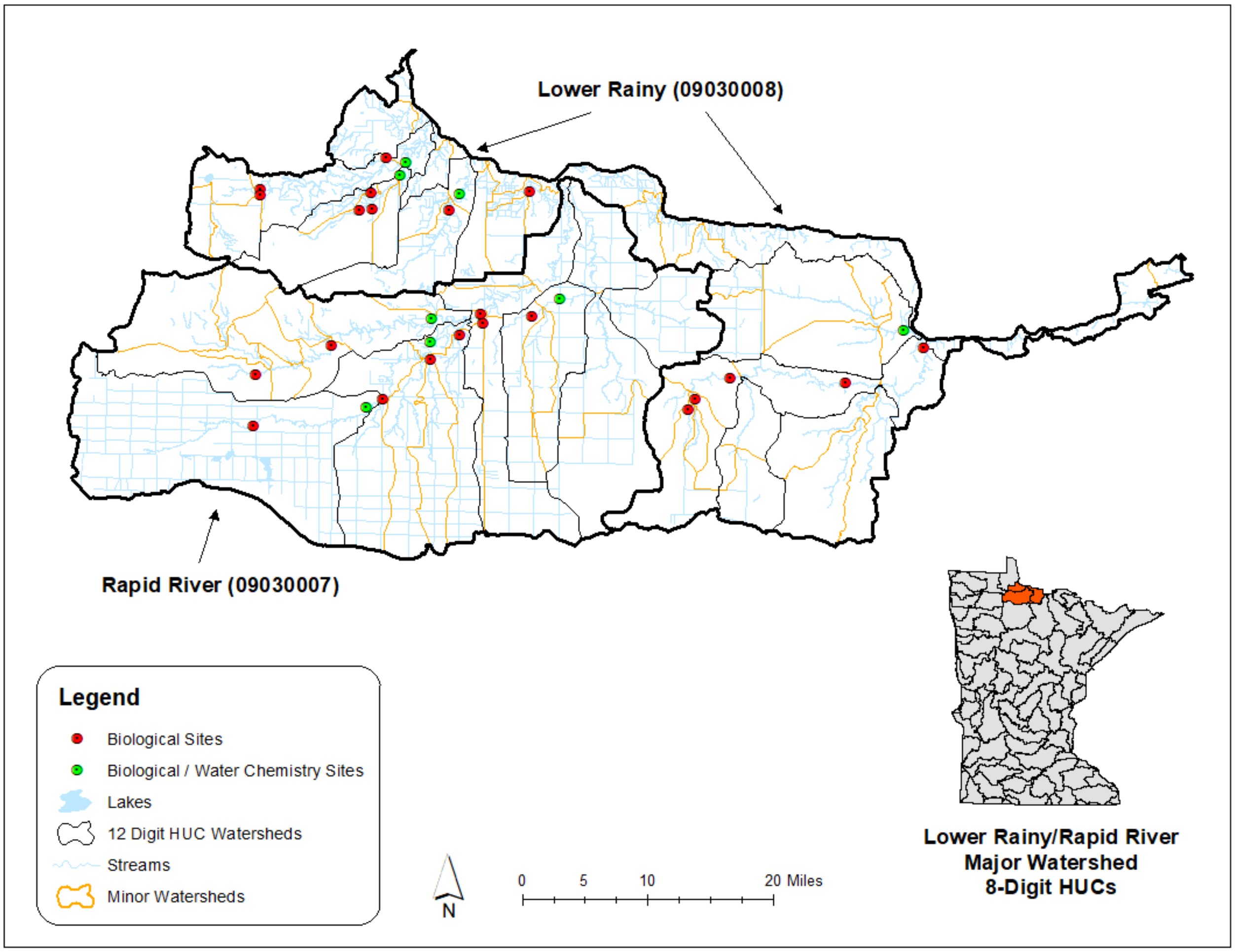


Figure 2. Intensive watershed monitoring sites for streams in the Lower Rainy River and Rapid River watersheds. This does not include independent water chemistry sites or biological monitoring sites established prior to IWM effort (3).

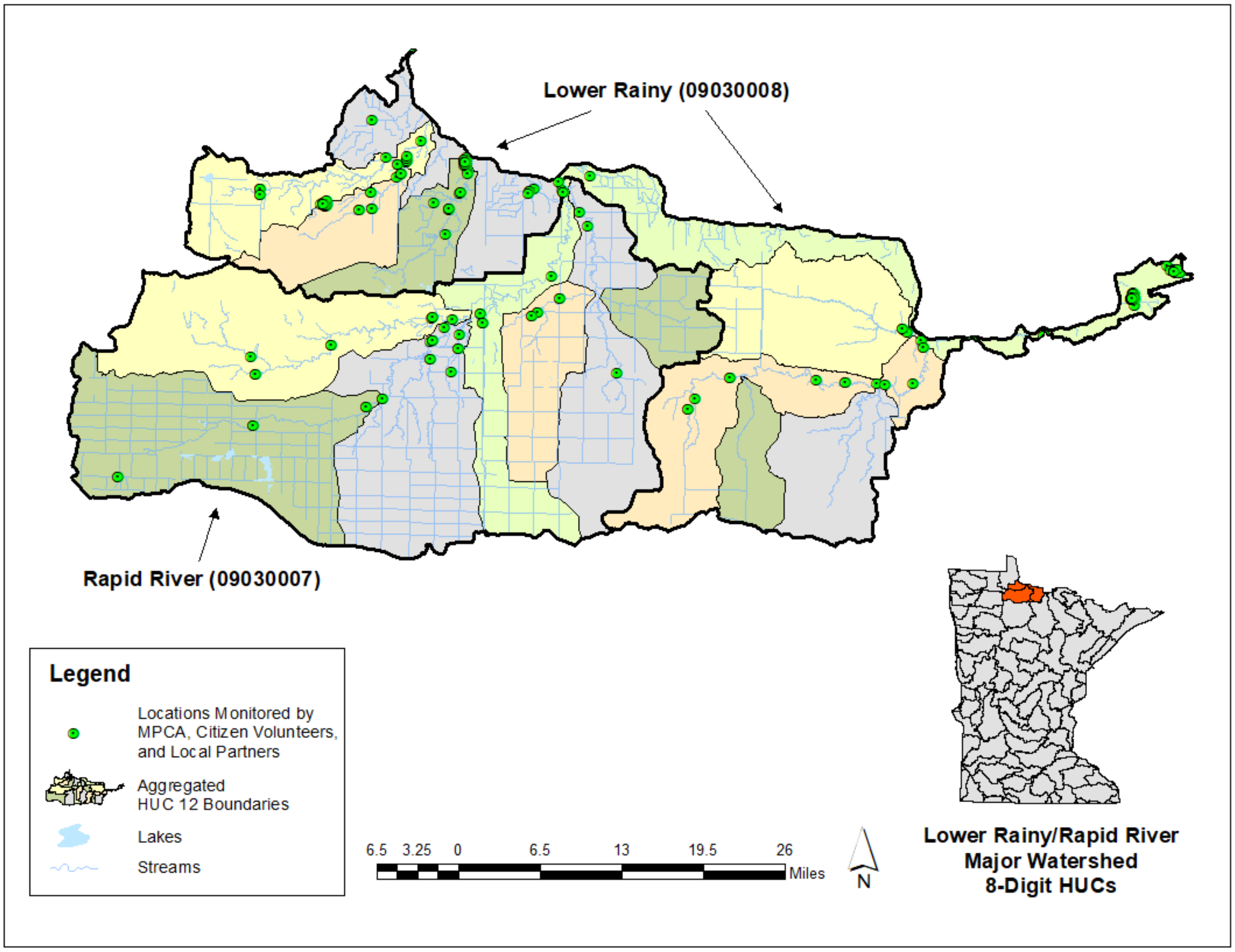


Citizen and local monitoring

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 the 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 and the Citizen Stream Monitoring Program. 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 both the Lower Rainy River and the Rapid River watersheds.

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Lower Rainy River and Rapid River watersheds.



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 *Escherichia coli* (E. coli) bacteria in the water.

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 from a lake or stream are safe to eat 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.

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.
Cold water general	CWg	2Ag	Cold water 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.
Cold water exceptional	CWe	2Ae	Cold water 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

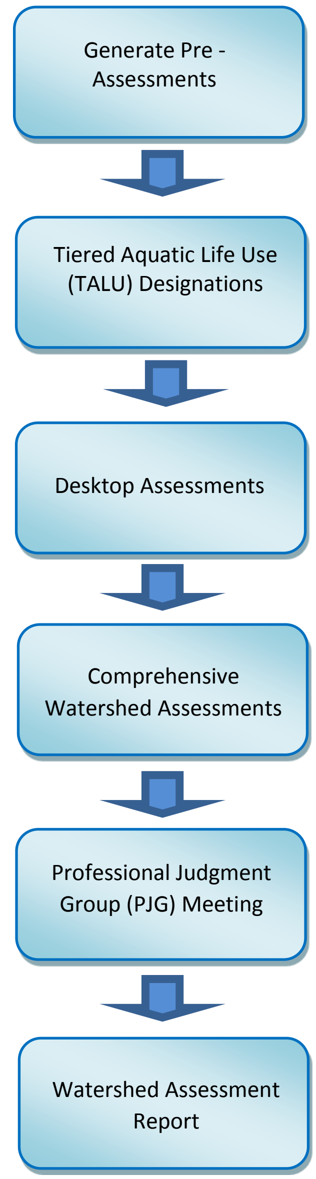
Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the 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 United States Geological Survey (USGS) 8-HUC plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the Minnesota Department of Natural Resources (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 ensure that data is valid and appropriate for assessment purposes. Tiered aquatic life use designations are determined before data are 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).

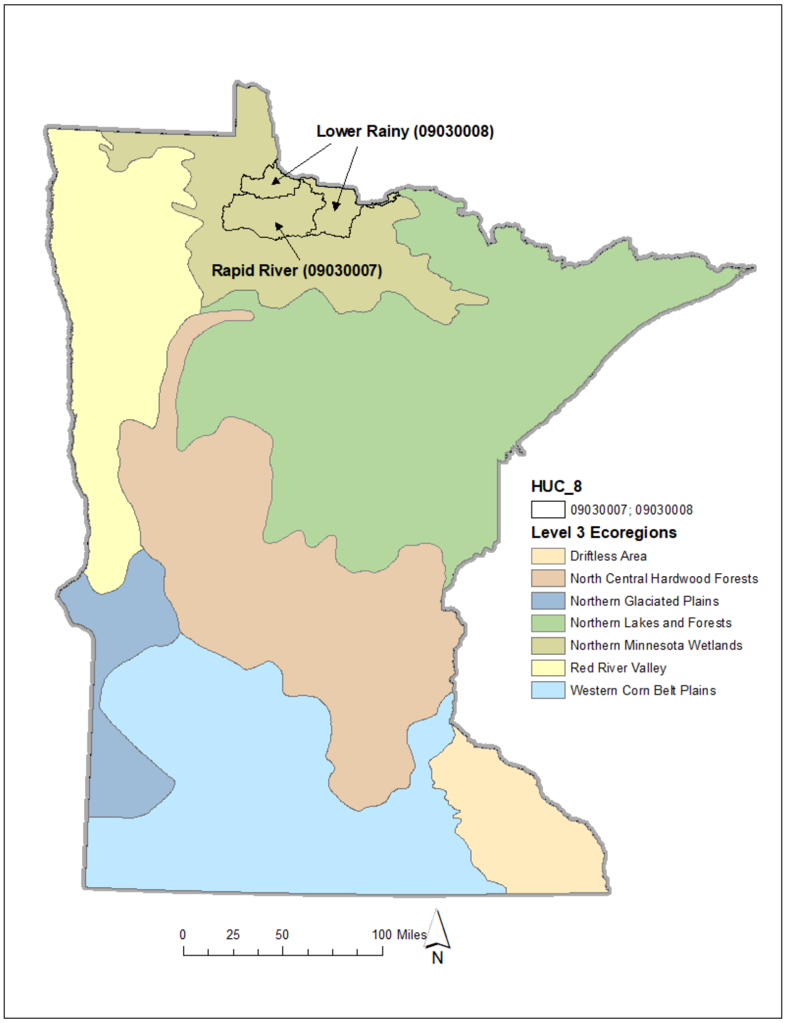
The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 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.

Overview of the Lower Rainy River and Rapid River watersheds

This report concerns two neighboring watersheds, the Lower Rainy River Watershed and the Rapid River Watershed, which collectively drain approximately 1,765 square miles of Lake of the Woods, Koochiching, and Beltrami counties in north central Minnesota. Like much of the rest of Minnesota, the landscape within the Lower Rainy River and Rapid River watersheds was, and continues to be shaped by glacial activity during the recent geologic past (~20,000-9,000 years ago). Both watersheds lie in the footprint of the ancient Glacial Lake Agassiz which, as it drained, left behind substantial peat deposits across much of north central Minnesota. This region's extensive peat bogs and wetland landscapes directly impact land use, hydrology, and biology within the Lower Rainy River and Rapid River watersheds. Wetlands and peat bogs hold large amounts of standing water and their nutrient poor soils largely restrict the use of land for agriculture. As harvestable timber stands in this region became scarce in the late 1800's, ditching campaigns were undertaken to drain much of the landscape in both watersheds for agricultural use. These efforts largely failed to produce arable land and much of the southern portion of both watersheds bear the evidence of these ditching efforts today. Today, land development in these watersheds is relatively limited, with most farming and residential land use located near the bank of the Rainy River and its major tributaries (Black River, Baudette River, and Rapid River etc.) Exposures of bedrock in these watersheds are relatively rare and most of the region's flowing water comes in direct contact with peat deposits giving many of the region's waterways a characteristic tannin stain.

Figure 5. The Lower Rainy River and Rapid River watersheds within the Northern Minnesota Wetlands ecoregion of Northern Minnesota.

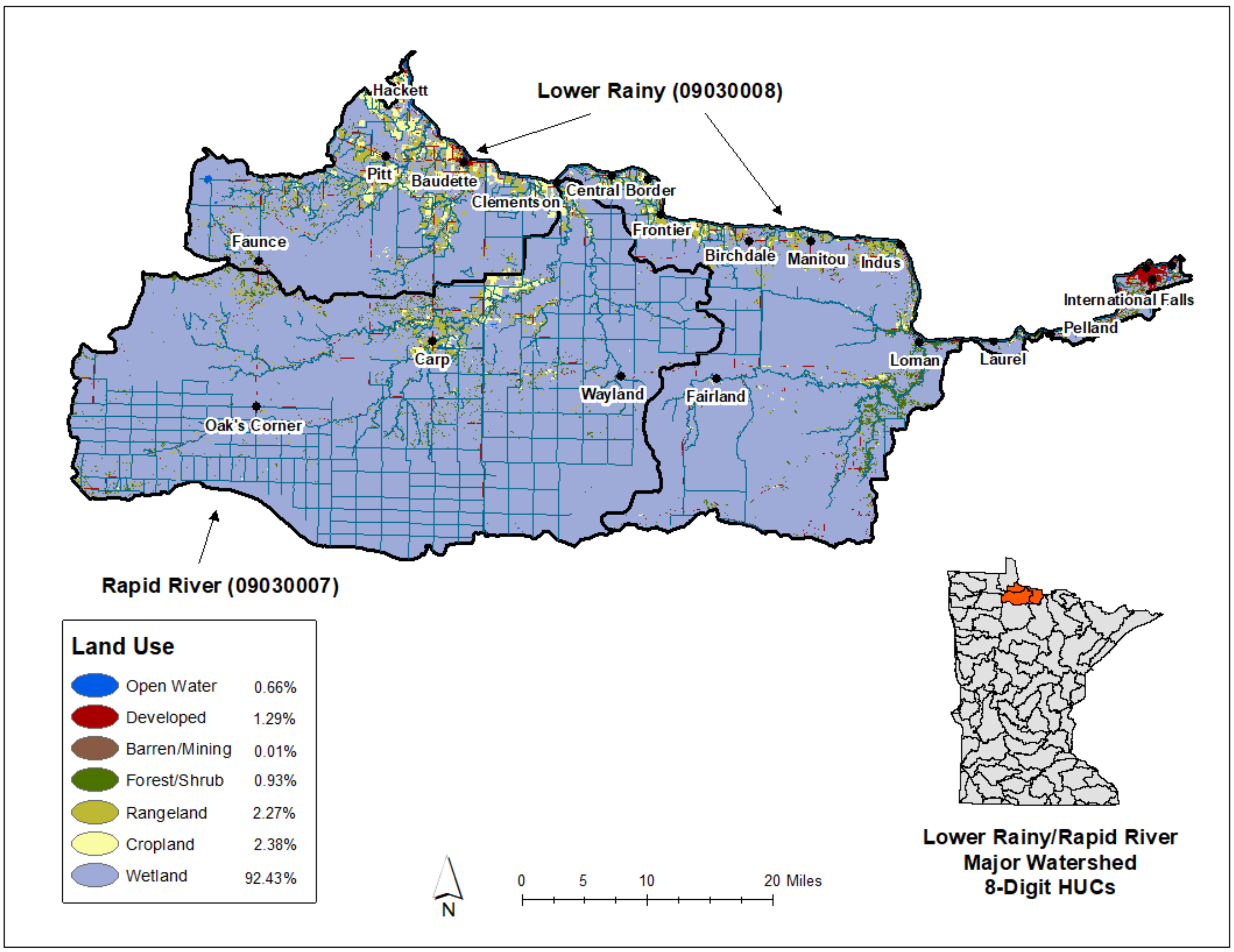


Land use summary

Historically, old growth pine forests covered much of the northern portion of the Lower Rainy River and Rapid River watersheds. Farther south, in their headwaters, much of the land in these watersheds was covered in untouched wetland and peat bogs. Fur trapping outposts were established in the region in the early 1700's as French Voyageurs trappers utilized the Rainy River as a conduit to access trapping territory to the north and west of Lake of the Woods. In the late 1800's, railroads brought more substantial development to the banks of the Rainy River. By the turn of the 20th century, logging had become the largest industry and largest employer in the region. Large sawmills were established along the banks of the Rainy River and logs were floated down most of its major tributaries. The towns of International Falls, Spooner, and Baudette quickly grew to become major regional producers of timber. Clearcutting operations left large piles of slash and, in 1910; a substantial drought hit the region providing the catalyst for violent wildfires. On October 7, 1910, sparks from a train were reported to have started a wildfire just west of the town of Williams. By the time the fire ceased, the Baudette /Spooner Fire as it came to be known had burned roughly 628 square miles, or 48% of the land area in Lake of the Woods County. Nearly all of Spooner and Baudette were destroyed in the fire and 43 lives were lost. Due to the region's harsh winters, peat bogs, and nutrient poor soil, the regions timber industry in the area was slow to recover from this disaster. With much of the region's timber resources harvested or lost to fire, many loggers and homesteaders turned to agriculture and commercial fishing. Local governments responded to a growing demand for agricultural land by investing in a ditching and dredging campaign to drain the regions wetlands and peat bogs, but the dredging efforts proved prohibitively expensive and largely ineffective. State government purchased much of this ditched land creating the Beltrami Island and Pine Island State Forests in 1933. Although efforts to remove "spoil piles" and reduce channelization in these ditched systems have begun, many of the wetlands, peat bogs, and streams which were ditched at the turn of the 20th century have largely maintained their ditched condition.

Today, much of the land within the Lower Rainy River and Rapid River watersheds remains managed in State Forest, Wildlife Management, and Scientific Natural Areas. Logging has rebounded to some degree and still represents one of the largest industries in these watersheds. Development and agricultural land use within these watersheds' is primarily concentrated along the banks of the Rainy River and its largest tributaries. The cities of Baudette and International Falls in the Lower Rainy River Watershed represent the region's largest population centers. Land use totals for these watersheds collectively are as follows: wetland (92.4%), cropland (2.38%), range (2.27%), developed (1.29%), forest (0.93%), open water (0.66%), and mining (0.01%) Figure 6.

Figure 6. Land use in the Lower Rainy River and Rapid River watersheds.



Surface water hydrology in the Lower Rainy River Watershed

The Lower Rainy River Watershed is not a nested watershed as it is composed of a conglomeration of tributaries with direct drainage to the Rainy River from the city of International Falls, west to the Rainy River's pour point (Wheeler's Point) at the Lake of the Woods. West of the Rapid River, this watershed's major waterways include Wabanica Creek, Winter Road River, Baudette River, Silver Creek, and Miller Creek. East of the Rapid River, the Black River and its tributaries comprise the bulk of this watershed's drainage area. Streams and rivers in the Lower Rainy River Watershed largely drain wetland and peat bog terrain. While much of the watershed's natural stream length remains unaltered the Lower Rainy River Watershed's wetlands and peat bogs were extensively ditched at the turn of the 20th century in attempt to drain land for agricultural development. A relatively small portion of these ditched systems have been restored to natural condition and today, 50% of the watershed's total stream length (including artificial created ditches) within the Lower Rainy River has been altered Figure 8. The Black River Watershed and its southern tributaries, including the south fork of the Black River, have been particularly impacted by this ditching. One dam is present in this watershed; located in the headwaters of the Winter Road River on Winter Road Lake.

Surface water hydrology in the Rapid River Watershed

The Rapid River is the main watercourse in this watershed. From its headwaters near Oak's Corner, the Rapid River travels east-northeast 35.5 miles through an extensively ditched wetland complex to its confluence with Miller Creek. From this confluence, the Rapid River travels further north towards its confluence with its North Branch picking up several smaller tributaries from the south including Chase Brook, Troy Brook, and Christy Creek. These tributaries drain large parts of the Red Lake Peatlands SNA and are extensively ditched in their headwaters. The North Branch of the Rapid River parallels the main stem for nearly 40 miles northeast where it meets the Rapid River northwest of the community of Carp. From its confluence with its north branch, the Rapid River flows north towards its confluence with the East Fork of the Rapid River. From this confluence, the Rapid River travels 1.6 miles to its confluence with the Rainy River at Clementson where a large rapid meets an outlet pool into the Rainy River.

The Rapid River Watershed bears the legacy of significant ditching campaigns undertaken at the beginning of the 20th century. While these ditches failed to drain land for farming, they have fundamentally altered the landscape and hydrology within this watershed. A relatively small portion of these ditched systems have been restored to natural condition. Today, 75% of the total stream length (including artificially created ditches) within the Lower Rainy River Watershed is altered Figure 8.

Figure 7. Map of percent modified streams by major watershed (8-HUC).

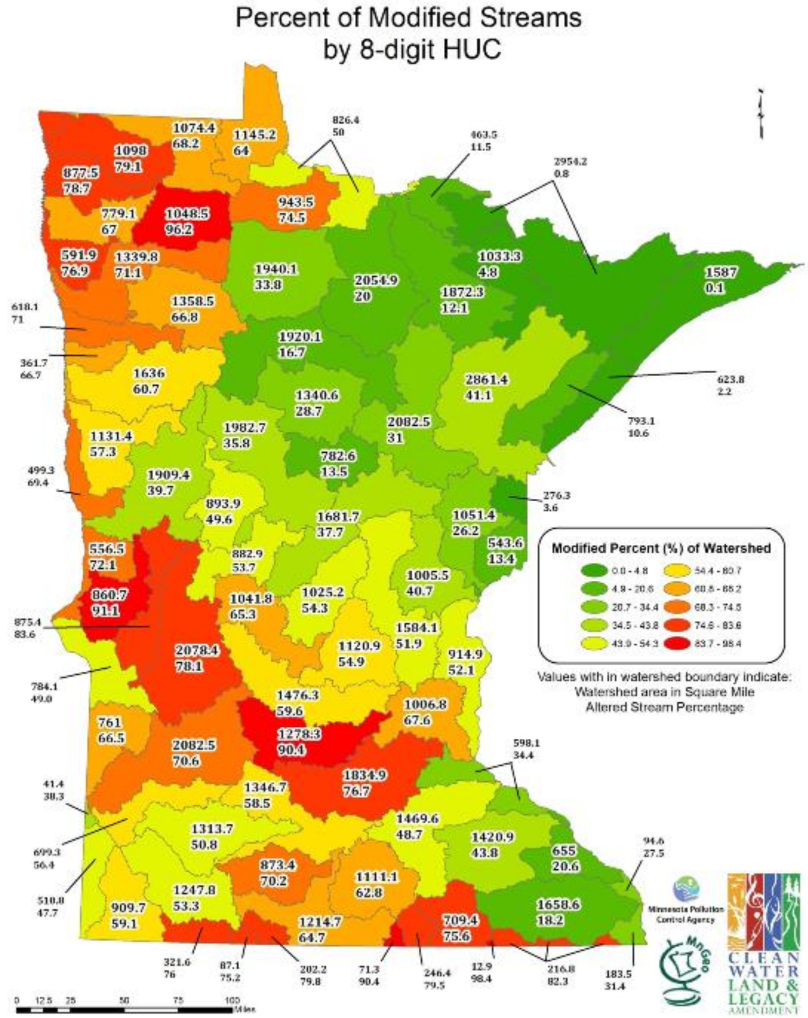
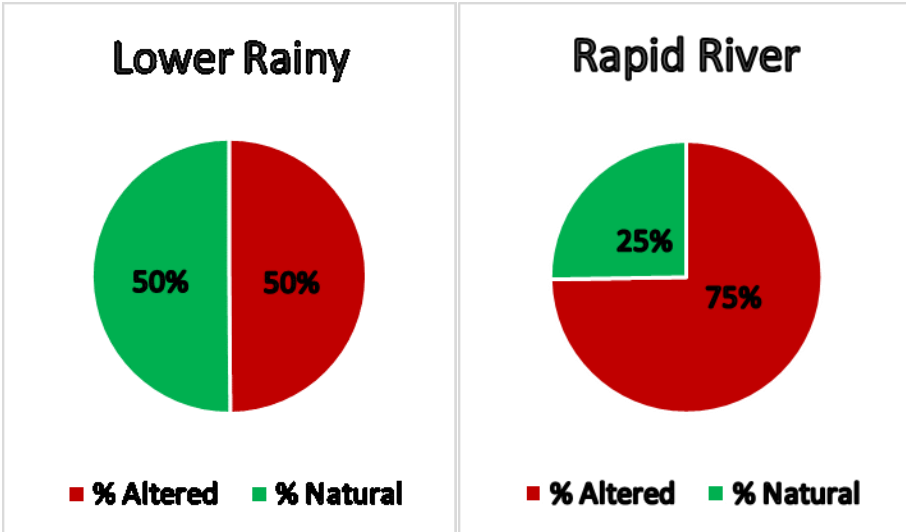


Figure 8. Comparison of natural to altered streams in the Lower Rainy River and Rapid River watersheds (percentages derived from the statewide altered Watercourse Project).

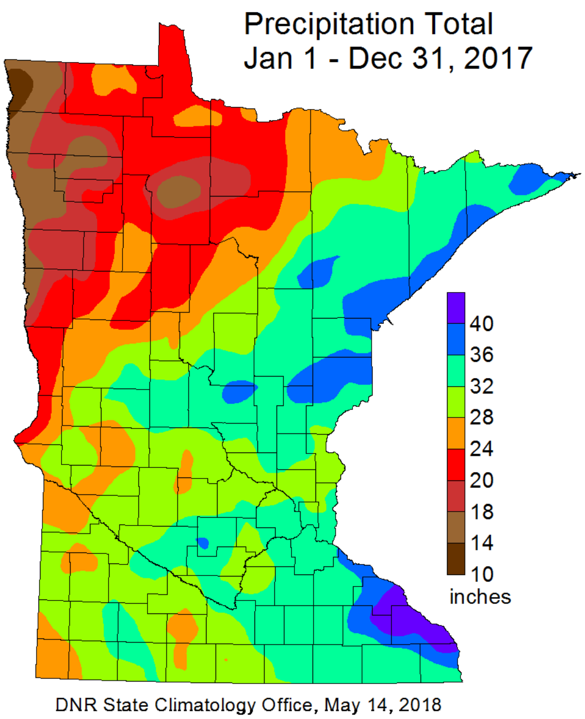


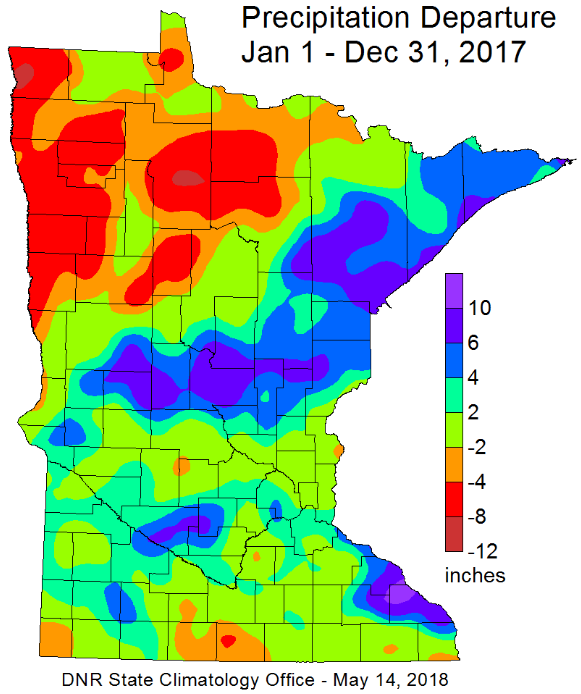
Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature is 4.5˚C for the state, while the mean summer (June-August) temperature for the Lower Rainy River and Rapid River watersheds is 17.4˚C and the mean winter (December-February) temperature is -14.5˚ C (DNR: Minnesota State Climatology Office, 2020).

Precipitation is an important source of water input to a watershed. Figure 9 displays two representations of precipitation for calendar year 2017. On the left is total precipitation, and according to this figure, the Lower Rainy River and Rapid River watersheds received 20 to 24 inches of precipitation in 2017. The display on the right shows the amount that precipitation levels departed from normal. The watershed area experienced precipitation that ranged from two to four inches below normal in 2017.

Figure 9. Statewide precipitation total (left) and precipitation departure (right) during 2017 (Source: DNR State Climatology Office, 2018)





The Lower Rainy River and Rapid River watersheds are located in the north central precipitation region. Figure 10 and Figure 11 display the areal average representation of precipitation for 20 and 100 years respectively. Though rainfall can vary in intensity and time of year, rainfall totals in this region display no significant trends over the last 20 years. However, precipitation exhibits a significant rising trend over the past 100 years ($p<0.001$). This is a strong trend and matches other regions throughout Minnesota.

Figure 10. Precipitation trends in north central Minnesota from 1998-2017 (Source: WRCC, 2019)

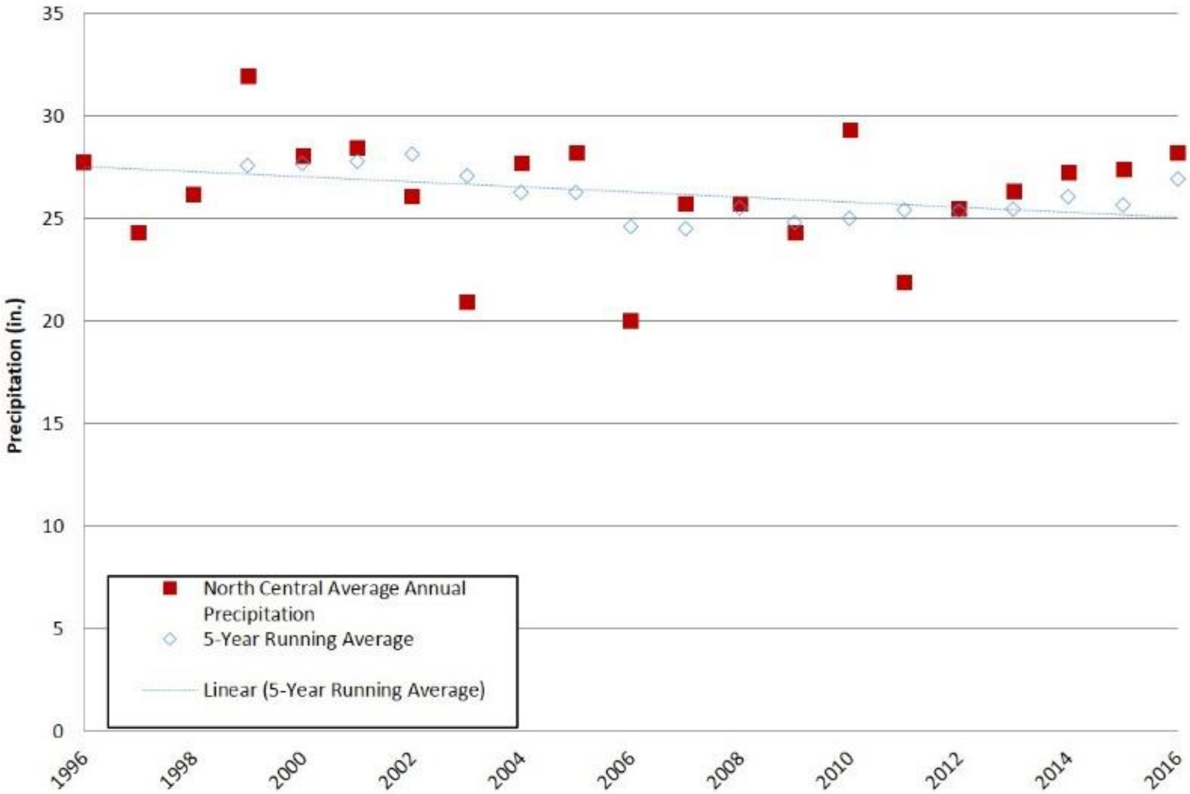
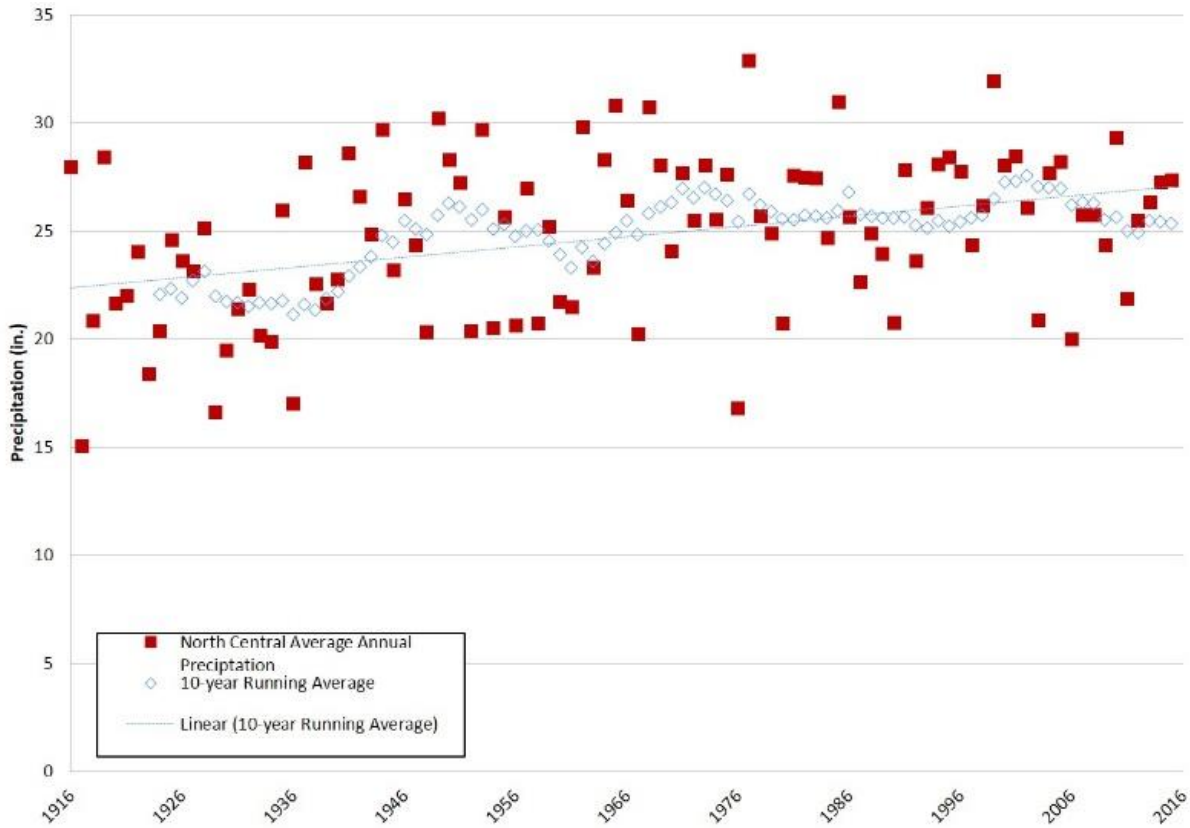


Figure 11. Precipitation trends in north central Minnesota from 1917-2016 (Source: WRCC, 2019)



Hydrogeology and groundwater quality and quantity

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.

Surficial and Bedrock Geology

Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface in much of the Lower Rainy River and Rapid River watersheds and is the parent material for the soils that have developed since glaciation. The depth to bedrock ranges from exposed at the surface to over 260 feet and is buried by deposits of the various ice lobes that reached these watersheds during the last glacial period, as well as during previous glaciations in the last 2.58 million years. The deposits at the surface are mostly unspecified with veins of the Des Moines ice lobe throughout the watershed. The unspecified areas consist primarily of post-glacial alterations to that sediment, including sand and gravel soil formation and peat accumulation. The Des Moines ice lobe deposited clayey glacial lake and lake modified till throughout these watersheds.

Bedrock is the main mass of rocks that form the Earth, located underneath the surficial geology and can be seen in only a few places where weathering has exposed the bedrock. Precambrian bedrock lies under the extent of the Lower Rainy River and Rapid River watersheds. The main terrane groups include the Quetico and Wabigoon subprovinces (Jirsa et al., 2011). The rock types that are found in the uppermost bedrock include basalt, gabbro, granite, greywacke, mafic metavolcanic rock, monzonite, and paragneiss (Morey & Meints, 2000). Bedrock exposure is typically seen in the northernmost extremities of the Lower Rainy River and Rapid River watersheds.

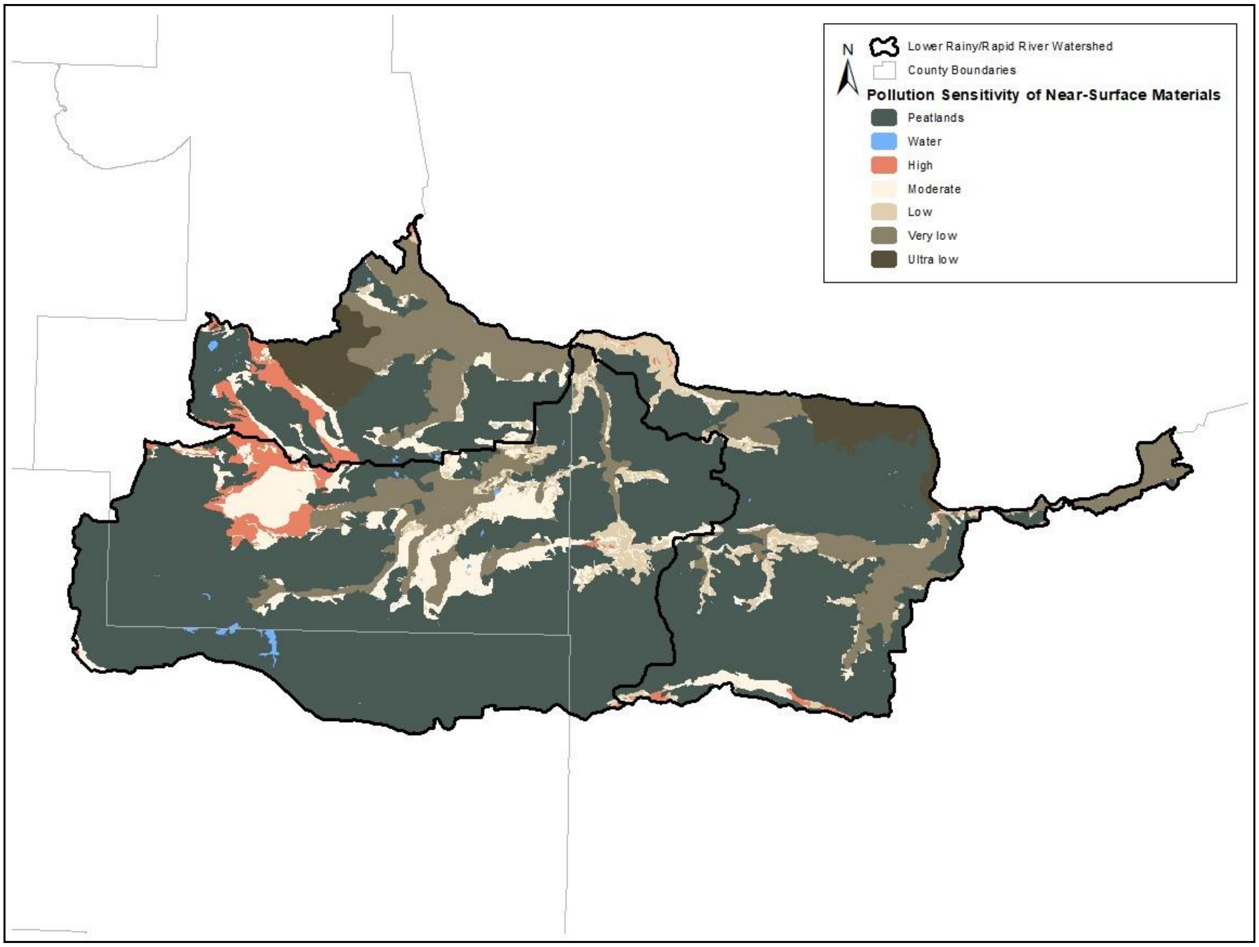
Aquifers

Groundwater aquifers are layers of water-bearing units that readily transmit water to wells and springs (USGS, 2019). As precipitation hits the surface, it infiltrates through the soil zone and into the void spaces within the geologic materials underneath the surface, saturating the material and becoming groundwater (Zhang, 1998). The water table is the uppermost portion of the saturated zone, where the pore-water pressure is equal to local atmospheric pressure. The geologic material determines the permeability and availability of water within the aquifer. The Lower Rainy River and Rapid River watersheds are predominately within the Western Groundwater Province, with some areas in the eastern region within the Arrowhead Groundwater Province. The Western Province consists of clayey glacial drift overlying Precambrian bedrock with limited extent sand aquifers (MNR, 2001). The Arrowhead Province consists of Precambrian rocks that may be exposed or underlie a thin layer of drift with groundwater found in faults and fractures (DNR, 2001). Groundwater in the surficial sands has moderate to limited availability. There is limited availability of groundwater in the buried sands and bedrock (DNR, 2001; DNR, 2020a).

Groundwater pollution sensitivity

Bedrock aquifers are typically covered with thick till, which normally makes them better protected from contaminant releases at the land surface. It is also less likely that withdrawals from wells would have a direct and significant impact on local surface water bodies. In contrast, surficial aquifers are typically more likely to: 1) be vulnerable to contamination, 2) have direct hydrologic connections to local surface water, and 3) influence the quality and quantity of local surface water. A 2016 statewide evaluation of pollution sensitivity of near-surface materials completed by the DNR is utilized to estimate pollution vulnerability up to ten feet from the land surface. This display is not intended to be used on a local scale, but as a coarse-scale planning tool. According to this data, the Lower Rainy River and Rapid River watersheds are primarily covered by peatland with only a small area of high potential pollution sensitivity, most likely due to the presence of sand and gravel Quaternary geology Figure 12 (DNR, 2016).

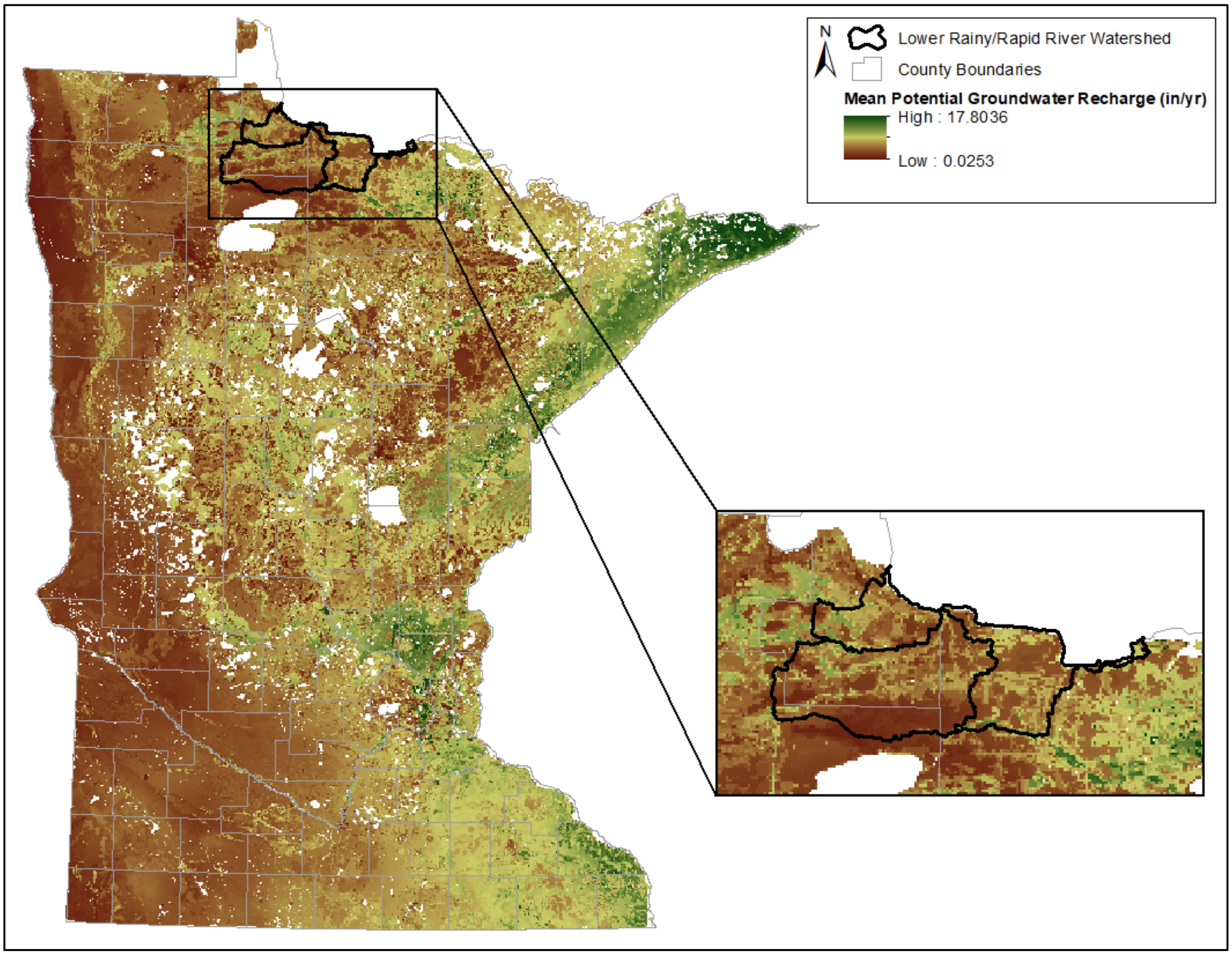
Figure 12. Pollution sensitivity of near surface materials for the Lower Rainy River and Rapid River watersheds



Groundwater potential recharge

Recharge of groundwater 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 Figure 13. Typically, recharge rates in unconfined aquifers are estimated at 20% to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). For the Lower Rainy River and Rapid River watersheds, the average annual potential recharge rate to surficial materials ranges from 1.03 to 10.94 inches per year, with an average of 4.15 inches per year. The statewide average potential recharge is estimated to be four inches per year with 85% of all recharge ranging from three to eight inches per year.

Figure 13. Average annual potential recharge rate to surficial materials in Lower Rainy River and Rapid River watersheds (1996-2010) (GIS Source: USGS, 2015)



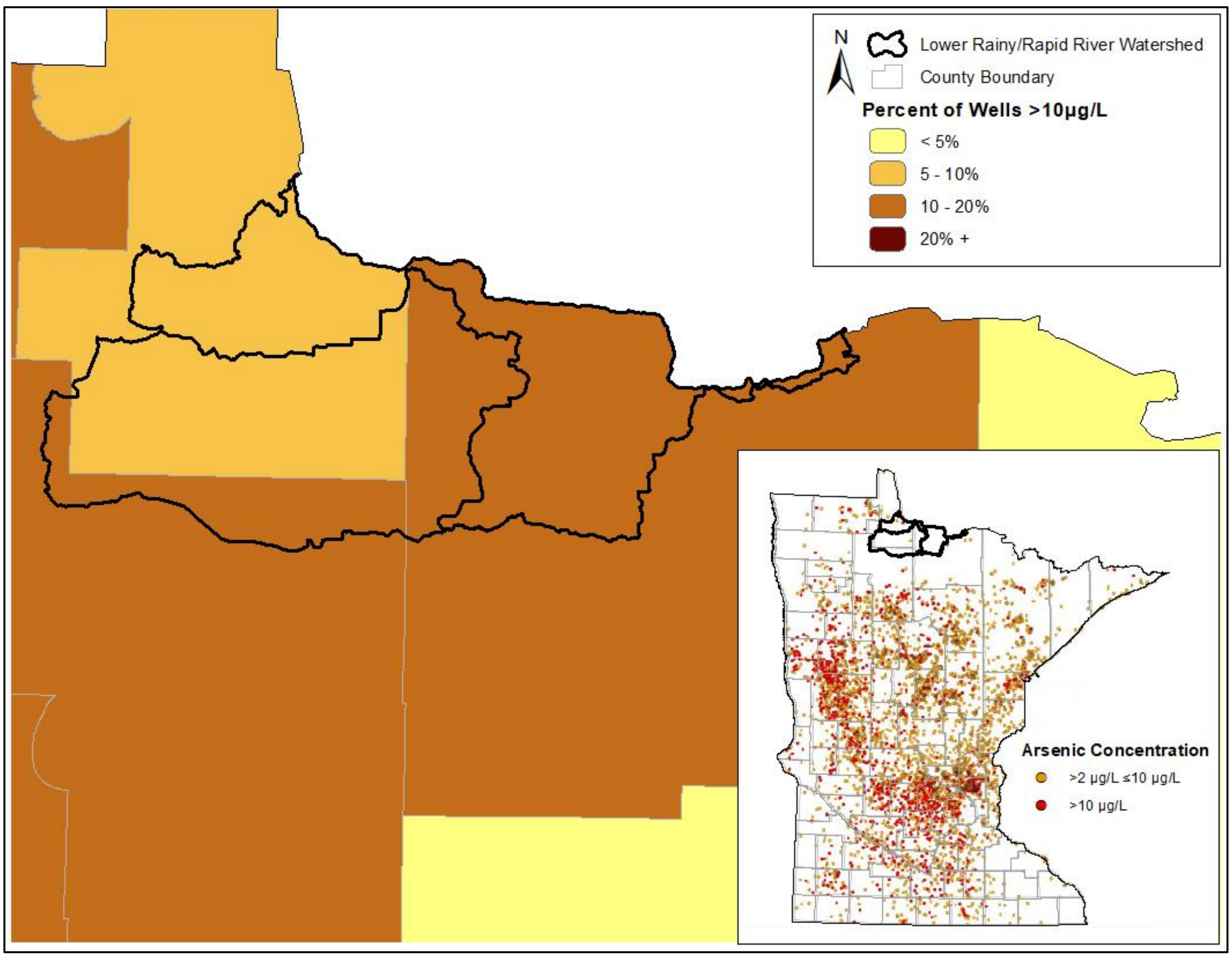
Groundwater quality

Approximately 75% of Minnesota's population receives their drinking water from groundwater, undoubtedly indicating that clean groundwater is essential to the health of its residents. 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 utilizing a mix of shallow monitoring wells and deeper domestic wells. However, there are currently no ambient groundwater wells located within this watershed; therefore, available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

From 1992 to 1996, the MPCA conducted baseline water quality sampling and analysis of Minnesota's principal aquifers. The Lower Rainy River and Rapid River watersheds are split between the Northeast and Northwest Region. The groundwater quality in the Northeast Region is considered good with comparable or lower concentrations of chemicals when compared to other regions with similar aquifers (MPCA, 1999a). The Northwest Region reported slightly higher concentrations of chemicals in the aquifers, especially where Cretaceous aquifers were located (MPCA, 1999b). However, there are no Cretaceous deposits found in the Northwest Region. Many of the exceedances identified were attributed to geology, such as deposits associated with Cretaceous bedrock and buried sand and gravel aquifers along stagnation moraines (MPCA, 1999b). Volatile organic compounds were also detected in both regions, with the most commonly detected compounds associated with well disinfection, atmospheric deposition, and fuel oils (MPCA, 1999a; MPCA, 1999b).

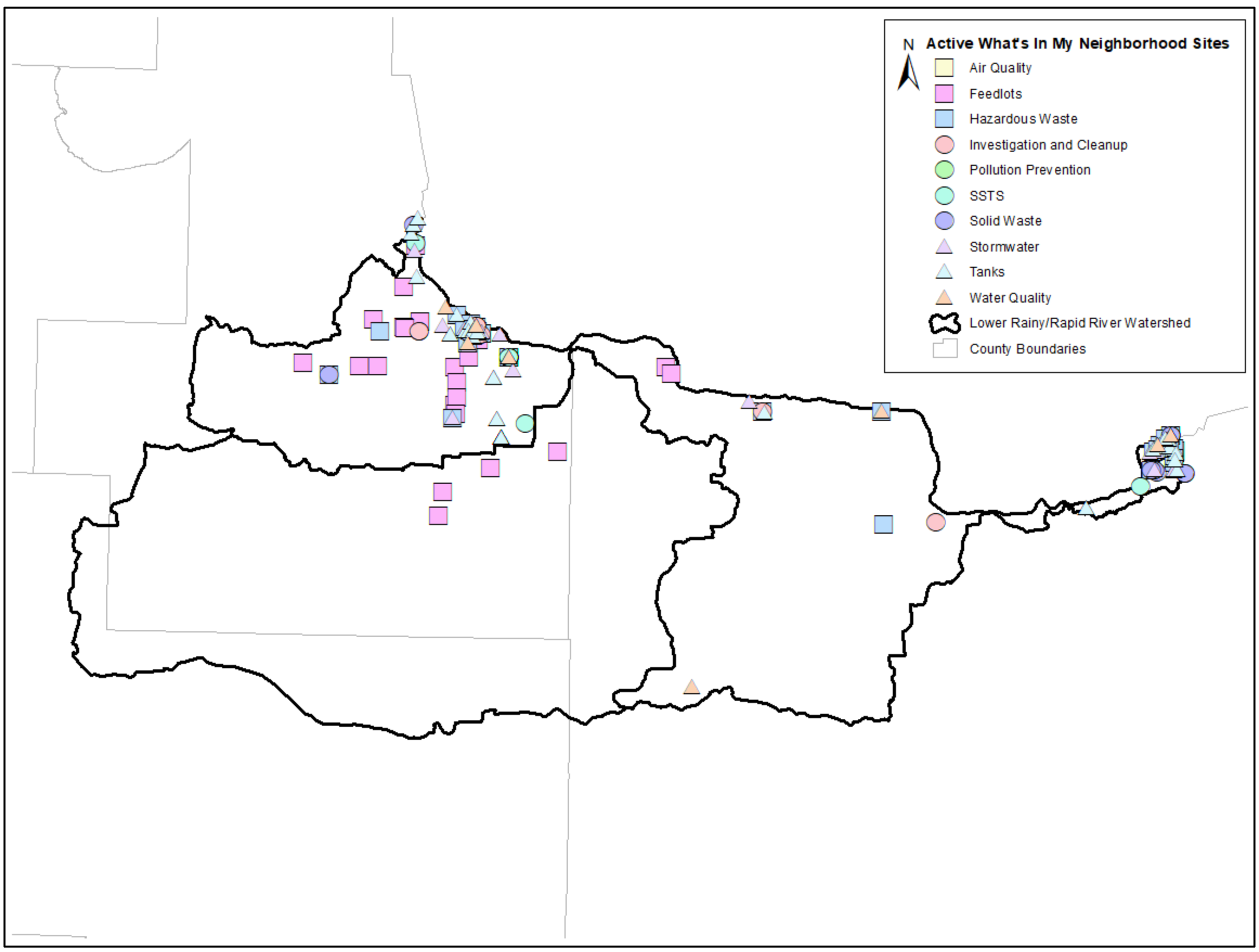
Mandatory testing by the Minnesota Department of Health (MDH) for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that an average of 10% of all wells installed after 2008 have arsenic levels above the maximum contaminant level (MCL) for drinking water of 10 micrograms per liter (ug/L) (MDH, 2020). In the Lower Rainy River and Rapid River watersheds, the majority of new wells are within the water quality standards for arsenic levels, but there are exceedances to the MCL. By county, the percentages of wells identified with concentrations exceeding the MCL are as follows: Koochiching (12.5%), Beltrami (10.8%), and Lake of the Woods (9.1%) (MDH, 2020) Figure 14. It is important to reiterate that the percentages of arsenic concentration exceedances are per county, not specifically for Lower Rainy River and Rapid River watersheds. For more information on arsenic in private wells, please refer to the MDH's website: https://www.health.state.mn.us/communities/environment/water/wells/waterquality/arsenic.html

Figure 14. Percent wells with arsenic occurrence greater than the MCL for the Lower Rainy River and Rapid River watersheds (2008-2017) (Source: MDH, 2020)



A statewide dataset of potentially contaminated sites and facilities with environmental permits and registrations is available at the MPCA's website, through a web-based application called, "What's In My Neighborhood" (WIMN). This MPCA resource provides the public with a method to access a wide variety of environmental information about communities across the state The data is divided into two groups: 1) potentially contaminated sites, and includes contaminated properties, formerly contaminated sites, and those that are being investigated for suspicion of being contaminated, and 2) businesses that have applied for and received different types of environmental permits and registrations from the MPCA. In the Lower Rainy River and Rapid River watersheds, there are currently 201 active sites identified by WIMN: 53 tanks (aboveground and underground), 38 stormwater sites (construction and industrial), 37 hazardous waste sites, 30 feedlots, 13 subsurface sewage treatment systems (SSTS), nine investigation and cleanup sites (brownfields and petroleum remediation), eight solid waste sites, eight water quality sites (wastewater), four air quality sites, and one pollution prevention site Figure 15. For more information regarding "What's in My Neighborhood", refer to the MPCA webpage: http://www.pca.state.mn.us/index.php/data/wimn-whats-in-my-neighborhood/whats-in-my-neighborhood.html.

Figure 15. Active "What's In My Neighborhood" site programs and locations for the Lower Rainy River and Rapid River watersheds (Source: MPCA, 2020)



Groundwater quantity

The Minnesota Department of Natural Resources (DNR) 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 usage to the DNR annually. The three largest permitted consumers of water in the state are (in order) power generation, public water supply (municipals), and industrial processing (DNR, 2020b). According to the DNR Permitting and Reporting System (MPARS), in 2017, the withdrawals within the Lower Rainy River and Rapid River watersheds collectively were primarily utilized for agricultural irrigation (63.4%) and water supply (27.7%). The remaining withdrawals include non-crop irrigation (5.5%), special categories (construction dewatering, snow/ice making, dust control) (2.9%), and industrial processing (0.5%). Withdrawals associated with agricultural irrigation, water supply and non-crop irrigation have demonstrated a decline in withdrawals from 1998 to 2017 ($p<0.05$, $p<0.05$, and $p<0.01$, respectively), while the remaining categories did not have adequate data available to conduct statistical analysis.

Figure 16 displays total high-capacity withdrawal locations within the watersheds. During 1998 to 2017, groundwater Figure 17 and surface water Figure 18 withdrawals within the Lower Rainy River and Rapid River watersheds have been decreasing ($p<0.05$ and $p<0.01$, respectively).

Figure 16. Locations of permitted high capacity withdrawals within the Lower Rainy River and Rapid River watersheds.

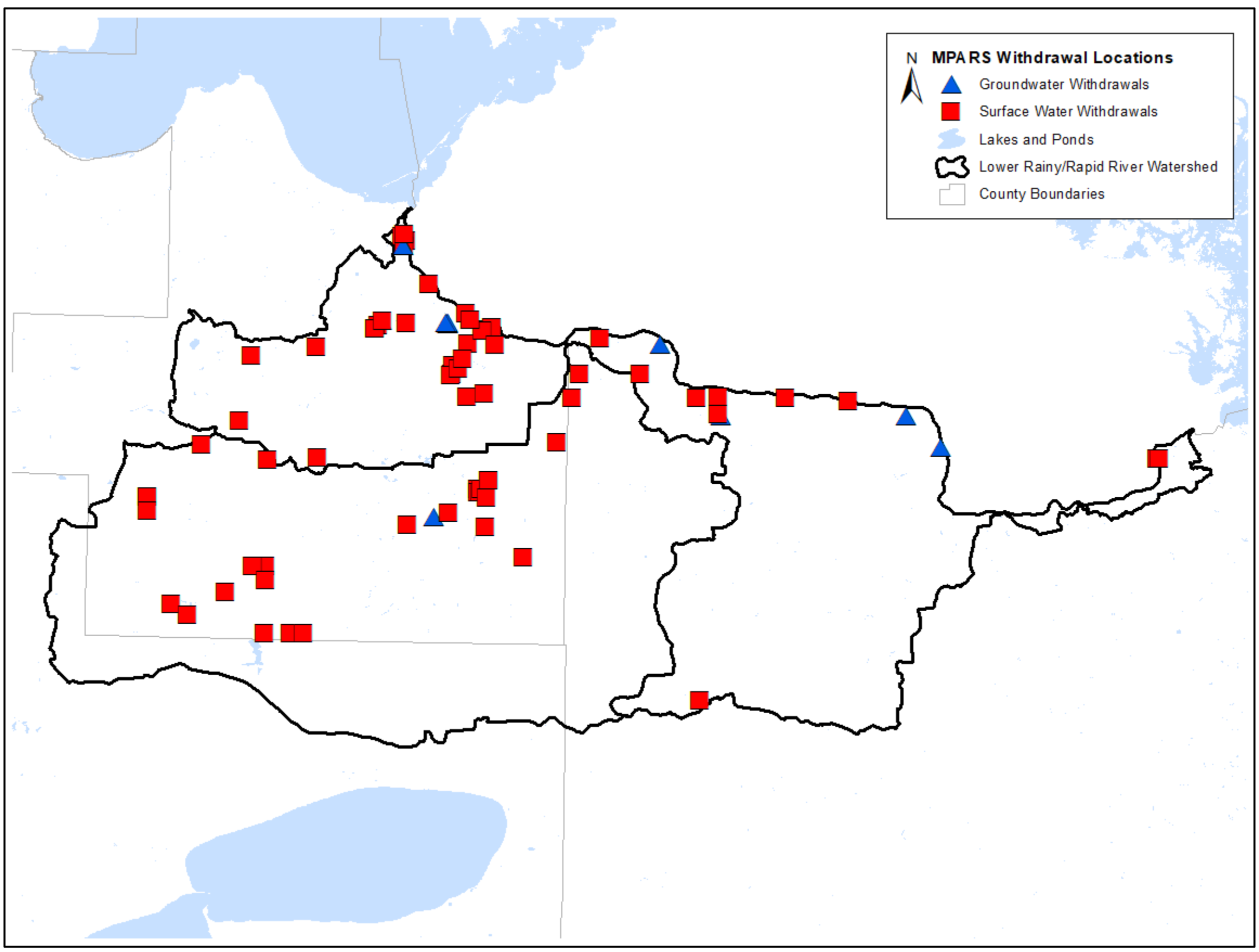


Figure 17. Total annual groundwater withdrawals in the Lower Rainy River and Rapid River watersheds (1998-2017)

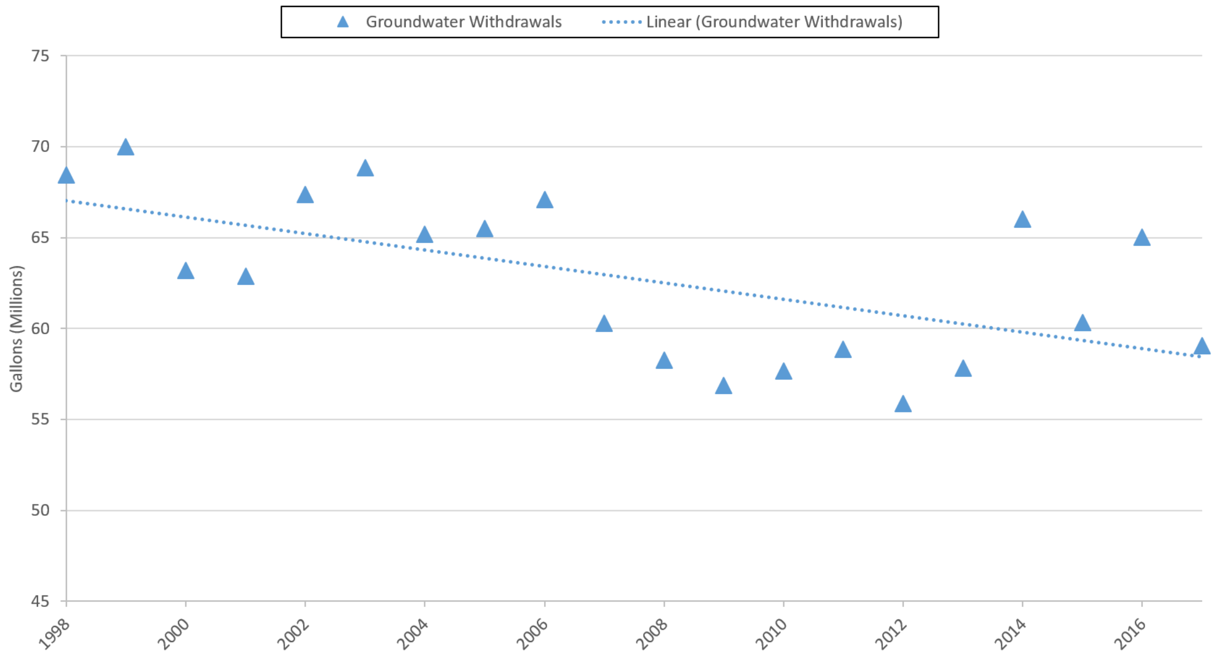
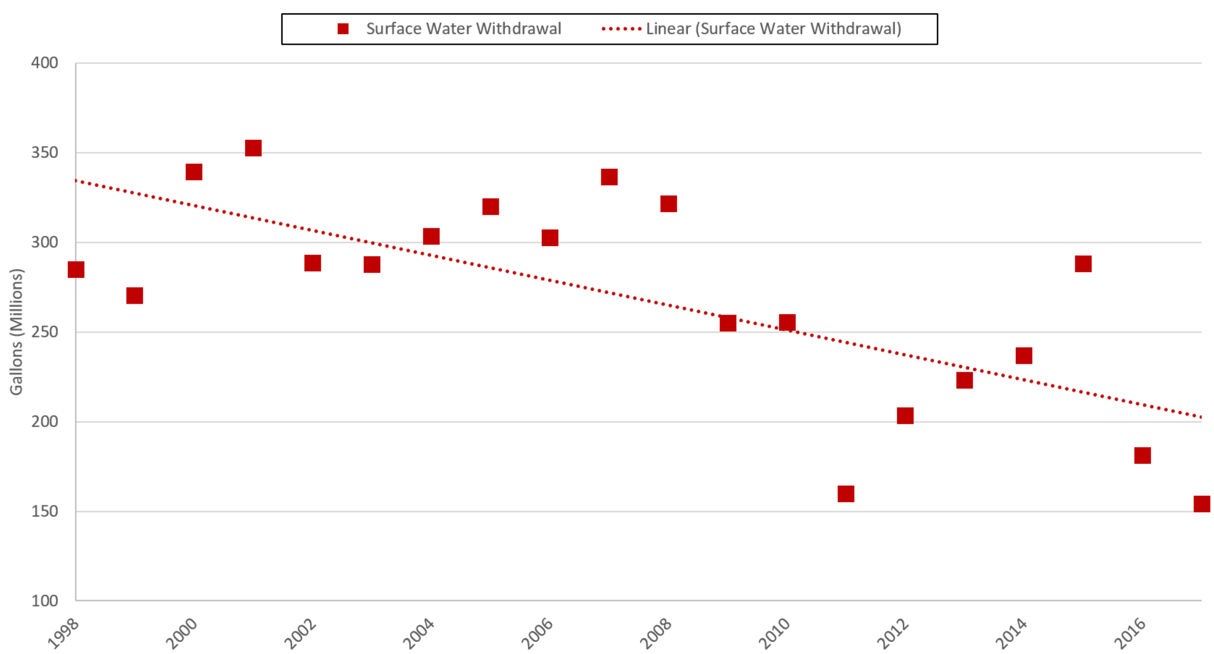


Figure 18. Total annual surface water withdrawals in the Lower Rainy River and Rapid River watersheds (1998-2017)



Wetlands

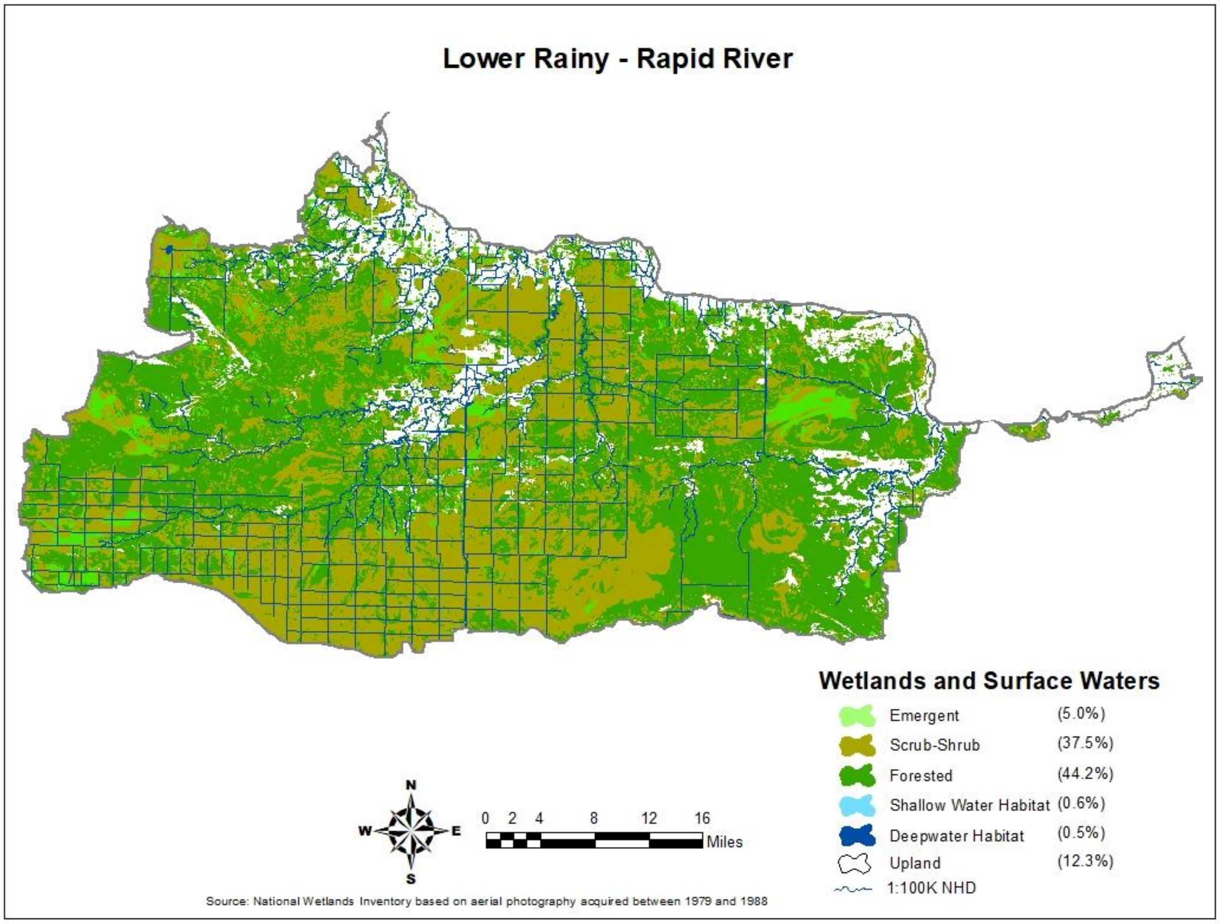
Wetlands are the predominant feature in the Lower Rainy River and Rapid River watersheds. National Wetlands Inventory data estimates 985,246 acres of wetlands—which cover approximately 87% of the watersheds Figure 19. The Lower Rainy River and Rapid River watersheds have the most wetlands of any major watershed in Minnesota. Coniferous swamps and bogs (i.e., forested wetlands) are the most abundant wetland type Figure 19 and are primarily composed of black spruce, tamarack, and/or white cedar. Scrub-shrub wetland (chiefly in the form of open bogs that have a carpet of Sphagnum moss and abundant low ericaceous shrubs), is also extensive in the Lower Rainy River and Rapid River watersheds.

The abundance and type of wetlands in the watershed are due to the glacial lake plain landform that it occurs in and the cool-wet climate of the region (MNGS 2017). The extremely flat landscape that remained following the retreat of Glacial Lake Agassiz had little capacity to drain surface water—promoting saturated soil conditions over expansive areas. Large peatlands formed as undecayed plant material accumulated vertically on saturated soils. The predominant water exchange in peatlands is through precipitation and evapotranspiration. As peat has low hydrologic conductivity, excess precipitation can slowly runoff via overland saturation flow along very low elevation gradients—providing source water for streams (Acreman and Holden 2013). This water often has low pH, low dissolved oxygen, and is high in dissolved organic matter. Most, if not all, of the natural stream channels in the Lower Rainy River and Rapid River watersheds appear to largely come from peatland overland saturation flow.

Despite concerted efforts, nearly all of the pre-settlement wetlands remain in the Lower Rainy River and Rapid River watersheds. The extensive ditch networks created in the 1910's-20's in the Red Lake Peatland were an attempt to develop the area for agricultural development, but were largely unsuccessful. Effective drainage and development were limited to areas along the main-stem of the Rapid and Rainy rivers. While the ditching likely increased peak stream flows in the watershed, wetland impacts were typically localized in proximity to the ditches where peat subsidence and increased tree growth rates can occur (Wright et al. 1992). An exception to this, is that the natural westerly water flow of the of the Red Lake Peatland in proximity of Highway 72 has been disrupted by the ditch network and road bed leading to more widespread peat subsidence and tree growth (Wright et al. 1992).

The most notable wetland features in these watersheds are the large patterned peatlands that have formed the distinctive and striking patterns of raised bogs and water tracks. Some water tracks are enriched with mineral rich groundwater that is forced through the peat via artesian pressure. Northern rich fen plant communities are found in these water tracks that support a number of rare plant species. Large patterned peatlands have been protected in the Red Lake, North, and South Black River Peatland Scientific and Natural Areas as well as on Red Lake Indian Reservation. In addition to the peatlands, wild rice populations have been documented on the Rainy River and several tributaries near Baudette, Minnesota.

Figure 19. Wetlands and surface water in the Lower Rainy River and Rapid River watersheds. Watershed coverage by general wetland type is provided in the legend.



Watershed-wide data collection methodology

Stream water sampling

Four water chemistry stations were sampled within the Rapid River Watershed from May through September in 2017, and again June through August of 2018, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Six water chemistry stations were sampled within the Lower Rainy River Watershed following the same schedule. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12-HUC subwatershed that was greater than 40 square miles in area (green and red circles in (Figure 2). A Surface Water Assessment Grant was awarded to the Lake of the Woods County Soil and Water Conservation District to conduct the water chemistry monitoring for both watersheds (See Appendix 2.1 and Appendix 2.2 for locations of stream water chemistry monitoring sites). See Appendix 1 for definitions of stream chemistry analytes monitored in this study). Seven subwatersheds did not have water chemistry stations due to small subwatershed size or lack of representative stream location for this monitoring effort.

Stream flow methodology

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

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring (IWM) in the Lower Rainy River and Rapid River watersheds was undertaken during the summers of 2017 and 2018. A total of 21 sites were established across the Lower Rainy River Watershed. In the Rapid River Watershed a total of 14 sites were established. These sites were located near the outlets of most minor 14-HUC watersheds when possible. In addition, three existing biological monitoring stations within the Rapid River Watershed were revisited. 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 and 2018. Low-flow conditions in both 2017 and 2018 prevented a number of sites from being sampled. In total, 15 WIDs were successfully sampled for biology in the Lower Rainy River Watershed. In the Rapid River Watershed, a total number of 12 WIDs were successfully sampled for biology. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically fish and macroinvertebrate IBIs, were calculated based on monitoring data collected for each of these communities. Fish and macroinvertebrate classification frameworks were 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). Any 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 Appendix 3.2, 3.3, 3.4, and 3.5.

Fish contaminants

The DNR fisheries staff collect most of the fish for the Fish Contaminant Monitoring Program. In addition, MPCA's biomonitoring staff collect up to five piscivorous (top predator) fish and five forage fish near the major watershed pour point as part of IWM. 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 were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 60-milliliter (mL) glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzed the samples for mercury and PCBs. If fish were tested for perfluorochemicals (PFCs), whole fish were shipped to AXYS Analytical Laboratory, which prepared and analyzed the homogenized fish fillets for 13 PFCs. Of the measured PFCs, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and has a reference dose. The MPCA determines which waters exceed impairment thresholds based on the fish contaminant analysis. The MPCA prepares and submits the Impaired Waters List to the U.S. Environmental Protection Agency (EPA) every even-numbered year. The MPCA has included waters impaired for contaminants in fish on the federal 303(d) Impaired Waters List since 1998. Impairment assessment for PCBs (and PFOS when tested) in fish tissue are based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week, the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 milligrams per kilogram (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 also 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 2006, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory, similar to 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 10% of the fish samples (measured as the 90^{th} percentile) exceed 0.2 mg/kg of mercury. At least five fish samples of the same species are required to make this assessment and only the last ten years of data are used for the assessment. The MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

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 FLUX32 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 (NO3+NO2-N), and total Kjeldahl nitrogen (TKN). More information can be found at the WPLMN website.

Pollutant load monitoring did not take place within either the Lower Rainy River or Rapid River 8-HUC watersheds. One site has been sampled on the Rainy River (not part of either watershed).

Groundwater monitoring

The MPCA maintains an Ambient Groundwater Monitoring Network that monitors the aquifers that are most likely to be polluted with non-agricultural chemicals. The purpose is to identify any changes in groundwater quality from normal, day-to-day practices. This network primarily targets shallow aquifers that underlie areas in urban areas, due to the higher tendency of vulnerability to pollution, and acts as an 'early warning system' for groundwater quality changes. The MPCA's Ambient Groundwater Monitoring Network consists of approximately 270 wells, most of which are shallow monitoring wells in sand and gravel aquifers, but also include deeper domestic wells, often located in the Prairie du Chien-Jordan aquifers.

Most wells in this early warning network contain water that was recently recharged into the groundwater, some even less than one year old. The wells in the early warning network are distributed among several different settings to determine the effect land use has on groundwater quality. These assessed land use settings are: 1) sewered residential, 2) residential areas that use subsurface sewage treatment systems (SSTS) for wastewater disposal, and 3) commercial or industrial, and 4) undeveloped (remote forested areas). The data collected from the wells in the undeveloped areas provide a baseline to assess the extent of any pollution from all other land use settings.

Water samples from the network wells generally are collected annually by MPCA staff. This sampling frequency provides sufficient information to determine trends in groundwater quality. The water samples are analyzed to determine the concentrations of over 100 chemicals, including nitrate, chloride, and VOCs. Furthermore, a subset of PFAS and CEC samples are collected in addition to the ambient groundwater suite.

Information on groundwater monitoring methodology is taken from "The Condition of Minnesota's Groundwater Quality", 2013-2017 (2019). To download ambient groundwater monitoring data, please refer to: https://www.pca.state.mn.us/data/groundwater-data

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 be indicating a response to human-caused impacts. The MPCA has developed IBIs to monitor the macroinvertebrate condition of depressional wetlands that have open water and the 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: https://www.pca.state.mn.us/water/wetland-monitoring

The MPCA currently does not monitor wetlands systematically by watershed. Alternatively, the overall status and trends of wetland quality in the state and by major ecoregion is being tracked through probabilistic monitoring. Probabilistic monitoring refers to the process of randomly selecting sites to monitor; from which, an unbiased estimate of the resource can be made. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

As few open water depressional wetlands exist in the watershed the focus will be on vegetation quality results of all wetland types.

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 larger 8-HUC watersheds respectively. 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 2017 assessment cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2017 intensive watershed monitoring (IWM) effort, but also considers available data from the last ten years. As drought conditions restricted our sampling efforts in 2017, a significant portion of the data collected in this assessment cycle collected the following summer in 2018.

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 stream aquatic life and aquatic recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the aggregated 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 assessed 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 Flowchart of aquatic life use assessment process). 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 (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*E. 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 exist, 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. For clarity, subwatershed results are organized by 8-HUC Watershed (Lower Rainy River or Rapid River). As no lakes have been monitored within the Lower Rainy River or Rapid River watersheds, summaries of lake water quality for subwatersheds will not be included.

Lower Rainy River subwatershed results

Subwatersheds Included: **Winter Road River, Peppermint Creek, Baudette River, Lower Rainy River, Black River, West Fork Black River, Middle Rainy River, *South Fork Black River, *Trib. to Black River**

*No information available. Results table and map not included.

Winter Road River Aggregated 12-HUC HUC 0903000806-01

The Winter Road River Subwatershed drains 83 square miles of land in the north central portion of the Lower Rainy River Watershed that lies mostly in Lake of the Woods County. The Winter Road River originates from the Winter Road Lake Peatland SNA and flows eastward for 30 miles before it is joined by Peppermint Creek just south of Minnesota Route 11. From its confluence with Peppermint Creek, the Winter Road River flows nine miles northwest through pasture and cropland to its confluence with the Rainy River. As with most of the Lower Rainy River Watershed, the landscape within this subwatershed is dominated by peat bogs and wetlands. Over 86% of the total land area in this subwatershed is comprised of wetlands with the majority of the watershed's developed land located near the community of Pitt and along the banks of the Rainy River. Much of the western portion of the watershed, and all of the land area west of Lake of the Woods County Highway 2 lies within the Beltrami State forest. Kelley Dam, a small earthen dam maintained by the DNR Fisheries Division, is located directly south of Winter Road Lake and represents the only dam found within both the Lower Rainy River and Rapid River watersheds.

Table 2. Aquatic life and recreation assessments on stream reaches: Winter Road 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: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030008-521 ***Unnamed Ditch,*** *Unnamed Ditch to Winter Road R*	17RN022	1.19	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--
09030008-506 ***Winter Road River,*** *Headwaters to Peppermint Cr*	17RN021, 17RN025	30.24	WWg	MTS	MTS	IF	IF	MTS	--	IF	IF	--	IF	SUP	--
09030008-502 ***Winter Road River,*** *Peppermint Cr to Rainy R*	17RN024	9	WWg	MTS	MTS	IF	IC	MTS	MTS	MTS	MTS	--	MTS	SUP	IC

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information

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

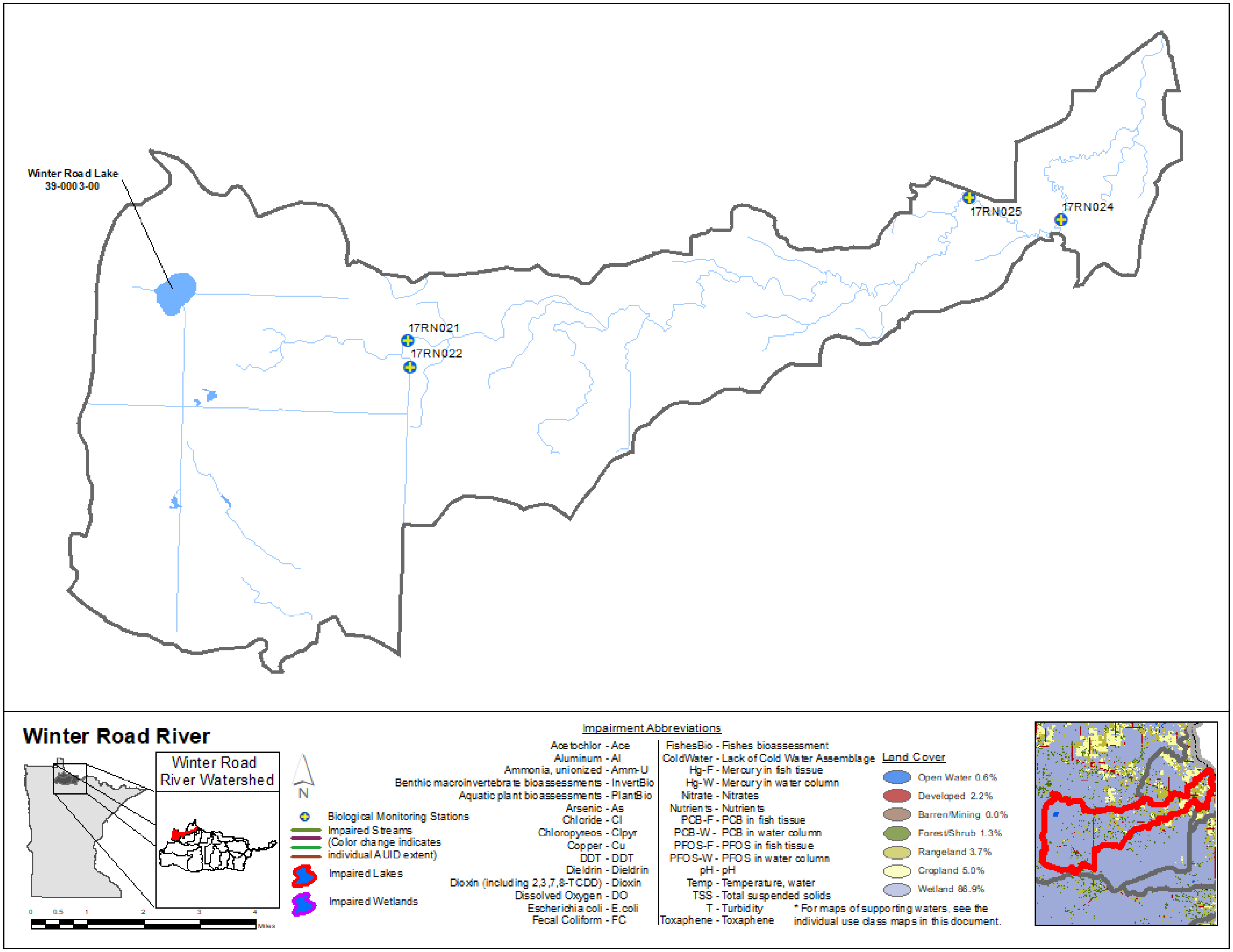
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Aquatic life indicators within the Winter Road Subwatershed indicate good water quality. In spite of the low flows experienced during the summer of 2018, macroinvertebrate communities sampled at both 17RN024 and 17RN025 yielded M-IBI scores well above the impairment threshold. A variety of stenothermic taxa (i.e., taxa that have specific thermal requirements for survival) including *Somatochlora minor* (17RN024), *Lype diversa*, and *Lepidostoma sp.* (17RN025) were collected at both sites. The presence of stenothermic macroinvertebrate taxa suggests there may be some groundwater contribution to this system that sustain favorable conditions for benthic macroinvertebrates. A relatively high diversity of fish species (29) were captured during monitoring of this subwatershed. Several sensitive species (mottled sculpin, silver lamprey, hornyhead chub, etc.) were present indicating excellent water quality. All F-IBI scores were exceptional indicating that this entire subwatershed drainage, including its tributaries, are in excellent biological condition.

Suspended sediment concentrations in the downstream reach of the Winter Road River indicates a system that could be vulnerable to future increases in sedimentation from the contributing watershed. However, an extensive clarity dataset (a surrogate for suspended sediment) does not support an impairment listing at this time. Protection from landscape disturbances that increase sediment mobilization and transport should be considered important to prevent future stress to aquatic life in the system. Bacterial contamination does not appear to be a significant problem for recreational use. A solitary bacteria exceedance is the result of an anomalous flow event in 2017.

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Winter Road River Aggregated 12-HUC.



Peppermint Creek Aggregated 12-HUC HUC 0903000806-02

The Peppermint Creek Subwatershed drains 64 square miles of Lake of the Woods County southwest of the community of Pitt. Peppermint Creek originates from a series of wetlands within the Beltrami Island State Forest and winds northeast for 15 miles before joining with the Winter Road River. Several unnamed ditches and small tributary streams join Peppermint Creek along its flow path. These streams include Little Peppermint Creek (-528) and Unnamed Ditch/Pitt Creek (-510). Pitt Creek is designated as a trout stream and stocked seasonally with Rainbow and Brown Trout. Like most of the Lower Rainy River Watershed, the land within the Peppermint Creek Subwatershed is predominately peat bog and wetland. Over 94% of the total land area in the subwatershed is comprised of wetlands. The limited amount of agricultural land use in this subwatershed (3.9 %) primarily occurs along the lower reaches of Peppermint Creek.

Table 3. Aquatic life and recreation assessments on stream reaches: Peppermint 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		
09030008-510 ***Unnamed ditch (Pitt Creek),*** *T159 R32W S16, south line to Peppermint Cr*	17RN028	5.51	CWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--
09030008-528 ***Little Peppermint Creek,*** *Unnamed Cr to Peppermint Cr*	17RN027	3.54	WWg	MTS	--	--	--	--	--	--	--	--	--	SUP	--
09030008-507 ***Peppermint Creek,*** *Headwaters to Winter Road R*	17RN026, 17RN029	15.26	WWg	MTS	--	IF	MTS	MTS	MTS	MTS	MTS	--	IF	SUP	IC

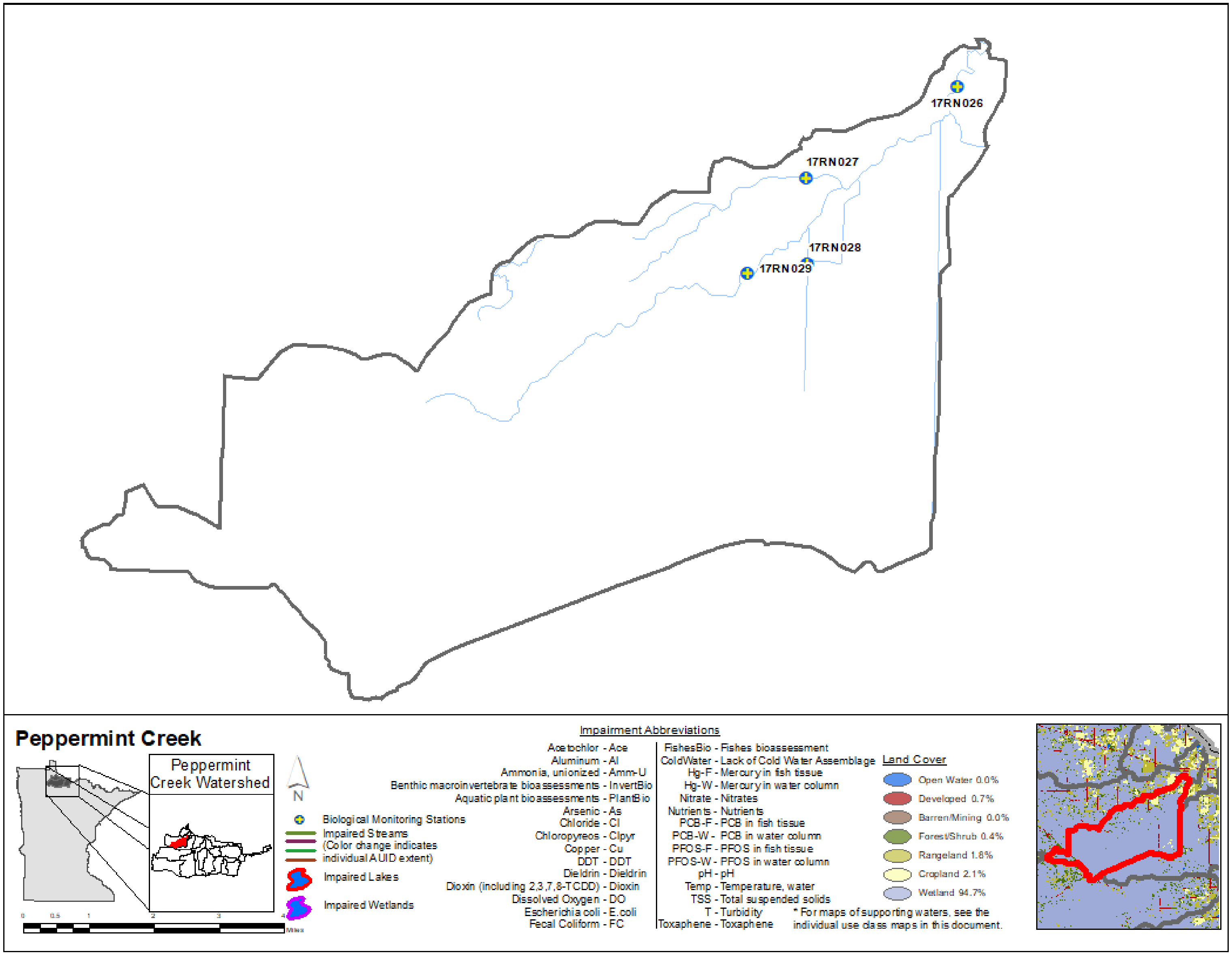
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Biological communities within the Peppermint Creek Subwatershed indicate good water quality. Macroinvertebrate samples were not collected in this subwatershed due to low water conditions. However, all F-IBI scores were above the impairment threshold, indicating good water quality. A total of 15 fish species were captured, and the fish community structure was similar between all three biological monitoring stations. Unnamed ditch/Pitt Creek (-510) is the only cold water resource (CWg) within the Lower Rainy River and Rapid River watersheds and is stocked annually as a put-and-take trout fishery. Both yearling Rainbow and Brown Trout have been stocked seasonally at Pitt Creek's confluence with Peppermint Creek to four miles upstream. Rainbow Trout were the only cold-water fish species captured during monitoring of Pitt Creek, with lengths between 276-334 mm. The F-IBI score for this station barely exceeded the impairment threshold and would fail without the stocked fish present within the sample. One additional Rainbow Trout was captured further downstream on a cool/warm-water section of Peppermint Creek (-507).

Assessable water chemistry data are limited to the downstream reach of Peppermint Creek. Bacteria data are incomplete but the available data suggests that recreational water quality is borderline poor due to bacterial contamination. Aquatic life use parameters (e.g., dissolved oxygen and suspended solids) do not appear to be significant stressors to aquatic communities.

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



Baudette River Aggregated 12-HUC HUC 0903000807-02

The Baudette River Subwatershed drains 59 square miles of land within the eastern portion of the Lower Rainy River Watershed. The Baudette River originates from a wetland located within the Lake of the Woods State Forest, near the southern edge of the Lower Rainy River Watershed. The river flows northeast for approximately 13 miles before it is joined by the West Fork of the Baudette River. The West Fork of the Baudette River drains agricultural land along the western edge of the subwatershed. From its confluence with its West Fork, the Baudette River continues flowing north-northeast for roughly seven miles and enters the Rainy River near the town of Baudette where it widens into a shallow bay. Numerous small ditches and unnamed tributaries enter the Baudette River along its 20-mile course to the Rainy River. Over 86% of the total land area within the subwatershed is comprised of wetland. Agricultural land use (rangeland and row crop) accounts for 10.8% of the subwatershed land area in the central and lower portion of the subwatershed. Only 2.8% of the land in the subwatershed is developed; most development is located in and around the city of Baudette and along the lower reaches of the Baudette River.

Table 4. Aquatic life and recreation assessments on stream reaches: Baudette 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: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030008-535 ***Baudette River,*** *Headwaters to Unnamed Cr*	17RN031, 17RN082	17.79	WWg	MTS	--	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	SUP	--
09030008-536 ***Baudette River,*** *Unnamed Cr to Rainy R*	--	2.55	WWg	--	--	EXS	MTS	MTS	--	MTS	--	--	MTS	IF	SUP

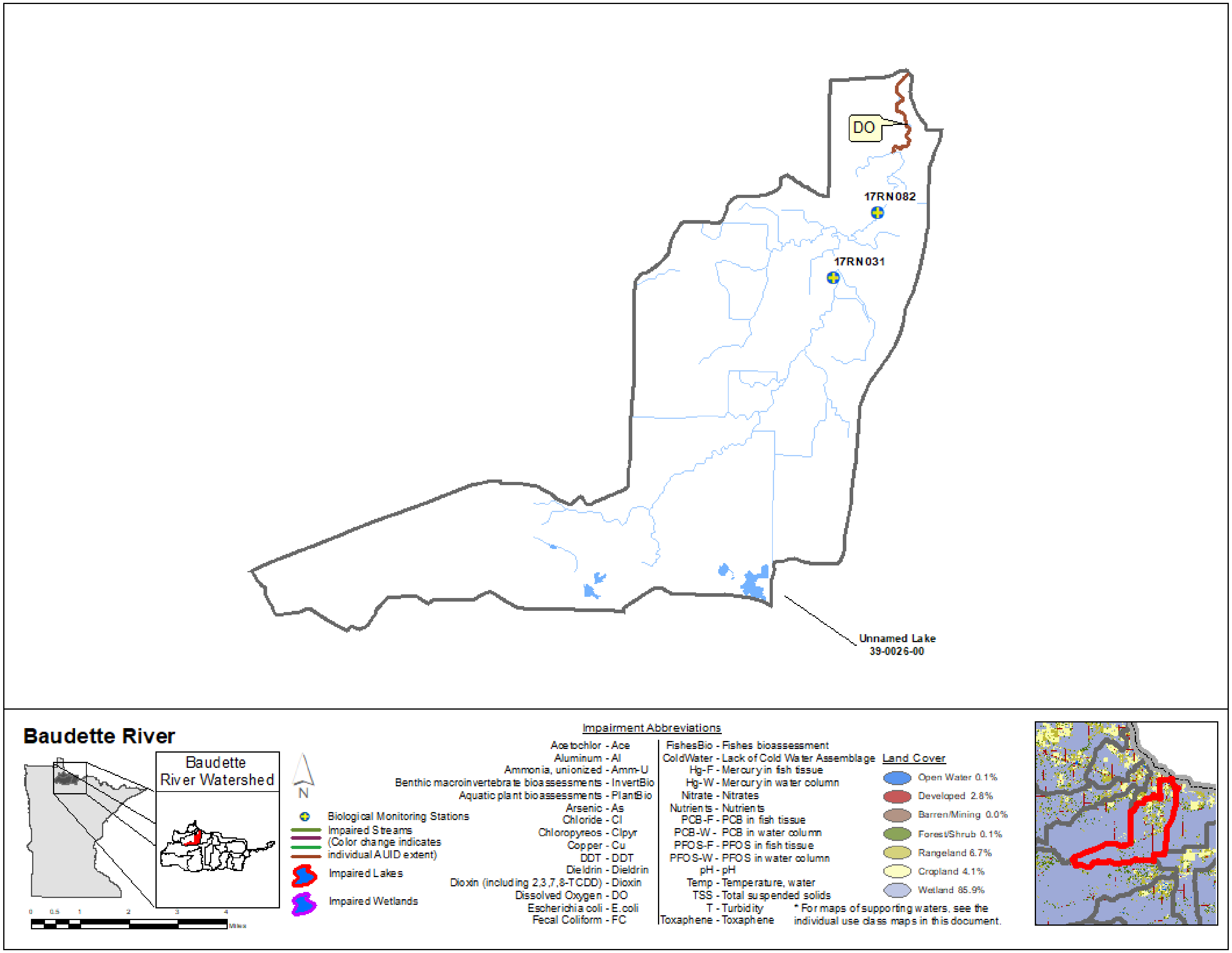
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Due to low flows in 2017 and 2018, no assessable aquatic macroinvertebrate samples were collected in the Baudette River Subwatershed. A total of 21 fish species were captured between two stations on the Baudette River, with F-IBI scores at both stations indicating good water quality. The fish community sampled at the upstream station (17RN031) scored above the exceptional use threshold (MPCA's highest use class designation). The sample contained numerous lithophilic spawners (species requiring clean coarse substrate to spawn) and several sensitive taxa that indicate good water quality conditions. Based on fish data, conditions in this subwatershed indicate good water quality.

Low dissolved oxygen in the downstream reach (-536) of the Baudette River triggered an aquatic life use impairment in 1994. Early morning data collected primarily in 2009 and 2010 indicated oxygen levels met standards during the summer months. However, a number of samples collected in the winter did still exceed the impairment threshold. The assessment is complicated by the fact that backflow from the Rainy River into Baudette Bay combined with the low-gradient, wetland nature of the watershed likely influences dissolved oxygen concentrations. Bacteria concentrations tested at the furthest downstream reach of the Baudette River (-536) indicate support for aquatic recreation.

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



Lower Rainy River Aggregated 12-HUC HUC 0903000807-01

The Lower Rainy River Subwatershed is composed of a conglomeration of small rivers and creeks located along the south bank of the Rainy River from the Rapid River's confluence with the Rainy River to the Rainy River's outlet at the Lake of the Woods. Major streams and rivers included within this subwatershed include, Silver Creek, Miller Creek, Hooper Creek, Wabanica Creek, and Sensky Creek. Silver Creek, the largest of these streams, is located just west of the village of Clementson. Silver Creek drains the entire eastern portion of the subwatershed. Numerous ditches and small, unnamed tributaries drain into Silver Creek. The Miller Creek drainage is located two miles west of Baudette; approximately half of this seven-mile long stream has been channelized. The Wabanica and Hooper Creek drainages are within the far northern lobe of the Lower Rainy River Watershed. When compared to other subwatersheds, agricultural land use (23.4%) is more prevalent. As with other subwatersheds, peat bogs and wetlands largely dominate the landscape, accounting for 70% of the land area. Most of the population within this subwatershed, and consequently developed land (3.3%), is located directly along the bank of the Rainy River.

Table 5. Aquatic life and recreation assessment on stream reaches: Lower Rainy River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

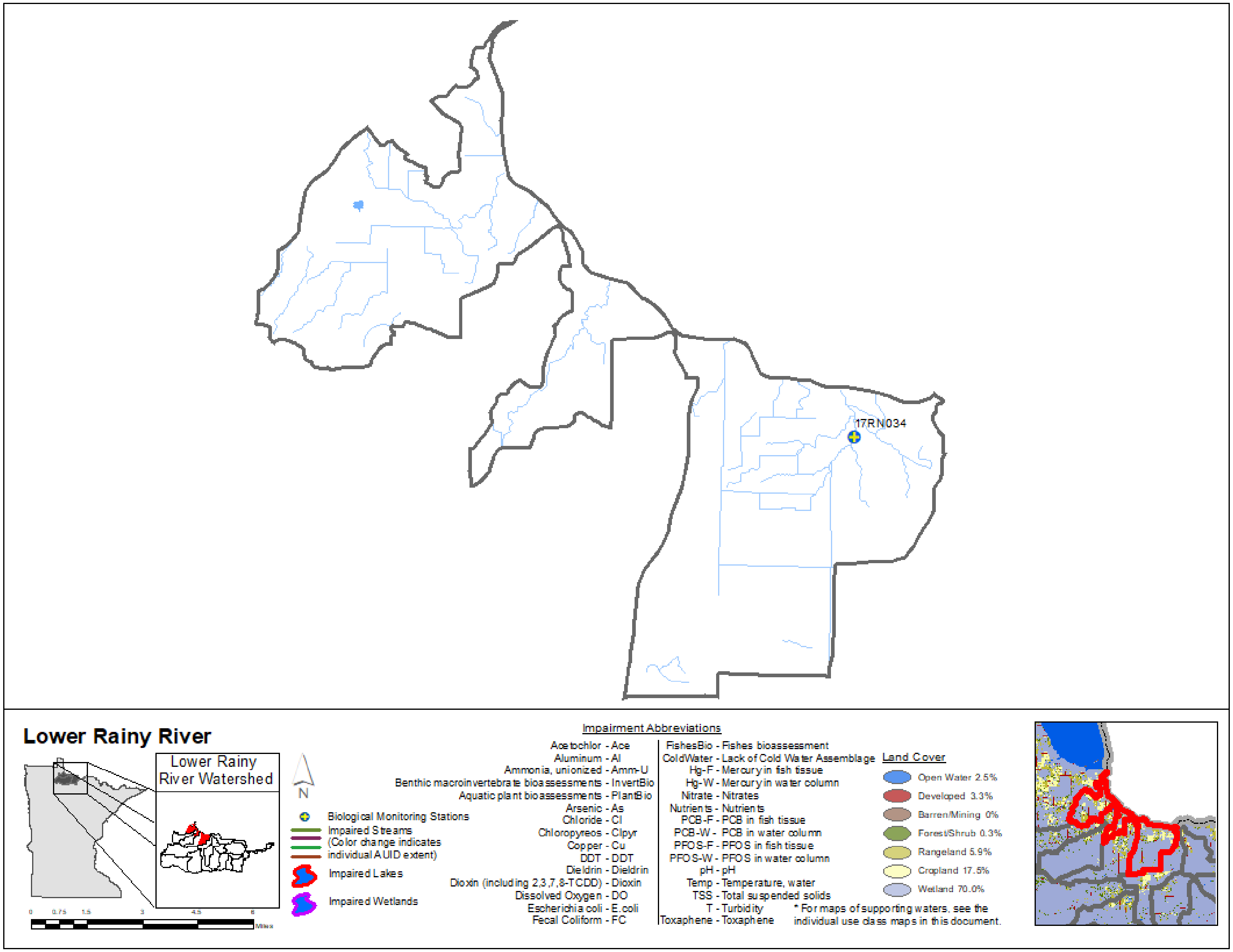
WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:**										**Aquatic life**	**Aquatic rec. (Bacteria)**
				Fish IBI	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides**	**Eutrophication**		
09030008-511 ***Silver Creek,*** *W Br Silver Cr to E Br Silver Cr*	17RN034	0.91	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information; = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Only one biological monitoring station, located on Silver Creek, was sampled for fish in this subwatershed. Both macroinvertebrates and water chemistry data were not collected due largely to low-flow conditions experienced within the IWM sampling (2017-2018) period. A total of ten fish species were captured, including some sensitive species (such as longnose dace & burbot) and multiple lithophilic spawning species (species requiring clean coarse substrate to spawn). The fish community at station 17RN034 is indicative of good water quality within Silver Creek.

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Lower Rainy River Aggregated 12-HUC.



Black River Aggregated 12-HUC HUC 0903000803-01

The Black River Subwatershed drains 136 square miles of land within Koochiching County. The Black River is the primary watercourse in this subwatershed, flowing 48 miles from its headwaters to its confluence with the Rainy River. Major tributaries to the Black River include the South Fork Black River and an unnamed tributary that joins the main stem of the Black River from the south. The South Fork Black River joins the main stem of the Black River near the small community of Fairland. The West Fork of the Black River joins the Black River 0.5 miles upstream of its confluence with the Rainy River. More than 70% of the subwatershed lies within Pine Island State Forest; most privately owned land is concentrated near Loman. Development accounts for only 0.8 % of the subwatershed land use. More than 95% of the land within this subwatershed consists of wetlands and peat bogs.

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

				Aquatic life indicators:											
WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides**	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
09030008-563 ***Unnamed Creek,*** *Unnamed Ditch to Black R*	17RN047	7.85	WWg	IC	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
09030008-545 ***Black River,*** *Headwaters to S Fk Black R*	17RN045, 17RN054	15.61	WWg	MTS	MTS	--	--	--	--	--	--	--	--	SUP	--
09030008-546 ***Black River,*** *S Fk Black R to Unnamed Cr*	10EM193, 17RN100	19.86	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
09030008-547 ***Black River,*** *Unnamed Cr to W Fk Black R*	17RN053	12.38	WWg	MTS	--	IF	EXS	EXS	MTS	MTS	MTS	--	IC	IC	NS

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information

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

Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

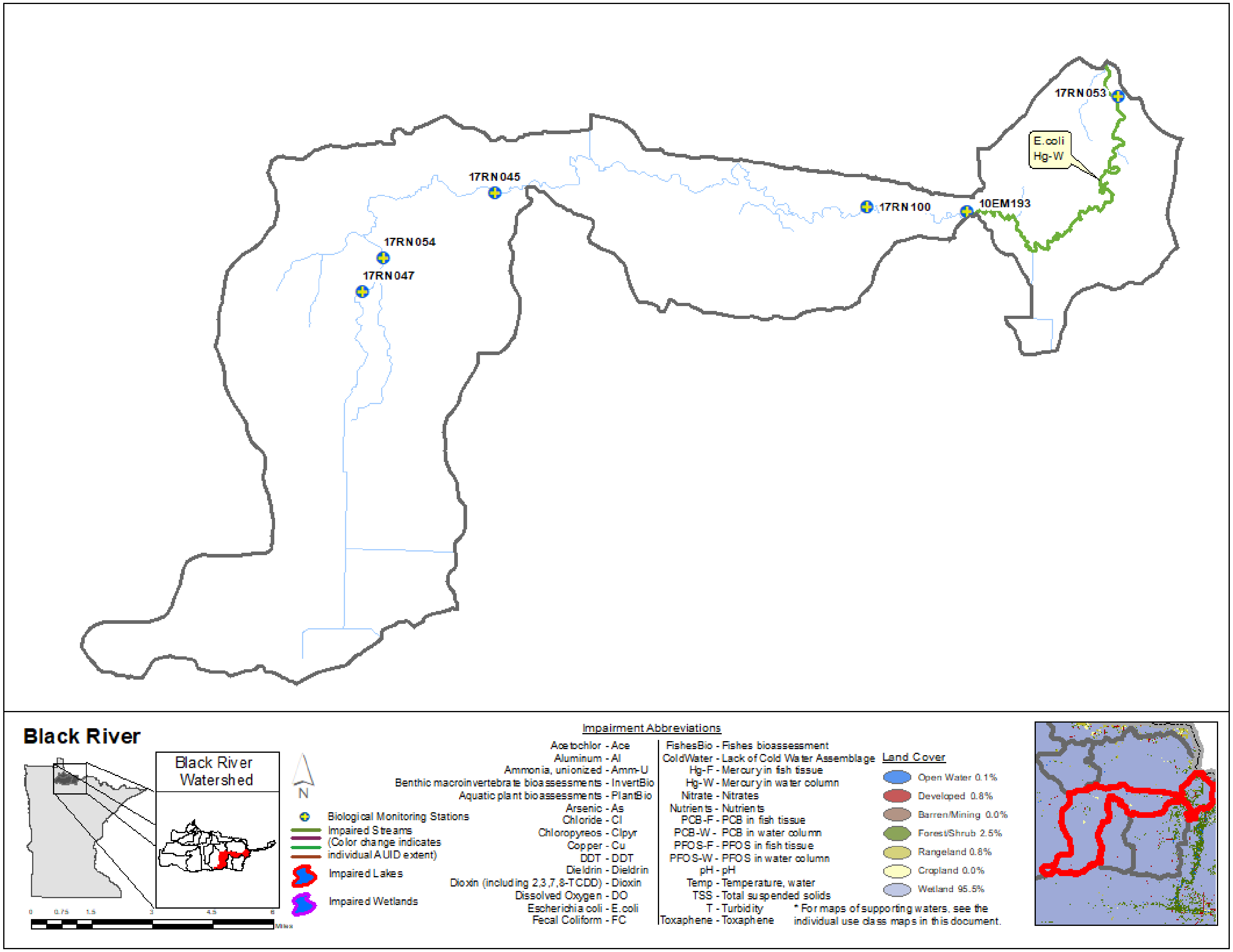
Summary

The biological monitoring results from the Black River Subwatershed are indicative of good water quality. Fish and macroinvertebrate indices of biological integrity (F-MBI and M-IBI) met standards across much of this subwatershed's upper reaches even though low flow conditions persisted throughout most of 2017 and 2018. Where samples could be collected, M-IBI scores consistently met aquatic life use standards. Several sensitive invertebrate taxa were collected in the upper reaches of the Black River, including caddisflies in the genus Lepidostoma and stoneflies in the genus Amphinemura. Both of these sensitive taxa are indicators of good water quality. High sediment concentrations further downstream, near the Black River's confluence with the Rainy River (17RN053), did not appear to have a negative impact on macroinvertebrate communities. Unfortunately, the macroinvertebrate data was not used to assess this reach because stream flow at the time of sampling was very low.

Twenty-seven species of fish and 1,985 individuals were captured from the Black River from its headwaters to its pour point with the Rainy River. Stations downstream of 17RN054 met the exceptional use (high quality water resource) standards for fish, with several sensitive and long-lived species present. Low fish IBI scores in the upper reaches were attributed to natural wetland conditions.

The assessment of aquatic life based on water chemistry indicators contradicted the biological monitoring results along the lower reach of the Black River. High suspended sediment concentrations in the lower Black River suggest that fish or macroinvertebrate communities should perform poorly. Although an assessment could not be made for macroinvertebrates, fish IBI scores are actually quite good in this reach. As a result, the overall aquatic life assessment was inconclusive due to the contradictory results among the chemical and biological indicators. High bacteria levels in the lower Black River indicate poor conditions for aquatic recreation.

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



West Fork Black River Aggregated 12-HUC HUC 0903000802-01

The West Fork Black River Subwatershed drains 127 miles of land across Koochiching County. From its headwaters located in the far western extent of the subwatershed, to its confluence with the Black River at Loman, the West Fork Black River travels 24 miles through predominantly bog and swamp landscape. There is a network of ditches in the headwaters region of the West Fork Black River and several other small unnamed ditches and tributaries enter the river along its flow path. Over 95% of the total land area in the West Fork Black River Subwatershed is comprised of wetlands. Pine Island State Forest and the North Black Peatland Scientific Natural Area are in the headwaters and southern portions of the subwatershed. Development accounts for only 0.4% of the land use within this subwatershed and occurs primarily near Loman and along the Rainy River.

Table 7. Aquatic life and recreation assessments on stream reaches: West fork Black 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		
09030008-543 ***Black River, West Fork*** *Headwaters to Black R*	17RN040	24.71	WWg	MTS	--	IC	IC	EXS	MTS	MTS	MTS	--	IF	SUP	NS

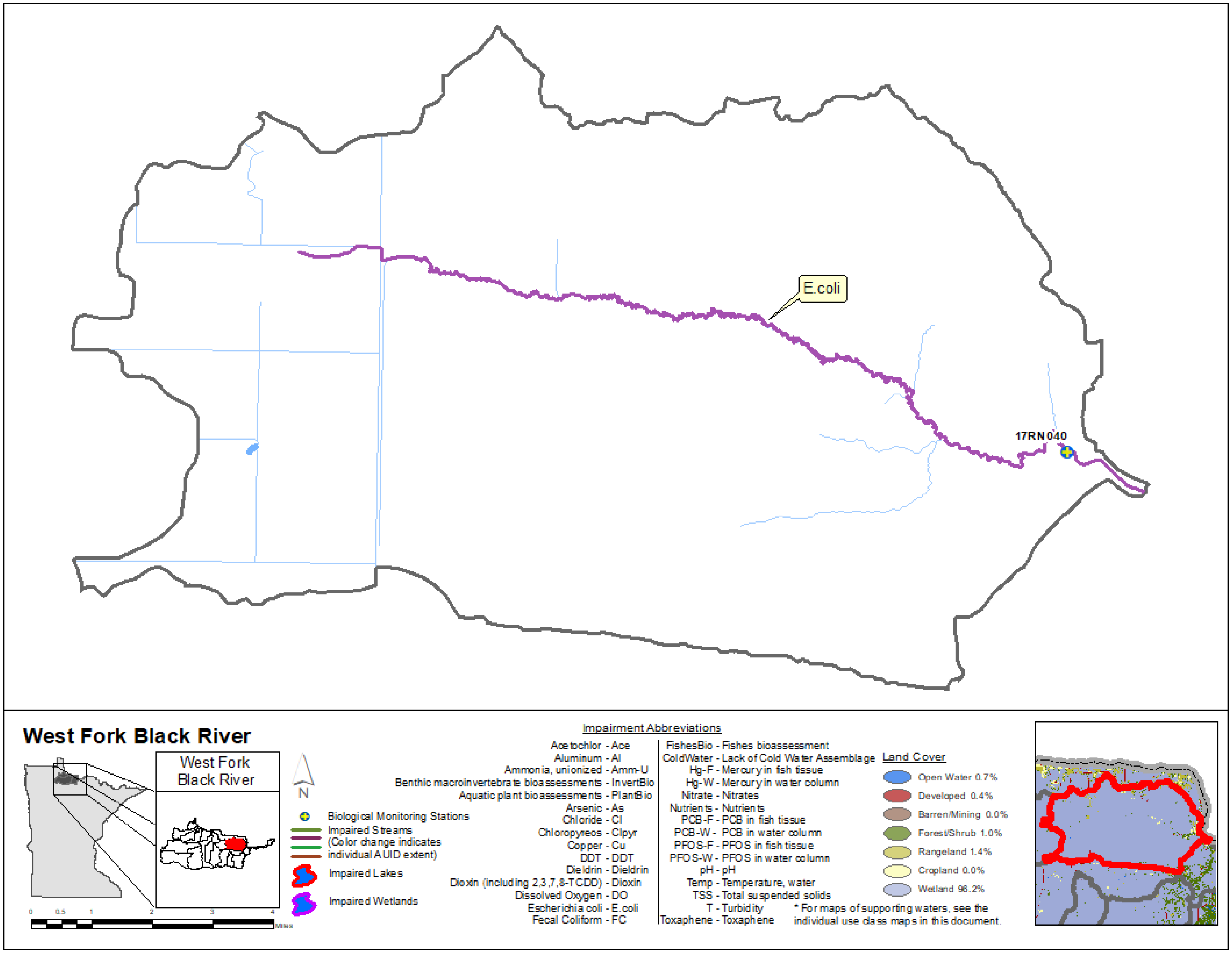
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information; = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Only one station (17RN040) was sampled for both fish and macroinvertebrates due to low-flow conditions in the summer of 2017 and 2018 (IWM sampling). The resulting macroinvertebrate index of biological integrity (M-IBI) score fell well below the general use lower confidence interval; however, this sample was not assessed due to low stream flow conditions at the time of sampling. Two macroinvertebrate samples collected during the summer of 2005 (outside of the assessment window) both score well above the impairment threshold and may provide a more accurate representation of the health of the subwatersheds macroinvertebrate community. Fish data collected from a single visit within the assessment window scored above the impairment threshold (17RN040). Pearl dace were collected in the sample, a sensitive species whose presence indicates that the water quality is good.

The water chemistry data indicates borderline conditions for aquatic communities. Minor exceedances of the dissolved oxygen standard occurred for a short period in 2017 and again in 2018. Suspended sediment levels were also high. Despite the poor water chemistry results, biological communities appear healthy. The potential for stressors due to human activities in this largely undisturbed watershed is low. Given these factors, the reach was not listed as impaired for aquatic life despite high suspended sediment levels. Elevated bacteria concentrations led to a new impairment for aquatic recreations.

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the West Fork Black River Aggregated 12-HUC.



Middle Rainy River Aggregated 12-HUC HUC 0903000805-01

The Middle Rainy River Subwatershed is composed of small rivers and creeks located along the south bank of the Rainy River from the Rapid River to the Rainy Lake Dam at International Falls. Major streams and rivers in this subwatershed include, Moonlight Creek, Burton Creek, and McCloud Creek. McCloud Creek, the largest of these streams is located roughly 3.5 miles west of the community of Birchdale. It flows five miles through crop and pasture-land to its confluence with the Rainy River. Moonlight Creek flows 2.5 miles from is headwaters directly east of International Falls to its confluence to the Rainy River. Burton Creek flows one mile to the Rainy River just east of Manitou. There is more agricultural land (19%) in the Middle Rainy River Subwatershed compared to other subwatersheds. Like the majority of the land in this watershed, bogs and wetlands are prevalent, accounting for 67% of the land area. The city of International Falls, the largest population center in the area, is located at the farthest eastern extent of this subwatershed.

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

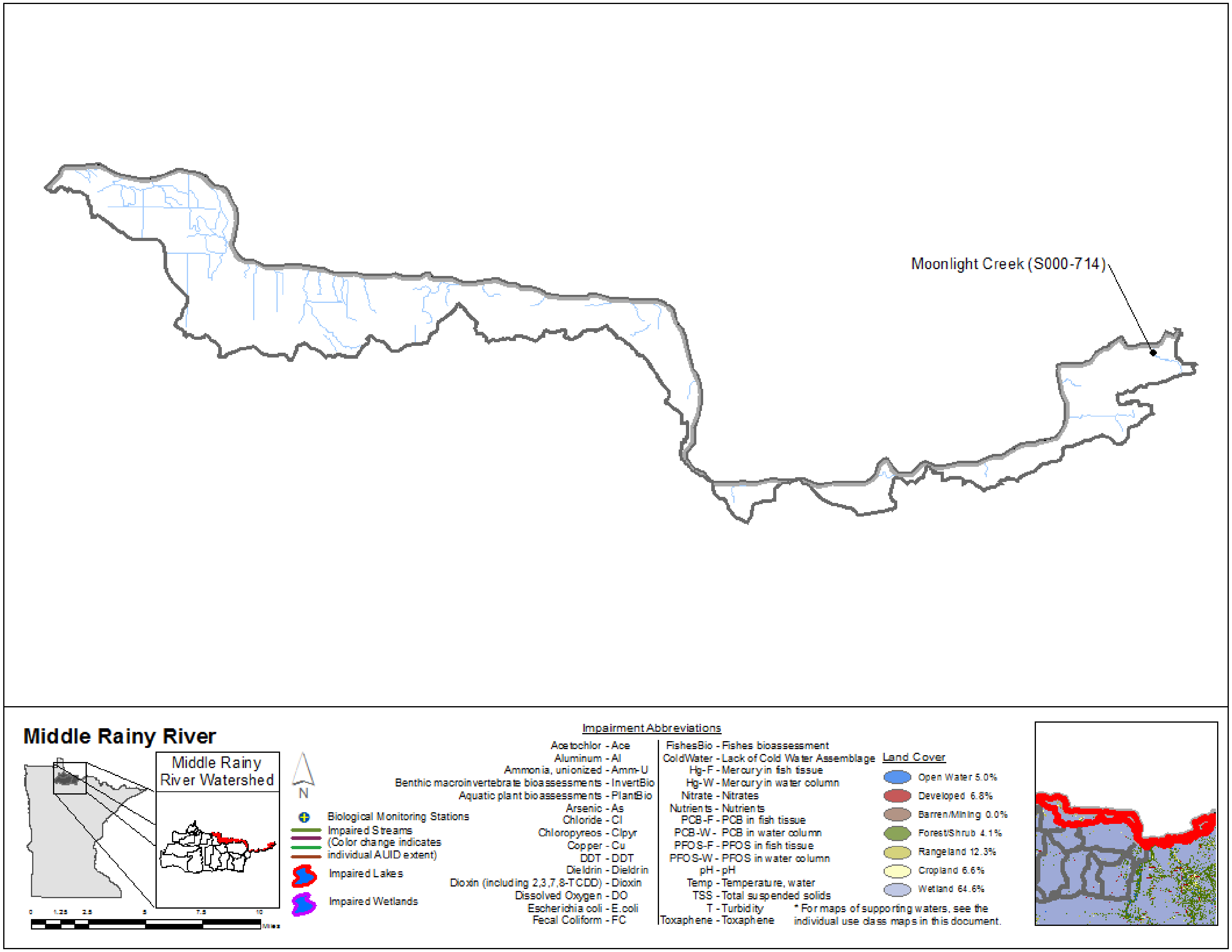
WID ***Reach name,*** *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030008-552 ***Moonlight Creek,*** *Headwaters to Rainy R*	--	2.41	WWg	--	--	MTS	IC	IC	--	MTS	--	--	IF	IC	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Fish and macroinvertebrate communities were not sampled in this subwatershed. Water chemistry data are limited to the downstream reach of Moonlight Creek prior to its confluence with Rainy River (-552). Sampling location on this reach is close to the Rainy Lake Dam. A number of the exceedances noted concurred with high flow events and may have been the result of backwater influence. Dissolved oxygen levels met goals for healthy aquatic communities. Elevated TSS and phosphorus concentrations do exist on this short reach.

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Middle Rainy River Aggregated 12-HUC.



South Fork Black River Aggregated 12-HUC HUC 0903000803-03

The South Fork Black River Subwatershed drains 46 square miles of remote wetland and peat bog terrain directly south of the community of Fairland in Koochiching County. From its source south of the community Fairland, the South Fork Black River flows 10.8 miles to its confluence with the Black River. All of this subwatershed lies within the Pine Island State Forest and/or the South Fork Black River Peatland Scientific Natural Area (SNA). Much of the headwaters of the subwatershed remain ditched as a result of drainage efforts undertaken at the beginning of the 20th century. This subwatershed is very sparsely populated with poor road access and very limited land development. Access and low stream flow issues prohibited sampling of fish, macroinvertebrates, and water chemistry.

Trib to Black River Aggregated 12-HUC HUC 0903000803-02

The Trib. to Black River Subwatershed drains 89 square miles of remote wetland and peat bog terrain southwest of the community of Loman in Koochiching County. An unnamed creek is the watersheds only significant waterway. Two tributaries to the unnamed creek meet 1.2 miles south of Black River Road where they meander two miles north to their confluence with the main stem of the Black River. This subwatershed lies entirely within the Pine Island State Forest and/or the South Fork Black River Peatland Scientific Natural Area (SNA). Approximately 96% of this subwatershed is comprised of wetlands. This subwatershed is very sparsely populated with relatively poor road access and very limited land development. Fish, macroinvertebrate, and water chemistry samples were not collected from this watershed.

Rapid River subwatershed results

Subwatersheds Included**: Upper Rapid River, North Branch Rapid River, Middle Rapid River, Lower Rapid River, Barton's Brook, East Fork Rapid River, *Wing River**

*****No information available. Results table and map not included.

Upper Rapid River Aggregated 12-HUC HUC 0903000701-01

The Upper Rapid River Subwatershed drains 209 square miles of remote ditched wetlands and peat bogs in Beltrami and Lake of the Woods counties. From its source southwest of Oak's Corner, the Rapid River travels east-northeast 35.6 miles until its confluence with Miller Creek. There are no large tributaries in this subwatershed but a series of uniformly spaced ditches drains the landscape into the headwaters of the Rapid River. This subwatershed is sparsely populated and the landscape is minimally developed with 99.5% of the watershed listed as wetland land use. Much of the Upper Rapid River Subwatershed lies within the Beltrami Island State Forest.

Table 9. Aquatic life and recreation assessments on stream reaches: Upper Rapid River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

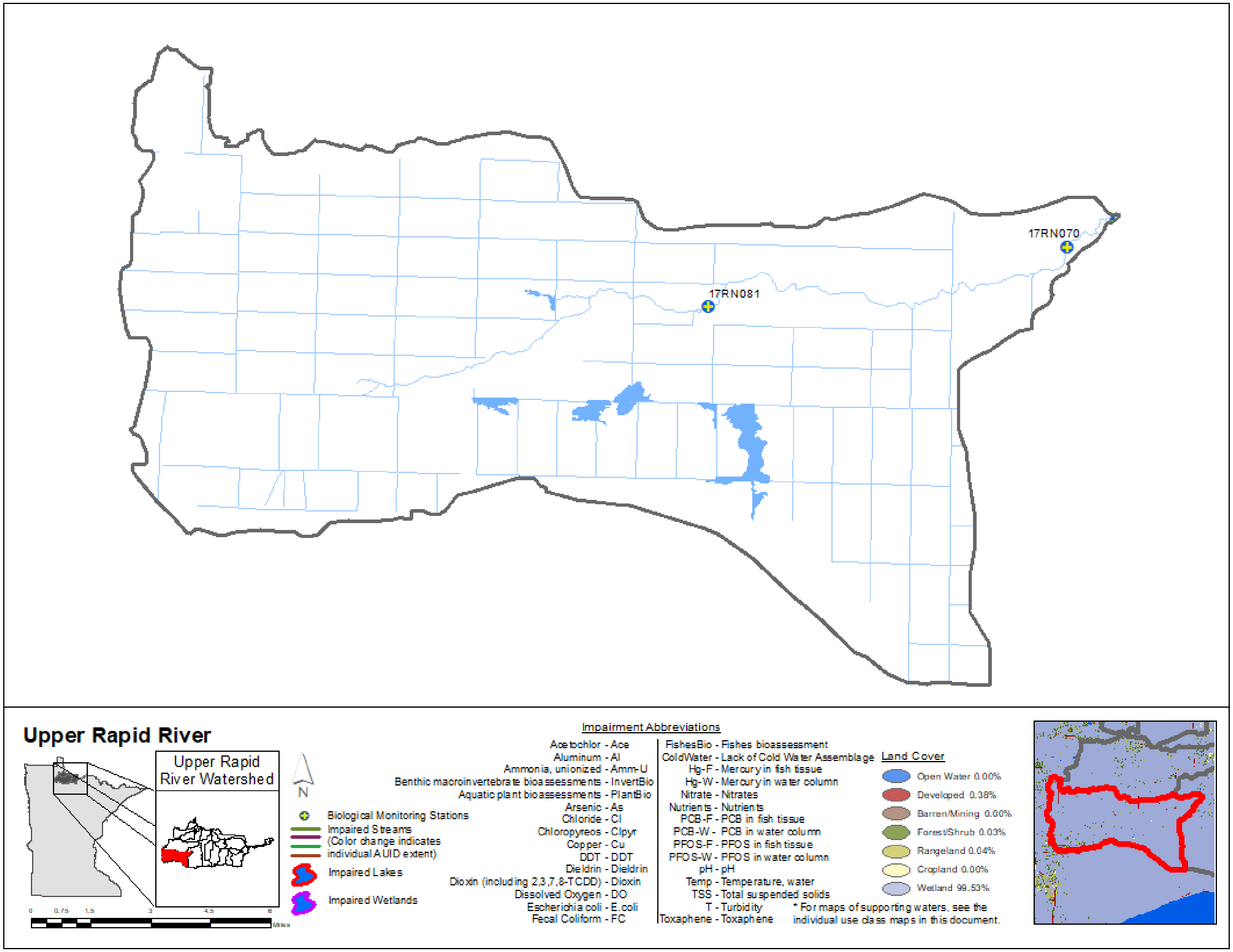
WID *Reach name,* *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication		
09030007-506 ***Rapid River,*** *Headwaters to Chase Bk*	17RN070, 17RN081	35.59	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Biological communities within the Upper Rapid River largely indicate good water quality. A macroinvertebrate sample collected from 17RN070 scored well above the impairment threshold in spite of the drought conditions in 2017 and 2018. *Ophiogomphus*, a sensitive dragonfly taxa, was observed indicating good water quality. Fish community data were collected at two biological monitoring stations along the Rapid River. Twenty-one species of fish were captured, with species diversity being relatively similar between both stations. The upstream station (17RN081) scored slightly below the impairment threshold. It is possible that low-flow conditions influenced the F-IBI score at this upper site. The sample consisted of individuals that live in headwater streams and included many young-of-the-year white suckers and a lack of long-lived species. The downstream station (17RN070) scored well above the impairment threshold. Chemistry data from this subwatershed is limited. The available data does not exceed the water quality standards.

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



North Branch Rapid River Aggregated 12-HUC HUC 0903000703-01

The North Branch of the Rapid River drains 184 square miles of largely wetland and peat bog landscape in Lake of the Woods County. From its headwaters in Beltrami Island State Forest, the North Branch of the Rapid River flows south towards its confluence with Meadow Creek, a small tributary that drains a peat bog complex. From its confluence with Meadow Creek, the North Branch Rapid River flows east 41 miles to its confluence with the main stem of the Rapid River near the community of Carp. Streams in the North Branch Rapid River Subwatershed are relatively unaltered when compared to the extensively ditched Upper Rapid River Subwatershed directly to the south. Mulligan Lake and Gustafson's Camp Peatland SNAs highlight the subwatershed's intact and largely untouched peatland landscapes.

Table 10. Aquatic life and recreation assessments on stream reaches: North Branch Rapid 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: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030007-503 ***North Branch Rapid River,*** *Headwaters to Rapid R*	05RN104, 17RN066, 17RN067	44.68	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	MTS	SUP	SUP
09030007-528 ***Unnamed Creek,*** *Unnamed Cr to N Br Rapid River*	17RN069	3.90	WWg	MTS	MTS	--	--	--	--	--	--	--	--	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information

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

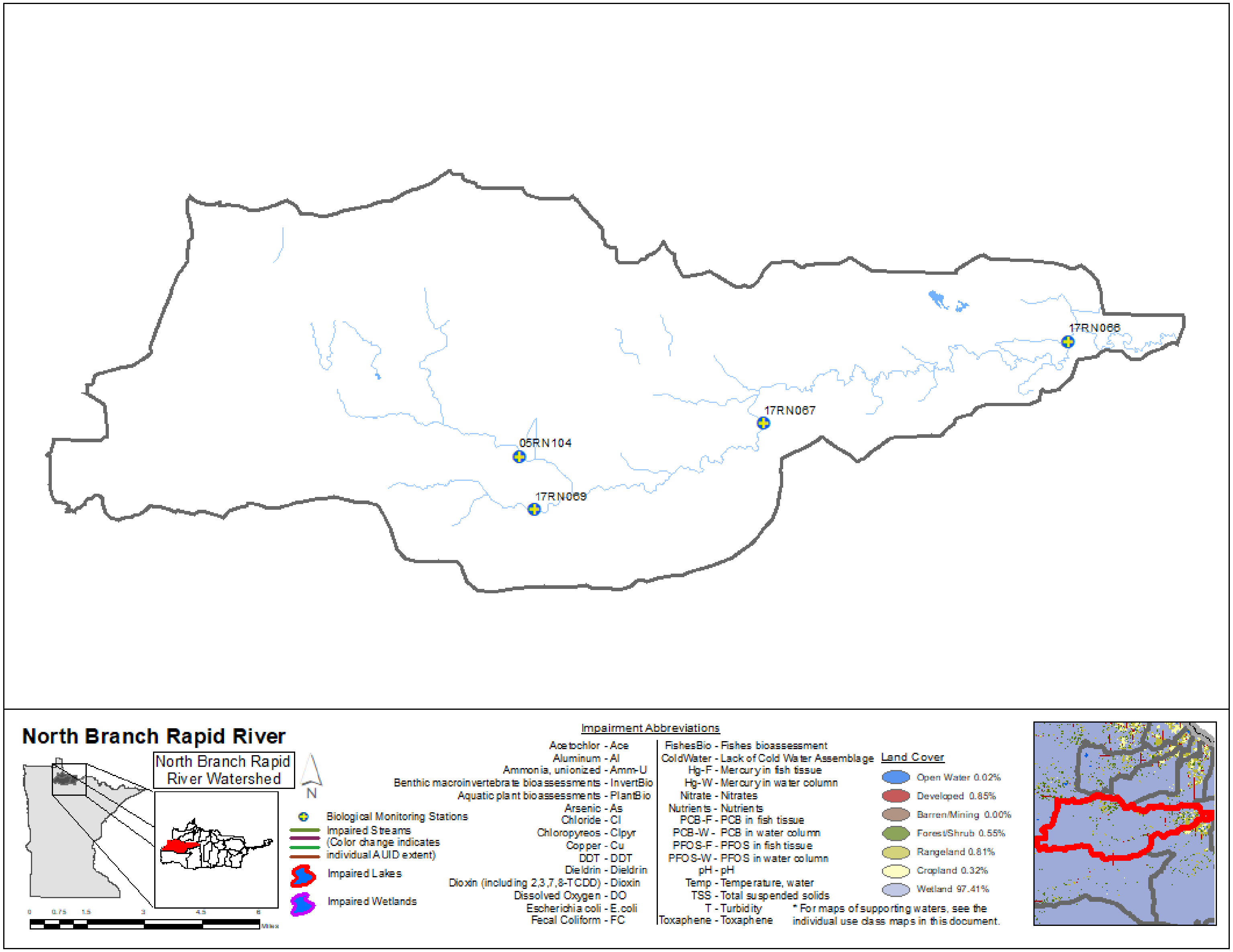
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Biological communities within the Upper Rapid River indicate good water quality. One Long-term Biological Monitoring Station (LTBM) on the North Branch Rapid River (05RN104) and an unnamed tributary (17RN069) were sampled for aquatic macroinvertebrates. M-IBI scores at both locations were above the impairment threshold. The unnamed tributary had an M-IBI score above the impairment threshold despite lower flow conditions. Water mites (*Hydrachnidia*) were hyper-dominant in this sample, likely due to low-flow conditions. However, several sensitive taxa were also collected including the mayfly genus *Eurylophella* and the caddisfly genus *Helicopsyche*. The presence of these sensitive taxa in this sample indicates good water quality conditions.

Fish community data were collected at three biological monitoring stations along the North Branch Rapid River (-503) and an additional station on unnamed creek (-528). The species diversity was relatively similar between stations. A Long-term Biological Monitoring (LTBM) station (05RN104) located in the headwaters of the North Branch Rapid River was the only station that was below the impairment threshold. The MPCA began to sample this LTBM station on a biennial schedule starting in 2013. All four visits to this station had F-IBI scores just below the impairment threshold. Large expanses of wetlands upstream of this station likely impact composition of the fish community and may confound an impairment interpretation. The fish community at the LTBM station is comprised of species that are typical of headwater streams that experience low dissolved oxygen events (related to wetland proximity). Available dissolved oxygen data met standards. TSS (total suspended solids), phosphorus, and other water chemistry parameters gathered from the North Branch Rapid River indicate that conditions are good for aquatic life. Bacteria data collected during 2017 and 2018 reveal good conditions for aquatic recreation.

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the North Branch of the Rapid River Aggregated 12-HUC.



Middle Rapid River Aggregated 12-HUC HUC 0903000702-01

The Middle Rapid River Subwatershed drains 173 square miles of wetlands and peat bog terrain in Lake of the Woods and Beltrami counties. Within this subwatershed, the Rapid River travels 7.5 miles northwest from its confluence with Miller Creek to its confluence with Chase Brook. From its confluence with Chase Brook, the Rapid River winds another 1.6 miles east to its confluence with Troy Creek where it again begins to flow northeast towards the community of Carp. Christy Creek joins the Rapid River just south of the North Branch of the Rapid River's confluence with the main stem of the Rapid River. The Rapid River's major tributaries in this subwatershed (Miller Creek, Chase Brook, Troy Brook, and Christy Creek) are all extensively ditched systems that flow through peat bogs, wetlands, and large parts of the Red Lake Peatland SNA. Most of this subwatershed is sparsely populated. The majority of the privately owned land is located along the banks of the Rapid River and the community of Carp. Over 97% of the total land area in the Middle Rapid River Subwatershed is comprised of wetlands.

Table 11. Aquatic life and recreation assessments on stream reaches: Middle Rapid 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: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030007-504 ***Rapid River,*** *Troy Cr to N Br Rapid R*	17RN079	7.97	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	IF	SUP	SUP
09030007-508 ***Troy Creek,*** *Headwaters to Rapid R*	17RN076	13.52	WWg	MTS	MTS	--	--	--	--	--	--	--	--	SUP	--
09030007-513 ***Christy Creek,*** *Moose Cr to Unnamed Cr*	17RN077	0.80	WWg	MTS	--	--	--	--	--	--	--	--	--	SUP	--
09030007-523 ***Miller Creek,*** *Headwaters to Rapid R*	17RN074	8.37	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

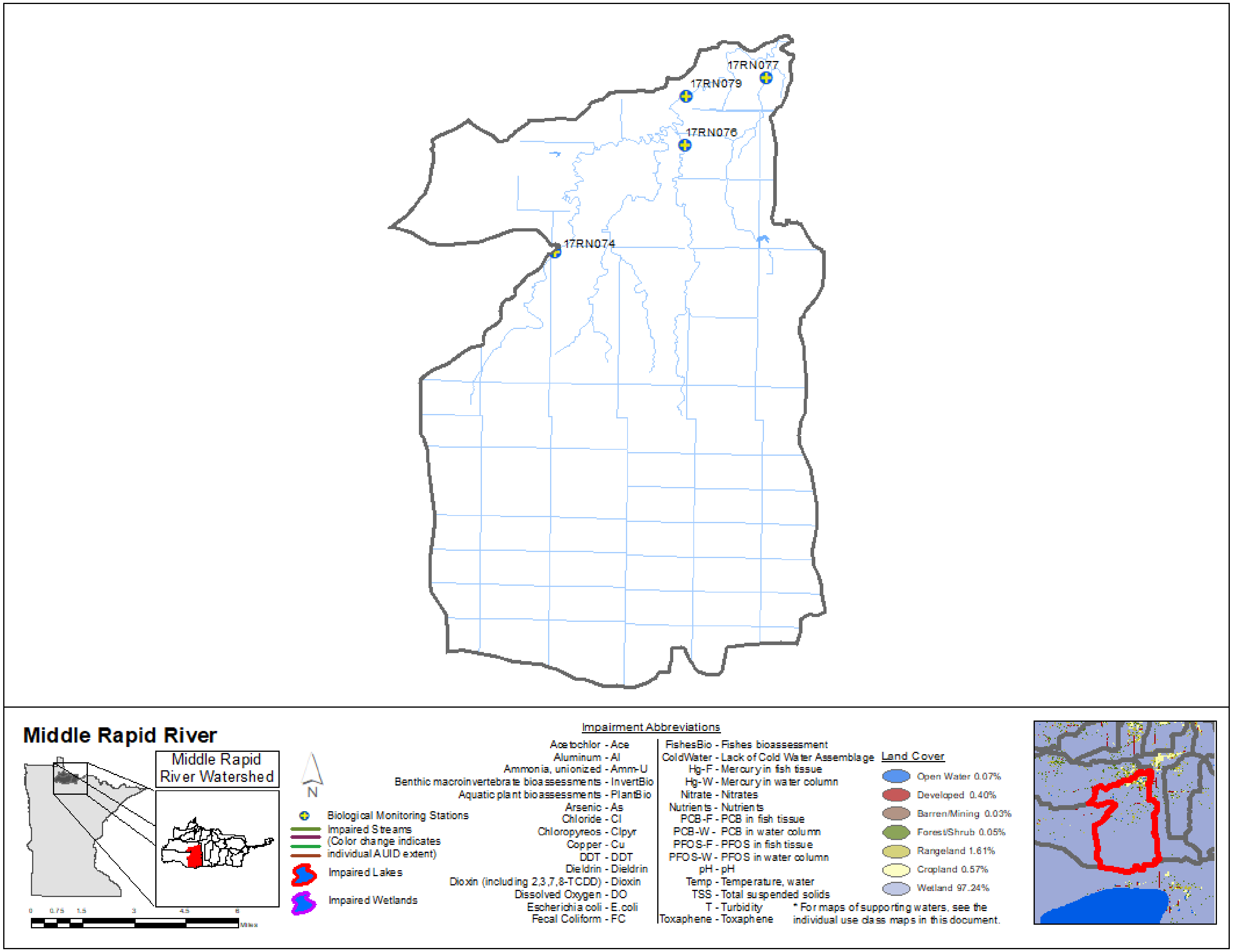
Summary

Aquatic life indicators within the Middle Rapid River indicate good water quality. Only two stations were sampled for aquatic macroinvertebrates due to low-flow conditions during the summers of 2017 and 2018. Chase Brook (17RN079) and Troy Creek (17RN076) had good MIBI scores in spite of being sampled in low flow conditions. The presence of numerous intolerant taxa in both of these samples indicates good water quality. Setodes, a genus of intolerant caddisfly, was observed in the Chase Brook sample (17RN079) and represents one of only 13 records in the MPCA's database.

A total of 20 fish species were captured from four stations on the Rapid River, Troy Creek, Christy Creek, and Miller Creek. All F-IBI scores indicated that the water quality was good, scoring well above their applicable impairment threshold. The F-IBI scores from both Christy Creek and Troy Creek are considered exceptional use (MPCA's highest use class designation) but similar aquatic macroinvertebrate scores were not available to justify the exceptional use aquatic life designation.

Chemistry data from the Rapid River indicate support for healthy aquatic communities, with low phosphorus and sediment concentrations. Bacteria levels during 2017 and 2018 were low, indicating supporting conditions for aquatic recreation.

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Middle Rapid River Aggregated 12-HUC.



Lower Rapid River Aggregated 12-HUC HUC 0903000705-01

The Lower Rapid River Subwatershed drains 106.4 square miles of Beltrami and Lake of the Woods counties. The Rapid River within this subwatershed flows northeast from its confluence with the North Branch of the Rapid River 26.5 miles to its confluence with the East Fork of the Rapid River. From its confluence with its East Fork, the main stem of the Rapid River winds 1.6 miles northwest towards its confluence with the Rainy River near Clementson. The Rapid River joins the Rainy River at Clementson Wayside Park (below State Highway 11) where a large rapids meets an outlet pool. This confluence is a well-known spawning area for Lake Sturgeon and a popular fishing destination. Peat bogs and wetland terrain dominate the landscape in this subwatershed (91.6%). Land development is concentrated along the banks of the Rapid River, County Highway 16, and the community of Clementson.

Table 12. Aquatic life and recreation assessments on stream reaches: Lower Rapid 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: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030007-501 ***Rapid River,*** *E Fk Rapid R to Rainy R*	--	1.64	WWg	--	--	IF	EXS	EXS	MTS	MTS	MTS	--	IC	NS	--
09030007-502 ***Rapid River,*** *N Br Rapid R to E Fk Rapid R*	05RN083, 17RN080	26.50	WWg	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	--	MTS	SUP	SUP
09030007-529 ***Unnamed Ditch,*** *Unnamed Ditch to Rapid R*	17RN078	4.75	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--

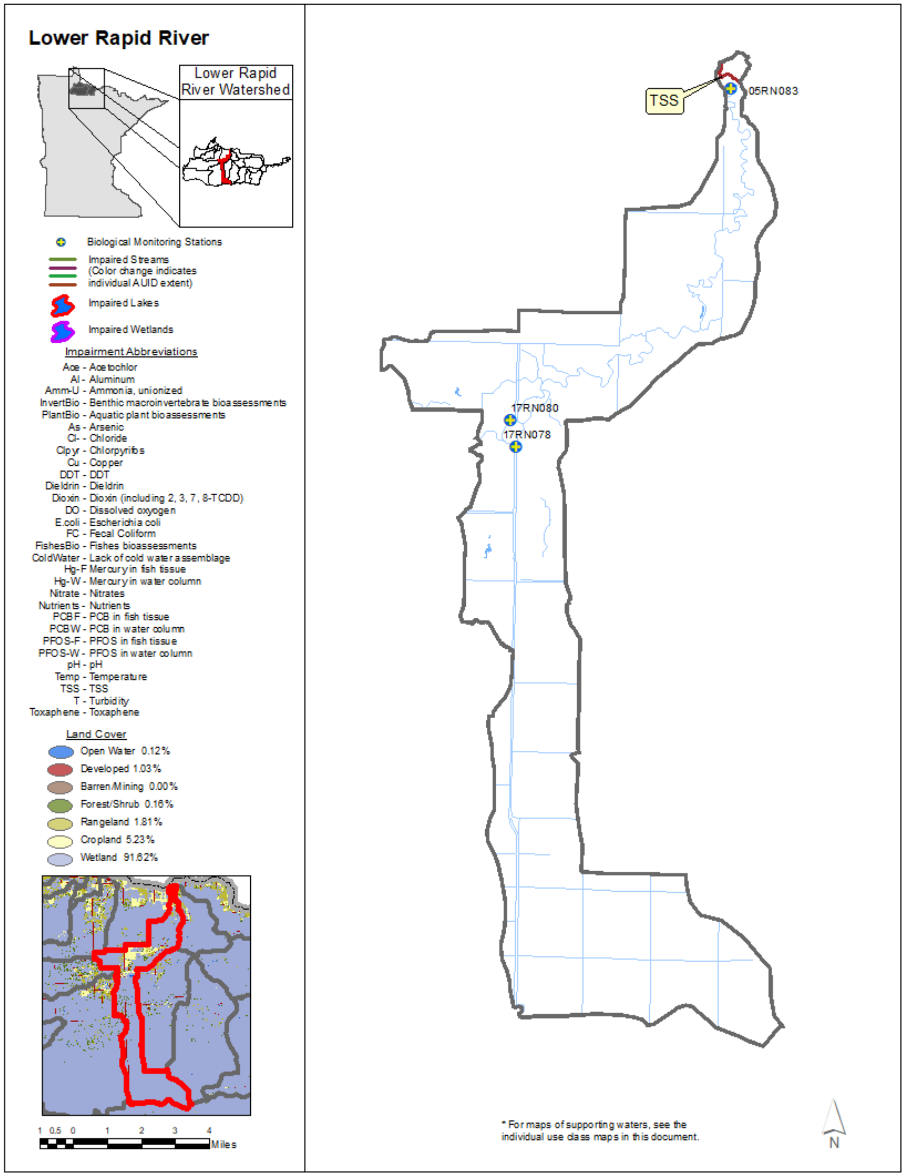
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Aquatic life indicators along the Lower Rapid River generally indicate good water quality with the exception of suspended sediment and water clarity impairments near the Rapid River's mouth (-501). Sensitive macroinvertebrate taxa were collected at stations 17RN080 and 05RN083. MIBI scores at both stations were above their impairment thresholds despite low-flow conditions. The FIBI score at station 17RN080 was well above the impairment threshold. These results suggest good conditions for aquatic life in the lowest reaches of the Rapid River. Fish and aquatic macroinvertebrate data from a small tributary to the Lower Rapid River (Unnamed Ditch -529) meet standards but are nearly impaired for both fish and aquatic macroinvertebrates.

High levels of suspended sediment occur in the lower reaches of the Rapid River as indicated by samples collected by the MPCA and local partners. Exceedances occurred throughout all months and years. High suspended solid values were often paired with poor water clarity observations. There is a trend towards decreasing water clarity over time. Area staff have also noted excessive sedimentation in the Rapid River outlet pool. This area is well known as a quality breeding ground for lake sturgeon. Restoration and protection efforts to mitigate sediment issues in the Rapid River will ensure that aquatic communities in downstream Rainy River do not become further impacted. Bacteria concentrations upstream of the confluence with the East Fork Rapid River are low and support recreation use.

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Lower Rapid River Aggregated 12-HUC.



Barton's Brook Aggregated 12-HUC HUC 0903000704-04

The Barton's Brook Subwatershed drains 76.7 square miles of largely wetland and peat bog landscape in Koochiching, Beltrami, and Lake of the Woods counties. From its headwaters in Lake of the Woods State Forest, five miles east of the community of Carp, Barton's Brook winds 11.5 miles east towards its confluence with the East Branch of the Rapid River. Much of this watershed is located within Lake of the Woods State Forest; the southernmost extent is in the Red Lake Peatland Scientific Natural Area (SNA). Some limited agricultural development occurs in the north near the intersection of County Highways 82 and 100. Most of the wetland's and peat bogs have been extensively ditched.

Table 13. Aquatic life and recreation assessments on stream reaches: Barton's Brook Aggregated 12-HUC.

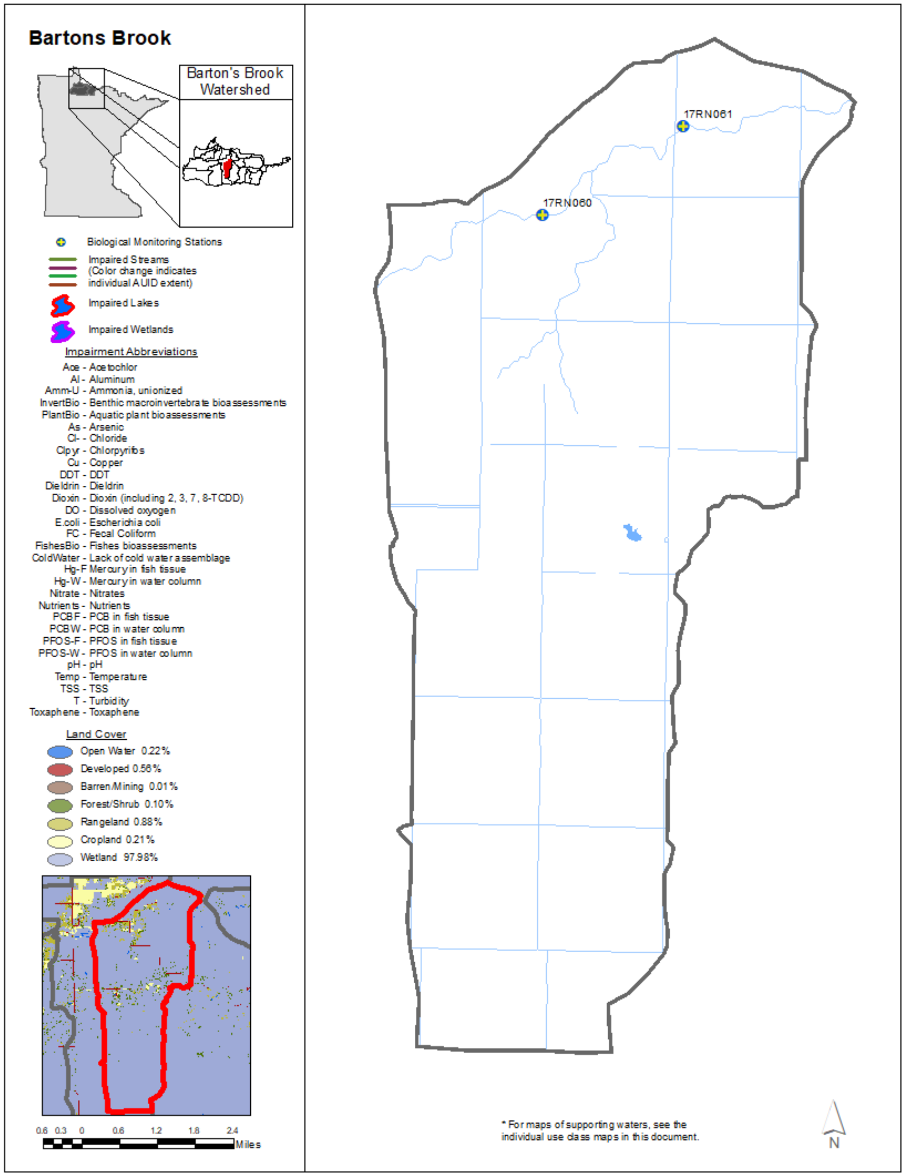
WID ***Reach name,*** *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
09030007-510 ***Barton's Brook,*** *Headwaters to E Br Rapid R*	17RN060, 17RN061	11.45	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Aquatic macroinvertebrates were not sampled within the Barton’s Brook Subwatershed due to low-flow conditions. Fish community data collected from two biological monitoring stations indicate that the water quality is good. The fish species were exactly the same between the stations, but individual taxa percentages and stream classes differed, resulting in different F-IBI scores. The upstream station (17RN060) was assessed using an F-IBI class tailored to low-gradient stream systems and scored well above the impairment threshold. The downstream station (17RN061) was assessed using the Northern Streams IBI class and scored just below the impairment threshold. Both stations were dominated by Phoxinus eos (northern redbelly dace) and other species typical of a low-gradient stream. Weighing both results collectively, the fish data suggest that biological communities are largely intact.

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Barton's Brook Aggregated 12-HUC.



East Fork Rapid River Aggregated 12-HUC HUC 0903000704-01

The East Fork Rapid River Subwatershed drains 142.84 square miles of land in Beltrami and Koochiching counties. From its headwaters near Wayland, the East Branch of the Rapid River flows for 13 miles to its confluence with the Wing River from the east. One mile north of the Wing River's confluence with the East Branch Rapid River, Barton's Brook joins from the west. From this point, the East Branch of the Rapid River flows another 13 miles to its confluence with the main stem of the Rapid River at Clementson. Peat bogs and wetland terrain dominate the landscape (97.8%) with some agricultural development concentrated along the banks of the East Branch Rapid River near Clementson. The eastern half of the Red Lake Peat Bog Scientific Natural Area (SNA) falls within this subwatershed.

Table 14. Aquatic life and recreation assessments on stream reaches: East Fork Rapid River Aggregated 12-HUC.

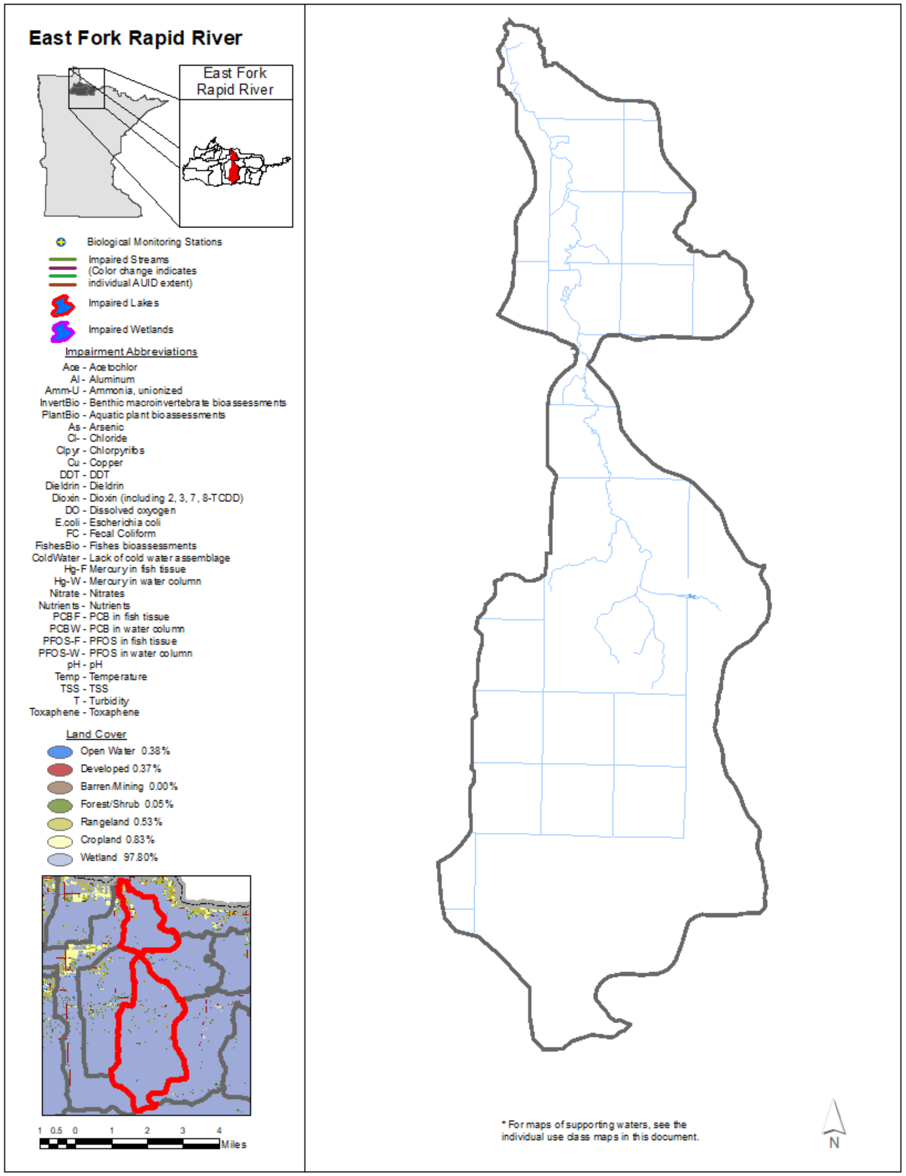
WID ***Reach name,*** *Reach description*	Biological Station ID	Reach length (miles)	Use class	Aquatic life indicators:										Aquatic life	Aquatic rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi tube	Chloride	pH	Ammonia $-NH_3$	Pesticides	Eutrophication		
09030007-509 ***East Branch Rapid River,*** *Barton's Bk to Rapid R*	--	13.44	WWg	--	--	IC	IC	IC	MTS	MTS	MTS	--	IC	IC	SUP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards); **IC** = Inconclusive Information
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information; ☐ = inconclusive information
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = warm water modified, **WWe** = warm water exceptional, **CWg** = cold water general, **CWe** = cold water exceptional, **LRVW** = limited resource value water

Summary

Water chemistry results indicate borderline conditions for aquatic communities in the downstream reach of the East Branch Rapid River (-509). Robust phosphorus, suspended sediment, and related clarity datasets indicate near-impairment conditions. Dissolved oxygen levels are also marginal for supporting aquatic communities. The predominately undisturbed watershed and the wetland/peat bog characteristics of this subwatershed's landscape may naturally depress dissolved oxygen levels. Sampling notes indicate this reach may become stagnant during portions of the summer. Bacteria concentrations indicate that recreational water quality is good. No fish or invertebrate data are available for this subwatershed.

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the East Fork Rapid River Aggregated 12-HUC.



Wing River Aggregated 12-HUC HUC 0903000704-01

The Wing River Subwatershed drains 50.2 square miles of remote wetland and peat bog terrain in Koochiching County. From its headwaters northwest of the community of Fairland, the Wing River flows 9.3 miles to its confluence with the East Branch of the Rapid River. This subwatershed lies entirely with the Pine Island State Forest. Land development is limited with 99.5% of this subwatershed occupied by wetlands. Fish, macroinvertebrate, and water chemistry sampling efforts were not undertaken in this subwatershed due to lack of accessibility.

Watershed-wide results and discussion

Assessment results and data summaries are grouped by sample type and included below for both the Lower Rainy River and Rapid River watersheds. Summaries are provided for streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption 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 Lower Rainy River and Rapid River watersheds.

Stream water quality

Of the 48 stream WIDs in the Lower Rainy River Watershed, 15 WIDs were assessed (Table 15). Of the assessed streams in the Lower Rainy River Watershed, 12 stream WIDs fully supported aquatic life and one stream WID fully supported aquatic recreation. Two reaches did not support recreation use.

Table 15. Assessment summary for stream water quality in the Lower Rainy River Watershed.

				Supporting		Non-supporting		Insufficient Data		
Watershed	**Area (acres)**	**# Total WIDs**	**# Assessed WIDs**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**# Delistings**
Lower Rainy River 8-HUC	**528876**	**48**	**15**	**12**	**1**	**0**	**2**	**1**	**0**	**0**
Winter Road River	53620	4	3	3	0	0	0	0	0	0
Peppermint Creek	41184	3	3	3	0	0	0	0	0	0
Baudette River	38088	10	2	1	1	0	0	1	0	0
Lower Rainy River	63420	16	1	1	0	0	0	0	0	0
Black River	87187	4	4	3	0	0	1	0	0	0
West Fork Black River	81582	2	1	1	0	0	1	0	0	0
Middle Rainy River	70073	4	1	0	0	0	0	0	0	0
South Fork Black River	29411	1	0	0	0	0	0	0	0	0
Trib. to Black River	57046	4	0	0	0	0	0	0	0	0

Of the 29 stream WIDs in the Rapid River Watershed, 12 WIDs were assessed (Table 16). Of the assessed stream WIDs in the Rapid River Watershed, 11 stream WIDs fully supported aquatic life and four supported aquatic recreation. One WID did not support aquatic life.

Table 16. Assessment summary for stream water quality in the Rapid River Watershed.

				Supporting		Non-supporting		Insufficient Data		
Watershed	Area (acres)	# Total WIDs	# Assessed WIDs	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	# Delistings
Rapid River 8-HUC	**603843**	**29**	**12**	**11**	**4**	**1**	**0**	**0**	**0**	**0**
Upper Rapid River	133967	4	1	1	0	0	0	0	0	0
North Branch Rapid River	118398	4	2	2	1	0	0	0	0	0
Middle Rapid River	110830	12	4	4	1	0	0	0	0	0
Lower Rapid River	68132	4	3	2	1	1	0	0	0	0
Barton's Brook	49090	1	1	1	0	0	0	0	0	0
East Fork Rapid River	91472	2	1	0	1	0	0	0	0	0
Wing River	32194	2	0	0	0	0	0	0	0	0

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Rainy River from 1970 to 2016 and from the Rapid River in 2017 (Table 17). All five WIDs of the Rainy River are listed as impaired for mercury in fish tissue and are covered under the Minnesota Statewide Mercury TMDL. Fish collected in 2016 from the Rainy River show mercury concentrations remain high: 10 Redhorse ranged from 0.113 ppm to 0.626 ppm and eight Smallmouth Bass ranged from 0.270 ppm to 0.440 ppm. The Rapid River had low mercury levels. Five white suckers collected from the Rapid River were composited into two samples for analysis; both samples were well below the 0.2 ppm mercury standard and PCBs were less than the reporting limit.

The PCBs in the Rainy River were generally low; however, a 62-inch Lake Sturgeon collected in 1987 had a remarkably high concentration, 1.42 ppm, while a somewhat smaller Sturgeon (54 inches) collected at the same time had a PCBs concentration of 0.32 ppm. Two Lake Sturgeon were next tested in 2002, and they had PCBs concentrations only slightly above the reporting limit (0.03 and 0.06 ppm). This appears to indicate PCBs have been greatly reduced in the Rainy River; however, two Redhorse collected downstream of International Falls in 2016 had PCBs concentrations of 0.187 and 0.213 ppm. Clearly, testing of PCBs in Rainy River fish will need to continue.

Table 17. Fish contaminants: summary of fish length, mercury, PCBs, and PFOS by waterway-species-year.

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
WID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N Samples	Mean	Max	< RL
09030008-539, 540, 559, 560, 561	RAINY R.*	Black Crappie	2002	FILSK	1	1	9.1	9.1	9.1	0.176	0.176	0.176				
		Lake Sturgeon	1987	FILSK	2	2	58.0	54.0	62.0	0.275	0.160	0.390	2	0.87	1.42	
			2002	FILET	7	7	47.1	39.4	53.0	0.064	0.051	0.080	2	0.045	0.06	
		Northern Pike	1970	PLUG	1	1	19.2	19.2	19.2	0.360	0.360	0.360				
			1979	WHORG	5	1	21.0	21.0	21.0	0.390	0.390	0.390				
			1986	FILSK	12	5	23.1	19.5	26.2	0.775	0.680	0.870	4	0.05	0.05	
			1993	FILSK	9	4	23.1	18.1	29.6	0.335	0.180	0.570	4	0.01	0.01	Y
			1997	FILSK	16	16	23.6	14.0	30.2	0.396	0.080	0.650	4	0.01	0.01	Y
			2002	FILSK	5	5	20.1	15.3	21.5	0.216	0.150	0.256				
			2013	FILSK	7	7	23.1	18.6	36.9	0.321	0.180	0.980				
		Quillback	2002	FILSK	4	1	17.0	17.0	17.0	0.277	0.277	0.277				
		Redhorse sp.	1993	FILSK	2	1	16.7	16.7	16.7	0.110	0.110	0.110	1	0.012	0.012	
			2002	FILSK	6	2	18.2	17.7	18.6	0.281	0.213	0.348				
			2016	FILSK	10	10	17.9	15.3	22.8	0.340	0.113	0.626	5	0.099	0.213	
		Rock Bass	2013	FILSK	5	1	8.1	8.1	8.1	0.280	0.280	0.280				
		Sauger	1978	PLUG	5	1	12.8	12.8	12.8	0.260	0.260	0.260	1	0.02	0.02	Y
				WHORG	5	1	12.8	12.8	12.8	0.120	0.120	0.120	1	0.1	0.1	
			1979	WHORG	5	1	12.8	12.8	12.8	0.250	0.250	0.250				
			1986	FILSK	3	1	13.3	13.3	13.3	0.870	0.870	0.870	1	0.06	0.06	
			1987	FILSK	8	2	12.7	12.6	12.7	0.435	0.360	0.510	1	0.01	0.01	
			1997	FILSK	13	13	13.1	11.2	16.5	0.216	0.120	0.590	3	0.01	0.01	
			2002	FILSK	10	10	13.1	10.6	15.2	0.402	0.199	0.675				

		Smallmouth Bass	1986	FILSK	15	3	14.8	13.0	17.0	0.727	0.580	0.900	2	0.055	0.06	
			1987	FILSK	18	4	14.1	13.2	15.0	0.523	0.410	0.690	2	0.115	0.22	
			1993	FILSK	13	3	14.0	12.9	16.0	0.347	0.280	0.470	3	0.017	0.027	
			2002	FILSK	5	5	13.9	12.0	16.1	0.342	0.223	0.558				
			2013	FILSK	7	7	15.1	11.0	19.2	0.381	0.149	0.722				
			2016	FILSK	8	8	13.0	11.8	13.6	0.373	0.270	0.440	2	0.025	0.025	Y
		Walleye	1970	PLUG	1	1	13.1	13.1	13.1	0.430	0.430	0.430				
			1978	PLUG	4	1	14.4	14.4	14.4	0.270	0.270	0.270	1	0.03	0.03	
				WHORG	4	1	14.4	14.4	14.4	0.270	0.270	0.270	1	0.05	0.05	Y
			1986	FILSK	6	2	16.6	16.2	17.0	0.900	0.820	0.980	2	0.05	0.05	Y
			1993	FILSK	16	6	17.5	11.2	25.2	0.512	0.150	0.980	6	0.0185	0.035	
			1997	FILSK	26	26	16.1	11.5	26.4	0.403	0.140	1.500	8	0.01875	0.05	
			2002	FILSK	6	6	17.0	10.8	28.9	0.530	0.168	1.280				
			2013	FILSK	12	12	15.2	10.8	28.7	0.256	0.135	0.796				
		White Sucker	1970	PLUG	2	2	15.9	15.0	16.7	0.285	0.220	0.350				
			1978	PLUG	10	2	18.3	17.9	18.7	0.190	0.170	0.210	2	0.12	0.17	
				WHORG	20	4	17.6	16.2	18.7	0.083	0.050	0.130	4	0.0575	0.1	
			1979	WHORG	21	4	17.1	15.5	18.4	0.095	0.060	0.130				
			1993	FILSK	5	1	17.3	17.3	17.3	0.160	0.160	0.160	1	0.031	0.031	
			1997	FILSK	17	3	18.1	16.8	19.0	0.174	0.092	0.280	3	0.01	0.01	Y
			2002	FILSK	5	2	15.9	15.6	16.2	0.148	0.047	0.249				
			2013	FILSK	10	2	16.6	16.3	16.8	0.180	0.154	0.206				
		Yellow Perch	1997	FILSK	12	2	9.4	9.2	9.6	0.200	0.170	0.230	1	0.01	0.01	Y
			2002	FILSK	8	1	9.9	9.9	9.9	0.241	0.241	0.241				
			2013	FILSK	5	1	8.0	8.0	8.0	0.102	0.102	0.102				
09030007-501	RAPID R.	White Sucker	2017	FILSK	5	2	8.4	7.6	9.1	0.111	0.111	0.111	2	0.025	0.025	Y

* 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: PLUG—dorsal muscle plug without skin; FILSK – fillet with skin; FILET—fillet without skin; WHORG—whole organism.

Pollutant load monitoring

The WPLMN monitors three sites within the Lower Rainy River and Rapid River 8-HUC watersheds as shown in Table 18. The Rainy River near Manitou Rapids is located on the mainstem of the Rainy River and will be highlighted in the Rainy River Large River Report. Data from this site are omitted from this report. Data from the East Fork of the Rapid River, a WPLMN subwatershed site, is limited at this time and is also not presented. This report will focus on the Rapid River at Clementson, the largest tributary of the Rainy River within the Lower Rainy River and Rapid River 8-HUC watersheds. The Rapid River at Clementson is a WPLMN Major Watershed site which is sampled year-round and has been in operation since 2010.

Table 18. WPLMN stream monitoring sites for the Lower Rainy River and Rapid River watersheds.

Site Type	Stream Name	USGS ID	DNR/MPCA ID	EQuIS ID
Basin	Rainy River nr Manitou Rapids	05133500	E75005001	S006-897
Major Watershed	Rapid River at Clementson, MN11	NA	H78007001	S000-184
Subwatershed	East Fork Rapid River nr Clementson, CSAH 18	NA	H78006001	S007-611

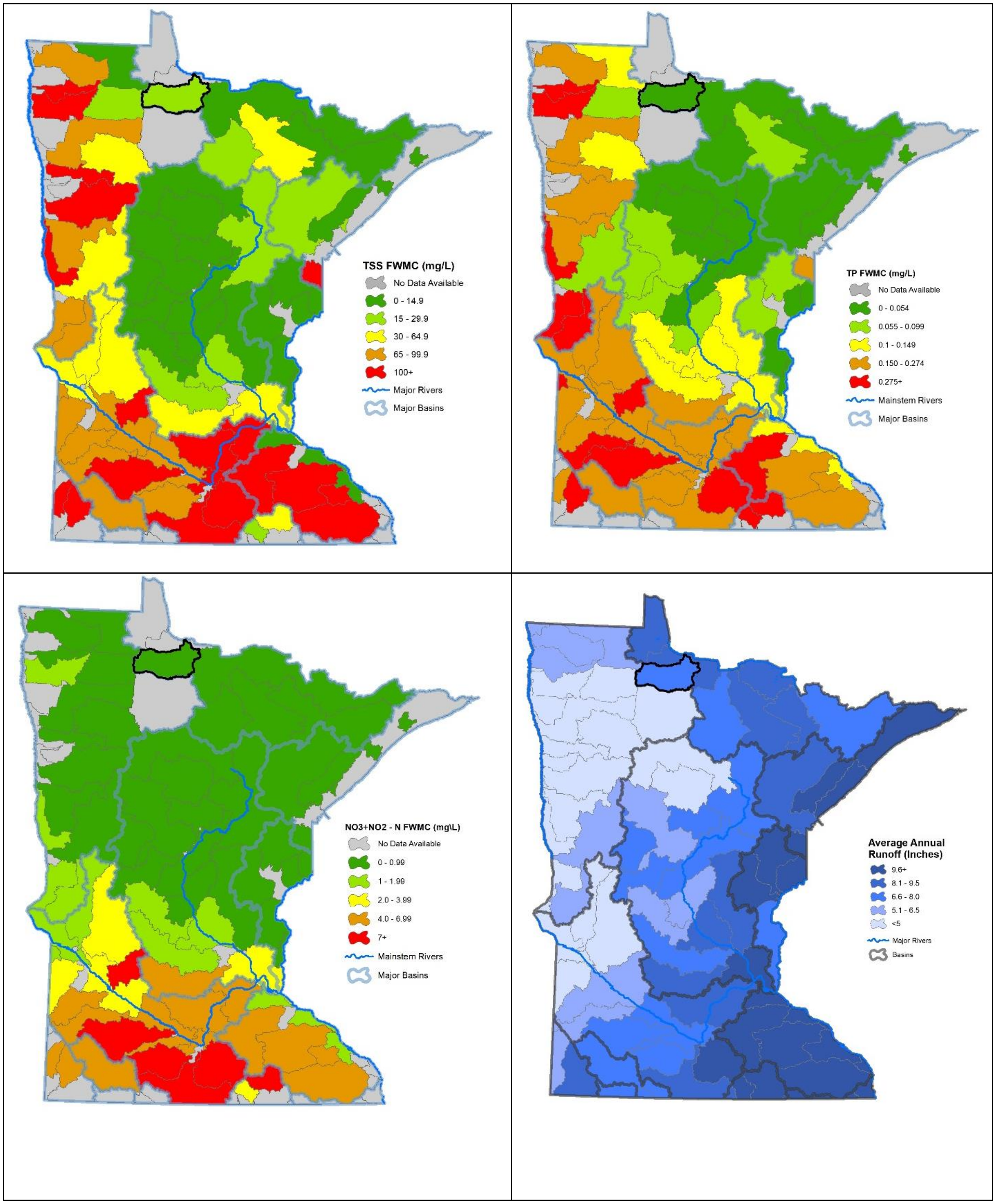
Average annual FWMCs of TSS, TP, and NO3+NO2-N for major watershed stations statewide are presented below, with the Rapid River Watershed highlighted. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that makes it to a river or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

As a general rule, elevated levels of TSS and NO3+NO2-N are regarded as non-point 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 non-point sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Excessive TSS, TP, and NO3+NO2-N in surface waters impacts fish and other aquatic life, as well as fishing, swimming and other recreational uses. High levels of NO3+NO2-N is a concern for drinking water.

When compared with other major watersheds throughout the state, Figure 33 shows the average annual TSS, TP, and NO3+NO2-N FWMCs for the Rapid River Watershed to be similar to watersheds in north central and northeast Minnesota, but drastically lower than the agriculturally-rich watersheds found in the northwest and southern regions of the state. Low levels of these pollutants indicate sources are generally naturally derived rather than elevated from anthropogenically induced changes to the landscape.

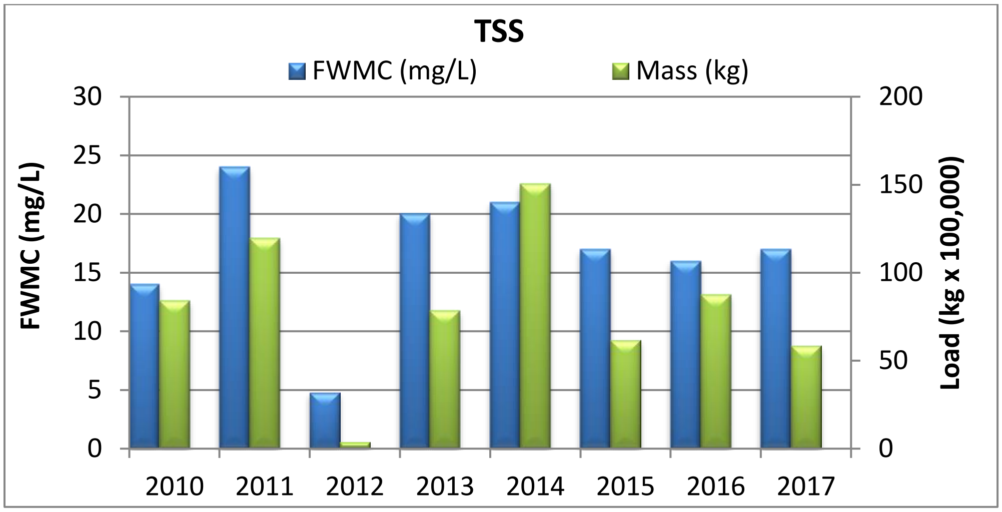
Figure 33. 2010-2016 Average annual TSS, TP, and NO_3-NO_2-N flow weighted mean concentrations, and runoff by major watershed.

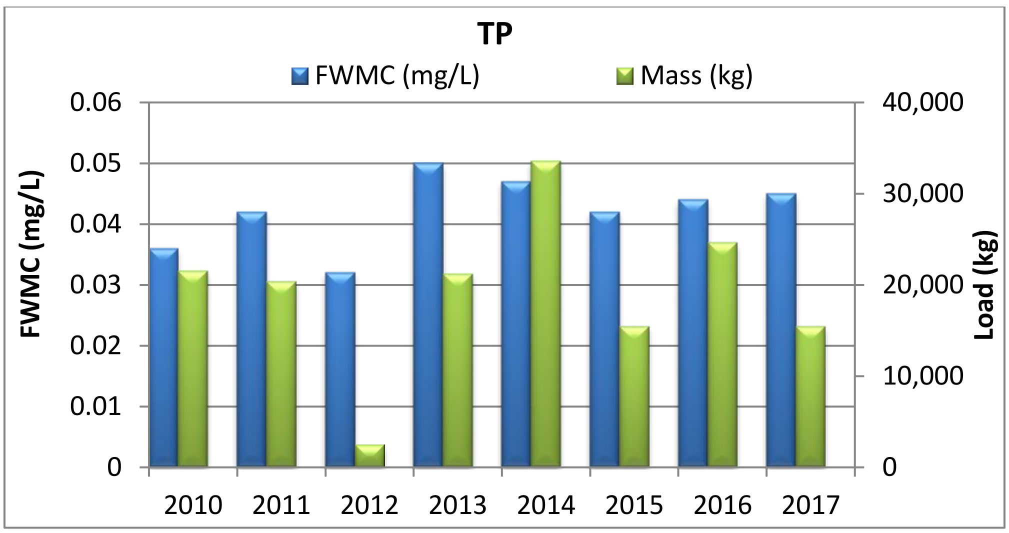


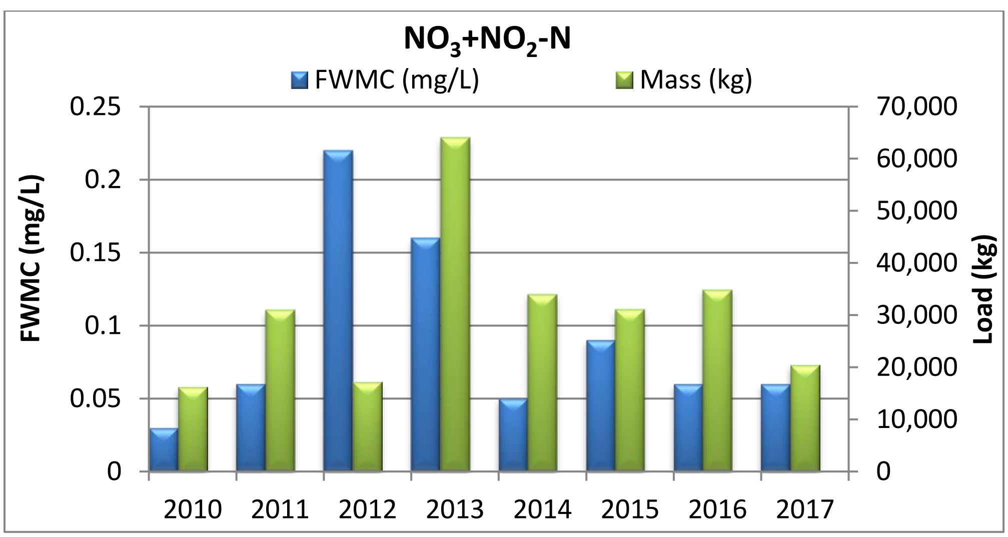
More information, including results for subwatershed stations, can be found at the [WPLMN website.]

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

Figure 34. TSS, TP, and NO_3+NO_2-N Flow weighted mean concentrations and loads for the Rapid River near Clementson, Minnesota.







Wetland condition

Wetland vegetation quality is generally high in Minnesota (Bourdaghs et al. 2019). This is driven by the large share of wetlands located in Minnesota's northern forest ecoregion where development and resulting wetland quality impacts are much less widespread compared to the rest of the state. Wetlands that are in exceptional or good condition have had few (if any) measurable changes in their expected native species composition or abundance distribution. Wetland vegetation quality is largely degraded outside of northern Minnesota, where non-native plant species (most notably Reed canary grass and Narrow leaf or Hybrid cattail) have replaced native wetland plant communities over the majority of the remaining wetlands (Bourdaghs et al. 2019).

As the entirety of the Lower Rainy River and Rapid River watersheds lie within Minnesota's Northern Forest Ecoregion, wetland vegetation quality in the watershed is expected to be high overall. An estimated 74% of the wetlands in the ecoregion are in good to exceptional vegetation condition (Bourdaghs et al. 2019). Wetland quality impacts in the watershed are likely localized. Primary impacts to wetland vegetation quality include peat subsidence and community changes adjacent to drainage ditches in peatlands and logging impacts in coniferous swamps.

Figure 35. Stream tiered aquatic life use designations in the Lower Rainy River and Rapid River watersheds.

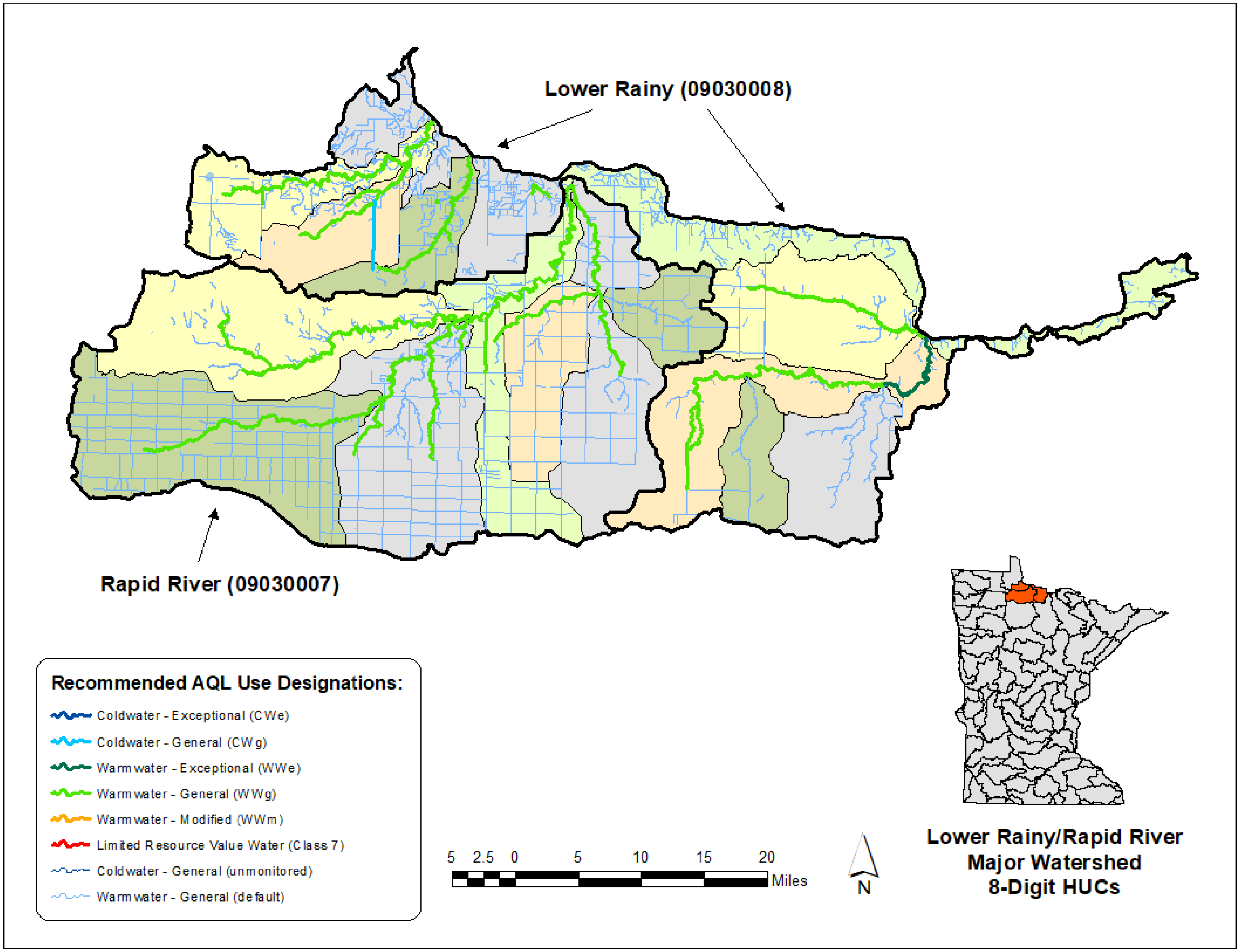


Figure 36. Fully supporting waters by designated use in the Lower Rainy River and Rapid River watersheds.

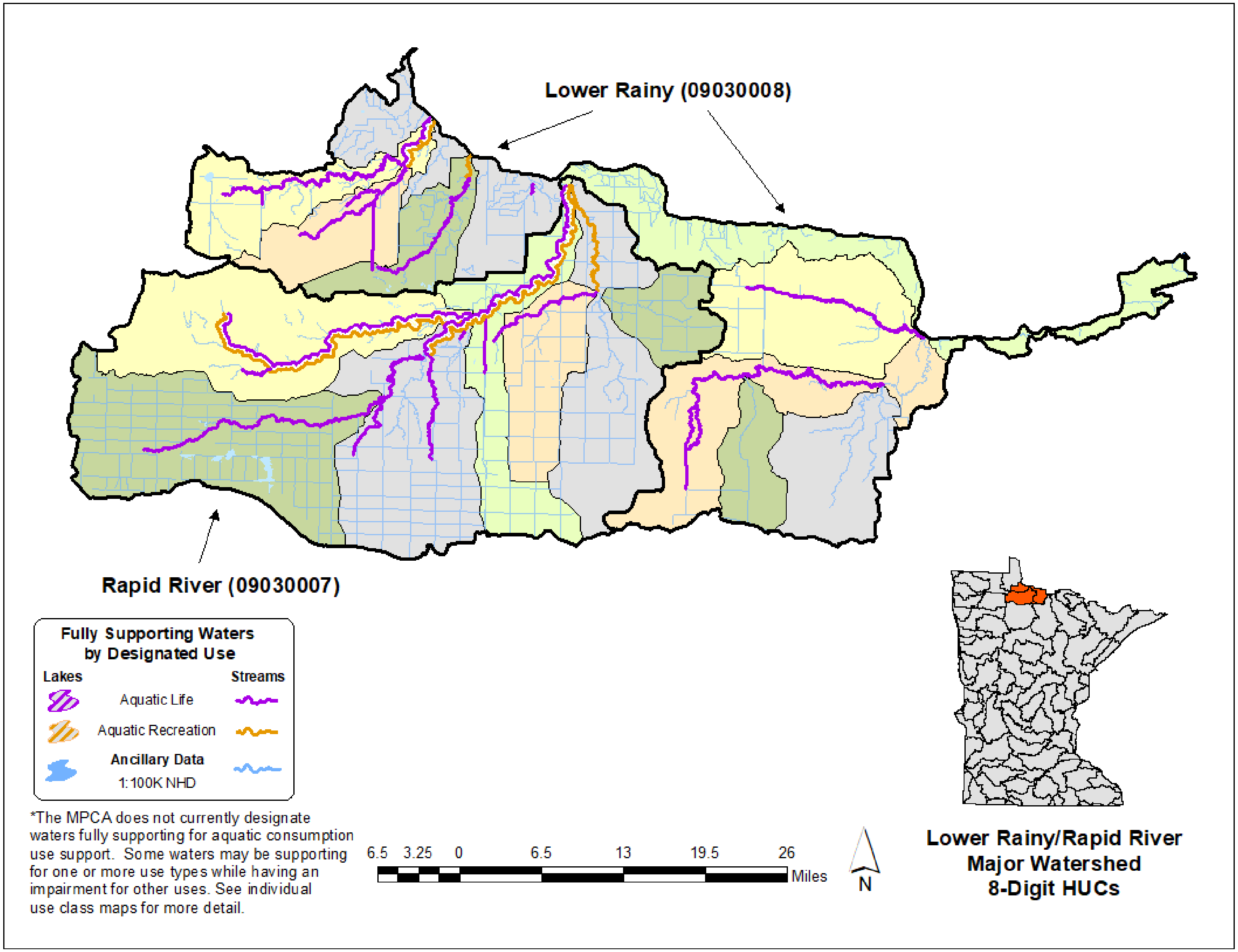


Figure 37. Impaired waters by designated use in the Lower Rainy River and Rapid River watersheds.

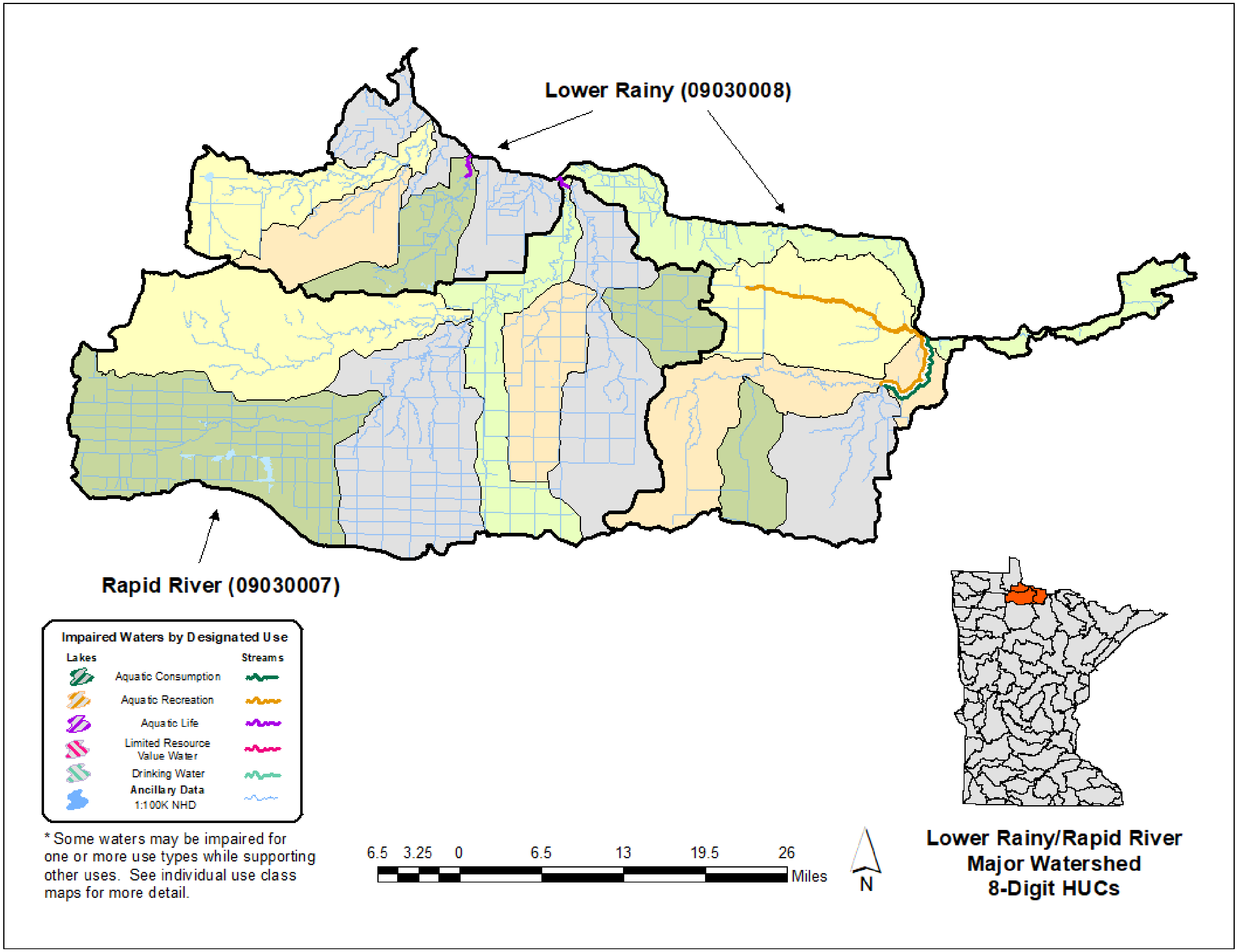


Figure 38. Aquatic consumption use support in the Lower Rainy River and Rapid River watersheds.

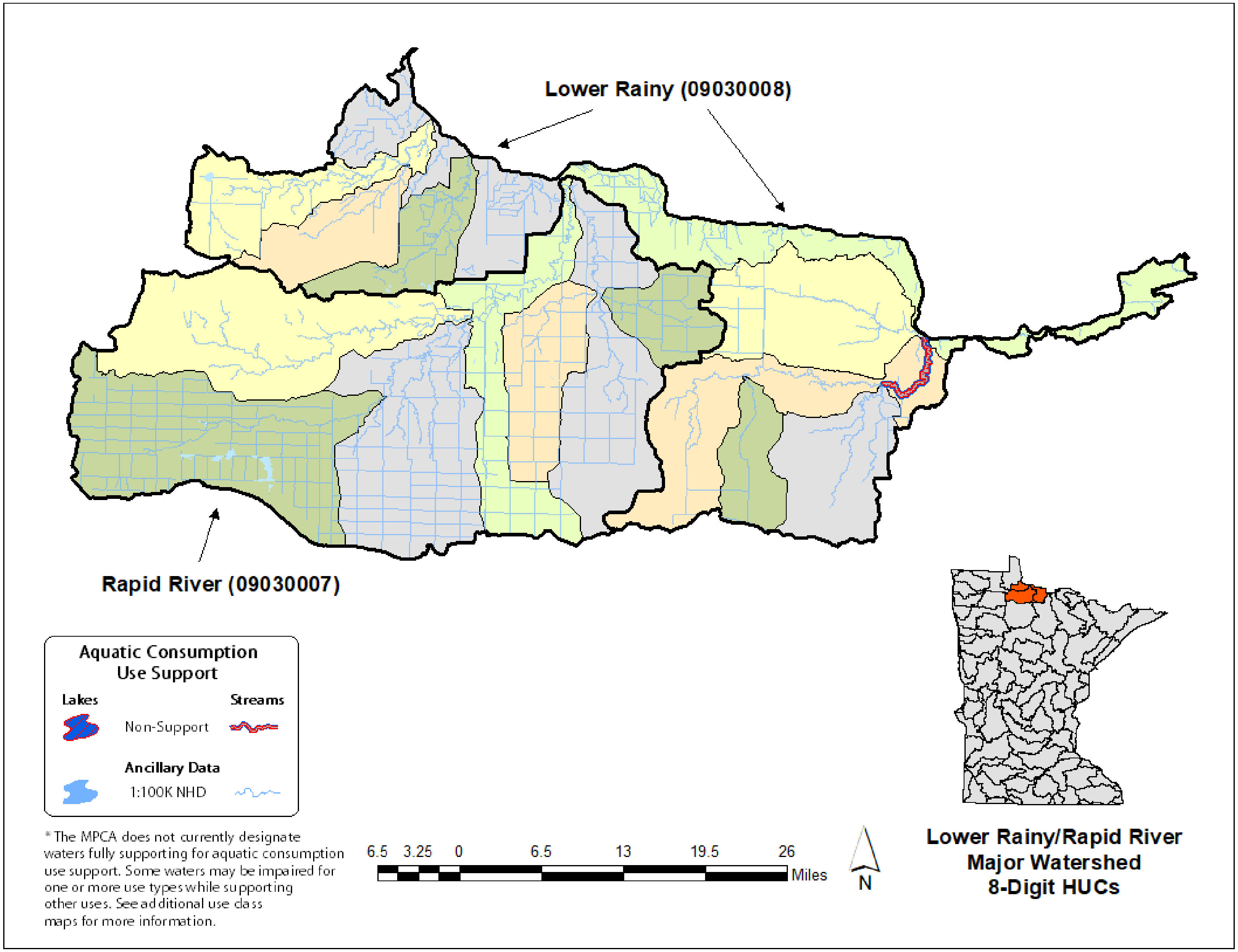


Figure 39. Aquatic life use support in the Lower Rainy River and Rapid River watersheds.

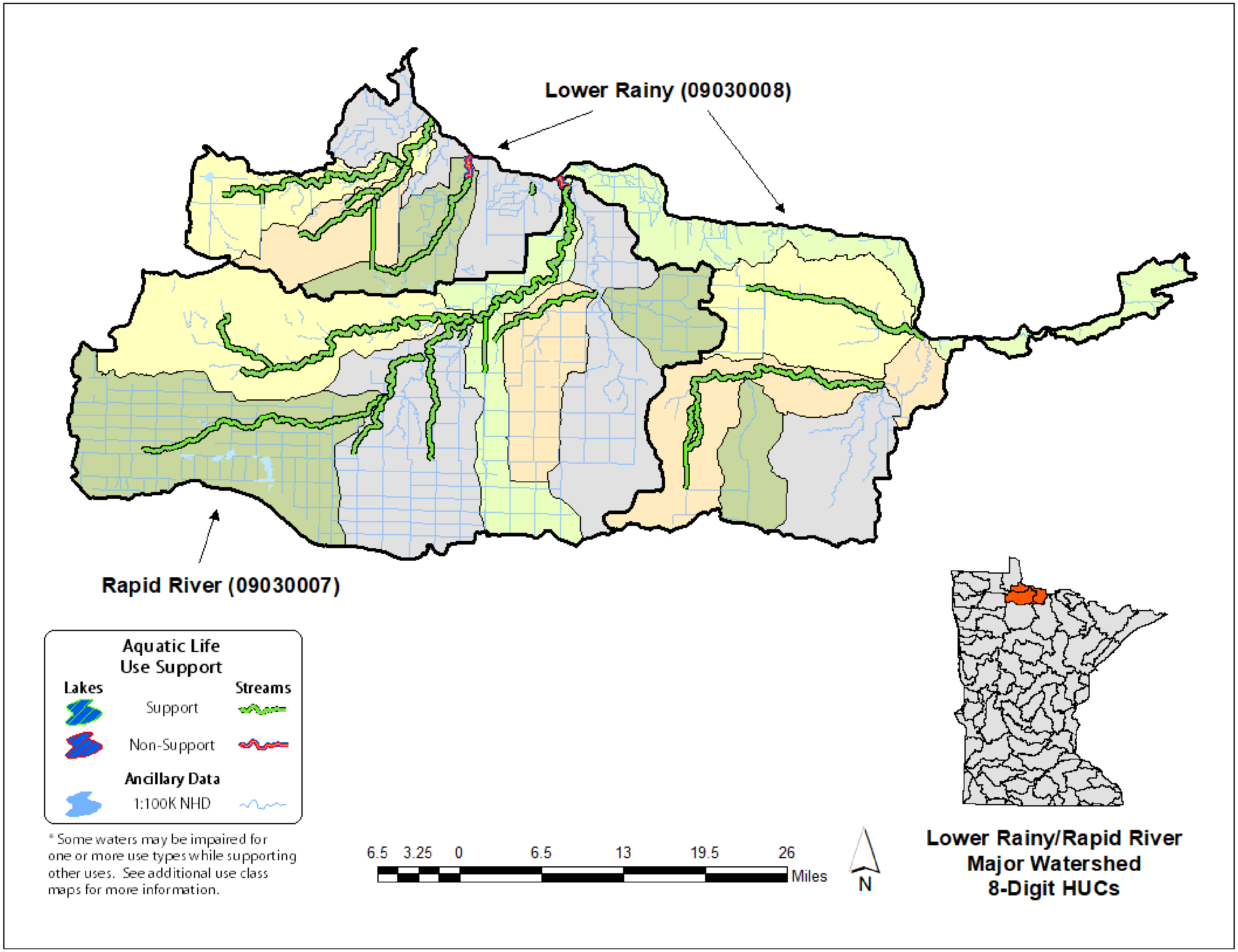
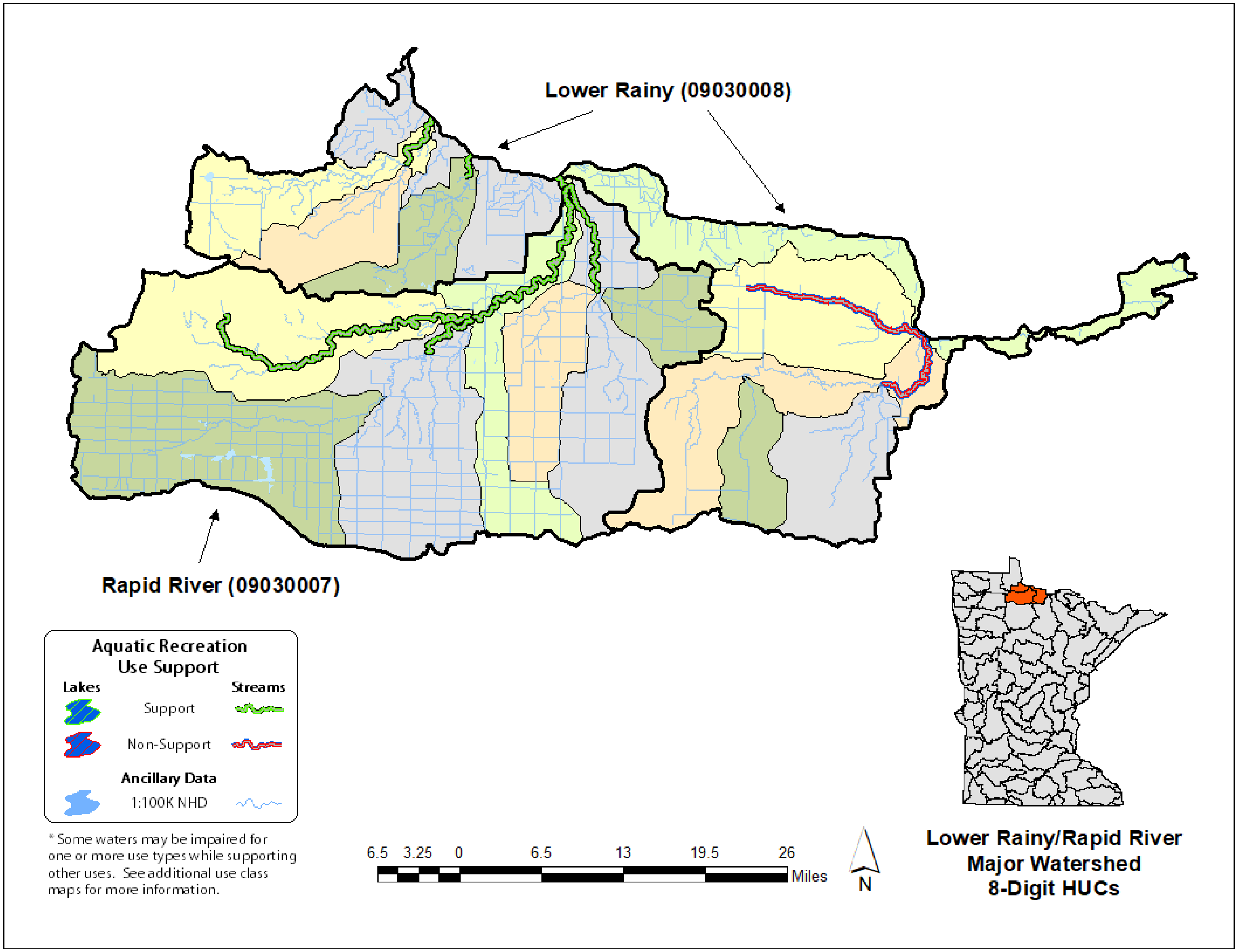


Figure 40. Aquatic recreation use support in the Lower Rainy River and Rapid River watersheds.



Transparency trends for the Lower Rainy River and Rapid River watersheds

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.

Three stream sites in the Rapid River Watershed have declining trends in water clarity. Two of these sites are located in the downstream reaches of the Rapid River, one is located in the downstream reach of the East Branch Rapid River Subwatershed.

The downstream reach of Moonlight Creek has an improving trend in water clarity, this was the only stream site where an improving transparency trend was detected. Five other locations had sufficient data for trend analysis, none having a detected trend in clarity.

Table 19. Water clarity trends.

Rapid River 8-HUC 09030007	Streams	Lakes
Number of sites w/increasing trend	0	--
Number of sites w/decreasing trend	3	--
Number of sites w/no trend	0	--

Lower Rainy River 8-HUC 09030008	Streams	Lakes
Number of sites w/increasing trend	1	--
Number of sites w/decreasing trend	0	--
Number of sites w/no trend	5	--

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 switched 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 covers over 100 sites across the state.

Priority waters for protection and restoration in the Rapid River and Lower Rainy River watersheds

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 and restoration 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 and restoration prioritization process include: whether a water has an active lake or river association, is publicly 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 a 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 risk priority ranking for each stream are shown in Appendix 7 and 8. 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 Rapid River Watershed, four general use streams were identified as priority class B designation, and eight with a priority class C designation. In the Lower Rainy River Watershed, four general use streams were identified as high priority (class B) and one reach is a cold water resource. While these streams currently meet standards, work done to maintain current condition is important to prevent impairment in the future.

Summaries and recommendations

Stream summary and recommendations

Aquatic resources span a wide range of conditions in the Lower Rainy River and Rapid River watersheds but, for the most part, conditions in these watersheds indicate support for healthy aquatic communities. While low-flow conditions during the IWM effort in 2017 and 2018 limited sampling opportunities within some reaches, 12 of the 15, or 80% of the stream reaches successfully sampled within the Lower Rainy River Watershed were found to support aquatic life. The Rapid River Watershed performed similarly with 11 of 12, or 91.6% of its sampled stream reaches found to support aquatic life. Conditions in the Winter Road River and Peppermint Creek subwatersheds are exceptionally good, producing the highest average MSHA scores. Fish and aquatic macroinvertebrate communities in these subwatersheds proved more diverse when compared to other subwatersheds and consistently yielded IBI scores above their respective impairment thresholds. Greater taxonomic diversity and the presence of intact habitat (less ditching and stream alteration) within these subwatersheds positions them as targets for future conservation efforts.

In some cases (e.g., North Branch Rapid River, West Fork Black River), IBI scores for fish and/or aquatic macroinvertebrate communities scored close to their respective IBI impairment thresholds. While the majority of land in the Rapid and Lower Rainy River watersheds is not developed, the contribution of water from wetlands and peat bogs may naturally depress dissolved oxygen levels in streams and negatively influence aquatic life. In both the Rapid River and Lower Rainy River watersheds many wetlands and peat bogs remain ditched because of an extensive campaign undertaken at the beginning of the 20th century (Figure 8). While these efforts failed to create substantial arable land, they added hundreds of miles of stream length to the watershed and markedly affected the region's hydrology. Where aquatic life is already compromised due to natural factors, anthropogenic stress in the form of ditching and dredging may exacerbate the problem and trigger an impairment.

Smaller tributaries to the Rainy River between International Falls and Baudette were difficult to assess for aquatic life. In the case of the Black River Subwatershed, thriving aquatic communities occurred in stream reaches where there were troubling levels of suspended solids and dissolved oxygen and the contributing watershed was mainly undeveloped. Assessment decisions where aquatic life indicators contradict one another, particularly in watersheds that are largely undeveloped, can be a challenge. At some sites, the location where water chemistry samples were collected led to uncertainty. A number of the smaller tributaries to the Rainy River have downstream reaches that function hydrologically as impoundments due to their close proximity to the larger river (e.g., Baudette River, Moonlight Creek). In these cases, low levels of dissolved oxygen may be attributable to backflow influence from the Rainy River. In all cases, the assessment teams strove for consistency in decision-making. Where both biological indicators clearly met standards the assessment teams considered stream reaches to support aquatic life.

Lowering the levels of suspended sediment in the Rapid River Watershed should be a point of focus for restoration and protection efforts going forward. Given that much of the landscape in this watershed remains dominated by wetlands, identifying specific sources of sediment presents a unique challenge. In more heavily altered landscapes of the state, sources of water quality degradation are obvious and numerous and present a variety of opportunities for restoration efforts. Improvement opportunities may be more limited in the Rapid River Watershed. Many smaller scale coordinated projects are likely to have a positive, cumulative effect. A successful approach to address the high levels of suspended sediment in the Rapid River will likely require a sustained collaborative effort between stakeholders.

Overall, the majority of streams in the Lower Rainy River and Rapid River watersheds support healthy aquatic communities. For these streams (e.g., Peppermint Creek, Winter Road River) prioritization and protection tools should provide technical water staff with a way to prevent future degradation.

Groundwater summary and recommendations

Both the quantity and quality of groundwater should be protected. Quantity is based on the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater withdrawals in the watershed have decreased slightly over the last 20 years ($p<0.05$) as well as surface water levels ($p<0.01$). The average potential groundwater recharge rate is equivalent to the state average and streamflow appears to be constant. While fluctuations due to seasonal variations are normal, long term changes in water levels should not be ignored.

Groundwater quality data were limited for these watersheds. Regional water quality data indicated that the northwest and northeast regions have groundwater quality that is considered good. The region lacks Cretaceous aquifers, which often have higher concentrations of chemicals. There are some exceedances to the arsenic MCL, which is often associated with geology. Furthermore, the pollution sensitivity of near-surface materials throughout the watershed was predominantly low to ultra-low, with only a few small areas with a high vulnerability associated with sand and gravel quaternary geology, which may experience a possible risk of contamination due to higher infiltration rates. At this time, it appears that there is not a great risk for groundwater contamination, but it is important to continue to monitor potentially harmful sites in order to inhibit possible water pollution.

Additional and continued monitoring will increase the understanding of the health of the watershed and its groundwater resources and aid in identifying the extent of the issues present and associated risks. Local monitoring efforts will help to increase the awareness of local water users and ensure that issues and risks are identified. Adoption of best management practices will benefit both surface and groundwater resources.

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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.

NO_3+NO_2-N (Nitrate plus Nitrite – Nitrogen) - Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, these species can stimulate excessive levels of algae in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-nitrogen to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen (NO_3+NO_2-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 (NH_3) - Ammonia is present in aquatic systems mainly as the dissociated ion NH_4^+, 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 NH_4^+ 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 Rapid River and Lower Rainy River watersheds

EQuIS ID	Biological station ID	WID	Waterbody name	Location	Aggregated 12-digit HUC
S001-962	17RN053	09030008-547	Black River	At MN Hwy 11 at Loman	Black River
S005-707	17RN024	09030008-502	Winter Road River	At Co Hwy 167, 4.5 mi NW of Baudette	Winter Road River
S007-611	17RN062	09030007-509	Rapid River, East Branch	Upstream of Co Hwy 18, 3 mi. SE of Clementson	Rapid River, East Branch
S009-445	05RN084	09030008-543	Black River, West Fork	At Co Hwy 82	Black River, West Fork
S009-446	17RN082	09030008-535	Baudette River	Adjacent to Co Hwy 1, 2.6 mi. SE of Baudette	Baudette River
S009-447	17RN026	09030008-507	Peppermint Creek	At Csah 177 (8th St SW), 5 mi. W of Baudette	Peppermint Creek
S009-451	05RN083	09030007-502	Rapid River	Downstream of Co Hwy 18, 1 mi. SE of Clementson	Lower Rapid River
S009-452	17RN066	09030007-503	Rapid River, North Branch	At Co Hwy 1, 12.75 mi S of Baudette	Rapid River, North Branch
S009-453	17RN079	09030007-504	Rapid River	At Co Hwy 1, 14.5 mi. S of Baudette	Rapid River, Middle Branch
S014-234	--	09030008-536	Baudette River	At boat launch off International Dr, at Baudette	Baudette River

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Lower Rainy River Watershed

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
09030008-502	17RN024	Winter Road River	Upstream of Hwy 11, 3 mi. NE of Pitt	Lake of the Woods	Winter Road River
09030008-506	17RN021	Winter Road River	Upstream of CR 2 SW, 6.5 mi. S of Williams	Lake of the Woods	Winter Road River
09030008-506	17RN025	Winter Road River	Downstream of CSAH 6 (29th Ave SW), 1 mi. SE of Pitt	Lake of the Woods	Winter Road River
09030008-507	17RN026	Peppermint Creek	Upstream of CSAH 177 (8th St SW), 2 mi. SE of Pitt	Lake of the Woods	Peppermint Creek
09030008-507	17RN029	Peppermint Creek	Downstream of CR 173 (41st Ave SW), 5 mi. SW of Pitt	Lake of the Woods	Peppermint Creek
09030008-510	17RN028	Pitt Creek	Adjacent to Pitt Grade Rd, 5 mi. S of Pitt	Lake of the Woods	Peppermint Creek
09030008-511	17RN034	Silver Creek	0.5 mi. E of CSAH 89, 2.5 mi. SW of Clementson	Lake of the Woods	Lower Rainy River
09030008-517	17RN055	Baudette River, West Fork	Adjacent to CSAH 1, 3.25 mi. SW of Baudette	Lake of the Woods	Baudette River
09030008-521	17RN022	Unnamed Ditch	Adjacent to CR 2 SW, 7 mi. S of Williams	Lake of the Woods	Winter Road River
09030008-528	17RN027	Little Peppermint Creek	Upstream of CSAH 3, 3 mi. SW of Pitt	Lake of the Woods	Peppermint Creek
09030008-534	17RN033	Silver Creek, East Branch	Downstream of CSAH 19 (29th Ave SE), 2 mi. SW of Clementson	Lake of the Woods	Lower Rainy River
09030008-535	17RN031	Baudette River	Upstream of CSAH 161 (19th St SW), 4 mi. S of Baudette	Lake of the Woods	Baudette River
09030008-535	17RN082	Baudette River	Adjacent to Hwy 1, 2.5 mi. SE of Baudette	Lake of the Woods	Baudette River
09030008-543	17RN040	Black River, West Fork	Downstream of CSAH 82 (W Fork Rd), 1.75 mi. NW of Loman	Koochiching	West Fork Black River
09030008-545	17RN045	Black River	Adjacent to CSAH 101, 11 mi. S of Birchdale	Koochiching	Black River
09030008-545	17RN054	Black River	Upstream of Fiero Truck Tr, 13 mi. S of Birchdale	Koochiching	Black River
09030008-546	17RN100	Black River	Upstream of UT 100, 4.75 mi. W of Loman	Koochiching	Black River
09030008-547	17RN053	Black River	Adjacent to Black River Rd, 1.5 mi. SE of Loman	Koochiching	Black River
09030008-554	17RN050	McCloud Creek	Downstream of CSAH 4, 4 mi. W of Birchdale	Koochiching	Middle Rainy River
09030008-562	17RN023	Wabanica Creek	Downstream of CSAH 167, 3 mi. S of Pitt	Lake of the Woods	Lower Rainy River
09030008-563	17RN047	Unnamed Ditch	Upstream of Fiero Truck Tr, 13.5 mi. S of Birchdale	Koochiching	Black River

Appendix 2.3 – Intensive watershed monitoring biological monitoring stations in the Rapid River Watershed

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
09030007-502	05RN083	Rapid River	Downstream of CR 18, 1 mi. SE of Clementson	Koochiching	Lower Rapid River
09030007-502	17RN080	Rapid River	Upstream of Hwy 72, 12 mi. S of Baudette	Lake of the Woods	Lower Rapid River
09030007-503	05RN104	Rapid River, North Branch	Upstream of Faunce Rd, 8 mi. S of Faunce	Lake of the Woods	North Branch Rapid River
09030007-503	17RN066	Rapid River, North Branch	Upstream of Hwy 1, 12 mi. S of Baudette	Lake of the Woods	North Branch Rapid River
09030007-503	17RN067	Rapid River, North Branch	Upstream of Bankton FR, 18.5 miles SW of Baudette	Lake of the Woods	North Branch Rapid River
09030007-504	17RN079	Rapid River	Upstream of Hwy 1, 14.5 mi. S of Baudette	Lake of the Woods	Middle Rapid River
09030007-506	17RN070	Rapid River	Upstream of Pitt Grade SW, 21 mi. SW of Baudette	Lake of the Woods	Upper Rapid River
09030007-506	17RN081	Rapid River	Upstream of Faunce FR, 30 mi SW of Baudette	Lake of the Woods	Upper Rapid River
09030007-507	17RN075	Chase Brook	Upstream of 67th St SW, 16.5 mi. S of Baudette	Lake of the Woods	Middle Rapid River
09030007-508	17RN076	Troy Creek	Downstream of Hwy 86, 16.5 mi. S of Baudette	Lake of the Woods	Middle Rapid River
09030007-509	05RN013	Rapid River, East Fork	Upstream of UT 9, 4.5 mi. SE of Clementson	Koochiching	East Fork Rapid River
09030007-510	17RN060	Barton's Brook	Upstream of Hwy 82, 11 mi. S of Clementson	Lake of the Woods	Barton's Brook
09030007-510	17RN061	Barton's Brook	Adjacent to Hwy 100, 9.5 mi. S of Clementson	Koochiching	Barton's Brook
09030007-513	17RN077	Christy Creek (Moose Creek)	Upstream of Hwy 83, 14 mi. S of Baudette	Lake of the Woods	Middle Rapid River
09030007-523	17RN074	Miller Creek	Upstream of Rapid River Rd, 20 mi. S of Baudette	Lake of the Woods	Middle Rapid River
09030007-528	17RN069	Unnamed creek	Upstream of Faunce FR, 23 mi SW of Baudette	Lake of the Woods	North Branch Rapid River
09030007-529	17RN078	Unnamed ditch	Adjacent to Hwy 72, 12.5 mi. S of Baudette	Lake of the Woods	Lower Rapid River

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 Cold Water	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 Cold Water	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 Cold Water	2A	52	32	NA	±12.4
9	Southern Cold Water	2A	72	43	NA	±13.8

Appendix 3.2 – Lower Rainy River biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
0903000802-01 (West Fork Black River)							
09030008-543	17RN040	Black River, West Fork	127.08	5	47	47.59	16-Aug-18
0903000803-01 (Black River)							
09030008-545	17RN054	Black River	47.78	7	42	38.44	27-Jun-18
09030008-547	17RN053	Black River	264.40	5	61	68.25	08-Aug-18
09030008-545	17RN045	Black River	76.31	5	47	61.30	23-Aug-17
09030008-546	17RN100	Black River	155.80	5	47	69.57	23-Aug-17
09030008-546	10EM193	Black River	158.80	5	47	69.59	22-Jul-10
0903000806-01 (Winter Road River)							
09030008-506	17RN021	Winter Road River	43.31	7	42	81.50	11-Jul-17
09030008-521	17RN022	Unnamed Ditch	18.17	6	42	80.42	17-Jul-17
09030008-502	17RN024	Winter Road River	140.67	5	47	76.57	22-Aug-17
09030008-502	17RN024	Winter Road River	140.67	5	47	70.76	11-Jul-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
09030008-506	17RN025	Winter Road River	74.57	5	47	74.28	12-Jul-17
0903000806-02 (Peppermint Creek)							
09030008-507	17RN029	Peppermint Creek	19.49	6	42	64.79	17-Jul-17
09030008-507	17RN026	Peppermint Creek	63.26	5	47	56.66	11-Jul-17
09030008-528	17RN027	Little Peppermint Creek	6.86	7	42	60.69	18-Jul-17
09030008-507	17RN029	Peppermint Creek	19.49	6	42	76.80	02-Aug-17
09030008-510	17RN028	Pitt Creek	21.12	11	35	36.67	12-Jul-17
0903000807-01 (Lower Rainy River)							
09030008-511	17RN034	Silver Creek	19.46	6	42	55.58	26-Jul-17
0903000807-02 (Baudette River)							
09030008-535	17RN031	Baudette River	37.37	6	42	76.43	17-Jul-17
09030008-535	17RN082	Baudette River	53.51	5	47	59.13	17-Jul-17

Appendix 3.3 – Rapid River Watershed biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
0903000701-01 (Upper Rapid River)							
09030007-506	17RN070	Rapid River	207.18	5	47	61.30	09-Aug-18
09030007-506	17RN081	Rapid River	81.04	5	47	41.45	27-Jul-17
0903000702-01 (Middle Rapid River)							
09030007-504	17RN079	Rapid River	343.42	5	47	52.34	26-Jul-17
09030007-513	17RN077	Christy Creek (Moose Creek)	33.43	6	42	80.97	25-Jun-18
09030007-508	17RN076	Troy Creek	32.63	7	42	68.04	15-Aug-18
09030007-508	17RN076	Troy Creek	32.63	7	42	66.10	26-Jun-18
09030007-523	17RN074	Miller Creek	41.05	7	42	52.98	01-Aug-17
0903000703-01 (North Branch Rapid River)							
09030007-503	05RN104	Rapid River, North Branch	64.28	5	47	46.80	05-Aug-15
09030007-503	05RN104	Rapid River, North Branch	64.28	5	47	45.75	20-Aug-13
09030007-503	05RN104	Rapid River, North Branch	64.28	5	47	44.14	20-Jul-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Fish class	Threshold	FIBI	Visit date
09030007-503	17RN066	Rapid River, North Branch	174.60	5	47	49.47	12-Jul-17
09030007-503	05RN104	Rapid River, North Branch	64.28	5	47	42.26	25-Jul-19
09030007-528	17RN069	Unnamed creek	25.10	7	42	78.71	15-Aug-18
09030007-503	17RN067	Rapid River, North Branch	129.31	5	47	54.50	24-Aug-17
0903000704-02 (Barton's Brook)							
09030007-510	17RN061	Barton's Brook	73.42	5	47	46.52	26-Jul-17
09030007-510	17RN060	Barton's Brook	30.40	7	42	71.85	01-Aug-17
0903000705-01 (Lower Rapid River)							
09030007-529	17RN078	Unnamed ditch	50.43	6	42	43.57	25-Jun-18
09030007-502	17RN080	Rapid River	580.42	4	38	58.37	22-Aug-17

Appendix 3.4 – Lower Rainy River Watershed biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Invert class	Threshold	MIBI	Visit date
0903000803-01 (Black River)							
09030008-545	17RN045	Black River	76.31	Northern Forest Streams GP	51	80.98	13-Aug-18
09030008-563	17RN047	Unnamed Ditch	32.46	Northern Forest Streams GP	51	52.23	13-Aug-18
09030008-546	17RN100	Black River	155.80	Northern Forest Streams RR	53	69.62	14-Aug-18
09030008-546	10EM193	Black River	158.80	Northern Forest Streams RR	53	58.64	25-Aug-10
0903000806-01 (Winter Road River)							
09030008-506	17RN025	Winter Road River	74.57	Northern Forest Streams RR	53	87.06	15-Aug-18
09030008-502	17RN024	Winter Road River	140.67	Northern Forest Streams RR	53	65.13	15-Aug-18

Appendix 3.5 – Rapid River Watershed 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
Upper Rapid River: 0903000701-01							
09030007-506	17RN070	Rapid River	207.18	Northern Forest Streams GP	51	85.59	14-Aug-18
0903000702-01 (Middle Rapid River)							
09030007-504	17RN079	Rapid River	343.42	Northern Forest Streams RR	53	73.51	14-Aug-18
09030007-508	17RN076	Troy Creek	32.63	Northern Forest Streams RR	53	68.75	15-Aug-18
0903000703-01 (North Branch Rapid River)							
09030007-503	05RN104	Rapid River, North Branch	64.28	Northern Forest Streams GP	51	49.00	07-Aug-19
09030007-503	05RN104	Rapid River, North Branch	64.28	Northern Forest Streams GP	51	58.00	05-Aug-15

09030007-503	05RN104	Rapid River, North Branch	64.28	Northern Forest Streams GP	51	58.35	21-Aug-13
09030007-528	17RN069	Unnamed creek	25.10	Northern Forest Streams GP	51	56.19	13-Aug-18
0903000705-01 Lower Rapid River							
09030007-502	05RN083	Rapid River	672.46	Northern Forest Rivers	49	56.49	14-Aug-18
09030007-502	17RN080	Rapid River	580.42	Northern Forest Rivers	49	57.72	14-Aug-18

Appendix 4.1 – Fish species found during biological monitoring surveys within the Lower Rainy River Watershed

Common name	Quantity of stations where present	Quantity of individuals collected
black crappie	1	1
blacknose dace	9	108
blacknose shiner	4	39
blackside darter	17	1612
brassy minnow	3	35
brook stickleback	14	381
burbot	6	15
central mudminnow	21	1533
common shiner	15	604
creek chub	15	831
fathead minnow	5	10
finescale dace	7	125
Gen: Ichthyomyzon	6	183
Gen: redhorses	2	69
golden shiner	2	5
hornyhead chub	6	29
Iowa darter	4	25
johnny darter	17	1041
lamprey ammocoete	3	166
logperch	5	60
longnose dace	5	81
mottled sculpin	5	195
muskellunge	1	1

Common name	Quantity of stations where present	Quantity of individuals collected
northern pike	11	39
northern redbelly dace	8	185
pearl dace	6	156
rainbow trout	2	7
rock bass	4	21
shorthead redhorse	5	16
silver lamprey	1	1
silver redhorse	4	36
smallmouth bass	2	14
tadpole madtom	2	20
trout-perch	6	320
walleye	4	11
white sucker	19	1319
yellow perch	3	97

Appendix 4.2 – Fish species found during biological monitoring surveys within the Rapid River

Common name	Quantity of stations where present	Quantity of individuals collected
bigmouth shiner	4	75
blacknose dace	13	842
blackside darter	12	909
brassy minnow	9	565
brook stickleback	15	1097
central mudminnow	15	956
common shiner	13	2949
creek chub	14	2337
fathead minnow	11	517
finescale dace	11	156
Gen: Ichthyomyzon	5	174
hornyhead chub	8	255
hybrid minnow	1	1
hybrid Phoxinus	1	2
Iowa darter	1	1
johnny darter	14	702
lamprey ammocoete	1	40
logperch	5	23
longnose dace	5	26
northern brook lamprey	1	1
northern redbelly dace	13	3314
pearl dace	13	476
shorthead redhorse	5	56
silver redhorse	4	18
smallmouth bass	2	69
white sucker	14	2164

Appendix 4.3 – Macroinvertebrate species found during biological monitoring surveys within the Lower Rainy River Watershed

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ablabesmyia	6	25
Acari	7	86
Acerpenna	3	20
Acilius	1	1
Acroneuria	4	5
Acroneuria lycorias	1	9
Aeshna	2	2
Aeshna umbrosa	4	11
Agabinae	1	1
Anacaena	4	9
Anafroptilum	1	3
Anopheles	3	4
Atherix	2	2
Atrichopogon	2	4
Baetidae	1	2
Baetis brunneicolor	1	11
Baetis flavistriga	2	11
Baetisca	3	3
Belostoma flumineum	2	2
Boyeria vinosa	4	6
Brachycentrus numerosus	2	10
Brillia	2	2
Caecidotea	1	3
Caenis	2	3
Caenis diminuta	7	127
Callicorixa	1	1
Calopterygidae	1	1
Calopteryx	3	7
Calopteryx aequabilis	2	4
Ceraclea	1	2
Ceratopogonidae	1	1
Ceratopogoninae	3	5
Ceratopsyche	1	8
Ceratopsyche bronta	1	1
Ceratopsyche morosa	1	3

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ceratopsyche slossonae	1	1
Cheumatopsyche	5	60
Chironomini	3	3
Chironomus	3	7
Cladotanytarsus	2	2
Coenagrionidae	2	21
Corduliidae	4	29
Corixidae	6	22
Corynoneura	1	1
Crambidae	1	4
Cricotopus	5	11
Cryptochironomus	3	6
Culicidae	1	2
Desmopachria convexa	1	2
Dicranota	1	1
Dicrotendipes	5	7
Diplocladius cultriger	1	1
Dixella	3	11
Dubiraphia	6	69
Dytiscidae	3	6
Endochironomus	1	3
Ephemera	1	1
Ephydridae	1	1
Eurylophella	5	15
Ferrissia	3	13
Fossaria rustica	2	2
Gerridae	1	1
Glyphopsyche irrorata	1	1
Glyptotendipes	1	5
Gomphidae	1	1
Gyraulus	2	43
Gyrinus	2	6
Haliplus	3	9
Helichus	1	1
Helicopsyche borealis	3	43
Helisoma anceps	1	5
Helopelopia	1	1
Hemerodromia	2	7
Heptageniidae	5	50

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Hirudinea	4	105
Hyalella	3	57
Hydraena	3	8
Hydrobiidae	4	104
Hydrochus	1	1
Hydroporus	1	1
Hydropsyche	2	7
Hydropsyche betteni	3	5
Hydropsychidae	3	13
Hydroptilidae	1	1
Hydrozoa	1	1
Kiefferulus	1	4
Labiobaetis propinquus	2	5
Labrundinia	2	7
Laccobius	1	1
Lepidostoma	2	2
Leptoceridae	1	1
Leptophlebiidae	7	142
Lethocerus	1	1
Leucrocuta	3	5
Limnephilidae	8	37
Limnephilus	1	2
Limnophyes	1	1
Liodessus	1	1
Lopescladius	1	1
Lymnaeidae	1	3
Lype diversa	1	3
Maccaffertium	7	23
Maccaffertium vicarium	1	7
Micrasema rusticum	2	6
Micropsectra	3	7
Microtendipes	7	32
Natarsia	1	1
Neoplasta	1	1
Neoplea striola	3	15
Neoporus	1	16
Nilothauma	1	1
Notonecta	1	1
Nyctiophylax	2	7

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ochrotrichia	1	1
Oecetis	2	7
Oecetis avara	3	12
Oecetis furva	1	2
Oecetis testacea	3	6
Oligochaeta	7	19
Ophiogomphus	1	1
Optioservus	4	37
Orconectes	8	16
Orthocladiinae	2	6
Orthocladius	1	1
Orthocladius (Symposiocladius)	5	14
Parachironomus	1	1
Paragnetina media	1	1
Parakiefferiella	3	8
Parametriocnemus	4	6
Paratanytarsus	5	6
Peltodytes	1	1
Perlidae	1	1
Phaenopsectra	5	14
Phryganeidae	1	1
Phylocentropus	2	3
Physella	8	249
Pisidiidae	9	45
Planorbidae	1	10
Platambus	1	1
Polycentropodidae	2	5
Polypedilum	7	43
Procladius	3	17
Procloeon	5	24
Pseudolimnophila	1	1
Pseudosuccinea columella	1	1
Pteronarcys	3	10
Ptilostomis	2	3
Pycnopsyche	3	9
Rhagovelia	1	1
Rheocricotopus	2	7
Rheotanytarsus	5	35

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Rheumatobates	1	1
Sialis	5	42
Sigara	2	2
Simulium	2	3
Siphloplecton	2	5
Somatochlora minor	3	3
Stempellina	1	1
Stempellinella	4	46
Stenacron	7	96
Stenacron interpunctatum	1	2
Stenelmis	3	66
Stenochironomus	8	27
Stictochironomus	1	1
Tanypodinae	3	7
Tanytarsini	2	7
Tanytarsus	8	116
Thienemanniella	1	1
Thienemannimyia Gr.	8	115
Tipula	1	1
Triaenodes	3	4
Tribelos	3	7
Trichocorixa	1	2
Xylotopus par	4	12
Zavrelimyia	3	8

Appendix 4.4 – Macroinvertebrate species found during biological monitoring surveys within the Rapid River Watershed

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ablabesmyia	7	41
Acari	9	285
Acerpenna pygmaea	2	5
Acilius	1	1
Acricotopus	1	12
Acroneuria	6	17
Aeshna umbrosa	2	7
Aeshnidae	1	1
Anacaena	2	12
Atrichopogon	2	11
Axarus	1	1
Baetis	1	1
Baetisca	4	9
Belostoma flumineum	2	5
Boyeria vinosa	2	4
Brachycentrus numerosus	2	5
Brillia	3	4
Caenis	1	14
Caenis diminuta	6	42
Caenis hilaris	4	46
Calopterygidae	1	6
Calopteryx	3	6
Calopteryx aequabilis	4	5
Ceraclea	1	1
Ceratopogonidae	1	2
Ceratopogoninae	6	56
Ceratopsyche	2	4
Ceratopsyche bronta	1	1
Cheumatopsyche	2	13
Chironomini	5	11
Chironomus	2	20
Coenagrionidae	2	3
Corduliidae	6	17
Corynoneura	2	3
Cricotopus	7	69
Cryptochironomus	2	7

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Cryptotendipes	2	2
Demicryptochironomus	1	2
Dicranota	1	5
Dicrotendipes	5	9
Dixella	2	6
Dubiraphia	8	70
Dytiscidae	2	5
Empididae	1	2
Endochironomus	3	7
Enochrus	1	6
Ephemera	1	1
Ephydridae	1	3
Eurylophella	2	4
Ferrissia	6	115
Fossaria	1	2
Fossaria rustica	1	1
Gerridae	1	1
Glyphopsyche irrorata	2	2
Glyptotendipes	3	7
Gomphidae	2	7
Gyraulus	5	20
Haliplus	2	22
Helichus	2	4
Helicopsyche borealis	5	11
Helisoma anceps	2	5
Hemerodromia	5	33
Heptageniidae	3	36
Hesperocorixa	1	1
Hexagenia	1	1
Hirudinea	4	14
Hyalella	4	86
Hydraena	4	15
Hydrobiidae	5	512
Hydropsyche	1	2
Hydropsyche betteni	1	2
Hydropsyche dicantha	1	1
Hydropsychidae	2	3
Hydroptila	2	6
Hydroptilidae	2	5

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Hydrozoa	1	1
Hygrotus	3	3
Iswaeon	2	3
Labiobaetis propinquus	1	8
Labrundinia	2	6
Lepidostoma	1	11
Leptoceridae	3	4
Leptophlebiidae	6	37
Lethocerus	1	1
Leucrocuta	1	5
Libellulidae	1	1
Limnephilidae	6	44
Limnophila	1	1
Liodessus	2	2
Lymnaea stagnalis	1	1
Lymnaeidae	1	11
Maccaffertium	4	44
Maccaffertium mediopunctatum	1	1
Maccaffertium vicarium	1	8
Macronychus glabratus	1	3
Micrasema rusticum	2	64
Micropsectra	4	17
Microtendipes	8	39
Molanna	1	1
Mystacides	1	1
Nanocladius	1	1
Natarsia	1	6
Nectopsyche	2	4
Nemata	2	3
Neoplasta	1	1
Neoplea striola	1	4
Nilotanypus	3	10
Nilothauma	1	1
Nixe	1	1
Notonecta	1	1
Nyctiophylax	3	10
Ochrotrichia	1	1
Oecetis	2	3

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Oecetis avara	5	26
Oecetis testacea	4	12
Oligochaeta	8	51
Ophiogomphus	4	6
Optioservus	3	26
Orconectes	3	10
Orthocladiinae	3	5
Orthocladius	3	8
Orthocladius (Symposiocladius)	1	1
Oxyethira	1	9
Paragnetina media	1	4
Parakiefferiella	3	4
Paralauterborniella nigrohalterale	2	4
Parametriocnemus	3	6
Paratanytarsus	3	46
Paratendipes	1	1
Perlidae	2	2
Phaenopsectra	4	25
Phryganeidae	3	3
Physa	1	14
Physella	9	97
Pisidiidae	10	144
Planorbella	4	6
Planorbidae	4	13
Polycentropodidae	1	2
Polypedilum	8	143
Procladius	2	14
Procloeon	5	27
Psectrocladius	1	3
Pteronarcys	5	14
Ptilostomis	2	13
Pycnopsyche	6	17
Rheocricotopus	3	8
Rheotanytarsus	7	84
Setodes	1	1
Sialis	4	11
Sigara	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Simulium	1	3
Sisyra	2	2
Somatochlora	1	1
Somatochlora minor	1	2
Stagnicola	1	1
Stempellina	3	7
Stempellinella	3	11
Stenacron	6	85
Stenelmis	5	84
Stenochironomus	8	47
Tabanidae	1	1
Tanypodinae	2	2
Tanytarsini	2	5
Tanytarsus	10	293
Thienemanniella	1	4
Thienemannimyia Gr.	9	102
Tipula	2	8
Triaenodes	4	54
Tribelos	5	27
Tricorythodes	1	3
Tvetenia	1	1
Valvata	1	18
Xylotopus par	4	16
Zavrelimyia	1	1

Appendix 5.1 – Lower Rainy River Watershed Stream Habitat Assessment Results

# Visits	Biological station ID	Reach name	Land use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish cover (0-17)	Channel morph. (0-36)	MSHA score (0-100)	MSHA rating
1	17RN031	Baudette River	3	8	11	13	12	47	Fair
1	17RN055	West Fork Baudette River	4	9.5	19.15	5	16	53.65	Fair
1	17RN082	Baudette River	3.5	8.5	17.75	15	20	64.75	Fair
Average Habitat Results: *Baudette River Aggregated 12-HUC*			**3.5**	**8.666667**	**15.96667**	**11**	**16**	**55.13333**	**Fair**
1	10EM193	Black River	4.5	14	20.1	9	25	72.6	Good
2	17RN045	Black River	5	9	12.95	7	11.5	45.45	Fair
2	17RN047	Unnamed Creek	5	11.75	9.35	14.5	13.5	54.1	Fair
2	17RN053	Black River	4.75	7.5	14	5.5	12.5	44.25	Poor
1	17RN054	Black River	5	10	16	15	21	67	Good
2	17RN100	Black River	5	9.5	15.83	7	17	54.32	Fair
Average Habitat Results: *Black River Aggregated 12-HUC*			**4.87**	**10.29167**	**14.705**	**9.666667**	**16.75**	**56.28667**	**Fair**
1	17RN023	Wabanica Creek	5	7	13.6	6	14	45.6	Fair
3	17RN033	East Branch Silver Creek	3.25	11	12.2	14	12.67	53.12	Fair
1	17RN034	Silver Creek	2.5	12	18.7	9	23	65.2	Fair
Average Habitat Results: *Lower Rainy River Aggregated 12-HUC*			**3.58**	**10**	**14.83333**	**9.666667**	**16.55667**	**54.64**	**Fair**
1	17RN026	Peppermint Creek	2.5	7	19	12	19	59.5	Fair
1	17RN027	Little Peppermint Creek	2.5	13	7	13	15	50.5	Fair
1	17RN028	Pitt Creek	5	9	21.7	12	10	57.7	Fair
2	17RN029	Peppermint Creek	5	12	11.22	14	17.5	59.73	Fair
Average Habitat Results: *Peppermint Creek Aggregated 12-HUC*			**3.75**	**10.25**	**14.73**	**12.75**	**15.375**	**56.8575**	**Fair**
2	17RN040	West Fork Black River	4.25	7.25	13.65	8.5	12	45.65	Fair

Average Habitat Results: ***West Fork Black River Aggregated 12-HUC***			**4.25**	**7.25**	**13.65**	**8.5**	**12**	**45.65**	**Fair**
1	17RN021	Winter Road River	5	11	16.1	13	17	62.1	Fair
1	17RN022	Unnamed Ditch	5	12	19.3	14	17	67.3	Good
3	17RN024	Winter Road River	3.83	10	19.23	11.33	22.67	67.07	Good
2	17RN025	Winter Road River	4.25	12	22.77	14.5	22.5	76.03	Good
Average Habitat Results: ***Winter Road River Aggregated 12-HUC***			**4.52**	**11.25**	**19.35**	**13.2075**	**19.7925**	**68.125**	**Good**

Qualitative habitat ratings

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

Appendix 5.2 – Rapid River Watershed Stream Habitat Assessment Results

# Visits	Biological station ID	Reach name	Land use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish cover (0-17)	Channel morph. (0-36)	MSHA score (0-100)	MSHA rating
1	17RN060	Barton's Brook	4	8	13	14	5	44	Fair
1	17RN061	Barton's Brook	5	10.5	17.6	14	15	62.1	Fair
Average Habitat Results: ***Barton's Brook Aggregated 12-HUC***			**4.5**	**9.25**	**15.3**	**14**	**10**	**53.05**	**Fair**
1	05RN083	Rapid River	4	8	16	5	15	48	Fair
3	17RN078	Unnamed Ditch	1.67	10	14.43	11	5	42.1	Poor
2	17RN080	Rapid River	1.25	7.25	18.5	6.5	9	42.5	Poor
Average Habitat Results: ***Lower Rapid River Aggregated 12-HUC***			**2.30666667**	**8.416667**	**16.31**	**7.5**	**9.666667**	**44.2**	**Poor**
1	17RN074	Miller Creek	5	12	7	13	15	52	Fair
3	17RN076	Troy Creek	3.83	10.67	18.68	12	18.33	63.52	Fair
1	17RN077	Christy Creek	3.25	10.5	17.7	13	21	65.45	Fair
2	17RN079	Rapid River	3.25	9.5	17.93	5.5	19	55.17	Fair
Average Habitat Results: ***Middle Rapid River River Aggregated 12-HUC***			**3.8325**	**10.6675**	**15.3275**	**10.875**	**18.3325**	**59.035**	**Fair**
6	05RN104	North Branch Rapid River	5	8.5	13.5	13.67	11.83	52.5	Fair
1	17RN066	North Branch Rapid River	4	10.5	17.15	10	15	56.65	Fair
2	17RN067	North Branch Rapid River	5	13	19.67	13	16	66.68	Good
2	17RN069	Unnamed Creek	5	11	12.2	14.5	15.5	58.2	Fair
Average Habitat Results: ***North Branch Rapid River Aggregated 12-HUC***			**4.75**	**10.75**	**15.63**	**12.7925**	**14.5825**	**58.5075**	**Fair**
3	10EM037	Unnamed Ditch	5	9.67	2	12	6	34.67	Poor
2	17RN070	Rapid River	5	8.25	17.77	5.5	11	47.52	Fair
1	17RN081	Rapid River	5	10.5	16.4	13	12	56.9	Fair
Average Habitat Results: ***Upper Rapid River Aggregated 12-HUC***			**5**	**9.473333**	**12.05667**	**10.16667**	**9.666667**	**46.36333**	**Fair**

Qualitative habitat ratings

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

Appendix 6.1 – Stream protection and prioritization results in the Lower Rainy River Watershed

Waterbody ID (WID)	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09030008-507	Peppermint Creek	General	Warm	neither	medium	med/low	med/high	C
09030008-535	Baudette River	General	Warm	neither	medium	med/low	med/high	C
09030008-506	Winter Road River	General	Warm	neither	med/low	med/low	med/high	C
09030008-521	Unnamed Ditch	General	Warm	neither	med/high	low	high	C
09030008-545	Black River	General	Warm	neither	medium	low	high	C
09030008-546	Black River	General	Warm	neither	low	low	med/high	C

Appendix 6.2 – Stream protection and prioritization results in the Rapid River Watershed

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09030007-529	Unnamed ditch	General	warm	one	high	low	high	B
09030007-503	Rapid River, North Branch	General	warm	one	med/low	low	high	B
09030007-506	Rapid River	General	warm	one	low	low	high	B
09030007-513	Christy Creek	General	warm	neither	med/high	med/low	medium	B
09030007-504	Rapid River	General	warm	neither	med/high	low	med/high	C
09030007-502	Rapid River	General	warm	neither	medium	low	med/high	C
09030007-508	Troy Creek	General	warm	neither	med/low	low	med/high	C
09030007-510	Barton's Brook	General	warm	neither	med/low	low	med/high	C
09030007-523	Miller Creek	General	warm	neither	low	low	high	C
09030007-528	Unnamed Creek	General	warm	neither	low	low	high	C