North Fork Crow River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

December 2011

Authors

MPCA North Fork Crow Watershed Team:
Aaron Onsrud
Pam Anderson
Dave Christopherson
Gerald Flom
Dan Helwig
Jeff Jasperson
Margaret Leech
Bruce Monson
Kris Parsons
Bruce Wilson

Contributors / acknowledgements

Citizen Lake Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture
Middle Fork Crow River Watershed District

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

Minnesota Pollution Control Agency

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

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

Document number: wq-ws3-07010204b

Contents

Executive Summary

The North Fork Crow River Watershed (07010204) is located in south-central Minnesota. Most of the watershed falls in the North Central Hardwood Forest Ecoregion with a small area in the south-central part of the watershed in the Central Cornbelt Plains Ecoregion, meaning the watershed was originally a mixture of hardwood trees and prairie. Much of the landscape of this watershed has been modified by the early settlers in the area and subsequent residents. Timber removal, draining wetlands, and modifying stream channels were all performed to make the land more suitable for agriculture. Now approximately 73 percent of the watershed is used for agricultural production.

In 2007 the Minnesota Pollution Control Agency (MPCA) undertook an intensive watershed monitoring (IWM) effort of the North Fork Crow River Watershed surface waters. Fifty-nine sites were sampled for biology at the outlet of variable sized sub-watersheds within the North Fork Crow Watershed. These locations included the mouth of the North Fork Crow River where it joins the South Fork Crow River, the Crow River where it joins the Mississippi River, outlet of the major tributaries and outlet of smaller headwater tributaries. The MPCA also completed water chemistry sampling at the outlet of sixteen of nineteen major sub-watersheds, and lake water quality sampling focusing on basins greater than 100 acres in size. In 2010, a holistic approach was started using the monitoring data collected to assess all of the watershed's surface water bodies for aquatic life, recreation and consumption use support. Where data was available, 82 stream reaches and 69 lakes were assessed in this effort. (Not all lake and stream AUIDs were able to be assessed due to insufficient data, modified channel condition or their status as limited resources waters.)

Only three stream AUIDs are fully supporting for aquatic life and, one is fully supporting for aquatic recreation. Seventeen stream reaches are non-supporting for aquatic life and fifteen for aquatic recreation throughout the watershed. Fifty-nine of the AUIDs had sites on channelized streams and are given either a good, fair, or poor in the report and others did not have enough information to assess. Aquatic consumption impairments span almost the length of the North Fork Crow River.

Twenty-eight of the watershed's assessed lakes are fully supporting for aquatic recreation. Forty-one lakes are non-supporting for aquatic recreation.

Land use modification and hydrologic alteration including groundwater withdrawal may be contributing factors to the observed poor water quality conditions. Additional monitoring to determine stressors followed by the development and implementation of restoration and protection strategies are needed to improve conditions and attain water quality standards in the North Fork Crow River Watershed.

I. Introduction

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

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

The passage of Minnesota's Clean Water Legacy Act of 2006 provided a policy framework and initial resources to state and local governments to accelerate efforts to monitor, assess, restore, and protect surface waters. Funding from the Clean Water Fund created by the passage of the Clean Water, Land, and Legacy Amendment to the state constitution allows a continuation of this work. In response, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of water monitoring programs to provide a more comprehensive assessment of water quality and expedite the restoration and protection process. This has permitted the MPCA to establish a goal to assess the condition of Minnesota's surface waters via a 10-year cycle and provides an opportunity to more fully integrate MPCA water resource management efforts in cooperation with local government and stakeholders, to allow for coordinated development and implementation of water quality restoration and improvement projects.

The rationale behind the watershed approach is to intensively monitor the streams and lakes within a major watershed to determine the overall health of water resources, identify impaired waters, and to identify waters in need of additional protection efforts. This monitoring strategy was implemented in the North Fork Crow River Watershed beginning in the summer of 2007. This report provides a summary of all water quality assessment results, and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units. Consequently, there is an opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at a watershed scale, rather than the reach-by-reach and parameter by parameter approach often historically employed. A watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and non-point sources of pollution and further the CWA goal of protecting, restoring, and preserving the quality of Minnesota's water resources.

II. The watershed monitoring approach

The watershed approach is a 10-year rotation for assessing waters of the state on the level of Minnesota's 81 major watersheds (Figure 1). The primary feature of the watershed approach is that it provides a unifying focus on the water resources within a watershed as the starting point for water quality assessment, planning, implementation, and results measures. The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDL's 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 2008a) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Load monitoring network

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

Water quality samples are collected year round at all MWLMP monitoring sites. Approximately 30-35 mid-stream grab samples are collected per site per year. Sample collection intensity is greatest during periods of moderate and high flow due to the importance these samples carry in pollutant load calculations. Sampling also occurs during low flow periods but at a lower frequency. Water quality and discharge data are combined in the "Flux32 Pollutant Load Model" to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs from Flux32 include pollutant loads and flow weighted mean concentrations (FWMC). A pollutant load is defined as the amount (mass) of a pollutant passing a stream location over a given unit of time. The flow weighted mean concentration is used to estimate the overall quality of water passing this point, computed by dividing the pollutant load by the total flow volume that passed the stream location over the same given unit of time.

Annual pollutant loads are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), and nitrate plus nitrite-nitrogen (nitrate-N). Primary outputs from Flux32 include pollutant loads (Table 1) and FWMC (Figures 1-4). When fully implemented, the MWLMP will monitor and compute pollutant loads at 81 stream sites across the State.

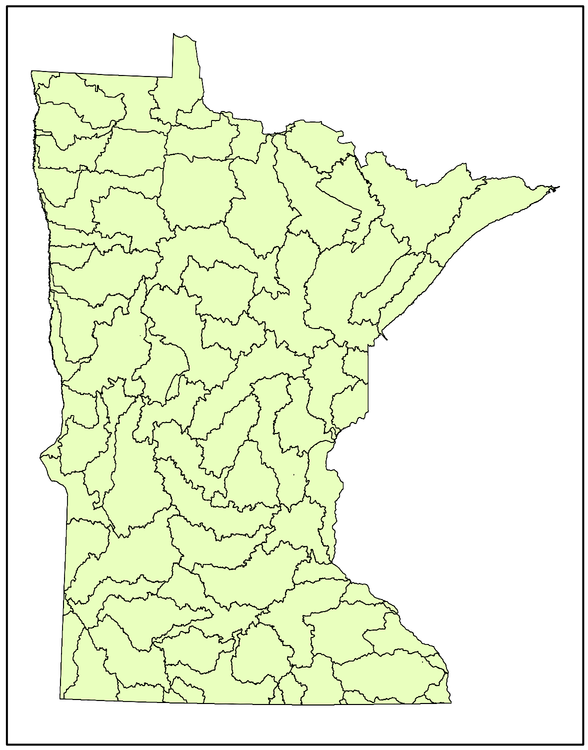


Figure 1. Major watersheds within Minnesota (8-Digit HUC)

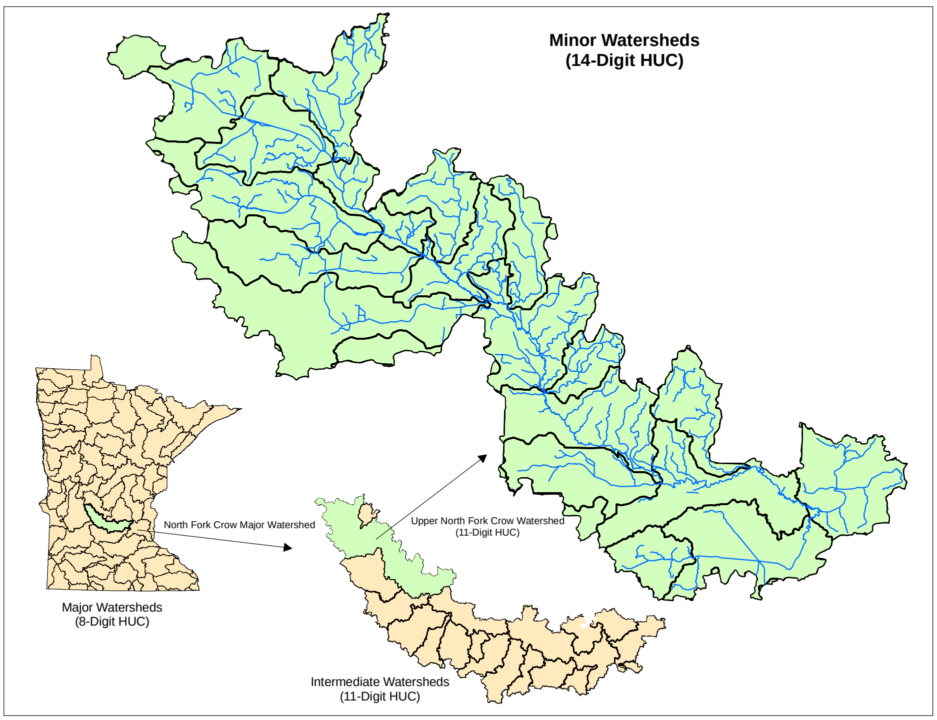
The on-going monitoring performed by the program is designed to measure and compare regional differences and long-term trends in water quality. This will be particularly helpful in putting the intensive watershed monitoring data for a given watershed (see below) into a longer-term context, given that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

Intensive watershed monitoring

Stream monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale. The foundation of this comprehensive approach is the 81 major watersheds within Minnesota. Streams are broken in to segments by hydrologic unit codes (HUC) to define separate waterbodies within a watershed. Sampling occurs in each major watershed once every 10 years. In this approach intermediate-sized (approx. HUC-11) and "minor" (14-digit HUC) watersheds are sampled along with the major watershed outlet to provide a complete assessment of water quality (Figure 2). River/stream sites are selected near the outlet at all watershed scales. This approach provides holistic assessment coverage of rivers and streams without monitoring every single stream reach (See Figure 3 for an illustration of the monitoring site coverage within the North Fork Crow River Watershed).

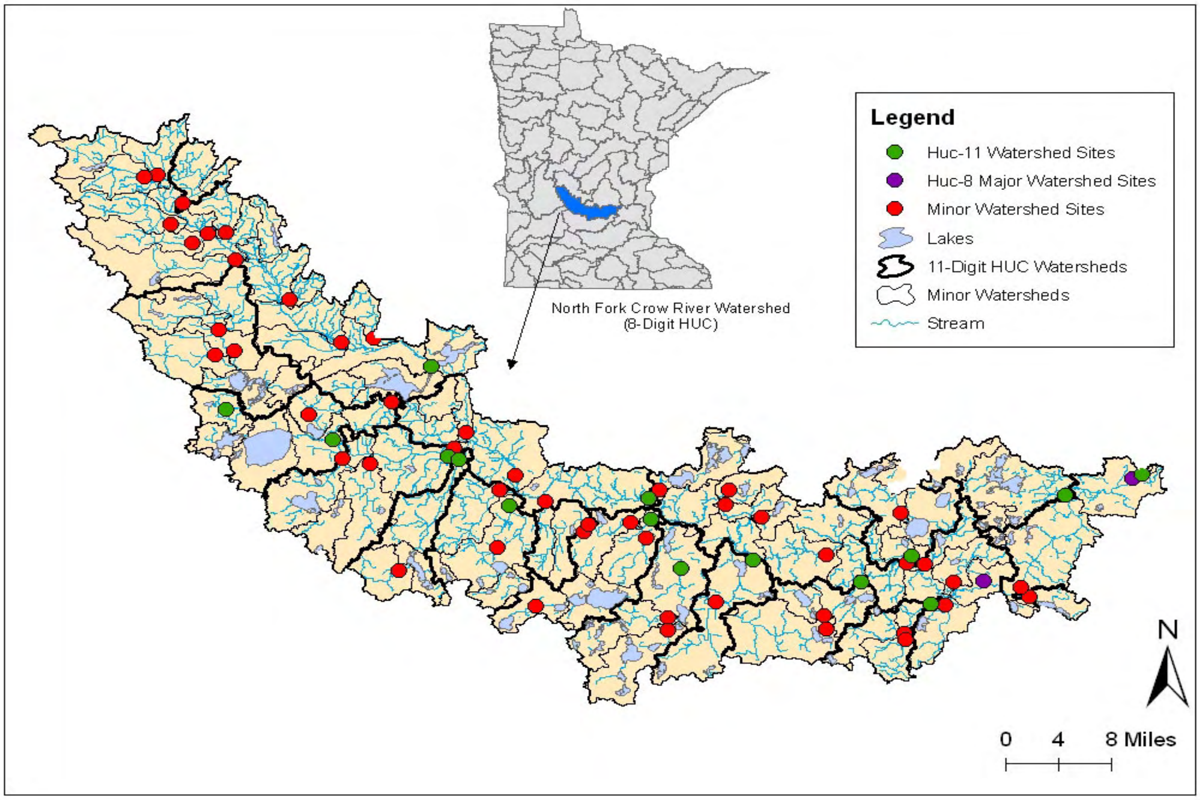
Figure 2. The intensive watershed monitoring design



The outlet of the major watershed (purple dots in Figure 3) is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation, and aquatic consumption use-support. Typically there is only one of these sites but, in the North Fork Crow River Watershed there are two fish contaminant sites. One is on the North Fork Crow River before the North and South Fork Crow Rivers meet and the other is on the Crow River before entering the Mississippi River. Each HUC-11 outlet (green dots in Figure. 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use-support. Watersheds at this scale generally consist of major tributary streams with drainage areas ranging from 75 to 150 square miles. Lastly, most minor watersheds (typically 10-20 square miles) are sampled for biology (fish and macroinvertebrates) to assess aquatic life use-support (red dots in Figure. 3). Specific locations for sites sampled as part of the intensive monitoring effort in the North Fork Crow River Watershed can be found in Appendix 4.

The second step of the intensive watershed monitoring effort consists of follow-up monitoring at areas determined to have impaired waters. This follow-up monitoring is designed to collect the information needed to initiate the stressor identification process in order to identify the source(s) and cause(s) of impairment to be addressed in TMDL development and implementation.

Figure 3. Intensive watershed monitoring stations in the North Fork Crow River Watershed



Lake monitoring

The MPCA conducts and supports lake monitoring for a variety of objectives. Lake condition monitoring activities are focused on assessing the recreational use support of lakes and identifying trends over time. The MPCA also assesses lakes for aquatic consumption use support, based on fish-tissue and water-column concentrations of toxic pollutants. Lake monitoring was brought into the watershed monitoring framework in 2009.

Even when pooling MPCA and local resources, the MPCA is not able to monitor all lakes in Minnesota. The primary focus of MPCA monitoring is lakes $\geq$500 acres in size ("large lakes"). These resources typically have public access points, they generally provide the greatest aquatic recreational opportunity to Minnesota's citizens, and these lakes collectively represent 72 percent of the total lake area (greater than 10 acres) within Minnesota. Though the primary focus is on monitoring and assessing larger lakes, the MPCA is also committed to directly monitoring, or supporting the monitoring of, the majority of lakes between 100-499 acres ("small lakes") for assessment purposes.

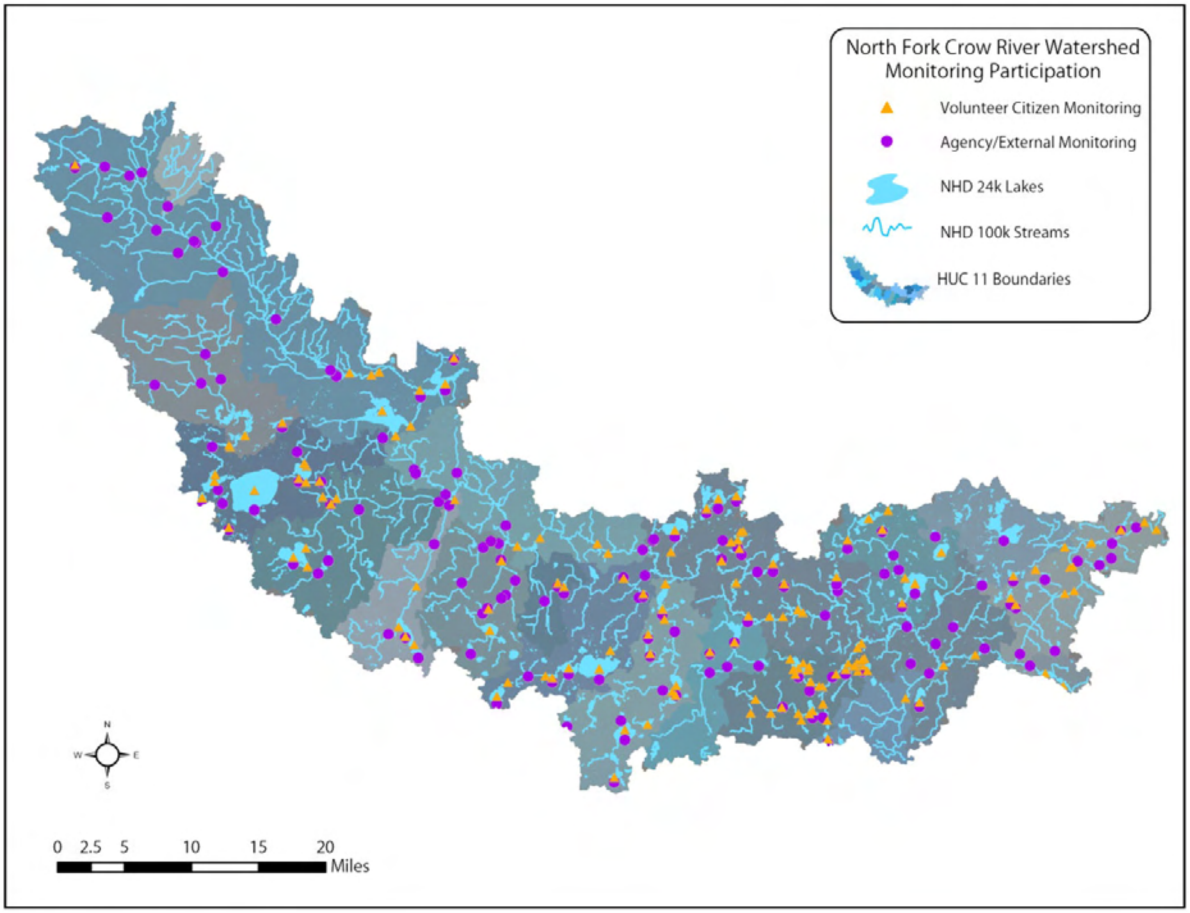
Citizen and local monitoring

Citizen monitoring is an important component of the watershed monitoring approach. The MPCA coordinates two programs aimed at encouraging citizen surface water monitoring: the Citizen Lake Monitoring Program and the Citizen Stream Monitoring Program. Like the permanent load monitoring network, sustained citizen monitoring can provide the long-term picture needed to help evaluate current status and trends. The advance identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites too, so that water quality data collected by volunteers are available for the years before and after the intensive monitoring effort by MPCA staff. This citizen-collected data helps agency staff interpret the results from the intensive monitoring effort, which only occurs one out of every 10 years. It also allows interested parties to track any water quality changes that occur in the years between the intensive monitoring events. Coordinating with volunteers to focus monitoring efforts where it will be most effective for planning and tracking purposes will help local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change. Figure 4 provides an illustration of citizen monitoring data used for assessment in the North Fork Crow River Watershed.

The MPCA also passes through funding via Surface Water Assessment Grants (SWAG) to local groups such as counties, soil and water conservation districts, watershed districts, nonprofits, and educational institutions to monitor lake and stream water quality. These local partners greatly expand our overall capacity to conduct sampling. Many SWAG grantees invite citizen participation in their monitoring projects.

The annual SWAG Request for Proposal (RFP) identifies the major watersheds that are scheduled for upcoming intensive monitoring activities. HUC-11 stream outlet chemistry sites and lakes less than 500 acres that need monitoring are identified in the RFP and local entities are invited to request funds to complete the sampling. SWAG grantees conduct detailed sampling efforts following the same established monitoring protocols and quality assurance procedures used by the MPCA. All of the lake and stream monitoring data from SWAG projects are combined with the MPCA's monitoring data to assess the condition of Minnesota lakes and streams.

Figure 4. Monitoring locations of local groups, citizens, and the MPCA lake monitoring staff in the North Fork Crow River Watershed



III. Assessment methodology

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

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008) (https://www.revisor.eg.state.mn.us/rules/?id=7050). These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams and wetlands are protected for aquatic life and recreation where these uses are attainable. Protection of aquatic life means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms, including fish and invertebrates. Protection of recreation means the maintenance of conditions suitable for swimming and other forms of water recreation. Protection of consumption means protecting citizens who eat fish inhabiting Minnesota waters or receive their drinking water from waterbodies protected for this use.

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

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

Assessment units

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

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

Determining use attainment status

Conceptually, the process for determining use attainment status of a waterbody is similar for each designated use: comparison of monitoring data to established water quality standards. However, the complexity of that process and the amount of information required to make accurate assessments varies between uses. In part, the level of complexity in the assessment process depends on the strength of the dose-response relationship; i.e., if chemical B exceeds water quality criterion X, how often is beneficial use Y truly not being attained. For beneficial uses related to human health, such as drinking water, the relationship is well understood and thus the assessment process is a relatively simple interpretation of numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 4.

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

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012) http://www.pca.state.mn.us/index.php/view-document.html?gid=8601 for guidelines and factors to consider when making such determinations.

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

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

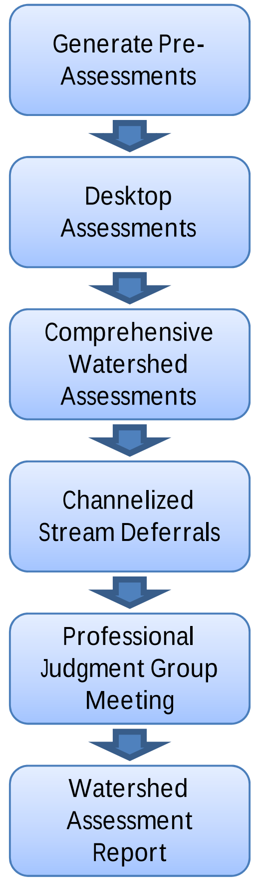
Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local government and volunteers. The data must meet rigorous quality-assurance protocols before being used. The MPCA stores surface monitoring data in United States Enivornmental Proctection Agency's STORET system and all monitoring data required or paid for by MPCA is entered into EQuIS, MPCA's front end data portal to STORET. Projects funded by MPCA include Clean Water Act Section 319 projects, Clean Water Partnership projects, SWAG projects and more recently, TMDL projects. Many local projects not funded by MPCA choose to submit their data to the MPCA in STORET-ready format so that it may be utilized in the assessment process. Prior to each biennial assessment cycle, the MPCA publishes a "Call for Data" in the State Register and contacts partner organizations directly to request their monitoring data.

Period of record

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

Figure 5. Flowchart of aquatic life use assessment process.



IV. The North Fork Crow River Watershed

The North Fork Crow River Watershed is located in the central portion of Minnesota. The 1,388 square mile watershed is located within the North Central Hardwood Forest Ecoregion except for a small area of Western Corn Belt Plains Ecoregion located in Meeker and Kandiyohi County (White 2007 Figure 6). The North Fork Crow River and its tributaries flow through seven counties where it combines with the South Fork Crow River in the town of Rockford. After the confluence it becomes called the Crow River which flows northeast to the Mississippi River. Litchfield, Buffalo, Rockford, St. Michael, and Albertville are the largest towns in the watershed, but the watershed is mostly rural, with developed areas making up only five percent of the land use (Figure 8). There is a combined population of about 96,990 people (NRCS) in this watershed. The area is primarily agricultural with 73 percent of the land used for cropland and pasture. The majority of the cropland is planted with corn and soybeans.

The North Fork Crow River Watershed is long and narrow west-east, with one large tributary called the Middle Fork Crow. The North Fork Crow and South Fork Crow combine to become the Crow River which is part of the North Fork Crow 8 Digit-HUC. The watershed is comprised of nineteen HUC-11 units, with the North Fork Crow main stem being split between the Upper, Middle, Lower, and Crow River units.

Stream monitoring began in 2007 in the North Fork Crow as part of the intensive watershed monitoring project, and lake monitoring began in 2009. While the majority of data used for assessment was collected from 2007 to 2009, available data from the last ten years was used for assessment. Fifty-nine sites were sampled throughout the watershed for biology (locations are available in Appendix 4). Sixteen sites were sampled for intensive water chemistry, and two sites was sampled for fish contaminants (locations are available in Appendix 3). Due to the dryness of the later part of the summer, MPCA was not able to sample all of the tributaries to the North Fork Crow for invertebrates, or sample water chemistry at all of the sites throughout the summer months.

Figure 6. The North Fork Crow Watershed within the North Central Hardwood Forest and Western Corn Belt Plains ecoregions of central Minnesota

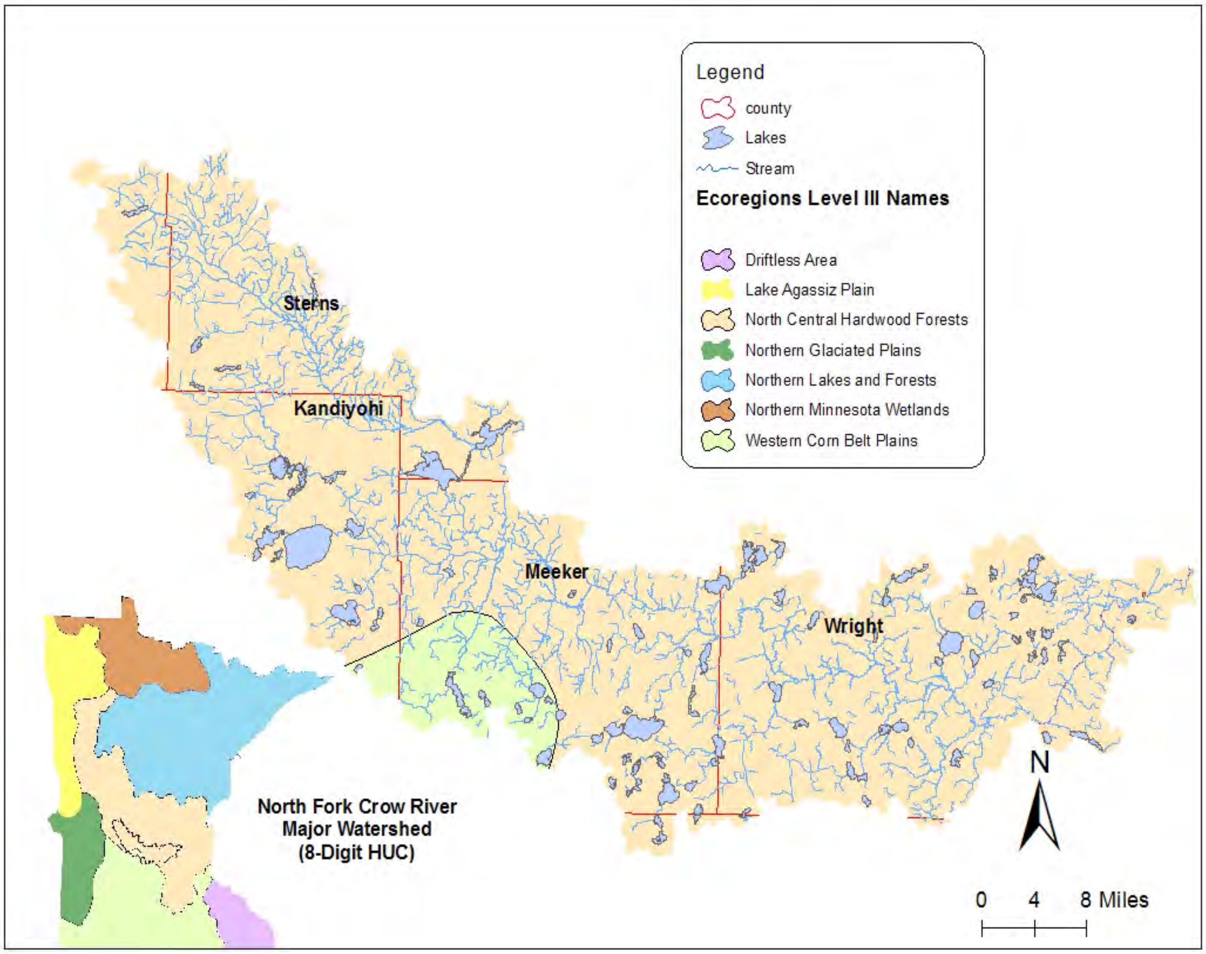
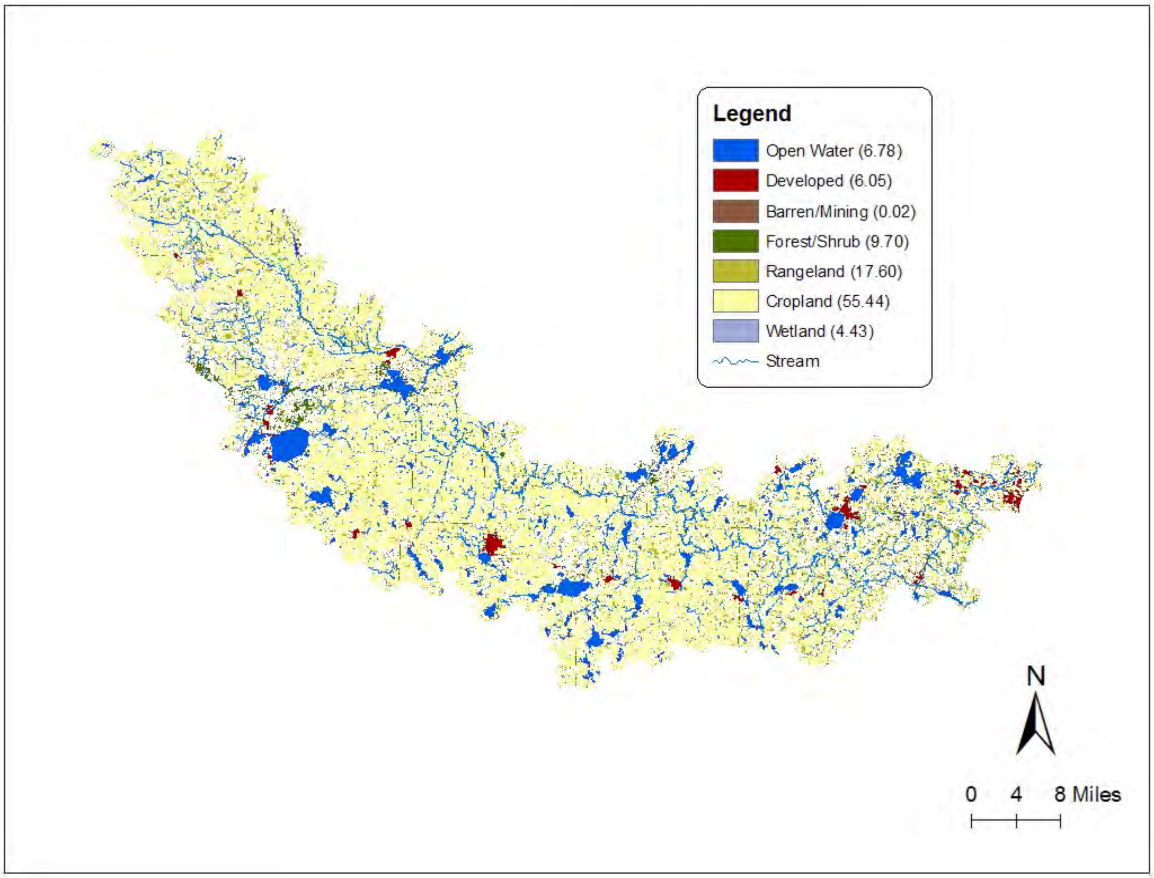


Figure 7. Land use in the North Fork Crow Watershed



V. Hydrogeology and groundwater resources

Geologic setting

The oldest, lowermost bedrock types in the watershed are Precambrian igneous and metamorphic rocks. In some areas they occur directly beneath glacial drift. In other parts of the watershed, both Precambrian sedimentary rocks and (younger) Cambrian rocks underlie the drift (Lindholm et al., 1974). The glacial drift that covers the watershed is as much as 500 feet. thick in some areas. Glacial till plains, end moraines and outwash deposits from the surface of the watershed. Outwash deposits are the most likely deposits to form significant surficial aquifers (Lindholm et al., 1974). The distribution of these surficial Quaternary sediments in the watershed can be seen in Hobbs et al. (1982).

Local hydrostratigraphy varies substantially from one end of the watershed to the other; compare Lindholm et al. (1974) and Falteisek (1998) for specific examples. More details about drift thickness, bedrock topography and characteristics of the surficial geologic units can be found in Lindholm et al. (1974). More detailed information about the hydrogeology of the northwestern fifth of the watershed, can be found in (Harris, 2003), (Berg, 2006), (Meyer, 1995), (Falteisek, 1998) and (Meyer, 1996).

Groundwater occurrence and aquifer characteristics

The North Fork Crow River Watershed falls within two of Minnesota's six Ground Water Provinces. The eastern fifth of the watershed lies within the Metro Province which is characterized by "sand aquifers in generally thick (> 100 ft.) sandy and clayey drift overlying Precambrian sandstone and Paleozoic sandstone, limestone and dolostone aquifers." The rest of the watershed is in the Central Province which is characterized by "sand aquifers in generally thick sandy and clayey glacial drift overlying Precambrian and Cretaceous bedrock." (MDNR, 2001).

Several highly productive aquifers are laterally continuous over large areas of the watershed. The most readily available groundwater occurs in surficial outwash bodies, the largest of which are near Brooten and Litchfield. Buried outwash aquifers, typically small, are also present in undifferentiated drift deposits (Lindholm et al., 1974). Sandstones form two extensive aquifers that underlie the drift in the eastern third of the watershed. In 1974, Lindholm et al. reported that they are the two most productive sources of water from bedrock and could support considerable ground-water development.

Since the bedrock aquifers are typically covered with thick till, they would normally be better protected from contaminant releases at the land surface. It is also less likely that withdrawals from these wells would have a direct significant impact on local surface water bodies. In contrast, surficial aquifers are typically more likely to (1) being vulnerable to contamination, (2) have direct hydrologic connections to local surface water and (3) influence the quality and quantity of local surface water.

Groundwater quality

According to USDA-NRCS (2008), specific resource concerns that are particularly relevant to groundwater or groundwater and surface water interactions include animal waste management, sealing of abandoned wells and removal or replacement of aging septic systems. Groundwater contamination susceptibility in the watershed is generally moderate in the lower region, slight in central areas, and high in the upper watershed, with a pocket of extreme susceptibility near the river upstream of the confluence of the North and South Forks of the Crow River (USDA-NRCS, 2008).

The following groundwater quality summaries are based primarily on MPCA ambient monitoring efforts and Minnesota Department of Agriculture (MDA) agricultural chemical monitoring efforts. The data sets are inadequate for a groundwater quality characterization of any specific aquifer, but they still provide useful insights. The MDA wells are typically shallow monitoring wells. Many of the MPCA wells, especially the "baseline" wells, are deeper domestic water supply wells (56 ft. to 419 ft. deep). Where nitrate or arsenic occurs at relatively high concentrations, it could be of concern for groundwater used as drinking water and for surface-waterbodies where they are recharged by groundwater.

Nitrate concentrations reported for the 21 MDA wells ranged from the reporting limit of 0.001 to 48.1 mg/L nitrate as N. Eleven of the MDA wells in the northwestern portion of the watershed had nitrate concentrations higher than the EPA maximum contaminant limit (MCL), of 10 mg/L nitrate as N. Nitrate was not detected in the 32 other wells, most of which are MPCA baseline wells. However, two other types of wells, both only 24 ft. deep, had concentrations of 4.90 mg/L nitrate and 37.42 mg/L.

Arsenic occurs naturally at concentrations above the MCL of 10 parts per billion (ppb) in deposits associated with Des Moines Lobe till - the till which covers the surface of the watershed according to Lindholm et al. (1974). Eleven of the 27 MPCA wells sampled had arsenic concentrations above the MCL. The eleven wells are distributed fairly evenly throughout the watershed. The highest concentration found was 82.6 ppb; the lowest concentration was 0.45 ppb.

Groundwater quantity

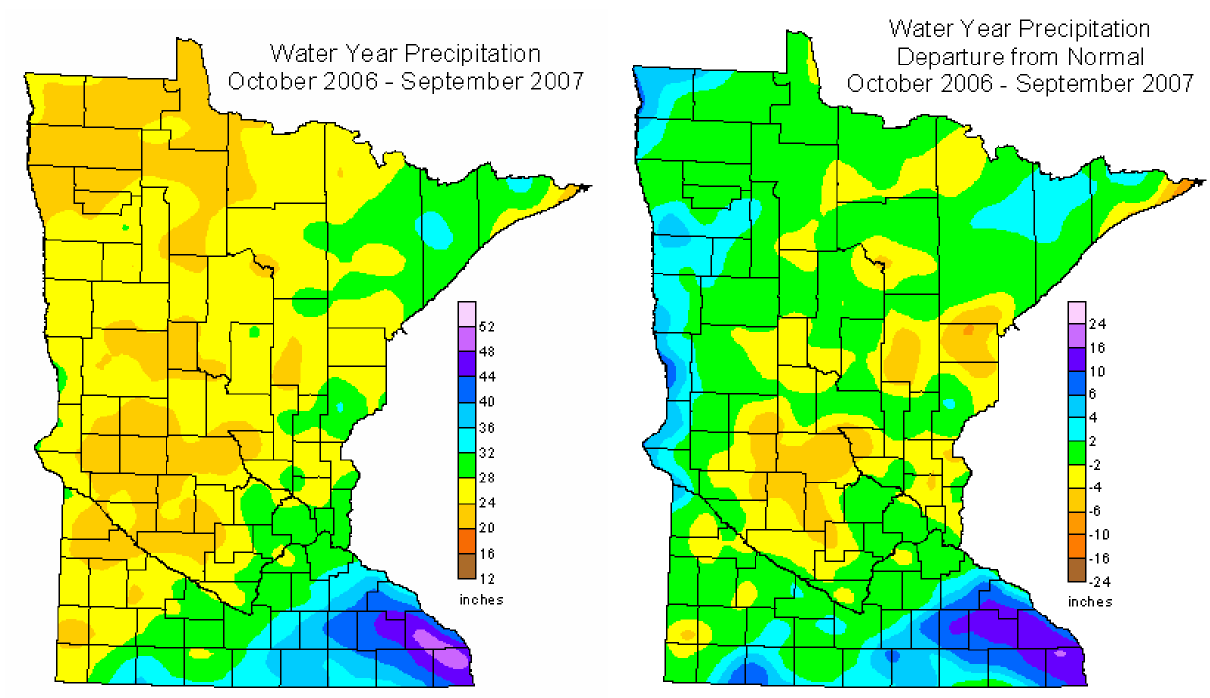
The MDNR state water use database lists 636 active (non-domestic) groundwater supply wells in the watershed for 2009. These wells withdrew 12,516 million gallons (MG) of groundwater in 2009, 12,883 MG in 2008 and 14,576 MG in 2007. Despite the recent downward trend, the amount withdrawn has generally trended upward between 1988 and 2009 with a low of 2477 MG in 1993. Of the 636 wells, 531 were listed as Quaternary (deep) aquifer wells and 246 of those were shallow water table wells. Twelve of the 14 wells that withdrew the most groundwater in 2009 were municipal waterworks supply wells. The southeastern third of the watershed has a relatively low density of water supply wells. A large number of water supply wells are located in the Bonanza Valley and adjacent to Grove Creek.

In 1974, six major aquifers were appraised and described as capable of supporting additional development by Lindholm et al. (1974). A groundwater model was also used by Van Voast (1971) to study one of the aquifers. More recently, there have been concerns about the impacts of groundwater withdrawals in the Bonanza Valley, particularly in the area around Brooten and Belgrade. Ongoing groundwater withdrawals combined with several years of reduced precipitation has led to water use conflicts and concerns about impacts on ecological resources (Reeves, 2009).

In 1991, Delin (1991) used a groundwater model to study the Brooten-Belgrade area. Results indicated that increased pumping during a three-year drought would lower regional water levels from two- five feet in each aquifer and as much as 20 feet. in the lowermost aquifer zone. It also indicated ground-water discharge to the East Branch Chippewa and North Fork Crow Rivers could be reduced by 38 percent.

Climate and precipitation

Figure 8. State wide precipitation levels during the 2007 water year



Precipitation is the source of almost all water inputs to a watershed. Precipitation in the watershed ranges from 25 to 29 inches each year. Evaporation estimates are between 36 to 37 inches annually (Minnesota State Climatologists Office, 1999). The October. 2006-September 2007 water year precipitation summary shows conditions were near normal to slightly drier than normal (Figure 7). Due to the lack of rainfall many invertebrate and fish sampling sites were canceled or not assessed due to low flow.

Figure 7 shows an areal average representation of precipitation in Central Minnesota. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center Link: http://www.wrcc.dri.edu/spi/divplot1map.html. Rainfall in the Central region has a statistically insignificant rising trend over the last 40 years. This contrasts with a state-wide spatial average showing a statistically significant rising trend. Though rainfall can vary in intensity and time of year, it appears that precipitation has not changed dramatically over the past 40 years in this area.

VI. Watershed wide data collection methodology

Load monitoring

The North Fork of the Crow River is monitored at MDNR gage site H18088001, two miles west of Rockford, Minnesota at Farmington Avenue, approximately two miles upstream of the confluence with the South Fork of the Crow River. The hydrograph of daily discharge data from 2007-2009 is provided in Figure 28. Intensive water quality sampling occurs year round at this site. Twenty to thirty-five grab samples are collected per year with sampling frequency greatest during periods of moderate to high flow. Frequent sampling during major run-off events is required to capture the largest pollutant loads and to accurately characterize shifting concentrations/flow dynamics. Low flow periods are also sampled and are well represented. This biased sampling methodology generally results in samples being well distributed over the entire range of flows.

Water chemistry and discharge data are input into the "Flux32" load estimation program to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs include: annual pollutant loads, defined as the amount (mass) of a pollutant passing a stream location over a defined period of time, and FWMCs, which are computed by dividing the pollutant load by the total seasonal flow volume. Annual pollutant loads and flow weighted means are calculated for TSS, TP, orthophosphate (OP), Total Kjeldahl Nitrogen (TKN) and nitrate plus nitrite nitrogen (nitrate-N).

Stream water sampling

Sixteen water chemistry stations were sampled from May thru September in 2007 and again June thru August of 2008 to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards in the 11 HUC sub-watersheds (green and purple circles in Figure 3). Following the IWM design, sampling locations were established near the outlet of the intermediate 11-HUC watersheds. Due to the small drainage area of Raymond Lake, Litchfield, and Sarah Creek sub-watersheds (11-HUC) intensive chemistry collection stations were not placed at their outlet. See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study.

Stream biological sampling

The biological monitoring component of the IWM in the North Fork Crow River Watershed was completed during the summer of 2007. A total of forty-nine sites were established across the watershed and sampled. These sites were located near the outlet of most minor HUC-14 watersheds, selected following the sampling design. In addition, 10 existing biological monitoring stations within the watershed were revisited in 2007. These monitoring stations were initially established as part of a random Upper Mississippi River Basin wide survey in 2000 or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2010 assessment was collected in 2007. A total of 73 AUIDs were sampled for biology in the North Fork Crow River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 24 AUID's. Waterbody assessments were not conducted for channelized AUIDs and coldwater streams, because Index Biological Integrity (IBI) had not been developed prior to the assessments. Nonetheless, the biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of the biological communities at each biological monitoring station an Index of Biological Integrity (IBI) was used, specifically the Fish Index of Biological Integrity (F-IBI) and the Macroinvertebrate Index of Biological Integrity (M-IBI). A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure. For both the F-IBI and the M-IBI, Minnesota's streams and rivers were divided into seven distinct classes, with each class having its own unique IBI. The classification factors used to produce the seven classes were drainage area, gradient, water temperature and geographic region of the state. Fish and macroinvertebrate communities occurring at sites within each class are more similar to each other than those occurring in other classes. These classification factors are unaffected by human disturbance to ensure that the framework reflects natural variability and that the resulting IBI's reflect human-induced impacts to the waterbody. IBI development was stratified by class, with a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals identified for each. IBI scores higher than the impairment threshold indicate that the stream reach supports its aquatic life use. Contrarily; scores below the impairment threshold indicate that the stream reach does not support its aquatic life use. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, land use activities, etc. For individual biological monitoring station IBI scores, thresholds and confidence intervals for all biological monitoring sites within the watershed refer to Appendices 5.3 and 5.4.

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the North Fork Crow River in 1990, 2000, and 2007. The Crow River outlet site was also sampled in 2007 and is included in this report. Since 1990, mercury samples from fish were collected in 38 lakes within the North Fork Crow River Watershed. PCBs were tested in a smaller set of lakes. Fish were collected in rivers by the MPCA biomonitoring unit and in lakes by the MDNR. Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled, filleted, and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue. In 2009, fish were collected from Madison Lake and analyzed for perfluorochemicals (PFCs). The whole fish were shipped frozen and on dry ice to AXYS Analytical Laboratory for processing and analysis of the fish for PFCs.

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

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

Lake water sampling

Lakes were not targeted during the IWM efforts that took place in 2007 and 2008. However, extensive monitoring of lakes has occurred in the North Fork Crow River Watershed in the past. Lake water chemistry and Secchi data used in this report was taken from the MPCA's STORET database. This data was collected by both MPCA staff and local partners including CLMP volunteers. Volunteers enrolled in the MPCA's Citizens Lake Monitoring Program (CLMP) have completed a majority of the lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at: http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a ten year period for Phosphorus, Chlorophyll-a and Secchi depth.

VII. Individual watershed results

HUC-11 watershed units

Assessment results are presented for each of the HUC-11 watershed units within the North Fork Crow River Watershed. This is intended to enable the assessment of all surface waters at one time and the ability to develop comprehensive TMDL studies on a watershed basis rather than the reach by reach and parameter by parameter approach often historically employed. This scale provides a robust assessment of water quality condition in the 11-digit watershed unit and is a practical size for the development, management, and implementation of effective TMDL and protection strategies. The primary objective is to portray all the impairments within a watershed resulting from the complex and multi-step assessment and listing process. The graphics presented for each of the HUC-11 watershed units contain the assessment results from the 2011 Assessment Cycle as well as any impairment listings carried forward from previous assessment cycles. Discussion of assessment results focuses primarily on the 2007 IWM effort but also considers all available data from the last 10 years.

Given all the potential sources of data and differing assessment methodologies for indicators and designated uses, it is not currently feasible to provide results or summary tables for every monitoring station by parameter. However, a summary table of AUIDs by parameter is available in Appendix 7, and summary tables of water chemistry results for each of the intensive watershed stations representing the outlet of the HUC-11 watersheds are provided in Appendix 2. In addition to being used for assessment, the data can provide valuable insight on water quality characteristics and potential parameters of concern in the watershed. Not all water chemistry parameters of interest have developed water quality standards. McCollor and Heiskary (1993) developed ecoregion expectations for a number of water quality parameters in streams that provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. The expectations were based on the 75th percentile from a long term dataset of least impacted streams.

Biological criteria has not yet been developed for all stream types, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible at some sampling sites. Stream types that were not formally assessed include channelized streams or ditches and coldwater streams. Habitat assessment results taken during each fish sampling visit are included. The categories of land use, riparian zone, instream zone (substrate, embeddedness, cover types and amounts), and channel morphology (depth variability, sinuosity, stability, channel development, velocity) combine for a total possible score of 100 points. Scores are included below with a discussion on factors leading to low scores. Habitat assessment provides information on available fish habitat, and land use and buffers along the immediate site reach, providing clues for impacts on fish communities such as siltation.

Stream assessment

This table provides a summary of all assessable AUIDs by parameter within the watershed (where sufficient information was available to make an assessment). The tables denote the use support status of each individual water chemistry and biological parameter, as well as an overall use support assessment for aquatic life and aquatic recreation for each assessable AUID. The assessment for aquatic life is derived from analyzing biological data, DO, turbidity, chloride, pH and NH3 to determine use status, while the assessment for aquatic recreation in streams is solely based on E. coli concentrations. Immediately following the AUID specific use support results, the location of any assessed biological monitoring sites are listed. Water chemistry station locations are not provided because information collected at specific locations within each AUID are combined for the purposes of conducting waterbody assessments. Some AUIDs within the sub-watershed do not have sufficient information for assessment and are not included in this table. Following the stream assessment table is a table describing a narrative biological condition of stations that could not be assessed due to their occurrence on channelized AUIDs, and so is not an assessment for aquatic life for these systems. For more information regarding channelized stream parameters refer to Appendix 4.1. For more information regarding chemistry parameters monitored in these studies refer to Appendix 1.

Channelized stream assessment

Ratings of “Good” for channelized streams are based on Minnesota’s general use threshold for aquatic life. Stations with IBIs that score above this general use threshold would be given a rating of “Good”. The “Fair” rating is calculated as a 15 point drop from the general use threshold. Stations with IBI scores below the general use threshold, but above the “Fair” threshold would be given a rating of “Fair”. Stations scoring below the Fair threshold would be considered “Poor”. For more information regarding channelized stream paramerters refer to Appendix 4.1.

Stream habitat results

These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) surveys that are conducted during each fish sampling visit. The MSHA provides information on available fish habitat, land use, and buffers along the immediate site reach, providing clues for impacts such as siltation or eutrophication which may lead to unhealthy fish and macroinvertebrate communities. The MSHA score is comprised of numerous scoring categories including land use, riparian zone, instream zone (substrate, embeddedness, cover types and amounts) and channel morphology (depth variability, sinuosity, stability, channel development, velocity), which are summed for a total possible score of 100 points. Total scores for each category and a summation of the total MSHA score are included with a narrative rating of good, fair or poor, indicating the overall condition of the station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores for each scoring category for that particular sub-watershed.

Watershed outlet water chemistry results

These summary tables display the water chemistry results for the intensive watershed station representing the outlet of the HUC-11 watershed. This data along with other data collected within the 10 year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed and includes those parameters most closely related to the standards or expectations used for determining the assessments (i.e. supporting aquatic life and aquatic recreational use). While not all of the water chemistry parameters of interest have developed water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of water quality parameters in streams that provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. For comparative purposes, water chemistry results for the Crow River Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams.

Lake water chemistry

These summaries explain lake water chemistry results for all lakes where assessment quality data is present. Basic morphometry data, trophic status, trophic status indicators, trend data (based on volunteer monitoring statistics) and the assessment status is provided where available.

Upper North.Fork Crow Watershed Unit HUC 07010204010

The Upper North Fork Crow watershed unit has a drainage area of 286.3 square miles and encompasses parts of Pope, Stearns, Kandiyohi, and Meeker Counties. The watershed includes the headwaters of the North Fork Crow as it flows southeast from the city of Grove Lake to the outlet of Lake Koronis. The predominant land use is cropland with rangeland being the second most abundant (Fig. 9). The outlet of this watershed is represented by site 07UM035, located on the North Fork River between Rice Lake and Lake Koronis.

Stream Water Chemistry

Eleven AUIDs are in the Upper North Fork Crow River HUC-11 watershed. Most of the reaches (main stem tributaries) had insufficient information to determine either aquatic life or aquatic recreation use support. The Skunk River, a nine mile reach considered to be a Class 7 (limited value resource water), was supporting what would be considered a healthy biological community for a Class 2 water, and the water chemistry parameters were also better than standards. The main stem North Fork Crow River was considered to be impaired for aquatic life from the headwaters in Grove Lake to its confluence with Lake Koronis. E. coli data exists only for the reach between Rice Lake and Lake Koronis and is considered to be supportive of aquatic recreation use.

Lake Water Chemistry

Five of the 15 lakes (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards; Grove (61-0023-00), Pirz (73-0144-00), and Mud (73-0200-01) lakes are considered to be supporting recreation use, Rice Lake (73-0196-00) is not supporting, and Lake Koronis (73-0200-02) was initially determined to be impaired but was changed to insufficient information after further review of the data. Lake Koronis is close to exceeding the eutrophication standards. Many of the lakes in the watershed are small headwaters lakes and are strongly influenced by runoff from their immediate watershed. The flow-through lakes, Rice and Koronis, which are located at the end of the watershed, are more strongly influenced by the watershed-wide transport of nutrients (Anderson 2010).

Table 1. Outlet water chemistry resultsfor Upper North Fork Crow Watershed**

Station Location:	North Fork Crow River at C.R. 34, 3.5 mi. SE of Paynesville
Storet ID:	S002-357
Station #:	07UM035

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	10	11	11	11	10	11	11	10	11	10	10
Minimum	19	2.82	10	0.025	0.025	7.92	0.036	2.8	400	32.2	15.97	60
Maximum	23	9.02	390	0.17	1.3	8.69	0.126	30	535	46.3	27.56	100
Mean[1]	21.36	5.66	79.71	0.05	0.41	8.32	0.07	9.11	456.20	38.75	20.69	76.50
Median	22	5.775	110	0.025	0.09	8.28	0.066	6.4	443.5	38.3	18.81	75
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	2	0			2						0
NCHF 75^{th} Percentile[4]				0.2	0.12		0.17		310		24	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Mill Creek HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 2. Stream biological sampling for Upper North Fork Crow Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionized ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-685, Headwaters (Grove Lk 61-0023-00) to Rice Lk	07UM009 07UM003 07UM032 07UM084	NS	NA	NS		NS	FS	FS	FS	FS	NS	NS	NA
07010204-531, Headwaters to N Fk Crow R	07UM039	NA	NA		IF			FS					
07010204-579, CD 36 to N Fk Crow R	07UM036	NA			NS	FS		FS				IF	NA
07010204-580, Unnamed ditch to N Fk Crow R	07UM038	NA		NS	IF	FS		FS	FS			IF	NA
07010204-581, Unnamed ditch to N Fk Crow R	07UM037	NA	NA		IF	FS		FS				IF	NA
07010204-584, Unnamed ditch to N Fk Crow R	07UM034	NA			NS	FS		FS				IF	NA
07010204-650, Unnamed cr to N Fk Crow R	07UM040	NA										NA	NA
07010204-687, Rice Lk to Lk Koronis	07UM035	NA	NS	NS	NS	FS	FS	FS	FS	FS	FS	NS	FS

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 3 Biological sampling of channelized stream reaches for Upper North Fork Crow Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-585, Crow River, North Fork, Headwaters (Grove Lk 61-0023-00) to Lk Koronis	07UM084	Upstream of 102nd Ave, 2 mi. S of Grove Lake	Fair	Fair
07010204-585, Crow River, North Fork, Headwaters (Grove Lk 61-0023-00) to Lk Koronis	07UM032	Downstream of CR 18, 2.5 mi. E of Grove Lake	Fair	Fair
07010204-531, Skunk River, Headwaters to N Fk Crow R	07UM039	Downstream of US 71, 3 mi. N of Belgrade	Good	Good
07010204-580, County Ditch 7, Unnamed ditch to N Fk Crow R	07UM038	Upstream of CR 14, 7 mi. N of Belgrade	Poor	--
07010204-581, County Ditch 7, Unnamed ditch to N Fk Crow R	07UM037	Upstream of 443rd Ave, 4 mi. N of Belgrade	Fair	Good
07010204-584, Judicial Ditch 1, Unnamed ditch to N Fk Crow R	07UM034	Upstream of CR 18 (470th St), 2.5 mi. SW of Padua	Poor	Poor
07010204-650, Unnamed creek, Unnamed cr to N Fk Crow R	07UM040	Downstream of CR 178, 3 mi. E of Georgeville	Poor	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 4 Stream habitat results for Upper North Fork Crow Watershed

Visits	Site ID	Stream 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	07UM009	Crow River, North Fork	2.0	5.0	20.8	13.0	31.0	71.8	Good
2	07UM032	Crow River, North Fork	0.75	8	15	12	12	47.75	Fair
1	07UM034	Judicial Ditch 1	5	11	18	5	22	61	Fair
1	07UM035	Crow River, North Fork	2.5	10.5	10	16	20	59	Fair
1	07UM036	Sedan Brook	5	11	4	9	17	46	Fair
1	07UM037	County Ditch 7	0	8.5	17.8	9	24	59.3	Fair
2	07UM039	Skunk River	0	7.25	17.5	13	19	56.75	Fair
1	07UM040	Trib. To Crow River, North Fork	0	9	14	6	10	39	Poor
2	07UM084	Crow River, North Fork	1	6	17.65	8	11.5	44.15	Poor
Average Habitat Results: *Upper North Fork Crow HUC-11 Watershed*			1.5	8.3	15.2	9.9	16.3	51.3	

Qualitative habitat ratings

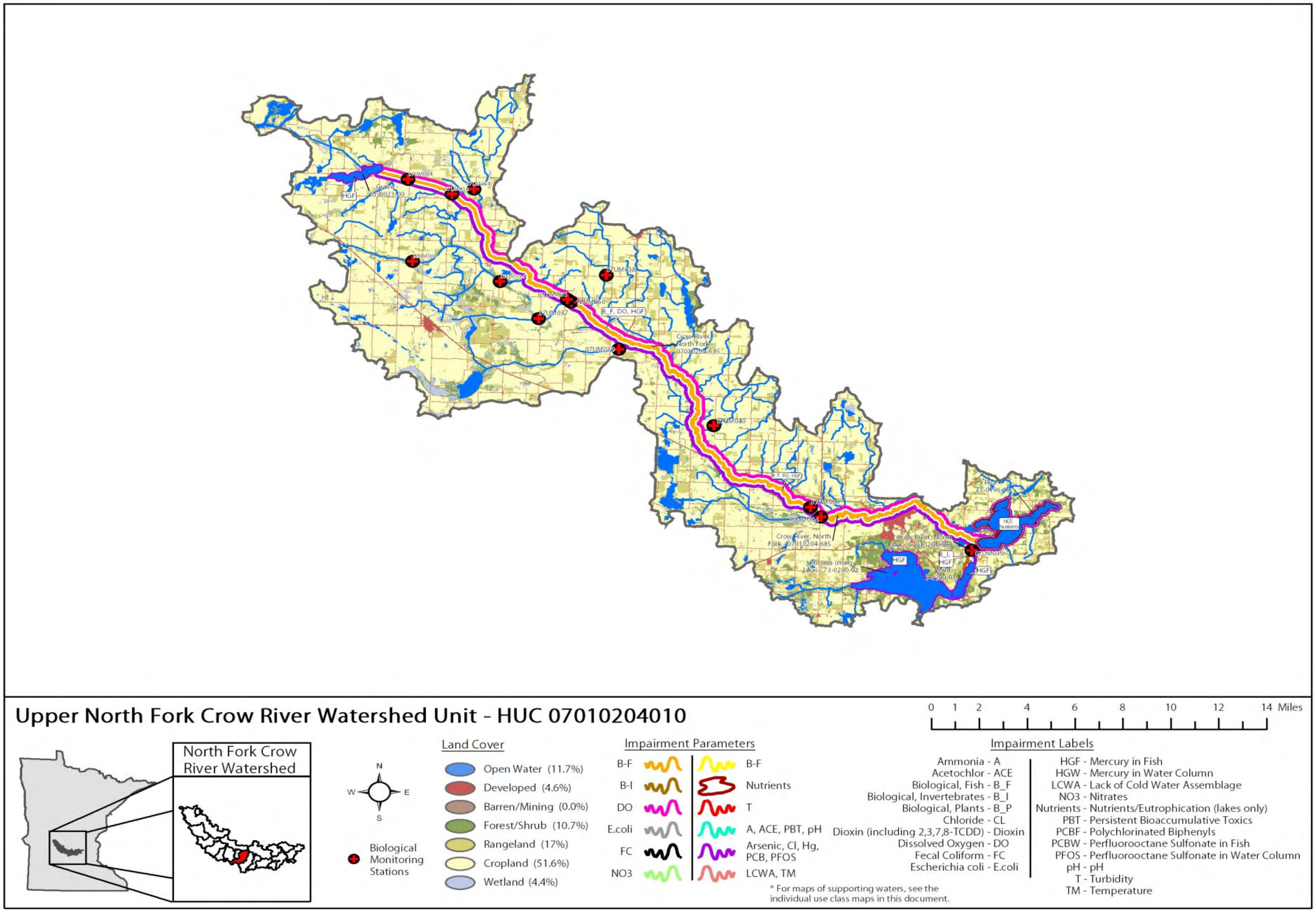
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Upper North Fork Crow Watershed summary

Nine of the eleven AUIDs in this watershed are channelized much like the rest of the North Fork Crow River. Of the four sites in two AUIDs that were assessed one was non-supporting of fish and not assessable for invertebrates, and the other was not assessable for fish and non-supporting of invertebrates. Of the biological stations that fell on channelized stream segments, one was rated good, three were fair, and three were poor for fish; for invertebrates two were rated good, two fair and one poor. These IBI scores follow the fair to poor habitat results (Table 4), which may help explain the fair to poor IBI scores.

Rice Lake is impaired for nutrients, while Lake Koronis was initially found impaired but later was changed to insufficient information. Three other lakes have been sampled in the watershed- Mud, Grove, and Pirz, and they all are fully supporting of aquatic recreation. The Upper North Fork Crow River HUC-11 would benefit from restoration activities to reduce TP levels that are impacting the downstream flow-through lakes, and from stream habitat restoration.

Figure 9 Land use and currently listed impaired waters by parameter, in the Upper North Fork Crow Watershed Unit



Raymond Lake Watershed unit HUC 07010204020

The Raymond Lake watershed is completely within Stearns County and has a drainage area of 18 square miles. The predominant land use is cropland with range land being the second most abundant (Figure 10). It is the second smallest HUC-11 in the North Fork Crow River Watershed, containing only two AUIDs. It drains 18 square miles of land and flows from Raymond Lake south into the Upper North Fork Crow HUC-11 at County Road 27 in North Fork Township. Due to the small size of the watershed there was no outlet water chemistry sampling completed.

Stream water chemistry

Limited data was available for this HUC-11; only one AUID is established, a two mile section of County Ditch 32. There is concern about the quality of the data collected on this reach, and as a result, no assessment determination could be made.

Lake water chemistry

The Raymond Lake HUC-11 watershed does not contain any lakes greater than 4 ha with assessment data.

Table 5. Stream biological sampling for Raymond Lake Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-578, Unnamed ditch to N Fk Crow R	07UM033	NA		NS	NS	FS		FS	FS			IF	NA

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 6. Biological sampling of channelized stream reaches for Raymond Lake Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-578, County Ditch 32, Unnamed ditch to N Fk Crow R	07UM033	Downstream of CR 27, 4.5 mi. NE of Brooten	Fair	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes)

Table 7 Stream habitat results for Raymond Lake Watershed

Visits	Site ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	07UM033	County Ditch 32	0	12	10	13	13	48	Fair
Average Habitat Results: *Raymond Lake HUC-11 Watershed*			0	12	10	13	13	48	

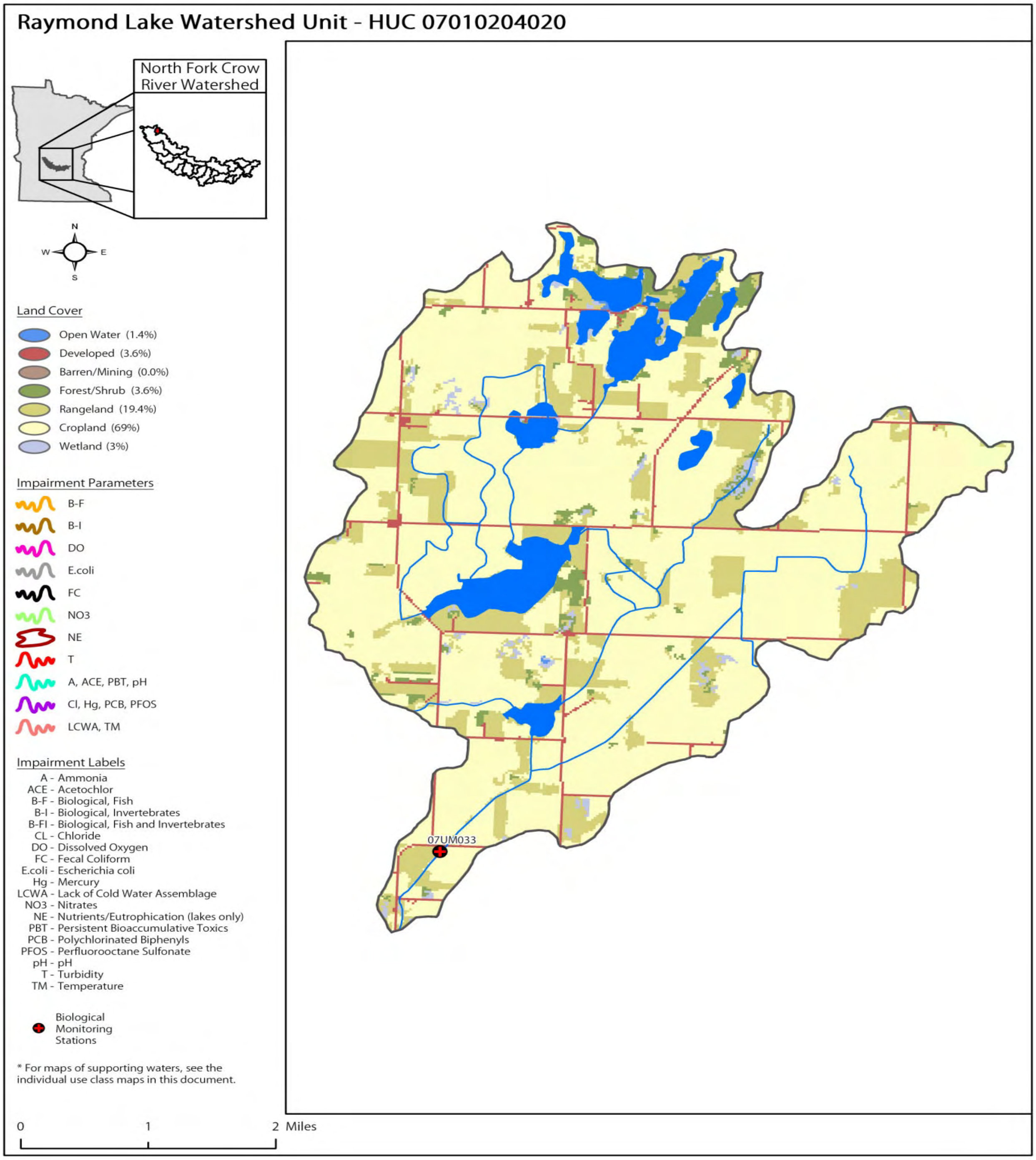
Qualitative habitat ratings

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)

Raymond Lake Watershed summary

In this small watershed there was only one site that was sampled for biology, and it was on a channelized stream so no formal assessment was made for biology. There was not enough water chemistry data to make an assessment. Using the channelized stream assessment scoring, one site was found to be in fair condition for both biology and habitat. When this watershed is revisited this HUC-11 will become part of the Upper North Fork Crow HUC-12.

Figure 10. Currently listed impaired waters by parameter, and land use in the Raymond Lake Watershed unit



Upper Middle Fork Crow River Watershed units HUC 07020002030

Upper Middle Fork Crow River is the headwaters of the Middle Fork Crow River. The HUC -11 encompasses parts of Kandiyohi, Stearns, and Pope Counties and drains an area of 97.5 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 11). The Middle Fork is made up of three HUC-11s before it enters the North Fork Crow River. The Upper Middle Fork Crow River flows southeast from Belgrade to Mud Lake in New London. Biological station 07UM010 represents the outlet of the watershed unit. This site is not actually in the Upper Middle Fork Crow River Watershed, but due to Mud Lake being the downstream end of the 11 digit-HUC the site was placed at the next bridge crossing downstream of the lake. It is the best representative site of this watershed.

Stream water chemistry

The Upper Middle Fork Crow River HUC-11 is split into five AUIDs, two on the main stem of the Middle Fork Crow River and three tributaries. The upper portion of the Middle Fork Crow River was considered to be fully supporting for aquatic recreation. The lower reach between Mud Lake and Nest Lake had conflicting data, and therefore no determination of support could be made. E. coli data was only available in this reach as well, and did not have sufficient exceedances to indicate impairment. Drought conditions during the primary sampling year (2007) played a role in the amount and quality of data available for assessments.

Lake water chemistry

Five of the nine basins (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards long (34-0066-00), and the four basins of Mud Lake (34-0158-01 through 34-0158-04) and are all considered to be supporting aquatic recreation use. For those on the main stem, upstream storage in larger lakes (e.g. Koronis) in the Upper North Fork Crow River HUC-11 watershed should serve to reduce downstream loads. Overall lake water quality in this watershed is of good condition (Anderson 2010).

Table 8. Outlet water chemistry resultsfor Upper Middle Fork Crow Watershed**

Station Location:	Middle Fork Crow River at C.R. 40, 0.5 mi. W of New London
Storet ID:	S002-299
Station #:	07UM010

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	13	11	13	13	13	13	13	13	11	13	13
Minimum	13	2.75	4	0.025	0.025	7.3	0.041	1.6	400	8.82	11.67	60
Maximum	24	12.5	2400	0.26	0.11	8.47	0.071	10	474	23.3	27.5	100
Mean[1]	17.64	6.55	118.85	0.07	0.04	7.98	0.05	4.29	436.00	16.74	20.87	78.62
Median	16	6.58	120	0.025	0.025	8.07	0.051	4	441	18.2	20.89	70
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	4	2			0						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Middle Fork Crow River HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 9. Stream biological sampling for Upper Middle Fork Crow Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-536, Unnamed cr to M Fk Crow R	07UM004 00UM046	NA	NA			FS						IF	NA
07010204-537, Headwaters to Mud Lk	07UM008	FS	FS			FS		FS			FS	FS	NA
07010204-539, Mud Lk to Nest Lk	07UM010	NA	NA	NS	NS	FS	FS	FS	FS	IF	FS	IF	IF
07010204-577, Unnamed cr to M Fk Crow R	07UM007	FS	FS			FS						FS	NA

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 10. Biological sampling of channelized stream reaches for Upper Middle Fork Crow Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-536, County Ditch 37, Unnamed cr to M Fk Crow R	07UM004	Upstream of 40th St, 6 mi. NW of New London	Good	Good
07010204-536, County Ditch 37, Unnamed cr to M Fk Crow R	00UM046	Upstream of C.R. 107, 6 mi. NW of New London	Good	--
07010204-539, Crow River, Middle Fork, Mud Lk to Nest Lk	07UM010	Upstream of CR 40, 0.5 mi. W of New London	Poor	Good

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 11. Stream habitat results for Upper Middle Fork Crow Watershed

Visits	Site ID	Stream 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	00UM046	County Ditch 37	4.5	11	6	13	11	45.5	Fair
2	07UM004	County Ditch 37	5	11.75	8.5	10	16.5	51.75	Fair
2	07UM007	County Ditch B6	3.75	13	16.75	13.5	27	74	Good
1	07UM008	Crow River, Middle Fork	5	11	13.4	10	11	50.4	Fair
Average Habitat Results: *Upper Middle Fork Crow HUC-11 Watershed*			4.5	12.0	11.9	11.7	19.1	59.1	

Qualitative habitat ratings

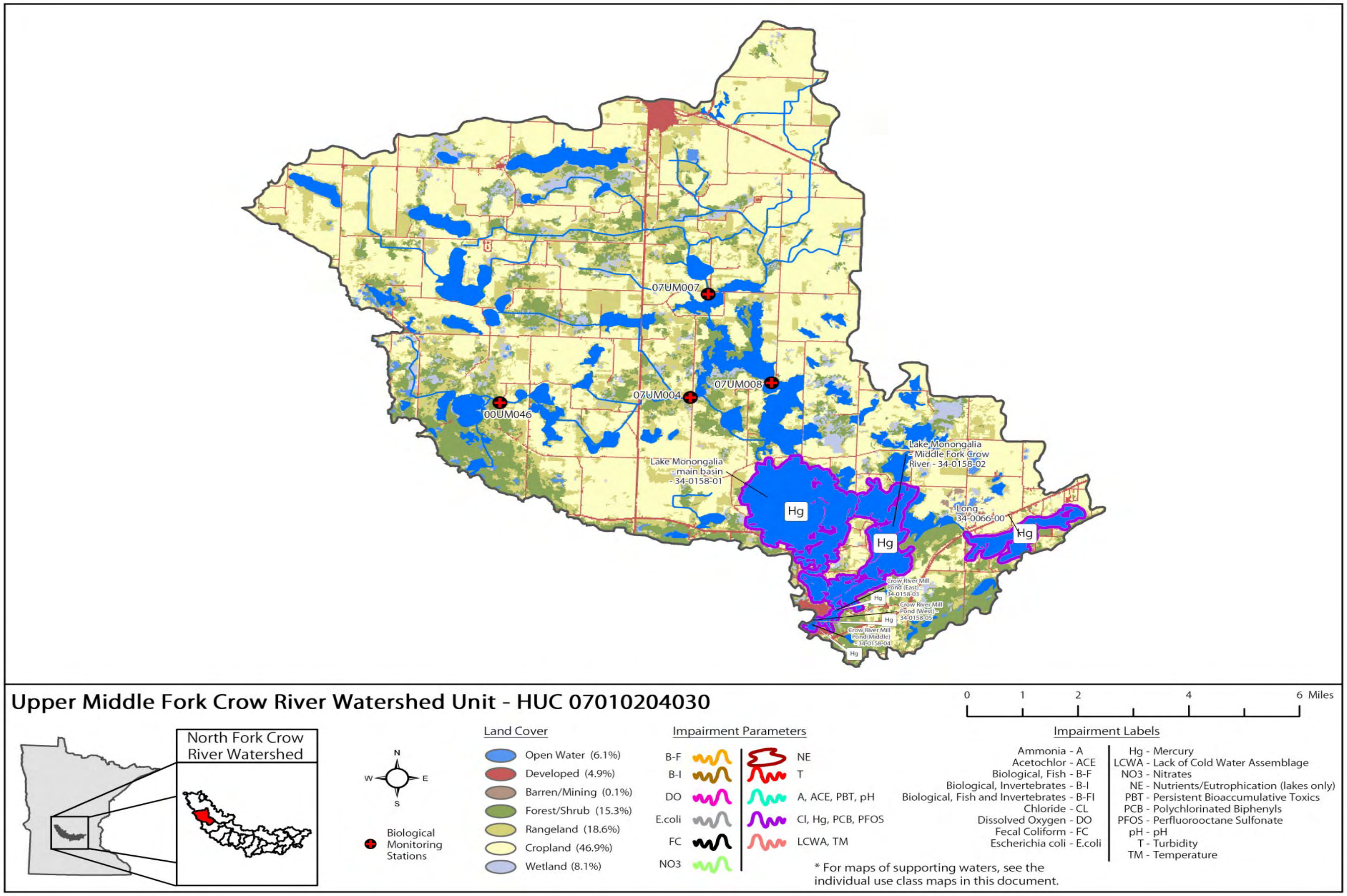
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Upper Middle Fork Crow Watershed summary

The headwaters to Mud Lake were found to be fully supporting of both fish and macroinvertebrates. The only other assessable AUID sampled in the watershed was fully supporting of both fish and macroinvertebrates. The channelized reaches are generally good. Of the natural reaches, two of three are good for fish and all three are good for invertebrates. The Upper Middle Fork Crow is one of the best for fish, invetebrate, and habitat scores in the entire watershed.

Long Lake and the four basins of Mud Lake are all considered to be supporting aquatic recreation use, but are listed as impaired for fish consumption due to high mercury. The percentage of forested land use is somewhat higher in this HUC-11 than it is in the larger HUC-8 watershed. This should result in somewhat lower watershed TP loading to lakes that are off the main stem of the Middle Fork Crow River.

Figure 11. Currently listed impaired waters by parameter, and land use in the Upper Middle Fork Crow River Watershed unit



Central Middle Fork Crow River Watershed unit HUC 07010204040

The Central Middle Fork Crow River Watershed unit, located in northeast Kandiyohi County and northwest Meeker County, drains an area of 83.5 square miles. The watershed unit includes the Middle Fork Crow River main stem from County Road 9 in New London to the confluence of Unnamed Creek 3.5 miles west of Crow River. The predominant land use is cropland with open water being the second most abundant (Figure 12). Green Lake is the largest lake in this watershed. The outlet of this watershed unit is represented by site 07UM002 on the Middle Fork Crow River.

Stream water chemistry

The Upper Middle Fork Crow River HUC-11 is split into five AUIDs two on the main stem Middle Fork Crow River (Nest Lake to the North Fork Crow River confluence) and three tributaries. The reach between Green Lake and the confluence had sufficient data to determine an impairment for aquatic recreation (E. coli), but had conflicting data water chemistry data so no determination of aquatic life use support could be made.

Lake water chemistry

Five of the nineteen basins (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards; Calhoun (34-0062-00), Elkhorn (34-0119-00), George (34-0142-00) and Green (34-0079-00) lakes were considered to be supporting aquatic recreation use, and Nest Lake (34-0154-00) was determined to be impaired. This watershed benefits from a considerable portion of the land use being in forested cover. Nest Lake provides the TP sink that prevents the downstream lakes from more rapid eutrophication. The lakes in the watershed are of relatively good water quality, based on available data (Anderson 2010).

Table 12. Outlet water chemistry resultsfor Central Middle Fork Crow Watershed**

Station Location:	Middle Fork Crow River at C.R. 40, 0.5 mi. W of New London
Storet ID:	S001-758
Station #:	O7UM002

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	10	11	11	11	10	11	11	10	11	10	10
Minimum	16	4.5	10	0.025	0.06	6.68	0.035	5.6	385	17.5	14.57	60
Maximum	110	8.01	2400	0.37	2.7	8.47	0.245	15	866	38.7	26.86	100
Mean[1]												
Median	41.91	6.35	68.35	0.15	0.85	8.09	0.11	7.75	530.10	20.63	19.50	80.80
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	1	1			0						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Central Middle Fork Crow River HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 13. Stream biological sampling for Central Middle Fork Crow Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-511, Green Lk to N Fk Crow R	07UM002	NA	NA	NS	IF	FS	FS	FS	FS	NS	FS	IF	NS
07010204-553, Unnamed cr to Lk Koronis	07UM041	NA	NA		IF	FS		FS			NS	IF	NA
07010204-652, Unnamed ditch to Unnamed ditch	07UM005	NA	NA									NA	NA

Abbreviations: **F-IBI** – Biological, Fish; **M-IBI** – Biological, Macroinvertebrates; **DO** – Dissolved Oxygen; **T** – Turbidity; **Cl** – Chloride; **pH** – pH; **NH3** – Unionized Ammonia; **Aq. Life** – Aquatic Life Use Assessment; **Aq. Rec.** – Aquatic Recreation Assessment

NA = Not Assessed; **FS** = Fully Support; **IF** = Insufficient Information; **NS** = Non-Support

Table 14. Biological sampling of channelized stream reaches for Central Middle Fork Crow Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-511, Crow River, Middle Fork, Green Lk to N Fk Crow R	07UM002	Downstream of CR 2, 5.5 mi. NW of Crow River	Poor	Good
07010204-553, Unnamed creek (County Ditch 4), Unnamed cr to Lk Koronis	07UM041	Upstream of CR 20, 5 mi. S of Paynesville	Poor	Fair
07010204-652, County Ditch 26, Unnamed ditch to Unnamed ditch	07UM005	Upstream of CR 102, 5 mi. E of New London	Poor	Poor

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 15. Stream habitat results for Central Middle Fork Crow Watershed

Visits	Site ID	Stream 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	07UM002	Crow River, Middle Fork	1.5	9	18	6	20	54.5	Fair
2	07UM005	County Ditch 26	2.25	9.75	11.5	10.5	12	46	Fair
1	07UM010	Crow River, Middle Fork	5	11	16.8	13	23	68.8	Good
1	07UM010	Crow River, Middle Fork	5	10	17.7	12	20	64.7	Good
1	07UM041	Trib. to Lake Koronis	0	10	8	14	12	44	Poor
Average Habitat Results: Central Middle Fork Crow HUC-11 Watershed			2.6	9.9	13.6	10.9	15.9	52.9	

Qualitative habitat ratings

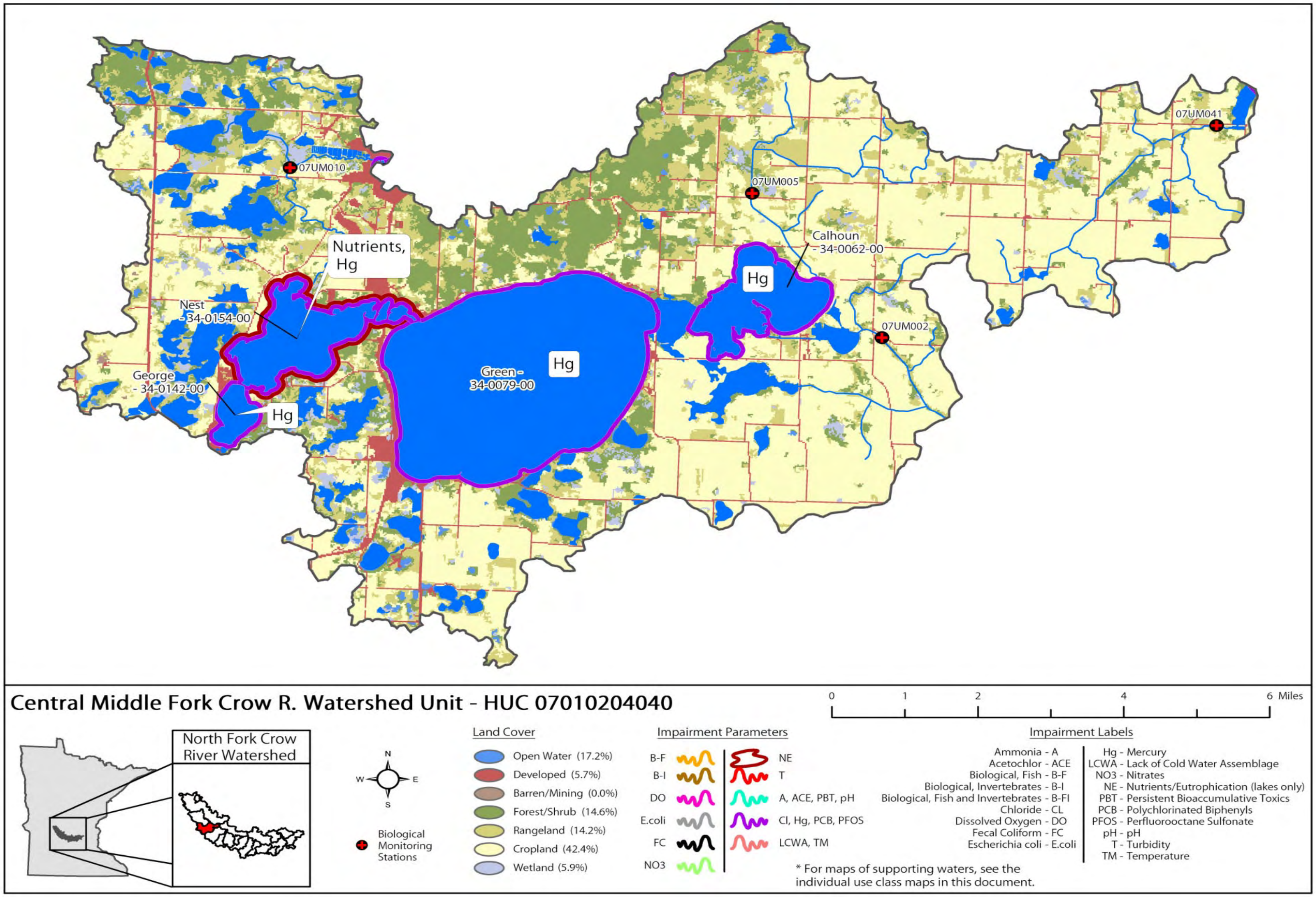
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Central Middle Fork Crow River Watershed summary

Three AUIDs were sampled in this watershed, but none of the sampling sites were natural stream sections so there is no formal assessment for biology. Using the channelized stream scoring method all three sites have poor scores for fish and macroinvertebrates had conflicting scores of a good, fair, and poor. Habitat scores do not reflect the poor IBI scores.

Five lakes were sampled for aquatic recreation and four of the five exhibited full support, while Nest Lake was impaired. Nest Lake is currently listed as impaired due to nutrients and mercury, and Calhoun and Green are listed for fish consumption because of mercury. The watershed would benefit from restoration activities to reduce TP levels influencing water quality in Nest Lake and in the more agriculturally developed areas draining to Lake Calhoun.

Figure 12. Land use and currently listed impaired waters by parameter, in the Central Middle Fork Crow River Watershed unit



Lower Middle Fork Crow River Watershed unit HUC 07010204050

The Lower Middle Fork Crow River Watershed unit encompasses parts of Kandiyohi and Meeker Counties and has a drainage area of 95.9 square miles. The southeast corner of the watershed is in the Western Corn Belt Plains Ecoregion. The predominant land use is cropland with rangeland being the second most abundant (Figure 13). The Lower Middle Fork Crow HUC-11 flows from the east to west from just west, of the town of Crow River to the confluence with the North Fork Crow just east of Manannah. The outlet of this watershed unit is represented by site 07UM011 on the Middle Fork Crow River.

Stream water chemistry

The Lower Middle Fork Crow River HUC-11 is split into six AUIDs the nine mile reach of County Ditch 47 (headwaters to confluence of the Middle Fork Crow River) and five small tributaries. The AUIDs were either very limited in water chemistry data, or had only biological data from channelized sites (i.e. insufficient to determine aquatic life use support), and no bacteria data were collected in this HUC-11 watershed.

Lake water chemistry

One of the fifteen basins (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards. Diamond Lake (34-0044-00) was found to be not supporting of aquatic recreation.

Table 16. Outlet water chemistry resultsfor Lower Middle Fork Crow River Watershed**

Station Location:	Middle Fork Crow River at C.R. 30, 1 mi. S of Manannah
Storet ID:	S002-028
Station #:	07UM011

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	10	11	11	11	10	11	11	10	11	10	10
Minimum	16	4.5	10	0.025	0.06	6.68	0.035	5.6	385	17.5	14.57	60
Maximum	110	8.01	2400	0.37	2.7	8.47	0.245	15	866	38.7	26.86	100
Mean[1]	41.91	6.35	68.35	0.15	0.85	8.09	0.11	7.75	530.10	20.63	19.50	80.80
Median	22	6.465	38	0.07	0.29	8.23	0.087	6.8	462	18.4	19.22	84
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	1	1			0						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Central Middle Fork Crow River HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 17. Stream biological sampling for Lower Middle Fork Crow River Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-511, Green Lk to N Fk Crow R	07UM011	NA	NA	NS	IF	FS	FS	FS	FS	NS	FS	IF	NS
07010204-532, Headwaters to M Fk Crow R	07UM016	NA	NA									NA	NA
07010204-600, Unnamed ditch to M Fk Crow R	07UM006	NA	NA									NA	NA

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 18. Biological sampling of channelized stream reaches for Lower Middle Fork Crow River Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-511, Crow River, Middle Fork, Green Lk to N Fk Crow R	07UM011	Upstream of CR 30, 1 mi. S of Manannah	Poor	Good
07010204-532, County Ditch 47, Headwaters to M Fk Crow R	07UM016	Downstream of 335th St, 2 mi. SW of Crow River	Poor	Fair
07010204-600, Unnamed creek, Unnamed ditch to M Fk Crow R	07UM006	Downstream of 120th Ave, 5 mi. W of Crow River	Fair	Fair

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 19. Stream Habitat results for Lower Middle Fork Crow River Watershed

Visits	Site ID	Stream 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	07UM011	Crow River, Middle Fork	5	14	18.9	8	13	58.9	Fair
1	07UM016	County Ditch 47	0	8	15.7	6	13	42.7	Poor
Average Habitat Results: *Lower Middle Fork Crow HUC-11 Watershed*			2.5	11	17.3	7	13	50.8	

Qualitative habitat ratings

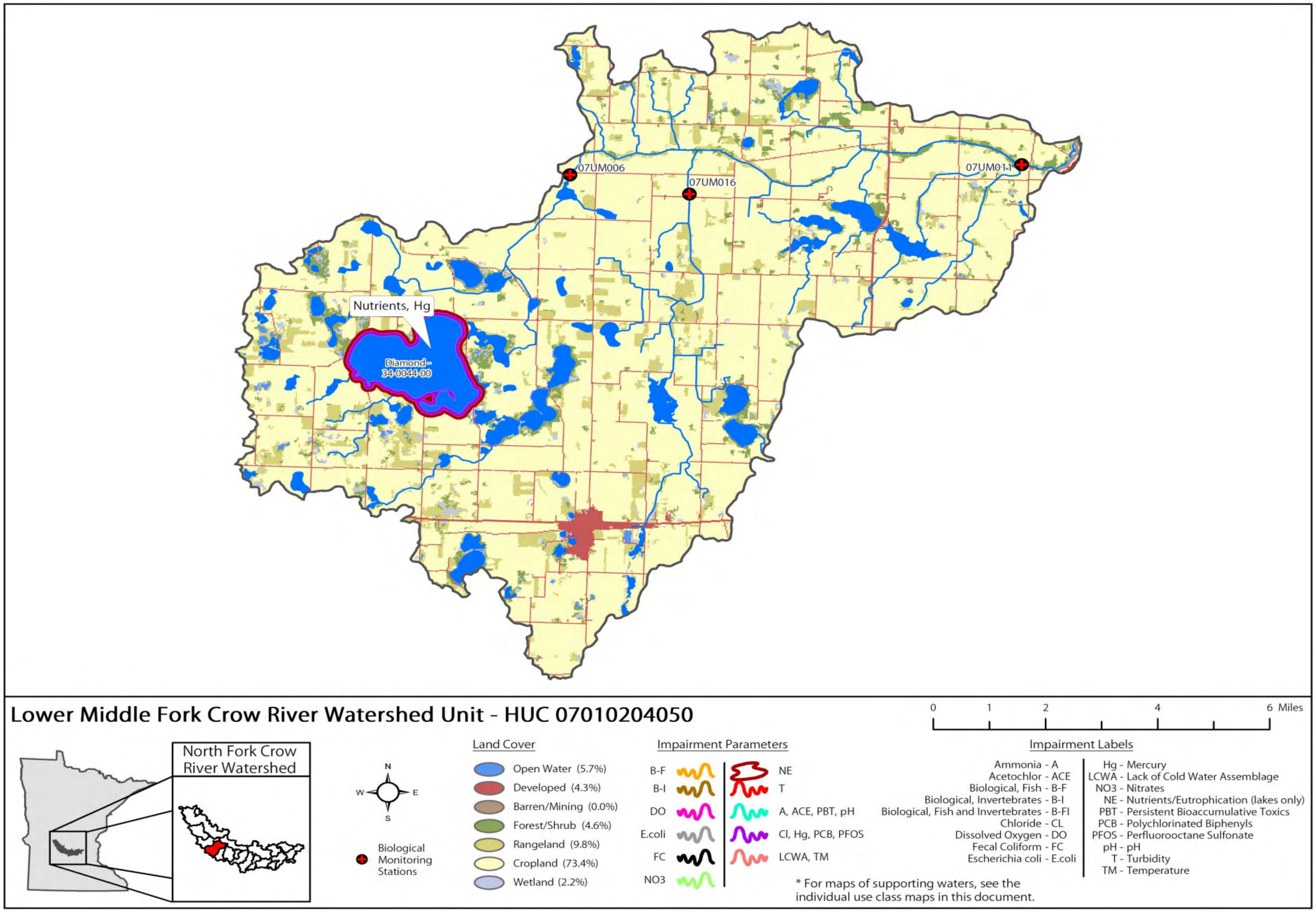
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Lower Middle Fork Crow River Watershed summary

Three sites were sampled for biology in this watershed and, all three were on channelized stream sections. Fish had score of poor (2) and fair (1), and invertebrates had scores of good (1) and fair (2). The fish scores reflect the fair and poor habitat scores, but invertebrate's scores do not follow the habitat score as closely.

This watershed is dominated by agricultural land uses. The lakes are not as buffered as in upstream watersheds. Additional data is being collected as part of the TMDL for Diamond Lake on a number of lakes in the watershed; the water quality data available would indicate that this watershed has degraded lake water quality (Anderson 2010).

Figure 13. Land use and currently listed impaired waters by parameter, in the Lower Middle Fork Crow River Watershed unit



Middle North Fork Crow River Watershed unit HUC 07010204090

The Middle North Fork Crow River watershed unit encompasses parts of Meeker and Stearns Counties and has a drainage area of 91.4 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 14).The Middle North Fork Crow 11 digit-HUC flows southeast from the outlet of Lake Koronis to just east of the town of Kingston where Eagle Creek enters the North Fork Crow River. The outlet of this watershed unit is represented by site 07UM013. Five of the six biological sites in this watershed unit are on the main stem North Fork Crow River.

Stream water chemistry

The Middle North Fork Crow River HUC-11 is split into 4 AUIDs, Stag Brook and three reaches of the main stem North Fork Crow River: from Lake Koronis to the confluence of the Middle Fork Crow River, then to Jewetts Creek, and finally to Washington Creek. Aquatic life impairments are found on each reach (i.e. fish and/or invertebrates); aquatic recreation use impairments (i.e. bacteria) are only found on the reach of the North Fork Crow River from the Middle Fork Crow River confluence to Jewetts Creek confluence.

Lake water chemistry

None of the four basins in this watershed have any water chemistry data. The basins are small, and likely shallow.

Table 20. Outlet Water Chemistry Resultsfor Middle North Fork Crow River Watershed**

Station Location:	North Fork Crow River at C.R. 19, in Kingston											
Storet ID:	07UM013											
Station #:	S002-024											
Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	12	11	12	12	12	12	12	12	11	12	12
Minimum	21	6.03	10	0.025	0.025	8.14	0.051	5.2	478	33	13.56	35
Maximum	40	9.03	1100	0.07	0.85	8.71	0.138	40	677	57.2	30.04	67.5
Mean[1]	29.45	7.30	48.92	0.03	0.45	8.40	0.10	22.95	563.33	44.56	21.29	53.54
Median	28	6.965	37	0.025	0.565	8.36	0.102	21.5	554	44.7	20.825	55
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	0			3						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Middle North Fork Crow River HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 21 Stream biological sampling for Middle North Fork Crow River Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-504, Lk Koronis to M Fk Crow R	07UM029	NS	FS	NS	IF	FS	FS	FS	FS		FS	IF	NA
	07UM074												
	00UM056												
07010204-506, Jewitts Cr to Washington Cr	07UM013	NS	NS	NS	IF	NS	FS	FS	FS	IF	NS	NS	IF
07010204-507, M Fk Crow R to Jewitts Cr	07UM021	NS	FS	NS	IF	FS	FS	FS	FS	NS	NS	NS	NS
07010204-572, Headwaters to N Fk Crow R	07UM023	NS	NS									NS	NA

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 22. Biological Sampling of channelized stream reaches for Middle Fork Crow River Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-504, Crow River, North Fork, Lk Koronis to M Fk Crow R	07UM074	Downstream of CR 365, 3 mi. NW of Manannah	Poor	Good
07010204-504, Crow River, North Fork, Lk Koronis to M Fk Crow R	00UM056	11.5 miles N of Grove City on Hwy 4, 1/2 mile E on C.R.	Poor	Good

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 23. Stream Habitat Results for Middle Fork Crow River Watershed

Visits	Site ID	Stream 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	00UM056	Crow River, North Fork	0.75	11	11.4	6	12	41.15	Poor
1	07UM013	Crow River, North Fork	2	9	16.05	7	16	50.05	Fair
2	07UM021	Crow River, North Fork	5	11.5	19.3	9	25.5	70.3	Good
2	07UM023	Stag Brook	2.25	6.5	8	9	15.5	41.25	Poor
2	07UM029	Crow River, North Fork	2.5	12.5	19.95	12.5	30	77.45	Good
2	07UM074	Crow River, North Fork	2.5	11.5	16	4	13	47	Fair
Average Habitat Results: *Middle North Fork Crow HUC-11 Watershed*			2.8	10.4	15.5	8.3	20.0	57.1	

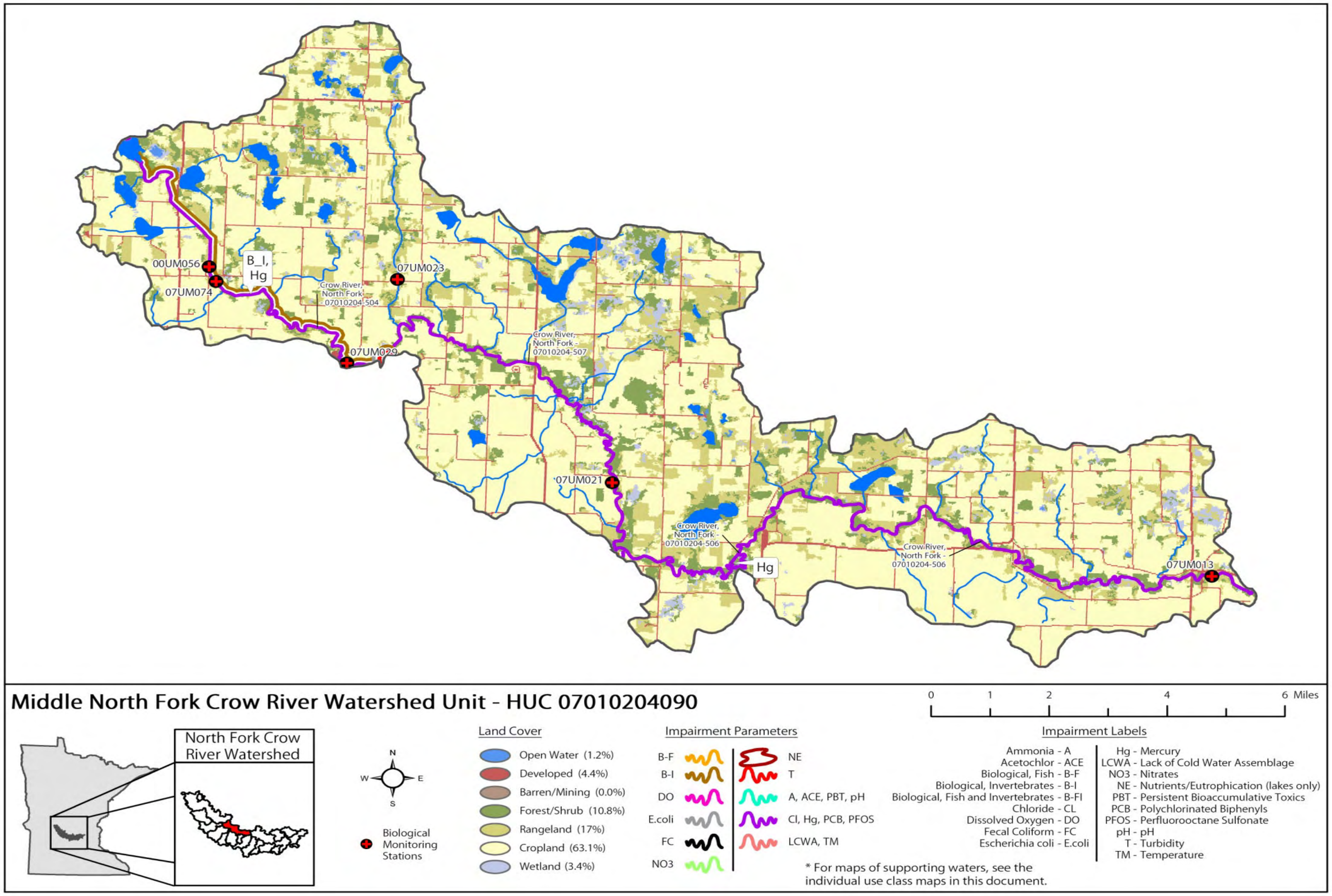
Qualitative habitat ratings

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)

Middle North Fork Crow River Watershed summary

Three of the four sampled AUIDs in this watershed have impaired biology. The fourth would have been listed, but the entire AUID is channelized except for a very small section. Reasons for the impairment are unclear. There are many different impairments of aquatic life and aquatic recreation, and habitat is a mix of good, fair, and poor ratings. More sampling will need to be done here to find the stressors.

Figure 14. Land use and currently listed impaired waters by parameter, in the Middle North Fork Crow Watershed unit



Long Lake Outlet Watershed unit HUC 07010204060

The Long Lake Outlet Watershed unit encompasses parts of Meeker and Kandiyohi Counties and has a drainage area of 48.6 square miles. The majority of the watershed falls within the Western Corn Belt Plains Ecoregion, while only a small area near the outlet is in the North Central Hardwood Forest Ecoregion. The predominant land use is cropland with rangeland being the second most abundant (Figure 15). The headwaters of this unit flow from west to east, from near the town of Atwater into Long Lake where it turns and heads northeast to the North Fork Crow River near Manannah. The outlet of this watershed unit is represented by site 07UM026 on Grove Creek.

Stream water chemistry

The Long Lake Outlet HUC-11 is split into 4 AUIDs the 10 mile reach of Grove Creek and three small tributaries. The tributary AUIDs were either very limited in water chemistry data, or had only biological data from channelized sites (i.e. insufficient to determine aquatic life use support), and no bacteria data. However, the main stem of Grove Creek had existing impairments for both aquatic life (dissolved oxygen and turbidity) and aquatic recreation uses (bacteria).

Lake water chemistry

Two of the nine basins (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards and found to be not supporting the use: Long Lake (47-0177-00) and Hope Lake (47-0183-00).

Table 24. Outlet water chemistry resultsfor Long Lake Outlet Watershed**

Station Location:	Grove Creek at 340th St., 1.5 mi. SE of Manannah
Storet ID:	S000-897
Station #:	07UM026

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	12	11	12	12	12	12	12	12	11	12	11
Minimum	10	3.06	17	0.025	0.71	7.71	0.112	3.6	477	24.6	13.04	19
Maximum	25	13.1	1100	0.11	2.1	8.52	0.287	62	668	51.8	27.4	95
Mean[1]	17.45	6.63	138.23	0.06	1.49	8.04	0.19	24.42	586.33	36.98	19.14	51.05
Median	18	6.31	120	0.07	1.45	7.955	0.1855	15.9	610	35.9	17.08	60
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	3	0			1						1
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Long Lake Outlet HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 25. Stream biological sampling for Long Lake Outlet Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-514, Unnamed cr to N Fk Crow R	07UM026	NS	NS	NS	NS	NS	FS	FS	FS	NS	NS	NS	NS
07010204-643, Unnamed lk to Long Lk	07UM017	NA				NS						IF	NA

Abbreviations: **F-IBI** – Biological, Fish; **M-IBI** – Biological, Macroinvertebrates; **DO** – Dissolved Oxygen; **T** – Turbidity; **Cl** – Chloride; **pH** – pH; **NH3** – Unionized Ammonia; **Aq. Life** – Aquatic Life Use Assessment; **Aq. Rec.** – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 26. Biological sampling of channelized stream reaches for Long Lake Outlet Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-643, County Ditch 26, Unnamed lk to Long Lk	07UM017	Downstream of CR 4, 5.5 mi. S of Grove City	Poor	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 27. Stream habitat results for Long Lake Outlet Watershed

Visits	Site ID	Stream 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	07UM026	Grove Creek	0	9	12	7	26	54	Fair
1	07UM017	County Ditch 26	0	8	9	2	10	29	Poor
		Average Habitat Results: *Long Lake Outlet HUC-11 Watershed*	0	8.5	10.5	4.5	18	41.5	

Qualitative habitat ratings

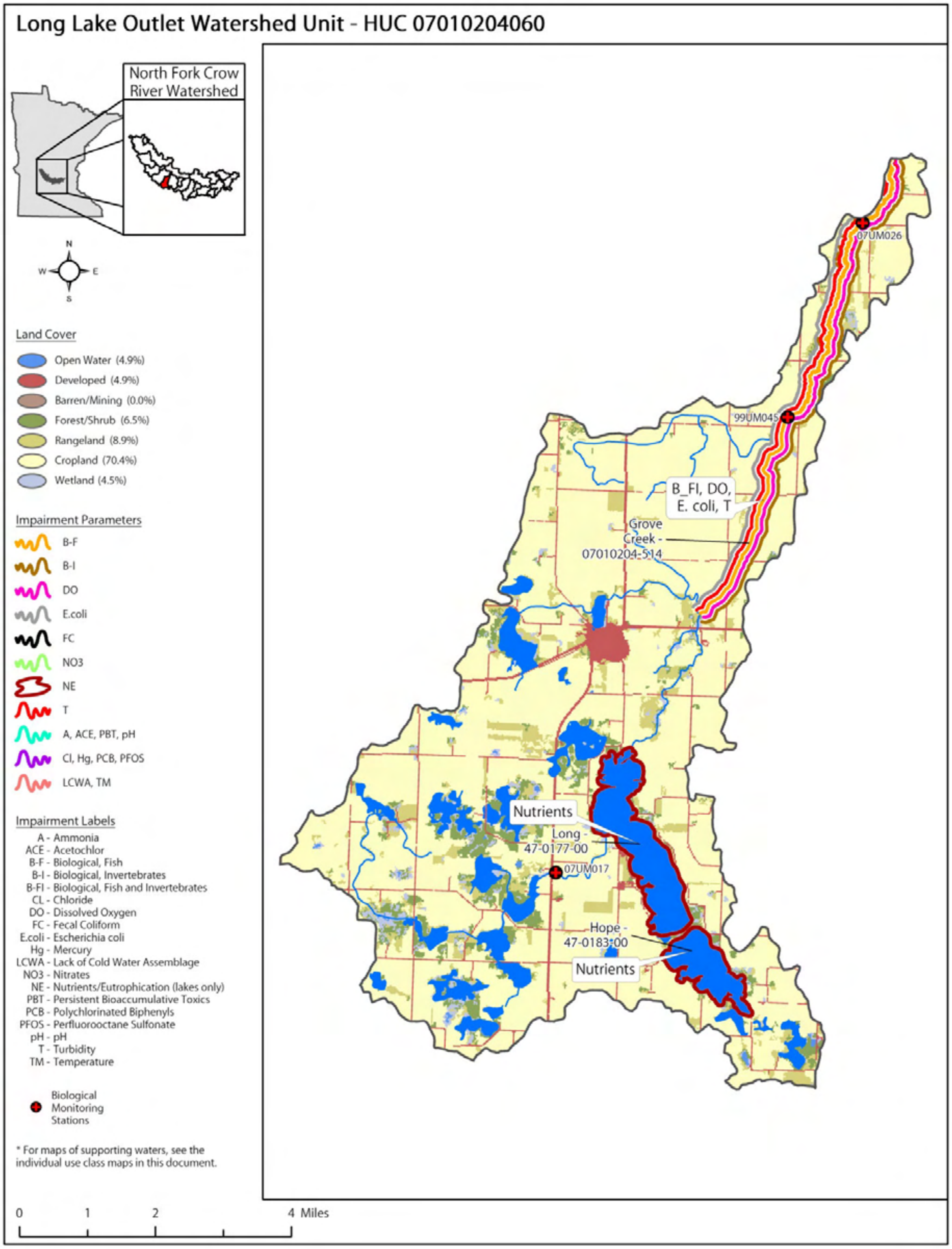
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Long Lake Outlet Watershed summary

Two AUIDs in this watershed have been sampled for biology one natural and one channelized. Both of them are not supporting of or poor for aquatic life. This could be due to Grove Creek having an existing impairment for dissolved oxygen, turbidity, and *E. coli,* or relatively poor habitat scores.

The lakes in this watershed are shallow, nutrient rich basins. Internal loading plays a significant role in the continued elevated TP levels. This watershed is intensively managed for agricultural purposes. The large lakes have very little buffer around them; little to no data is available on the smaller basins. Based on existing water quality data, it is recommended that this watershed be considered for restoration activities to improve lake water quality conditions (Anderson 2010).

Figure 15. Land use and currently listed impaired waters by parameter, in the Long Lake Watershed unit



Jewett Creek Watershed unit HUC 07010204070

The Jewett Creek Watershed unit is completely in Meeker County and has a drainage area of 68.1 square miles. The southern half of the watershed is within the Western Corn Belt Plains Ecoregion. The predominant land use is cropland with rangeland being the second most abundant (Figure 16). Jewett Creek also flows through Litchfield which is the largest city in the North Fork Crow drainage. There are two main streams in this HUC-11 Jewett Creek and Battle Creek. Battle Creek is in the northern part of the watershed and Jewett Creek is in the south. Headwaters of both streams flow from south to north and come together just before entering the North Fork Crow River. The outlet of this watershed unit is represented by site 07UM028 on Jewett Creek.

Stream water chemistry

The Jewett Creek HUC-11 is split into three AUIDs the 8.5 mile reach of Jewett Creek and two tributaries. The upstream tributary evaluation was limited to biological data that was collected on a channelized site (i.e. insufficient to determine aquatic life use support). The main stem Jewett Creek reach had existing impairments for both aquatic life (fish, invertebrates, dissolved oxygen and chloride) and aquatic recreation uses (bacteria). A proposal is de-list the Jewett Creek reach for ammonia was reviewed and will be submitted to EPA with the 2012 303(d) Impaired Waters list. The downstream tributary, Battle Creek, had existing impairments for aquatic life use (fish and invertebrates).

Lake water chemistry

One of the nineteen basins (larger than 4 ha) in the watershed has been assessed against aquatic recreation use standards and found to be supporting the use: Ripley Lake (west portion) (47-0134-02).

Table 28. Outlet water chemistry resultsfor Jewett Creek Watershed**

Station Location:	Jewett Creek at 300th St. ,3 mi. N of Litchfield											
Storet ID:	S000-919											
Station #:	07UM028											
Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	13	11	13	13	13	13	13	13	11	13	13
Minimum	51	5.06	33	0.025	0.48	7.8	0.128	1.2	13.63	28.1	11.41	60
Maximum	320	10.17	690	0.12	13	8.62	0.56	6	1774	102	28.84	100
Mean[1]	166.91	7.43	169.30	0.06	4.86	8.13	0.32	2.86	941.13	61.48	20.65	83.08
Median	190	7.2	190	0.05	5	8.12	0.288	2.8	882	55.6	19.66	100
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	3	0	0			1						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Jewett Creek HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 29. Stream biological sampling for Jewett Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-552, south line to Jewitts Cr	07UM027	NS	NS	NS				FS			NS	NS	NA
07010204-585, Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	01UM002 01UM001 07UM028 07UM031	NS	NS	NS	NS	FS	NS	FS	FS	NS	NS	NS	NS

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 30. Biological sampling of channelized stream reaches for Jewett Creek Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-585, Jewitts Creek (County Ditch 19, 18, and 17), Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	01UM002	Upstream of Co. Rd. 42	Poor	Poor
07010204-585, Jewitts Creek (County Ditch 19, 18, and 17), Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	01UM001	Upstream of Hwy 24, near Litchfield	Poor	Fair
07010204-585, Jewitts Creek (County Ditch 19, 18, and 17), Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	07UM031	Upstream of CR 1, in Litchfield	Poor	Poor

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 31. Stream habitat results for Jewett Creek Watershed

Visits	Site ID	Stream 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	00UM097	Jewitts Creek	0	9.5	9.1	14	17	49.6	Fair
1	01UM001	Jewitts Creek	1	10	10	11	10	42	Poor
1	01UM002	Jewitts Creek	1.5	9	13	14	14	51.5	Fair
1	07UM027	Trib. to Jewitts Creek	0	9	8.55	11	21	49.55	Fair
2	07UM028	Jewitts Creek	2.25	12	12.1	10.5	19	55.85	Fair
1	07UM031	County Ditch 19	0	6	12.4	13	16	47.4	Fair
		Average Habitat Results: *Jewett Creek HUC-11 Watershed*	1.2	9.9	11.2	11.8	16.9	51.0	

Qualitative habitat ratings

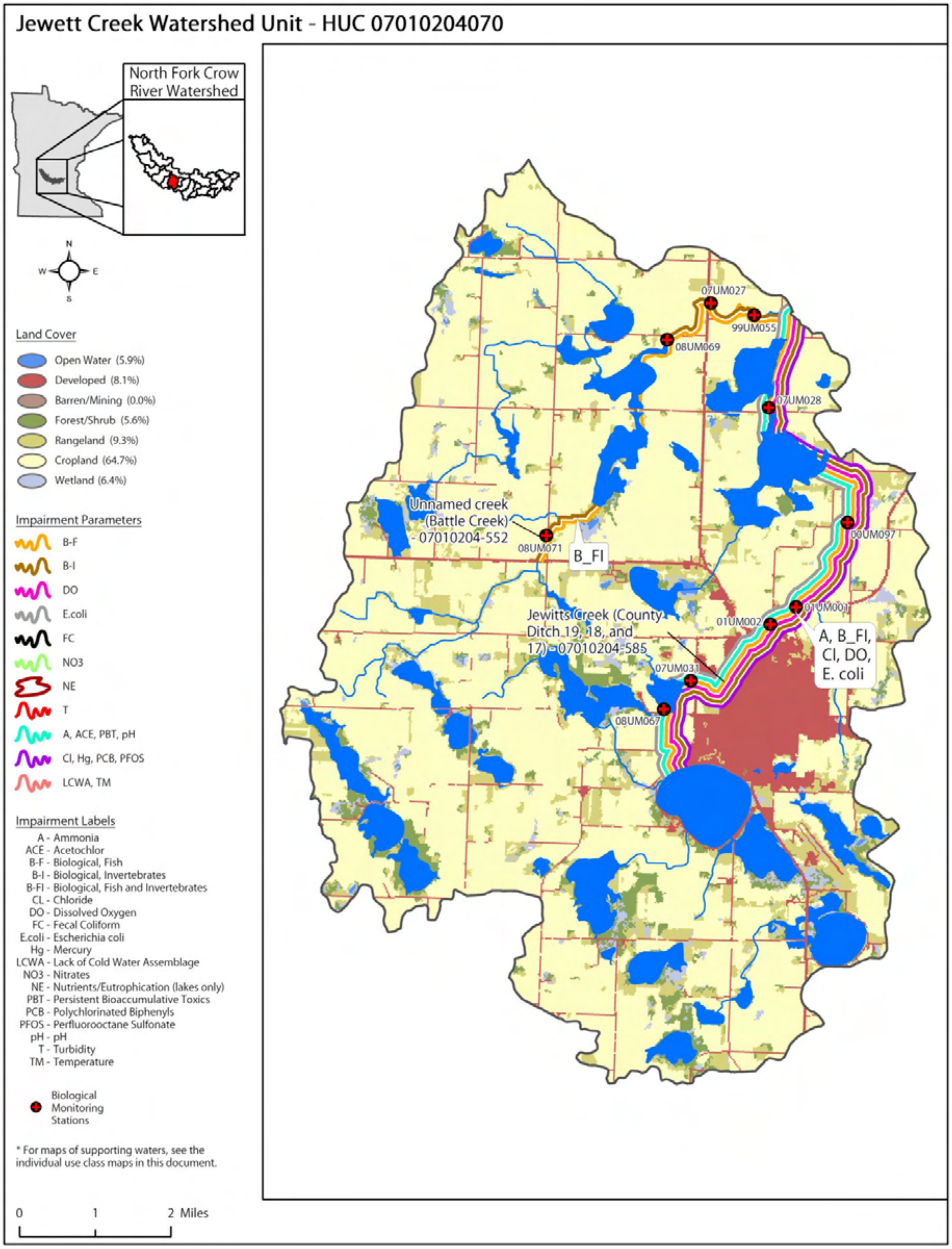
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Jewett Creek Watershed summary

No biological sites in this watershed scored well on either natural or channelized reaches. The habitat scores are rated fair, but there are existing impairments for bacteria, dissolved oxygen, and chloride which may be contributing to the low fish and invertebrate scores.

Little data exists on the remaining small basins in the watershed. While Ripley is in good condition, it is anticipated that the smaller basins may be more impacted by nutrients. Little data exists on the remaining small basins in the watershed, which are likely quite shallow. This watershed is intensively altered, with high percentages of agricultural and urban land uses. (Anderson 2010).

Figure 32. Land use and currently listed impaired waters by parameter, in the Jewett Creek Watershed unit



Litchfield Watershed unit HUC 07010204080

The Litchfield Watershed unit is completely in Meeker County and has a drainage area of 23.1 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 17). The headwaters start just south of Highway 12, two miles east of Litchfield, and flows due north to the North Fork Crow River near Forest City. Due to the size of the watershed and lack of water there was no outlet water chemistry site sampled on this HUC-11.

Stream water chemistry

The Litchfield HUC-11 is split into three small AUIDs, County Ditch 35 upstream of Richardson Lake (two AUIDs), and the portion from Dunn's Lake to County Ditch 36. These reaches only have data on chloride; no other chemistry data exits. As a result, no assessment of aquatic life has been made in this watershed.

Lake water chemistry

Two of the three basins (larger than 4 ha) in the watershed have been assessed against aquatic recreation use standards and found to be not supporting that use: Richardson Lake (47-0088-00) and Dunn's Lake (47-0082-00).

Table 33. Stream biological sampling for Litchfield Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-548, Unnamed cr to Unnamed cr	00UM057	NA										NA	NA

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 34. Biological sampling of channelized stream reaches for Litchfield Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-548, Unnamed creek, Unnamed cr to Unnamed cr	00UM057	Downstream of CR 11	Poor	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 35. Stream habitat results for Litchfield Watershed

Visits	Site ID	Stream 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	00UM057	Trib. to Crow River, North Fork	0	8	6	11	9	34	Poor
		Average Habitat Results: *Litchfield HUC-11 Watershed*	0	8	6	11	9	34	

Qualitative habitat ratings

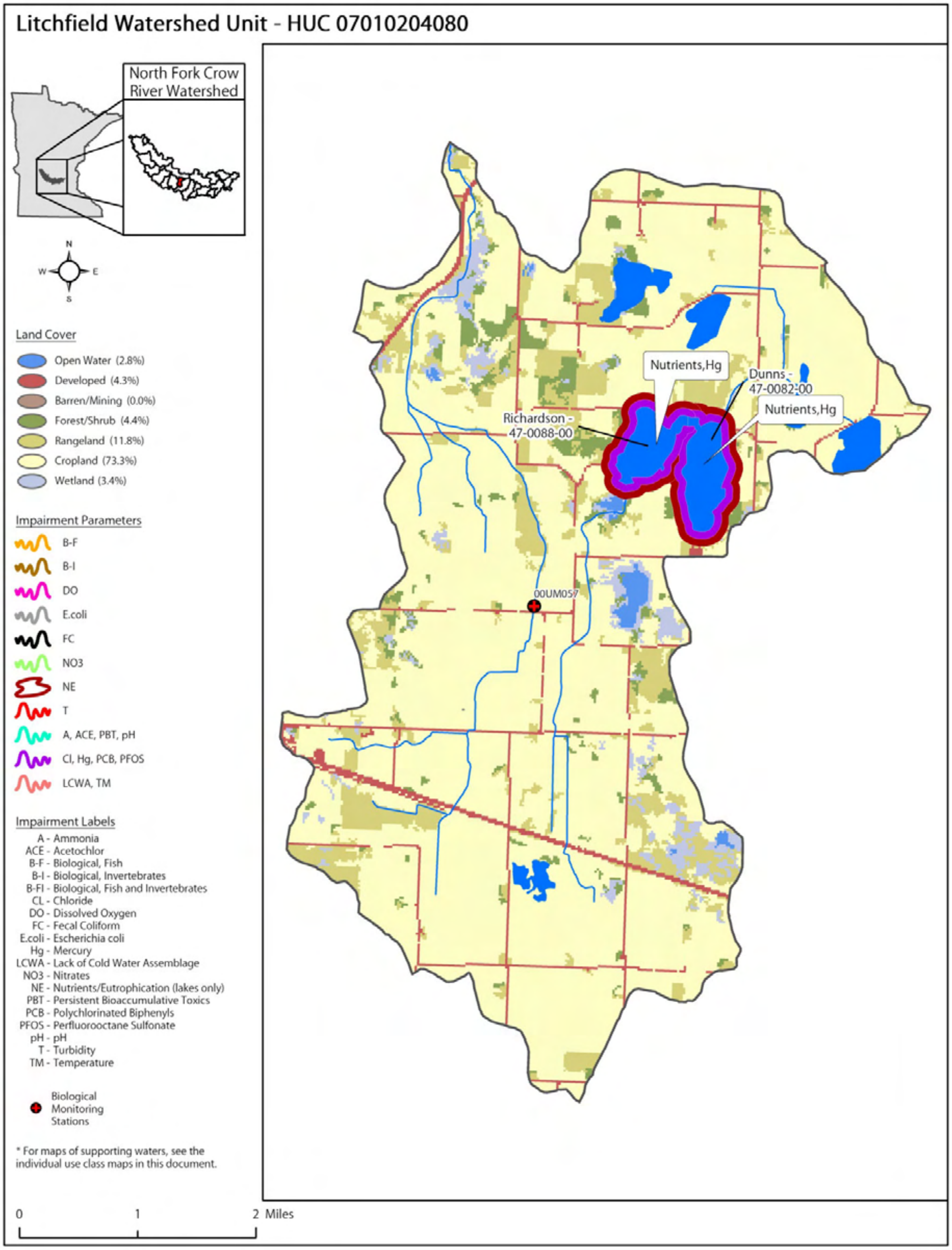
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Litchfield Watershed summary

One AUID in this watershed was sampled for biology. The channelized reach has a score of poor which is the same as the poor habitat score. This is a possible reason for the low IBI score.

Agriculture is the primary land use in this watershed. The lakes are highly eutrophic; watershed loading, and in the case of Dunn's Lake, internal loading, are driving increased eutrophication. The lakes are of poor water quality; watershed improvements would be recommended to improve the lake condition (Anderson 2010).

Figure 17. Land use and currently listed impaired waters by parameter, in the Litchfield Watershed unit



Washington Creek Watershed unit HUC 07010204100

The Washington Creek Watershed unit is completely in Meeker County and has a drainage area of 69.2 square miles. The southwest tip of this watershed falls in the Western Corn Belt Plains Ecoregion, with the rest of the watershed in the North Central Lakes and Forests Ecoregion. The predominant land use is cropland with rangeland being the second most abundant (Figure 18). The watershed starts as Sucker Creek at Lake Minnie-Belle where it flow east to Lakes Manuella, Stella, and Washington. At the outflow from Lake Washington, the name changes to Washington Creek. Washington Creek flows north out of Lake Washington and combines with County Ditch 36 before it enters the North Fork Crow River southeast of Kingston. The outlet of this watershed unit is represented by site 07UM014 on Washington Creek.

Stream water chemistry

The Washington Creek HUC-11 is split into four AUIDs Lake Minnie-Belle Outlet, Sucker Creek, Washington Creek and County Ditch 36. The Lake Minnie-Belle Outlet, Sucker Creek, and County Ditch 36 don't have sufficient information for an aquatic life assessment. Washington Creek was determined to not be supporting aquatic recreation (i.e. bacteria). Data for aquatic life assessment was conflicting, and the biological data was collected from channelized sites (i.e. insufficient for aquatic life assessment determination).

Lake water chemistry

Four of the 16 basins in this watershed have been assessed as supporting for aquatic recreation use: Stella (47-0068-00), Manuella (47-0050-00), Washington (47-0046-00), and Minnie-Belle (47-0119-00).

Table 36. Outlet water chemistry resultsfor Washington Creek Watershed**

Station Location:	County Ditch 9 at C.R. 21, 4 mi. S of Kingston
Storet ID:	S003-935
Station #:	07UM014

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	12	11	12	12	12	12	12	12	11	12	12
Minimum	5.9	0.64	15	0.025	0.025	7.5	0.071	5.6	467	5.69	13.6	19
Maximum	16	9.19	1700	0.24	0.7	8.59	0.35	22	593	33.9	31.92	100
Mean[1]	11.25	4.74	161.08	0.06	0.13	8.05	0.19	12.73	516.58	21.35	20.93	51.17
Median	12	3.58	110	0.025	0.025	8	0.16	12	501.5	23.2	20.495	47.5
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	7	2			2						1
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Washington Creek HUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 37. Stream biological sampling for Washington Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-518, Washington Lk to N Fk Crow R	07UM014 07UM030	NA	NA	NS	NS	FS	FS	FS	FS	NS	NS	IF	NS
07010204-547, Powers Lk outlet to Washington Cr	07UM020	NA	NA			FS						IF	NA
07010204-669, Lk Minnie Belle to T118 R31W S12, east line						FS						IF	NA

Abbreviations: **F-IBI** – Biological, Fish; **M-IBI** – Biological, Macroinvertebrates; **DO** – Dissolved Oxygen; **T** – Turbidity; **Cl** – Chloride; **pH** – pH; **NH3** – Unionized Ammonia; **Aq. Life** – Aquatic Life Use Assessment; **Aq. Rec.** – Aquatic Recreation Assessment

NA = Not Assessed; **FS** = Fully Support; **IF** = Insufficient Information; **NS** = Non-Support

Table 38. Biological sampling of channelized stream reaches for Washington Creek Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-518, Washington Creek, Washington Lk to N Fk Crow R	07UM014	Downstream of CR 21, 4 mi. S of Kingston	Poor	Poor
07010204-518, Washington Creek, Washington Lk to N Fk Crow R	07UM030	Upstream of 273rd St, 5 miles N of Dassel	Fair	Fair
07010204-547, County Ditch 36, Powers Lk outlet to Washington Cr	07UM020	Upstream of CR 21, 5 mi. SE of Kingston	Poor	Poor

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 39. Stream habitat results for Washington Creek Watershed

Visits	Site ID	Stream 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	07UM018	Sucker Creek	2.5	13.5	18.8	12	28	74.8	Good
1	07UM014	County Ditch 9	5	11	12.35	9	24	61.35	Fair
1	07UM020	County Ditch 36	2.5	9	14	13	18	56.5	Fair
1	07UM030	Washington Creek	3.5	10	20	7	18	58.5	Fair
Average Habitat Results: *Washington Creek HUC-11 Watershed*									

Qualitative habitat ratings

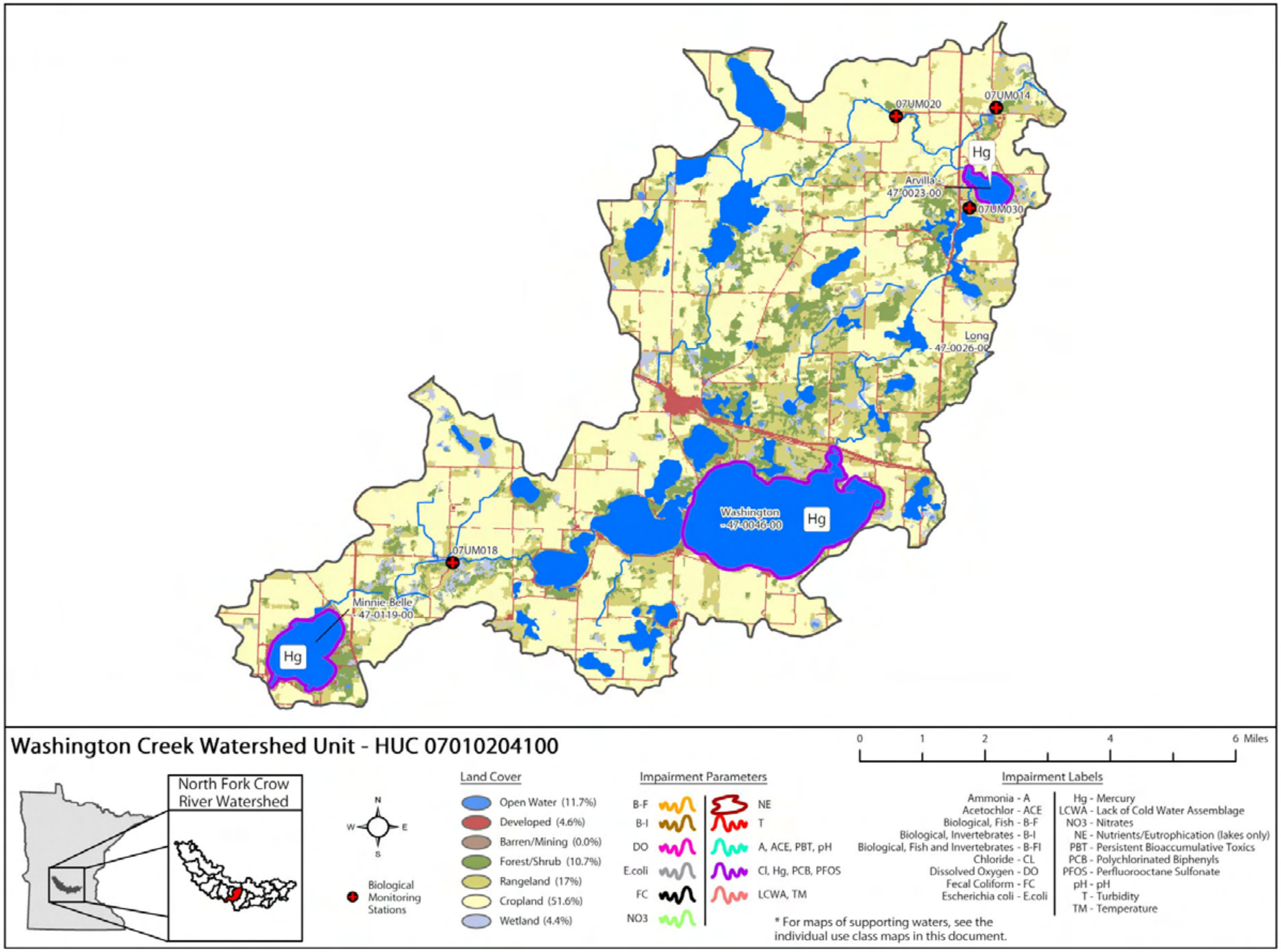
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Washington Creek Watershed summary

Two AUIDs in the watershed were sampled for biology. All three biological stations were on channelized reaches and have fair and poor scores. Habitat scores on these reaches are fair. Lack of good habitat could be a major factor in the fish and invertebrate IBI scores.

This watershed has considerably more forested cover than most upstream watersheds in the HUC-8. Many of the lakes are in a chain, which benefits each downstream lake as TP is trapped in the basin immediately upstream. Washington Lake is in the upper portion of the watershed and has tributaries from lakes of good water quality (Stella, Minnie-Belle). Since upstream lakes retain much of the phosphorus that flow into them, Lake Washington benefits from this storage of phosphorus in upstream, deep lakes. Little data is available on the smaller lakes. Based on the existing data, the lakes in the Washington Creek HUC-11 are of good water quality and the watershed would benefit from protection strategies to maintain current conditions (Anderson 2010).

Figure 18. Land use and currently listed impaired waters by parameter, in the Washington Creek Watershed unit



Lower North Fork Crow River Watershed unit HUC 07010204160

The Lower North Fork Crow River Watershed unit encompasses parts of Wright County and a very small portion of Meeker County at the upstream end of the HUC-11. The Lower North Fork Crow Watershed has a drainage area of 193.1 square miles, the second largest drainage area in the 8 digit-HUC. The predominant land use is cropland with rangeland being the second most abundant (Figure 19). The Lower North Fork Crow HUC-11 flows southeast from where Eagle Creek enters the North Fork Crow River to the confluence of the South Fork Crow River in the town of Rockford. The outlet of this watershed unit is represented by site 07UM046 on the North Fork Crow River. This site is also where fish tissue samples were taken for mercury and PCBs for fish consumption. Four of the eight biological sites in this watershed unit are on the main stem North Fork Crow River.

Stream water chemistry

The Lower North Fork Crow River HUC-11 is split into six AUIDs – three small tributaries, Mill Creek, and two reaches of the main stem North Fork Crow River, upstream and downstream of Mill Creek. The tributaries had insufficient data to determine use support. Mill Creek had sufficient chemistry data to determine impairments for aquatic life use (dissolved oxygen and turbidity) and aquatic recreation use (bacteria). The entire reach of the North Fork Crow River in this HUC-11 was determined to be impaired for both aquatic life (dissolved oxygen, turbidity, fish and macroinvertebrates) and aquatic recreation uses (bacteria).

Lake water chemistry

Twelve of the thirty-two basins in this watershed have been assessed for aquatic recreation use, of these, five are supporting and seven are not supporting of this use (Table 40).

Table 40. Lakes assessed for aquatic recreation use in the Lower North Fork Crow River HUC-11

COUNTY	DNR Lake ID	Lake Name	Lake Area (hectares)	Maximum Depth (meters)	Recreation Assessment
MEEKER	47000200	Francis	425	5.8	FS
WRIGHT	86004100	Dean	70	7	NS
WRIGHT	86004600	Crawford	43	5.8	FS
WRIGHT	86008600	Fountain	171	4.6	NS
WRIGHT	86011200	Malardi	39		NS
WRIGHT	86018200	Rock	73	11	NS
WRIGHT	86021700	Granite	143	10.4	NS
WRIGHT	86022100	Camp	48	15.8	NS
WRIGHT	86027300	French	137	16.5	NS
WRIGHT	86027900	West Lake Sylvia	361	27	FS
WRIGHT	86028800	John	160	8.5	FS
WRIGHT	86028900	East Lake Sylvia	270	23.8	FS

Table 41. Outlet water chemistry resultsfor Lower North Fork Crow Watershed**

Station Location:	North Fork Crow River at C.R. 32, 5 mi. NW of Rockford
Storet ID:	S000-615
Station #:	07UM046

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	12	11	12	12	12	12	12	12	11	12	12
Minimum	8	6.33	11	0.025	0.025	8.09	0.086	17	483	21.4	15.63	10
Maximum	44	17.8	550	0.07	1.1	8.9	0.321	83	686	45.8	30.6	68
Mean[1]	28.36	9.17	53.24	0.03	0.42	8.53	0.19	52.08	572.17	34.10	22.83	24.75
Median	27	7.77	48	0.025	0.37	8.545	0.189	54	564	33.5	21.195	19
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	0			8						6
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower North Fork Crow RiverHUC-11, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 42. Stream biological sampling for Lower North Fork Crow Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-503, Mill Cr to S Fk Crow R	O7UM046	NS	NS	NS	NS	NS	FS	FS	FS	NS	NS	NS	NS
07010204-509, Unnamed cr to N Fk Crow R	00UM058 07UM089	NA										NA	NA
07010204-592, French Lk to N Fk Crow R	07UM048	NA				FS						IF	NA
07010204-656, Headwaters Granite Lk to Unnamed cr	07UM049	NA										NA	NA
07010204-556, Meeker/Wright County line to Mill Cr	07UM059 07UM055 07UM050	NS	NS	NS	IF	NS	FS	FS	FS	NS	NS	NS	NS

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 43. Biological sampling of channelized stream reaches for Lower North Fork Crow Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-509, Eagle Creek. Unnamed cr to N Fk Crow R	00UM058	1 mile East of C.R. 19 on county road, 2 mi. NE	Fair	--
07010204-509, Eagle Creek. Unnamed cr to N Fk Crow R	07UM089	Downstream of 318th St, 1.5 mi. NE of Kingston	Fair	--
07010204-592, French Creek, French Lk to N Fk Crow R	07UM048	Downstream of CR 3, in French Lake	Fair	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 44. Stream habitat results for Lower North Fork Crow Watershed

			Land Use	Riparian	Substrate	Fish Cover	Channel Morph.	MSHA Score	MSHA
Visits	**Site ID**	**Stream Name**	**(0-5)**	**(0-15)**	**(0-27)**	**(0-17)**	**(0-36)**	**(0-100)**	**Rating**
1	00UM058	Eagle Creek	1.25	13	17.15	4	20	55.4	Fair
1	07UM046	Crow River, North Fork	3.5	10	20.2	6	19	58.7	Fair
1	07UM048	French Creek	5	14	8	2	9	38	Poor
1	07UM049	Trib. to Crow River, North Fork	1.5	10.5	9	3	21	45	Fair
1	07UM050	Crow River, North Fork	5	9.5	15	5	20	54.5	Fair
1	07UM055	Crow River, North Fork	1.5	7.5	18	6	14	47	Fair
1	07UM059	Crow River, North Fork	2.5	8.5	20.2	8	33	72.2	Good
1	07UM089	Eagle Creek	2.5	11	21.7	8	26	69.2	Good
Average Habitat Results: *Lower North Fork Crow HUC-11 Watershed*			2.8	10.5	16.2	5.3	20.3	55.0	

Qualitative habitat ratings

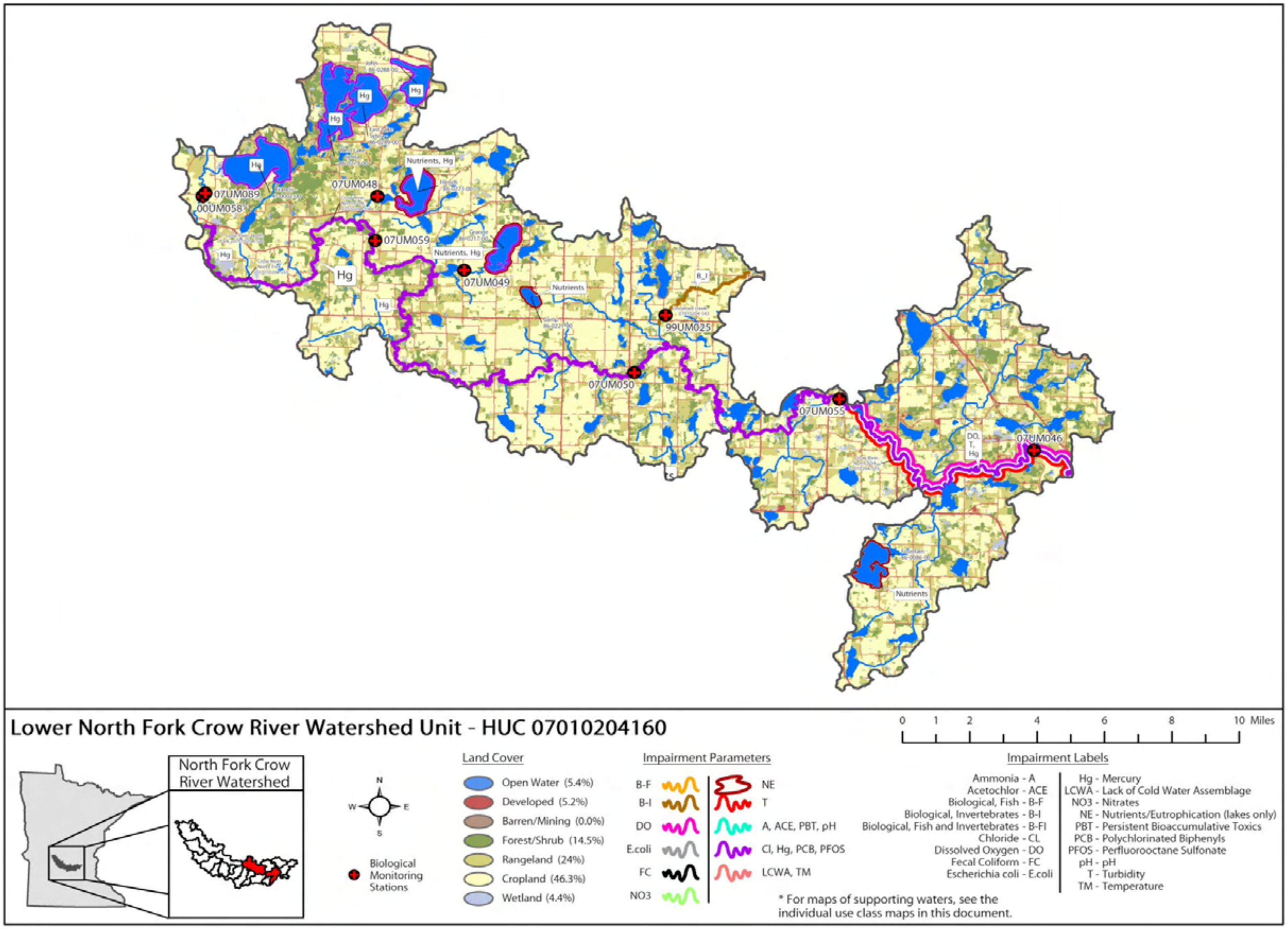
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

North Fork Crow Watershed summary

Five AUIDs in the watershed were sampled for biology. Two of the five were assessed as not supporting aquatic life, while the other channelized reaches scored fair. Habitat in the watershed is fair, but there are both turbidity and dissolved oxygen problems throughout this watershed.

The Lower North Fork Crow River Watershed is a very lake-rich watershed. The upstream, headwaters lakes are of high quality and are in the least developed portion of the watershed. As you move downstream, land use disturbance increases. Considering the severe degradation in several of the lakes, it is recommended that this watershed undergo restoration activities to reduce levels of TP entering the lake systems (Anderson 2010).

Figure 19. Land use and currently listed impaired waters by parameter, in the Lower North Fork Crow River Watershed unit



Collinwood Creek Watershed unit HUC 07010204110

The Collinwood Creek Watershed unit, located in southeast Meeker County, southwest Wright County, and north central McLeod County encompasses an area of 80.4 square miles. The headwaters originate in a lake rich area near the small town of Jenne. Silver Creek flows north to Pigeon Lake, where it turns east to Collinwood Lake, and combines with Collinwood Creek flowing from the south. Collinwood Creek Flows north to Big Swan Lake, then north into the North Fork Crow River two miles northwest of Knapp. Cropland is the primary land use in the watershed (Figure 20). Silver Creek is the only named tributary to Collinwood Creek. The outlet of the watershed unit is represented by site 07UM015.

Stream water chemistry

The Collinwood Creek HUC-11 is split into four AUIDs Silver Creek, Inlet to Collinwood Lake Outlet to Big Swan Lake, and Collinwood Creek. Silver Creek, the inlet to Collinwood Lake, and the outlet to Big Swan Lake either have insufficient information to make an aquatic life assessment determination or the sampling locations are not appropriate for assessments (i.e. outlet is often reflective of lake conditions instead of streams). Collinwood Creek was determined to not be supporting aquatic recreation (i.e. bacteria); data for aquatic life assessment also indicated impaired conditions for dissolved oxygen and turbidity. The biological data for this reach was collected from channelized sites (i.e. insufficient for aquatic life assessment determination and therefore the aquatic life use impairment will be deferred until tiered aquatic life uses are assigned.

Lake water chemistry

Seven of the thirty-five basins in this watershed have been assessed for aquatic recreation use: Erie (47-0064-00) and Long (47-0026-00) were supporting and Hook (43-0073-00), Jennie (47-0015-00), spring (47-0032-00), Big Swan (47-0038-00), and Collinwood (86-0293-00) were not supporting aquatic recreation use.

Table 45. Outlet water chemistry resultsfor Collinwood Creek Watershed**

Station Location:	Collinwood Creek at 30th St. SW, 4 mi. NE of Dassel
Storet ID:	S004-420
Station #:	07UM015

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	11	11	11	11	11	11	11	11	11	11	11
Minimum	5.6	2.37	5	0.025	0.025	7.66	0.064	7.2	343	8.11	14.25	10
Maximum	16.82863295	4.9715	124.591			8.1309						37.961
Mean[1]	27	7.63	2400	0.22	0.91	8.78	0.278	110	646	28	25.54	100
Median	18.97	5.18	124.59	0.09	0.28	8.14	0.19	27.05	452.27	16.04	19.48	44.00
WQ standard[2]	<230	>5	126/1260		6.5-8.5						20	<230
# WQ exceedances[3]	0	4	1			1						1
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Collinwood Creek HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 46. Stream biological sampling for Collinwood Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-557, Unnamed cr to Collinwood Lk	07UM019	NA				FS						IF	NA
07010204-604, Unnamed cr (Unnamed lk outlet) to Big Swan Lk	07UM015	NA		NS	NS	NS	FS	FS	FS	NS	NS	IF	NS

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 47. Biological sampling of channelized stream reaches for Collinwood Creek Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-557, Silver Creek, Unnamed cr to Collinwood Lk	07UM019	Downstream of CR 15, 5 mi. SE of Dassel	Fair	--
07010204-604, Collinwood Creek, Unnamed cr (Unnamed lk 47-0031-00 outlet) to Big Swan Lk	07UM015	30th St. SW, 4 mi. NE of Dassel	Good	Poor

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 48. Stream habitat results for Collinwood Creek Watershed

Visits	Site ID	Stream 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	07UM019	Silver Creek	1	11	18	4	20	54	fair
	Average Habitat Results: *Collinwood Creek HUC-11 Watershed*		1	11	18	4	20	54	

Qualitative habitat ratings

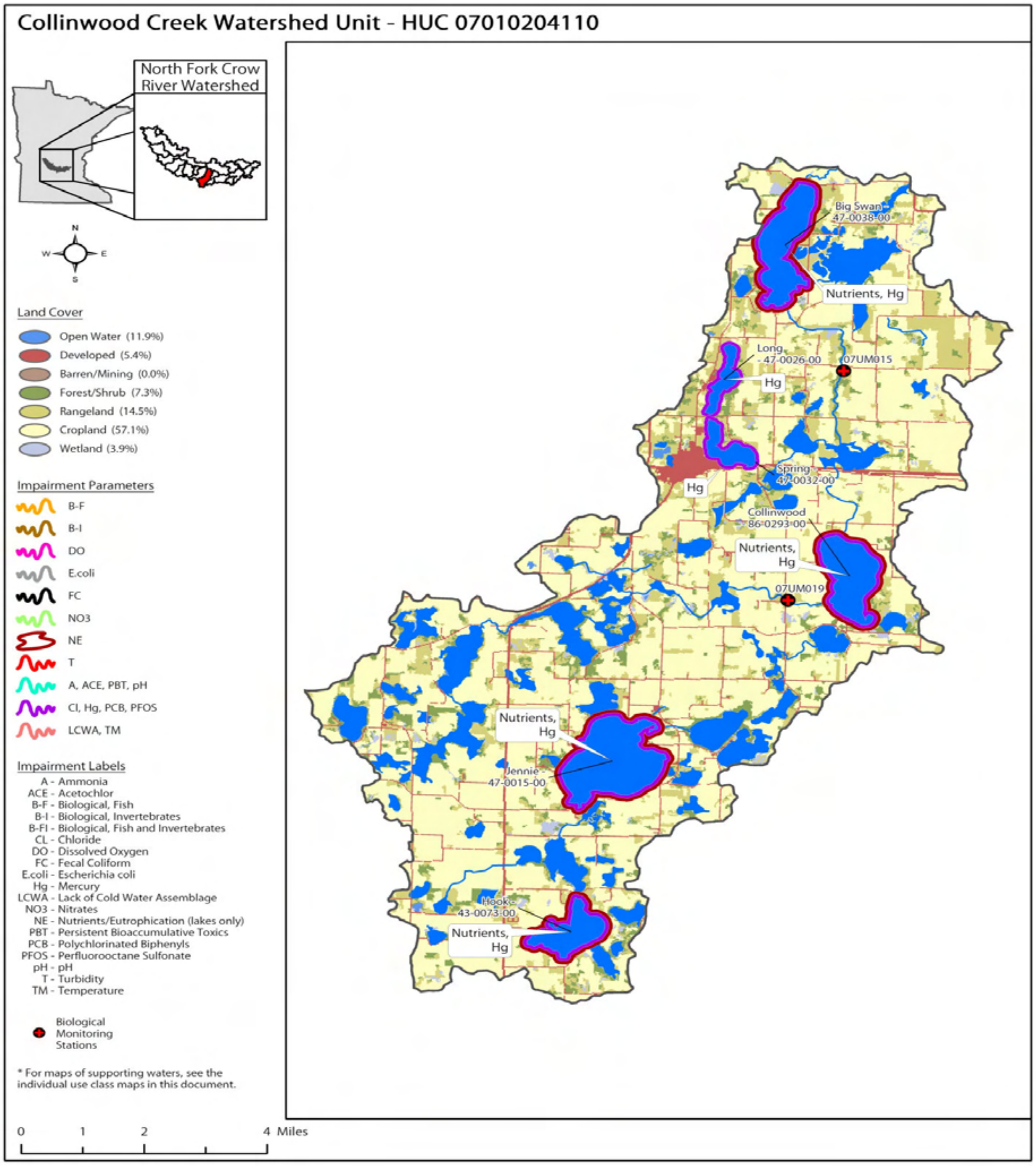
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Collinwood Creek Watershed summary

Two AUIDs in the watershed were sampled for biology. One was rated fair and one poor for fish and one good for invertebrates. Habitat was rated fair, but turbidity and dissolved oxygen was a problem on some AUIDs

Collinwood Creek HUC-11 is a very lake rich watershed. Many of the lakes have very large watershed to lake ratios; the lake is receiving runoff from a large land area. The lakes in this watershed also tend to be shallow. While there are some lakes in the watershed in good condition, it is recommended that work be done in the watershed to reduce TP loading, as the majority of the lakes with existing data are impaired (Anderson 2010).

Figure 20. Land use and currently listed impaired waters by parameter in the Collinwood Creek Watershed unit



Sucker Creek Watershed unit HUC 07010204120

The Sucker Creek watershed unit encompasses parts of Wright, Mc Leod and Meeker Counties and has a drainage area of 46.5 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 21). Headwaters of Sucker Creek start near Lake Byron and flow north, skirting the city of Cokato to the south and east and into Cokato Lake. Sucker Creek flows east out of Cokato Lake and enters the North Fork Crow River about two miles east of the lake. The outlet of the watershed unit is represented by site 07UM061.

Stream water chemistry

The Sucker Creek HUC-11 is split into 2 AUIDs Sucker Creek upstream of Cokato Lake and downstream of Cokato Lake to the confluence of the North Fork Crow River. Upstream of the lake, the biological data was collected from channelized sites (i.e. insufficient for aquatic life assessment determination). The downstream AUID had sufficient data to determine not support of aquatic life use based on both invertebrates and turbidity. Bacteria data exists for the downstream reach however; it was not possible to conclusively determine aquatic recreation use was supported.

Lake water chemistry

Three of the five basins in this watershed have been assessed as not supporting aquatic recreation use: Smith (86-0025-00), Cokato (86-0263-00), and Brooks (86-0264-00). The Sucker Creek HUC-11 watershed is intensively row cropped and has a high proportion of urban development compared to upstream watersheds. The lakes with existing data in this watershed are impaired; the watershed would benefit from restoration activities to improve the water quality (Anderson 2010).

Table 49. Outlet water chemistry resultsfor Sucker Creek Watershed**

Station Location:	Sucker Creek at C.R. 4, 2 mi. W of Albright											
Storet ID:	S002-021											
Station #:	07UM061											
Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	12	11	12	12	12	12	12	12	11	12	12
Minimum	26	5.94	2	0.025	0.12	8.1	0.036	4	499	48.2	13.29	43
Maximum	28	12.13	190	0.26	2	8.85	0.116	34	555	58.9	29.28	100
Mean[1]	26.82	7.55	31.56	0.09	1.03	8.51	0.06	16.47	532.33	53.74	21.78	69.58
Median	27	7.36	44	0.075	0.97	8.515	0.053	18	533	54.3	20.77	60
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	0			6						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Sucker Creek HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 50. Stream biological sampling for Sucker Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-682, Cokato Lk to N Fk Crow R	07UM061	FS	NS	NS	IF	NS	FS	FS	FS	IF	FS	NS	IF
07010204-684, Headwaters to Cokato Lk	07UM100 07UM058	NA	NA						IF			IF	NA

Abbreviations: **F-IBI** – Biological, Fish; **M-IBI** – Biological, Macroinvertebrates; **DO** – Dissolved Oxygen; **T** – Turbidity; **Cl** – Chloride; **pH** – pH; **NH3** – Unionized Ammonia; **Aq. Life** – Aquatic Life Use Assessment; **Aq. Rec.** – Aquatic Recreation Assessment

NA = Not Assessed; **FS** = Fully Support; **IF** = Insufficient Information; **NS** = Non-Support

Table 51. Biological sampling of channelized stream reaches for Sucker Creek Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-684, Sucker Creek, Headwaters to Cokato Lk	07UM100	Upstream of 7th St, In Cokato	Poor	Poor
07010204-684, Sucker Creek, Headwaters to Cokato Lk	07UM058	Upstream of CR 31, 0.5 mi. S of Cokato	Poor	Poor

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 52. Stream habitat results for Sucker Creek Watershed

Visits	Site ID	Stream 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	07UM100	Sucker Creek	0	12	14	6	13	45	Fair
1	07UM058	Sucker Creek	0	7	8	15	9	39	Poor
1	07UM061	Sucker Creek	2.5	10	16.4	8	18	54.9	Fair
Average Habitat Results: *Sucker Creek HUC-11 Watershed*			0.8	9.7	12.8	9.7	13.3	46.3	

Qualitative habitat ratings

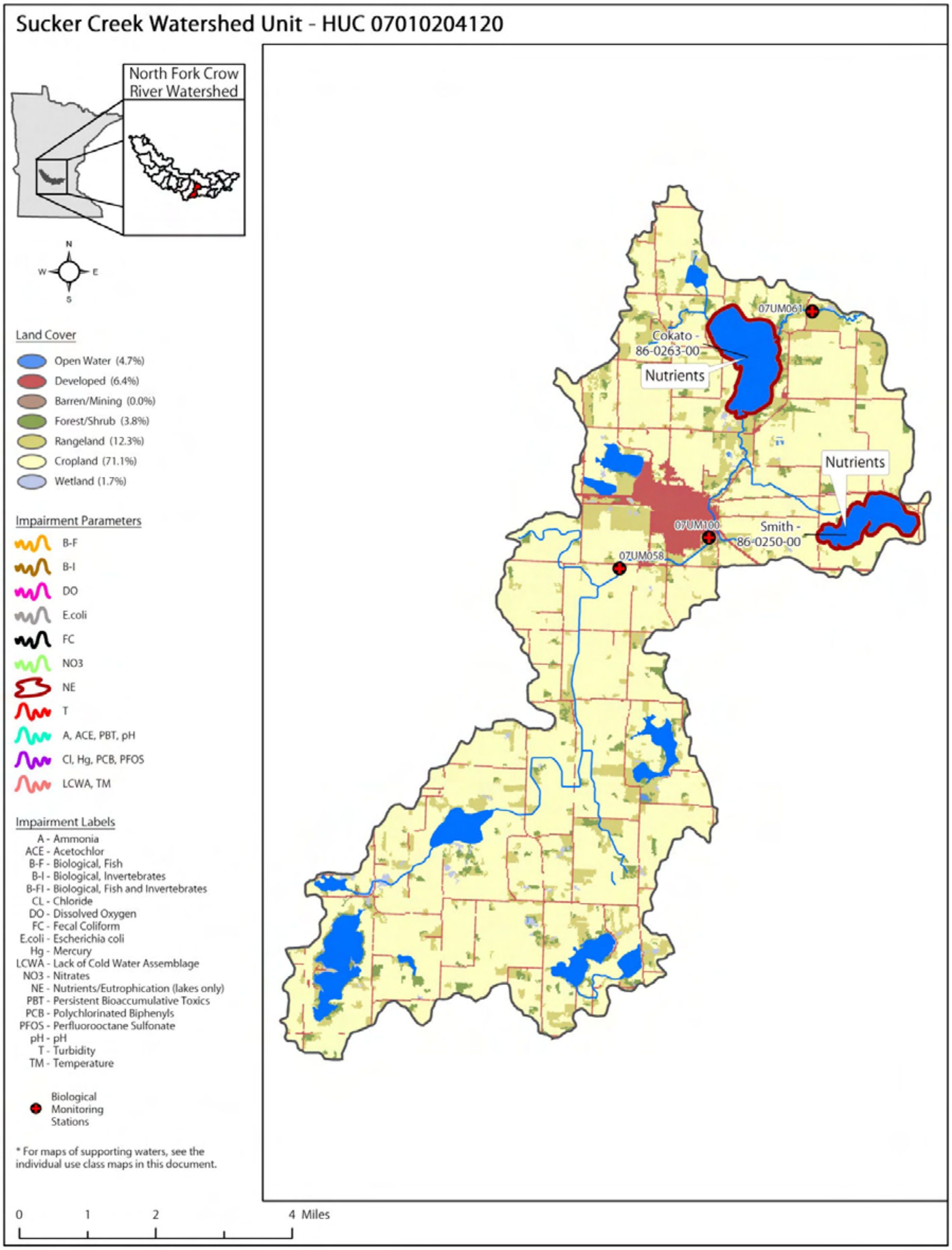
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Sucker Creek Watershed summary

Two AUIDs in the watershed were sampled for biology. The only site monitored on a natural stream section was found impaired for biology, and the two sites on channelized reaches rated as poor. The habitat scores at the sites are predominately low. Another factor to the low IBI scores could be that the streams headwaters are on impaired lakes.

The Sucker Creek HUC-11Watershed is intensively row cropped and has a high proportion of urban development compared to upstream watersheds. The lakes with existing data in this watershed are impaired; the watershed would benefit from restoration activities to improve the water quality (Anderson 2010).

Figure 21. Land use and currently listed impaired waters by parameter, in the Sucker Creek Watershed unit



Twelve Mile Creek Watershed unit HUC 07010204130

The Twelve Mile Creek Watershed unit is completely in Wright County and has a drainage area of 58.7 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 22). Twelve Mile Creek Watershed is made up of two distinct branches - Twelve Mile Creek and County Ditch 10. County Ditch 10 is in the southern part of the watershed and it flows from west to east starting just southeast of Cokato. It flows east into Lake Ann and Lake Emma where it turns north and flows three miles into Twelve Mile Creek. Twelve Mile Creek starts northwest of Howard Lake and flows southeast into the lake and the city of Howard Lake. It then turns due east for two miles and combines with County Ditch 10 where it continues east into Little Waverly Lake. After it exits the lake it flows north to the North Fork Crow River. There were no fish or invertebrate sample taken at the outlet of this watershed due to low flow.

Stream water chemistry

The Twelve Mile Creek HUC-11 is split into 12 AUIDs; County Ditch 10 makes up four of the AUIDs and Twelve Mile Creek another two. The remainder is small tributaries to lakes or streams with insufficient data available to determine aquatic life use. The only assessments that were able to be made were on Twelve Mile Creek downstream from Little Waverly Lake to the confluence with the North Fork Crow River. Aquatic life was determined to be impaired due to low dissolved oxygen and aquatic recreation use (due to excessive bacteria levels) was impaired on the reach as well.

Lake water chemistry

Six of the twelve basins in this watershed have been assessed as not supporting aquatic recreation use: Dutch (86-0184-00), Emma (86-0188-00), Ann (86-0190-00), Howard (86-0199-00), and Waverly (86-0114-00), and Little Waverly (86-0106-00). This watershed has undergone significant development; row crop, pasture, and urban land uses make up the majority of the watershed. Watershed runoff combined with limited buffers has led to degraded conditions in the area lakes. Historical point sources have also contributed to degraded conditions in some of the lakes. It is recommended that this watershed have restoration practices put into place to reduce the TP loading to the lakes and improve the water quality (Anderson 2010).

Table 53. Outlet water chemistry resultsfor Twelve Mile Creek Watershed**

Station Location:	Twelve Mile Creek at C.R. 107, 2.5 mi. N of Waverly
Storet ID:	S001-405
Station #:	No Biological Data

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	11	11	11	11	11	11	11	11	11	11	11
Minimum	37	3.67	9	0.025	0.025	7.42	0.109	6.4	415	1.69	15.27	10
Maximum	140	8.77	2400	0.44	0.3	9.18	0.534	91	1130	130	33.18	100
Mean[1]	62.18	6.03	230.17	0.16	0.10	8.35	0.28	21.76	648.09	30.99	21.42	60.09
Median	47	5.77	200	0.12	0.07	8.5	0.249	12	579	16.8	19.95	60
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	4	2			5						1
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Twelve Mile Creek HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 54. Stream biological sampling for Twelve Mile Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DOFinal	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-563, Unnamed ditch to Unnamed ditch	07UM099	NA	NA			FS						IF	NA
07010204-681, Little Waverly Lk to N Fk Crow R				NS	NS	IF	FS	FS	FS	NS	NS	NS	NS

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 55. Biological sampling of channelized stream reaches for Twelve Mile Creek Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-563, County Ditch 10, Unnamed ditch to Unnamed ditch	07UM099	Downstream of Keets Ave, 2 mi. S of Howard Lake	Fair	Fair

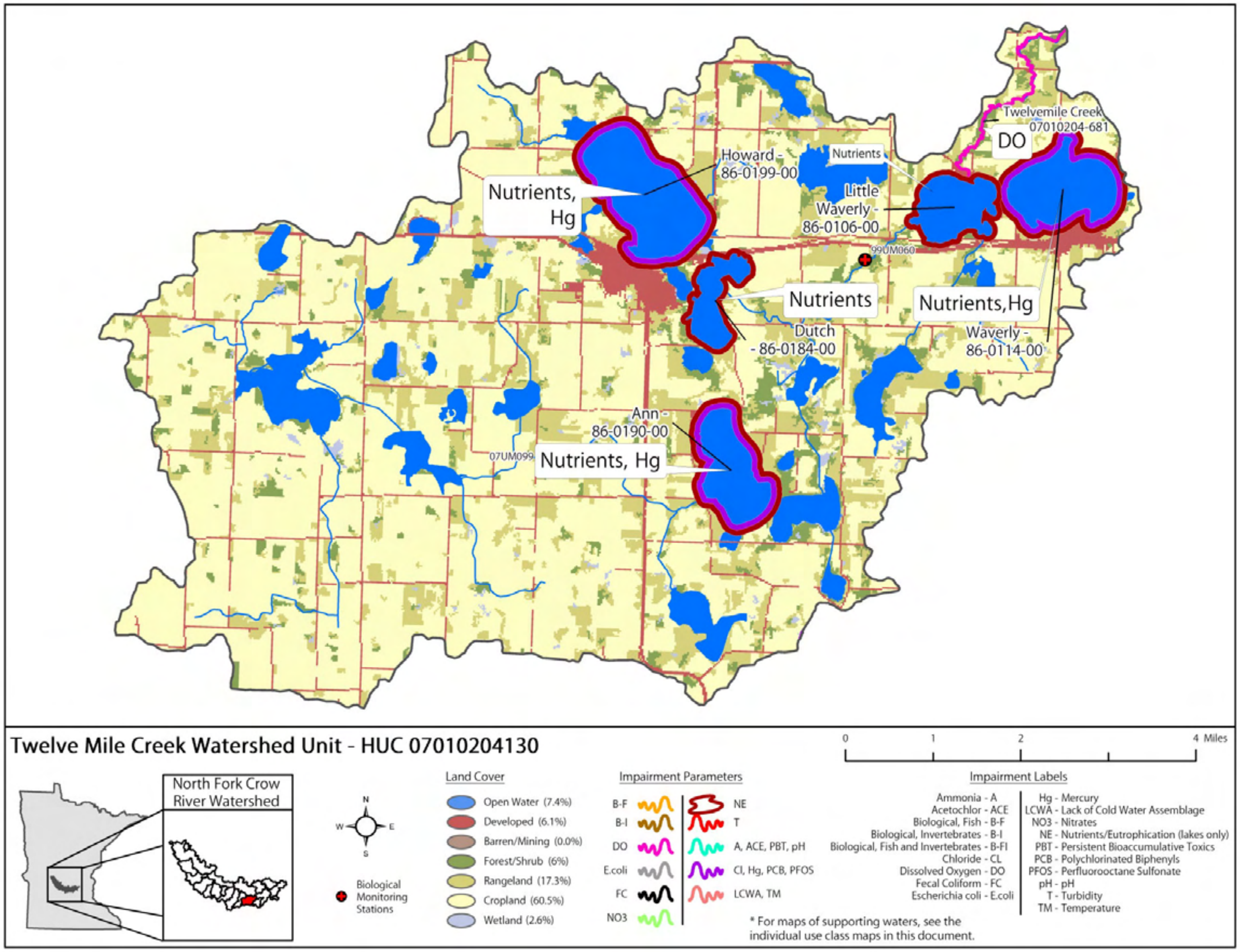
See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Twelve Mile Creek Watershed summary

One AUID was sampled for biology and this site scored fair. Having only one site in a AUID makes it hard to determine sources of problems, but the dissolved oxygen impairment could play a role in the biological impairments.

This watershed has undergone significantly development; row crop, pasture, and urban land uses make up the majority of the watershed. Watershed runoff combined with limited buffers has led to degraded conditions in the area lakes. Historical point sources have also contributed to degraded conditions in some of the lakes. It is recommended that this watershed have restoration practices put into place to reduce the TP loading to the lakes and improve the water quality (Anderson 2010).

Figure 22. Land use and currently listed impaired waters by parameter, in the Twelve Mile Creek Watershed unit



Louzer Lake Outlet Watershed unit HUC 07010204150

The Louzer Lake Outlet Watershed unit encompasses parts of Wright and Carver Counties and has a drainage area of 31.1 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 23). The headwaters of the watershed start near the Carver and Wright County lines and run north through the Woodland Wildlife Management Area then into the North Fork Crow River east of Montrose. The outlet of the watershed unit is represented by site 07UM044.

Wetland biological sampling

The Woodland Wildlife Management Area contains Mud Lake (Woodland WMA) (86-0085-00), a small wetland that was sampled in 2002 and 2004. The plant IBI score was below impairment thresholds and confidence intervals and is currently listed as impaired for aquatic life based on data on plants.

Stream water chemistry

The Louzer Lake Outlet HUC-11 has only two AUIDs; an unnamed creek that drains to the Woodland WMA, and from the WMA to the confluence to the North Fork Crow River. Both AUIDs have aquatic life impairments based on chemistry, turbidity upstream of the wetland, and dissolved oxygen downstream. Aquatic recreation impairments are found on the entire reach. No biological data was available from either AUID to review for assessments.

Lake water chemistry

One of the five basins in this watershed has been assessed as supporting aquatic recreation use: Mary (86-0193-00). Lakes in the Louzer Lake Outlet HUC-11 tend to be small and deep. The watershed is less intensively row cropped than upstream watersheds, and the lakes appear to have a forested buffer in most cases. It is recommended that the watershed be protected to maintain current TP levels and prevent further increases (Anderson 2010).

Table 56. Outlet water chemistry resultsfor Louzer Lake Watershed**

Station Location:	Louzers Lake Outlet at C.R. 25, 3.5 mi. E of Montrose
Storet ID:	S002-020
Station #:	07UM044

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	11	11	11	11	11	11	11	11	11	11	11
Minimum	37	3.67	9	0.025	0.025	7.42	0.109	6.4	415	1.69	15.27	10
Maximum	140	8.77	2400	0.44	0.3	9.18	0.534	91	1130	130	33.18	100
Mean[1]	62.18	6.03	230.17	0.16	0.10	8.35	0.28	21.76	648.09	30.99	21.42	60.09
Median	47	5.77	200	0.12	0.07	8.5	0.249	12	579	16.8	19.95	60
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	4	2			5						1
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Louzers Lake Outlet HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 57. Stream biological sampling for Louzer Lake Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-667, Woodland WMA wetland (86-0085-00) to N Fk Crow R	07UM044	NA		NS	NS	FS	FS	FS	FS	NS	NS	NS	NS

Abbreviations: **F-IBI** – Biological, Fish; **M-IBI** – Biological, Macroinvertebrates; **DO** – Dissolved Oxygen; **T** – Turbidity; **Cl** – Chloride; **pH** – pH; **NH3** – Unionized Ammonia; **Aq. Life** – Aquatic Life Use Assessment; **Aq. Rec.** – Aquatic Recreation Assessment

NA = Not Assessed; **IF** = Insufficient Information; **NS** = Non-Support; **FS** = Fully Support

Table 58. Biological sampling of channelized stream reaches for Louzer Lake Watershed

AUID	Biological Station ID	Biological Station Location	F-IBI Quality	M-IBI Quality
07010204-667, Unnamed creek, Woodland WMA wetland (86-0085-00) to N Fk Crow R	07UM044	Upstream of CR 25, 3.5 mi. E of Montrose	Poor	--

See Appendix 4.1 for clarification on the good/fair/poor thresholds and Appendix 4.2 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 59. Stream habitat results for Louzer Lake Watershed

Visits	Site ID	Stream 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	07UM035	Crow River, North Fork	2.5	10.5	10	16	20	59	Fair
Average Habitat Results: *Louzer Lake Outlet HUC-11 Watershed*			2.5	10.5	10	16	20	59	

Qualitative habitat ratings

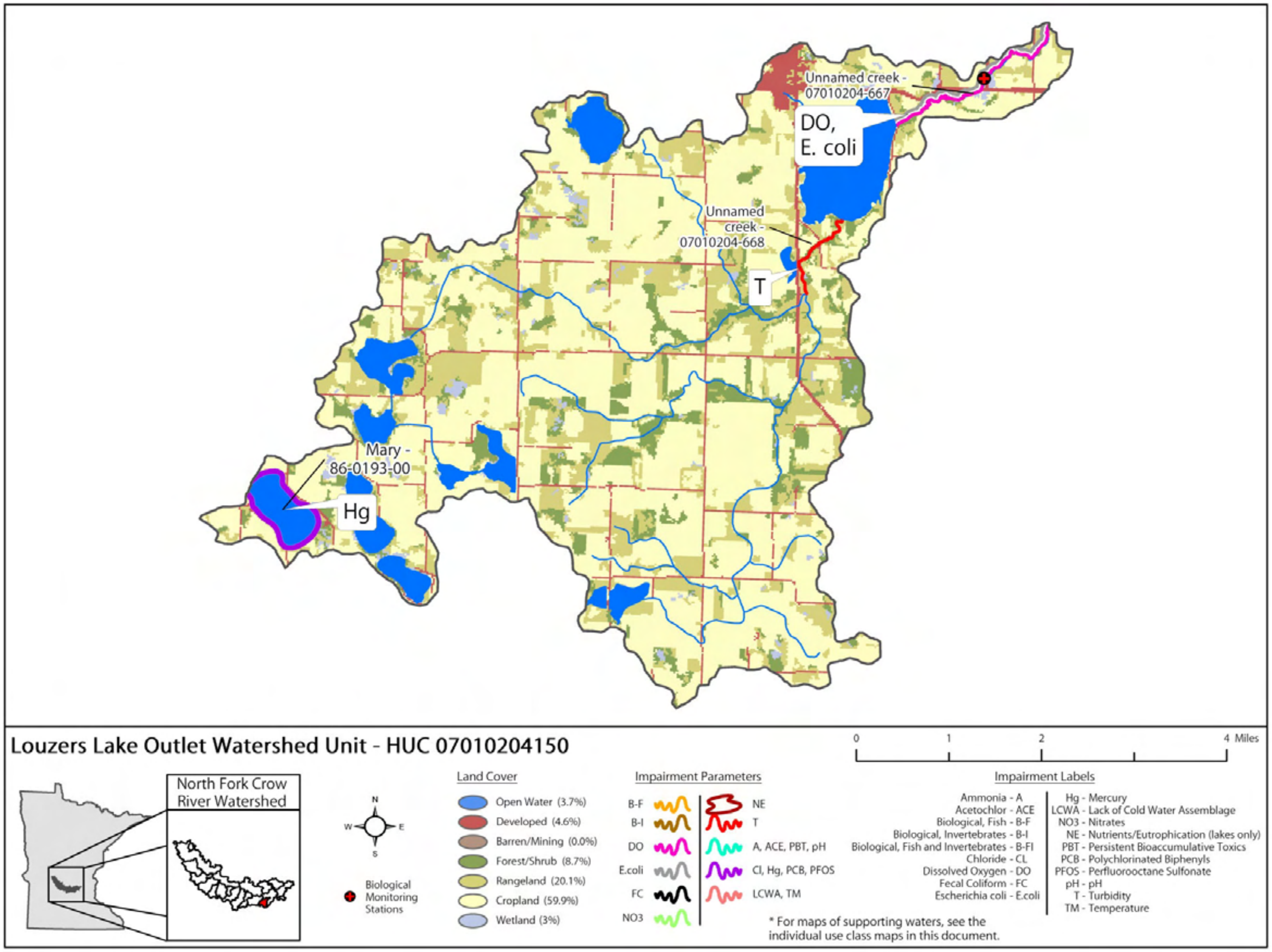
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Louzer Lake Watershed summary

One stream AUID was sampled for biology in this watershed, and this channelized reach scored poor. The water chemistry results point toward problems with dissolved oxygen and turbidity.

Lakes in the Louzers Lake Outlet HUC-11 tend to be small and deep. The watershed is less intensively row cropped than upstream watersheds, and the lakes appear to have a forested buffer in most cases. It is recommended that the watershed be protected to maintain current TP levels and prevent further increases (Anderson 2010).

Figure 23. Land use and currently listed impaired waters by parameter, in the Louzer Lake Outlet Watershed unit



Mill Creek Watershed unit HUC 07010204140

The Mill Creek Watershed unit is completely in Wright County and has a drainage area of 58.5 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 24). The headwaters of the watershed start in Maple Lake and flows south through Ramsey Lake, continuing east to Light Foot Lake, where it turns south to Buffalo Lake. Between Light Foot Lake and Buffalo Lake there is a 100 meter culvert that has a significant drop at the downstream end creating a fish barrier. Mill Creek exits Buffalo Lake on the south end of the lake and heads south to Deer Lake. From Deer Lake the stream meanders through wetland areas and heads southeast to the North Fork Crow River three miles south of the city of Buffalo. The outlet of the watershed unit is represented by a water chemistry only site where no biology was collected due to a defined channel through a wetland.

Stream water chemistry

The Mill Creek Watershed is made up of only one AUID for streams - Mill Creek from Ramsey Lake to Buffalo Lake. Only bacteriological data was available on this reach; it was determined to be supporting aquatic recreation use.

Lake water chemistry

Six of the seventeen basins in this watershed have been assessed for aquatic recreation use: Upper Maple (86-0134-01) and Pulaski (main bay) (86-0053-02) were assessed as supporting, and Buffalo (86-0090-00), Deer (86-0107-00), Ramsey (86-0120-00), and Light Foot (86-0122-00) as not supporting. The Mill Creek Watershed has a high percentage of forested land cover compared to upstream watersheds. The large, deeper lakes in the headwaters of the watershed are considered to be supporting aquatic recreation. However, the more downstream water bodies are impaired. The watershed would benefit from restorative practices to maintain or reduce TP loading in the watershed (Anderson 2010).

Table 60. Outlet water chemistry resultsfor Mill Creek Watershed**

Station Location:	Mill Creek at C.R. 12, 3 mi. S of Buffalo
Storet ID:	S002-018
Station #:	No Biological Data

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	11	11	11	11	11	11	11	11	11	11	11	11
Minimum	13	2.64	3	0.025	0.025	7.91	0.062	7.2	413	15.1	15.16	7
Maximum	43	10.03	2400	0.54	0.67	8.72	0.36	76	536	48.1	32.45	100
Mean[1]	26.73	6.52	66.57	0.11	0.22	8.33	0.16	36.29	480.27	30.72	23.20	31.73
Median	25	6.41	70	0.025	0.2	8.31	0.134	35	488	29.2	22.6	26
WQ standard[2]	230	5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	1			2						4
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Mill Creek HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 61. Stream biological sampling for Mill Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-524,Ramsey Lk to Buffalo Lk	07UM047	FS	FS									FS	NA
07010204-515, Buffalo Lk to N Fk Crow R				NS	NS	NS	FS	FS	FS	NS	NS	NS	NS

Abbreviations: **F-IBI** – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 62. Stream habitat results for Mill Creek Watershed

Visits	Site ID	Stream 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	07UM047	Mill Creek	5	12	10	11	15	53	Fair
		Average Habitat Results: *Mill Creek HUC-11 Watershed*	5	12	10	11	15	53	

Qualitative habitat ratings

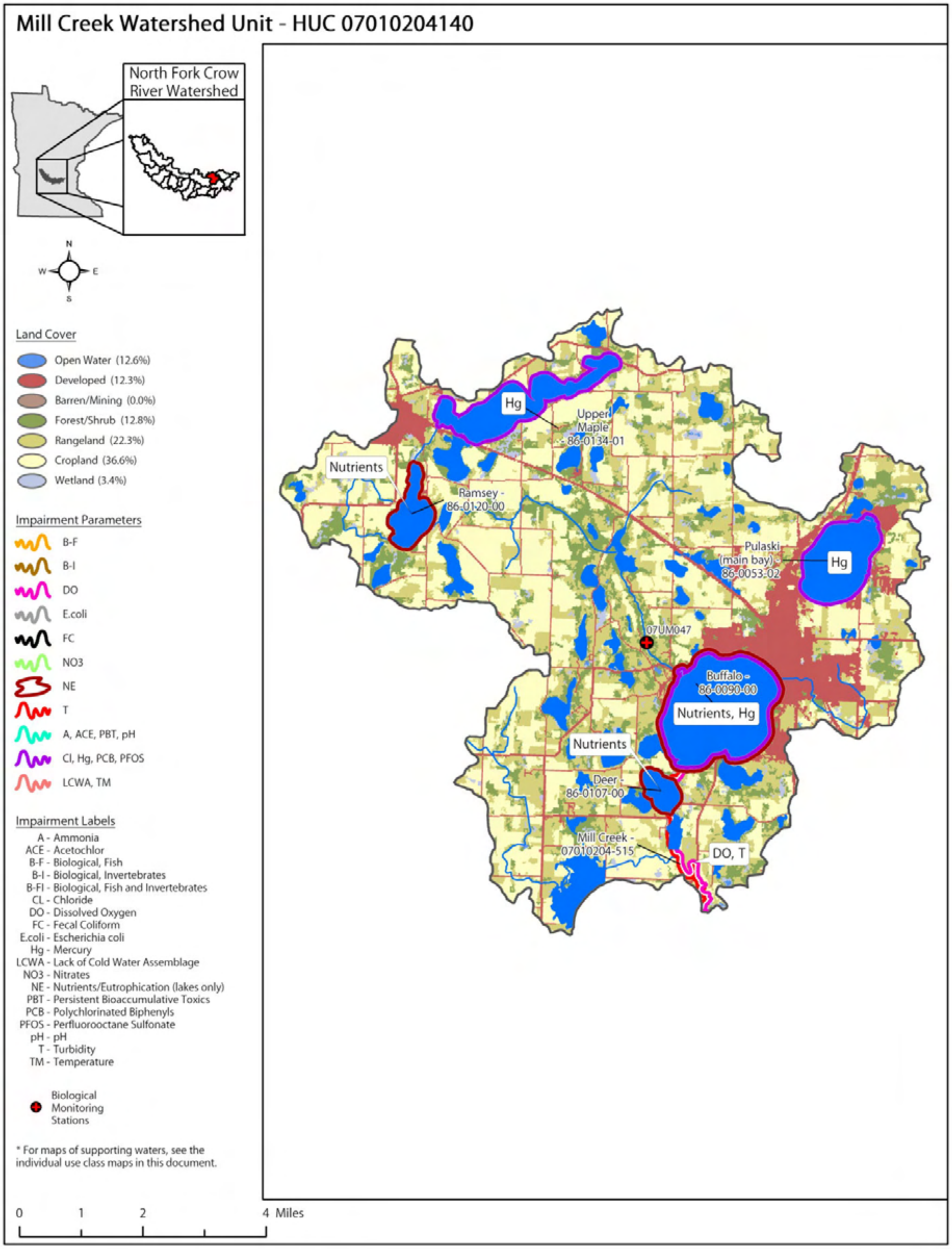
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Mill Creek Watershed summary

One AUID was sampled for biology in this watershed and was found to be supporting of aquatic life. This site had a fair habitat score, but below the site was a long culvert with a one meter drop which is likely acting as a fish barrier limiting upstream biological potential.

The Mill Creek Watershed has a high percentage of forested land cover compared to upstream watersheds. The large, deeper lakes in the headwaters of the watershed are considered to be supporting aquatic recreation. However, the more downstream water bodies are impaired. The watershed would benefit from restorative practices to maintain or reduce TP loading in the watershed (Anderson 2010).

Figure 24. Land use and currently listed impaired waters by parameter, in the Mill Creek Watershed unit



Sarah Creek Watershed unit HUC 07010204170

The Sarah Creek Watershed unit is completely in Hennepin County and has a drainage area of 8.6 square miles, which is the smallest watershed unit in the North Fork Crow River Watershed. The predominant land use is cropland with rangeland being the second most abundant (Figure 25). The headwaters of the watershed start in Loretto and flows west into Lake Sarah, where it continues west and enters the Crow River in Rockford. The outlet of the watershed unit is represented by site 07UM001.

Stream water chemistry

The Sarah Creek HUC-11 is split into 2 AUIDs – a small tributary to Sarah Lake, and Sarah Creek from the lake to the confluence with the Crow River. The tributary did not have enough data to determine use support; Sarah Creek had sufficient data to determine impairment for aquatic recreation use (bacteria). No determination of aquatic life use was made, due to limited available data.

Lake Water Chemistry

The Sarah Creek Watershed is quite small and is comprised of the two basins of Sarah Lake. As the basins exceed the lake eutrophication standards, restoration activities are planned as part of the TMDL currently underway for these basins (Anderson 2010).

Table 63. Stream biological sampling for Sarah Creek Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-628, Lk Sarah to Crow R	07UM001	NA				NS				NS		IF	NS

Abbreviations:

F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 64. Stream habitat results Sarah Creek Watershed

Visits	Site ID	Stream 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	07UM001	Sarah Creek	2.5	13.5	21	9	22	68	Good
Average Habitat Results: *Sarah Creek HUC-11 Watershed*			2.5	13.5	21	9	22	68	

Qualitative habitat ratings

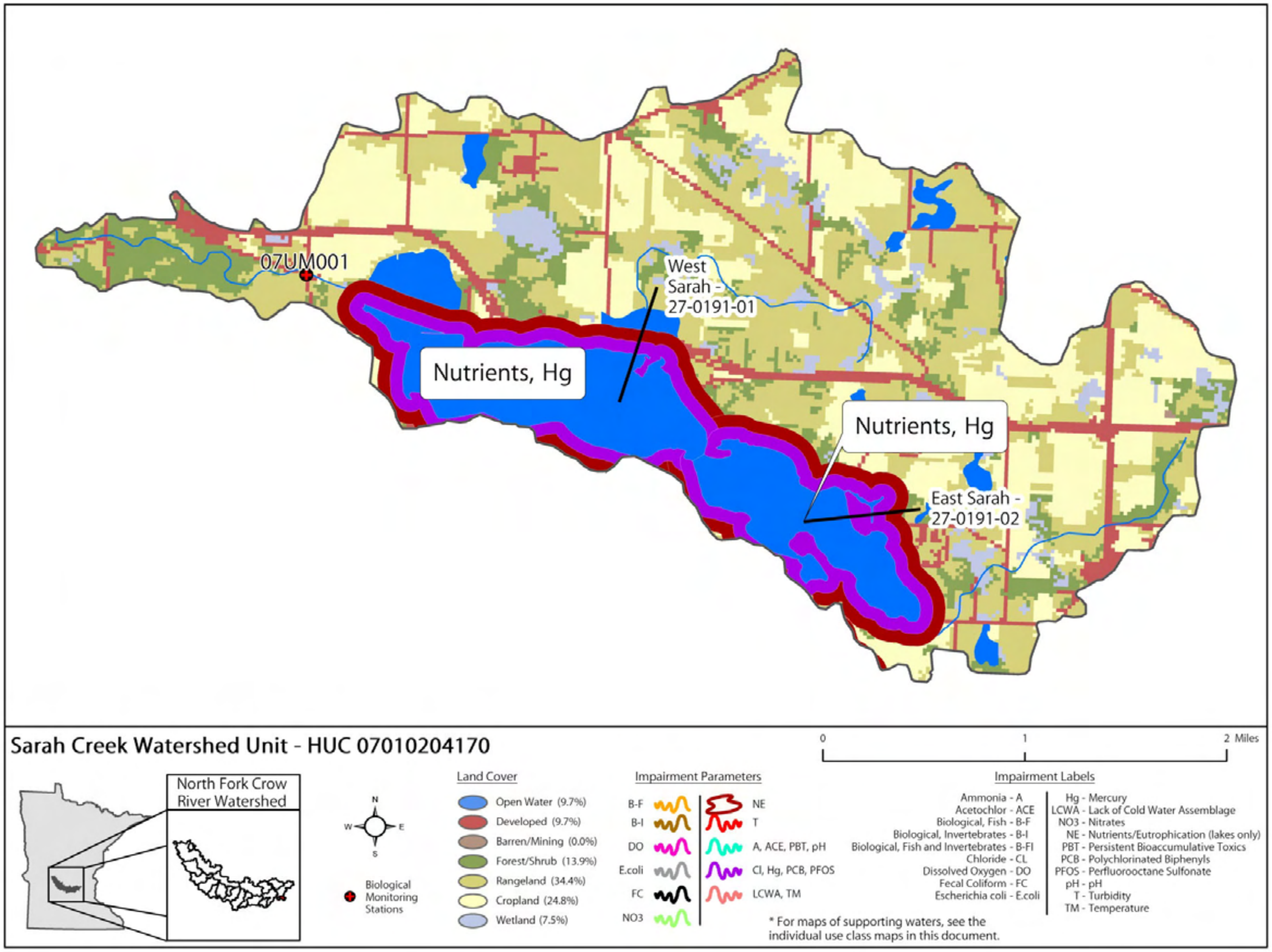
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Sarah Creek Watershed summary

Due to low flow, no fish or invertebrate data was assessed. Habitat is good at the site but with Lake Sarah , an impaired water body, being the headwaters a potential for water quality problems may exist.

Sarah Lake has an existing TMDL underway for exceeding the lake Eutrophication standards.

Figure 25. Land use and currently listed impaired waters by parameter, in the Sarah Creek Watershed unit



St. Michael Watershed unit HUC 07010204180

The St. Michael Watershed unit is completely in Wright County and has a drainage area of 53.4 square miles. The predominant land use is cropland with rangeland being the second most abundant (Figure 26). The watershed starts in a shallow lake wetland complex called Pelican Lake, and flows east into the city of St. Michael were it flows into the Crow River. There was not enough flow to sample fish or invertebrates.

Stream water chemistry

The St. Michael HUC-11 Watershed is comprised of only one AUID, Regal Creek. Only chemistry data was available for this AUID; existing impairments for aquatic life (dissolved oxygen) and aquatic recreation (bacteria) were found to still be valid. Local monitoring is ongoing to verify the aquatic life impairment based on dissolved oxygen.

Lake water chemistry

Three of the thirteen basins in the St. Michael HUC-11 Watershed have been assessed as not supporting aquatic recreation use: Beebe (86-0023-00), Pelican (86-0031-00), and Constance (86-0051-00).

Table 65. Outlet water chemistry resultsfor Saint Michael Watershed**

Station Location:	Unnamed Creek at C.R. 19, in St. Michael
Storet ID:	S002-030
Station #:	No Biological Data

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	10	9	10	10	10	9	10	10	10	10	10	10
Minimum	16	5.14	28	0.025	0.025	7.74	0.16	2.4	283	4.69	15.01	41
Maximum	41	7.97	2400	0.11	1.2	8.27	0.363	20	498	16.7	24.42	90
Mean[1]	30.20	6.82	317.78	0.06	0.30	8.03	0.28	8.36	404.90	10.11	19.56	57.70
Median	31.5	6.55	210	0.0525	0.205	8.05	0.278	6	423	10.34	18.785	60
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	2			0						0
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Unnamed Creek HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 66. Stream biological sampling for Saint Michael Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-542, Unnamed cr to Crow R				NS	NS	FS	FS	FS	FS	NS	NS	NS	NS

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

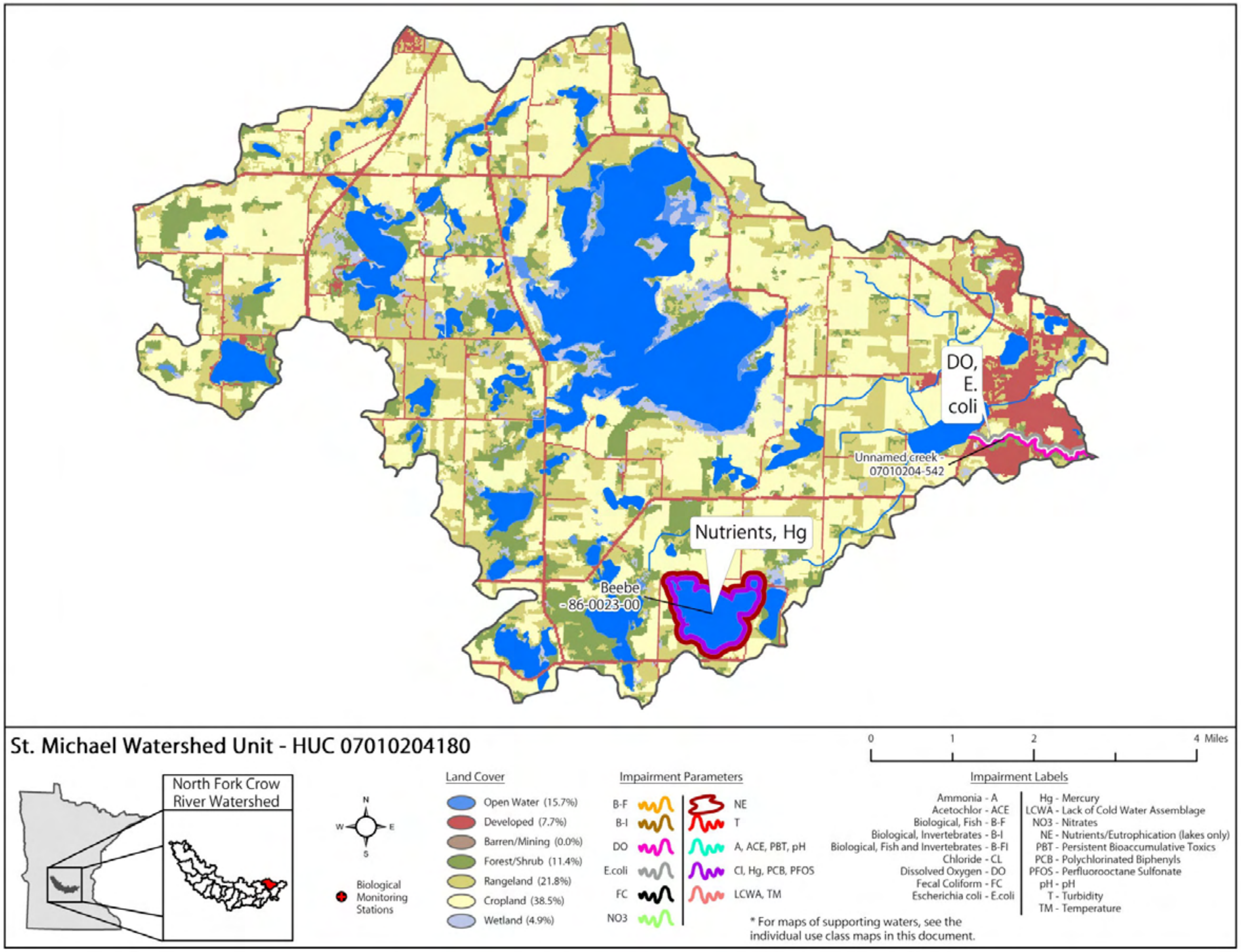
NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

St. Michael Watershed summary

No biological samples were taken in this watershed. There are existing dissolved oxygen and bacteria impairments that were found to still be valid. Three lakes have been sampled for aquatic recreation, and are not supporting this use.

Lakes in this watershed tend to be shallow. As such, they have limited abilities to assimilate TP loading. This watershed is less intensively managed for agriculture uses and is more forested than most of the other watersheds in the HUC-8. It is recommended that the watershed move towards restorative practices to reduce the TP loading to the lakes. It will also be important to address internal loading in the lakes-to-reach lake eutrophication standards (Anderson 2010).

Figure 26. Land use and currently listed impaired waters by parameter, in the St. Michael Watershed unit



Crow River Watershed unit HUC 07010204190

The Crow River Watershed unit, located in northeastern Wright County and northwestern Hennepin County, encompasses and area of 71.7 square miles. The watershed unit includes the Crow River from the confluence of the North Fork Crow and South Fork Crow Rivers in Rockford and continues northeast to the confluence with the Mississippi River near Rogers. The Crow River Watershed unit flows through a matrix of agricultural and pasture land from Rogers to St. Michael where land use changes to predominantly urban developed and includes the cities of St. Michael and Rogers (Figure 27).

Stream water chemistry

The Crow River HUC-11 consists of two AUIDs a small tributary to the Crow River with no chemistry data, and the 25 mile reach of the main stem Crow River from the confluence of the North and South Fork Crow Rivers to the Mississippi River. The Crow River is not supporting aquatic life uses (based on data for dissolved oxygen, turbidity, fish, and macroinvertebrates). The Crow River had an existing impairment for aquatic recreation use (fecal coliform). The reach was reviewed for delisting, but it was determined that while new data no longer indicate impairment, the bacteria data are very close to the threshold and the two immediate upstream reaches of the North and South Fork Crow Rivers both also have aquatic recreation use impairments based on bacteria. So the impairment desogmatopm should remain on the Crow River.

Lake water chemistry

Five of the twenty-one basins in the Crow River HUC-11 Watershed have been assessed for aquatic recreation use: Cowley (27-0169-00), Hafften (27-0199-00), and Foster (86-0001-00) are not supporting aquatic recreation and Martha (86-0009-00) and Charlotte (86-0011-00) are supporting. This watershed is one of the more urbanized watersheds in this HUC-8. Available data indicate that lakes in the headwaters regions are of the best quality; those further downstream are more eutrophic. Considering the increasing development of this watershed (conversion of agricultural and forested land use to urban), it is recommended that restorative practices be implemented to reduce TP loading to the lakes and prevent further water quality impacts (Anderson 2010).

Table 67. Outlet water chemistry resultsfor Crow River Watershed**

Station Location:	Crow River at C.R. 36, 4 mi. N of Rogers
Storet ID:	S004-433
Station #:	No Biological Data

Parameter	Chloride	D.O.	E. Coli	NH_3	$NO_2 + NO_3$	pH	TP	TSS	Spec. Cond.	Sulfate	Temp.	T-Tube
Units	mg/L	mg/L	#/100 ml	mg/L	mg/L		mg/L	mg/L	uS/cm	mg/L	C	cm
# Samples	10	10	10	10	10	10	10	10	10	10	10	10
Minimum	30	7.21	15	0.025	0.025	7.96	0.157	23	567	38.1	16.76	17
Maximum	71	11.28	410	0.025	3.2	8.91	0.379	55	807	63.9	28.86	28
Mean[1]	46.20	9.12	53.62	0.03	0.88	8.54	0.22	44.50	655.70	49.58	22.06	21.60
Median	45	8.735	42.5	0.025	0.375	8.525	0.215	47	645.5	51.25	20.44	21
WQ standard[2]	<230	>5	126/1260			6.5-8.5						20
# WQ exceedances[3]	0	0	0			7						3
NCHF 75th Percentile[4]			0.2	0.12		7.9	0.05	5.6		260	21.7	

[1]Geometric mean of all samples is provided for *E. coli*.
[2]Total suspended solids and transparency tube standards are surrogate standards derived from the turbidity standard of 25
[3]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

[4]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Crow River HUC, a component of the IWM work conducted in 2007 and 2008. This site specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 68. Stream biological sampling for Crow River Watershed

AUID	Bio Station ID	Fish IBI	Invert IBI	NO2&NO3	DO Final	Turbidity	Chloride	pH	Un-ionzed ammonia	E. coli	Phosphorus	Aquatic Life	Aquatic Recreation
07010204-502, S Fk Crow R to Mississippi R	00UM080 00UM081	NS	NS	NS	NS	NS	FS	FS	FS	NS	NS	NS	NS

Abbreviations:
F-IBI – Biological, Fish
M-IBI – Biological, Macroinvertebrates
DO – Dissolved Oxygen
T – Turbidity
Cl – Chloride
pH – pH
NH3 – Unionized Ammonia
Aq. Life – Aquatic Life Use Assessment
Aq. Rec. – Aquatic Recreation Assessment

NA = Not Assessed
FS = Fully Support
IF = Insufficient Information
NS = Non-Support

Table 69. Stream habitat results for Crow River Watershed

Visits	Site ID	Stream 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	00UM070	Trib. to Crow River	2.25	11	17.25	9	18	57.5	Fair
2	00UM080	Crow River	2.4	9.0	15.9	5.0	27.5	59.8	Fair
2	00UM081	Crow River	1	9.25	18.5	8.5	24.5	61.75	Fair
Average Habitat Results: *Crow River HUC-11 Watershed*			1.77	9.39	17.20	7.07	24.86	60.29	

Qualitative habitat ratings

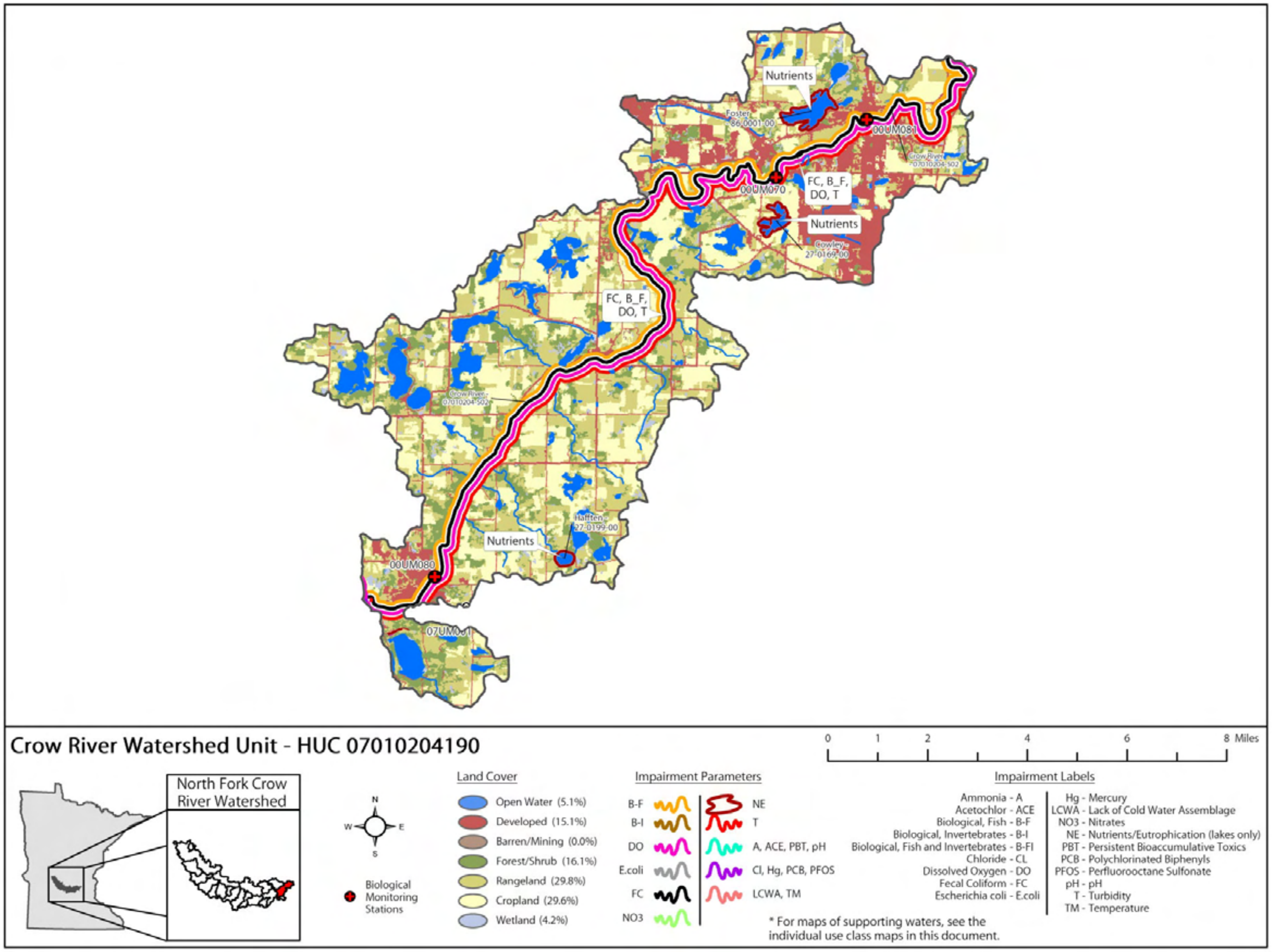
Good: MSHA score above the median of the least-disturbed sites (MSHA > 66)
Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
Poor: MSHA score below the median of the most-disturbed sites (MSHA < 45)

Crow River Watershed summary

One AUID in this watershed was sampled for biology and is not supporting of aquatic life. The main stem of the Crow River has an existing impairment for aquatic recreation (fecal coliform) and is listed for aquatic life (dissolved oxygen and turbidity). Habitat is fair through-out the watershed.

This watershed is one of the more urbanized watersheds in the HUC-8. Available data indicates that lakes in headwaters regions are of the best quality; those further downstream are more eutrophic. Considering the increasing development of this watershed (conversion of agricultural and forested land use to urban), it is recommended that restorative practices be implemented to reduce TP loading to the lakes and prevent further water quality impacts (Anderson 2010).

Figure 27. Land use and currently listed impaired waters by parameter, in the Crow River Watershed unit



VIII. Watershed wide results and discussion

Fish contaminants

Fish collection and analysis

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the North Fork Crow River in 1990, 2000, and 2007. The Crow River outlet site was also sampled in 2007 and is included in this report. Since 1990, mercury samples from fish were collected in 38 lakes within the North Fork Crow River Watershed. PCBs were tested in a smaller set of lakes. Fish were collected in rivers by the MPCA bio-monitoring unit and in lakes by the MDNR. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue. In 2009, fish were collected from Madison Lake and analyzed for perfluorochemicals (PFCs). The whole fish were shipped frozen and on dry ice to AXYS Analytical Laboratory for processing and analysis of the fish for PFCs.

Mercury

Descriptive statistics for fish total length and mercury concentrations are summarized by water-way and species in Table 70. Mercury data were available for 15 fish species in the North Fork Crow River Watershed. Median mercury concentrations in the river fish ranged from 0.20 to 0.33 mg/kg; in lakes, the median ranged from 0.01 to 0.56 mg/kg. As is typically seen in Minnesota lakes, walleye and northern pike had the highest mercury concentrations. The highest mercury concentration, 1.52 mg/kg, was in a walleye from Koronis Lake (73-0200-00). As a benchmark for the mercury concentrations, summary statistics are shown for years 2000 to 2008 from the Minnesota Fish Contaminant Program database (Table 71). Walleye and northern pike have very similar ranges of mercury concentrations, with the statewide mean mercury concentrations of 0.34 mg/kg and 0.36 mg/kg, respectively. Most of the high mercury concentrations in sport fish were from northern Minnesota lakes, because of the watershed and water chemistry characteristics of the northern waters.

The 2010 Impaired Water Inventory includes 35 of the 38 lakes in the watershed with mercury tissue data. Hafften Lake (27-0199-00) is one of the lakes not in the inventory; however, recent data indicates it is impaired due to mercury in fish tissue and it will be added to the 2012 inventory. The other two lakes not in the inventory, Manuella (47-0050-00) and Stella (47-0068-00), had samples of bluegill sunfish, largemouth bass, and black crappie that were not of sufficient sample sizes to make an impairment assessment. Their maximum mercury concentrations suggest they would not be impaired due to mercury. Eighteen of the 38 impaired waterways (includes North Fork Crow River and Crow River outlet) have at least one fish species that has a 90th percentile mercury concentration that falls within 0.2 to 0.57 mg/kg, which qualifies for inclusion in the Minnesota Statewide Mercury TMDL (http://www.pca.state.mn.us/water/tmdl/tmdl-mercuryplan.html). Therefore, these 18 lakes have a completed TMDL. The other 20 impaired lakes have higher 90th percentiles and, therefore, a TMDL is still required. In Table 1, they are identified as impairment Category 4 and Category 5, respectively.

The goal for the statewide mercury TMDL is for the 90th percentile of mercury concentrations in top predator species to be less than 0.2 mg/kg. Implementation of the mercury TMDL is focused primarily on reducing mercury emissions to the atmosphere, because wastewater point source discharges are less than one percent of the total mercury load to the state.

Polychlorinated Biphenyls (PCBs)

Fish were tested for PCBs in the North Fork Crow River in 1990, 2000, and 2007 (Table 72a). None of the PCBs concentrations exceeded the laboratory reporting limit of 0.01 mg/kg. In 2007, only the largest carp (24 inches) was analyzed for PCBs, because the highest concentrations are found in the larger fish. If the PCB concentrations had been high, follow-up testing would have included small fish. In PCB-contaminated rivers, bottom-feeders such as carp typically have the highest concentrations of PCBs.

Thirty-four of the lakes in the North Fork Crow Watershed were tested for PCBs (Table 72b). All but two of the lakes had concentrations of PCBs near or below the reporting limit. Pulaski Lake (86-0053-00) had a single composite sample of eight white suckers with a concentration of 0.12 mg/kg and five composite samples of walleye that ranged from 0.01 to 0.1 mg/kg, collected in 1993. Waverly Lake (86-0114-00) had a single 30-inch carp with a concentration of 0.14 mg/kg, collected in 2004. Neither the river nor the lakes exceeded the impairment threshold for PCBs in fish tissue.

Perfluorochemicals (PFCs)

Perfluorochemicals (PFCs) emerged as a global pollutant in 2001 when scientists reported perfluorooctane sulfonate (PFOS) was measured in wildlife throughout the world. Numerous studies have demonstrated that PFOS is the primary form of PFCs found in fish and other biota. The Minnesota Department of Health (MDH) has developed a reference dose for PFOS that allows for calculation of fish consumption advisories. More recently, lakes and rivers throughout Minnesota have been analyzed for PFCs in fish.

Fish from nine lakes in the North Fork Crow Watershed were tested for PFCs in 2007 and 2008 (Table 73). PFOS was determined to be less than the laboratory reporting limit (one–five µg/kg) for all samples except two fish species in Lake Sarah (27-0191-01). In five northern pike, analyzed separately, the PFOS concentrations ranged from 7 to 14 µg/kg. In three out of 10 bluegill sunfish samples from Lake Sarah, PFOS concentrations were six to nine µg/kg (the others were less than the reporting limit of five µg/kg). The mean PFOS concentrations for a species must exceed 200 µg/kg to be classified as impaired for PFOS in fish tissue.

Table 70. Descriptive statistics of mercury concentrations by waterway and species

Class 4	Class 5	Waterway	Lake ID	Species	N	Length (in) Min	Length (in) Max	Length (in) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Median	Mercury (mg/kg) 90 Pctl
I		North Fork Crow River		Carp	13	15.4	23.8	19.0	0.118	0.383	0.262	0.260	0.355
				Channel Catfish	9	12.2	23.4	17.3	0.120	0.420	0.233	0.210	0.404
				Northern Pike	1	18.2	18.2	18.2	NA	NA	0.200	NA	NA
				Smallmouth Bass	5	9.3	15.5	11.3	0.210	0.550	0.302	0.240	0.450
				Walleye	13	11.9	20.3	15.2	0.159	0.664	0.297	0.273	0.385
I		Crow River Outlet		Carp	8	14.9	26.1	20.7	0.073	0.357	0.208	0.204	0.334
				Smallmouth Bass	6	12.0	17.2	14.4	0.150	0.640	0.347	0.334	0.555
I		West Sarah and	27-0191-01	Bluegill sunfish	1	7.1	7.1	7.1	0.091	0.091	0.091	0.091	NA
		East Sarah	27-0191-02	Black crappie	1	7.7	7.7	7.7	0.063	0.063	0.063	0.063	NA
				Carp	3	18.8	28.2	24.1	0.026	0.076	0.059	0.075	0.076
				Northern pike	5	19.4	32.3	25.8	0.120	0.470	0.274	0.270	0.470
				Yellow bullhead	1	14.4	14.4	14.4	0.068	0.068	0.068	0.068	NA
	I	Hafften	27-0199-00	Bluegill sunfish	1	6.6	6.6	6.6	0.190	0.190	0.190	0.190	NA
		Assigned to 2012		Black crappie	1	7.8	7.8	7.8	0.160	0.160	0.160	0.160	NA
		Impaired list		Black bullhead	1	12.7	12.7	12.7	0.178	0.178	0.178	0.178	NA
				Northern pike	5	20.3	32.8	25.9	0.236	0.691	0.465	0.418	0.691
	I	Diamond	34-0044-00	Bluegill sunfish	1	6.8	6.8	6.8	0.033	0.033	0.033	0.033	NA
				Carp	3	15.1	23.8	20.3	0.017	0.074	0.047	0.050	0.074
				Northern pike	72	15.9	32.8	22.9	0.037	0.491	0.131	0.121	0.205
				Walleye	6	7.9	26.9	18.1	0.070	0.680	0.266	0.223	0.643
				Yellow perch	14	4.7	7.2	5.5	0.011	0.035	0.018	0.016	0.031
I		Calhoun	34-0062-00	Bluegill sunfish	1	5.8	5.8	5.8	0.134	0.134	0.134	0.134	NA
				Black bullhead	1	9.0	9.0	9.0	0.175	0.175	0.175	0.175	NA
				Black crappie	1	7.7	7.7	7.7	0.198	0.198	0.198	0.198	NA
				Carp	1	24.3	24.3	24.3	0.201	0.201	0.201	0.201	NA
				Northern pike	6	20.5	27.8	25.2	0.259	0.415	0.326	0.325	0.408
I		Long	34-0066-00	Northern pike	67	17.2	33.6	21.3	0.060	0.939	0.286	0.220	0.565
				Rock bass	1	8.7	8.7	8.7	0.180	0.180	0.180	0.180	NA
				Smallmouth bass	1	11.4	11.4	11.4	0.010	0.010	0.010	0.010	NA

Class		Waterway	Lake ID	Species	N	Length (in)			Mercury (mg/kg)				
4	5					Min	Max	Mean	Min	Max	Mean	Median	90 Pctl
				Walleye	6	12.8	22.3	17.4	0.200	0.610	0.412	0.445	0.602
				White sucker	2	18.2	20.2	19.2	0.040	0.110	0.075	0.075	0.110
				Yellow perch	14	5.1	7.0	5.5	0.040	0.178	0.081	0.060	0.153
I		George	34-0142-00	Northern pike	79	14.1	34.3	21.7	0.055	1.031	0.294	0.251	0.534
				Walleye	5	16.8	18.7	17.5	0.345	0.464	0.386	0.355	0.464
				Yellow perch	16	5.5	9.8	6.7	0.050	0.258	0.101	0.085	0.130
	I	Nest	34-0154-00	Bluegill sunfish	1	6.4	6.4	6.4	0.120	0.120	0.120	0.120	NA
				Carp	2	21.5	28.9	25.2	0.089	0.250	0.170	0.170	0.250
				Channel catfish	1	23.7	23.7	23.7	0.180	0.180	0.180	0.180	NA
				Northern pike	3	18.5	26.3	22.6	0.310	0.450	0.400	0.440	0.450
				Walleye	3	13.5	22.7	17.8	0.320	0.650	0.480	0.470	0.650
	I	Monongalia	34-0158-00	Bluegill sunfish	1	6.7	6.7	6.7	0.103	0.103	0.103	0.103	NA
				Carp	1	25.9	25.9	25.9	0.047	0.047	0.047	0.047	NA
				Northern pike	6	19.0	30.3	24.2	0.317	0.970	0.565	0.501	0.946
I		Hook	43-0073-00	Northern pike	48	16.4	39.4	23.7	0.060	0.480	0.178	0.171	0.297
I		Francis	47-0002-00	Bluegill sunfish	1	6.4	6.4	6.4	0.070	0.070	0.070	0.070	NA
				Northern pike	6	13.9	30.3	20.6	0.110	0.360	0.227	0.240	0.353
				Yellow bullhead	1	10.5	10.5	10.5	0.140	0.140	0.140	0.140	NA
	I	Jennie	47-0015-00	Bluegill sunfish	2	5.7	7.4	6.6	0.015	0.040	0.028	0.028	0.040
				Carp	4	14.3	24.0	18.6	0.015	0.071	0.038	0.033	0.071
				Largemouth bass	2	8.6	13.5	11.1	0.029	0.040	0.035	0.035	0.040
				Northern pike	19	16.2	29.8	22.1	0.035	0.396	0.126	0.074	0.322
				Walleye	5	12.4	27.9	19.7	0.066	0.610	0.289	0.140	0.610
				Yellow perch	2	5.7	6.8	6.3	0.017	0.028	0.023	0.023	0.028
I		Long	47-0026-00	Bluegill sunfish	1	6.5	6.5	6.5	0.039	0.039	0.039	0.039	NA
				Carp	2	20.2	22.8	21.5	0.026	0.028	0.027	0.027	0.028
				Walleye	3	11.3	20.9	17.0	0.069	0.410	0.253	0.280	0.410
I		Spring	47-0032-00	Bluegill sunfish	1	6.7	6.7	6.7	0.110	0.110	0.110	0.110	NA
				Carp	2	17.8	22.9	20.4	0.094	0.180	0.137	0.137	0.180
				Northern pike	5	17.9	31.5	24.6	0.140	0.440	0.298	0.340	0.440

Class						Length (in)			Mercury (mg/kg)				
4	5	Waterway	Lake ID	Species	N	Min	Max	Mean	Min	Max	Mean	Median	90 Pctl
	I	Big Swan	47-0038-00	Black crappie	1	8.6	8.6	8.6	0.163	0.163	0.163	0.163	NA
				Carp	1	24.8	24.8	24.8	0.202	0.202	0.202	0.202	NA
				Channel catfish	5	15.1	25.2	20.6	0.102	0.248	0.180	0.167	0.248
				Northern pike	5	21.5	29.1	25.0	0.139	0.212	0.179	0.180	0.212
				Walleye	5	15.3	22.2	18.4	0.102	0.585	0.264	0.152	0.585
I		Washington	47-0046-00	Bluegill sunfish	1	6.9	6.9	6.9	0.038	0.038	0.038	0.038	NA
				Black crappie	2	9.5	10.2	9.9	0.054	0.059	0.057	0.057	0.059
				Carp	4	20.5	32.0	26.1	0.015	0.064	0.047	0.055	0.064
				Largemouth bass	5	11.7	18.3	14.5	0.073	0.420	0.190	0.090	0.420
				Smallmouth bass	1	14.6	14.6	14.6	0.165	0.165	0.165	0.165	NA
				Walleye	5	12.0	23.0	17.4	0.074	0.400	0.257	0.340	0.400
		Manuella*	47-0050-00	Bluegill sunfish	1	6.3	6.3	6.3	0.040	0.040	0.040	0.040	NA
				Largemouth bass	1	15.3	15.3	15.3	0.196	0.196	0.196	0.196	NA
		Stella*	47-0068-00	Bluegill sunfish	1	6.9	6.9	6.9	0.101	0.101	0.101	0.101	NA
				Black crappie	1	9.6	9.6	9.6	0.092	0.092	0.092	0.092	NA
				Largemouth bass	2	9.7	10.0	9.9	0.134	0.140	0.137	0.137	0.140
I		Dunns	47-0082-00	Black crappie	3	7.4	10.5	8.5	0.029	0.250	0.140	0.142	0.250
				Carp	3	19.8	25.5	22.7	0.060	0.130	0.103	0.120	0.130
				Largemouth bass	3	9.1	16.7	12.5	0.100	0.340	0.183	0.110	0.340
				Northern pike	29	13.3	34.0	22.3	0.093	0.377	0.187	0.160	0.317
				Walleye	1	11.8	11.8	11.8	0.040	0.040	0.040	0.040	NA
				Yellow perch	12	5.6	6.8	6.3	0.023	0.150	0.078	0.080	0.122
I		Richardson	47-0088-00	Bluegill sunfish	1	6.5	6.5	6.5	0.063	0.063	0.063	0.063	NA
				Black crappie	2	6.8	7.7	7.3	0.033	0.100	0.067	0.067	0.100
				Carp	7	14.2	24.5	19.6	0.030	0.230	0.127	0.140	0.216
				Largemouth bass	3	12.5	19.3	16.2	0.270	0.500	0.407	0.450	0.500
				Northern pike	43	12.9	31.3	21.9	0.078	0.680	0.227	0.169	0.420
				Walleye	6	17.0	18.4	17.6	0.102	0.480	0.175	0.116	0.444
				Yellow perch	14	5.2	8.5	7.2	0.015	0.270	0.156	0.170	0.252

Class						Length (in)			Mercury (mg/kg)				
4	5	Waterway	Lake ID	Species	N	Min	Max	Mean	Min	Max	Mean	Median	90 Pctl
I		Minnie-Belle	47-0119-00	Bluegill sunfish	2	6.4	6.7	6.6	0.042	0.081	0.062	0.062	0.081
				Largemouth bass	5	10.8	11.5	11.3	0.281	0.426	0.341	0.337	0.426
				Walleye	2	12.3	18.7	15.5	0.120	0.460	0.290	0.290	0.460
				Yellow bullhead	1	12.9	12.9	12.9	0.280	0.280	0.280	0.280	NA
I		Grove	61-0023-00	Bluegill sunfish	1	6.1	6.1	6.1	0.092	0.092	0.092	0.092	NA
				Black bullhead	1	12.9	12.9	12.9	0.073	0.073	0.073	0.073	NA
				Brown bullhead	1	12.6	12.6	12.6	0.020	0.020	0.020	0.020	NA
				Carp	1	25.0	25.0	25.0	0.190	0.190	0.190	0.190	NA
				Northern pike	98	9.8	27.5	19.8	0.114	0.627	0.263	0.247	0.395
				Yellow bullhead	2	10.8	12.3	11.6	0.196	0.230	0.213	0.213	0.230
				Yellow perch	11	2.0	6.0	3.3	0.029	0.110	0.048	0.038	0.078
	I	Rice	73-0196-00	Black crappie	1	8.4	8.4	8.4	0.064	0.064	0.064	0.064	NA
				Carp	4	13.4	26.9	20.2	0.060	0.570	0.228	0.140	0.570
				Channel catfish	1	19.4	19.4	19.4	0.240	0.240	0.240	0.240	NA
				Northern pike	3	18.2	28.5	23.0	0.160	0.260	0.210	0.210	0.260
				Walleye	3	12.1	20.6	16.5	0.160	0.460	0.290	0.250	0.460
	I	Koronis (main lake)	73-0200-02	Bluegill sunfish	2	6.0	6.0	6.0	0.096	0.117	0.107	0.107	0.117
				Black bullhead	1	8.3	8.3	8.3	0.130	0.130	0.130	0.130	NA
				Carp	3	23.5	30.5	27.3	0.130	0.210	0.160	0.140	0.210
				Northern pike	10	18.3	37.1	26.1	0.170	0.859	0.452	0.305	0.840
				Shorthead redhorse	1	16.0	16.0	16.0	0.057	0.057	0.057	0.057	NA
				Walleye	9	10.5	28.5	18.8	0.130	1.520	0.674	0.503	1.337
				White sucker	2	17.8	18.0	17.9	0.129	0.140	0.135	0.135	0.140
				Yellow perch	1	8.4	8.4	8.4	0.169	0.169	0.169	0.169	NA
	I	Beebe	86-0023-00	Bluegill sunfish	1	6.8	6.8	6.8	0.040	0.040	0.040	0.040	NA
				Walleye	7	13.1	26.3	21.2	0.090	0.660	0.406	0.500	0.642
				Yellow bullhead	1	11.0	11.0	11.0	0.090	0.090	0.090	0.090	NA
	I	Pulaski (main bay)	86-0053-02	Bluegill sunfish	1	6.2	6.2	6.2	0.077	0.077	0.077	0.077	NA
				Walleye	5	14.2	26.4	20.4	0.150	0.650	0.344	0.340	0.650
				White sucker	1	19.3	19.3	19.3	0.100	0.100	0.100	0.100	NA

Class						Length (in)			Mercury (mg/kg)				
4	5	Waterway	Lake ID	Species	N	Min	Max	Mean	Min	Max	Mean	Median	90 Pctl
	I	Buffalo	86-0090-00	Carp	3	17.1	25.3	21.5	0.037	0.062	0.053	0.059	0.062
				Channel catfish	10	16.6	28.8	22.1	0.160	0.890	0.328	0.249	0.686
				Walleye	3	14.6	23.4	18.8	0.082	0.540	0.301	0.280	0.540
				Yellow perch	1	8.7	8.7	8.7	0.035	0.035	0.035	0.035	NA
	I	Waverly	86-0114-00	Bluegill sunfish	1	6.9	6.9	6.9	0.173	0.173	0.173	0.173	NA
				Black crappie	1	7.7	7.7	7.7	0.123	0.123	0.123	0.123	NA
				Carp	2	20.3	30.0	25.2	0.141	0.144	0.143	0.143	0.144
				Northern pike	5	20.7	27.8	24.8	0.206	0.482	0.354	0.379	0.482
				Walleye	5	13.5	23.0	18.5	0.253	0.774	0.531	0.557	0.774
I		Upper Maple	86-0134-01	Bluegill sunfish	1	6.9	6.9	6.9	0.070	0.070	0.070	0.070	NA
				Carp	1	29.0	29.0	29.0	0.057	0.057	0.057	0.057	NA
				Northern pike	9	15.0	23.4	18.7	0.150	0.260	0.207	0.200	0.252
	I	Ann	86-0190-00	Black crappie	2	9.2	10.8	10.0	0.090	0.398	0.244	0.244	0.398
				Carp	1	23.1	23.1	23.1	0.120	0.120	0.120	0.120	NA
				Northern pike	6	18.1	23.4	20.8	0.221	0.763	0.329	0.249	0.713
				Walleye	4	15.2	24.8	18.9	0.160	0.570	0.285	0.205	0.570
I		Mary	86-0193-00	Black crappie	1	8.6	8.6	8.6	0.032	0.032	0.032	0.032	NA
				Northern pike	6	21.1	27.1	24.3	0.155	0.271	0.216	0.225	0.269
				Yellow bullhead	1	12.7	12.7	12.7	0.175	0.175	0.175	0.175	NA
	I	Howard	86-0199-00	Black crappie	1	9.3	9.3	9.3	0.097	0.097	0.097	0.097	NA
				Northern pike	4	19.0	28.3	23.5	0.140	0.250	0.185	0.175	0.250
				Walleye	3	18.7	25.0	21.6	0.240	0.580	0.373	0.300	0.580
I		Granite	86-0217-00	Black crappie	1	7.6	7.6	7.6	0.030	0.030	0.030	0.030	NA
				Northern pike	7	15.1	29.5	21.3	0.070	0.230	0.126	0.090	0.220
				Walleye	2	20.7	23.3	22.0	0.200	0.340	0.270	0.270	0.340
	I	French	86-0273-00	Bluegill sunfish	1	7.2	7.2	7.2	0.110	0.110	0.110	0.110	NA
				Black crappie	1	8.0	8.0	8.0	0.130	0.130	0.130	0.130	NA
				Carp	3	19.2	28.2	23.1	0.020	0.120	0.056	0.029	0.120
				Northern pike	4	16.5	30.5	24.2	0.095	0.440	0.281	0.295	0.440
				Walleye	4	14.0	26.8	19.7	0.140	0.590	0.358	0.350	0.590

Class						Length (in)			Mercury (mg/kg)				
4	5	Waterway	Lake ID	Species	N	Min	Max	Mean	Min	Max	Mean	Median	90 Pctl
	I	West Lake Sylvia	86-0279-00	Bluegill sunfish	1	6.9	6.9	6.9	0.100	0.100	0.100	0.100	NA
				Northern pike	4	17.4	30.2	23.9	0.310	0.720	0.440	0.365	0.720
				Walleye	3	12.8	22.1	16.9	0.270	0.600	0.390	0.300	0.600
I		John	86-0288-00	Bluegill sunfish	1	6.7	6.7	6.7	0.110	0.110	0.110	0.110	NA
				Northern pike	1	26.8	26.8	26.8	0.290	0.290	0.290	0.290	NA
				Walleye	4	14.7	23.8	19.3	0.270	0.540	0.350	0.295	0.540
				Yellow bullhead	1	12.8	12.8	12.8	0.180	0.180	0.180	0.180	NA
I		East Lake Sylvia	86-0289-00	Bluegill sunfish	1	6.7	6.7	6.7	0.120	0.120	0.120	0.120	NA
				Carp	1	20.8	20.8	20.8	0.034	0.034	0.034	0.034	NA
				Largemouth bass	1	12.6	12.6	12.6	0.460	0.460	0.460	0.460	NA
				Northern pike	3	18.2	28.2	22.9	0.340	0.460	0.410	0.430	0.460
				Walleye	3	13.4	22.3	17.2	0.320	0.510	0.400	0.370	0.510
	I	Collinwood	86-0293-00	Bluegill sunfish	1	6.7	6.7	6.7	0.022	0.022	0.022	0.022	NA
				Carp	3	2.3	18.9	10.6	0.039	0.170	0.101	0.094	0.170
				Largemouth bass	5	10.0	18.2	13.1	0.038	0.583	0.251	0.045	0.583
				Walleye	4	11.1	25.8	18.9	0.300	0.530	0.420	0.425	0.530
				Yellow perch	1	9.0	9.0	9.0	0.160	0.160	0.160	0.160	NA

I – Impaired: Class 4 (qualified for inclusion in Statewide Mercury TMDL); Class 5 (303(d) list – requires TMDL)

*Not Impaired or insufficient sample size

NA - not available

Note: some of the species with N = 1 are composites of multiple fish in one sample, but 90th percentiles cannot be calculated

Table 71. Mercury concentrations of ten most abundant species in the Minnesota fish contaminant database from 2000-2008, sorted from highest to lowest mercury concentration

Species		Mercury Concentration (mg/kg - ww)						Total Fish Length (in)		
Common Name	Scientific Name	N	90th pctl	Min	Max	Mean		Min	Max	Mean
Walleye	*Sander vitreus*	2525	0.72	0.02	2.63	0.34		6.8	29.7	17.1
Northern Pike	*Esox lucius*	5293	0.71	0.01	2.95	0.36		7.5	45.5	22.2
Channel Catfish	*Ictalurus punctatus*	325	0.53	0.01	1.19	0.22		10	36	19.9
Smallmouth Bass	*Micropterus dolomieu*	528	0.46	0.02	1.24	0.25		1.2	20.3	12.9
Largemouth Bass	*Micropterus salmoides*	518	0.41	0.01	1.39	0.22		5.3	18.9	12.9
Common Carp	*Cyprinus carpio carpio*	359	0.31	0.01	0.70	0.16		4.5	35.9	21.8
Black Crappie	*Pomoxis nigromaculatus*	278	0.26	0.01	0.62	0.12		4.0	16.1	8.7
White Sucker	*Catostomus commersonii*	161	0.26	0.01	0.53	0.12		4.4	21.1	16.0
Yellow Perch	*Perca flavescens*	596	0.20	0.01	0.84	0.10		1.5	12.6	7.0
Bluegill Sunfish	*Lepomis macrochirus*	353	0.17	0.01	0.40	0.09		2.6	9.6	6.9

Table 72. Summary of total PCBs concentrations by waterway and species: (a) North Fork Crow River and (b) North Fork Crow River Watershed lakes

a. Crow River

WATERWAY	LOCATION	SPEC	Year	N	PCBs (mg/kg)
CROW R., N FORK	DAYTON TO HIGHLAND, WRIGHT CO.	Carp	2000	5	< 0.01
		Channel catfish	2000	4	< 0.01
		Smallmouth bass	2000	2	< 0.01
		Walleye	2000	2	< 0.01
	RM 112.5-113, NEAR HWY 22	Carp	1990	2	< 0.01
		Channel catfish	1990	1	< 0.01
		Northern Pike	1990	2	< 0.01
		Walleye	1990	1	< 0.01
	2.5 MI W OF ROCKFORD	Carp	2007	1	< 0.01

b. Lakes

				PCBs (mg/kg)	
Lake ID	Lake Name	Species	N	Max	Mean
27-0191-00	Sarah	Carp	1	< 0.01	< 0.01
		Northern pike	1	< 0.01	< 0.01
34-0044-00	Diamond	Northern pike	4	< 0.01	< 0.01
		Walleye	1	< 0.01	< 0.01
34-0062-00	Calhoun	Carp	1	< 0.01	< 0.01
34-0066-00	Long	Northern pike	2	< 0.01	< 0.01
34-0079-00	Green	Carp	2	0.04	0.02
		Northern pike	3	0.03	0.02
		Walleye	2	0.03	0.02
		White sucker	1	0.02	0.02
34-0142-00	George	Northern pike	1	< 0.01	< 0.01

b. Lakes			PCBs (mg/kg)		
Lake ID	Lake Name	Species	N	Max	Mean
34-0154-00	Nest	Carp	2	0.06	0.03
		Channel catfish	1	< 0.01	< 0.01
		Northern pike	1	0.01	0.01
		Walleye	1	< 0.01	< 0.01
34-0158-01	Mud	Carp	1	< 0.01	< 0.01
47-0002-00	Francis	Northern pike	1	< 0.01	< 0.01
47-0015-00	Jennie	Carp	1	< 0.01	< 0.01
		Walleye	1	< 0.01	< 0.01
47-0026-00	Long	Carp	1	< 0.01	< 0.01
47-0032-00	Spring	Carp	1	0.02	0.02
47-0038-00	Big Swan	Carp	1	< 0.01	< 0.01
		Channel catfish	2	< 0.01	< 0.01
47-0046-00	Washington	Carp	1	0.02	0.02
		Walleye	1	< 0.01	< 0.01
47-0082-00	Dunns	Carp	1	0.02	0.02
		Largemouth bass	1	< 0.01	< 0.01
		Northern pike	1	< 0.01	< 0.01
47-0088-00	Richardson	Bluegill sunfish	1	< 0.01	< 0.01
		Carp	4	0.02	0.01
		Largemouth bass	2	< 0.01	< 0.01
		Northern pike	1	< 0.01	< 0.01
		Walleye	1	< 0.01	< 0.01
47-0119-00	Minnie-Belle	Walleye	1	0.02	0.02
61-0023-00	Grove	Black bullhead	1	< 0.01	< 0.01
		Carp	1	< 0.01	< 0.01
		Northern pike	3	< 0.01	< 0.01
73-0196-00	Rice	Carp	2	< 0.01	< 0.01
		Channel catfish	1	0.03	0.03
		Northern pike	1	< 0.01	< 0.01
		Walleye	1	< 0.01	< 0.01
73-0200-01	Koronis	Bluegill sunfish	1	< 0.01	< 0.01
		Black bullhead	1	< 0.01	< 0.01
		Carp	3	0.03	0.02
		Northern pike	4	< 0.01	< 0.01
		Shorthead redhorse	1	< 0.01	< 0.01
		Walleye	3	< 0.01	< 0.01
		White sucker	1	< 0.01	< 0.01
86-0023-00	Beebe	Walleye	1	< 0.01	< 0.01
86-0053-02	Pulaski (main bay)	Bluegill sunfish	1	< 0.01	< 0.01
		Walleye	5	0.10	0.06
		White sucker	1	0.12	0.12
86-0090-00	Buffalo	Carp	2	< 0.01	< 0.01
		Channel catfish	3	0.07	0.04
		Walleye	1	< 0.01	< 0.01

b. Lakes			PCBs (mg/kg)		
Lake ID	Lake Name	Species	N	Max	Mean
86-0114-00	Waverly	Carp	1	0.14	0.14
86-0134-01	Upper Maple	Carp	1	< 0.01	< 0.01
86-0190-00	Ann	Walleye	1	< 0.01	< 0.01
86-0193-00	Mary	Northern pike	1	< 0.01	< 0.01
86-0199-00	Howard	Walleye	1	< 0.01	< 0.01
86-0217-00	Granite	Northern pike	1	< 0.01	< 0.01
		Walleye	1	0.02	0.02
86-0273-00	French	Bluegill sunfish	1	< 0.01	< 0.01
		Black crappie	1	< 0.01	< 0.01
		Carp	3	0.15	0.06
		Northern pike	4	< 0.01	< 0.01
		Walleye	4	< 0.01	< 0.01
86-0279-00	West Lake Sylvia	Northern pike	1	0.06	0.06
		Walleye	1	0.05	0.05
86-0288-00	John	Bluegill sunfish	1	< 0.01	< 0.01
		Northern pike	1	< 0.01	< 0.01
		Walleye	1	< 0.01	< 0.01
		Yellow bullhead	1	< 0.01	< 0.01
86-0289-00	East Lake Sylvia	Carp	1	0.07	0.07
		Northern pike	1	0.13	0.13
		Walleye	1	0.07	0.07
86-0293-00	Collinwood	Carp	2	< 0.01	< 0.01
		Walleye	3	< 0.01	< 0.01

data from 1990 - 2003

Table 73. Summary of PFOS concentrations in lakes

				PFOS (µg/kg)	
Lake ID	WATERWAY	Species	N	MAX	MEAN
27-0191-00	SARAH	Bluegill sunfish	6	9	6.5
		Black crappie	5	< 5	< 5
		Northern pike	5	14	10.4
47-0015-00	JENNIE	Bluegill sunfish	1	< 1	< 1
47-0046-00	WASHINGTON	Bluegill sunfish	1	< 1	< 1
47-0050-00	MANUELLA	Bluegill sunfish	1	< 1	< 1
47-0068-00	STELLA	Bluegill sunfish	1	< 1	< 1
47-0119-00	MINNIE-BELLE	Bluegill sunfish	1	< 1	< 1
73-0200-00	KORONIS	Bluegill sunfish	1	< 1	< 1
86-0031-00	PELICAN	Bluegill sunfish	6	< 5	< 5
		Black crappie	6	< 5	< 5
		Largemouth bass	5	< 5	< 5
86-0293-00	COLLINWOOD	Bluegill sunfish	1	< 1	< 1

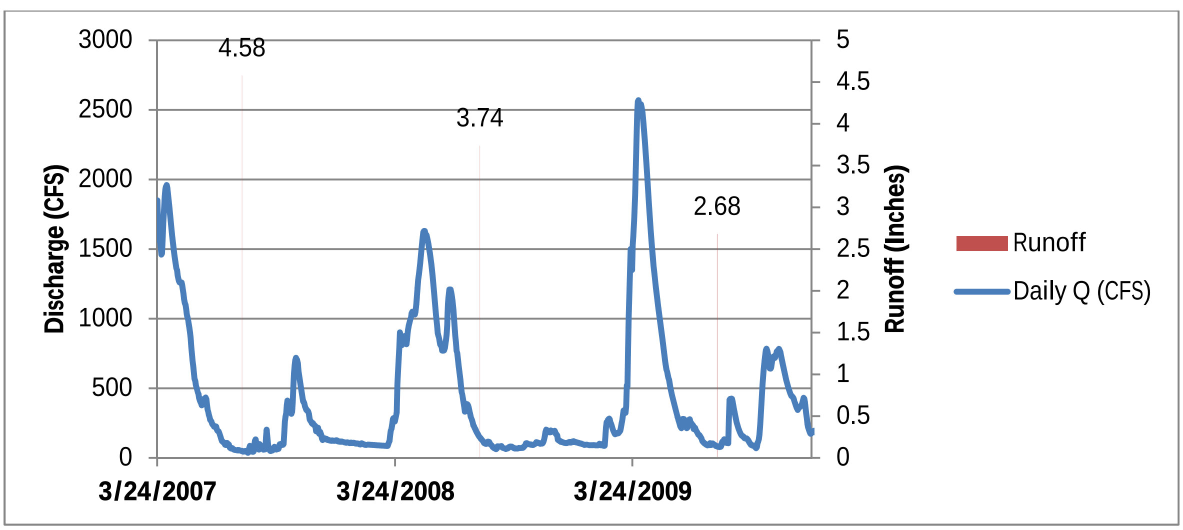
Load monitoring network

Funded with appropriations from Minnesota's Clean Water Legacy Fund, the MWLMP is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlet of the major tributaries (8 digit HUC scale) draining to these rivers. Since the program's inception in 2007 the MWLMP has adopted a multi-agency monitoring design that combines site specific stream flow data from USGS and MDNR flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services, local monitoring organizations, and MPCA MWLMP staff. The data used to compute annual pollutant loads at 81 river monitoring sites across Minnesota. Data will also be used to assist with TMDL studies and implementation plans, watershed modeling efforts, and watershed research projects.

Intensive water quality sampling occurs year round at all MWLM sites. Thirty to thirty-five mid-stream grab samples are collected, per site per year, with sampling frequency greatest during periods of moderate to high flow. Correlations between concentration and flow exist for many of the monitored pollutants, and because these relationships can shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented, but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

Annual water quality and daily average discharge data are coupled in the "Flux32," pollutant load model, originally developed by Dr. Bill Walker and upgraded in 2010 by the U.S. Army Corp of Engineers and MPCA, to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary outputs include annual and daily pollutant loads, and flow weighted mean concentrations (pollutant load/total flow volume). Loads and flow weighted mean concentrations are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (nitrate-N) and total Kjeldahl nitrogen (TKN).

Figure 28. Hydrograph and annual runoff for North Fork of the Crow River, 2007-2009



Pollutant load monitoring

The North Fork of the Crow River is monitored at MDNR gage site H18088001, two miles west of Rockford, Minnesota at Farmington Avenue, approximately two miles upstream of the confluence with the South Fork of the Crow River. The hydrograph of daily discharge data from 2007-2009 is provided in Figure 28.

Many years of water quality data from throughout Minnesota combined with previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR) (MPCA 2010a), each with unique nutrient standards. Of the state's three RNR's (North, Central, South), the North Fork of the Crow load monitoring station is located within the Central RNR. Annual flow weighted mean concentrations (FWMCs) were calculated for years 2007-2009 (Figures 29-32) and compared with RNR standards (only TP and TSS draft standards are available for the Central RNR). It should be noted that while a FWMC exceeding given water quality standard is generally a good indicator the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10 percent and greater (MPCA 2010a), over the most recent 10-year period and not based on comparisons with FWMCs. A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10 percent of the individual samples collected over the assessment period were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, soils, slopes, climatic events and other watershed factors. However, as a general rule, TSS and nitrate plus nitrite-N are regarded as "non-point" source pollutants derived from many smaller diffuse sources such as urban stormwater runoff from impervious surfaces or agricultural runoff. Total phosphorus and dissolved orthophosphate can be attributed to "non-point" as well as "point" or end of pipe sources such as industrial or sewage treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed and transported with sediment during runoff.

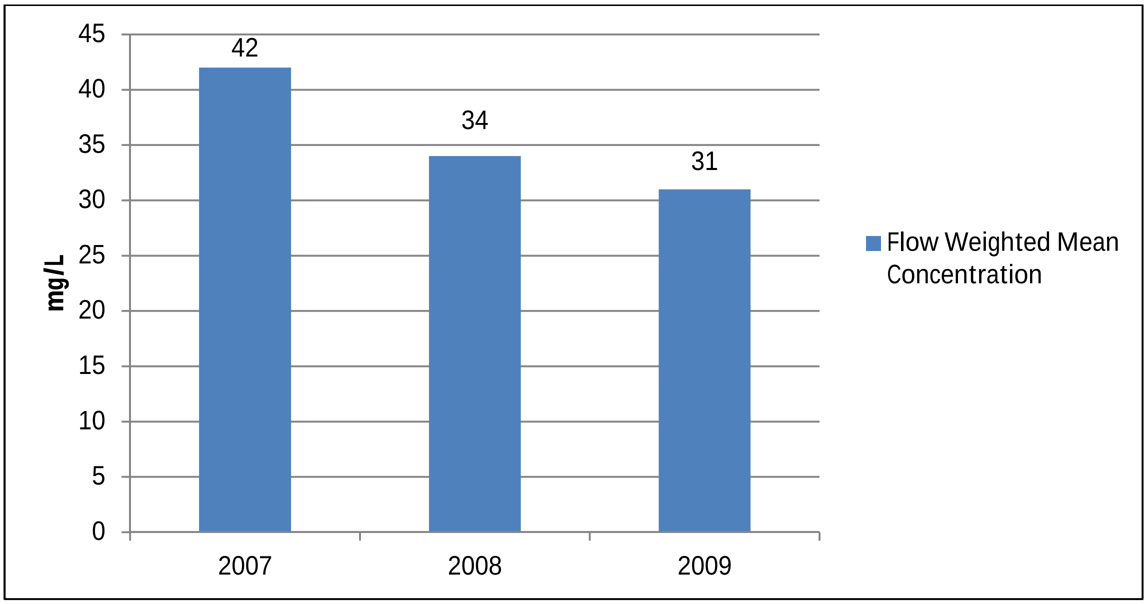
Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as: canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development rather than after low intensity post-canopy events where less surface runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in FWMCs and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated.

Total suspended solids

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

Currently, the state of Minnesota's TSS standards are moving from the "development phase" into the "approval phase" and must be considered draft until the process is complete. Within the Central RNR, the TSS draft standard is 30 mg/L (MPCA 2010c); TSS concentrations in the North Fork of the Crow River Watershed at or above 30 mg/L are considered to impair aquatic life (MPCA 2010a). When greater than 10 percent of the individual samples exceed the draft standard, the river is out of compliance. There were 68 samples analyzed for TSS from 3/2007 to 12/2009, 48 (70 percent) were above 30 mg/l while the annual flow weighted mean concentrations were 42, 34 and 31 mg/l for 2007-2009 (Figure 29). Samples with greater than 30 mg/l were collected at the initial snowmelt runoff, spring rain events, and late summer low flows (algal growth). The flow weighted means calculated for each year are in Figure 29.

Figure 29. Total Suspended Solids (TSS) flow weighted mean concentrations for the North Fork of the Crow River



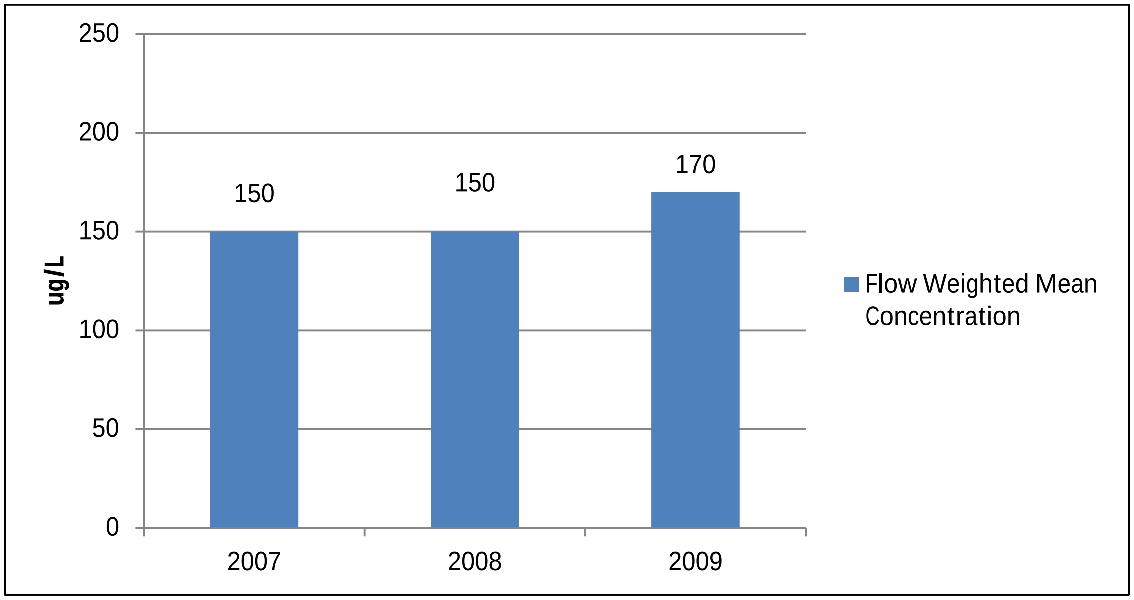
Total phosphorus

Nitrogen (N), phosphorus (P), and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often limits or restricts the growth of aquatic plant species (University of Missouri Extension 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. However, excessive levels of phosphorus over-stimulate aquatic plant and algae growth resulting in reduced water quality (eutrophication). Eutrophication in rivers and streams can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries, and toxins from cyanobacteria (blue green algae) which can affect human and animal health

Total phosphorus (TP) standards for Minnesota's rivers are in the final approval phase and are considered draft standards until final approval. The North Fork of the Crow River's load monitoring station is located within the central RNR which has a proposed TP draft standard of 100 ug/l. The FWMCs (Figure 30.) for 2007-2009 were 150, 150 and 170 ug/l. For 2007-2009 60 samples were analyzed for TP and 57 were above 100 ug/l.

Prior to 2007-2009, the most recent period of intense data collection for the North Fork of the Crow was 5/2001 to 6/2003 (Crow River Diagnostic Study, 2005). The FWMC for TP for this period was 245 ug/l. In 2004 the major point source contributor of TP to the North Fork of the Crow (municipal WWTP at Litchfield) was given a total phosphorus discharge limit of 1000 ug/l. Phosphorus removal resulted in a reduction in the average discharged effluent TP concentration from over 10,000 ug/l to less than 300 ug/l and an annual load reduction of approximately 20,000 kg of TP to the North Fork of the Crow.

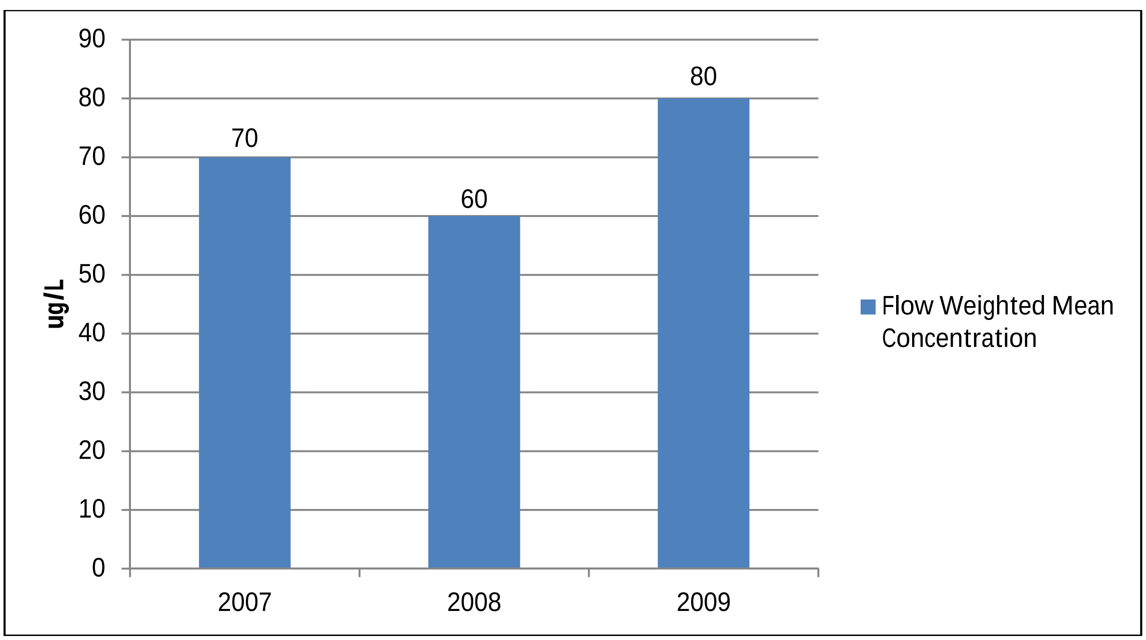
Figure 30. Total Phosphorus (TP) flow weighted mean concentrations for the North Fork of the Crow River



Dissolved Orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The FWMCs from 2007-2009 are 70, 60 and 80 ug/l, approximately 45 percent of the TP concentration. Comparison of FWMCs from 2001-2003 to 2007-2009 shows a reduction in FWMCs from 170 ug/l to 75 ug/l.

Figure 31. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the North Fork of the Crow River



Nitrate plus nitrite - nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems, and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA 2010). 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-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.

Nitrate- N can be a common toxicant to aquatic organisms in Minnesota's surface waters with invertebrates appearing to be the most sensitive to nitrate toxicity. Studies have shown that the elevated nitrate-nitrogen levels from Minnesota rivers contribute to hypoxia (low levels of dissolved oxygen) in the Gulf of Mexico. This occurs by nitrate-nitrogen stimulating the growth of algae which, through death and decay, consume large amounts of dissolved oxygen and thereby threaten aquatic life (MPCA and MSUM 2009).

Draft nitrate-N standards have been proposed (2012) for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a one-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a four-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate- N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA 2010b).

Calculations of the North Fork of the Crow River's nitrate-N loads indicate an increasing trend from a FWMC of 0.72 mg/l in 2007 to 1.6 mg/l in both 2008 and 2009 (Table 5). The average FWMC from 2001-2003 was 0.75 mg/l.

Figure 32. Nitrate + Nitrite Nitrogen Flow weighted mean concentrations for the North Fork of the Crow River

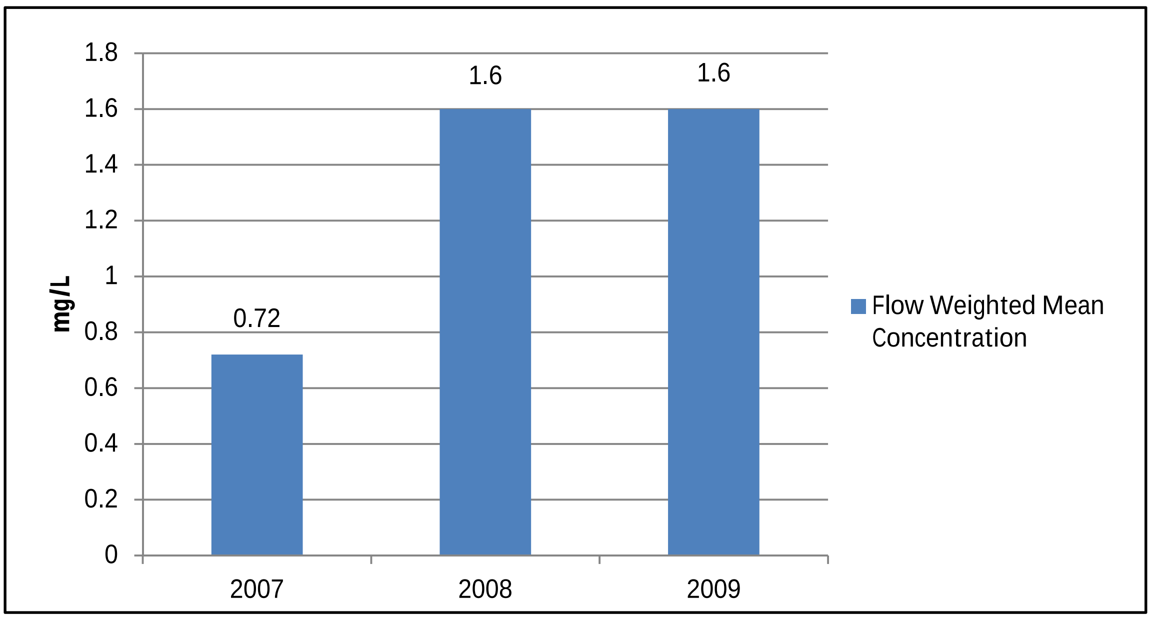


Table 74. Annual pollutant loads by parameter calculated for North Fork Crow River Near Rockford, MN, 2007-2009

	2007	2008	2009
Parameter	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	27,300,000	15,400,000	17,000,000
Total Phosphorus	98,000	69,000	92,000
Ortho Phosphorus	44,000	28,000	46,000
Nitrate + Nitrite Nitrogen	467,000	722,000	849,000

Stream quality

The North Fork Crow River Watershed has been split into 82 distinct assessment units (AUIDs). Not all AUIDs have data collected on them and some have insufficient data to be assessed for aquatic life and/or aquatic recreation. Biological, chemical, physical, and/or bacteriological monitoring occurs on many of these AUIDs. Presence of stream channel alteration is found throughout the watershed. The main stem North Fork Crow River does benefit from a number of large, flow-through lakes in the middle of the watershed that allow for sediment and phosphorus to drop out of the river. However, by the downstream end of the watershed, the river is impaired for both aquatic life and aquatic recreation uses.

Table 75. Assessment summary for stream water chemistry in the North Fork Crow River Watershed

Waterbody	Area (miles^2)	# AUIDs With Some Data*	Supporting		Non-support	
			# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation
North Fork Crow River HUC 8	1428	73	3	1	17	15
Upper North Fork Crow River	286	8		1	2	
Raymond Lake	18					
Upper Middle Fork Crow River	97.5	4	2			
Central Middle Fork Crow River	83.5	3				1
Lower Middle Fork Crow River	95.9	3				1
Long Lake Outlet	48.6	2			1	1
Jewett Creek	68.1	2			2	1
Litchfield	23.1	1				
Middle North Fork Crow River	91.4	4			4	1
Washington Creek	69.2	3				1
Collinwood Creek	80.4	2				1
Sucker Creek	46.5	2			1	
Twelve Mile Creek	58.7	2			1	1
Mill Creek	58.5	2	1		1	1
Louzer Lake Outlet	31.1	1			1	1
Lower North Fork Crow River	193.1	5			2	2
Sarah Creek	8.6	1				1
St. Michael	53.4	1			1	1
Crow River	71.7	1			1	1

*Not all AUIDs have sufficient data to assess for aquatic life or aquatic recreation

Lake quality

Headwater lakes tend to be of higher quality than those in the intensively cultivated portions of the watershed. Lakes with assessment level data are found in 17 of the 19 HUC-11 watersheds in the larger North Fork Crow River Watershed HUC-8. Of these 250 lakes (greater than 4 ha), 35 percent have at least some data (TP, chl-*a*, and/or Secchi), and 27 percent have been assessed for aquatic recreation use. Of the 69 lakes that had sufficient data for assessment, 28 were found to be supporting and 41 were not supporting aquatic recreation use (i.e. swimming and boating) (Anderson 2010).

No distinct patterns develop across the watershed; deep and shallow lakes can be found throughout. Transitional forest-prairie soils are found across the entire watershed and erosion is typically associated with these soil types. There are several predominant flow-through lakes in the watershed (Rice, Koronis, Nest, and Green) which provide a TP sink for the North Fork Crow River. As a result, Rice Lake and Nest Lake are impaired, and Lake Koronis is very close to exceeding the eutrophication standards. Green Lake benefits from the reduction in TP that occurs as the river flows through Nest Lake as it is still of high quality. The majority of the lakes in the watershed are not on the North Fork Crow River (i.e. not main stem flow-through lakes). These shallow lakes, in addition to watershed loading of TP, are also experiencing internal loading, which will further complicate restoration efforts (Anderson 2010).

Table 76. Assessment summary for lake water chemistry in the North Fork Crow River Watershed

HUC-11 Units	Area (Hectares)	Percent of HUC-8	Number of lakes > 4 ha	Number of assessed lakes	Fully Supporting Aquatic Recreation	Not Supporting Aquatic Recreation
Upper North Fork Crow River	74,130	19	15	4	3	1
Raymond Lake	4,672	1		0		
Upper Middle Fork Crow River	25,242	7	9	5	5	
Central Middle Fork Crow River	21,628	6	19	5	4	1
Lower Middle Fork Crow River	24,827	6	15	1		1
Long Lake Outlet	12,578	3	9	2		2
Jewett Creek	17,629	5	18	1	1	
Litchfield	5,978	2	3	2		2
Middle North Fork Crow River	23,669	6		0		
Washington Creek	17,914	5	16	4	4	
Collinwood Creek	20,812	5	35	7	2	5
Sucker Creek	12,043	3	5	3		3

Twelve Mile Creek	**15,190**	**4**	**12**	**6**		**6**
Mill Creek	15,144	4	17	6	2	4
Louzers Lake Outlet	8,054	2	5	1	1	
Lower North Fork Crow River	49,967	13	32	12	5	7
Sarah Creek	2,227	1	2	2		2
St. Michael	13,817	4	13	3		3
Crow River	18,559	5	21	5	2	3

Figure 33. Impaired waters by designated use in the North Fork Crow River Watershed

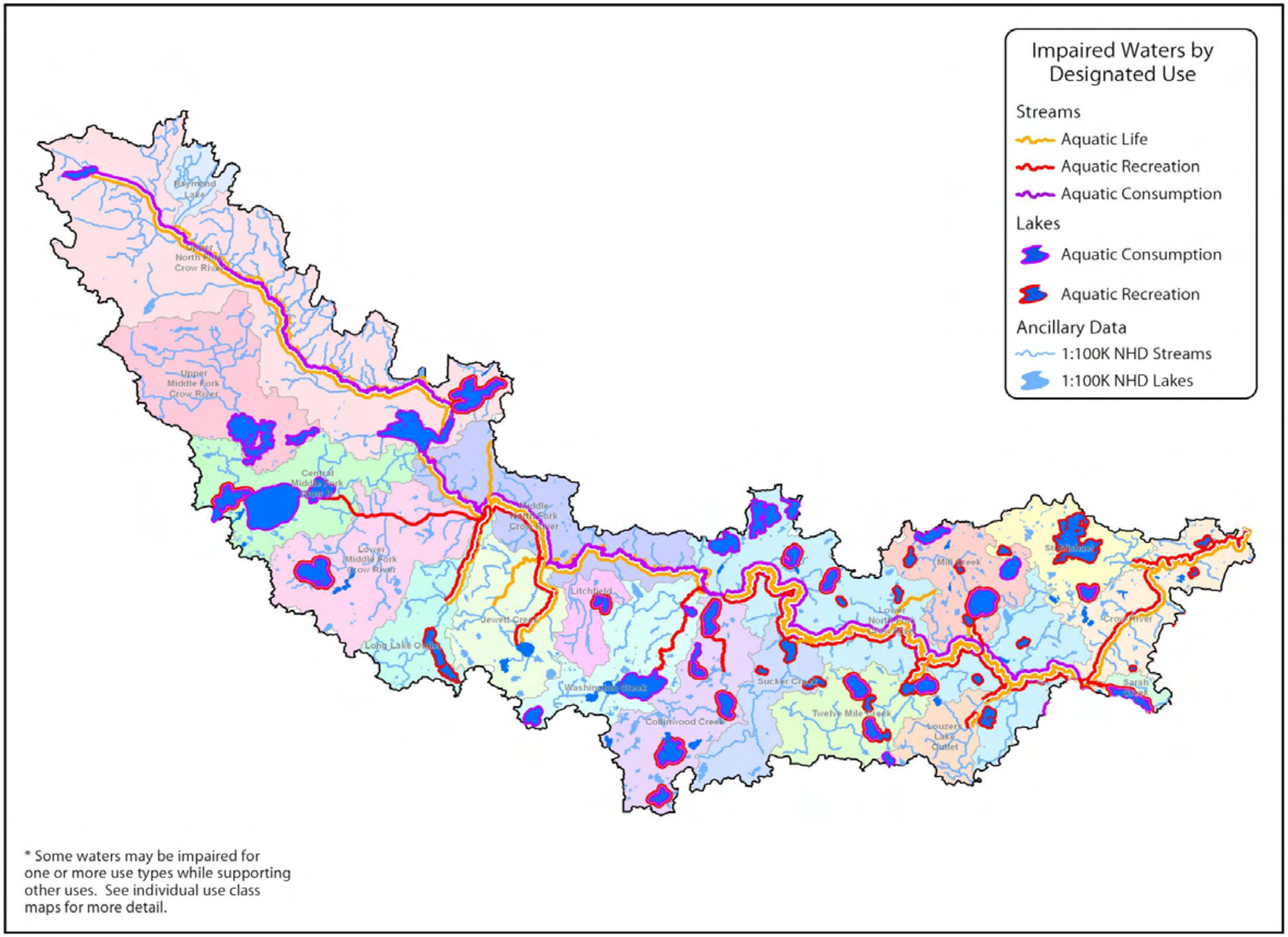


Figure 34. Fully supporting waters by designated use in the North Fork Crow River Watershed

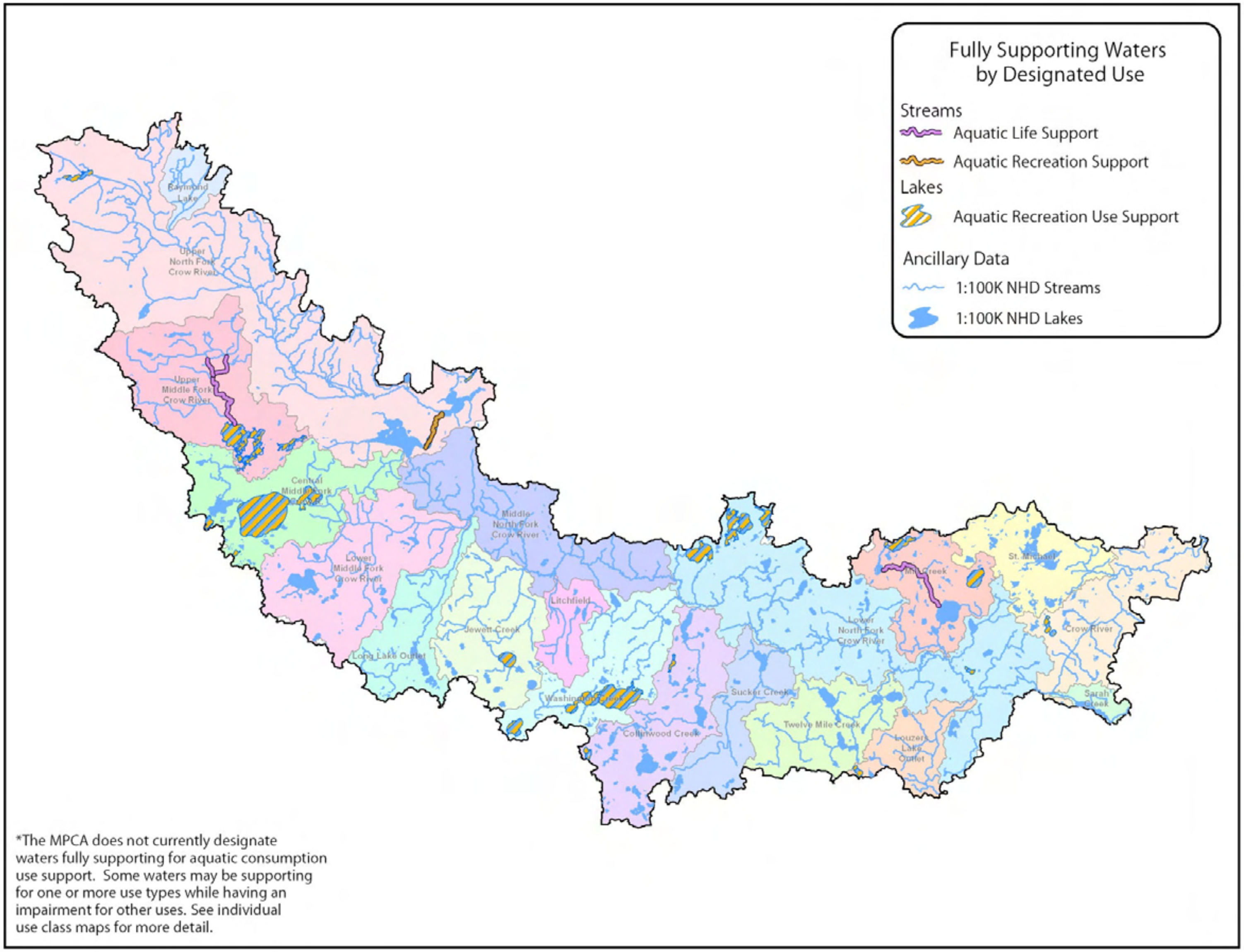


Figure 35. Aquatic consumption use support in the North Fork Crow River Watershed

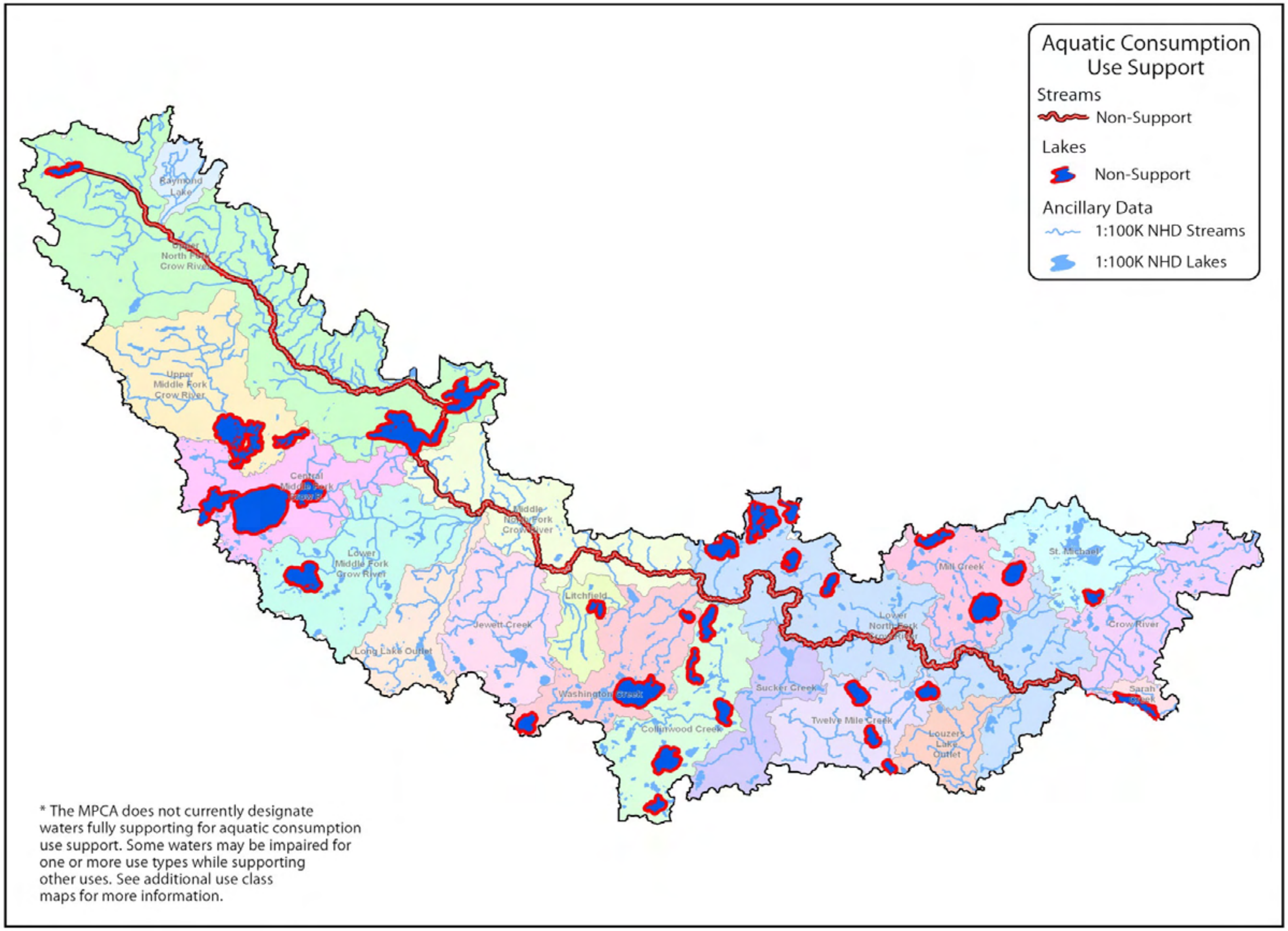
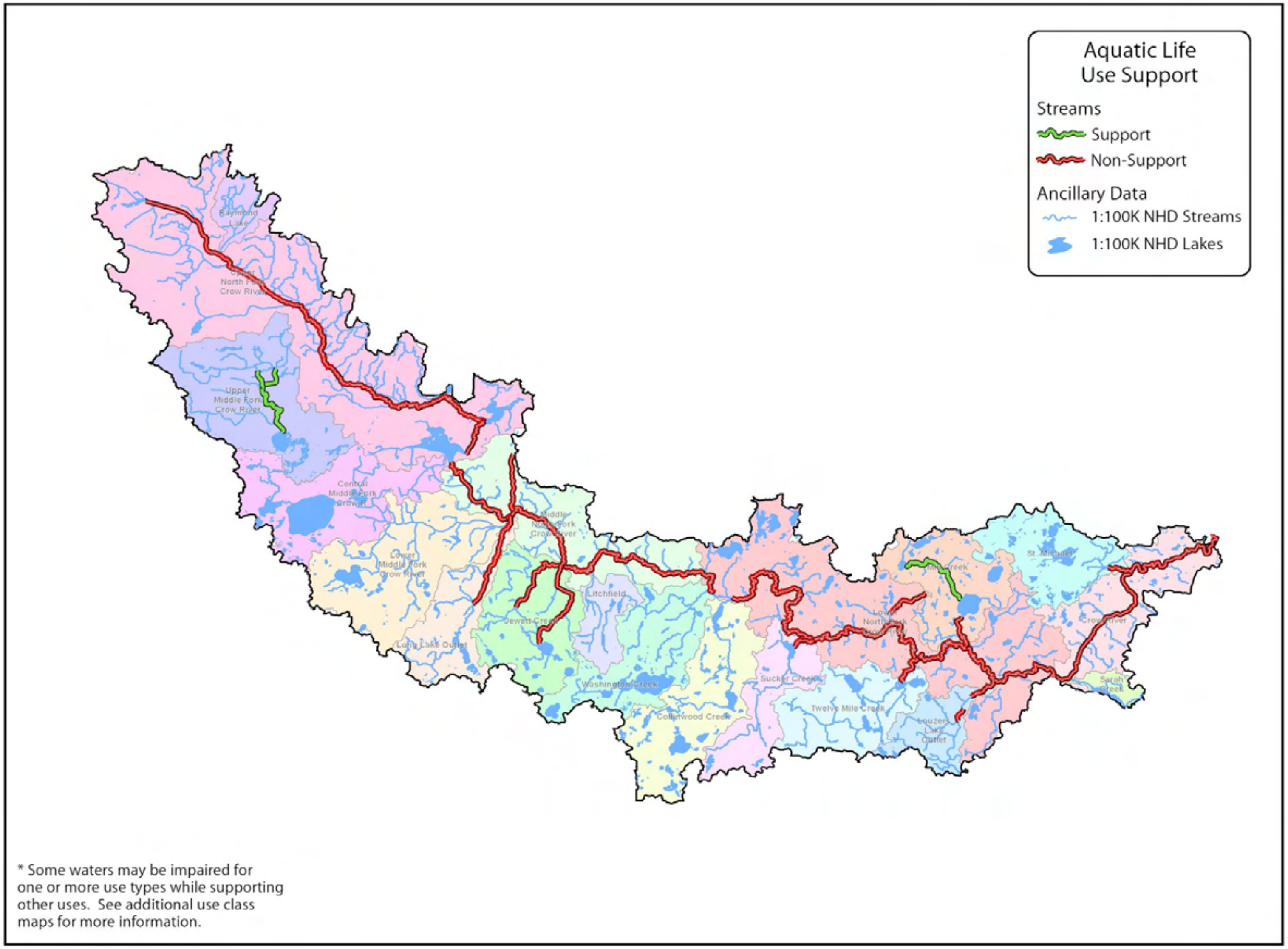


Figure 36. Aquatic life use support in the North Fork Crow River Watershed



IX. Trends

Table 77. Pollutant trends for the North Fork Crow River

Pollutant trends for the North Fork of the Crow River

HUC 07010204 Period of Record: 1953 - present Site: S000-004 (CR-0.2)	Total Suspended Solids	Biochemical Oxygen Demand	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Chloride	pH
overall trend	**no trend**	**no trend**	**no trend**	**increase**	**no trend**	**increase**	**no trend**
avg. annual change				**3.0%**		**4.1%**	
(range: lower limit				(1.8%)		(3.2%)	
upper limit)				(4.0%)		(5.1%)	
total change				**371%**		**893%**	
(range: lower limit				(155%)		(517%)	
upper limit)				(688%)		(1633%)	
(p-value)				0.01		0.00	
1995 - 2009 trend	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**
avg. annual change	**-2.9%**						
(range: lower limit	(-7.3%)						
upper limit)	(-0.2%)						
total change	**-35%**						
(range: lower limit	(-68%)						
upper limit)	(-3%)						
(p-value)	0.09						

(A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.)
(Ranges for annual and total changes are 90% confidence intervals.)

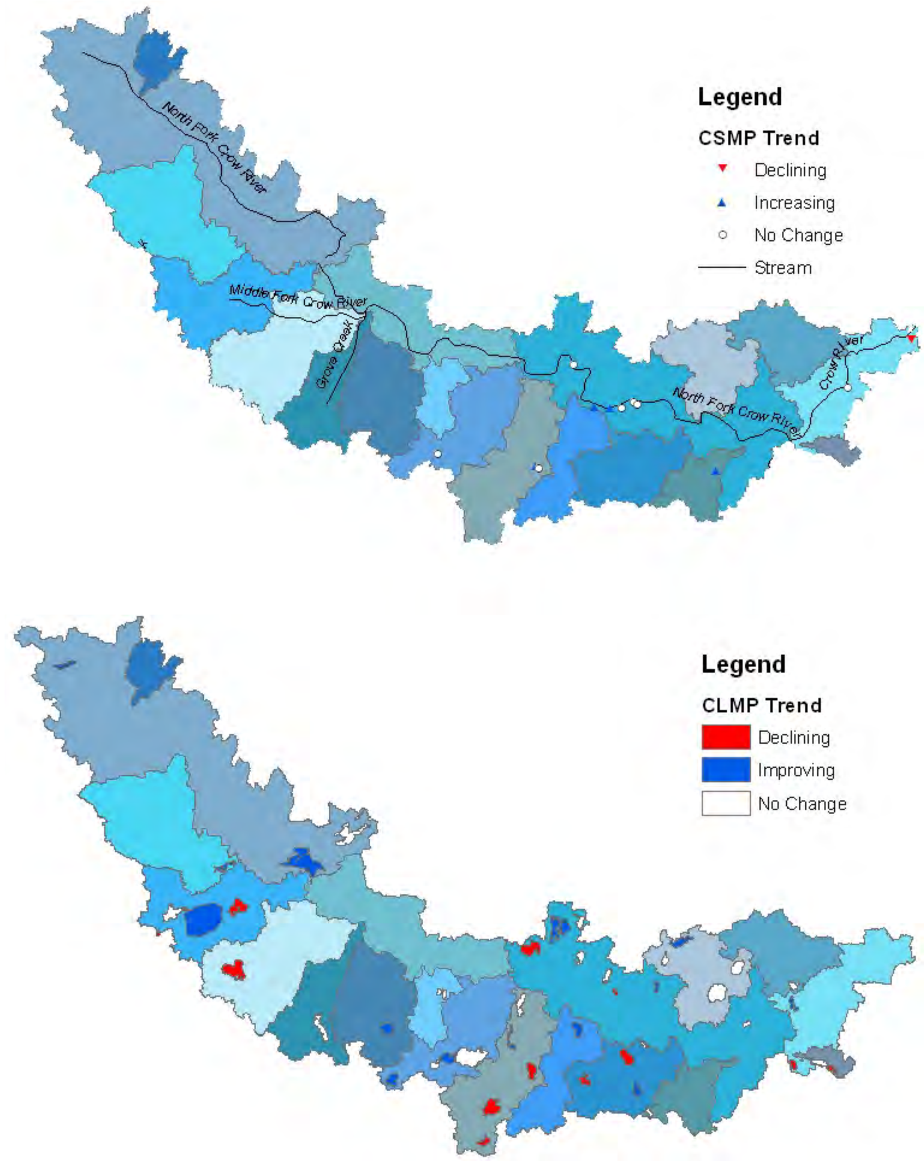
Water-Clarity Trends at Citizen-Monitoring Sites

N Fork Crow HUC 07010204	Streams	Lakes
number of sites w/ increasing trend	3	17
number of sites w/ decreasing trend	1	12
number of sites w/ no trend	17	20

Water Chemistry data were analyzed for trends for the long term period of record (1953-present) and near term period of record (1995-present)(Table77). There were significant increases in nitrite/nitrates and chlorides during the long term period of record. A significant decrease in total suspended solids was observed during the short term period of record. Citizen volunteer monitoring of stream and lakes occurs throughout the watershed. Water clarity has improved in 75 percent of the monitored stream sites and 61 percent of the monitored lakes.

Citizen Stream Monitoring Program/Citizen Lake Monitoring Program

Figure 37. Transparency trends in the North Fork Crow River Watershed



CLMP and CSMP volunteers collect transparency data on lakes and streams across Minnesota each year. CLMP volunteers collect Secchi disk transparency and CSMP volunteers collect transparency tube data to determine the clarity of the waters they are monitoring. Secchi transparency is related to the phosphorus and chlorophyll-*a* concentration in the lakes (i.e. productivity related to algal growth). Transparency tube data is related to total suspended solids and turbidity in streams (i.e. sedimentation). Statistically significant trends can be calculated after a minimum of eight years of data have been collected at a specific location. For lakes, the trend applies to the entire lake. For streams, the trend applies to the specific site that was sampled; not necessarily the entire reach of the stream segment (Table 33). In the North Fork Crow River Watershed, improving trends in transparency were detected on 17 lakes and three stream sites. Declining trends were detected on 12 lakes and one stream site.

X. Summary and recommendations

The North Fork Crow River Watershed has some widespread problems throughout the entire watershed. Many of the tributaries to the North Fork Crow are channelized through agricultural land. Three re-occurring water chemistry problems within the watershed are high nitrate levels, high nutrient levels, and low dissolved oxygen levels. Turbidity becomes more and more prevalent as you go further downstream in the watershed. After the South Fork Crow combines with the North Fork the turbidity becomes much worse. Biological data shows consistently poor conditions throughout the watershed; only three of nineteen AUIDs assessed for aquatic life are fully supporting of that use. Some 11 digit-HUCs have more problems than others, such as Jewett Creek which is not supporting aquatic life and aquatic recreation based on monitoring data for fish, invertebrates, dissolved oxygen, nitrates, chloride, E. coli, phosphorus (Table 34).

Deeper, headwater watershed lakes tend to be of higher water quality in the watershed. As you progress downstream into more intensively developed (urban and agricultural) land and to shallower basins, the water quality declines. Steps taken to reduce runoff into these basins will be necessary, in addition to addressing internal loading, to improve the quality of the lakes in the North Fork Crow River Watershed.

There are many different stressors present throughout the watershed and breaking down the watershed into smaller areas that have similar stressors may help to pin point the problems in those areas.

Literature Cited

Anderson, P. 2010. Assessment Report of Selected Lakes within the North Fork Crow River Watershed Upper Mississippi River Basin. Minnesota Pollution Control Agency. St. Paul, MN.

Berg, J., 2006, Geologic Atlas of Pope County, Minnesota, Part B: County Atlas Series C-15: St. Paul, Minnesota, Minnesota Department of Natural Resources.

Chirhart, J. 2003. Development of a Macroinvertebrate Index of Biological Integrity (MIBI) for Rivers and Streams of the St. Croix River Basin in Minnesota. Minnesota Pollution Control Agency, St. Paul, Minnesota. 38 p.

Crow River Organization of Water (2005). Crow River Diagnostic Study. http://www.crowriver.org/DiagnosticStudyCondensed%20Report.pdf.

Delin, G., 1991, Simulation of Effects of Groundwater Development on Water Levels in Glacial-Drift Aquifers in the Brooten-Belgrade Area, West-Central Minnesota: Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4193, 1991. 66 p, 36 fig, 6 tab, 31 ref. Project.

Falteisek, J., 1998, Geologic Atlas of Stearns County, Minnesota: Minnesota Geological Survey County Atlas C-10, pt. B.

Harris, K. L., 2003, Geologic Atlas of Pope County, Minnesota, Part A: St. Paul, Minnesota, Minnesota Geological Survey.

Heiskary, S.A. and C.B. Wilson. 2005. Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. 3rd Ed. MPCA. St. Paul, MN 150 pp.

Hobbs, H. C., Goebel, J. E., and Lusardi, B. A., 1982, Geologic map of Minnesota, Quaternary geology: 1:500,000., MGS State Map Series S-1, Minnesota Geological Survey.

Lindholm, G. F., Farrell, D. F., and Helgesen, J. O., 1974, Water resources of the Crow River Watershed, south-central Minnesota: Hydrologic Atlas 528, U.S. Geological Survey with Minnesota Geological Survey.

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

Meyer, G., 1995, Geologic Atlas of Stearns County, Minnesota: Minnesota Geological Survey County Atlas C-10, pt. A: St. Paul, Minnesota, Minnesota Geological Survey.

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

Minnesota Pollution Control Agency (MPCA) and Minnesota State University of Mankato (MSUM). 2009. State of the Minnesota River, Summary of Surface Water Quality Monitoring 2000-2008. http://mrbdc.wrc.mnsu.edu/reports/basin/state_08/2008_fullreport1109.pdf.

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

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

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

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

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

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

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

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

Minnesota Pollution Control Agency (MPCA) and Minnesota State University of Mankato (MSUM). 2009. State of the Minnesota River, Summary of Surface Water Quality Monitoring 2000-2008. http://mrbdc.wrc.mnsu.edu/reports/basin/state_08/2008_fullreport1109.pdf.

National Resource Conservation Service (NRCS). 2008. Rapid Watershed Assessment: Crow River (Upper Fork) (MN)07010204. NRCS. USDA. http://www.mn.nrcs.usda.gov/technical/rwa/Assessments/07010204.html.

Niemela, S.L., and Feist, M. D. 2000. Index of Biotic Integrity Guidance for Coolwater Rivers and Streams of the St. Croix River Basin. Minnesota Pollution Control Agency, St. Paul, Minnesota. 47 p.

Reeves, L., 2009, Buffalo Aquifer and Bonanza Valley Studies Initiated: St. Paul, Minnesota, Minnesota Department of Natural Resources.

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

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

Van Voast, W. A., 1971, Ground water for irrigation in the Brooten-Belgrade area, west-central Minnesota: U.S. Geol.Survey Water-Supply Paper 1899-E, 24 p.

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

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

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

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

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

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

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

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

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

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

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

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

Appendix 2. Intensive chemistry monitoring stations in the North Fork Crow River Watershed

FieldNum	STORET ID	Waterbody Name	Location	HUC-11
07UM046	S000-615	North Fork Crow River	C.R. 32, 5 mi. NW of Rockford	07010204-160
07UM043	S001-405	Twelve mile Creek	C.R,. 107, 2.5 mi. N of Waverly	07010204-130
07UM011	S002-028	Middle Fork Crow River	C.R. 30, 1 mi. S of Manannah	07010204-050
07UM013	S002-024	North Fork Crow River	C.R. 19, in Kingston	07010204-090
07UM014	S003-935	County Ditch #9	C.R. 21, 4 mi. S of Kingston	07010204-100
07UM015	S004-420	Collinwood Creek	30th St. SW, 4 mi. NE of Dassel	07010204-110
07UM010	S002-299	MIddle Fork Crow River	C.R. 40, 0.5 mi. W of New London	07010204-030
07UM061	S002-021	Sucker Creek	C.R. 4, 2 mi. W of Albright	07010204-120
07UM028	S000-919	Jewett Creek	300th St. ,3 mi. N of Litchfield	07010204-070
07UM002	S001-758	Middle Fork Crow River	C.R. 2, 5.5 mi. NW of Crow river	07010204-040
07UM026	S000-897	Grove Creek	340th St., 1.5 mi. SE of Manannah	07010204-060
07UM044	S002-020	Unnamed Trib. to North Fork Crow	C.R. 25, 3.5 mi.E of Montrose	07010204-150
07UM045	S002-030	Unnamed Trib. to Crow River	C.R. 19, in St. Michael	07010204-180
07UM035	S002-357	North Fork Crow River	C.R. 34, 3.5 mi. SE of Paynesville	07010204-010
	S004-433	Crow River	East of C.R. 36, 4 mi. N of Rogers	07010204-190
	S002-018	Mill Creek	C.R. 12, 3 mi. S of Buffalo	07010204-140

Appendix 3. Biological monitoring stations in the North Fork Crow Watershed

Field Number	Waterbody Name	Location	Drain Mi²
00UM046	County Ditch 37	Upstream of C.R. 107, 6 mi. NW of New London	8.02
00UM056	Crow River, North Fork	11.5 miles N of Grove City on Hwy 4, 1/2 mile E on C.R.	318.30
00UM057	Trib. to Crow River, North Fork	downstream of CR 11	5.01
00UM058	Eagle Creek	1 mile East of C.R. 19 on county road, 2 mi. NE Kingston	19.34
00UM070	Trib. to Crow River	downstream of C.R. 144	4.58
00UM080	Crow River	downstream of Hwy 55 @ Rockford	2637.15
00UM081	Crow River	Upstream of Hwy 101, 4 mi. S. of Elk River	2750.27
00UM097	Jewitts Creek	upstream of C.R. 34, 1.5 mi. N.E. of Litchfield	29.60
01UM001	Jewitts Creek	Upstream of Hwy 24, near Litchfield	26.38
01UM002	Jewitts Creek	Upstream of Co. Rd. 42	26.25
07UM004	County Ditch 37	Upstream of 40th St, 6 mi. NW of New London	20.24
07UM005	County Ditch 26	Upstream of CR 102, 5 mi. E of New London	7.37
07UM006	Trib. to Crow River, Middle Fork	Downstream of 120th Ave, 5 mi. W of Crow River	37.04
07UM007	County Ditch B6	Upstream of CR 35, 4 mi. S of Belgrade	17.24
07UM008	Crow River, Middle Fork	Downstream of 255th Ave, 5 mi. N of New London	47.68
07UM009	Crow River, North Fork	Downstream of 270th Ave, 3.5 mi. West of Paynesville	209.87
07UM010	Crow River, Middle Fork	Upstream of CR 40, 0.5 mi. W of New London	110.03
07UM011	Crow River, Middle Fork	Upstream of CR 30, 1 mi. S of Manannah	270.39
07UM013	Crow River, North Fork	Downstream of CR 19, in Kingston	791.28
07UM014	County Ditch 9	Downstream of CR 21, 4 mi. S of Kingston	83.39
07UM015	Collinwood Creek	30th St. SW, 4 mi. NE of Dassel	66.48
07UM016	County Ditch 47	Downstream of 335th St, 2 mi. SW of Crow River	24.54
07UM017	County Ditch 26	Downstream of CR 4, 5.5 mi. S of Grove City	14.05
07UM018	Sucker Creek	Downstream of CR 28, 2 mi. SW of Casey	13.32
07UM019	Silver Creek	Downstream of CR 15, 5 mi. SE of Dassel	20.69
07UM020	County Ditch 36	Upstream of CR 21, 5 mi. SE of Kingston	28.99
07UM021	Crow River, North Fork	Downstream of 328th St, 8 mi. N of Litchfield	683.49
07UM023	Stag Brook	Upstream of 356th St, 2.5 mi. NE of Manannah	5.27
07UM026	Grove Creek	Downstream of 340th St, 1.5 mi. SE of Manannah	50.37
07UM027	Trib. to Jewitts Creek	Downstream of CR 22, 4 mi. W of Forest City	21.27
07UM028	Jewitts Creek	Downstream of 300th St, 3 mi. N of Litchfield	37.72
07UM029	Crow River, North Fork	Upstream of CR 30, in Manannah	325.83
07UM030	Washington Creek	Upstream of 273rd St, 5 miles N of Dassel	47.67

07UM031	County Ditch 19	Upstream of CR 1, in Litchfield	23.59
07UM032	Crow River, North Fork	Downstream of CR 18, 2.5 mi. E of Grove Lake	24.62
07UM033	County Ditch 32	Downstream of CR 27, 4.5 mi. NE of Brooten	13.51
07UM034	Judicial Ditch 1	Upstream of CR 18 (470th St), 2.5 mi. SW of Padua	13.24
07UM035	Crow River, North Fork	Upstream of CR 35, 2.5 mi. SE of Paynesville	270.57
07UM036	Sedan Brook	Upstream of CR 201, 3 mi. NE of Brooten	19.03
07UM037	County Ditch 7	Upstream of 443rd Ave, 4 mi. N of Belgrade	15.50
07UM038	County Ditch 7	Upstream of CR 14, 7 mi. N of Belgrade	12.32
07UM039	Skunk River	Downstream of US 71, 3 mi. N of Belgrade	29.95
07UM040	Trib. to Crow River, North Fork	Downstream of CR 178, 3 mi. E of Georgeville	5.44
07UM041	Trib. to Lake Koronis	Upstream of CR 20, 5 mi. S of Paynesville	9.19
07UM044	Trib. to Crow River, North Fork	Upstream of CR 25, 3.5 mi. E of Montrose	27.99
07UM046	Crow River, North Fork	Downstream of Farmington Ave SE, 3 mi. W of Rockford	1339.72
07UM047	Mill Creek	East of CR 109, 2 mi. W of Buffalo	28.00
07UM048	French Creek	Downstream of CR 3, in French Lake	9.73
07UM049	Trib. to Crow River, North Fork	Upstream of CR 102, 2 mi. S of West Albion	4.26
07UM050	Crow River, North Fork	Downstream of CR 7, in Highland	1095.51
07UM055	Crow River, North Fork	Downstream of CR 12, 5.5 mi. N of Montrose	1199.45
07UM058	Sucker Creek	Upstream of CR 31, 0.5 mi. S of Cokato	26.37
07UM059	Crow River, North Fork	Downstream of CR 3, 1 mi. S of French Lake	1002.49
07UM061	Sucker Creek	Downstream of CR 4, 2 mi. W of Albright	46.25
07UM074	Crow River, North Fork	Downstream of CR 365, 3 mi. NW of Manannah	318.56
07UM084	Crow River, North Fork	Upstream of 102nd Ave, 2 mi. S of Grove Lake	21.29
07UM089	Eagle Creek	Downstream of 318th St, 1.5 mi. NE of Kingston	19.32
07UM099	County Ditch 10	Downstream of Keets Ave, 2 mi. S of Howard Lake	23.51
07UM100	Sucker Creek	Upstream of 7th St, In Cokato	29.60

Appendix 4.1 Good/fair/poor thresholds for biological stations on non-assessed channelized AUIDs

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

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

Appendix 4.2 Channelized stream AUID IBI score FISH

National Hydrography Dataset (NHD)Assessment Segment AUID	BiologicalStation ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: 07010204010 (Upper North Fork Crow)									
07010204-531	07UM039	Skunk River	29.95	6	100 - 40	39 - 25	24 - 0	45	20-Jun-07
07010204-531	07UM039	Skunk River	29.95	6	100 - 40	39 - 25	24 - 0	55	31-Jul-07
07010204-580	07UM038	County Ditch 7	12.32	6	100 - 40	39 - 25	24 - 0	0	20-Jun-07
07010204-581	07UM037	County Ditch 7	15.50	6	100 - 40	39 - 25	24 - 0	36	19-Jun-07
07010204-584	07UM034	Judicial Ditch 1	13.24	6	100 - 40	39 - 25	24 - 0	11	18-Jun-07
07010204-650	07UM040	Trib. to Crow River, North Fork	5.44	6	100 - 40	39 - 25	24 - 0	0	21-Jun-07
07010204-685	07UM032	Crow River, North Fork	24.62	6	100 - 40	39 - 25	24 - 0	30	18-Jun-07
07010204-685	07UM084	Crow River, North Fork	21.29	6	100 - 40	39 - 25	24 - 0	43	19-Jun-07
07010204-685	07UM084	Crow River, North Fork	21.29	6	100 - 40	39 - 25	24 - 0	28	21-Aug-07
07010204-685	07UM032	Crow River, North Fork	24.62	6	100 - 40	39 - 25	24 - 0	26	21-Aug-07
HUC 11: 070102004020 (Raymond Lake)									
07010204-578	07UM033	County Ditch 32	13.51	6	100 - 40	39 - 25	24 - 0	33	19-Jun-07
07010204-578	07UM033	County Ditch 32	13.51	6	100 - 40	39 - 25	24 - 0	32	30-Jul-07
HUC 11: 07010204030 (Upper Middle Fork Crow)									
07010204-536	00UM046	County Ditch 37	8.02	6	100 - 40	39 - 25	24 - 0	52	27-Jun-00
07010204-536	07UM004	County Ditch 37	20.24	6	100 - 40	39 - 25	24 - 0	60	25-Jun-07
07010204-536	07UM004	County Ditch 37	20.24	6	100 - 40	39 - 25	24 - 0	52	31-Jul-07
HUC 11: 07010204040 (Central Middle Fork Crow)									
07010204-511	07UM002	Crow River, Middle Fork	166.88	5	100 - 50	49 - 35	34 - 0	33	26-Jun-07
07010204-539	07UM010	Crow River, Middle Fork	110.03	5	100 - 50	49 - 35	34 - 0	25	27-Jun-07
07010204-539	07UM010	Crow River, Middle Fork	110.03	5	100 - 50	49 - 35	34 - 0	27	26-Jul-07
07010204-553	07UM041	Trib. to Lake Koronis	9.19	7	100 - 40	39 - 25	24 - 0	21	16-Jul-07
07010204-652	07UM005	County Ditch 26	7.37	7	100 - 40	39 - 25	24 - 0	31	25-Jun-07
07010204-652	07UM005	County Ditch 26	7.37	7	100 - 40	39 - 25	24 - 0	0	31-Jul-07

HUC 11: 07010204050 (Lower Middle Fork Crow)									
07010204-511	07UM011	Crow River, Middle Fork	270.39	5	100 - 50	49 - 35	34 - 0	30	02-Jul-07
07010204-532	07UM016	County Ditch 47	24.54	6	100 - 40	39 - 25	24 - 0	22	16-Jul-07
07010204-600	07UM006	Trib. to Crow River, Middle Fork	37.04	6	100 - 40	39 - 25	24 - 0	26	16-Jul-07
HUC 11: 07010204060 (Long Lake Outlet)									
07010204-514	99UM045	Grove Creek	47.51	6	100 - 40	39 - 25	24 - 0	18	19-Jul-99
07010204-643	07UM017	County Ditch 26	14.05	6	100 - 40	39 - 25	24 - 0	0	12-Jul-07
HUC 11: 07010204070 (Jewett Creek)									
07010204-585	01UM002	Jewitts Creek	26.25	6	100 - 40	39 - 25	24 - 0	1	25-Jun-01
07010204-585	01UM001	Jewitts Creek	26.38	6	100 - 40	39 - 25	24 - 0	0	25-Jun-01
07010204-585	07UM031	County Ditch 19	23.59	7	100 - 40	39 - 25	24 - 0	0	12-Jul-07
07010204-585	01UM002	Jewitts Creek	26.25	6	100 - 40	39 - 25	24 - 0	0	22-Jul-08
07010204-585	07UM028	Jewitts Creek	37.72	6	100 - 40	39 - 25	24 - 0	31	02-Jul-07
07010204-585	07UM028	Jewitts Creek	37.72	6	100 - 40	39 - 25	24 - 0	30	01-Aug-07
07010204-585	07UM028	Jewitts Creek	37.72	6	100 - 40	39 - 25	24 - 0	9	21-Jul-08
HUC 11: 07010204080 (Litchfield)									
07010204-548	00UM057	Trib. to Crow River, North Fork	5.01	6	100 - 40	39 - 25	24 - 0	0	28-Jun-00
HUC 11: 07010204090 (Middle North Fork Crow)									
07010204-504	00UM056	Crow River, North Fork	318.30	5	100 - 50	49 - 35	34 - 0	29	28-Jun-00
07010204-504	07UM074	Crow River, North Fork	318.56	5	100 - 50	49 - 35	34 - 0	31	17-Jul-07
07010204-504	07UM074	Crow River, North Fork	318.56	5	100 - 50	49 - 35	34 - 0	21	01-Aug-07
HUC 11: 07010204100 (Washington Creek)									
07010204-518	07UM030	Washington Creek	47.67	7	100 - 40	39 - 25	24 - 0	36	17-Jul-07
07010204-518	07UM014	County Ditch 9	83.39	5	100 - 50	49 - 35	34 - 0	22	17-Jul-07
07010204-547	07UM020	County Ditch 36	28.99	6	100 - 40	39 - 25	24 - 0	14	17-Jul-07
HUC 11: 07010204110 (Collinwood Creek)									
07010204-557	07UM019	Silver Creek	20.69	6	100 - 40	39 - 25	24 - 0	26	18-Jul-07
HUC 11: 07010204120 (Sucker Creek)									
07010204-684	07UM100	Sucker Creek	29.60	6	100 - 40	39 - 25	24 - 0	21	16-Jul-07
07010204-684	07UM058	Sucker Creek	26.37	6	100 - 40	39 - 25	24 - 0	7	18-Jul-07

HUC 11: 07010204130 (Twelve mile Creek)									
07010204-563	07UM099	County Ditch 10	23.51	7	100 - 40	39 - 25	24 - 0	34	12-Jul-07
HUC 11: 07010204150 (Louzer Lake Outlet)									
07010204-667	07UM044	Trib. to Crow River, North Fork	27.99	7	100 - 40	39 - 25	24 - 0	19	28-Jun-07
HUC 11: 07010204160 (Lower North Fork Crow)									
07010204-509	00UM058	Eagle Creek	19.34	6	100 - 40	39 - 25	24 - 0	36	28-Jun-00
07010204-509	07UM089	Eagle Creek	19.32	6	100 - 40	39 - 25	24 - 0	34	17-Jul-07
07010204-592	07UM048	French Creek	9.73	7	100 - 40	39 - 25	24 - 0	31	18-Jul-07

Appendix 4.3 Channelized stream AUID IBI score macroinvertbrate

National Hydrography Dataset (NHD)Assessment Segment AUID	BiologicalStation ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 07010204010 (Upper North Fork Crow									
07010204-531	07UM039	Skunk River	29.95	7	100 - 39	38 - 23	22 - 0	59.44	07-Aug-07
07010204-531	07UM039	Skunk River	29.95	7	100 - 39	38 - 23	22 - 0	40.30	07-Aug-07
07010204-581	07UM037	County Ditch 7	15.50	7	100 - 39	38 - 23	22 - 0	50.20	07-Aug-07
07010204-584	07UM034	Judicial Ditch 1	13.24	7	100 - 39	38 - 23	22 - 0	7.49	06-Aug-07
07010204-685	07UM032	Crow River, North Fork	24.62	7	100 - 39	38 - 23	22 - 0	28.68	06-Aug-07
07010204-685	07UM084	Crow River, North Fork	21.29	7	100 - 39	38 - 23	22 - 0	25.76	06-Aug-07
HUC 11: 07010204030 (Upper Middle Fork Crow)									
07010204-536	07UM004	County Ditch 37	20.24	7	100 - 39	38 - 23	22 - 0	49.82	07-Aug-07
HUC 11: 07010204040 (Central Middle Fork Crow)									
07010204-511	07UM002	Crow River, Middle Fork	166.88	7	100 - 39	38 - 23	22 - 0	75.13	08-Aug-07
07010204-539	07UM010	Crow River, Middle Fork	110.03	7	100 - 39	38 - 23	22 - 0	48.64	07-Aug-07
07010204-553	07UM041	Trib. to Lake Koronis	9.19	7	100 - 39	38 - 23	22 - 0	36.98	08-Aug-07
07010204-652	07UM005	County Ditch 26	7.37	7	100 - 39	38 - 23	22 - 0	16.45	08-Aug-07

HUC 11: 07010204050 (Lower Middle Fork Crow)									
07010204-511	07UM011	Crow River, Middle Fork	270.39	7	100 - 39	38 - 23	22 - 0	75.89	09-Aug-07
07010204-532	07UM016	County Ditch 47	24.54	7	100 - 39	38 - 23	22 - 0	31.65	08-Aug-07
07010204-600	07UM006	Trib. to Crow River, Middle Fork	37.04	7	100 - 39	38 - 23	22 - 0	26.69	08-Aug-07
HUC 11: 07010204060 (Long Lake Outlet)									
07010204-514	99UM045	Grove Creek	47.51	7	100 - 39	38 - 23	22 - 0	45.16	13-Sep-99
HUC 11: 07010204070 (Jewett Creek)									
07010204-585	01UM002	Jewitts Creek	26.25	7	100 - 39	38 - 23	22 - 0	13.20	20-Sep-01
07010204-585	01UM001	Jewitts Creek	26.38	7	100 - 39	38 - 23	22 - 0	16.14	20-Sep-01
07010204-585	07UM028	Jewitts Creek	37.72	7	100 - 39	38 - 23	22 - 0	31.02	14-Aug-07
HUC 11: 07010204090 (Middle North Fork Crow)									
07010204-504	00UM056	Crow River, North Fork	318.30	7	100 - 39	38 - 23	22 - 0	71.19	19-Sep-00
07010204-504	07UM074	Crow River, North Fork	318.56	7	100 - 39	38 - 23	22 - 0	52.15	08-Aug-07
HUC 11: 07010204100 (Washington Creek)									
07010204-518	07UM014	County Ditch 9	83.39	6	100 - 48	47 - 32	31 - 0	21.39	14-Aug-07
07010204-518	07UM030	Washington Creek	47.67	5	100 - 37	36 - 21	20 - 0	31.36	14-Aug-07
07010204-547	07UM020	County Ditch 36	28.99	6	100 - 48	47 - 32	31 - 0	14.31	14-Aug-07
HUC 11: 07010204110 (Collinwood Creek)									
07010204-604	07UM015	Collinwood Creek	66.48	6	100 - 48	47 - 32	31 - 0	22.90	14-Aug-07
HUC 11: 07010204120 (Sucker Creek)									
07010204-684	07UM100	Sucker Creek	29.60	6	100 - 48	47 - 32	31 - 0	22.67	08-Aug-07
07010204-684	07UM058	Sucker Creek	26.37	6	100 - 48	47 - 32	31 - 0	24.06	08-Aug-07
HUC 11: 07010204130 (Twelve Mile Creek)									
07010204-563	07UM099	County Ditch 10	23.51	6	100 - 48	47 - 32	31 - 0	27.36	08-Aug-07

Appendix 5.1 Minnesota statewide IBI thresholds and confidence limits

	Use Class	Drainage Area	Invertebrate Class	Threshold	CI	Upper	Lower
Fish							
	2B	5 mi^2 -> 34 mi^2	--	46	±13.5	59.5	32.5
	2B	35mi^2 -> 199 mi^2	--	46	±13.5	59.5	32.5
	2B	200 mi^2 ->	--	61	±13.5	74.5	47.5
Invertebrates							
	2B	0 mi^2 -> 39 mi^2	GP	54.005	±14.9	68.905	39.505
	2B	40 mi^2 ->	GP	57.66	±14.9	72.56	72.56
	2B	0 mi^2 -> 499 mi^2	RR	52.556	±14.9	67.456	67.456

Appendix 5.2 Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B	39	±11	50	28
2	Southern Streams	2B	45	±9	54	36
3	Southern Headwaters	2B	51	±7	58	44
4	Northern Rivers	2B	35	±9	44	26
5	Northern Streams	2B	50	±9	59	41
6	Northern Headwaters	2B	40	±16	56	24
7	Low Gradient	2B	40	±10	50	30

Invertebrates						
1	Northern Forest Rivers	2B	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B	52.4	±13.6	66	38.8
5	Southern Streams RR	2B	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B	38.3	±13.6	51.9	24.7

Appendix 5.3 Biological monitoring results – fish IBI

National Hydrography Dataset (NHD)Assessment Segment AUID	BiologicalStation ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 11: 07010204010 (Upper North Fork Crow)							
07010204-579	07UM036	Sedan Brook	19.03	7	40	0	19-Jun-07
07010204-685	99UM050	Crow River, North Fork	103.11	5	50	48	15-Jul-99
07010204-685	07UM003	Crow River, North Fork	85.56	5	50	46	20-Jun-07
07010204-685	07UM009	Crow River, North Fork	209.87	5	50	48	26-Jun-07
07010204-687	07UM035	Crow River, North Fork	270.57	5	50	32	20-Aug-07
HUC 11: 07010204030 (Upper Middle Fork Crow)							
07010204-537	07UM008	Crow River, Middle Fork	47.68	7	40	66	26-Jul-07
07010204-577	07UM007	County Ditch B6	17.24	6	40	79	21-Jun-07
07010204-577	07UM007	County Ditch B6	17.24	6	40	57	22-Aug-07

HUC 11: 07010204030 (Upper Middle Fork Crow)							
07010204-537	07UM008	Crow River, Middle Fork	47.68	7	40	66	26-Jul-07
07010204-577	07UM007	County Ditch B6	17.24	6	40	79	21-Jun-07
07010204-577	07UM007	County Ditch B6	17.24	6	40	57	22-Aug-07
HUC 11: 07010204060 (Long Lake Outlet)							
07010204-514	07UM026	Grove Creek	50.37	5	50	18	25-Jun-07
HUC 11: 07010204070 (Jewett Creek)							
07010204-552	99UM055	Trib. to Crow River, North Fork	21.94	6	40	27	01-Jul-99
07010204-552	07UM027	Trib. to Jewitts Creek	21.27	7	40	0	02-Jul-07
07010204-585	00UM097	Jewitts Creek	29.60	6	40	15	06-Sep-00
07010204-585	00UM097	Jewitts Creek	29.60	6	40	32	21-Jul-08
HUC 11: 07010204090 (Middle North Fork Crow)							
07010204-504	07UM029	Crow River, North Fork	325.83	5	50	32	27-Jun-07
07010204-504	07UM029	Crow River, North Fork	325.83	5	50	28	22-Aug-07
07010204-506	07UM013	Crow River, North Fork	791.28	4	35	25	03-Jul-07
07010204-507	07UM021	Crow River, North Fork	683.49	4	35	20	28-Jun-07
07010204-507	07UM021	Crow River, North Fork	683.49	4	35	25	23-Aug-07
07010204-572	07UM023	Stag Brook	5.27	7	40	31	25-Jun-07
07010204-572	07UM023	Stag Brook	5.27	7	40	40	20-Aug-07
HUC 11: 07010204120 (Sucker Creek)							
07010204-682	07UM061	Sucker Creek	46.25	6	40	75	24-Jul-07
HUC 11: 07010204130 (Twelve Mile Creek)							
07010204-679	99UM060	Twelve Mile Creek	48.30	6	40	38	07-Jul-99
HUC 11: 07010204140 (Mill Creek)							
07010204-524	07UM047	Mill Creek	28.00	6	40	40	19-Jul-07

HUC 11: 07010204160 (Lower North Fork Crow)							
07010204-503	07UM046	Crow River, North Fork	1339.72	4		4	07-Jul-99
07010204-543	99UM025	Trib. to Crow River, North Fork	3.71	6	40	32	16-Jul-07
07010204-556	07UM059	Crow River, North Fork	1002.49	4	35	0	18-Jul-07
07010204-556	07UM050	Crow River, North Fork	1095.51	4	35	25	23-Jul-07
07010204-556	07UM055	Crow River, North Fork	1199.45	4	35	28	24-Jul-07
07010204-656	07UM049	Trib. to Crow River, North Fork	4.26	6	40	26	25-Jul-07
HUC 11: 07010204190 (Crow)							
07010204-502	00UM080	Crow River	2637.15	4	35	32	26-Jul-00
07010204-502	00UM081	Crow River	2750.27	4	35	28	14-Aug-00
07010204-502	00UM080	Crow River	2637.15	4	35	31	25-Jul-07
07010204-502	00UM081	Crow River	2750.27	4	35	30	23-Aug-07
07010204-525	00UM070	Trib. to Crow River	4.58	6	40	20	18-Aug-00

Appendix 5.4 Biological monitoring results – macroinvertebrate IBI

National Hydrography Dataset (NHD)Assessment Segment AUID	BiologicalStation ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 11: 07010204010 (Upper North Fork Crow)							
07010204-687	07UM035	Crow River, North Fork	270.57	6	46.8	36.14	08-Aug-07
HUC 11: 07010204130 (Twelve mile Creek)							
07010204-537	07UM008	Crow River, Middle Fork	47.68	7	38.3	47.43	07-Aug-07
07010204-577	07UM007	County Ditch B6	17.24	7	38.3	68.83	07-Aug-07
HUC 11: 07010204060 (Long Lake Outlet)							
07010204-514	07UM026	Grove Creek	50.37	7	38.3	25.19	09-Aug-07
HUC 11: 07010204070 (Jewett Creek)							
07010204-552	99UM055	Trib. to Crow River, North Fork	21.94	5	35.9	37.26	13-Sep-99
07010204-552	07UM027	Trib. to Jewitts Creek	21.27	7	38.3	8.28	17-Sep-00
07010204-585	00UM097	Jewitts Creek	29.60	7	38.3	16.22	09-Aug-07
HUC 11: 07010204090 (Middle North Fork Crow)							
07010204-504	07UM029	Crow River, North Fork	325.83	5	35.9	33.60	08-Aug-07
07010204-506	07UM013	Crow River, North Fork	791.28	2	30.7	36.76	08-Aug-07
07010204-507	07UM021	Crow River, North Fork	683.49	2	30.7	60.82	09-Aug-07
07010204-572	07UM023	Stag Brook	5.27	6	46.8	26.35	14-Aug-07
HUC 11: 07010204120 (Sucker Creek)							
07010204-682	07UM061	Sucker Creek	46.25	6	46.8	41.91	09-Aug-07
HUC 11: 07010204140 (Mill Creek)							
07010204-524	07UM047	Mill Creek	28.00	6	46.8	60.90	09-Aug-07

HUC 11: 07010204160 (Lower North Fork Crow)							
07010204-503	07UM046	Crow River, North Fork	1339.72	2	30.7	24.40	14-Sep-99
07010204-503	07UM046	Crow River, North Fork	1339.72	2	30.7	13.61	09-Aug-07
07010204-543	99UM025	Trib. to Crow River, North Fork	3.71	6	46.8	37.78	09-Aug-07
07010204-556	07UM055	Crow River, North Fork	1199.45	2	30.7	24.31	13-Aug-07
07010204-556	07UM059	Crow River, North Fork	1002.49	2	30.7	40.36	13-Aug-07
07010204-556	07UM050	Crow River, North Fork	1095.51	2	30.7	46.63	13-Aug-07
HUC 11: 07010204190 (Crow)							
07010204-502	00UM080	Crow River	2637.15	2	30.7	22.85	21-Sep-00
07010204-502	00UM081	Crow River	2750.27	2	30.7	35.54	21-Sep-00
07010204-502	00UM081	Crow River	2750.27	2	30.7	24.21	13-Aug-07
07010204-502	00UM080	Crow River	2637.15	2	30.7	11.47	13-Aug-07

Appendix 6 AUID table of results (by parameter and beneficial use)

Full support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets Standards or Ecoregion Norms (+); Exceeds Standards or Ecoregion Norms (-); Channelized streams were not assessed for aquatic life.

				USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS			
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Oxygen Demand (BOD)	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010204010 (Upper North Fork Crow)																							
07010204-531	Skunk River	Headwaters to N Fk Crow R	9.6	7				NA	NA							IF	+						
07010204-576	County Ditch 5	Unnamed cr to N Fk Crow R	6.9	2B	IF	NA											+	+				-	
07010204-579	Sedan Brook	CD 36 to N Fk Crow R	2.4	2B	NA	NA		-								NS	+	+					
07010204-580	County Ditch 7	Unnamed ditch to N Fk Crow R	2.7	2B	IF	NA		NA								IF	+	+	+		-		
07010204-581	County Ditch 7	Unnamed ditch to N Fk Crow R	4.7	2B	IF	NA		NA	NA							IF	+	+					
07010204-582	Judicial Ditch 1	Unnamed ditch to Grove Lk	1.8	2B	IF	NA										NS	+	+	+				

07010204-583	Judicial Ditch 1	Lincoln Lk to Unnamed ditch	2.2	2B	NA	NA											NS	+	+						
07010204-584	Judicial Ditch 1	Unnamed ditch to N Fk Crow R	3.4	2B	IF	NA			NA								NS	+	+						
07010204-650	Unnamed creek	Unnamed cr to N Fk Crow R	2.4	2B	NA	NA			NA																
07010204-685	Crow River, North Fork	Headwaters (Grove Lk 61-0023-00) to Rice Lk	47.8	2B	NS	NA	NS		-	NA				+				+	+				-	-	+
07010204-687	Crow River, North Fork	Rice Lk to Lk Koronis	3.6	2B	NS	FS	NS		NA	-				+			NS	+	+				-	+	+
07010204-700	County Ditch 36	CD 38 to Sedan Bk	1.4	2B	NA	NA			NA																
HUC 11: 070102004020 (Raymond Lake)																									
07010204-578	County Ditch 32	Unnamed ditch to N Fk Crow R	2.0	2B	IF	NA			NA								NS	+	+	+			-		
HUC 11: 07010204030 (Upper Middle Fork Crow)																									
07010204-536	County Ditch 37	Unnamed cr to M Fk Crow R	6.8	2B	IF	NA			NA	NA									+						
07010204-537	Crow River, Middle Fork	Headwaters to Mud Lk	8.1	2B	FS	NA			+	+								+	+					+	
07010204-539	Crow River, Middle Fork	Mud Lk to Nest Lk	5.5	2B	IF	IF			NA	NA				+	IF		NS	+	+	+			-	+	
07010204-577	County Ditch B6	Unnamed cr to M Fk Crow R	1.3	2B	FS	NA			+	+									+						
07010204-651	Unnamed creek	Long Lk to M Fk Crow R	1.7	2B	IF	NA																			

HUC 11: 07010204040 (Central Middle Fork Crow)																									
07010204-511	Crow River, Middle Fork	Green Lk to N Fk Crow R	15.9	2B	IF	NS			NA	NA				+	NS		IF	+	+	+			-	+	
07010204-541	Crow River, Middle Fork	Nest Lk to Green Lk	0.1	2B	NA	NA													+					+	
07010204-553	Unnamed creek (County Ditch 4)	Unnamed cr to Lk Koronis	1.5	2B	IF	NA			NA	NA							IF	+	+					-	
07010204-569	County Ditch 26	Unnamed ditch to Lk Calhoun	1.0	2B	IF	NA													-					-	
07010204-652	County Ditch 26	Unnamed ditch to Unnamed ditch	1.5	2B	NA	NA			NA	NA															
HUC 11: 07010204050 (Lower Middle Fork Crow																									
07010204-511	Crow River, Middle Fork	Green Lk to N Fk Crow R	15.9	2B	IF	NS			NA	NA				+	NS		IF	+	+	+			-	+	
07010204-532	County Ditch 47	Headwaters to M Fk Crow R	9.5	2B	NA	NA			NA	NA															
07010204-589	Unnamed creek	Unnamed cr to Diamond Lk	0.3	2B	IF	NA												+					-		
07010204-600	Unnamed creek	Unnamed ditch to M Fk Crow R	1.0	2B	NA	NA			NA	NA															
07010204-672	Unnamed creek	Headwaters to Wheeler Lk	3.0	2B	IF	NA												+					-		

HUC 11: 07010204060 (Long Lake Outlet)																									
07010204-514	Grove Creek	Unnamed cr to N Fk Crow R	10.1	2B	NS	NS			-	-				+	NS		NS	+	-	+		+	-	-	
07010204-535	Unnamed creek	Town Slough to Grove Cr	2.1	7					NA																
07010204-642	Grove Creek	Unnamed cr to Unnamed cr	0.3	2B	NA	NA			NA																
07010204-643	County Ditch 26	Unnamed lk to Long Lk	2.2	2B	IF	NA			NA										-						
07010204-696	Unnamed creek	Long Lk to Unnamed cr	3.2	2B	NA	NA									FS		NS								
HUC 11: 07010204070 (Jewett Creek)																									
07010204-552	Unnamed creek (Battle Creek)	T120 R31W S32, south line to Jewitts Cr	6.4	2C	NS	NA			-	-								+					-	-	
07010204-585	Jewitts Creek (County Ditch 19, 18, and 17)	Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	8.6	2C	NS	NS			-	-				-	NS		NS	+	+	+		+	-	-	
07010204-614	County Ditch 19	Chicken Lk to Jewitts Cr	1.0	2B	NA	NA			NA	NA															

HUC 11: 07010204080 (Litchfield)																									
07010204-548	Unnamed creek	Unnamed cr to Unnamed cr	3.6	28	NA	NA			NA	-													-	-	
07010204-615	Unnamed creek (County Ditch 35)	Unnamed to Richardson	1.6	28	IF	NA								+										-	
07010204-616	Unnamed creek (County Ditch 35)	Headwaters to Unnamed cr	2.7	2B	IF	NA								+											
07010204-623	Unnamed creek	Dunns Lk to CD 36	2.0	2B	IF	NA								+										-	
HUC 11: 07010204090 (Middle North Fork Crow)																									
07010204-504	Crow River, North Fork	Lk Koronis to M Fk Crow R	8.7	2B	NS	NA	NS		-	-				+			IF	+	+	+			-		
07010204-506	Crow River, North Fork	Jewitts Cr to Washington Cr	22.3	2B	NS	IF	NS		-	-				+	IF		IF	+	-	+			-	-	
07010204-507	Crow River, North Fork	M Fk Crow R to Jewitts Cr	10.9	2B	NS	NS	NS		-	+				+	NS		IF	+	+	+		+	-	-	
07010204-572	Stag Brook	Headwaters (Unnamed lk 73-0153-00) to N Fk Crow R	5.7	2C	NS	NA			-	-															
HUC 11: 07010204100 (Washington Creek)																									
07010204-518	Washington Creek (County Ditch 9)	Washington Lk to N Fk Crow R	11.1	2B	IF				NA	NA				+				+	+	+			-	-	
07010204-547	County Ditch 36	Powers Lk outlet to Washington Cr	6.1	2B	IF				NA	NA									+						
07010204-554	Sucker Creek	Unnamed cr to Lk Manuella	3.1	1B,	NA														+						

07010204-669	Lake Minnie Belle Outlet	Lk Minnie Belle to T118 R31W S12, east line	1.5	2B	IF														+						
HUC 11: 07010204110 (Collinwood Creek)																									
07010204-546	Unnamed creek (Big Swan Lake Outlet)	Big Swan Lk to N Fk Crow R	1.3	2B	NA	IF								+				+	+	+		-	-	-	
07010204-557	Silver Creek	Unnamed cr to Collinwood Lk	4.3	2B	IF	NA			NA										+						
07010204-604	Collinwood Creek	Unnamed cr (Unnamed lk 47-0031-00 outlet) to Big Swan Lk	3.8	2B	IF	NS			NA					+				+	-	+			-	-	
HUC 11: 07010204120 (Sucker Creek)																									
07010204-682	Sucker Creek	Cokato Lk to N Fk Crow R	2.3	2B	NS	IF			+	-				+				+	-	+			-	+	
07010204-684	Sucker Creek	Headwaters to Cokato Lk	14.1	2B	IF	NA			NA	NA										IF					
HUC 11: 07010204130 (Twelve Mile Creek)																									
07010204-559	County Ditch 10	Unnamed ditch to Grass Lk	2.6	2B	IF	NA													-						
07010204-560	County Ditch 10	Grass Lk to Unnamed ditch	2.0	2B	IF	NA													+						
07010204-561	Unnamed ditch	Headwaters to CD 10	2.2	2B	IF	NA													-						

07010204-563	County Ditch 10	Unnamed ditch to Unnamed ditch	2.6	2B	IF	NA			NA	NA									+						
07010204-564	County Ditch 10	Unnamed ditch to Lk Ann	0.6	2B	IF	NA													+						
07010204-565	Unnamed creek	Lk Emma to Twelve Mile Cr	2.2	2B	IF	NA													+						
07010204-595	Unnamed creek	Headwaters to Howard Lk	1.2	2B	IF	NA													+						
07010204-596	Unnamed creek	Headwaters to Howard Lk	1.	2B	IF	NA													+						
07010204-634	Unnamed creek	Waverly Lk to Little Waverly Lk	0.2	2B	NA	NA													+						
07010204-648	Unnamed creek	Headwaters to Waverly Lk	0.1	2B	NA	NA													-						
07010204-679	Twelve Mile Creek	Dutch Lk to Little Waverly Lk	3.7	2B	IF	NA													+						
07010204-681	Twelve Mile Creek	Little Waverly Lk to N Fk Crow R	3.6	2B,	NS	NS								+				+	IF	+			-	-	
HUC 11: 07010204140 (Mill Creek)																									
07010204-515	Mill Creek	Buffalo Lk to N Fk Crow R	3.7	2B	NS	NS								+				+	-	+		-	-	-	
07010204-524	Mill Creek	Ramsey Lk to Buffalo Lk	8.0	2B	FS	NA			+	+															

HUC 11: 07010204150 (Louzer Lake Outlet)																									
07010204-667	Unnamed creek	Woodland WMA wetland (86-0085-00) to N Fk Crow R	2.6	2B	NS	NS			NA					+				+	+	+		-	-	-	
07010204-668	Unnamed creek	Unnamed cr to Woodland WMA wetland (86-0085-00)	1.2	2B	IF	NS								+				+	+	+					
HUC 11: 07010204160 (Lower North Fork Crow)																									
07010204-503	Crow River, North Fork	Mill Cr to S Fk Crow R	13.7	2B	NS	NS	NS		-	-				+				+	-	+		-	-	-	
07010204-509	Eagle Creek	Unnamed cr to N Fk Crow R	2.4	2C	NA	NA			NA																
07010204-555	Crow River, North Fork	Washington Cr to Meeker/Wright County line					NS																		
07010204-556	Crow River, North Fork	Meeker/Wright County line to Mill Cr	47.7	2B	NS	NS	NS		-	-				+				+	-	+		+		-	
07010204-592	French Creek	French Lk to N Fk Crow R	2.4	2B	IF	NA			NA										+						
07010204-656	Unnamed creek	Headwaters (Granite Lk 86-0217-00) to Unnamed cr	1.7	2B	NA	NA			NA																
HUC 11: 07010204170 (Sarah Creek)																									
07010204-625	Unnamed creek	Headwaters to Lk Sarah	2.0	2B	IF	NA													+						
07010204-628	Sarah Creek	Lk Sarah to Crow R	2.5	2B	IF	NS			NA										-						

HUC 11: 07010204180 (St. Michael)																									
07010204-542	Unnamed creek (Regal Creek)	Unnamed cr to Crow R	2.3	2B	NS	NS								+				+	+	+		-	-	-	
HUC 11: 07010204190 (Crow)																									
07010204-502	Crow River	S Fk Crow R to Mississippi R	25.0	2B	NS	NS			-	-	IF	IF	IF	+		IF		+	-	+		-	-	-	
07010204-525	Unnamed creek	Headwaters to Crow R	3.1	7					NA																

Appendix 7 Minnesota's ecoregion-based lake eutrophication standards

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