Snake River Watershed Monitoring Assessment Project

Minnesota Pollution Control Agency

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

1.0 Introduction

The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. The Federal Clean Water Act (CWA) requires states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, fishing, or swimming. Section 305(b) requires a summary of the status of the state's surface waters, while Section 303(d) of the CWA requires the state 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 reductions needed to restore a water body so that it can support its intended use.

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment (MPCA 2006). To be successful preventing and addressing 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 Minnesota Legislature has recently appropriated additional resources as part of the Clean Water Legacy Act to be directed towards water quality assessment and TMDL development. In response, the MPCA has developed a watershed monitoring strategy which will promote an effective and efficient integration of water monitoring programs to provide a more complete assessment of water quality and expedite the TMDL process. This strategy utilizes a nested watershed approach allowing aggregation of watersheds from course (8-digit major watershed), intermediate (11-digit watersheds), and fine scales (14-digit minor watersheds). In the summer of 2006 a pilot study of this new monitoring strategy was conducted in the Snake River Watershed. The primary objective of this study was to integrate 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.

2.0 Study Area

Located in east-central Minnesota, the Snake River Watershed encompasses most of Kanabec County and parts of Aitkin, Mille Lacs, Pine, and Isanti Counties. The total drainage area of the watershed is 1,008 square miles. The watershed is a relatively flat glacial till plain crossed by several east-west morainal belts. The moraines are mainly undulating areas of hills and depressions (MCD 1959). Land cover percentages in the watershed are: forest (48.3%), rangeland (24.3%), wetland (14.3%), cropland (8.1%), developed (3.6%), and open water (1.3%) (Fig. 1).

The approximately 100 mile long Snake River has its source in the wetland region of Solona State Forest and flows in a southerly direction to Mora where it turns and flows eastward to its

junction with the St. Croix River below Pine City. The mean gradient is 4.9 ft./mi., one of the highest in central Minnesota, and the mean discharge is approximately 600 cfs (Waters 1977). Principal tributaries include the Groundhouse, Ann, and Knife rivers; as well as Mud, Mission, and Pokegama Creeks. The upper watershed is primarily undeveloped with extensive forest and wetland land cover. From Mora to Pine City the Snake River is considerably lower in gradient and the wooded banks give way to a wide farming valley. Downstream of Pine City the river returns to wooded bluffs and flows through a series of rapids and pools to it's confluence with the St. Croix River.

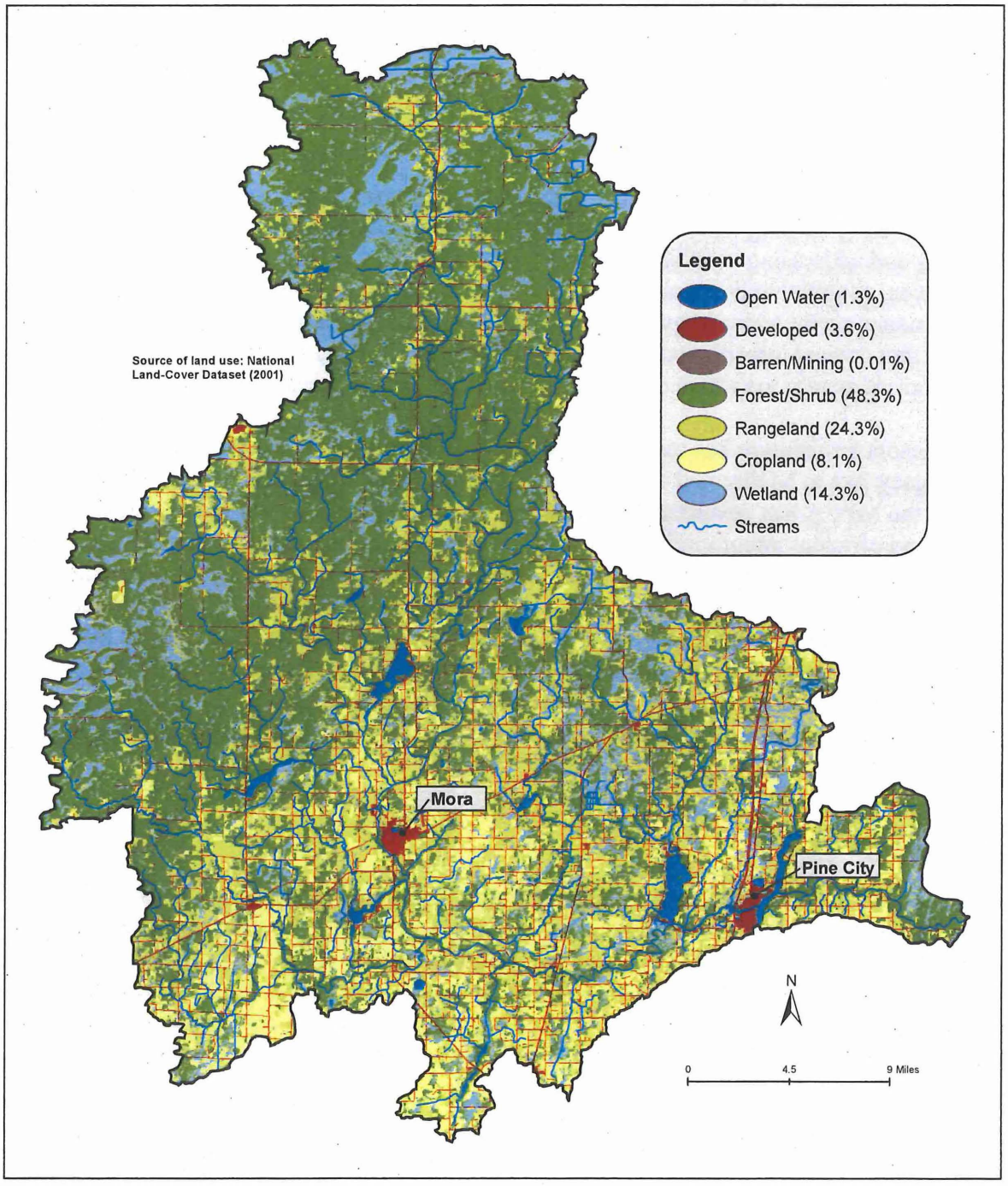

Figure 1. Land use in the Snake River Watershed.

Like much of the Upper St. Croix River Basin, the Snake River Watershed was once densely covered with stands of white pine that were extensively logged in the latter half of the 19th century. Although the second growth trees of aspen, birch and other hardwoods are still harvested for pulpwood and other wood products, agriculture is now the primary industry (MDNR 1977). As Fig. 1 illustrates, much of the agricultural activity occurs in the southern half of the watershed. Recreational opportunities such as fishing, hunting, camping, and canoeing are also numerous due to the amount of public land and river access available in the watershed.

3.0 Methods

Site selection

In the interest of restoring and protecting our water resources the legislature recently appropriated additional resources for monitoring, assessment, and TMDL development. In response, the MPCA developed a watershed monitoring strategy intended to integrate water monitoring programs to provide a more complete assessment of water quality and to facilitate the collection of data necessary for the development of TMDL's on surface waters determined to be impaired. Initially this monitoring effort will focus on streams and rivers within a watershed but could eventually include lakes and wetlands.

This new monitoring strategy utilizes a nested watershed approach allowing aggregation of watersheds from a course to fine scale (Fig. 2). The course level framework that serves as the foundation of this comprehensive monitoring strategy is the major watershed or 8-digit Hydrologic Unit Code (HUC), of which there are 81 delineated within Minnesota (Fig. 3). Intermediate (equivalent to 11-digit HUC) and minor (14-digit HUC) watersheds within the major watershed are also sampled to provide a complete assessment of water quality. Site selection is determined by systematically sampling

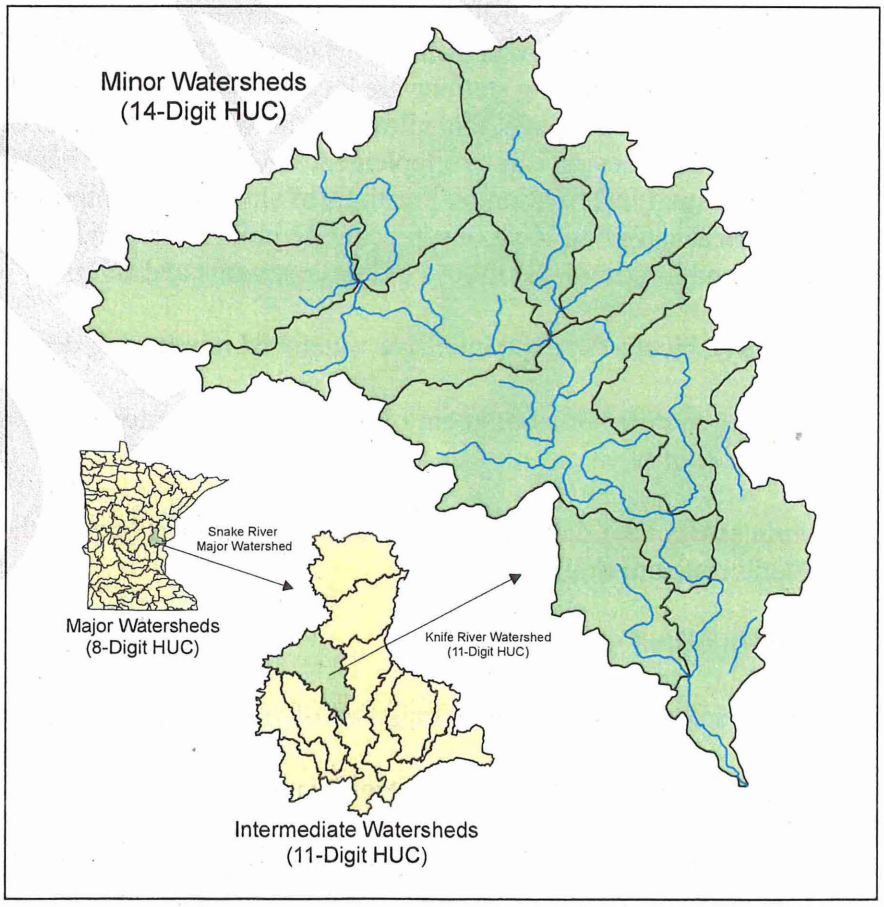

Figure 2. The nested watershed monitoring design.

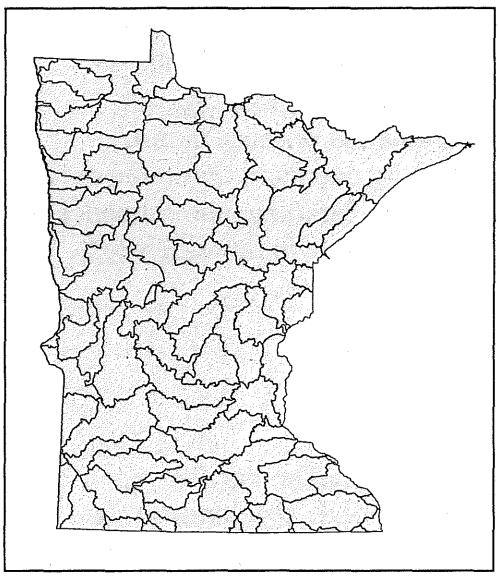

Figure 3. Major watersheds within Minnesota (8-Digit HUC).

near the mouth or "pour point" at all watershed scales. This approach provides an unbiased, systematic census of all streams within a major watershed down to the scale of minor watersheds (typically 10 -20 square mile drainage areas).

The pour point of the major watershed is sampled for biology, water chemistry, and fish contaminants to provide data for the assessment of aquatic life and aquatic consumption use support, as well as preliminary screening level data for aquatic recreation use support. Moving up the watershed, each 11-digit HUC pour point is sampled for biology and water chemistry to allow for the assessment of aquatic life use support and aquatic recreation screening. Watersheds at this scale generally consist of major tributary streams (typically 75 – 150 square miles). Lastly, most minor watersheds within each 11-digit HUC are sampled for biology to make assessments of aquatic life use support. Sampling is not conducted at some minor watersheds for reasons including; wetland or lake dominated minors that do not represent riverine conditions, flow through minors or multiple upstream minors adequately characterized by a downstream sampling location, minor watersheds representing ephemeral streams, and remote watersheds that are too difficult to access. Sampling stations are located in a systematic, unbiased manner near the pour point of each watershed outlet that allows for reasonable stream access and represents a lotic environment. This design can be supplemented with more traditional site selection protocols to provide additional information on locations of site specific interest such as; regional reference sites, historical sampling locations, bracketing point source discharges or other known locations of interest, and longitudinal surveys of larger streams and rivers.

The primary objectives of the intensive watershed monitoring design are to:

1) provide a systematic assessment of overall stream water quality within 11-digit hydrologic watershed units,

2) obtain assessment data on all water quality indicators (aquatic life, aquatic recreation, and aquatic consumption),

3) locate impaired watersheds,

4) provide information for the completion of TMDL studies on impaired waters,

5) and to more efficiently use and integrate monitoring resources.

All 81 major watersheds within Minnesota will eventually undergo a similar effort in order to complete the cycle of monitoring statewide. In addition, the watershed monitoring strategy has a

phase II component which will consist of follow up monitoring at all 11-digit HUC's determined to have impaired waters. This tailored intensive monitoring effort will be designed to collect the information needed to initiate the stressor identification process in order to identify the source(s) and cause(s) of impairment. The HUC-11 watershed units are of practical size for the development, management, and implementation of effective TMDL's and follows a similar approach used by the state of Ohio (Ohio EPA, 2005). Rather than develop TMDL's on a reach by reach basis, TMDL's can be developed at the watershed scale to address multiple impairments and more efficiently address the insidious effects of non-point source pollution. Phase II studies will be a coordinated effort between the MPCA's Environmental Analysis and Outcomes Division and the Regional Division as TMDL scheduling permits.

In the summer of 2006 a pilot study of this new monitoring strategy was conducted in the Snake River Watershed. Sixty-four sampling visits were conducted at a total of 57 discrete stations (Fig. 4) (Appendix 1). Some stations were sampled twice for quality assurance/quality control purposes. All sites were sampled for fish, invertebrates, physical habitat, and one-time water chemistry. Sampling locations representing the pour points of HUC-11 watersheds (n=11) were also sampled more extensively for water chemistry parameters. In addition, fish were collected for contaminant analyses at the site representing the pour point of the Snake River Watershed.

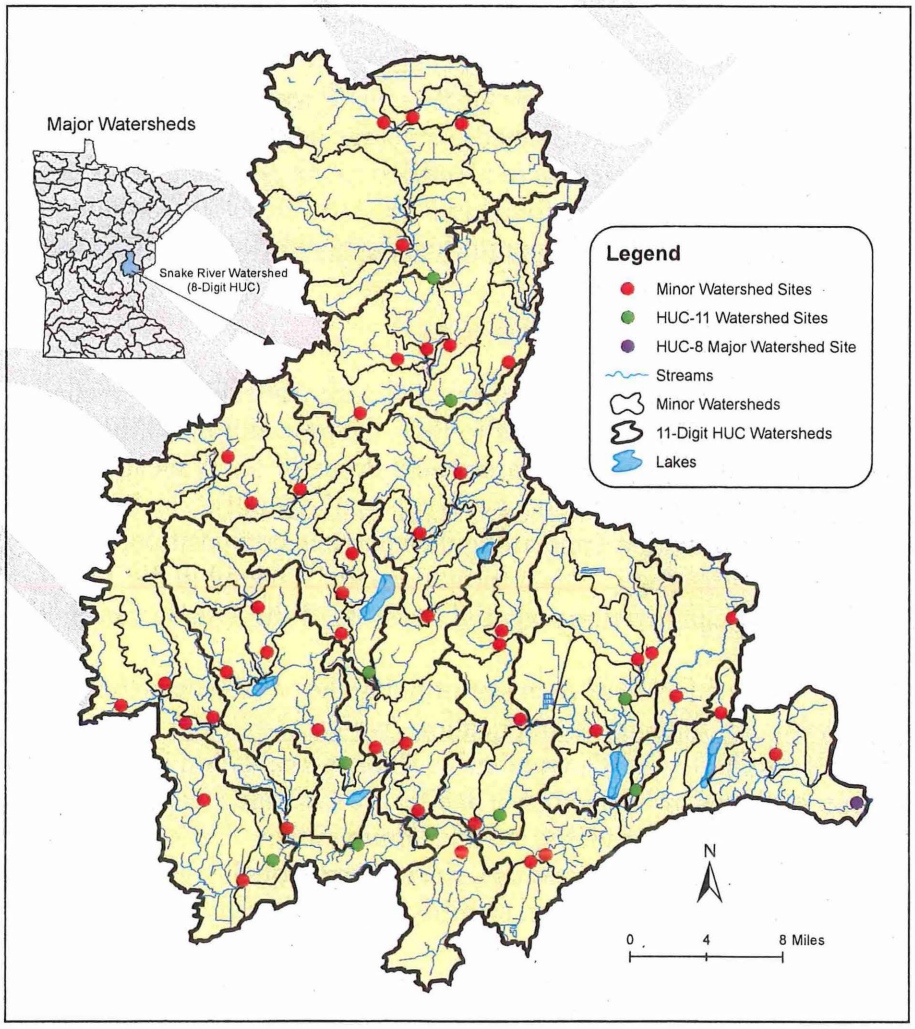

Figure 4. Monitoring stations in the Snake River Watershed.

Fish Community Assessment

Fish communities were sampled by electrofishing (pulsed DC) during base-flow conditions between June 19 and August 16, 2006. The reach length needed to collect a representative sample of fish followed guidance provided by Lyons (1992), and ranged from 150m to 500m. A single electrofishing pass was conducted at each site, sampling all available habitat types in the proportion that they occurred. Fish were processed in the field, and included identifying each individual to species, enumeration, batch weights by species, minimum and maximum total length of each species, and recording any external abnormalities. Discussion of the fish community methodology utilized can be found in Niemela and Feist (2000) or see MPCA Fish Community Sampling Protocol for Stream Monitoring Sites available at: www.pca.state.mn.us/water/biomonitoring/sf-sop-fish.pdf.

Macroinvertebrate Community Assessment

Macroinvertebrate communities were sampled during base-flow conditions between July 31 and September 6, 2006. A qualitative multi-habitat (QMH) sample was collected at each site to characterize the overall macroinvertebrate diversity of the sample reach. A D-frame dip net and sieve bucket (both 500 *u*m mesh) were the only equipment required for this sampling method. A total of 20 sampling efforts were collected at each site, sampling each of the major productive habitat types present within the reach in equal proportion. All material collected by the 20 sampling efforts was composited in a sieve bucket, transferred to 1 L plastic sample jars, and preserved in 100% denatured ethanol. The QMH sample was sub-sampled by a certified lab until a minimum of 300 organisms were collected. Any large and/or rare organisms were also sampled. All organisms sub-sampled were identified to the generic level if possible. A complete discussion of the methodology can be found in MPCA Invertebrate Sampling Procedures (http://www.pca.state.mn.us/water/biomonitoring/biomonitoring-invertebratesampling.pdf).

Physical Habitat Assessment

A quantitative habitat assessment was performed at each wadeable site to characterize the quality of habitat available at the stream reach and follows the procedures outlined in the MPCA Physical Habitat and Water Chemistry Assessment Protocol for Wadeable Stream Monitoring Sites (http://www.pca.state.mn.us/publications/wq-bsm3-01.pdf). The habitat assessment provides quantitative information concerning the substrate composition, cover for fish, riparian land use, and stream morphology. This information can be useful in the TMDL and stressor identification process to characterize potential stressors of the aquatic community.

Physical habitat is also evaluated at each site utilizing the Minnesota Stream Habitat Assessment (MSHA)(http://www.pca.state.mn.us/publications/wq-bsm3-02.pdf). The MSHA is a qualitative habitat assessment similar to Ohio's Qualitative Habitat Evaluation Index (QHEI)(Rankin 1989, 1995). Important attributes of the available habitat are evaluated and scored based on their overall importance to supporting viable aquatic communities. The MSHA rates the habitat at a stream reach based on surrounding land use, riparian zone quality and bank erosion, substrate and in-stream cover quality, and channel stability and complexity.

Water Chemistry Assessment

Surface water samples of total phosphorous (TP), ammonia nitrogen ($NH^3 + NH^4$), total suspended solids (TSS), and nitrite-nitrate ($NO^2 + NO^3$) were collected once at each site. Samples were collected into appropriate containers, preserved, and delivered to the Minnesota Department of Health for analysis within specified holding times. Field measurements were also performed for dissolved oxygen, pH, specific conductance, transparency, and water temperature using standard methods.

At the eleven sites representing the pour-point of each HUC-11 watershed within the Snake River Watershed, more extensive water chemistry sampling was conducted in order to provide additional information for the assessment of water quality condition and use support. In addition to the parameters indicated above, samples were taken for the analysis of chloride, sulfate, and *E. coli* bacteria using standard methods. Samples were taken twice each month from May through September for a total of ten samples over this period. Stations were established in Storet for all sites representing the HUC-11 watersheds.

In 1998, the Snake River Watershed Management Board (SRWMB) and its local partners established a long term monitoring program in an attempt to identify problem areas and provide a baseline of water quality information for future evaluation efforts in the Snake River Watershed. As part of this effort, twelve sample stations were established in strategic locations throughout the watershed to characterize localized water quality/quantity conditions. Samples were collected once per week for six weeks during spring melt (April – May), twice per month June – November, and two storm event samples over a ten year period. Water chemistry parameters collected were similar to those proposed for this study with the exception of chloride, sulfate, $NH^3 + NH^4$, and specific conductance. Additionally, fecal coliform data was collected in lieu of *E. coli*. In an effort to more efficiently use monitoring resources and collaborate with local partners it was determined that six of the existing SRWMB sampling locations could serve as the HUC-11 pour point station for the purposes of this study. The watersheds that were adequately represented by existing SRWMB stations included: the Upper Snake River, Knife River, Mission Creek, Groundhouse River, Pokegama Creek, and Mud Creek watersheds. The data collected by the SRWMB for these stations was used in lieu of the MPCA sampling these stations in 2006, the period of record and number of samples varies by station.

Fish Contaminants

The MPCA watershed monitoring strategy contains a component that requires the collection of fish at stations representing the pour point of the major watershed (8-digit HUC). The objective is to collect fish for the analysis of contaminants to assess whether or not the surface water is meeting the beneficial use of aquatic consumption. The acceptability of fish for human consumption is considered a beneficial use separate from aquatic life use support. Of the bioaccumulative pollutants that have been monitored in fish, mercury and PCBs are the primary contaminants found at levels of concern to human consumers of fish. Top carnivore species are particularly important for mercury analysis and rough fish species for PCB analysis.

It was determined that this sampling would only be conducted at the 8-digit HUC level due to the likelihood of being able to collect the fish necessary at this scale. Collecting top carnivores of edible size becomes less likely as you progress to smaller scale watersheds, as does the prospect of citizens fishing these surface waters for consumption purposes. Therefore, the station representing the pour point of the major 8-digit watershed (06SC007) will in effect characterize the entire watershed for the purposes of aquatic consumption use support.

An adequate size class distribution of smallmouth bass (top carnivore) and shorthead redhorse (rough fish) were collected at the station representing the pour point of the Snake River Watershed (06SC007) to assess the contamination level of mercury and PCBs in the watershed. Fish were preserved using appropriate methods, deposited and processed at the Minnesota Department of Natural Resources fish processing lab, and analyzed by the Minnesota Department of Health for the contaminants of concern.

Determining Use Attainment Status

Water quality standards are the fundamental benchmarks by which the quality of surface waters is measured. It is the water quality standards that are 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 the Minnesota Water Quality Standards (Minnesota Rules Chapter 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 drinking water, fishing (aquatic life), swimming (aquatic recreation), or human 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.

Numeric water quality standards represent safe 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, and the MPCA may use a variety of tools to fully assess beneficial uses. Assessment methodologies often differ by parameter and beneficial use, and consider multiple factors of the pollutants concentration; such as chronic value, maximum value, final acute value, magnitude, duration, and frequency. For additional information see: MPCA Guidance Manual for Assessing the Quality of Minnesota Surface Waters (http://www.pca.state.mn.us/publications/wq-iw1-04.pdf).

Narrative standards are statements of unacceptable conditions in and on the water, such as biological condition, that protect their designated uses. Narrative biological criteria 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. Each metric in an IBI denotes a quantifiable attribute of the biological assemblage that changes in a predictable way with varying levels of human influence. An index typically includes 8-12 metrics that fall into 3 broad categories: 1) species richness and composition, 2) trophic

composition and reproductive function, and 3) abundance and condition. The unitless scores assigned to each metric quantify how far any particular metric value deviates from a range of reference values. When the metrics are summed together the resulting score characterizes the biological integrity or "health" of a site (Karr et al. 1986). Because the rivers and streams in Minnesota are physically, chemically and biologically diverse, the measured characteristics are compared to specific reference values for the type and size of river or stream within a geographic region that minimizes natural variablity. The index scores at reference sites provide the basis for establishing impairment thresholds and making determinations of aquatic life use support.

Biological data are used to assess stream reaches for impaired biological condition for both the 305(b) report and the 303(d) list. The period of record is the most recent decade of data and information. Biological assessments can be based on a single biological monitoring event on a given waterbody. Sites that have IBI scores above the threshold level of impairment are considered to be **fully supporting** of aquatic life. Sites that have IBI scores below the threshold level of impairment are considered **non-supporting** of aquatic life. Confidence limits (95%) have been applied to the reference site based IBI impairment thresholds. Sites with IBI scores within the confidence limits will be further evaluated by professional judgment teams. A **partial support** status may be assigned to a stream segment if multiple samples taken at sites within the assessment unit provide discrepant information. Reaches that are non-supporting or partially supporting of their aquatic life uses are identified as candidates for the 303(d) list. Preliminary impairment thresholds used to assess riverine surface waters in the St. Croix River Basin, which includes the Snake River Watershed , can be found in Table 1. Large rivers (> 270 mi^2) were not assessed due to a dataset currently insufficient for IBI calibration.

Table 1. Initial Assessment and Fish Community IBI Thresholds for the 305(b) Report and 303(d) List in the St. Croix River Basin.

	Use Support or Listing Category Based on IBI score		
Drainage Area	Full Support Not Listed	Partial Support Listed	Non-Support Listed
< 20 mi^2	IBI ≥ 46	Assessment unit has multiple sites with discrepant results	IBI < 46
20 mi^2 - 54 mi^2	IBI ≥ 68		IBI < 68
55 mi^2 - 270 mi^2	IBI ≥ 69		IBI < 69

Following the initial assessment based on the IBI scores, a final determination of impairment for 303(d) listing is based on an assessment of all available information. This information includes habitat quality, available water chemistry data, the biological condition of nearby upstream and downstream segments, local land use information, and other watershed data. The MPCA will present this information to the appropriate professional judgment team for the basin in which the reach is located to help make final determinations of use support for 303(d) listing.

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river system assessments is the river reach or "assessment unit". A river assessment unit usually extends from one significant tributary stream to another or from the headwaters to

the first tributary and is variable in length. A reach may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minnesota Rules, Chapter 7050), or when there is a significant morphological feature such as a dam or lake within the reach. The MPCA is using the 1:24,000 scale High Resolution National Hydrologic Dataset (NHD) to define and index stream assessment units. Each river reach is identified by a unique waterbody identifier (known as it's AUID), comprised of the USGS eight digit hydrologic unit code plus a three character code that is unique within each HUC. It is for these specific reaches that the data are evaluated for potential use impairment.

To help refine the approach for assessing biological communities, US EPA is encouraging states to develop and adopt a tiered aquatic life use system (TALUS) for their waters. The MPCA began exploring TALUS development in earnest following the 2006 listing cycle. As part of that effort and through discussions with stakeholders, questions have been raised about the process for assessing ditches in Minnesota. In 2006, the MPCA engaged other state agencies and stakeholders in a discussion of the monitoring, assessment and listing process, including the approach for assessing ditches. An outcome of that discussion was the recommendation to defer listing any new ditches for aquatic life impairments, unless acutely toxic conditions are found, until appropriate thresholds are developed for ditches through the TALUS development effort.

4.0 Results and Discussion

Results are presented for each of the 11-digit HUC watershed units sampled within the Snake River Watershed in 2006, enabling us to assess all surface waters at one time and develop comprehensive TMDL studies on a watershed basis rather than the reach by reach approach historically used. This scale provides a robust assessment of water quality condition in the watershed unit and is a practical size for the development, management, and implementation of effective TMDL's. A list of all sampling sites by AUID, IBI score, and use attainment status is provided in Appendix 2.

Fish contaminant results are reported separately because the data requirements and protocols used in the assessments are very different. The acceptability of fish for human consumption is considered a beneficial use separate from aquatic life use support. This is because the two uses are assessed independently; i.e., a waterbody may be impaired for one but not the other. In other words, toxicants may be at levels that have no ill effects on aquatic life (fully supporting), but due to bioaccumulation, the fish are not safe to eat (impaired for aquatic consumption). The graphics presented for each of the 11-digit HUC watershed units include impairments of aquatic consumption but are not discussed here because assessments are not typically made at the individual AUID level as they are for other beneficial uses.

Biological criteria has not yet been developed for all stream types, therefore, assessment of aquatic life use support was not possible at some sampling sites. Streams types that were not assessed include coldwater streams, large rivers, channelized streams or ditches, and streams characterized by a predominant wetland condition (wetland habitat, naturally low dissolved oxygen, and depauperate fish community). Information on the development and use of the St. Croix River Basin IBI can be found in Niemela and Feist (2000) available at: http://www.pca.state.mn.us/water/biomonitoring/sf-ibi-stcroix.pdf

Invertebrate data has not yet been assessed because of the drought conditions experienced in 2006 during the invertebrate sampling index period of August and September. MPCA staff are currently evaluating the effects of drought on invertebrate community structure in an effort to determine the applicability of these samples to characterize water quality condition. Information on the MIBI for streams of the St. Croix River Basin (Chirhart 2003) can be found at: http://www.pca.state.mn.us/publications/reports/biomonitoring-mibi-stcroix.pdf

Water chemistry results are presented in a summary table for each 11-digit HUC. The data, as presented, is not a determination of use support as the data requirements and assessment methodologies differ by parameter and any assessment of use support would utilize all available data on an AUID within the most recent 10-year period. In addition, 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 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. The intent of these summary tables is to present the data collected as part of this study and to highlight potential parameters of concern. Summary tables for existing SRWMB long term monitoring stations represent data collected over their period of record and typically contain multiple years of data.

Upper Snake River Watershed Unit – HUC 07030004010

The Upper Snake River Watershed Unit, located in southeast Aitkin County, drains an area of 129.3 square miles. The watershed forms the headwaters of the Snake River and consists of several low gradient, bog stained streams that originate in large alder, willow, and black spruce swamps. The upper Snake River flows in a westerly direction to the small community of Pliny, where it turns and flows south to McGrath. The entire watershed is largely undeveloped and consists predominantly of forest, shrub, and wetland land cover (Fig. 5). The pour point of this watershed unit is 2 miles SE of McGrath at the Hwy. 18 bridge, and is represented by site 06SC132.

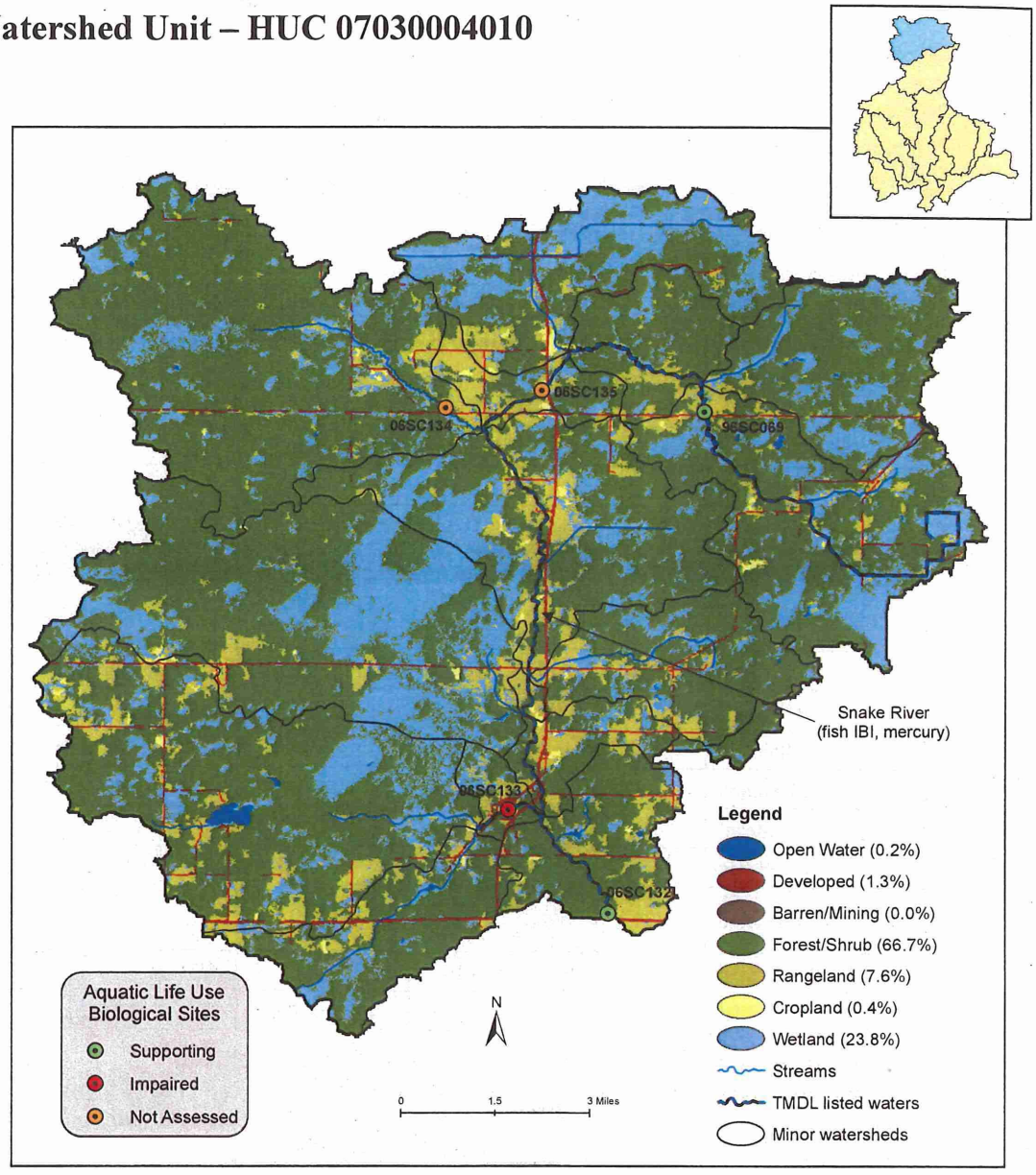

Figure 5. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Upper Snake River Watershed Unit.

Five biological sampling events were conducted at discrete stations within the Upper Snake River Watershed Unit in 2006. Two sites on the main-stem Snake River (96SC069 and 06SC132) have IBI scores of 86 and 69 respectively, and are fully supporting for aquatic life. However, the Snake River reach from the headwaters to Hay Creek (AUID 07030004-508) was listed as impaired for aquatic life (F-IBI) in a previous assessment cycle (2002). Available data on this AUID suggests that the impairment is likely due to the previous assessment of data from a channelized reach, as all IBI scores from stations exhibiting natural stream channels indicate full support. The station on Bear Creek in the town of McGrath (06SC133) has an IBI score of 33 and is not supporting for aquatic life. This is significantly below the biological criterion of IBI $\geq$ 68 for this stream type and Bear Creek (AUID 07030004-552) was added to the impaired waters list in the 2008 Assessment Cycle. Bear Creek was also listed in 2008 for pH based on available data from an existing SRWMB monitoring station. Two sites (06SC134, Trib. to Snake River and 06SC135, Snake River) were not assessed in this watershed during

the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Upper Snake River Watershed Unit (06SC132) between 4/9/2001 and 9/28/2006. Results indicate that no parameters for which there is data are in potential violation of water quality standards or exceed ecoregion expectations (Table 2).

Table 2. Water chemistry results at the site representing the pour point of the Upper Snake River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Snake River at HWY 18, 2 mi. SE of McGrath, MN											
Storet ID:	S001-727											
Station ID:	06SC132 – pour point of Upper Snake River HUC-11 Watershed (07030004-010)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples		21	16		19	21	39	38			49	67
Minimum		6.6	1		0.005	6.8	0.02	0.5			-.6	23
Maximum		13.3	1100		0.08	8.5	0.09	11.0			24.4	60
Mean[1]		9.4	42		0.016	7.3	0.04	2.7			11.6	57.9
Median		8.96	50		0.005	7.2	0.035	2.0			10.6	60
WQ standard	230	5.0	200/ 2000			6.5 - 9.0					30	20
# WQ exceedances[2]		0/21	0/16			0/21					0/49	0/67
NLF 75th percentile[3]				0.2	0.03	7.9	0.05	5.6	260		21.7	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

With the exception of Bear Creek, water quality conditions within the Upper Snake River Watershed Unit appear to be adequate and meeting their designated uses. Phase II monitoring in the watershed could be restricted to the Bear Creek sub-watershed in order to identify the source(s) and cause(s) of the impairment.

Lower Upper Snake River Watershed Unit – HUC 07030004020

The Lower Upper Snake River Watershed Unit, located in southeast Aitkin and northern Kanabec Counties, encompasses an area of 113.5 square miles. The watershed unit includes the Snake River main-stem from Hwy 18, 2 miles SE of McGrath to the confluence of Chelsey Brook. Like the Upper Snake River Watershed, it is largely undeveloped and consists predominantly of forest, shrub, and wetland land cover (Fig. 6). Named minor watersheds within this watershed unit include Bergman, Cowan's, and Chelsey brooks, and Hay Creek. The pour point of this watershed unit is represented by site 06SC123, on the Snake River.

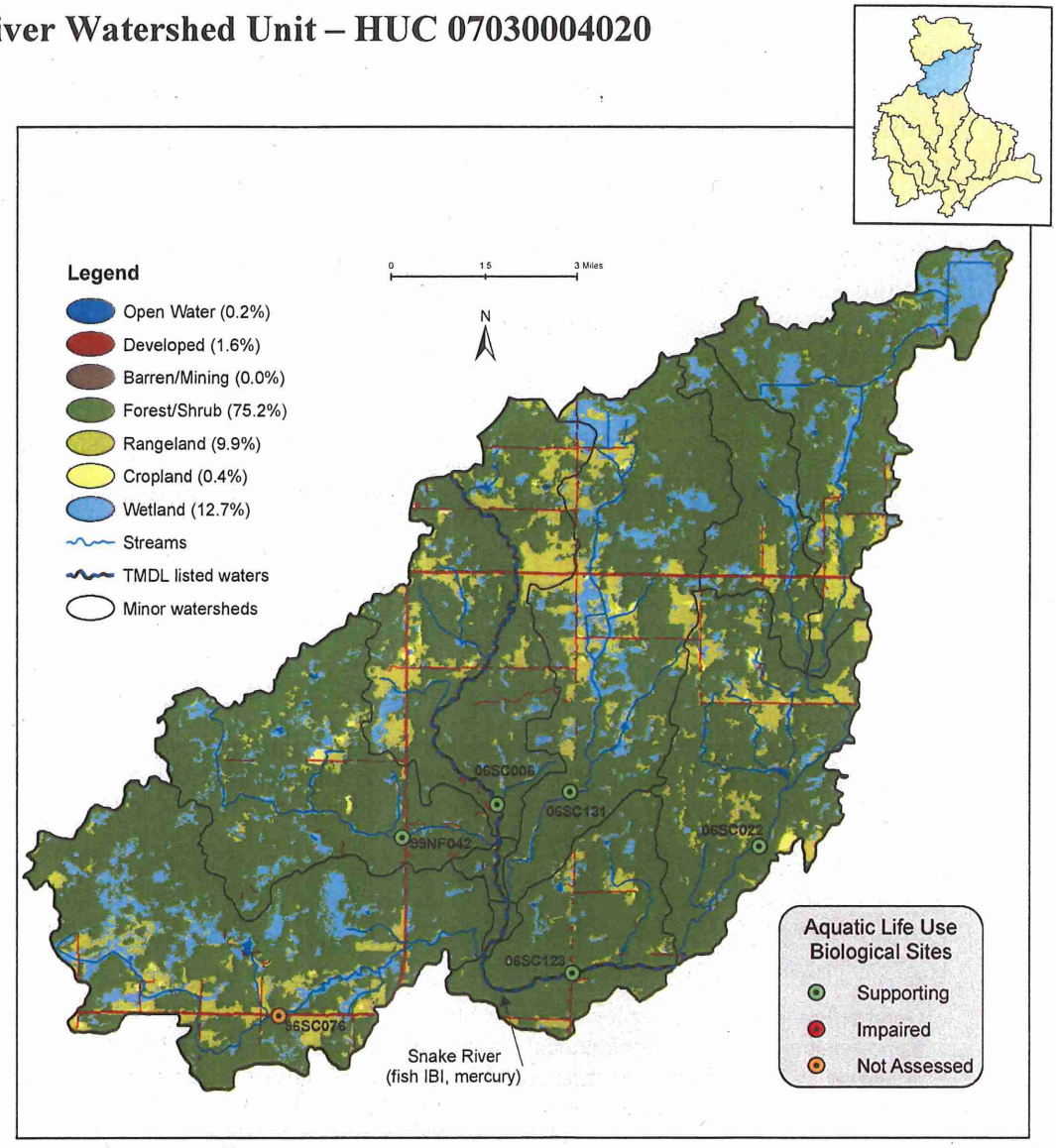

Figure 6. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Lower Upper Snake River Watershed Unit.

Six biological sampling events were conducted at discrete stations within the Lower Upper Snake River Watershed Unit in 2006. The two sites on the main-stem Snake River (06SC006 and 06SC123) have IBI scores of 74 and 75 respectively, and indicate full support for aquatic life. However, the two sampling stations fall on separate AUID's (07030004-508 and 07030004-523). The upper station (06SC006) is within the previously listed reach (F-IBI) of the Snake River (AUID 07030004-508, headwaters to Hay Creek). As previously mentioned, impairment of this reach is not widespread and is limited to a channelized section of the Snake River near the town of Pliny. Biological monitoring stations on Chelsey (06SC022), Cowan's (06SC131), and Bergman (99NF042) brooks all indicate full support for aquatic life; scoring 66, 68, and 77 respectively for biological integrity. The site on Hay Creek (96SC076) was not assessed in this watershed during the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data collected at the station representing the pour point of the Lower Upper Snake River Watershed Unit (06SC123) did not indicate any potential water quality problems within the

watershed. Results indicate that no parameters for which there is data are in potential violation of water quality standards or exceed ecoregion expectations (Table 3), with the exception of pH. One of ten pH measurements was slightly below (6.1) the water quality standard range (6.5-9.0), which is likely attributed to the naturally low alkalinities found in the wetland dominated headwater streams of this region.

Table 3. Water chemistry results at the site representing the pour point of the Lower Upper Snake River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Snake River at Olympic St., 3 mi. E of Woodland, MN											
Storet ID:	S004-067											
Station ID:	06SC123 – pour point of Upper Lower Snake River HUC-11 Watershed (07030004-020)											
Parameter	Chloride	D.O.	E. coli	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples	10	9	10	10	10	10	10	10	10	10	10	8
Minimum	1.9	6.5	4	<0.05	<0.05	**6.1**	0.014	<1.0	60	<5.0	10.0	>100
Maximum	5.1	10.0	64	0.12	<0.05	8.4	0.063	1.6	202	15	25.7	>100
Mean[1]	3.5	8.7	17	0.035	<0.05	7.5	0.031	0.9	156	8.1	20.8	>100
Median	3.3	9.1	18	<0.05	<0.05	7.7	0.029	0.9	172	7.7	22.3	>100
WQ standard	230	5.0	126/ 1260			6.5 - 9.0					30	20
# WQ exceedances[2]	0/10	0/9	0/10			1/10					0/10	0/8
NLF 75th percentile[3]				0.2	0.03	7.9	0.05	5.6	260		21.7	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Overall, water quality conditions in the Lower Upper Snake River Watershed Unit appear to be adequate and meeting their designated uses. No intensive Phase II or follow up monitoring is recommended at this time.

Middle Snake River Watershed Unit – HUC 07030004030

The Middle Snake River Watershed Unit encompasses an area of 153.5 square miles. The watershed unit includes the Snake River main-stem from the Chelsey Brook to Mud Creek confluences. The river flows in a southerly direction almost the entire length of Kanabec County, before it turns and flows east just south of Mora. Named minor watersheds within this watershed unit include Snowshoe and Spring brooks, and Rice Creek. The upper half of this watershed remains largely forested while the lower half has been converted primarily to agricultural land uses (Fig. 7). The pour point of this watershed unit is represented by site 06SC112, on the Snake River near Brunswick.

Nine biological sampling events were conducted at eight discrete stations within the Middle Snake River Watershed Unit in 2006. Four stations in this watershed unit are located on the Snake River main-stem (06SC118, 06SC116, 06SC112, and 06SC115). IBI scores range from 71 – 94, all indicating good to excellent biological integrity. Station 06SC112 was sampled twice, scoring 91 and 94 successively. However, only station 06SC118 has a drainage area < 270 mi^2 and could be assessed for aquatic life using fish community biological criterion at this time. The IBI score of 86 indicates full support of the reach (AUID 07030004-506, Chelsey Brook to Knife River). Snowshoe Brook (06SC117) and an unnamed tributary to the Snake River (06SC113) score 73 and 68 respectively and are fully supporting for aquatic life. Spring Brook (06SC114) has an IBI score of 34 and is not supporting for aquatic life. This concurs with previous fish community sampling conducted at

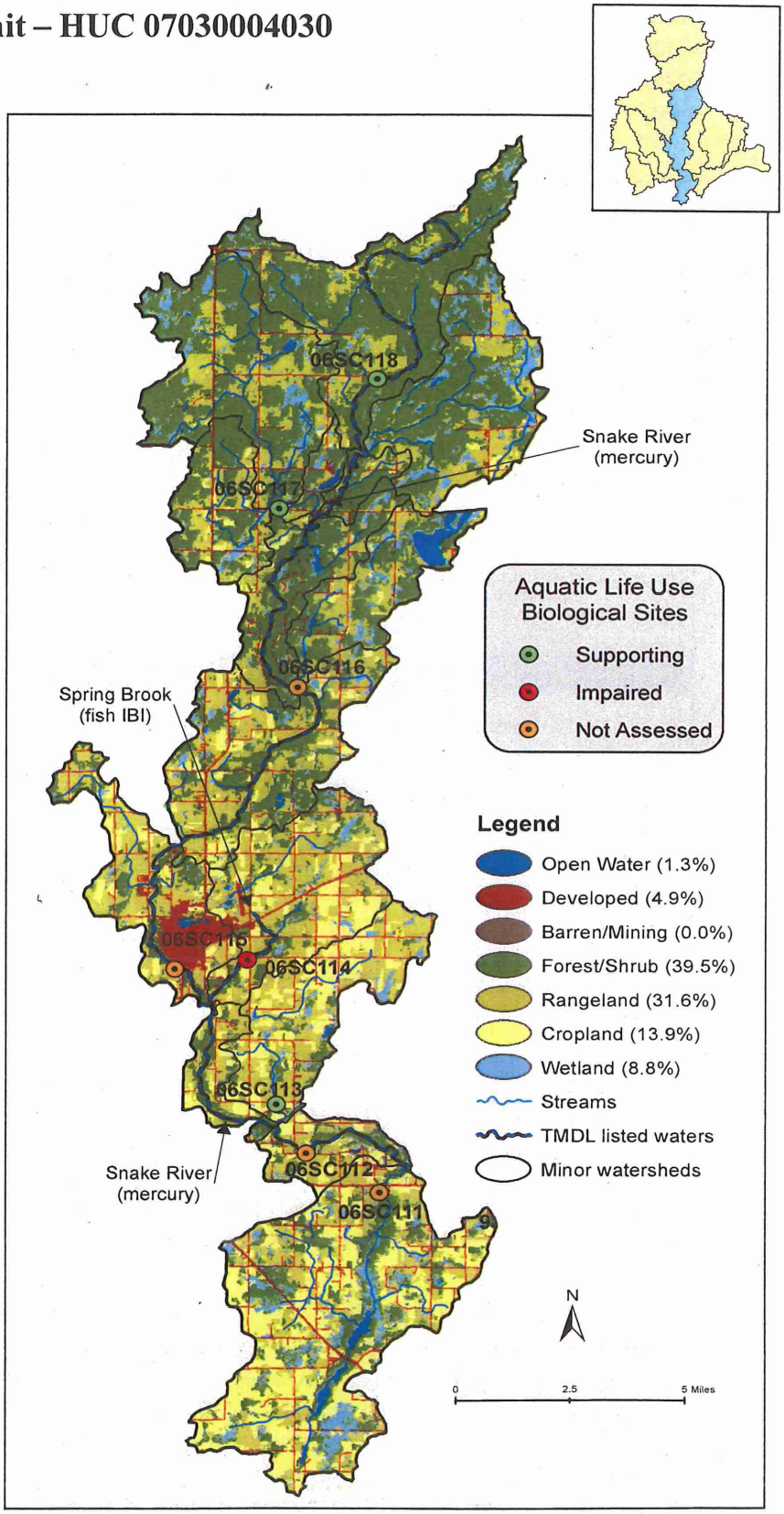

Figure 7. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Middle Snake River Watershed Unit.

another location that resulted in Spring Brook (AUID 07030004-515) being placed on the impaired waters list in 2002. The site on Rice Creek (06SC111) was not assessed in this watershed during the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data collected at the station representing the pour point of the Middle Snake River Watershed Unit (06SC112) did not indicate any potential water quality problems within the watershed with the exception of pH and nitrogen (NO^2+NO^3)(Table 4). Two of ten pH measurements were narrowly outside (6.1 and 9.5) the water quality standard range of 6.5-9.0. The mean nitrogen concentration is 0.21 mg/l and exceeds the ecoregion expectation of 0.12 mg/l. A potential source of the elevated levels could be the Groundhouse River, which also has elevated nitrogen, and enters the Snake River approximately two miles upstream of this site.

Table 4. Water chemistry results at the site representing the pour point of the Middle Snake River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Snake River along 150th Ave., 3 mi. E of Brunswick, MN											
Storet ID:	S004-070											
Station ID:	06SC112 – pour point of Middle Snake River HUC-11 Watershed (07030004-030)											
Parameter	Chloride	D.O.	E. coli	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples	10	9	10	10	10	10	10	10	10	10	10	8
Minimum	4	5.9	8	<0.05	0.09	**6.1**	0.044	<1.0	142	<5.0	11.2	>100
Maximum	9.2	13.0	84	0.07	0.37	**9.2**	0.093	3.6	317	11	27.1	>100
Mean[1]	7.3	10.8	30	0.03	**0.21**	8.1	0.063	2.1	262	5.2	21.8	>100
Median	7.9	11.3	30	<0.05	0.21	8.3	0.059	1.8	279	5.3	22.9	>100
WQ standard	230	5.0	126/ 1260			6.5 - 9.0		100			30	20
# WQ exceedances[2]	0/10	0/9	0/10			2/10		0/10			0/10	0/8
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

With the exception of Spring Brook, water quality conditions within the Middle Snake Watershed Unit appear to be adequate and meeting their designated uses. Phase II monitoring in the watershed could be restricted to the Spring Brook sub-watershed in order to identify the source(s) and cause(s) of the impairment. Additional monitoring could also be conducted to determine if pH and nitrogen are of concern and to identify their sources. The SRWMB has an existing monitoring strategy in the Snake River Watershed that will provide valuable insight into the sources and contributions of pollutants within the watershed.

Knife River Watershed Unit – HUC 07030004040

The Knife River Watershed Unit, located in northeast Mille Lacs and northwest Kanabec Counties, drains an area of 108.0 square miles. The headwaters originate within the Mille Lacs State Wildlife Management Area. The Knife River flows southeast through a matrix of wetland, forest, and rangeland land cover types to Knife Lake (Fig. 8). From Knife Lake the river flows south to its confluence with the Snake River just north of Mora. Agricultural land uses are more predominant in the lower portion of the watershed and the area surrounding Knife Lake is moderately developed. The pour point of this watershed unit is represented by site 96SC097.

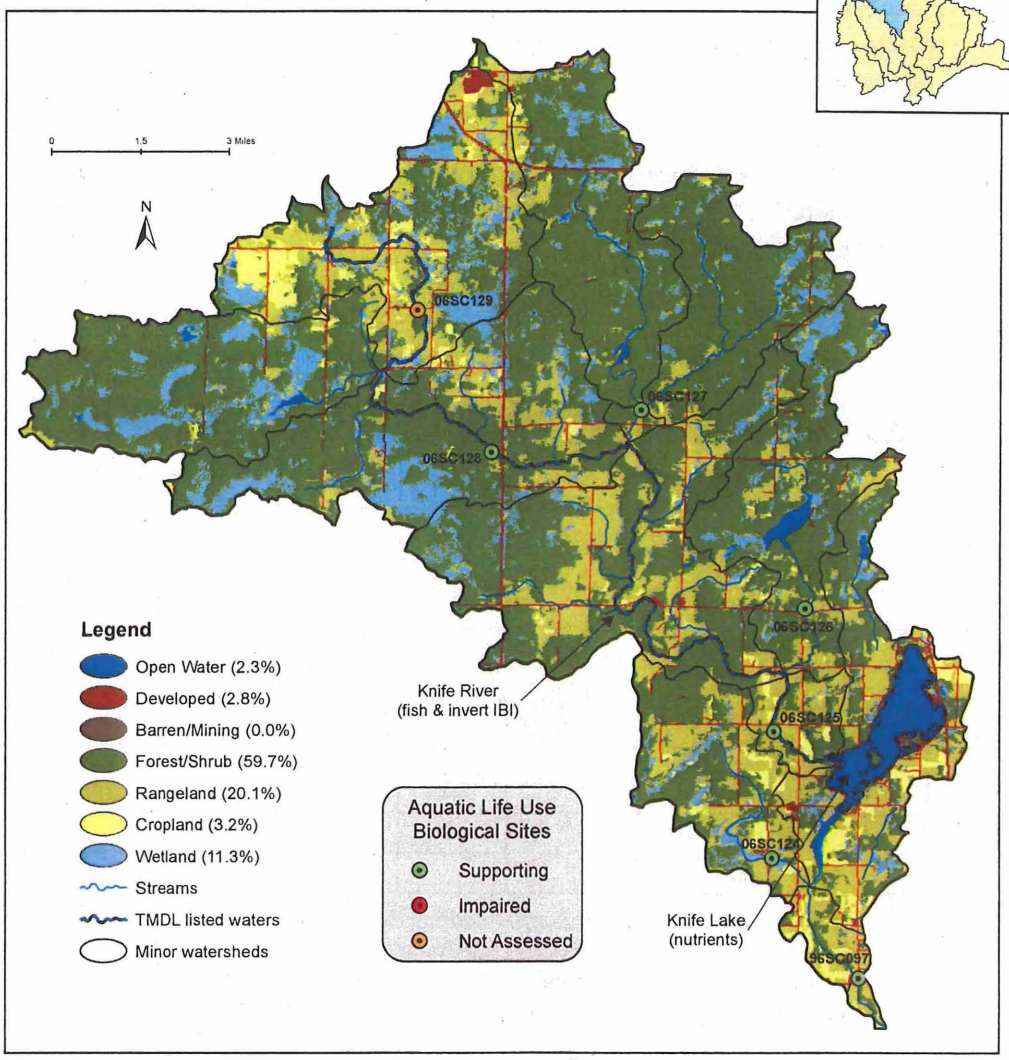

Figure 8. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Knife River Watershed Unit.

Seven biological sampling events were conducted at discrete stations within the Knife River Watershed Unit in 2006. Three stations on the Knife River (06SC128, 06SC125, and 96SC097) have IBI scores of 82, 67, and 74 respectively, and indicate full support for aquatic life. The Knife River has been split into two assessment reaches (AUID 07030004-537, Dry Run to Knife Lake and 07030004-549, Knife Lake to Snake River). Previous biological sampling resulted in the upper Knife River reach (07030004-537) being listed as non-supporting for aquatic life use (F-IBI and M-IBI). Bean Brook (06SC126) has an IBI score of 77 and is fully supporting for aquatic life. Two unnamed tributaries to the Knife River (06SC127 and 06SC124) also indicate full support, scoring 91 and 68 respectively. The site on Dry Run (06SC129) was not assessed in this watershed during the 2008 Assessment Cycle due to a predominant wetland condition within the sampling reach.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Knife River Watershed Unit (96SC097) between 4/7/2004 and 11/22/2005. Results indicate a potential water quality problem with fecal coliform and to a lesser extent nitrogen (NO^2+NO^3)(Table 5). Two of

fifteen fecal coliform samples exceeded the maximum standard of 2000 organisms per 100 milliliters. Additional bacteria data should be collected in order to calculate a monthly geometric mean to determine aquatic recreation use support. The mean nitrogen concentration is 0.13 mg/l and marginally exceeds the ecoregion expectation of 0.12 mg/l. A single dissolved oxygen (D.O.) value of forty-one measurements fell below (2.0 mg/l) the water quality standard (5.0 mg/l) and does not indicate a potential D.O. impairment (>10% violations, minimum 20 observations).

Table 5. Water chemistry results at the site representing the pour point of the Knife River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Knife River at CR 77, 3 mi. N of Mora, MN											
Storet ID:	S003-528											
Station ID:	96SC097 – pour point of Knife River HUC-11 Watershed (07030004-040)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	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	Deg C	cm
# Samples		41	15		21	41	41	41			41	
Minimum		**2.0**	2		0.005	6.87	0.02	0.5			2.1	
Maximum		14.5	**6400**		0.6	8.66	0.1	27.0			28.9	
Mean[1]		10.4	47		**0.13**	7.6	0.06	4.5			13.9	
Median		10.23	20		0.07	7.6	0.06	4.0			13.3	
WQ standard	230	5.0	200/ 2000			6.5 - 9.0		100			30	20
# WQ exceedances[2]		1/41	2/15			0/41		0/41			0/41	
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Knife Lake is also currently listed as non-supporting of aquatic recreation due to excess nutrients. Phase II intensive monitoring should be conducted in the Knife River Watershed Unit in order to assess use support status for all indicators and to determine what pollutant(s) and/or stressor(s) are causing or contributing to the impairments in the watershed.

Ann River Watershed Unit – HUC 07030004050

The Ann River Watershed Unit, located primarily within Kanabec County, drains an area of 84.2 square miles. The headwaters originate within the Mille Lacs State Wildlife Management Area and flows southeast as the Little Ann River through a mostly undeveloped wetland/forest matrix to Ann Lake (Fig. 9). From Ann Lake the Ann River flows southeast approximately eleven miles to Fish Lake through a landscape that has been primarily converted to pasture and other agriculture land uses. The confluence of the Ann and Snake Rivers is located just downstream of the Fish Lake outlet near Mora, MN. The pour point of this watershed unit is represented by site 06SC122.

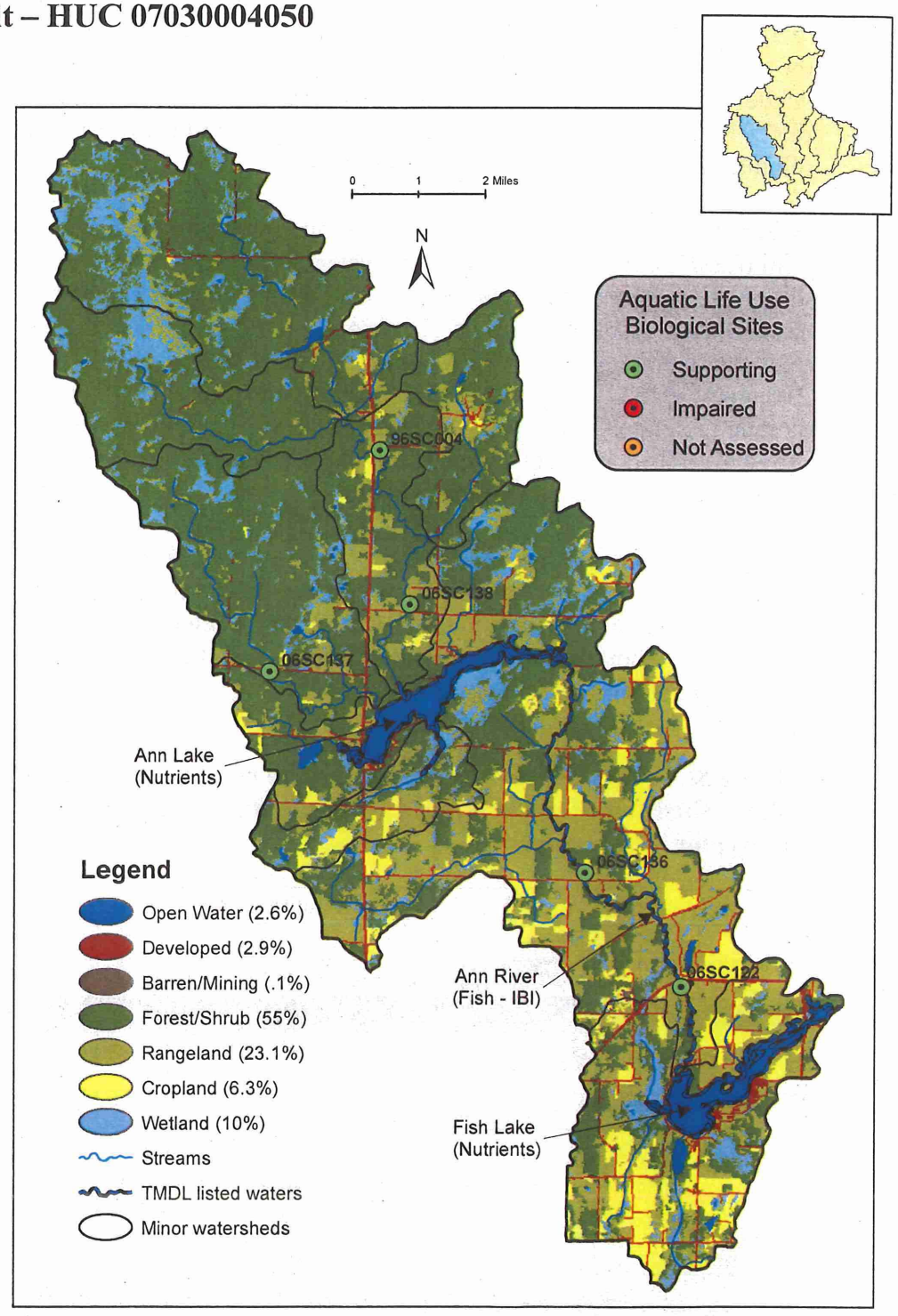

Figure 9. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Ann River Watershed Unit.

Six biological sampling events were conducted at five discrete stations within the Ann River Watershed Unit in 2006. Progressing from upstream to downstream in the watershed, the general trend is a decrease in IBI score. In the upper half of the watershed stations on Camp Creek (06SC137) and the Little Ann River (96SC004 and 06SC138) have fish community IBI scores ranging from 76-97, all indicating full support of their aquatic life use. The two stations on the Ann River main-stem (06SC136 and 06SC122) have IBI scores of 67 and 71 respectively, and narrowly meet their biological expectation for aquatic life use support. This trend seems to correlate with the change in land use from forest/wetland to pasture/agriculture in the southern half of the watershed.

However, previous biological sampling in this watershed (1996 and 1998) resulted in the Ann River reach (AUID 07030004-511) being listed as non-supporting for aquatic life use (F–IBI) and follows the trend of decreasing IBI scores progressing downstream. Available macroinvertebrate data also suggests impairment of the Ann River reach and will likely be listed as impaired for this indicator in the 2010 assessment cycle. In addition, both Ann and Fish Lakes are currently listed as non-supporting of aquatic recreation due to excess nutrients.

Water chemistry data collected at the station representing the pour point of the Ann River Watershed Unit (06SC122) indicated a potential water quality problem with e-coli bacteria and to a lesser extent dissolved oxygen and pH (Table 6). Six of ten samples taken between 5/25/2006 and 9/29/2006 exceeded the e-coli standard of 126 organisms/100ml. However, the water quality standard is based on a 30 day geometric mean with a minimum of 5 samples necessary to calculate. The geometric mean of 210 reported in Table 6 is a seasonal mean (May – Sept.) and is not sufficient for determination of aquatic recreation use support. This is considered screening level data and suggests a potential problem. Additional data should be collected to calculate a monthly geometric mean in order to determine aquatic recreation use support.

Additionally, one of nine dissolved oxygen measurements fell below (4.3 mg/l) the water quality standard of 5.0 mg/l and one of ten pH values fell outside (6.0) the water quality standard range of 6.5-9.0. Follow up monitoring should be conducted to determine if sufficient violations exist in order to assess use support status for these parameters and determine if they are causing or contributing to the biological impairment in the watershed.

Table 6. Water chemistry results at the site representing the pour point of the Ann River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Ann River at HWY 23, 2 mi. SW of Mora, MN											
Storet ID:	S004-066											
Station ID:	06SC122 – pour point of Ann River HUC-11 Watershed (07030004-050)											
Parameter	Chloride	D.O.	E. coli	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples	10	9	10	10	10	10	10	10	10	10	10	8
Minimum	2.8	**4.3**	23	<0.05	<0.05	**6.0**	0.039	1.2	131	<5.0	10.1	91
Maximum	4.6	10.5	1100	0.11	0.15	7.9	0.094	3.2	368	8.6	23.3	>100
Mean[1]	3.6	6.8	**210**	0.034	0.05	7.2	0.064	2.2	266	4.3	18.9	97
Median	3.5	5.9	380	<0.05	<0.05	7.3	0.066	2.4	258	3.8	20.1	>100
WQ standard	230	5.0	126/ 1260			6.5 - 9.0		100			30	20
# WQ exceedances[2]	0/10	1/9	0/10			1/10		0/10			0/10	0/8
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Groundhouse River Watershed Unit – HUC 07030004060

The Groundhouse River Watershed Unit, located in eastern Mille Lacs and southwest Kanabec Counties, encompasses an area of 87.7 square miles. The headwaters originate in a mostly undeveloped wetland/forest matrix, much of which is located within Rum River State Forest. Several small tributaries drain into the Groundhouse River, most notably the West and South Fork Groundhouse rivers. Agricultural land uses are more predominant in the lower portion of the watershed unit (Fig. 10). Significant development is sparse within the watershed unit, with the greatest density in the town of Ogilvie. The pour point of this watershed unit is represented by site 06SC061.

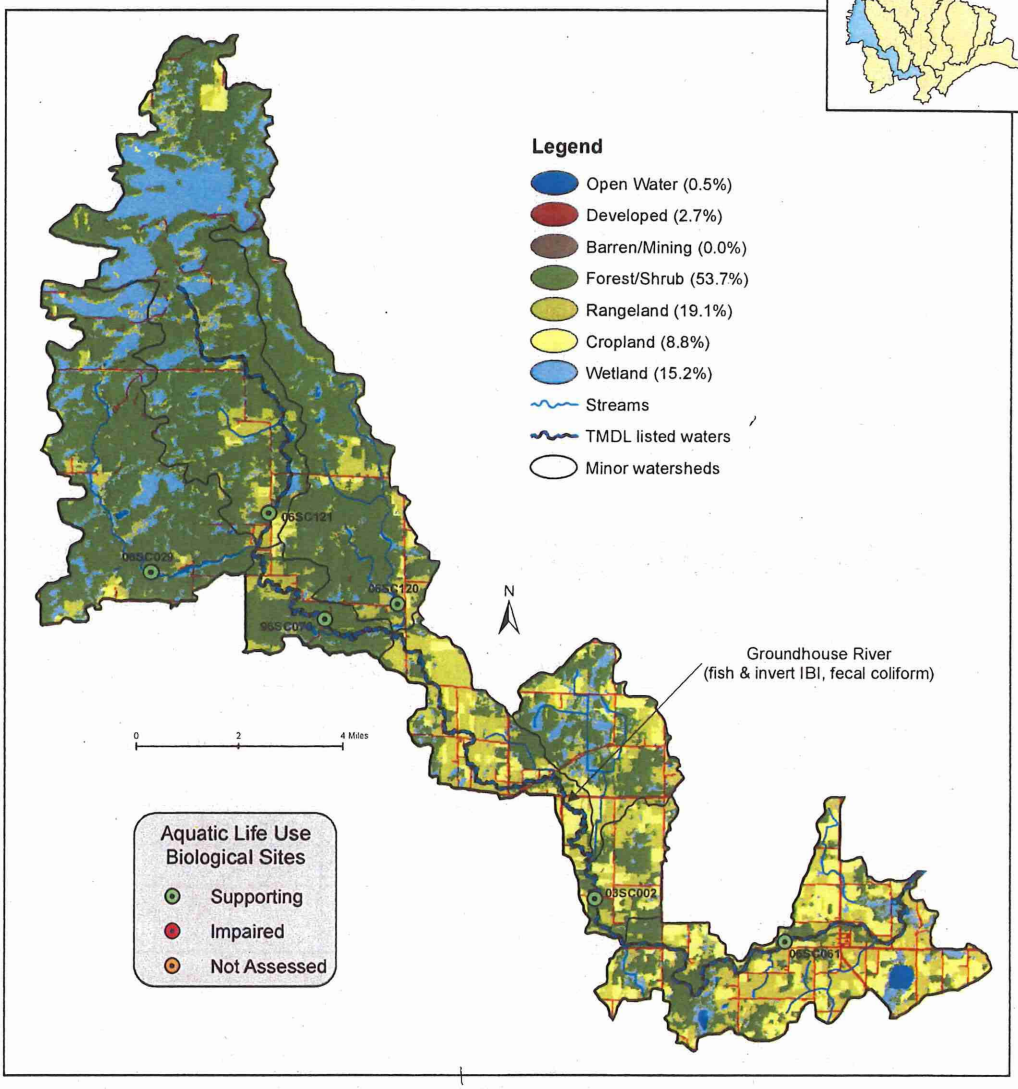

Figure 10. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Groundhouse River Watershed Unit.

Six biological sampling events were conducted at discrete stations within the Groundhouse River Watershed Unit in 2006. The Groundhouse River is split into two assessment reaches (AUID 07030004-513, headwaters to S.F. Groundhouse River and 07030004-512, S.F. Groundhouse River to Snake River). Two stations (06SC121 and 96SC070) on the upper reach (07030004-513) have IBI scores of 86 and 83 respectively, and are fully supporting for aquatic life. Another station (03SC002) scores below (66) the threshold of 69 but is within the 95% confidence limit. Previous biological sampling in this watershed resulted in the upper Groundhouse River reach being listed as non-supporting for aquatic life use (F-IBI and M-IBI). The station (06SC061) on the lower Groundhouse River reach (07030004-512) has an IBI score of 70, narrowly meeting the biological expectation for use support. The West Fork Groundhouse River (06SC029) and an unnamed tributary (06SC120) also are full supporting, scoring 79 and 82 respectively.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Groundhouse River Watershed Unit (06SC061) between 4/7/2004 and 10/25/2005. Results indicate fecal coliform and nitrogen (NO^2+NO^3) are parameters of concern in this watershed unit (Table 7). Three of thirty-three fecal coliform samples exceeded the maximum standard of 2000 organisms per 100 milliliters, including one extremely high observation of 25,000 organisms on 10/5/2005. These results concur with previously available data, as the Groundhouse River was listed as impaired for aquatic recreation in the 2002 Assessment Cycle. The mean nitrogen concentration is 0.44 mg/l and significantly exceeds the ecoregion expectation of 0.12 mg/l. A single dissolved oxygen (D.O.) value out of forty-seven measurements fell below (2.2 mg/l) the water quality standard (5.0 mg/l) and does not indicate a potential D.O. impairment (>10% violations, minimum 20 observations).

Table 7. Water chemistry results at the site representing the pour point of the Groundhouse River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Groundhouse River at HWY 65, 1 mi. W of Brunswick, MN											
Storet ID:	S003-532											
Station ID:	06SC061 – pour point of Groundhouse River HUC-11 Watershed (07030004-060)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	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	Deg C	cm
# Samples		47	33		11	44	23	36			47	
Minimum		**2.2**	20		.005	6.6	0.05	1.0			5.5	
Maximum		14.28	**25000**		1.5	8.6	0.2	38.0			23.9	
Mean[1]		9.5	157		**0.44**	7.5	0.08	5.9			14.5	
Median		9.5	110		0.3	7.5	0.07	3.5			15.2	
WQ standard	230	5.0	200/ 2000			6.5 - 9.0		100			30	20
# WQ exceedances[2]		1/47	3/33			0/44		0/36			0/47	
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Phase II intensive monitoring is not necessary as TMDL studies in the Groundhouse River are currently underway to identify the pollution sources causing and contributing to the impairments and to develop implementation plans for restoration. Lane and Cormier (2004) concluded that excessive fine sediment is the leading cause of the biological impairment. Agricultural animal operations are the primary source of fecal coliform in the watershed unit (Tetra Tech, 2008).

South Fork Groundhouse River Watershed Unit – HUC 07030004070

The South Fork Groundhouse River Watershed Unit, located primarily within southwest Kanabec Counties, drains an area of 51.3 square miles. The headwaters originate in a wetland/ forest matrix within the Rum River State Forest. The river flows in a southerly direction for approximately ten miles before it turns and flows northeast to its confluence with the Groundhouse River three miles southeast of Ogilvie. Agricultural land uses (pasture and cultivated cropland) are predominant in the watershed (Fig. 11). Although there are several small unnamed tributaries in this watershed, none are delineated as 14-digit HUC minor watersheds. The pour point of this watershed unit is represented by site 03SC003.

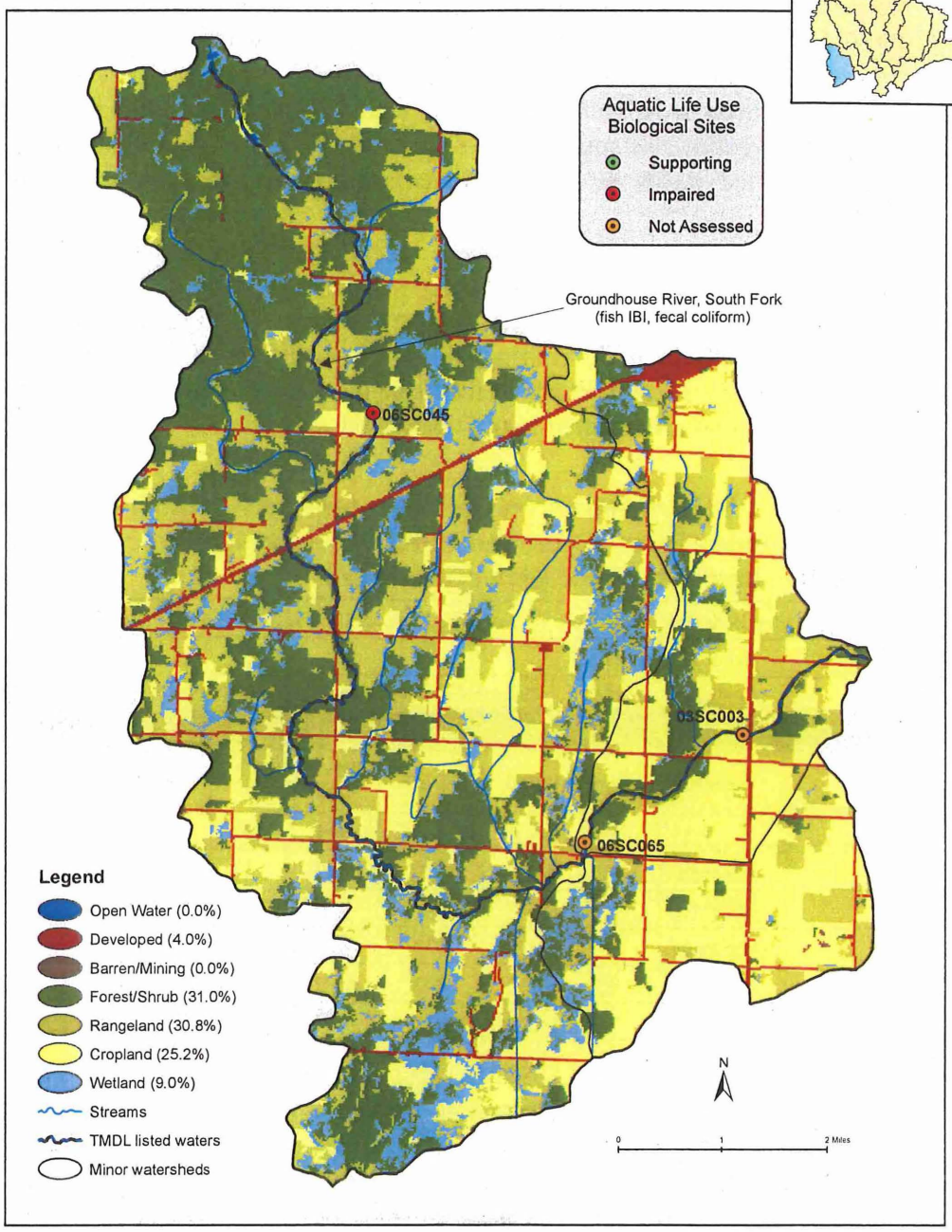

Figure 11. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the South Fork Groundhouse River Watershed Unit.

Five biological sampling events were conducted at three discrete stations within the South Fork Groundhouse River Watershed Unit in 2006. Station 06SC045 was sampled twice, scoring 19 and 13 successively, and is not supporting for aquatic life. Both results are significantly below the biological criterion of IBI ≥ 46 for this stream type and the South Fork Groundhouse River (AUID 07030004-573) was added to the impaired waters list in the 2008 Assessment Cycle. This AUID was also listed in a previous assessment cycle as impaired based on the macroinvertebrate assemblage (M-IBI). Data from stations 06SC045 and 03SC003 on the South Fork Groundhouse River were not assessed for aquatic life in the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data collected at the station representing the pour point of the South Fork Groundhouse River Watershed Unit (03SC003) indicated a potential water quality problem with e-coli bacteria and nitrogen (NO^2+NO^3)(Table 8). Five of ten samples taken between 5/25/2006 and 9/29/2006 exceeded the e-coli standard of 126 organisms/100ml. The water quality standard is based on a 30 day geometric mean with a minimum of 5 samples necessary to calculate. The geometric mean of 130 reported in Table 8 is a seasonal mean (May – Sept.) and is not sufficient for determination of aquatic recreation use support by itself. However, other data available during the 2008 Assessment Cycle resulted in this AUID being listed as impaired for aquatic recreation.

The mean nitrogen concentration of 1.3 mg/l significantly exceeds the ecoregion expectation of 0.12 mg/l. Single violations of water quality standards were observed for dissolved oxygen (3.8 mg/l) and pH (6.4). The mean specific conductance (337 *u*S/cm) slightly exceeded the ecoregion expectation of 310 *u*S/cm. Follow up monitoring should be conducted to determine if sufficient violations exist in order to assess use support status for these parameters and determine if they are causing or contributing to the biological impairment in the watershed.

Table 8. Water chemistry results at the site representing the pour point of the South Fork Groundhouse River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	South Fork Groundhouse River at HWY 47, 3.6 mi. S of Ogilvie, MN											
Storet ID:	S003-638											
Station ID:	03SC003 – pour point of SF Groundhouse River HUC-11 Watershed (07030004-070)											
Parameter	Chloride	D.O.	E. coli	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples	10	9	10	10	10	10	10	10	10	10	10	8
Minimum	5.3	**3.8**	40	<0.05	0.27	**6.4**	0.068	<1.0	247	6.1	10.4	54
Maximum	14	15.5	470	0.11	3.2	8.0	0.140	13	404	17	22.8	>100
Mean[1]	9.1	9.9	**130**	0.047	**1.3**	7.5	0.101	4.4	**337**	9.5	19.1	92
Median	9.1	9.5	123	<0.05	1.2	7.5	0.100	2.8	346	9.0	20.1	>100
WQ standard	230	5.0	126/ 1260			6.5 - 9.0		100			30	20
# WQ exceedances[2]	0/10	1/9	0/10			1/10		0/10			0/10	0/8
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Mud Creek Watershed Unit – HUC 07030004080

The Mud Creek Watershed Unit, located within southwest Kanabec and southeast Pine Counties, drains an area of 64.9 square miles. Mud Creek is a low gradient stream that flows in a southerly direction over its course for approximately twenty three miles to its confluence with the Snake River near Grasston. Land use is predominantly pastured rangeland with scattered areas of forest, shrub, and wetland throughout (Fig. 12). Row crop agricultural land uses become more prevalent in the lower portion of the watershed. Tributaries to Mud Creek consist of several small channelized streams or ditches. The pour point of this watershed unit is represented by site 06SC107.

Five biological sampling events were conducted at discrete stations within the Mud Creek Watershed Unit in 2006. Mud Creek is split into two assessment reaches (AUID 07030004-566, headwaters to Quamba Lake and 07030004-567, Quamba Lake to Snake River). One station (06SC110) on the upper reach has an IBI score of 68 and indicates full support. However, previous biological sampling resulted in the upper Mud Creek reach (07030004-566) being listed as non-supporting for aquatic life use (F-IBI and M-IBI). The lower Mud Creek reach (07030004-567) was sampled at two locations (06SC109 and 06SC107) and has IBI scores of 86 and 56 respectively. Multiple but discrepant results on an AUID indicate partial support of aquatic life. This AUID was also listed in a previous assessment cycle as impaired based on macroinvertebrate and fish assemblage data (M-IBI and F-IBI). Two sites (06SC018, Trib. to Mud Creek and 06SC108, County Ditch #4) were not

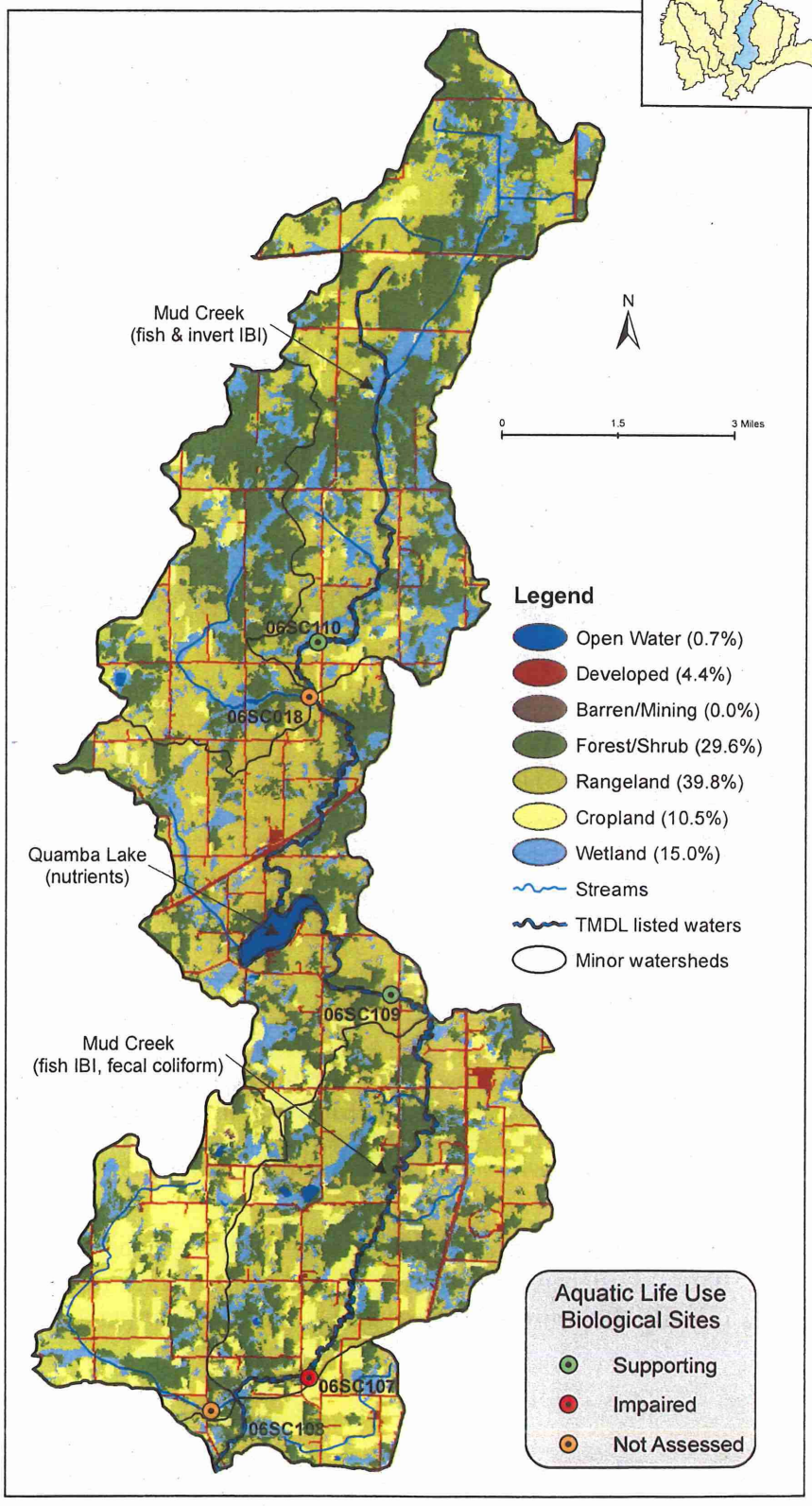

Figure 12. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Mud Creek Watershed Unit.

assessed in this watershed during the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Mud Creek Watershed Unit (06SC107) between 4/7/2004 and 4/19/2006 (Table 9). Results indicate Mud Creek (AUID 07030004-567) is impaired for aquatic recreation (fecal coliform). More than 10 percent (7 of 20) individual fecal coliform values exceeded the 200 organisms per 100 ml standard. Two of twenty fecal coliform values exceeded the maximum standard of 2000 organisms per 100 milliliters, including one extremely high observation of 16,000 organisms on 10/5/2005. Two of thirty-nine pH values were below (6.2) the water quality standard range of 6.5 - 9.0 but does not indicate impairment (>10% violations, minimum 20 observations).

Table 9. Water chemistry results at the site representing the pour point of the Mud Creek Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Mud Creek at CR 5, 1 mi. NW of Grasston, MN											
Storet ID:	S003-533											
Station ID:	06SC107 – pour point of Mud Creek HUC-11 Watershed (07030004-080)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	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	Deg C	cm
# Samples		39	20		22	39	39	39			39	
Minimum		6	18		0.005	**6.2**	0.05	1.0			1.2	
Maximum		15.9	**16000**		0.3	8	0.2	17.0			26.6	
Mean[1]		9.2	139		0.05	7.3	0.09	6.6			14.4	
Median		8.7	91		0.04	7.37	0.08	6			14.3	
WQ standard	230	5.0	200/ 2000			6.5 - 9.0		100			30	20
# WQ exceedances[2]		0/39	2/20			2/39		0/39			0/39	
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Quamba Lake is also currently listed as non-supporting of aquatic recreation due to excess nutrients. Phase II intensive monitoring should be conducted in the Mud Creek Watershed Unit in order to identify the source(s) and cause(s) of the impairments.

Lower Snake River Watershed Unit – HUC 07030004090

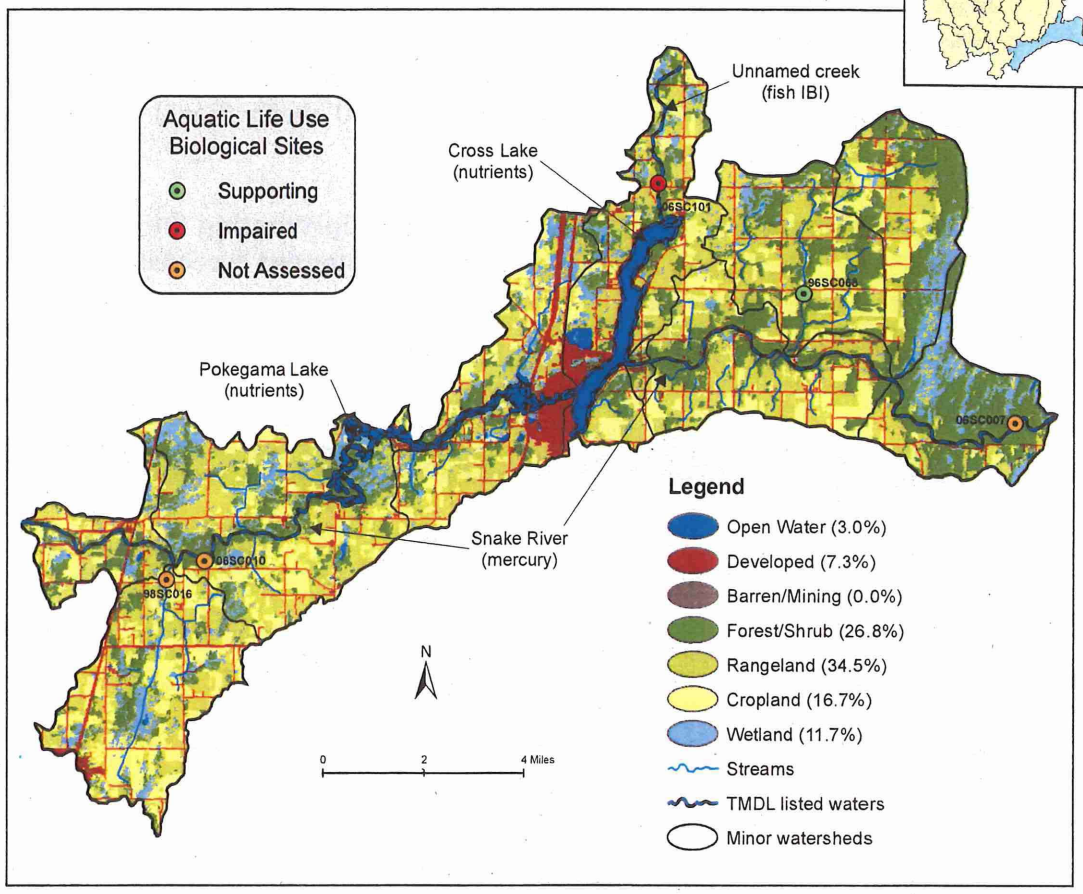

Figure 13. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Lower Snake River Watershed Unit.

The Lower Snake River Watershed Unit, located in southern Pine County, encompasses an area of 90.0 square miles. The watershed unit includes the Snake River main-stem from Mud Creek to its confluence with the St. Croix River. The river flows in an easterly direction through a wide farming valley to Cross Lake in Pine City. After flowing through Cross Lake and over the dam that maintains the lake level, the river continues east past wooded bluffs to its confluence. Considerable development of homes and cabins exist on this lower section, however, the last three miles of the river is protected within Chengwatana State Forest. Land cover is variable in the watershed unit; with a prevalence of agricultural land uses in the upper portion, areas of significant development in and around Pine City, and predominantly forest/shrub in the lower portion (Fig. 13). The pour point of this watershed unit is represented by site 06SC007.

Six biological sampling events were conducted at five discrete stations within the Lower Snake River Watershed Unit in 2006. Two stations in this watershed unit are located on the Snake River main-stem (06SC010 and 06SC007). IBI scores range from 73 – 89, all indicating good to excellent biological integrity. Station 06SC007 was sampled twice, scoring 74 and 89 successively. However, large river sites (drainage area > 270 mi^2) are not currently being assessed for aquatic life using fish community data in the St. Croix River Basin. Bear Creek (96SC068) has an IBI score of 62 and is fully supporting for aquatic life. A tributary to Cross Lake (06SC101) has an IBI score of 28 and is not supporting for aquatic life. This is significantly below the biological criterion of IBI $\geq$ 46 for this stream type and the reach (AUID 07030004-577) was added to the impaired waters list in the 2008 Assessment Cycle. The site on Hay Creek (98SC068) was not assessed in this watershed during the 2008 Assessment Cycle due to the channelized condition of the stream channel within the sampling reach.

Water chemistry data collected at the station representing the pour point of the Lower Snake River Watershed Unit (06SC007) did not indicate any potential water quality problems within the watershed. Results indicate that no parameters for which there is data are in potential violation of water quality standards or exceed ecoregion expectations (Table 10), with the exception of pH. One of ten pH measurements was below (5.8) the water quality standard range (6.5-9.0), but is not sufficient data to indicate impairment (>10% violations, minimum 20 observations).

Table 10. Water chemistry results at the site representing the pour point of the Lower Snake River Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Snake River near mouth, 9 mi. E of Pine City, MN											
Storet ID:	S000-128											
Station ID:	06SC007 - pour point of Lower Snake River HUC-11 Watershed (07030004-090)											
Parameter	Chloride	D.O.	E. coli	NH3 + NH4	NO2 + NO3	pH	TP	TSS	Spec. cond.	Sulfate	Temp.	T-tube
Units	mg/l	mg/l	#/100ml	mg/l	mg/l		mg/l	mg/l	uS/cm	mg/l	Deg C	cm
# Samples	10	9	10	10	10	10	10	10	10	10	10	8
Minimum	4.4	6.3	<4	<0.05	<0.05	**5.8**	0.040	2.0	130	<5.0	11.3	67
Maximum	7.3	13.4	28	<0.05	0.16	9.0	0.098	9.3	263	9.2	25.8	>100
Mean[1]	6.2	8.7	10	<0.05	0.11	7.4	0.063	4.5	216	4.4	20.4	93
Median	6.2	8.2	9	<0.05	0.12	7.6	0.061	4.2	222	3.8	22.6	98
WQ standard	230	5.0	126/ 1260			6.5 - 9.0		100			30	20
# WQ exceedances[2]	0/10	0/9	0/10			1/10		0/10			0/10	0/8
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

With the exception of the tributary to Cross Lake (06SC101), water quality conditions within the Lower Snake Watershed Unit appear to be adequate and meeting their designated uses. Phase II monitoring in the watershed could be restricted to this sub-watershed in order to identify the source(s) and cause(s) of the impairment. Existing volunteer monitoring data indicates *E. coli* bacteria may be a parameter of concern. Cross Lake is also listed as non-supporting of aquatic recreation due to excess nutrients in this watershed unit.

Pokegama Creek Watershed Unit – HUC 07030004100

The Pokegama Creek Watershed Unit, located in eastern Kanabec and southern Pine Counties, drains an area of 90.4 square miles. Pokegama Creek is a low gradient stream that flows in a southerly direction over its course for approximately nineteen miles to Pokegama Lake. Only a very short stream segment exists between the lake and Pokegama Creek's confluence with the Snake River. Land use is predominantly pastured rangeland with scattered areas of forest/shrub (Fig. 14). Wetlands are also prevalent throughout the watershed. Significant tributaries include East Pokegama Creek and an unnamed creek. The pour point of this watershed unit is located above the lake in order to characterize the stream condition and is represented by site 06SC042.

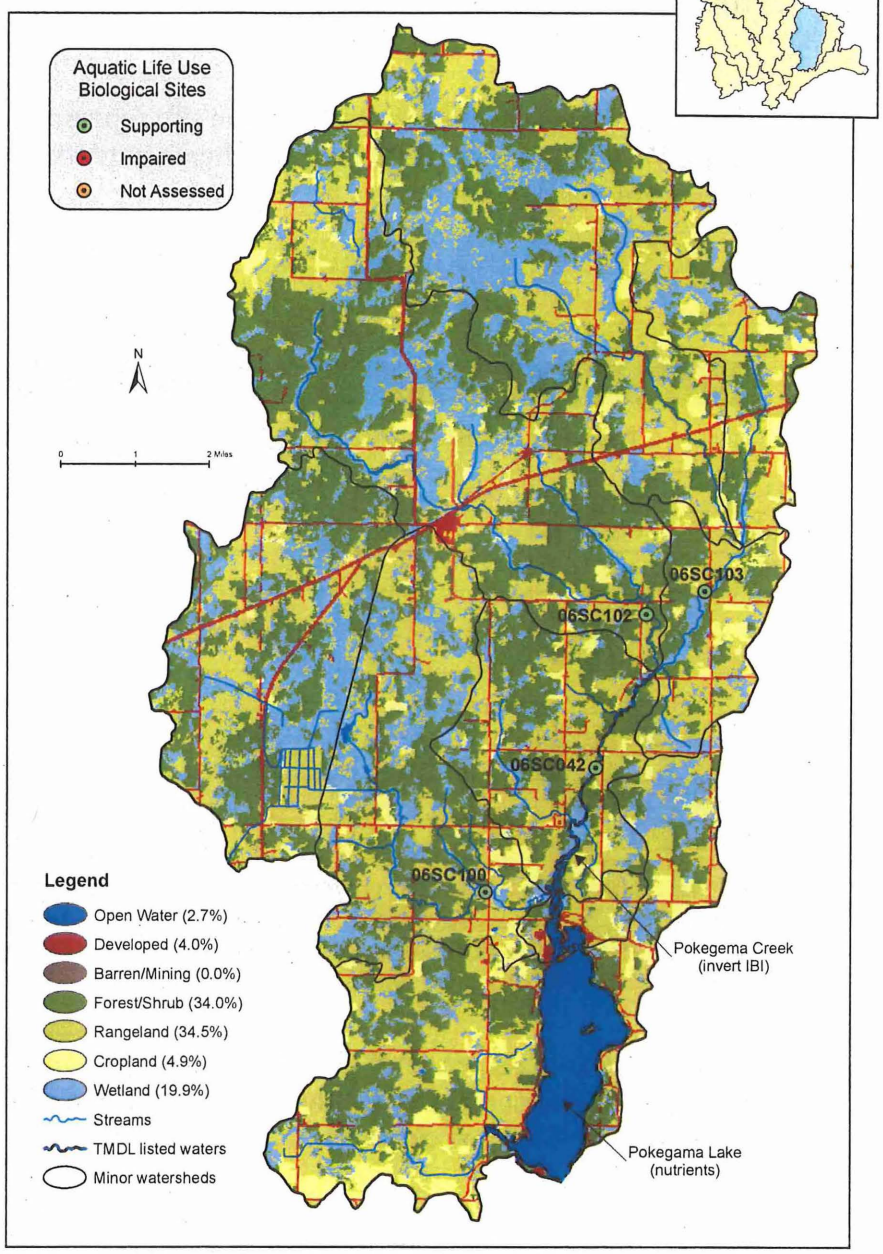

Figure 14. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Pokegama Creek Watershed Unit.

Five biological sampling events were conducted at four discrete stations within the Pokegama Creek Watershed Unit in 2006. A station (06SC102) on an upper reach of Pokegama Creek has an IBI score of 74 and indicates full support of aquatic life. The lower station (06SC042) has an IBI score below (64) the threshold of 68 but is within the 95% confidence limit. This lower reach (AUID 07030004-532, East Pokegama Creek to unnamed creek) was listed in a previous assessment cycle as impaired based on the macroinvertebrate assemblage (M-IBI). East Pokegama Creek has an IBI score of 70 and is fully supporting of aquatic life. Station 06SC100 (Trib. to Pokegama Creek) was sampled twice, scoring 51 and 42 successively, and is assessed as fully supporting. The score of 42 is below the impairment threshold of 46 for this stream type, but is within the 95% confidence limit.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Pokegama Creek Watershed Unit (06SC042) between 4/6/2004 and 4/19/2006. Results indicate that no

parameters for which there is data are in potential violation of water quality standards or exceed ecoregion expectations (Table 11), with the exception of pH. Two of forty pH measurements were below (6.32 and 6.35) the water quality standard range (6.5-9.0), but does not indicate impairment (>10% violations, minimum 20 observations).

Table 11. Water chemistry results at the site representing the pour point of the Pokegama Creek Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Pokegama Creek at CR 14, 6 mi. NW of Pine City, MN											
Storet ID:	S002-542											
Station ID:	06SC042 – pour point of Pokegema Creek HUC-11 Watershed (07030004-100)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	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	Deg C	cm
# Samples		45	19		24	40	47	47			44	
Minimum		5.6	20		.005	**6.32**	.032	1.0			1.5	
Maximum		16.7	800		.13	8.5	.21	25.0			25.85	
Mean[1]		9.2	120		.023	7.3	.076	4.9			13.28	
Median		9.1	140		.01	7.3	.062	3.0			13.04	
WQ standard	230	5.0	200/ 2000			6.5 - 9.0		100			30	20
# WQ exceedances[2]		0/45	0/19			2/40		0/47			0/44	
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Pokegama Lake is also currently listed as non-supporting of aquatic recreation due to excess nutrients. Phase II intensive monitoring should be conducted in the Pokegama Creek Watershed Unit in order to identify the source(s) and cause(s) of the impairments.

Mission Creek Watershed Unit – HUC 07030004110

The Mission Creek Watershed Unit, located in southern Pine County, drains an area of 36.7 square miles. The headwaters of Mission Creek originate just southwest of Hinckley. The creek flows in a mostly southwest direction to its confluence with the Snake River 2.5 miles west of Pine City. Land use is predominantly pastured rangeland with scattered areas of row crop agriculture (Fig. 15). Wetlands are also prevalent throughout, particularly in the middle reaches of the watershed. A roughly 2.5 mile reach in the upper section of Mission Creek is currently designated as a trout stream. No minor watersheds are delineated within the watershed. The pour point of this watershed unit is represented by site 06SC104.

Four biological sampling events were conducted at three discrete stations within the Mission Creek Watershed Unit in 2006. The three stations are located on two AUID's (07030004-547 and 07030004-548). Two stations (06SC106 and 06SC105) on the upper reach have IBI scores of 49 and 43 respectively and the reach is considered partial supporting for aquatic life. In addition, this AUID was listed in previous assessment cycles as impaired based on macroinvertebrate and fish assemblage data (M-IBI and F-IBI). Station 06SC104 was sampled twice on the lower reach (AUID 07030004-548), scoring 13 and 11 successively. These results are significantly below the biological criterion of IBI $\geq$ 68 for this stream type and the reach was added to the impaired waters list in the 2008 Assessment Cycle.

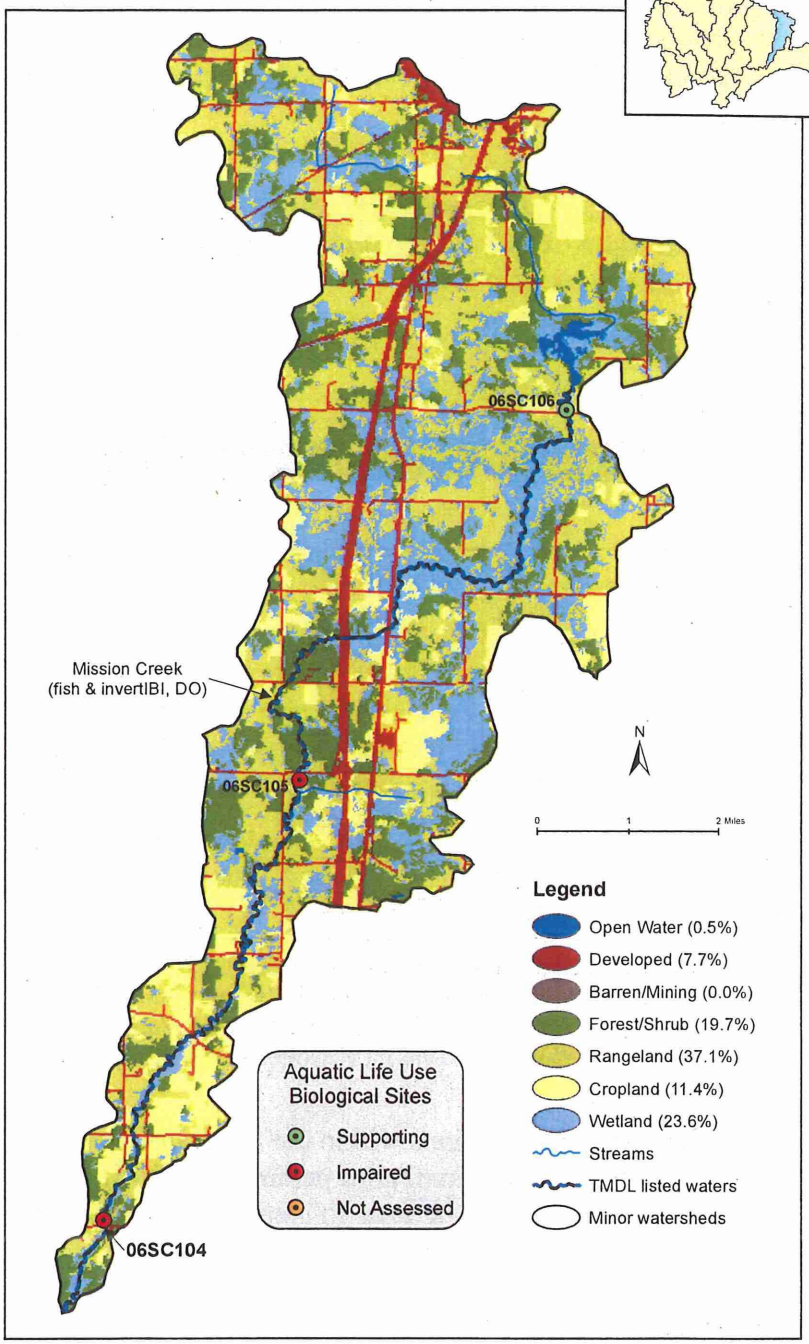

Figure 15. Sampling locations and their use support status, land use characteristics, minor watersheds, and currently listed impaired waters in the Mission Creek Watershed Unit.

Water chemistry data was collected by the SRWMB at the station representing the pour point of the Mission Creek Watershed Unit (06SC104) between 4/6/2004 and 4/19/2006. Results indicate dissolved oxygen is a parameter of concern in this watershed, and to a lesser extent fecal coliform (Table 12). Twelve of forty-six values violated the minimum D.O. standard of 5.0 mg/l. The

data set was sufficient (>10% violations, minimum 20 observations) to list Mission Creek (AUID 07030004-548) as non-supporting of aquatic life for this parameter in the 2008 Assessment Cycle. One of twenty fecal coliform values exceeded (7300) the maximum standard of 2000 organisms per 100 milliliters. However, the results are not sufficient to assess the reach as non-supporting for aquatic recreation. Three of forty-five pH measurements were outside (6.05, 6.14 and 9.75) the water quality standard range (6.5-9.0), but does not indicate an impairment (>10% violations, minimum 20 observations).

Table 12. Water chemistry results at the site representing the pour point of the Mission Creek Watershed Unit. Bold values indicate potential exceedances of a water quality standard or ecoregion expectation.

Station location:	Mission Creek at CR 53, 2 mi. W of Pine City, MN											
Storet ID:	S003-531											
Station ID:	06SC104 – pour point of Mission Creek HUC-11 Watershed (07030004-110)											
Parameter	Chloride	D.O.	Fecal Coliform	NH3 + NH4	NO2 + NO3	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	Deg C	cm
# Samples		46	20		22	45	43	39			46	4
Minimum		**.05**	10		0.005	6.05	0.04	0			0.5	65
Maximum		13.8	**7300**		.66	**9.75**	0.5	22.0			26.6	100
Mean[1]		7.4	104		0.07	7.12	0.1	4.4			13.8	81
Median		7.3	60		0.005	7.11	0.08	3.0			13.8	79
WQ standard	230	5.0	200/ 2000			6.5 - 9.0		100			30	20
# WQ exceedances[2]		12/46	1/20			3/45		0/39			0/46	0/4
NCHF 75th percentile[3]				0.20	0.12	8.4	0.17	18	310		24	

[1]Geometric mean of all samples is provided for E. coli or fecal coliform.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform (2000/100ml).
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

Water quality conditions within the Mission Creek Watershed Unit are not meeting the designated use of aquatic life for a number of parameters (F-IBI, M-IBI, and D.O.). Phase II intensive monitoring should be conducted in order to identify the source(s) and cause(s) of the impairments.

11-Digit HUC Watershed	Watershed Unit Name	Stream Name	Field Number[1]	Sample Type[2]	Location	County	Latitude[3]	Longitude[3]
07030004010	Upper Snake River							
		Snake River	96SC069	BIO	CR 2, 2.5 mi. E. of Pliny	Aitkin	46.33351178	-93.21024405
		Trib. to Snake River	06SC134	BIO	Upstream of CR 2, 1 mile W. of Pliny	Aitkin	46.33421939	-93.29524226
		Bear Creek	06SC133	BIO	Upstream of CR 9 bridge in McGrath	Aitkin	46.24203748	-93.27374259
		Snake River	06SC135	BIO	Downstream of Hwy 65, just N. of Pliny	Aitkin	46.33821189	-93.26348876
		Snake River	06SC132	WQ	@ Hwy 18, 2 miles SE of McGrath	Aitkin	46.21717723	-93.24076083
07030004020	Lower Upper Snake River							
		Bergman Brook	99NF042	BIO	~0.15 miles W of Hwy 65, 3 mi. N of Woodland	Kanabec	46.15631843	-93.27859721
		Hay Creek	96SC076	BIO	Upstream of S.H. 27, 2 miles W. of Woodland	Kanabec	46.11534647	-93.31944493
		Cowan's Brook	06SC131	BIO	Downstream of CR 61, 5 miles NE of Woodland	Aitkin	46.16682831	-93.22207628
		Chelsey Brook	06SC022	BIO	Upstream of CR 85, 5 miles SW of Giese	Kanabec	46.15444195	-93.15853863
		Snake River	06SC006	BIO	Snake River County Park, 3 miles NE of Woodland	Aitkin	46.16396925	-93.2469512
		Snake River	06SC123	WQ	Upstream of CR 61, 3 miles NE of Woodland	Kanabec	46.12530824	-93.22106157
07030004030	Middle Snake River							
		Spring Brook	06SC114	BIO	Downstream of CR 11 @ Jct. with CR 1, 1 mile SE of Mora	Kanabec	45.86737617	-93.26737223
		Trib. to Snake River	06SC113	BIO	Downstream of CR 17, 4 miles SE of Mora	Kanabec	45.81666211	-93.25363909
		Snowshoe Brook	06SC117	BIO	Accessed right off CR 3, 3 miles SE of warman	Kanabec	46.02539136	-93.25395202
		Rice Creek	06SC111	BIO	Hwy 70, 3 miles W. of Grasston	Kanabec	45.78587023	-93.20706932
		Snake River	06SC118	BIO	South of CR 24, 3 miles E of Warman	Kanabec	46.07085995	-93.20999132
		Snake River	06SC116	BIO	Upstream of CR 19, 6 miles NE of Mora	Kanabec	45.96289896	-93.24498754
		Snake River	06SC115	BIO	Upstream of Hwy 65 in Mora	Kanabec	45.86410366	-93.30030805
		Snake River	06SC112	WQ	Along 150th Ave., 4 miles SE of Mora	Kanabec	45.79950946	-93.23993674
07030004040	Knife River							
		Trib. to Knife River	06SC124	BIO	Downstream of CR 76, 5 miles NW of Mora	Kanabec	45.9494527	-93.33830279
		Bean Brook	06SC126	BIO	Upstream of CR 3, 4 miles SW of Warman	Kanabec	46.01003957	-93.32720948
		Knife River (Dry Run)	06SC129	BIO	Downstream of CR 115, 4 miles S. of Isle	Mille Lacs	46.08192804	-93.46296674
		Trib. to Knife River	06SC127	BIO	Upstream of CR 15, 5 miles W of Warman	Kanabec	46.05807021	-93.38481885
		Knife River	06SC128	BIO	Upstream of Hwy 47, 7 miles W. of Warman	Mille Lacs	46.04765136	-93.43646229
		Knife River	06SC125	BIO	Downstream of CR 88, 6 miles N. of Mora	Kanabec	45.98005116	-93.33776856
		Knife River	96SC097	WQ	@ C.R. 77, 3 mi. N. of Mora	Kanabec	45.92042601	-93.30815473
07030004050	Ann River							
		Camp Creek	06SC137	BIO	Downstream of Hwy 26, 2 miles NW of Ann Lake	Kanabec	45.92027102	-93.46227281
		Little Ann River	96SC004	BIO	@ Hwy. 47, 4 mi. N. of Ann Lake	Kanabec	45.9687383	-93.42882213
		Little Ann River	06SC138	BIO	Upstream of CR 26, 3 miles N of Ann Lake	Kanabec	45.93514053	-93.41889173
		Ann River	06SC136	BIO	Upstream of CR 12, 3 miles W. of Mora	Kanabec	45.87688956	-93.36360914
		Ann River	06SC122	WQ	Downstream of Hwy 23, 2 miles SW of Mora	Kanabec	45.85221191	-93.33348075
07030004060	Groundhouse River							
		Trib. to Groundhouse River	06SC120	BIO	Upstream of CR 56, 2 miles SW of Ann Lake	Kanabec	45.88594877	-93.47731033
		West Fork Groundhouse River	06SC029	BIO	1/2 mile N. of CR 116, 9 miles NE of Milaca	Mille Lacs	45.89459805	-93.57687359
		Groundhouse River	06SC121	BIO	Downstream of CR 24, 5 miles W. of Ann Lake	Kanabec	45.91140163	-93.52954107
		Groundhouse River	96SC070	BIO	@ Rum River State Forest	Kanabec	45.88154621	-93.50687055
		Groundhouse River	03SC002	BIO	downstream of 150th Ave., 2 mi. S.E. of Ogilvie	Kanabec	45.80275568	-93.39621925
		Groundhouse River	06SC061	WQ	Upstream of Hwy 65, 1 mile W. of Brunswick	Kanabec	45.79076485	-93.31921389
07030004070	South Fork Groundhouse River							
		South Fork Groundhouse River	06SC045	BIO	Upstream of CR 13, 3 miles W. of Ogilvie	Kanabec	45.82364442	-93.48639625
		South Fork Groundhouse River	06SC065	BIO	Upstream of CR 4, 5 miles S. of Ogilvie	Kanabec	45.76333236	-93.44286949
		South Fork Groundhouse River	03SC003	WQ	upstream of Hwy. 47, 4 mi. S. of Ogilvie	Kanabec	45.77863473	-93.41125281
07030004080	Mud Creek							
		County Ditch #4	06SC108	BIO	Downstream of CR 17, 2 miles NW of Grasston	Kanabec	45.80720867	-93.19286361
		Trib. to Mud Creek	06SC018	BIO	Downstream of CR 73, 1 mile N. of Quamba	Kanabec	45.941911	-93.16702456
		Mud Creek	06SC110	BIO	Downstream of CR 5, 4 miles W. of Brook Park	Kanabec	45.95227843	-93.16465768
		Mud Creek	06SC109	BIO	Upstream of CR 120, 1 mile NW of Henriette	Kanabec	45.885801	-93.14466114
		Mud Creek	06SC107	WQ	Upstream of CR 5, 1 mile NW of Grasston	Kanabec	45.81355093	-93.16625992

11-Digit HUC Watershed	Watershed Unit Name	Stream Name	Field Number[1]	Sample Type[2]	Location	County	Latitude[3]	Longitude[3]
07030004090	Lower Snake River							
		Trib. to Cross Lake	06SC101	BIO	Upstream of CR 125, 2 miles SE of Beroun	Pine	45.89059138	-92.92916862
		Bear Creek	96SC068	BIO	CR 10, 4 mi. N.E. of Pine City	Pine	45.85945541	-92.86947265
		Hay Creek	98SC016	BIO	Just downstream of CSAH 5, 9 mi. NW of Rock Creek	Pine	45.77863208	-93.13240963
		Snake River	06SC010	BIO	Downstream of Hwy 107, just E. of Grasston	Pine	45.78387423	-93.11657658
		Snake River	06SC007	FC	Downstream of CR 9, 9 miles E. of Pine City	Pine	45.82285821	-92.78311475
07030004100	Pokegama Creek							
		Trib. to Pokegama Creek	06SC100	BIO	CR 13, 3 miles E. of Henriette	Pine	45.87712199	-93.06333152
		Pokegama Creek	06SC102	BIO	CR 130, 2 miles SE of Brook Park	Pine	45.93101038	-93.01930984
		East Pokegama Creek	06SC103	BIO	Downstream of CR 131, 4 miles SE of Brook Park	Pine	45.93550769	-93.00344095
		Pokegama Creek	06SC042	WQ	Downstream of CR 14, 6 miles NW of Pine City	Pine	45.90124269	-93.03293882
07030004110	Mission Creek							
		Mission Creek	06SC106	BIO	CR 16, 2 miles SE of Mission Creek	Pine	45.96213186	-92.91632063
		Mission Creek	06SC105	BIO	CR 14, 1 mile W. of Beroun	Pine	45.90316224	-92.97708884
		Mission Creek	06SC104	WQ	Upstream of CR 53, 2 miles W. of Pine City	Pine	45.83294022	-93.0214004

[1] Field number assigned to each station to designate a unique sampling location.

[2] Indicates level of sampling effort at each station. BIO=one time biological, physical habitat, and water chemistry; WQ=site represents pour point of HUC-11 watershed, 10x sampling of water chemistry (in addition to BIO); FC=site represents pour point of Snake River Watershed, fish contaminants sampling (in addition to BIO & WQ).

[3] Latitude and Longitude are formatted in WGS84 decimal degrees.

11-Digit HUC Name	AUID[1]	Stream Name	Field Number	Drainage Area (mi²)	Sample Date	Channel Condition[2]	MSHA[3]	Fish IBI[4]	Assessment[5]	TMDL Status[6]
Upper Snake River										
	07030004-552	Bear Creek	06SC133	30.0	07/17/06	NA	70.8	33	NS	AL[F-IBI(08), pH(08)]
	07030004-557	Trib. to Snake River	06SC134	19.8	07/17/06	OC	47.0	19	N/A	
	07030004-508	Snake River	96SC069	16.5	07/11/06	NA	70.1	86	FS	AL[F-IBI(02)], AC[Hg(98)]
	07030004-508	Snake River	06SC135	34.5	07/11/06	OC	44.5	37	N/A	AL[F-IBI(02)], AC[Hg(98)]
	07030004-508	Snake River	06SC132	133.6	07/12/06	NA	76.6	69	FS	AL[F-IBI(02)], AC[Hg(98)]
Lower Upper Snake River										
	07030004-508	Snake River	06SC006	142.2	06/21/06	NA	81.6	74	FS	AL[F-IBI(02)], AC[Hg(98)]
	07030004-507	Chelsey Brook	06SC022	28.4	07/24/06	NA	61.5	66	FS*	
	07030004-509	Hay Creek	96SC076	13.0	07/06/06	OC	59.5	88	N/A	
	07030004-517	Cowan's Brook	06SC131	14.5	07/18/06	NA	59.8	68	FS	
	07030004-523	Snake River	06SC123	200.2	07/12/06	NA	79.2	75	FS	AC[Hg(98)]
	07030004-541	Bergman Brook	99NF042	11.5	07/17/06	NA	55.0	77	FS	
Middle Snake River										
	07030004-506	Snake River	06SC118	249.3	07/06/06	NA	85.0	86	FS	AC[Hg(98)]
	07030004-506	Snake River	06SC116	298.6	08/02/06	NA	71.0	71	N/A	AC[Hg(98)]
	07030004-515	Spring Brook	06SC114	5.7	07/18/06	NA	57.3	34	NS	AL[F-IBI(02)]
	07030004-524	Snake River	06SC112	665.1	06/20/06	NA	56.5	91	N/A	AC[Hg(98)]
	07030004-524	Snake River	06SC112	665.1	08/09/06	NA	60.5	94	N/A	AC[Hg(98)]
	07030004-525	Snake River	06SC115	434.5	06/21/06	NA	69.9	91	N/A	AR[FC(08)], AC[Hg(98)]
	07030004-558	Snowshoe Brook	06SC117	22.4	07/11/06	NA	61.8	73	FS	
	07030004-569	Trib. to Snake River	06SC113	7.6	06/20/06	NA	66.0	54	FS	
	07030004-575	Rice Creek	06SC111	23.8	07/19/06	OC	54.7	49	N/A	
Knife River										
	07030004-537	Knife River (Dry Run)	06SC129	10.3	07/07/06	NA	48.5	16	N/A	AL[M-IBI(06)]
	07030004-549	Knife River	06SC128	29.6	07/18/06	NA	80.6	82	FS	AL[F-IBI(02),M-IBI(04)]
	07030004-549	Knife River	06SC125	80.7	07/19/06	NA	79.8	67	FS*	AL[F-IBI(02),M-IBI(04)]
	07030004-551	Knife River	96SC097	107.6	07/11/06	NA	76.0	74	FS	
	07030004-559	Trib. to Knife River	06SC127	15.8	07/07/06	NA	83.0	91	FS	
	07030004-560	Bean Brook	06SC126	8.0	07/06/06	NA	83.2	77	FS	
	07030004-562	Trib. to Knife River	06SC124	6.3	07/11/06	NA	63.5	68	FS	
Ann River										
	07030004-511	Ann River	06SC136	64.3	07/17/06	NA	77.4	67	FS*	AL[F-IBI(02)]
	07030004-511	Ann River	06SC122	71.8	06/20/06	NA	57.5	71	FS	AL[F-IBI(02)]
	07030004-518	Little Ann River	96SC004	20.0	06/19/06	NA	78.7	84	FS	
	07030004-518	Little Ann River	06SC138	27.8	07/17/06	NA	73.4	97	FS	
	07030004-571	Camp Creek	06SC137	4.5	07/18/06	NA	69.3	76	FS	
	07030004-571	Camp Creek	06SC137	4.5	08/09/06	NA	76.9	94	FS	
Groundhouse River										
	07030004-512	Groundhouse River	06SC061	126.7	07/18/06	NA	75.4	70	FS	AR[FC(08)]
	07030004-513	Groundhouse River	06SC121	19.2	07/07/06	NA	65.8	86	FS	AL[F-IBI(02),M-IBI(04)], AR[FC(02)]
	07030004-513	Groundhouse River	96SC070	42.4	07/06/06	NA	73.7	83	FS	AL[F-IBI(02),M-IBI(04)], AR[FC(02)]
	07030004-513	Groundhouse River	03SC002	69.1	07/11/06	NA	87.4	66	FS*	AL[F-IBI(02),M-IBI(04)], AR[FC(02)]
	07030004-538	W.F. Groundhouse River	06SC029	12.1	07/17/06	NA	54.4	79	FS	
	07030004-570	Trib. to Groundhouse River	06SC120	12.0	06/19/06	NA	64.9	82	FS	

11-Digit HUC Name	AUID[1]	Stream Name	Field Number	Drainage Area (mi²)	Sample Date	Channel Condition[2]	MSHA[3]	Fish IBI[4]	Assessment[5]	TMDL Status[6]
SF Groundhouse River										
	07030004-573	S.F. Groundhouse River	06SC045	5.8	07/17/06	NA	47.7	19	NS	AL[M-IBI(04),F-IBI(08)], AR[FC(08)]
	07030004-573	S.F. Groundhouse River	06SC045	5.8	08/16/06	NA	51.6	13	NS	AL[M-IBI(04),F-IBI(08)], AR[FC(08)]
	07030004-573	S.F. Groundhouse River	06SC065	36.3	07/19/06	OC	49.0	91	N/A	AL[M-IBI(04),F-IBI(08)], AR[FC(08)]
	07030004-573	S.F. Groundhouse River	06SC065	36.3	08/09/06	OC	50.8	89	N/A	AL[M-IBI(04),F-IBI(08)], AR[FC(08)]
	07030004-573	S.F. Groundhouse River	03SC003	47.9	07/07/06	OC	70.6	86	N/A	AL[M-IBI(04),F-IBI(08)], AR[FC(08)]
Mud Creek										
	07030004-563	Trib. to Mud Creek	06SC018	7.2	07/17/06	OC	61.9	53	N/A	
	07030004-566	Mud Creek	06SC110	18.8	07/13/06	NA	49.7	68	FS	AL[F-IBI(02),M-IBI(04)]
	07030004-567	Mud Creek	06SC109	41.3	07/18/06	NA	78.2	82	PS	AL[F-IBI(02)], AR[FC(08)]
	07030004-567	Mud Creek	06SC107	66.5	07/13/06	NA	69.8	56	PS	AL[F-IBI(02)], AR[FC(08)]
	07030004-568	County Ditch #4	06SC108	7.0	06/20/06	OC	59.0	21	N/A	
Lower Snake River										
	07030004-503	Snake River	06SC010	789.6	08/07/06	NA	64.0	73	N/A	AC[Hg(98)]
	07030004-514	Bear Creek	96SC068	6.5	07/10/06	NA	67.0	62	FS	
	07030004-522	Hay Creek	98SC016	11.6	06/19/06	OC	50.0	52	N/A	
	07030004-577	Trib. to Cross Lake	06SC101	3.3	06/22/06	NA	53.0	28	NS	AL[F-IBI(08)]
	07030004-587	Snake River	06SC007	972.0	07/05/06	NA	84.0	89	N/A	AC[Hg(98)]
	07030004-587	Snake River	06SC007	972.0	08/10/06	NA	85.9	74	N/A	AC[Hg(98)]
Pokegama Creek										
	07030004-530	Pokegama Creek	06SC102	19.1	07/10/06	NA	80.1	77	FS	
	07030004-531	East Pokegama Creek	06SC103	22.8	07/10/06	NA	65.7	70	FS	
	07030004-532	Pokegama Creek	06SC042	47.2	06/22/06	NA	57.2	64	FS*	AL[M-IBI(04)]
	07030004-534	Trib. to Pokegama Creek	06SC100	9.2	06/19/06	NA	68.0	51	FS	
	07030004-534	Trib. to Pokegama Creek	06SC100	9.2	08/07/06	NA	58.0	42	FS*	
Mission Creek										
	07030004-547	Mission Creek	06SC106	11.3	07/10/06	NA	52.5	49	PS	AL[F-IBI(02),M-IBI(04)]
	07030004-547	Mission Creek	06SC105	29.4	07/13/06	NA	46.5	43	PS	AL[F-IBI(02),M-IBI(04)]
	07030004-548	Mission Creek	06SC104	38.8	07/10/06	NA	55.0	13	NS	AL[F-IBI(08),DO(08)]
	07030004-548	Mission Creek	06SC104	38.8	08/07/06	NA	41.0	11	NS	AL[F-IBI(08),DO(08)]

[1] Assessment Unit Identifier (AUID) - unique waterbody code comprised of 8-digit HUC plus unique three digit identifier within HUC.

[2] The condition of the stream channel within the sampling reach. NA=natural channel, OC=old channelization.

[3] MPCA Stream Habitat Assessment (MSHA) score for each site. Scores range from 0 (poor habitat) to 100 (excellent habitat).

[4] IBI score based on the fish community assessment of the site. Scores range from 0 (lowest biological integrity) to 100 (highest biological integrity).

[5] Assessment of aquatic life use support for each AUID based only on 2006 fish community data collected as part of this study.
FS=full support, FS*=full support (below IBI threshold score but within confidence interval), PS=partial support, NS=non-support, N/A=not assessed.
Potential reasons for N/A include: coldwater stream, channelized stream condition, wetland habitat, or large river site (>270 mi² drainage area).

[6] The assessment history of impaired reaches (TMDL listed AUID's) based on all available data. Indicates the impaired use, pollutant or stressor, and the year listed.
Impaired designated use codes - AL=aquatic life, AR=aquatic recreation, AC=aquatic consumption
Pollutant or stressor codes - F-IBI=fish index of biological integrity, M-IBI=macroinvertebrate index of biological integrity, FC=fecal coliform, DO=dissolved oxygen, Hg=mercury in fish tissue