Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List

2010 Assessment Cycle
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Forward

Since the Clean Water Act became law in 1972, very significant and often dramatic improvements in the water quality of the nation’s surface waters have been accomplished. Notable Minnesota examples include the Mississippi River below the Twin Cities, the Rainy River below International Falls, and the lower St. Louis River near Duluth, to name just three. Most of these gains can be attributed to vast improvements in domestic and industrial wastewater treatment, due largely to the Clean Water Act National Pollutant Discharge Elimination System permit program, and the Construction Grants program. Point source discharges have been significantly “cleaned up” as a result of these two programs (which is not to say that all point source pollution problems have been solved). The contribution of pollutants from nonpoint sources, from agriculture, construction and development sites, forestry, urban runoff, etc., is now the major reason that many of Minnesota’s waters are considered impaired. The prevention and control of nonpoint source pollution remains one of the Minnesota Pollution Control Agency’s, and the public’s, greatest pollution challenges.

It is the responsibility of the Minnesota Pollution Control Agency to monitor Minnesota’s rivers and lakes, to assess water quality, and to report the results to the public. This task extends to documenting the water quality “success stories”, as well as documenting those rivers and lakes that still need improvement. This Guidance Manual deals with the need to assess water quality with available data, which may be plentiful in places but is often just enough to satisfy minimum data requirements. The methodologies in this Guidance Manual are designed to reap the most information, value, and benefit possible from limited data.

This Guidance Manual was developed to help federal, tribal, state, and county staff, and the public in general, understand the water quality assessment process. It will be updated as assessment methods improve and as new pollution problems emerge that require assessment. Comments and suggestions from readers are encouraged and will be used to help improve the guidance.

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# Abbreviations, Acronyms, and Symbols

<table>
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<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ch.</td>
<td>Chapter</td>
</tr>
<tr>
<td>Chl-a</td>
<td>Chlorophyll-a, corrected for pheophytin</td>
</tr>
<tr>
<td>CLMP</td>
<td>Citizen Lake Monitoring Program</td>
</tr>
<tr>
<td>CSMP</td>
<td>Citizen Stream Monitoring Program</td>
</tr>
<tr>
<td>CWP</td>
<td>Clean Water Partnership</td>
</tr>
<tr>
<td>DELT</td>
<td>Deformities, eroded fins, lesions or tumors</td>
</tr>
<tr>
<td>DO</td>
<td>Dissolved oxygen</td>
</tr>
<tr>
<td>EMAP</td>
<td>Environmental Monitoring and Assessment Program</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>FAV</td>
<td>Final Acute Value</td>
</tr>
<tr>
<td>GLI</td>
<td>Great Lakes Water Quality Initiative</td>
</tr>
<tr>
<td>IBI</td>
<td>Index of Biotic Integrity</td>
</tr>
<tr>
<td>L</td>
<td>Liter</td>
</tr>
<tr>
<td>LAP</td>
<td>Lake Assessment Program</td>
</tr>
<tr>
<td>MDA</td>
<td>Minnesota Department of Agriculture</td>
</tr>
<tr>
<td>MDH</td>
<td>Minnesota Department of Health</td>
</tr>
<tr>
<td>MFCA</td>
<td>Minnesota Fish Consumption Advisory</td>
</tr>
<tr>
<td>MDNR</td>
<td>Minnesota Department of Natural Resources</td>
</tr>
<tr>
<td>μg/L</td>
<td>microgram per liter or ppb</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligram per liter or ppm</td>
</tr>
<tr>
<td>MPCA</td>
<td>Minnesota Pollution Control Agency</td>
</tr>
<tr>
<td>NCHF</td>
<td>North Central Hardwood Forest Ecoregion</td>
</tr>
<tr>
<td>ng/L</td>
<td>Nanogram per liter or parts per trillion</td>
</tr>
<tr>
<td>NGP</td>
<td>Northern Glaciated Plains Ecoregion</td>
</tr>
<tr>
<td>NHD</td>
<td>National Hydrographic Data</td>
</tr>
<tr>
<td>NLF</td>
<td>Northern Lakes and Forests Ecoregion</td>
</tr>
<tr>
<td>NTU</td>
<td>Nephelometric turbidity units</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyls</td>
</tr>
<tr>
<td>pg/L</td>
<td>Picogram per liter or parts per quadrillion.</td>
</tr>
<tr>
<td>ppb</td>
<td>Microgram per liter or parts per billion</td>
</tr>
<tr>
<td>ppm</td>
<td>Milligram per liter or parts per million</td>
</tr>
<tr>
<td>ppq</td>
<td>Picogram per liter or parts per quadrillion</td>
</tr>
<tr>
<td>ppt</td>
<td>Nanogram per liter or parts per trillion</td>
</tr>
<tr>
<td>pt.</td>
<td>Part</td>
</tr>
<tr>
<td>QA/QC</td>
<td>Quality Assurance/Quality Control</td>
</tr>
<tr>
<td>R.</td>
<td>Rule</td>
</tr>
<tr>
<td>STORET</td>
<td>EPA water quality data STOrage and RETrieval system</td>
</tr>
<tr>
<td>TMDL</td>
<td>Total Maximum Daily Load</td>
</tr>
<tr>
<td>TP</td>
<td>Total Phosphorus</td>
</tr>
<tr>
<td>TSI</td>
<td>Trophic State Index</td>
</tr>
<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>WCBP</td>
<td>Western Corn Belt Plains Ecoregion</td>
</tr>
<tr>
<td>≥</td>
<td>Greater than or equal to</td>
</tr>
<tr>
<td>≤</td>
<td>Less than or equal to</td>
</tr>
</tbody>
</table>
I. Introduction

A. Background

Minnesota is blessed with abundant water resources. Our lakes, rivers, and streams play a vital role in the state’s economy and the richness of the quality of life residents and visitors enjoy. The enormous opportunities for water related recreation these resources provide, such as aesthetic enjoyment, swimming, fishing, boating and canoeing depend, to a great extent, on good water quality. Within Minnesota’s borders lie the headwaters of three major continental watersheds, the Great Lakes/St. Lawrence River, the Mississippi River, and the Red River of the North/Hudson Bay watersheds. Thus, Minnesotans have the privilege and, with that, the huge responsibility of living “upstream” of millions of downstream users of these major waterways. Minnesota’s water resources include about 105,000 river miles, 4.5 million acres of lakes and reservoirs including approximately 1.4 million acres of Lake Superior in Minnesota, and about 9.3 million acres of wetlands.

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 lakes, rivers, streams, and wetlands. With the exception of mercury contamination of fish, a widespread problem throughout much of the lake-rich upper Midwest, the water quality of many Minnesota surface waters meets or exceeds most water quality standards. The goal of the MPCA is to maintain the existing high quality of waterbodies that are meeting standards. However, too many surface waters receive enough pollutant loading from a variety of sources that they do not meet one or more water quality standards. If the extent of the violations of standards exceed the guidelines spelled out in this Guidance Manual (Guidance), those surface waters are considered to be “impaired”. The goal of the MPCA is to improve the quality of impaired waters so water quality standards are met and beneficial uses are restored, where these uses are attainable.

B. Purpose and scope

Rivers, streams, wetlands, and lakes determined to be not supporting beneficial uses (i.e., impaired) are listed in both of the two federally mandated compilations of assessed waters, the 305(b) report (the integrated narrative report) and the 303(d) list. Under the “integrated” approach to the preparation of these two documents, as described in Section VI, the distinctions between them have mostly disappeared.

The MPCA began assessing waters for use support in the mid 1970s for the 305(b) report, and has developed guidance and protocols for interpreting water quality data and information used to determine impaired conditions. The purpose of this Guidance is to consolidate the existing protocols into one document, to define the data and information requirements needed to determine impairment for the various categories of pollutants, and to provide a rationale for the thresholds selected that indicate impairment.

The scope of this Guidance includes methods for assessing surface waters for the following categories of pollutants:

- those having toxicity-based standards
- those having human health-based standards
- conventional pollutants and water quality characteristics
- *E. coli* coliform bacteria
- eutrophication of lakes (effects of excess nutrients)
- impairment of the biological community
- fish tissue contaminants

The assessment of surface water and groundwater for drinking water purposes is, with one exception, mostly outside the scope of this Guidance. Most surface water monitoring programs are not focused on assessing quality for drinking. The Minnesota Department of Health (MDH) monitors municipal finished-water supplies for compliance with drinking water standards. Also, aquatic life standards may
be more stringent than drinking water standards for the pollutants for which the MPCA has surface water data (e.g., mercury and most other trace metals), or the pollutant is not relevant to drinking water (e.g., dissolved oxygen, ammonia, excess nutrients).

However, the MPCA is assessing Class 1B and 1C surface waters, which are protected as a source of drinking water, for potential impairments by nitrate nitrogen. The MPCA is doing this in recognition of the trend of increasing nitrate concentrations in Minnesota streams and the public health and economic impacts arising from elevated nitrate concentrations in drinking water, which is a particular concern in some areas of Minnesota.

The minimum data requirements and the use support and impairment determination thresholds used in water quality assessments for both the integrated narrative report and 303(d) list are summarized in Section XV. The tables in Section XV are designed to help the reader visualize and compare in one place the basic assessment methods. Definitions of terms, a complete discussion of data requirements, assessment protocols, and supportive discussion for each pollutant category can be found in the appropriate sections of the Guidance.

Table 1. Assessment methods that have changed or are new in this Guidance. (See appropriate section of Guidance for details.)

<table>
<thead>
<tr>
<th>Pollutant Category</th>
<th>Location of Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 7 exceedence assessment approach</td>
<td>Section XI.</td>
</tr>
<tr>
<td>Fecal coliform -&gt; E. coli transition</td>
<td>Section X.A.</td>
</tr>
<tr>
<td>Nitrate assessments</td>
<td>Section VIII.C.</td>
</tr>
<tr>
<td>Turbidity meter differences</td>
<td>Section VII.B.1.c.</td>
</tr>
<tr>
<td>Updating the discussion on turbidity</td>
<td>Section V.D.</td>
</tr>
</tbody>
</table>

C. Disclaimers and future changes to this Guidance

To people not involved with conducting water quality assessments, the determination of an impaired condition would seem to be a straightforward process: waters are either impaired or not impaired. However, the assessment process can be very complex and it includes a certain amount of uncertainty. The MPCA must consider many different types and sources of data, different categories of pollutants, different uses of surface waters, the variability in natural systems, and many other variables. The goal of this Guidance is to accurately and completely describe the assessment methods, and to make the assessment process as clear and understandable to all parties as possible. Nevertheless, questions about the assessment process will invariably arise that the Guidance fails to answer. Readers are encouraged to access the many resources listed in Section XIV, including MPCA staff, for additional information. Two MPCA products which may be especially useful and related to this Guidance are the Volunteer Surface Water Monitoring Guide (MPCA 2003) [http://www.pca.state.mn.us/water/monitoring-guide.html] and the Data Access Web site [http://www.pca.state.mn.us/data/eda]. The Monitoring Guide provides information on planning a monitoring program, as well as data quality and management. The Data Access Web site allows Minnesotans to access environmental data on surface waters statewide.

This Guidance does not affect the rights and administrative procedures available to all affected or interested parties. The Guidance is not part of any water quality rule – it does not have the force of law. It serves to guide the interpretation and application of current water quality standards that are in water quality rules. If any party feels that an MPCA decision based on the Guidance is not supported by the facts, or they have any issue related to the MPCA’s use of the Guidance, that party can comment or challenge the MPCA’s actions in the following ways:

- Directly contact MPCA staff, management, or the Commissioner, orally or in writing.
- Request that the issue be brought before the MPCA Citizens’ Board for hearing.
• Request a contested case hearing if the issue involves an MPCA permit action, or any other MPCA action for which a contested case hearing is an appropriate forum to resolve the concern.
• Challenge the MPCA action in the appropriate legal jurisdiction.

The MPCA updates this Guidance every two years since that is the current EPA mandated schedule for preparation of both the integrated narrative report and the 303(d) list. The MPCA involves the public when major changes to the Guidance are being considered.
II. Water Quality Standards

Water quality standards are one of the fundamental tools that help protect Minnesota’s surface waters from pollution. Water quality standards consist of three elements (USEPA 1994, Minn. R. chs. 7050 and 7052):

1. classifying waters with designated beneficial uses
2. narrative requirements and numeric concentration standards to protect those uses
3. nondegradation (antidegradation) policies to maintain and protect existing uses and high quality waters

Water quality standards are the fundamental benchmarks used to assess the quality of all surface waters. In Minn. R ch. 7050, statewide water quality standards are listed in Minn. R. ch. 7050.0220 to 7050.0227. Lake Superior water quality standards are found in Minn. R. ch. 7052.0100.

The term “water quality standards” is commonly used in both a broad and narrow sense. Broadly speaking, water quality standards include all the legal requirements in water quality rules described above and include the general standards found in 7050.0210, minimum wastewater treatment requirements, and effluent limits for point source dischargers. In the more narrow sense, pollutant-specific numeric and narrative criteria when associated with a beneficial use classification are referred to as “standards”; both numeric and narrative criteria define acceptable conditions for the protection of the uses we make of waters of the state. The term “water quality standards” is used in the more narrow sense throughout this document, but will be described in more complete terminology when needed. For a more complete discussion of water quality standards see this Web site: http://www.pca.state.mn.us/water/standards/index.html.

A. Beneficial use classes for surface waters

Minn. R. ch. 7050 identifies seven beneficial uses for which surface waters are protected, as listed below. The use class numbers 1 – 7 are not intended to imply a priority rank to the uses.

<table>
<thead>
<tr>
<th>Use Class</th>
<th>Beneficial Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Drinking water</td>
</tr>
<tr>
<td>Class 2</td>
<td>Aquatic life and recreation</td>
</tr>
<tr>
<td>Class 3</td>
<td>Industrial use and cooling</td>
</tr>
<tr>
<td>Class 4A</td>
<td>Agricultural use, irrigation</td>
</tr>
<tr>
<td>Class 4B</td>
<td>Agricultural use, livestock, and wildlife watering</td>
</tr>
<tr>
<td>Class 5</td>
<td>Aesthetics and navigation</td>
</tr>
<tr>
<td>Class 6</td>
<td>Other uses</td>
</tr>
<tr>
<td>Class 7</td>
<td>Limited resource value waters (not fully protected for aquatic life because of lack of water, lack of habitat, or extensive physical alterations)</td>
</tr>
</tbody>
</table>

Class 2 waters are further divided into subclasses as follows:

| Class 2A  | Cold water fisheries, trout waters |
| Class 2Bd | Cool and warm water fisheries, in addition these waters are protected as a source of drinking waters |
| Class 2B  | Cool and warm water fisheries (not protected for drinking water) |
| Class 2C  | Indigenous fish and associated aquatic community |
| Class 2D  | Wetlands |

All surface waters in Minnesota, including lakes, rivers, streams, and wetlands, are protected for aquatic life and recreation where these uses are attainable, unless the waterbody has been individually assessed and re-classified as a limited resource value water. Protection of aquatic life means the maintenance of healthy, diverse, and successfully reproducing populations of aquatic organisms, including invertebrates as well as fish. Protection of recreation for all surface waters, except wetlands and limited resource value waters means the maintenance of conditions suitable for swimming and other forms of water recreation. Recreation in wetlands (Class 2D) means boating and other forms of aquatic recreation for which they may be usable (this does not preclude swimming if that use is suitable). This is consistent with the goal in the Clean Water Act (CWA) that the nation’s waters should be “fishable” and “swimmable” wherever...
attainable. Limited resource value waters (Class 7) do not support swimming, but they may support wading, nature study, or other forms of recreation that do not involve total immersion in the water. Class 7 waters support a very limited fishery and aquatic community because of lack of water, habitat, and usually extensive human alterations. Most limited resource value waters are headwater channelized ditches. Class 7 waters make up about one percent (~ 950-1000 miles) of Minnesota’s approximately 105,000 miles of rivers and streams.

Both Class 2 and Class 7 waters, i.e., all surface waters of the state, are also protected for industrial (Class 3A, B & C), agricultural (Class 4A & B), aesthetics and navigation (Class 5), and other uses (Class 6). For example, the St. Croix River from the dam in Taylor’s Falls to its mouth is classified as 1C, 2Bd, 3B, 4A, 4B, 5 and 6; this reach is therefore protected for all uses defined by these use classes (Minn. R. 7050.0470, subp. 6). If a pollutant has standards with numeric criteria for more than one beneficial use class, the most stringent applies.

All ground waters, but only selected surface waters, such as the St. Croix example cited above, are protected as a source of drinking water (Class 1). The federal drinking water standards apply to these waters (Minn. R. ch. 7050.0221). Again, the assessment of groundwater for potential impairment of the drinking water use is outside the scope of this Guidance and this, in general, for surface waters also. One exception is the assessment of Class 1B and 1C surface waters for compliance with safe drinking water standards for nitrate nitrogen (see Section VIII.C.).

B. Numeric water quality standards

A water quality standard with a numeric criterion is a safe concentration of a pollutant in water, associated with a specific beneficial use. Standards with numeric criteria are associated with all use classes except Class 6 (other uses). 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, such as chemical and biological monitoring, to fully assess beneficial uses. The assessment of surface waters for impairment could include a review of any of the applicable beneficial uses and associated criteria. But, in practice, waters are typically assessed only with respect to aquatic life and aesthetic uses. However, compliance with the Class 2 standards will, with few exceptions, protect the usually less sensitive Class 3, 4, 5 and 6 beneficial uses. Aquatic life standards are more stringent than drinking water standards for many pollutants. Therefore, application of Class 2 standards may “protect” drinking water as well. For example, the drinking water and aquatic life standards for selenium are 50 and 5 μg/L, respectively.

All Class 2 standards for toxic pollutants have three parts (except un-ionized ammonia, di-2-ethylhexyl phthalate, hexachlorobenzene, and vinyl chloride, which have only a chronic standard and no maximum standard or final acute value):

- chronic standard
- maximum standard, and
- Final Acute Value

The chronic standard is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects to the organism itself, or to human or wildlife consumers of aquatic organisms. The maximum standard protects aquatic organisms from potential lethal effects of a short-term “spike” in toxicant concentrations. The maximum standard is always equal to one half of the Final Acute Value (FAV). The FAV is most often used as an “end-of-pipe” effluent limit to prevent an acutely toxic condition in the effluent or the mixing zone. The Class 2 standards for toxic pollutants are found in Minn. R. chs. 7050 and 7052. They are listed in Appendix B.

Class 2 chronic standards are based on one of three “end points”, as listed below:

- **Toxicity-based** - The chronic standard is based on the direct toxicity of the toxicant to fish and other aquatic life.
- **Human Health-based** - The chronic standard is based on the protection of people that eat fish from Minnesota waters (and drink the water, if the surface water is also a Class 1 water).
- **Wildlife-based** - The chronic standard is based on the protection of wildlife species that eat aquatic organisms (At this time, only Minn. R. ch. 7052 has wildlife-based standards; Minn. R. ch. 7050 does not).

The usual practice for the MPCA is to calculate both a toxicity-based and a human health-based criterion, and the more restrictive of the two is adopted into Minn. R. ch. 7050 as the applicable chronic standard. The standards for some pollutants can change from toxicity-based to human health-based or vice versa depending on the subclass of Class 2 waters. See Tables B-3 and B-6 in Appendix B. Wildlife-based criteria have not been calculated outside of those adopted in Minn. R. ch. 7052. **Maximum standards and FAVs are always toxicity-based,** never human health or wildlife-based.

Most of Minnesota’s aquatic life (Class 2) standards are based on U.S. Environmental Protection Agency (EPA) aquatic life criteria. This is true for most states. EPA develops and publishes the criteria as required by section 304(a) of the CWA. MPCA has developed a few standards on its own in the absence of an EPA criterion (e.g., atrazine and cobalt).

In the development of aquatic life criteria and associated guidance, the EPA and MPCA have addressed some of the many toxicological, water chemistry, and practical realities that affect the impact a toxicant has on aquatic life. For example, pollutant concentrations and flow volumes vary in effluents and in receiving streams over time, aquatic organisms can tolerate higher concentrations of toxicants for shorter periods of time, and the sensitivity of aquatic organisms to toxicants often varies over their life span. EPA’s approach for expressing water quality standards addresses varying toxicant concentrations, length of an averaging period for the standard, and the number of acceptable exceedances over time. These concepts are highly relevant to the interpretation of water quality standards and the assessment of waterbodies for impairment. They are referred to as follows:

- magnitude
- frequency
- duration

**Magnitude** refers to the concentration for a given pollutant represented by the standard. For example, the chronic, maximum and FAV standards for cyanide are 5.2, 22, and 45 μg/L, respectively. This is the “magnitude” of cyanide that, if not exceeded in the water, will protect the aquatic community from chronic and acute toxic effects.

**Frequency** refers to the number of times a standard may be exceeded over a period of time and still provide the desired level of protection. EPA guidance specifies that standards should not be exceeded more than once in three years. The three year time frame for acceptance of one exceedance is based on studies of the time it takes the aquatic community to recover from a major perturbation.

The MPCA reviewed the exceedance frequency question and concluded that EPA’s one exceedance in three years recommendation can be overly stringent (Maschwitz 1990). A recognized deficiency in the EPA guidance is that the magnitude of the exceedance is not addressed. For example, two exceedances of 1.5 times the chronic standard in three years are not likely to have the same impact on aquatic organisms as two exceedances of 15 times the chronic standard; EPA treats both cases equally. Considered without application of professional judgment, two exceedances of 1.5 times the chronic standard could result in a false conclusion of impairment.

Another potentially overly protective aspect of the three-year frequency is the way this time period was determined. A detailed review of studies that measured the time it takes aquatic communities to recover following a major perturbation indicates that three years was adequate time for most members of the aquatic communities to return to pre-perturbation status (invertebrates recover faster, fish take longer) (Niemi et al. 1988). But, most of these studies of recovery times followed major spills or other catastrophic events that destroyed or had major impacts on the entire resident community. Small exceedances of a chronic standard are not likely to have the same impact as a major spill, resulting in toxicant concentrations in the stream well above acute standards, for example. These considerations went into the selection of the threshold percent exceedances discussed in Section VII.

**Duration** refers to the period of time the measured water concentrations of a toxicant can be averaged and still provide the desired level of protection to the aquatic community, or to the human or wildlife
consumers of aquatic organisms. In the context of toxicity to aquatic organisms, it would be over-
protective and toxicologically unrealistic to consider a standard as an instantaneous maximum
concentration (no averaging period). On the other hand, concentrations averaged over too long a time
could be under-protective, if it allowed unacceptably high concentrations to be “masked” by the
average. In general, toxicant concentrations can persist for a longer period of time at the level of the
chronic standard than at the level of the maximum or FAV standards and still be protective. This is
because chronic effects generally are only manifested after an extended exposure at concentrations
above the chronic standard. In contrast, lethal or sublethal effects could occur after a relatively short
exposure at concentrations equal to the maximum or FAV standards.

EPA recommends the following averaging periods for chronic and maximum standards (EPA 1991):

- Toxicity and human health-based standards:
  - chronic – four day average
  - maximum – one hour average

The MPCA has expanded these concepts and modified the durations of the averaging periods for various
types of standards as shown below (Minn. R. ch. 7050.0222, subp 7):

- chronic standards
  - toxicity-based: four-day average
  - human health or wildlife-based: 30-day average
- maximum standard - one-day average (specified as a one-day maximum in Minn. R.
  ch. 7052.0200, subp. 5 for purposes of calculating a daily maximum effluent limit)

- final acute values - one-day average

The 30-day averaging period for human health and wildlife-based chronic standards recognizes the
longer life spans of humans and wildlife species relative to aquatic invertebrates, but it is short enough
to address the possible impacts that might occur during sensitive periods of early fetal development, for
example. The selection of a one-day averaging period for the maximum and FAV standards, in lieu of
the EPA recommended one-hour average, is based almost entirely on the practicalities of monitoring
frequencies. It is very rare that sampling is frequent enough to determine a one-hour average value either
in ambient waters or in effluents. Also, the one-day duration for the maximum standard, which may be
the basis for setting daily maximum effluent limits, matches the period for these limits.

A more complete discussion of duration and frequency can be found in EPA (1991). A complete
description of how Class 2 standards are determined by the MPCA can be found in MPCA (2000e).

C. Narrative water quality standards

A water quality standard with a narrative criterion is a statement that prohibits unacceptable conditions
in or upon the water, such as floating solids, scum, visible oil film, or nuisance algae blooms. Narrative
standards (standards with narrative criteria) are sometimes called ‘free froms’ because they help keep
surface waters free from very fundamental and basic forms of water pollution. The association between
the criterion and beneficial use is less well defined for narrative standards than it is for numeric
standards (standards with numeric criteria).

Because narrative standards are not quantitative, the determination that one has been exceeded
typically requires a “weight of evidence” approach to data analysis showing a consistent pattern
of violations. There is an unavoidable element of professional judgment involved in using
narrative standards to determine impairment. As such, the descriptions of the methodologies for
determining impairments because of violations of narrative standards require more discussion
than determining impairment of numeric standards. The narrative standards most relevant to this
Guidance are found in Minn. R. ch. 7050.0150. These narrative standards protect surface waters
and aquatic biota from:

- eutrophication (particularly lakes)
- impairment of the biological community
• impairment of fish for human consumption

The narrative standards in Minn. R. ch. 7050.0150, subp. 3 contain terminology, the interpretation of which in the context of the standards will be aided by the definitions that follow. Additional relevant narrative rule language is quoted in Section X B and Section XII.

“Altered materially”, “material increase”, “material manner”, “seriously impaired”, and “significant increase” mean that pollution of the waters of the state has resulted in degradation of the physical, chemical or biological qualities of the waterbody, such that attainable or previously existing beneficial uses are threatened or lost.

“Fish and other biota”, “normal fishery” and “lower aquatic biota” mean the aquatic community including but not limited to game and non-game fish, minnows and other small fish, mollusks, insects, crustaceans and other invertebrates, submerged or emergent rooted vegetation, suspended or floating algae, substrate-attached algae and microscopic organisms. “Other biota” includes aquatic or semi-aquatic organisms that depend on the aquatic community for food or habitat such as amphibians, waterfowl and certain wildlife species.

“Normal fishery” and “normally present” mean, the fishery and other aquatic biota expected to be present in the waterbody in the absence of pollution of the water, consistent with any variability due to natural hydrological, substrate, habitat, or other physical and chemical characteristics. Expected presence is based on comparing the aquatic community in the waterbody of interest to the aquatic community in representative reference waterbodies.

D. Nondegradation

A third element of water quality standards, in addition to numeric or narrative standards and the beneficial uses they protect, is nondegradation. The fundamental concept of nondegradation (equivalent to the federal term, antidegradation) is the protection of waterbodies whose water quality is better than the applicable standards, so that the existing high quality is maintained and not allowed to degrade down to the level of water quality standards. This Guidance deals with assessing, listing and ultimately restoring waters that do not meet water quality standards, and does not describe the application of nondegradation provisions (see MPCA 1988a and 1988b). However, the nondegradation concept is a very important aspect of pollution control, because preventing the degradation of surface waters is always less costly to society than the restoration of waters once they have become degraded. That is, it is always less costly to prevent clean waters from becoming polluted in the first place, than it is to clean them up after they no longer support designated uses. Also, once degraded, it may not be possible to restore some polluted conditions to health in the foreseeable future (e.g., heavily contaminated bottom sediments).

Federal guidance establishes three levels or tiers of nondegradation (EPA 1994). The first level is, at a minimum, waters should be in compliance with water quality standards, and that beneficial uses should be protected. Level two is the protection of waters that have water quality better than standards so the existing high quality is maintained, unless there is a social and economic need to degrade the waters down to the level of the standards (Minn. R. ch. 7050.0185). The third level, which provides the highest level of protection from pollution, are waters designated as outstanding, very sensitive or unique resources (Minn. R. ch. 7050.0180). The MPCA has specifically designated a number of waters that are special for a variety of reasons. In Minnesota these special waters are called Outstanding Resource Value Waters (ORVW).

ORVWs are placed into one of two categories “prohibited” or “restricted”. New or expanded point and nonpoint sources of pollution are entirely prohibited to the first category (examples are waters in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park). New or expanded point and nonpoint sources of pollution are not allowed to the restricted category unless the discharger can demonstrate there is no “prudent or feasible alternative” to allowing the increased pollutant loading (examples in the restricted category are Lake Superior and federal and state designated scenic and recreational river segments such as the St. Croix River).
In addition to designated ORVWs, which are located statewide, all surface waters in the Lake Superior basin that are not ORVWs or not Class 7 Limited Resource Value Waters are designated as Outstanding International Resource Waters (OIRW) (Minn. R. ch. 7052.0300). Implementation of nondegradation for OIRW waters focuses on reducing the loading of bioaccumulative pollutants to the Lake Superior basin because of the sensitivity of the Lake Superior ecosystem to these pollutants. Guidance on how to implement nondegradation for ORVWs and for all surface waters can be found in MPCA (1988a and 1988b), respectively. Information on implementation of nondegradation for OIRWs is included in Minn. R. ch. 7052.0300 – 7052.0330.
III. Listing of Impaired Waters and TMDLs

A. TMDL lists required

The 1972 amendments to the federal CWA require the MPCA to assess the water quality of rivers, streams, wetlands, and lakes in Minnesota (Code of Federal Regulations, title 40, part 130). Waters determined to be not meeting water quality standards and not supporting assigned beneficial uses are defined as “impaired”. Impaired waters are listed and reported to the citizens of Minnesota and to EPA in the CWA 303(d) list, a subset of the integrated report. The integrated narrative report and 303(d) list are required in separate sections of the CWA. The beneficial uses assessed in this context are aquatic life, aquatic consumption, aquatic recreation, and aesthetics (Classes 2 and 5). In the 2010 reporting cycle, Minnesota will assess Class 1 surface waters for the drinking water beneficial use with regard to nitrate exceedance of the drinking water standard.

The integrated narrative report is a state report to the United States Congress of the condition of the nation’s waters and the progress states are making toward cleaning up surface waters to protect beneficial uses and meet water quality standards. The integrated narrative report includes a review of all waters with any available data; only those that have sufficient data for assessment methodologies will be formally assessed as fully support or not supporting beneficial uses. The 303(d) list, a subset of this report, is a tabulation only of waters considered to be impaired. “Impaired water” or “impaired condition” is defined in Minn. R. ch. 7050.0150 as follows:

... a water body that does not meet applicable water quality standards or fully support applicable beneficial uses, due in whole or in part to water pollution from point or nonpoint sources, or any combination thereof.

The listing of a waterbody on the 303(d) list triggers a response on the part of the MPCA to address the causes and sources of the impairment. This process is called a Total Maximum Daily Load (TMDL) analysis. The purpose of the TMDL is to focus attention and resources on impaired waters to ultimately bring them back into compliance with water quality standards. The tables in this Guidance that show the exceedance thresholds and standards used to determine an impaired condition for the 303(d) list use the terms “Listed” or “Not Listed.” This is because listing (or not listing) is the end result of the assessment process.

The terms “impaired” or “not impaired” are not used because it is possible that some waterbodies are not meeting water quality standards because of natural conditions; it is more appropriate to include these waterbodies in Category 4. Categories 5 and 4 together comprise the inventory of impaired waters. For example, subsequent monitoring and data analysis carried out as part of the TMDL study may determine that the exceedances of standard(s) are because of natural causes.

Fundamentally the 303(d) list and TMDLs are federal programs. Most states, including Minnesota, choose to carry out the assessments and prepare the 303(d) list themselves; if states fail to act, EPA is obligated to act for them. Currently, both the integrated narrative report and the 303(d) list are updated every two years. This Guidance Manual reflects the most currently approved EPA guidance available at the time of assessments, which were performed in the spring of 2009. The EPA issued a new integrated guidance on the water quality assessment and 305(b)/ 303(d) reporting process in 2001 and an updated guidance in 2003 for 2004 reporting (EPA 2005), and a 2008 Addendum. The elements of the integrated report are discussed further in Section VI.

The EPA guidance provides greater flexibility to states to place impaired waters in one of five categories depending on the pollutant(s), the nature of the impairment, and the time frame needed for appropriate corrective actions. The MPCA has incorporated the integrated approach into its assessment process, and this Guidance reflects the integrated approach.
B. TMDL Analysis

As stated, each waterbody put on the 303(d) list triggers a TMDL analysis. The TMDL determines the capacity of the impaired waterbody to assimilate pollutant loadings and still meet water quality standards. A TMDL is the sum of the individual waste loads from point sources, nonpoint sources, and natural background, with an additional loading allowance for a margin of safety. This is generally described by the following equation:

\[
\text{TMDL} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}
\]

Where:
- \( \text{WLA} \) = waste load allocation, quantification of pollutant loads from point sources discharging to the waterbody
- \( \text{LA} \) = load allocation, quantification of pollutant loads from nonpoint sources to the waterbody
- \( \text{MOS} \) = margin of safety, reflects uncertainty in the analysis, a desire to provide an extra margin of protection for the beneficial uses, or allowance for future growth.

The 303(d) list and the TMDL process are the bridge connecting designated uses, water quality standards, and water quality data. Because of the regulatory ramifications of being placed on the 303(d) list, it is important for the MPCA to make fair and consistent decisions. The protocols described in this Guidance are designed to facilitate that.

The first steps in the TMDL process are identifying local partners and initiating further monitoring. Monitoring should determine the source(s) of the pollution, including point, nonpoint, and contributions from natural sources. Next a plan is developed to reduce the pollutant loading to bring the waterbody back into compliance with water quality standards.

The EPA must approve the 303(d) list, so the lists prepared by states are draft until public comments are reviewed and the list is approved by EPA. When new lists are prepared, all previously listed reaches remain on the new list unless new data or a significant change in the reach supports de-listing the reach (see Section XIII).

C. Public Participation and EPA Approval of 303(d) List

Public involvement in the TMDL process is very important because ultimately the public must be part of the solution. Indeed, public involvement is required to obtain EPA approval of the 303(d) list. The public has several opportunities to comment on the TMDL list as it is developed:

- calls for data to the public, noticed in State Register from the MPCA
- informal meetings – may be with multiple interested parties or “one on one”
- statewide public informational meetings to discuss the draft list of impaired waters and the Guidance Manual
- draft 303(d) list noticed in State Register with request for comments. This provides an opportunity to comment on this Guidance too.

Comments may be sent directly to EPA about the MPCA list at anytime in the process.

The EPA must approve each state’s draft 303(d) list. They look for adherence to federal TMDL guidance as well as adherence to the state’s own guidance, and for consistency with the letter and intent of the CWA. Once the 303(d) list is approved by EPA, the TMDL process can start. At this stage, there are additional opportunities for the public to comment as the TMDL process moves forward. All TMDL projects will include local citizens and interest groups. Completed TMDLs in draft must be published in the State Register for comment. Interested parties are encouraged to contact MPCA staff at the appropriate MPCA Regional Office for more information on active TMDLs in their area of interest (see Section XIV).
IV. Monitoring and Data Management

Water quality and other types of data are the most important component of impairment determinations. Data collection and analysis involve sampling, laboratory analysis, quality assurance/quality control (QA/QC), data storage and, finally, data analysis. Most water quality data used in this process are a result of monitoring by the MPCA, but comparable data collected by others are used also, as long as the data meet acceptable QA/QC requirements.

Monitoring is particularly challenging in Minnesota because of our abundance of water resources. To meet this challenge, the MPCA has developed a strategy for monitoring the state’s waters. The strategy provides a framework for MPCA monitoring efforts and it provides the data needed to assess Minnesota’s water resources and track water quality trends.

The monitoring strategy relies on four components:

- MPCA monitoring
- monitoring by other organizations (local units of government, lake associations, watershed groups, etc.)
- statewide remote sensing
- volunteer monitoring

Each component contributes important data that results in statewide coverage and data confidence.

Full implementation of the strategy will result in the monitoring and assessment of the state’s lakes and streams on a 10-year cycle. Monitoring is done by major watershed, with six to eight watersheds monitored each year. The monitoring focuses on streams down to the 10-20 square miles drainage area, and all lakes greater than 500 acres. At least 25 percent of lakes between 100 and 500 acres would also be assessed. An initial 10-year schedule for watershed monitoring has been developed and is available at http://www.pca.state.mn.us/water/monitoring/index.html. The schedule will be updated on an annual basis.

The strategy provides for statewide assessment of water quality by building on a foundation of citizen monitoring, remote sensing, and other information to direct attention to waters that may be changing or that have an indication of impairment. The result is a cost-effective approach to identifying impaired waters and tracking trends (see Figure 2).

In the 2009 Legislative session, the MPCA received sufficient funding from the newly-created Clean Water Fund to allow for full implementation of the surface water components of the 10-Year Water Quality Monitoring Strategy during the 2010-2011 biennium. The new Clean Water Fund was created after Minnesota voters approved the Clean Water, Wildlife, Cultural Heritage and Natural Areas Amendment on Nov. 4, 2008. The Amendment increases the sales and use tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009, continuing through 2034. Of those funds, 33 percent is to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater, with at least five percent of the fund targeted to protect drinking water sources.
A. The watershed approach

In 2004 the MPCA developed a 10-Year Water Quality Monitoring Strategy. That strategy guides implementation of the MPCA’s monitoring efforts, and also identified how monitoring by other organizations and citizen volunteers fits into the overall monitoring effort. The strategy provides for statewide assessment of water quality by building on a foundation of citizen monitoring, remote sensing, and other information to direct attention to waters that may be changing or that have an indication of impairment. The full strategy can be found on the MPCA Web site at www.pca.state.mn.us/water/pubs/wqms-report.html.

The MPCA surface water monitoring program is implemented on a major watershed (watershed) approach. There are 81 major watersheds (8-digit Hydrologic Unit Codes) in Minnesota. Appendix A details the MPCA’s watershed monitoring approach more fully, and includes a draft watershed monitoring schedule developed in 2008. That schedule is expected to be updated annually.

The MPCA surface water monitoring program is implemented on a major watershed approach. There are 81 major watersheds (8-digit Hydrologic Unit Codes) in Minnesota. The watershed approach is a 10-year rotation for assessing waters of the state on the level of Minnesota’s major watersheds. The primary feature of the watershed approach is a unified focus on the water resource as a starting point for water quality assessment, planning, and results measure. This approach may be modified to meet local conditions, based on factors such as watershed size, landscape diversity, and geographic complexity (e.g., Twin Cities metro area). As noted above, a preliminary schedule has been developed for monitoring the key lakes and streams in each of the state's 81 major watersheds on a 10-year cycle. Monitoring has been initiated or completed in 18 of the watersheds. Appendix A details the MPCA’s watershed monitoring approach more fully.

Some components of the MPCA core monitoring programs rotate through the 10 basins to produce data, balanced over time, for the 10-year assessment period. For example, the MPCA fixed station river monitoring is designed so that the sites in each major basin are sampled twice in each 10-year period.
This basin-level monitoring supplements the watershed monitoring approach to provide robust assessment data, trends over time, and information about the state’s water resources as a whole.

There is more opportunity to utilize sources of data outside the MPCA and get public involvement with the watershed approach. Also, it facilitates the assessment of the combined effects of point and nonpoint sources and integration of data and programs to address both. This reporting schedule forms the basis for the scheduled starting and completion dates for developing TMDLs on the list submitted to EPA for approval.

Table 2. Schedule for the rotation by basin of MPCA’s long-term chemical monitoring at milestone stations

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2009, 2014, 2019

2010, 2015, 2020
B. Sample collection

It is outside the scope of this Guidance to describe in detail the sampling procedures, but some highlights are discussed below. For more detail, see MPCA Grab Sampling Protocol Document (MPCA 2000a).

Rivers and streams are sampled at a point where the water is well mixed, in such a way as to avoid contamination from surface film or flotsam, bottom sediments, and airborne particulates from sampling equipment or bridge decks. Sampling frequency is often once per month but will vary with the type and purpose of the monitoring. Samples requiring preservation are preserved in the field. Samples are cooled to four degrees Celsius for transport to the analytical lab. In-field measurements may be made of pH, dissolved oxygen, temperature, conductivity, and turbidity. Decisions about the number and timing of samples and field measurements consider the effects of season and flow conditions on water quality.

The “clean” technique is used to collect samples for trace metal analyses. This involves special bottle preparation, sampling procedures, and special handling, storage and lab analysis. Teflon sample bottles are cleaned by the analytical lab and double bagged. In the field two people take the sample. One “dirty hands” person handles the outside bag and other equipment not specially cleaned. The second “clean
hands” person handles the inside bag, the sample bottle and takes the sample. In the lab, low detection level trace metal analyses are performed in a special “clean room”.

Lake samples used for assessments are collected during the summer growing season, usually from about mid-May through the end of September. The sample site is most often located over the point of maximum lake depth. Multiple sample sites are needed if the lake is “bayed” or has a complex shoreline. Each lake sampling date, which may include data averaged together from one or more sampling sites on a lake, is considered a single sample for assessment purposes.

Surface water samples are typically collected from the upper, well-mixed layer of lake water with an “integrated” sampler, which is a PVC tube with an inside diameter of 3.5 cm (1.4 inches) and a length of two meters (6.5 feet). The tube is lowered vertically into the water until it is submerged, allowed to fill and the top end is stoppered. This procedure obtains an “integrated” 2-liter sample of the upper two meters of the epilimnion, which provides a representative sample of lake water quality in the summer. The sample is subset into individual bottles and preserved as per lab requirements for nutrient and chlorophyll-α, corrected for pheophytin (Chl-α) analyses. If needed, near-bottom samples are collected with a 2-liter Van Dorn sampler. Near-bottom samples may be needed if hypolimnetic conditions could affect the trophic status of the whole lake; for example, if internal loading of nutrients from bottom sediments to the hypolimnion was suspected.

Dissolved oxygen and temperature readings may be taken through the lake water column from surface to bottom to ascertain the depth of the thermocline and hypolimnetic oxygen conditions. Secchi disk and any other pertinent field measurements are taken. Further details may be found in the Minnesota Lake and Watershed Data Collection Manual (Heiskary et al. 1994), which is available in hard copy from the Minnesota Lakes Association or online (see Section XIV).

### C. Types of monitoring

A common thread linking most types of surface water monitoring is measurement of a waterbody’s condition. These data are used to determine if the waterbody is meeting water quality standards and to help guide resource management decisions. The MPCA surface water monitoring can be categorized by purpose as follows:

- **condition monitoring** – status and trends in water quality
- **problem investigation monitoring** – description of causes and sources of impairment
- **effectiveness monitoring** – the extent to which remedial activities had an effect on water quality
- **targeted monitoring** – investigation of specific events, such as a fish kill

Condition monitoring of rivers and lakes is the primary source of data used in assessments. Data from the other types of monitoring are used only if they are amenable to being compared to water quality standards and suited to the assessment process generally. For example, in most cases the data should provide an unbiased representation of water quality during the overall period of time under consideration, rather than just water quality under certain conditions. Data sets from problem investigation monitoring projects that are designed to measure total pollutant loads can sometimes be used for condition assessments with additional data analysis steps, as described below. Data should be entered into EPA’s water quality data storage and retrieval system (called STORET, in Section IV.F.).

Condition monitoring is carried out by several MPCA programs and includes both random and targeted biological monitoring, routine chemical monitoring, and citizen monitoring.

Appendix A details the condition monitoring conducted by the MPCA and partners to implement the watershed monitoring approach. The MPCA also relies on statistically based monitoring as a complement to trend and watershed monitoring. This monitoring design also supports determination of trends over time when an area of the state is again visited. Results for individual sites are used for assessing aquatic life use support of the stream reach. In 2009, streams and wetlands are being sampled using randomly selected sites to determine the overall state-wide condition of these water resources.

While random site studies provide a good overview of condition, it doesn’t tell us where the impaired sites are located. To address this, in 2006 MPCA initiated an intensive major watershed monitoring approach that targets sites in a watershed using a hierarchical hydrologic design. In the first phase,
biological and water chemistry sampling is performed near the outlet of a major watershed, and also in the downstream reaches of minor watersheds within the major watershed. In the second phase, additional monitoring is performed in a progressive manner at upstream locations in those minor watersheds found to be impaired during the first phase. This design will provide more information when a stream reach is listed as impaired, and is expected to shorten the time needed to develop and implement a TMDL plan.

With the passage of the state Clean Water Legacy Act and associated funding, the MPCA is now on track to intensively monitor each of the state’s major watersheds on a 10-year cycle, provided that funding is continued. In addition, the MPCA, in cooperation with the Department of Natural Resources, U.S. Geological Survey, Metropolitan Council, and other partners, is establishing permanent flow and chemistry monitoring stations at the outlets (also referred to as “pour points”) of each of the state’s major watersheds. This monitoring network will allow the state to track trends in flow and pollutant loadings at each major watershed and to identify year-to-year variability for each watershed.

The MPCA also samples a network of approximately 80 “fixed” monitoring stations on rivers and streams throughout the state, called “Minnesota Milestone” stations. This program provides basic water chemistry data, particularly useful for trend analysis. The MPCA has been monitoring some Milestone stations continuously since the 1950s. Currently, Milestone stations are sampled once per month except for two winter months, on a basin rotation basis (Table 2). The program provides about 50 measurements for each variable monitored over a 10-year assessment period.

Condition monitoring also includes lake monitoring as part of the Citizen Lake Monitoring Program (CLMP) (Secchi disk readings), and stream monitoring as part of the Citizen Stream Monitoring Program (CSMP) (transparency tube readings). CLMP data are used as part of the database for assessing lakes (in Section X.B.). However, no lakes are placed on the 303(d) list based solely on CLMP data. Through the CSMP and other Agency monitoring that incorporate the transparency tube measurements, there is now a data set of sufficient scope and record to establish a relationship between transparency tube and turbidity measurements. Starting in the 2006 assessment cycle, transparency tube results are used as a surrogate for turbidity. See Section VII.B.1.c for a more detailed description of the relationship and corroboration required.

As indicated, data from the other types of monitoring are usually not used in water quality assessments by the MPCA with some exceptions. A brief description of these types and the exceptions follow.

Problem investigation monitoring includes monitoring as part of Clean Water Partnership (CWP), Lake Assessment Program (LAP), load allocation, or TMDL studies. As the name implies, problem investigation monitoring investigates potential sources of pollution, nutrient loading, etc., to rivers or lakes and recommends appropriate remedial measures. Local governments and other entities have important roles in these programs. Quality-assured data from CWP and LAP projects can be used by the MPCA in impairment assessments. Waste load allocation studies may be part of an overall TMDL analysis or a separate intensive monitoring effort to assess the impact of a point source discharge on a low-flow stream.

Problem-investigation monitoring often has as its purpose the determination of pollutant loads carried by streams. To do this, the monitoring is often focused on certain periods of time or certain events (such as rainfall or high flows), and is thus not necessarily representative of overall conditions. In addition, the monitoring is often done through flow-weighted composite samples, which are not necessarily amenable to the determinations of pollutant concentrations over time that are required for water quality standards assessments.

In some cases, specialized statistical analysis can take these two factors into account and make the adjustments necessary for accurate condition assessments. A prerequisite of the analysis is adequate knowledge of the hydrology of the particular stream and watershed as well as of various characteristics of the pollutant. The MPCA has used load-design data sets for assessments in a number of instances. Examples are the North Shore Loading Project turbidity data, collected and analyzed by MPCA staff; the Metropolitan Council Watershed Outlet Monitoring Program turbidity data, collected and analyzed by Metropolitan Council Environmental Services staff; and the atrazine data, collected by the Minnesota Department of Agriculture (MDA) and analyzed by MPCA staff in consultation with MDA. The number
of such analyses performed each assessment cycle is dependent on the availability of the necessary data regarding stream and pollutant characteristics and on Agency resources.

Effectiveness monitoring includes special studies designed to assess the results of pollution reduction or remedial actions. An example would be the monitoring up and down stream of a new or expanded wastewater treatment plant, or follow-up monitoring after the implementation phase of a CWP project.

Targeted monitoring provides information about a particular point of interest and is limited in space and time. Examples include the monitoring associated with spills, emergency bypasses, suspected illegal discharge, or fish kills.

For further details on all types of monitoring see MPCA (1995).

D. Use of data from other sources

Involvement of local units of government and other governmental agencies in the monitoring of water quality is always encouraged, and the MPCA actively seeks data from all sources utilizing appropriate QA/QC. The MPCA solicits data from outside sources through a notice published in the State Register.

Analytical labs providing data must be certified under the lab certification program operated by MDH, and the data to be used in assessments should be entered into STORET. Criteria used to determine whether to use data from other sources are outlined in MPCA (2003). A major aspect of monitoring that the MPCA must consider when reviewing outside data for use in assessments is the purpose for which the data were collected. For example, samples collected to characterize "events" such as the effects of storm runoff on a river may not be suitable, if used alone, to characterize the overall water quality of the river. It is important that outside data be used and interpreted correctly.

The screening and entry of data from outside sources into STORET can be very labor intensive, and this often becomes a barrier to utilizing "outside" data. Thus, there is a much greater chance that valuable outside data will be used if the outside parties enter the data into STORET themselves. In general, data under consideration from any source that has been reviewed and found to satisfy QA/QC requirements will be used in water quality assessments following the priority listed below:

- data collected through the MPCA monitoring programs
- data collections funded by state or federal money (e.g., CWP or LAP data), for which STORET entry is required
- data from any source readily accessible through STORET
- data in an electronic format from which assessments can be made directly, or in a form easily entered into STORET (e.g., data collected by governmental or other major entities that provide monitoring data in places where MPCA has little or no monitoring)
- data in a form amenable to STORET entry that fills an important gap in MPCA data

Sources of water quality data outside the MPCA that have been used in water quality assessments include the following:

- Metropolitan Council Environmental Services
- United States Geological Survey
- Upper Mississippi River Headwaters Board
- Big Fork River Watch
- Hennepin County Conservation District River Watch
- South Dakota Environment and Natural Resources Department
- North Dakota Health Department
- Wisconsin Department of Natural Resources
- Western Lake Superior Sanitary District
- National Forest Service
- Minnesota Department of Agriculture
- Iowa
Data obtained through projects the MPCA funds must be the result of a clearly defined and documented purpose and it must satisfy specific data needs. This documentation is called an “information protocol”, and it has proven to be very useful to MPCA staff considering the broad range of types and purposes of monitoring programs carried out by agencies and other organizations.

Occasionally, the MPCA receives monitoring data collected on border waters just outside of Minnesota. The MPCA believes that use of such data, assuming they meet data standards, are another source of data that should be included in the state's assessment process. Professional judgment groups, on a case by case basis, may consider monitoring data taken just outside the border or from border waters collected by entities outside of Minnesota. In determining whether to use the data in assessments, the professional judgment groups will consider the proximity of the collection point to Minnesota, including any intervening tributaries between the monitoring location and the Minnesota border that may affect the ability of the monitoring site to represent the Minnesota waterbody. In addition, MPCA staff will use such data where it is made available through our calls for data, but will not actively seek out non-Minnesota-collected data. Data from non-Minnesota sources will have to meet all the existing data standards for consideration in assessments, including entry into STORET.

E. Quality assurance/quality control and laboratory analyses

The data used in impairment decisions must be of reliable quality. From field sampling to lab analysis to data assessment and all the steps in between, there are many opportunities for the introduction of errors. Therefore, it is difficult to overstate the importance of spelling out QA/QC protocols for each step along the way, and the careful adherence to them. This applies to the data generated by the MPCA and data used from outside parties. It is important to recognize, however, that no matter how rigorous the QA/QC procedures employed, errors in data will occur. This simple fact alone emphasizes the need for professional judgment in the process to spot these errors (see Section V.E).

Monitoring and data management at the MPCA are performed in accordance with the requirements specified in a Quality Management Plan (MPCA 2000a) approved by the EPA and available for public review on the MPCA Web site (in Section XIV.B.). Each monitoring program within the MPCA administers quality control checks and data quality assessments.

Most water samples collected by the MPCA are analyzed by the MDH’s analytical laboratory. Laboratory analyses of samples strictly follow appropriate QA/QC procedures, as outlined in (MPCA 2000a).

River and lake samples taken at Milestone stations are routinely analyzed for a standard set of chemicals and water quality characteristics, which are listed below. Trace metals are often added to the list of variables monitored at Milestone stations. Other monitoring programs will sample for a variety of additional chemicals consistent with the purpose of the monitoring.

River and stream samples collected at the Milestone stations are routinely analyzed for the following:

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>dissolved oxygen</td>
</tr>
<tr>
<td>nitrite/nitrate nitrogen</td>
<td>temperature</td>
</tr>
<tr>
<td>ammonia nitrogen</td>
<td></td>
</tr>
<tr>
<td>conductivity</td>
<td></td>
</tr>
<tr>
<td>turbidity</td>
<td></td>
</tr>
<tr>
<td><em>E. coli</em> (collected for special programs and when sample holding times can be met)</td>
<td></td>
</tr>
</tbody>
</table>

The following variables are added at Milestone stations for the months of June, July, August, and September, and where continuous flow data are available:

- total phosphorus
- corrected chl-a
- pheophytin
- 5-day biochemical oxygen demand [BOD]
- residue, total non-filterable (total suspended solids)
- suspended volatile solids
- stream flow

Lake samples are typically analyzed for the following:

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>total phosphorus</td>
<td>pH</td>
</tr>
<tr>
<td>total Kjeldahl nitrogen</td>
<td>conductivity</td>
</tr>
<tr>
<td>nitrate/nitrite nitrogen</td>
<td>Secchi disk</td>
</tr>
<tr>
<td>residue, total non-filterable</td>
<td>temperature (profile)</td>
</tr>
<tr>
<td>(total suspended solids)</td>
<td>dissolved oxygen (profile)</td>
</tr>
<tr>
<td>alkalinity</td>
<td></td>
</tr>
<tr>
<td>chloride</td>
<td></td>
</tr>
<tr>
<td>color</td>
<td></td>
</tr>
<tr>
<td>turbidity</td>
<td></td>
</tr>
<tr>
<td>corrected chl-a</td>
<td></td>
</tr>
</tbody>
</table>

F. Data storage and retrieval - STORET

As a rule, MPCA surface water monitoring data are stored in the EPA’s water quality data STOrage and RETrieval system (STORET). STORET is designed to be a central repository for data from all agencies that monitor water quality. Data in STORET can be easily shared with other agencies and any interested party. STORET also provides a broad range of tools for the analysis of data.

Before data can be entered into STORET, geographic and hydrographic identifiers for sampling locations must be established. When a sampling location is established, the type of waterbody is identified, such as lake, stream, wetland, well, or treated effluent. This step has implications for sampling and future assessments because stations identified as "lake stations", for example, will be sampled following lake sampling methods and the samples will be analyzed for variables pertinent to lakes, and similarly for river stations. For example, Milestone station UM-826, while located in navigation pool number two of the Mississippi River, is identified and sampled as a river station. As such, the data from UM-826 are evaluated based on water quality standards pertinent to rivers and not lakes. Also, specific collection and lab methods associated with the data are required for data to be entered into STORET.

The STORET database is open to the public for retrievals using a request application on the EPA Web site. The use of STORET by other agencies, like the Minnesota District of the U.S. Geological Survey (USGS), enhances the practicality of incorporating their monitoring results into water quality assessments. Using data from external sources require a careful review of methods and location information. The common database format in STORET ensures that much of this information is included with the data. A common data location also allows other agencies to simply direct MPCA staff to an appropriate data set already accessible to all users.
V. General Aspects of Data Assessment

A. Delineation of river reaches and definition of ‘lakes’

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes, and wetlands is called the “assessment unit”. A river assessment unit usually extends from one significant tributary to another or from the headwaters to the first significant tributary and is typically less than 20 miles in length. The river may be further divided into two or more assessment units when there is a change in the use classification (as defined in Minn. R. ch. 7050), or when there is a significant morphological feature such as a dam, or a lake within the river. In the past, Minnesota used EPA’s Reach File 1, Reach File 3 and the 1:100,000 scale National Hydrography Dataset (NHD) to define assessment units. Many of our current assessment units have the same boundaries as Reach File 1 reaches, or sub-segments of Reach File 1 reaches.

The MPCA is now using the 1:24,000 scale high resolution NHD to identify stream and lake assessment units for Geographical Information Systems purposes because it provides a much more complete and accurate accounting of these waterbodies in the state. All of our assessment units are indexed to the NHD. The high resolution NHD was created from 1:24,000 scale Minnesota Department of Natural Resources (MDNR) stream traces and lake areas. Each waterbody is identified by a unique waterbody identifier code. For streams, the code is comprised of the USGS eight digit subbasin code plus a three character code that is unique within each subbasin. It is for these specific reaches that the data are evaluated for potential use impairment. The MPCA consults with border states during the assessment process and documents reasons for any discrepancies in assessment determination between Minnesota and the specific border state.

Lake and wetland identifiers are assigned by the MDNR. Bulletin 25 (MDNR 1968) has been the primary basis for identifying lakes and reservoirs. However, some “lakes” listed in Bulletin 25 are really wetlands. If a “lake” in Bulletin 25 is listed as a wetland on the MDNR Public Waters Inventory, it will be considered a Class 2D wetland [unless it is being used as a lake, for example, if it is being managed for fishing], and it will be protected for the maintenance of a healthy aquatic community and for boating and other forms of aquatic recreation for which they are suitable. This may exclude swimming because the shallow water, soft bottom substrates, and plentiful vegetation make many wetlands unattractive for swimming. Waterbodies identified as wetlands will not be assessed using the eutrophication factors discussed in Section X.B.
Also, to help define reservoirs for assessment of the impacts of excess nutrients the MPCA will use a minimum hydraulic residence time of 14 days. Reservoirs with residence times less than 14 days will not be assessed as lakes. For this purpose, residence times are usually determined under conditions of low flow. A mean flow for the four-month summer season (June – September) with a once in 10 year recurrence interval is normally used. The MPCA may establish a minimum residence time of less than 14 days on a site-specific basis if credible scientific evidence shows that a shorter residence time is appropriate for that reservoir. The 14-day residence time was originally established as part of the “Phosphorus Strategy” to guide the MPCA in the application of the 1 mg/L phosphorus effluent limit in Minn. R. ch. 7050.0211 (MPCA 2000b). The 14-day residence time is consistent with EPA’s current guidance, which recommends that reservoirs with residence times less than 14 days be included with rivers for the purposes of nutrient criteria development (EPA 2000a, Kennedy 2001).

The application of residence time is relevant in the assessment of eutrophication described in this Guidance, since the nutrient impairment threshold values are applied to lakes and reservoirs rather than rivers. The eutrophication of rivers is a concern, but the assessment of rivers will require the development of separate river-specific eutrophication thresholds. The professional judgment teams will consider residence time as part of their “weight of evidence” review.

Bulletin 25 provides unique identification numbers for all lakes greater than 10 acres in size in Minnesota (15,291 listed). The Bulletin 25 numbers serve as the STORET station numbers; for example, 27-0147 is Peter Lake in Hennepin County. In addition to the six-digit numbers, a two-digit suffix may be added as a basis for defining distinct bays in a lake (e.g., 27-0147-02 = North Bay in Peter Lake). The bay suffixes are assigned consecutively, starting with the most downstream (outlet) bay as “-01”, and so on. The full eight-digit number is used as the assessment unit identifier for lakes and wetlands.

Lake acreage and location information used by MPCA in lake assessments are drawn from High Resolution NHD. The MDNR Public Waters Inventory, which encompasses Bulletin 25, is an additional source of identification numbers and is updated routinely as new waterbodies are identified (e.g., mine pit lakes).

Currently, the MPCA is only monitoring and assessing depressional open water/emergent wetlands. Assessed wetlands that were not included in the original Bulletin 25 publication are assigned unique identification numbers by the MDNR using the same eight-digit format. Wetland assessment unit delineations are based on the National Wetland Inventory (NWI) digital data set. However, if there has been significant alterations (e.g., drainage, filling) in the wetland basin since the NWI (i.e., aerial photographs used to generate these maps were obtained in the late 70s/early 80s), assessment unit boundaries were modified to reflect these changes using Geographic Information System software and current aerial imagery.

Typically, the listing of impaired waters is by individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue. Over the time it takes fish, particularly game fish, to grow to “catchable” size and accumulate pollutants to unacceptable levels there is a good chance they have moved considerable distance to the site where they were sampled. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach. Thus, the impaired reaches often include several assessment units.
B. Period of record

The MPCA uses data collected over the most recent 10-year period for all the water quality assessments considered for 303d impairments. Years of record are based on the USGS water year. Water years are from October 1 of one year through September 30 of the following year. It is preferable to split the year in the fall, when hydrological conditions are usually stable, than to use calendar years. Data for all 10 years of the period are not required to make an assessment.

Generally, the most recent data from the 10-year assessment period is reviewed first when assessing toxic pollutants, eutrophication, and fish tissue contaminants. Also, the more recent data for all pollutant categories may be given more weight by members of the professional judgment teams if, for example, trends are indicated or if conditions impacting water quality are known to have changed in the reach during the 10-year period (e.g. wastewater treatment plant upgrades). The goal is to use data from the 10-year period that best represents the current water quality conditions.

The MPCA uses a period as long as 10 years in its assessments for several reasons. It provides reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented. For example, the 10-year period is likely to include some samples collected during critical periods such as during a rain storm or drought. On the other hand, data collected over 10 years are less likely to only represent an unusually wet or dry period and it reduces the chance that one or two samples will distort the rest of the data, if they happened to have been collected during very atypical conditions. From a practical standpoint, the 10-year period means there is a better chance of meeting the minimum data requirements.

C. Values below detection

The concentrations of some pollutants in surface waters, particularly the highly bioaccumulative pollutants, may be below standard analytical detection limits. That is, the true concentration may be below the ability of the analytical method to measure. Examples of method detection limits for some toxicants are shown in Appendix B. It may be difficult to determine in advance of monitoring whether ambient concentrations will be below detection. Thus, data sets that include values below the level of detection, or “less than values” are a possibility. Best professional judgment will be used in the assessment of these data sets, taking into account such information as the following:

- the relative number of “less-than” values compared to the number of “dets”
- the extent the “dets” are above the method detection limit
- the magnitude of the difference between the method detection limit, the chronic standard, and expected ambient concentrations
- information from data in other media such as fish tissue or sediment data

Re-sampling in these situations may be necessary if new analytical methods with lower method detection limits have become available. Values below the level of detection, even if greater than the standard, will not be considered an exceedence of the standard. Values below the level of detection will be considered a data point for the purposes of meeting the minimum data requirement.

Fish tissue analytical results below detection are assigned a value equal to one half the method detection limit for use in assessments. For other pollutant categories, if values below the level of detection must be assigned a number in order to include them in the calculation of an average, the formula shown below is used. A geometric or log mean is used to calculate a mean for data sets that include “less thans” when the data are not normally distributed. This formula adjusts the assigned value downward as the number of “less thans” goes up, relative to the total number of values, and vice versa.

\[
\text{Value assigned to “less than”} = \text{LOD} \left( 1 - \frac{\text{Number of values < LOD}}{\text{Total number of values}} \right)
\]

Where LOD = level of detection
D. Uncertainty in water quality assessments

The MPCA is very cognizant of the hazards of making assessments with limited data. The selection of the minimum data requirements for water quality assessment is clearly a compromise between the need to assess as many waterbodies across the state as possible (a 305b consideration), and the importance of minimizing the probability of making an erroneous assessment, a 303d consideration. The methods described in this Guidance deal with this problem in a variety of ways, depending on the pollutant category. For example, lakes assessed for eutrophication are screened first using ecoregion-based total phosphorus thresholds that represent the “high end” of the range of total phosphorus values that will support swimming use in a given ecoregion (Section X.B.5). Again, the purpose is to minimize the chance of incorrectly labeling a waterbody as impaired.

Nonetheless, some level of uncertainty is part of every analysis of water quality data. There is always a chance that a waterbody will be assessed as impaired when in fact it is not or assessed as un-impaired when in fact it is. The number of data points the MPCA requires as a minimum for 305(b) or 303(d) water quality assessments is small in the context of statistical analyses of uncertainty. The approach used by the MPCA to make impairment decisions, which is a screening of the data using the impairment thresholds, followed by a review by professionals, makes the best use of limited data. This is the approach recommended by the EPA.

With this approach, the probability of making an incorrect impairment decision of either type – a determination of impairment when the waterbody is not, or a determination that the waterbody is not impaired when it is – are roughly equal. Some states use an approach that requires more data and statistical tests that significantly reduce the probability of making an erroneous determination that a waterbody is impaired (when it’s not), but at the cost of significantly increasing the probability of an erroneous determination that the waterbody is not impaired (when it is).

Essentially all assessments are subject to review by a team of professional water quality experts (see next section). Review of the data by professionals is a very important part of minimizing erroneous impairment determinations, and this review would be required whether or not statistical tests are used. The possible erroneous placement of a waterbody on the 303(d) impaired list is a concern because of the regulatory and monetary implications of 303(d) listing. It has been the experience of the MPCA that very few waterbodies have been incorrectly determined to be impaired.

When the professional review of data collected for a lake or stream finds conflicting or inadequate information to make a confident assessment, and more monitoring could resolve the need, notes are added to a list (streams) or part of the assessment memo (lakes). This information is shared during each assessment cycle with MPCA monitoring programs and other water monitoring organizations that might pursue the needed monitoring.

E. Professional judgment, weight of evidence, and independent applicability

1. Professional judgment

It is important to recognize the value and necessity of including professional judgment as a “formal” step in the assessment process. Professional judgment must enter into the impairment decision-making process. No assessment guidance and protocol, no matter how detailed, can address all the unforeseen aspects of the multi-step assessment process. Also, the variety and variability found in nature means that professional judgment must enter into the process. Aquatic ecosystems, including biological communities and the natural cycles in water chemistry, are very complex and are always reacting to a changing environment. Professionals must have the latitude to interpret the protocols in the context of their knowledge and experience with the factors that influence water quality and biology. Professionals include the people that take water samples and measurements in the field as well as the biologists, hydrologists and statisticians that analyze the data. A professional review of available data can extract the most value from small data sets. Without professional review, assessments are more likely to result in an incorrect impairment decision.
A professional judgment team is formed for each basin. The team is comprised of, for example, regional MPCA basin coordinators knowledgeable about local water quality issues, MPCA monitoring and data assessment staff, and staff from organizations outside the MPCA whose data were used in the assessments, if appropriate. The professional judgment groups meet to review how the data were used and interpreted, and whether outside data were used appropriately. They determine whether the data (possibly data combined from more than one source) are adequate and appropriate for making statements about use-support and about causes of impairment (such as low dissolved oxygen or high phosphorus, etc.).

2. **Independent applicability**

MPCA staff and professional judgment groups compare monitoring data from all sources to the water quality standards for a specific stream reach or lake to assess protection of beneficial uses. If data are available to assess more than one type of standard that protect the same beneficial use, exceedance of any one applicable standard normally indicates impairment. This concept is called “independent applicability”. In general, independent applicability means that a water body should meet multiple assessment tests (standards) to be considered un-impaired for a given use. This is consistent with the national and state goal to protect the “chemical, physical, and biological integrity” of surface waters, and it is consistent with EPA guidance. EPA’s discussion of independent applicability is the integration of assessments of 1) chemical-specific data, 2) biological assessments, and 3) whole effluent toxicity testing (EPA 1991). The independent tests must apply to the same beneficial use. Independent applicability does not apply when assessing different uses, such as aquatic life (toxicity), fish consumption (human health), swimming (recreation), or aesthetics. Assessments for different uses are carried out separately.

In the context of surface water assessments, a typical example of where independent application applies is when both chemical and biological data are available for the same waterbody. Both the chemical (numeric) and biological (narrative) standards protect aquatic life. Both standards should be met for the waterbody to be considered un-impaired for aquatic life. In this example the applicable standards are evaluated independently in the context of “weight of evidence” to assess the single beneficial use.

It is not appropriate to apply independent applicability when one or more of the data sets do not represent a true exceedance of the applicable standard, for example, if the conditions listed below can be demonstrated. Examples of when professional judgment will be part of the assessment are as follows:

- more than half of the values are below the method detection limit (“less than” values)
- data were collected at a time or under circumstances that make them unrepresentative of true water quality conditions (e.g. during a rain storm or after a chemical spill)
- data are old and do not represent current conditions

3. **Weight of evidence**

The professional judgment group’s first step in making impairment decisions is to review the results of an “automated” pre-assessment of the available chemical and biological data. The pre-assessment is a computerized screening of the data which identifies waterbodies meeting minimum data requirements, appropriate periods of record, and showing the necessary exceedances of impairment thresholds. Following a review of the pre-assessment results, the team considers a wide range of factors that can affect water quality, and use impairment. For examples, the team may consider the following:

- the quality and quantity of all available data
- the magnitude, duration, and frequency of exceedances
- timing of exceedances
- naturally occurring conditions that affect pollutant concentrations and toxicity
- weather and flow conditions
Based on all the relevant information, a final impairment decision is made regarding a given water quality standard and the associated beneficial use. These decisions are based on a “weight of evidence” concept, which simply means that when all the readily available data and information are considered together, and in the appropriate context (e.g., ecoregion, known pollution sources, etc.), a convincing pattern emerges on the condition of the waterbody.

The MPCA assembles the professional judgment groups and chairs the meetings; the MPCA takes responsibility for all team decisions regarding impairment. While consensus of opinion on impairment decisions is the goal, and is normally achieved, if consensus cannot be obtained, the MPCA will make the final decision. All professional judgment decisions are recorded on a “Professional Judgment Group Transparency Form for Assessed Streams”. The transparency form is now part of a database that captures and documents the proceedings of the professional judgment meetings. An example of the types of information placed on the form for four assessed waterbodies is included as Appendix D.

F. Determination of four- and thirty-day average concentrations for pollutants with toxicity-based and human health-based standards

The calculation of average pollutant concentrations can be complicated by the fact that concentrations can vary significantly during any given period of time. This is particularly true for nonpoint-source pollutants, which generally enter streams through stormwater or spring snowmelt and fluctuate greatly with flow. Limited discrete grab samples, as are often used in condition monitoring, may be inadequate to characterize average conditions over time.

Continuous sampling would be the ideal method for determining average concentrations in such cases. As a practical matter, composite samples taken at high flows, supplemented with grab samples taken at base flows, can provide very good estimates of overall conditions. The composite samples are taken by stage-activated automated samplers; time-based composite samples give precise average concentrations over the period of collection, but in some cases, where there is adequate knowledge of the hydrology of the particular stream and watershed as well as of the characteristics of the pollutant, flow-based composite samples may be judged to be acceptable. The concentrations of all samples taken during the 4- or 30-day period are weighted for their respective flow periods to calculate the average concentration.

When automated composite samples are not available, grab samples alone, if they adequately represent the different flow conditions, may be used to determine average concentrations. Again, concentrations are weighted for their respective flow periods to calculate the average concentration. It should be noted that this is only possible when concentrations can be tied to flow and there is adequate knowledge of the flow during the period.
VI. Elements of the Integrated Report

A. Introduction

As discussed in Section III, the purpose of the integrated report is to convey the use-support status of all surface waters statewide, while the purpose of the 303(d) list is to identify impaired waterbodies for which a plan must be developed to remedy the pollution problem(s) (the TMDL). The integrated narrative report replaces the former 305(b) report and incorporates the 303(d) list as an appendix item. Because there are differences in reporting purposes for these two sections of the CWA, when discussing waterbodies that do not meet water quality standards, the term “non-support” is associated with the integrated narrative report and the term “impaired” with the 303(d) list.

In 2004, Minnesota initiated the integrated reporting process, combining 305(b) reporting and 303(d) listing, known as the Consolidated Assessment & Listing Methodology (CALM). For the 2010 reporting cycle, Minnesota will use the Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the CWA dated July 29, 2005, and subsequent memoranda on Information Concerning 2008 and 2010 Clean Water Act Sections 303(d), 305(b) and 314 Integrated Reporting and Listing Decisions dated October 12, 2006 and May 5, 2009 respectively.

The integrated reporting process establishes that a list of impaired waters be forwarded to EPA by April 1 of every even-numbered year. This time frame paves the way for using categorization of surface waters as the means for developing a 303(d) list. The categorization of surface waters ties listing of impaired waters to the assessment of the waters of the state and is described in Section B immediately following. The integrated process has changed how impaired waters are determined.

Data used for the integrated report need to be adequate both with respect to quality and quantity. However, as indicated, waterbodies may be categorized in the integrated narrative report to reflect non-support and insufficient data, where additional data must be collected before a definitive impairment categorization for the 303(d) list can be made. In general, these waterbodies are placed in subcategories of category 3 to allow the state to differentiate between non-supporting and insufficient data waters, and potentially supporting waters for the purposes of future monitoring. See Section VI.B for a list of categories. Table 3 summarizes, in general, the types and sources of data used in the two assessments. The reader is advised to see the appropriate sections of this Guidance for details. Note in Table 3 that the same types of data are used to identify both candidates and “finalists” for the 303(d) list.

Table 3. Generalized summary of data and information used for the integrated narrative report and determination of impairment for the 303(d) list. (See appropriate section of Guidance for details.)

<table>
<thead>
<tr>
<th>Type or Source of Data or Information</th>
<th>Used in Assessments for:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Integrated Report</td>
</tr>
<tr>
<td>Milestone stations, and other chemistry data</td>
<td>Y</td>
</tr>
<tr>
<td>Clean water partnership - rivers</td>
<td>Y</td>
</tr>
<tr>
<td>Clean water partnership - lakes</td>
<td>Y</td>
</tr>
<tr>
<td>Lake Assessment Program</td>
<td>Y</td>
</tr>
<tr>
<td>Citizen lake monitoring program (Secchi disk)</td>
<td>Y</td>
</tr>
<tr>
<td>Citizen stream monitoring program (Transparency tube)</td>
<td>Y</td>
</tr>
<tr>
<td>Bio-monitoring (indices of biotic integrity)</td>
<td>Y</td>
</tr>
<tr>
<td>Chemistry data which is part of bio-monitoring</td>
<td>A</td>
</tr>
<tr>
<td>Fish tissue contaminants (fish consumption advise)</td>
<td>Y</td>
</tr>
<tr>
<td>Metals data obtained using clean technique</td>
<td>Y</td>
</tr>
</tbody>
</table>
### B. Integrated reporting

As alluded to in the previous section, integrated reporting of assessed surface waters follows the guidance provided by EPA (EPA 2005). It begins with the collection and assessment of all available data within a 10 year window of data using the guidelines in this or subsequent guidance to make determinations of impaired, not impaired, insufficient information, or not assessed for each assessment unit based on use support assessments. An assessment unit is defined as a surface water body or portion thereof for which monitoring data are available. See Section V.A. for a description of how the extent of an assessment unit is determined.

Once an assessment has been made, the assessment unit is categorized into one of the five main categories or sub-categories. The categorization of an assessment unit occurs automatically within the Assessment Database (Version 2.3) (ADB) provided by EPA and is based on the data provided. The use of ADB V2.3 allows for a variety of different approaches to categorizing an assessment unit. Minnesota is continuing with an overall categorization per assessment unit for 2010 reporting. In addition, the ADB allows states to apply their own categorization to each assessment unit and Minnesota uses the following state categories or subcategories to identify the overall assessment status of each assessment unit, which is intended to aid in determining future monitoring scheduling.

<table>
<thead>
<tr>
<th>Category/Subcategory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>All designated uses are met and no use threatened.</td>
</tr>
<tr>
<td>2</td>
<td>Some uses are met; none are threatened and insufficient data to assess other uses.</td>
</tr>
<tr>
<td>3A</td>
<td>No data or information to determine if any designated use is attained.</td>
</tr>
<tr>
<td>3B</td>
<td>Data are available for a review and generally indicate non-support, but insufficient data and information to determine TMDL impairment. (Example: single lake data point showing non-support)</td>
</tr>
<tr>
<td>3C</td>
<td>Data available that currently has no assessment tools to allow its use in assessing. (Example: data with only eco-region expectation standards)</td>
</tr>
<tr>
<td>3D</td>
<td>Data are available for a review and generally indicate full support, but insufficient data and information to assess for category 1 or 2.</td>
</tr>
<tr>
<td>3E</td>
<td>Data are available for a review, but insufficient data and information to determine full support or TMDL impairment. (Example: lake data just below the threshold showing non-support)</td>
</tr>
<tr>
<td>4A</td>
<td>Impaired or threatened but all needed TMDLs have been completed.</td>
</tr>
<tr>
<td>4B</td>
<td>Impaired or threatened but doesn’t require a TMDL because it is expected to attain standards in the near future.</td>
</tr>
<tr>
<td>4C</td>
<td>Impaired or threatened but doesn’t require a TMDL because impairment not caused by a pollutant.</td>
</tr>
<tr>
<td>4D</td>
<td>Impaired or threatened but existing data strongly suggests a TMDL is not required because the impairment is solely the result of natural sources: a final determination of Category 4D will be made in the next listing cycle pending confirmation from additional information (i.e. water quality or land use).</td>
</tr>
<tr>
<td>5A</td>
<td>Impaired or threatened by multiple pollutants and no TMDL plans approved.</td>
</tr>
</tbody>
</table>
5B Impaired or threatened more than one pollutants and either one or more TMDL plans approved but not all or at least one impairment is in another Category 4 subgroup.

5C Impaired or threatened by one pollutant.

All assessment units falling into category 5 become the 303(d) TMDL list. This draft list is subject to review and public comment before submittal to the EPA, which may result in the reassessment of a particular assessment unit into one of the other categories. Assessment units falling into category 4 are impaired waters, but are not part of the 303(d) list because of the reasons given above in the category descriptions. These waters appear with the category 5 waters on an impaired inventory, which is a comprehensive list of all the current impaired assessment unit/pollutant combinations.

C. Levels of use support

The purpose of meeting water quality criteria is to protect the beneficial uses associated with the standards. See Section II.A. for a description of the beneficial uses. As stated in Section II.A., all surface waters in Minnesota are protected for aquatic life and recreation. To accomplish this in the integrated process, three use supports are assessed for Class 2 waters. These use supports are aquatic life, aquatic consumption, and aquatic recreation. Class 7 waters are considered limited resource value waters and as such were reviewed to protect aquatic life and recreation against applicable standards.

The aquatic life use support assessments are aimed at protecting the organisms that reside in the surface waters of the state, while the aquatic consumption use support’s goal is to protect consumers of the aquatic life. The aquatic recreation use support is assessed for protection of recreation in surface waters as described in Section II.A. The combined assessments of these three use supports are aimed at being consistent with the goal in the CWA that the nation’s waters should be “fishable and swimmable” wherever attainable.

In addition, beginning with the 2010 assessment and reporting cycle, the drinking water use support will be assessed with regard to the drinking water standard for nitrates in Class 1 surface waters.

Based on the review of the water quality data and other relevant information compared to the standards for a given pollutant or water quality characteristic, the use supports may be assessed as:

- fully supported
- insufficient data
- not supported (= non-support)
- not assessed

As stated previously, an assessment unit’s overall integrated assessment is impaired, not impaired, insufficient information, or not assessed based on the worst case use support assessment. An overall not impaired assessment implies that no use support was assessed as “not supported”. A “not assessed” overall assessment occurs when no data are available to make any use support assessment, subcategory 3A. An insufficient information assessment generally was reserved for assessment units placed in subcategory 3B, 3C, 3D, or 3E.

The categorization of an assessment unit is an added step that occurs in the integrated process. It does not change the way assessments are reported in the integrated process. Assessment units fully supporting all assessed use supports are identified as “fully supporting” in the integrated report and they do not appear on the 303(d) list. For purposes of integrated reporting, a waterbody that is determined overall to be neither fully or non-supporting is considered to have insufficient data to make an integrated assessment. It would fall into EPA’s category 3 and is earmarked for additional state monitoring by providing it with a state subcategory of 3E. A determination of non-support indicates an impaired condition and the waterbody may go on the 303(d) list. Generally a waterbody is listed unless a secondary analysis determines there is insufficient information for listing, in which case the waterbody is placed in subcategory 3B.

A use is considered not assessed if there are insufficient or no data to determine support. For some assessments, lake eutrophication for example, the insufficient data category is a trigger for further analysis of that waterbody before an impairment decision is made (if it meets minimum data requirements). The MPCA maintains a list of waterbodies for which insufficient data are available to
make a complete assessment, but the available data suggest some impairment. This list will help establish priorities for allocating future monitoring resources.

D. Data used for the integrated report

The EPA encourages states to review as many waterbodies as resources permit when preparing the integrated report, recognizing that there are various levels of confidence associated with varying quantities of data. To that end, and to facilitate the integrated assessment process, all available data within a 10 year window beginning in the water year 12 years prior to the reporting year are considered initially for the integrated report.

For the 303(d) list development, minimum data requirements are in place for a number of assessments (lake eutrophication, transparency tube, dissolved oxygen) (See Table 3 and Section VI.A). In addition, a draft 303(d) list will include listings from the previous cycle’s final approved TMDL list that were not de-listed, removed by correction, or for which a TMDL plan was approved. These inclusions may be referred to as carry forwards and may not reflect the data for the same use supports or pollutant parameters as are found in the 10 year window used for the current integrated report. In such cases there might be differences in reporting between the integrated narrative report and the appendix containing the 303(d) listings.

E. Data quality

The integrated assessment process requires a quality rating or confidence level be assigned to the data used to make use support assessments. The rating options available in the ADB are low, fair, good, or excellent for each type of data (physical/chemical, biological, pathogens, etc.). In an effort to use “all available data” in the integrated process, Minnesota conducted a public call for data in 2008 to obtain data from stakeholders. Use support assessments are carried out separately for lakes and streams and the rating process for each type of assessment is as follows:

1. Data quality for lake assessments

The data used in these assessments was derived from STORET, so we are assured that certain “quality control” thresholds were already established for the data. Hence our definition of “quality” will focus on the relative amount of information available for the assessment. In the case of our aquatic recreational use assessments, Total Phosphorus (TP) is the primary variable used so we place the greatest emphasis on the amount of TP data available for the assessment. The “quality” terms were drawn from the EPA guidance. In general we feel that assessments based on multiple measurements are more reliable than those based on only a few measurements.

The rationale for assigning the respective “quality” definitions corresponds roughly to typical lake-monitoring regimens (e.g. monthly sampling during the summer season), whereby four TP samples often represent one summer; eight samples two summers and 12 samples two-three summers. In the case of 303(d) assessments eight or more TP, corrected chl-a and Secchi measurements are usually required to determine if a lake should be placed on the 303(d) list and was considered “excellent” quality data for assessment.

Data quality characterizations for integrated assessments

<table>
<thead>
<tr>
<th>Quality</th>
<th>“Available data”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>&lt; 4 TP measurements</td>
</tr>
<tr>
<td>Fair</td>
<td>4 ≤ TP &lt; 8, some chl-a &amp; Secchi</td>
</tr>
<tr>
<td>Good</td>
<td>8 ≤ TP &lt; 12, some chl-a &amp; Secchi</td>
</tr>
<tr>
<td>Excellent</td>
<td>8 TP, 8 corrected chl-a &amp; 8 Secchi</td>
</tr>
</tbody>
</table>
2. Data quality for stream assessments

The data for stream assessments include data drawn from STORET as well as other data that are made available through a specified cut off date. The cutoff date will depend on when the date of the first professional judgment group assessment meeting is scheduled and will occur early enough to allow for the compilation of pre-assessment data before the meeting.

The quality of data used in these assessments is based on the four tiered rating system available in the ADB with a rating assigned to each type of data used in each use support assessment. For aquatic life use support data quality ratings are as follows:

- **excellent** – both biological and physical/chemical data available
- **good** – either biological or physical/chemical data available in sufficient quantities, which the professional judgment group deems enough to make a good assessment
- **fair** – physical/chemical data available in sufficient quantities, which the professional judgment group deems enough to make a fair assessment
- **low** – only a few physical/chemical parameters available in minimum quantities needed to make an assessment

Aquatic consumption use support assessments at this time use fish consumption advisory data from the MDH, which we have assigned a ’good’ quality rating.

For aquatic recreation use support data quality ratings, some general guidelines are given below:

- **excellent** – 6-7 months of data with at least 5 observations
- **good** – ~3-5 months of data with at least 5 observations
- **fair** – ~1-2 months of data with at least 5 observations
- **low** – no months with at least 5 observations, very few additional data points above the minimum 10 required

In addition, another factor considered in rating the quality of aquatic recreation data is looking at the dates when samples were collected (years and months). A lower quality rating is generally given where all the data are collected in one calendar year and/or where the dataset does not include months that typically have higher *E. coli* counts (June – September).
VII. Assessment Based on Numeric Standards for Protection of Aquatic Life

A. Pollutants with toxicity-based water quality standards

Protection of “aquatic life” with applicable Class 2 chronic standards means protection of the aquatic community from the direct harmful effects of toxic substances, and protection of human and wildlife consumers of fish or other aquatic organisms. This section of the Guidance deals with the former, the assessment of water quality for pollutants that have toxicity-based chronic standards.

Surface waters are assessed to determine if they are of a quality needed to support the aquatic community that would be found in the river or stream under natural conditions. The concepts of present-day “natural conditions” and “reference conditions” are discussed in Section X.B.2. In general, two types of data are used in toxicity-based assessments: water chemistry data, which is the subject of this section, and biological data, which is the subject of Section XII.A. Pre-assessments based on chemistry data and biological data are combined into a preliminary combined assessment for aquatic life use-support determinations.

1. Pollutants

The pollutants that have toxicity-based standards most often included in MPCA water quality assessments are briefly discussed. Pollutants other than those mentioned here may be assessed also, as data allow.

a) Trace metals

Trace metals with toxicity-based standards used in water quality assessments include cadmium, chromium, copper, lead, nickel, selenium and zinc (numeric standards for metals are listed in Appendix B). Mercury is discussed in the Chapter VIII, because it has a human health-based standard.

The MPCA water quality standards for trace metals are listed as “total” metal in both Minn. R. chs. 7050 and 7052, but they are applied to ambient waters as “dissolved” metal standards. The total standard is multiplied by the appropriate conversion factor to convert it to a dissolved standard (Appendix B, Tables B-1 and B-5). The difference between total and dissolved metal is that the sample for the latter is filtered through a 0.45 micron pore filter to remove most suspended particulates before analysis. The sample for total metal is not filtered. The change from total to dissolved metal standards is based on substantial evidence that particulate bound metals are generally not as toxic to aquatic organisms as the ionic or weakly bound forms of metal. The dissolved analysis better estimates the toxic fraction of metals in most natural waters. It is EPA policy that metal standards should be in the form of dissolved metal (EPA 1993).

Both total and dissolved “clean” technique metals data are available at most sampling locations throughout the state except in the Lake Superior basin where most of the data are total. Total and dissolved metal data will be used in the assessments for both the integrated narrative report and the 303(d) list until there are adequate data to switch completely to dissolved metal data. Total metal data will be compared to total metal standards and dissolved data will be compared to dissolved standards.

The standards for cadmium, chromium III, copper, lead, nickel, and zinc vary with ambient total hardness. Thus, the standards for these metals are in the form of formulas that reflect the hardness/toxicity relationship (Appendix B, Tables B-4 and B-7). To calculate the appropriate metal standard, a sample is collected for total hardness along with the metal sample. Each measured value for a hardness-dependent metal is compared to an individually calculated standard based on the hardness at the same time and place the metal sample was taken.
Water quality assessments using Class 2 water quality standards [Std] for trace metals listed as “Total,” include the following metals: Aluminum, Antimony, Arsenic, Cadmium, Chromium III, Chromium VI, Cobalt, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc.

Chronic Standard (Std) for Trace Metal (total)

- **Toxicity-based**
  - Convert Std to dissolved Std
  - Multiply total Std by adjustment factor in Minn. R. 7050.0222, subp. 9
  - If factor < 1.0 (dissolved Std is < total Std) (adjustment factor is never > 1.0)
  - Result is dissolved Std
  - Compare dissolved Std to dissolved ambient data (filtered sample)

- **Human health-based**
  - No conversion to dissolved Std
  - Compare Std to total [unfiltered] analysis of ambient water
  - If factor = 1.0, or no factor listed, then factor = 1.0. total and dissolved Std are equal

Hypothetical example: Total Copper Std = 15 μg/L @ a hardness of 200 mg/L

Total Std = 15 μg/L, toxicity-based; factor = 0.960
Dissolved Std = 14.4 μg/L (15 μg/L X 0.960)

Therefore, compare the 14.4 μg/L dissolved Std to the dissolved ambient copper analysis to assess for compliance with water quality standards.

**b) Un-ionized ammonia**

Ammonia at elevated levels in the un-ionized form (NH₃) is toxic to aquatic life. When water column concentrations of un-ionized ammonia exceed water quality standards, sensitive species, and particularly the sensitive early life stages of fish (post-hatch fry) will show sub-lethal adverse effects. At higher concentrations, death can occur. The chronic un-ionized ammonia standards are shown below:

- Class 2A. 0.016 mg/L un-ionized ammonia
- Class 2Bd, B, C, D. 0.04 mg/L un-ionized ammonia

The fraction of total ammonia in the un-ionized form in water is dependent on ambient pH and temperature. Therefore, pH and temperature as well as total ammonia must be measured at the same time and place to determine the un-ionized ammonia concentration. Beyond its toxic properties, excess ammonia can have an indirect adverse impact on aquatic life also. The oxidation of ammonia to nitrite and water require significant dissolved oxygen resources. Too much ammonia in the water, such as might occur after a spill of high ammonia strength wastewater, can reduce dissolved oxygen levels to the point that fish kills occur.
c) Chloride

Elevated levels of chloride in surface waters are usually an indication of pollution from a wide range of potential sources. Point sources include the discharge of process water from some industries as well as municipal wastewater treatment plant effluents. Nonpoint sources include runoff from salt piles or from urban streets where road salt has been applied. Besides being a general indicator of human impacts on water quality, high levels of chloride can harm aquatic organisms, possibly by interfering with the organism’s osmoregulatory capabilities. The Class 2 chronic standard for chloride is 230 mg/L.

2. Data requirements and determination of impaired condition

Water quality data available through STORET for the most recent 10 year period is used in waterbody assessments for the integrated narrative report and the 303(d) list. Exceedances of standards for toxic pollutants are assessed over consecutive three year periods, consistent with the once in three-year exceedance frequency discussed in Section II.B. One exceedance of the chronic standard in three years is not considered impairment (two or more is). One exceedance of the maximum standard in three years indicates impairment. A minimum of five data points is needed for each three-year period. If more than one sample was taken within a four-day period the values are averaged (usually an arithmetic mean is appropriate) and the four-day average is counted as one value in the assessment.

The protocol for assessing three-year intervals is to look first for exceedances in the most recent three years of available data. This is followed by a search for exceedances in any three-year interval containing the minimum five data points. The three-year intervals may overlap but the years must be consecutive. In other words, the three-year intervals used in the assessment are determined by available data and not by the calendar (except they must be within the most recent 10-year period). The selection of appropriate three-year intervals may be made by a professional judgment group. Most, if not all, impairment determinations for toxic pollutants will be reviewed by an appropriate professional judgment group.

River or stream reaches with fewer than five data points, but with one exceedance of the chronic or, especially, the maximum standard, will be given a high priority for follow-up sampling. These will be flagged by the professional review teams, and placed on an internal MPCA list of waters needing further monitoring and assessment. The protocol for impairment determinations is the same for the 305(b) use support and 303(d) impairment assessments (Table 4).

Table 4. Summary of data requirements and exceedance thresholds for assessment of pollutants with toxicity-based standards for the 305b report and the 303d list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points*</th>
<th>Use Support or Listing Category Based on Exceedances of Chronic Standard**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Standard Exceedance Threshold →</td>
<td>No more than 1 in 3 years</td>
<td>2 or more in 3 yrs.</td>
</tr>
<tr>
<td>Most recent 10 years</td>
<td>5, within a 3-yr. period</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

* 4-day central (mean or median) values
** One exceedance of the maximum standard in three years is considered Not Supporting

B. Conventional pollutants

Conventional pollutants or water quality characteristics assessed include dissolved oxygen, pH, temperature, and turbidity. Turbidity is measured directly or estimated from transparency tube and/or total suspended solids measurements.
1. Pollutant or water quality characteristic

The conventional pollutants most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

a) Low dissolved oxygen

Dissolved oxygen (DO) is required for essentially all aquatic organisms to live. DO is not a toxicant and, in general, the more DO in the water, up to about 110 percent of saturation, the better, for aquatic organisms. If DO drops below acceptable levels, desirable aquatic organisms, such as fish, can be killed or harmed. Dissolved oxygen standards differ depending on the use class of the water:

- Class 2A. Not less than 7 mg/L as a daily minimum
- Class 2Bd, 2B, 2C. Not less than 5 mg/L as a daily minimum
- Class 2D. Maintain background
- Class 7. Not less than 1 mg/L as a daily average, provided that measurable concentrations are present at all times

DO concentrations go through a diurnal cycle in most rivers and streams; concentrations generally reach their maximum in late afternoon and their minimum just after sunrise. Photosynthesis by algae and other green plants during the day gives off oxygen to the water which increases DO concentrations. At nightfall photosynthesis stops, but the continued respiration of living things, including green plants and bacteria, uses oxygen faster than it is replaced. This causes a gradual decline in DO levels throughout the night that usually culminates an hour or so after sunrise. For this reason, measurements of dissolved oxygen to be compared to the daily minimum standard are best taken no later than two hours after sunrise. DO measurements taken later in the day are not likely to represent the low point in the daily DO cycle. Timing is not as critical in the winter because daily DO cycles are not as pronounced as they are in the summer.

In Minnesota the critical conditions for stream DO usually occur during the late summer season when water temperatures are high and stream flows are normally low. During winter months, ice cover inhibits atmospheric re-aeration, and groundwater inflows contribute to low DO concentrations. When this is combined with oxygen-demanding loadings from eutrophication or point sources, winter low DO concentrations can occur.

Because of the seasonal and diurnal variability in DO concentrations, data sets of only 10 independent observations are seldom sufficient to display the pattern of dynamic DO in a stream and provide the basis for a confident assessment. For this reason, a total of 20 independent observations (rather than 10) are now required for DO assessments. In non-winter months (April through November) measurements should be made before 9:00 am in order to measure the lowest diurnal DO concentration.

Under revised assessment criteria beginning with the 2010 assessment cycle, the DO standard must be met at least 90 percent of the time during both the 5-month period of May through September and the 7-month period of October through April. Accordingly, no more than 10 percent of DO measurements can violate the standard in either of the two periods.

Further, measurements taken after 9:00 in the morning during the 5-month period of May through September are no longer considered to represent daily minimums, and thus measurements of > 5 DO later in the day are no longer considered to be indications that a stream is meeting the standard.

A stream is considered impaired if 1) more than 10 percent of the “suitable” (taken before 9:00) May through September measurements, or more than 10 percent of the total May through September measurements, or more than 10 percent of the October through April measurements violate the standard, and 2) there are at least three total violations.
A designation of “full support” for DO requires at least 20 “suitable” measurements from a set of monitoring data that give a representative, unbiased picture of DO levels over at least two different years.

b) pH

The pH of water is a measure of the degree of its acid or alkaline reaction. A pH of 7.0 is neutral; pH below 7 is acid, above 7 is alkaline. The applicable pH standard for most Class 2 waters is a minimum of 6.5 and a maximum of 8.5, based on the more stringent of the standards for the applicable multiple beneficial uses. pH values that are either too high or too low can be harmful to aquatic organisms; however, natural waters can exhibit a very broad range of pH values. pH values that are outside the range of the standard because of natural causes are not considered exceedances.

c) Turbidity

Turbidity in water is caused by suspended soil particles, algae, etc., that scatter light in the water column making the water appear cloudy. Excess turbidity can significantly degrade the aesthetic qualities of waterbodies. People are less likely to recreate in waters degraded by excess turbidity. Also, turbidity can make the water more expensive to treat for drinking or food processing uses. Turbidity values that exceed the standard can harm aquatic life. Aquatic organisms may have trouble finding food, gill function may be affected, and spawning beds may be covered.

Turbidity is measured in nephelometric turbidity units (NTU). The standards are shown below:

- 10 NTU, Class 2A waters
- 25 NTU, Class 2Bd, B, C, D waters

Transparency and total suspended solids (TSS) values reliably predict turbidity and can serve as surrogates at sites where there are an inadequate number of turbidity observations. Large sets of monitoring data have been used to develop transparency and TSS thresholds which will identify the large majority of waters with turbidity impairments while minimizing the number of waterbodies falsely identified. For transparency, a transparency tube measurement of less than 20 centimeters indicates a violation of the 25 NTU turbidity standard. For TSS, a measurement of more than 60 mg/L in the Western Corn Belt Plains (WCBP) and Northern Glaciated Plains (NGP) ecoregions or more than 100 mg/L in the North Central Hardwood Forest (NCHF) ecoregion indicates a violation.

Turbidity is a highly variable water quality measure. Because of this variability, and the use of TSS and transparency as surrogates, a total of 20 independent observations (rather than 10) are now required for a turbidity assessment. If sufficient turbidity measurements exist, only turbidity measurements will be used to determine impairment. If there are insufficient turbidity measurements, any combination of independent turbidity, transparency, and total suspended solids observations may be combined to meet assessment criteria. If there are multiple observations of a single parameter in one day, the mean of the values will be used in the assessment process.

If there are observations of more than one of the three parameters in a single day, the hierarchy of consideration for assessment purposes will be turbidity, then transparency, then total suspended solids. For a water body to be listed as impaired for turbidity, at least three observations and 10 percent of observations must be in violation of the turbidity standard. This is an increase in the number of violations required, which was previously 10 percent of 10 required observations.

Previously (2006 and 2008), assessments that took into account volunteer-collected transparency tube observations required corroboration by the judgment of MPCA staff and by local resource and/or watershed project staff, if available. Corroboration of volunteer-collected transparency tube data is no longer required, based on the following rationale:
• Corroboration of transparency tube data is inconsistent with assessment requirements for all other volunteer collected data.
• Professional Judgment Group (PJG) meetings provide a forum for reviewing all data; this process should be sufficient for volunteer-collected transparency tube data.
• Considerable time is spent trying to locate local corroborators, processing review documents, and tracking comments.
• Lack of a local partner willing to review the data for assessment purposes has lead to a significant amount of transparency tube data being excluded from assessments.

The MPCA has not analyzed enough data on Class 2A waters to determine transparency or TSS thresholds for violation of the 10 NTU standard. If turbidity related data (turbidity, t-tube, TSS) data indicate impairment on a Class 2A water (based on the 25 NTU standard), the waterbody is assessed as impaired for turbidity. If turbidity related data indicate a Class 2A water is in full support, the water body is considered “not assessed” since it is based on the transparency and TSS thresholds for the 25 NTU, and not the 10 NTU standard.

d) Temperature
High water temperatures, or rapid elevations of temperature above ambient, can be very detrimental to fish. The actual temperature that is harmful depends on the kind of fish, the time of year, and the life stage of the fish at the time. Cold water fish such as trout are particularly intolerant of high temperatures. The temperature standard for Class 2A cold water sport fish is a narrative nondegradation statement of “no material increase”. This standard is interpreted in a straightforward quantitative way. A demonstration of a “material increase” means that temperature data must show a statistically significant increase when measured, for example, upstream and downstream of a stream modification, upstream and downstream of a point or nonpoint heat source, or before and after a modification that might impact stream temperature. Temperatures must be for similar time frames such as weeks or seasons. Normally the Student’s t-test is used to test for significance of the temperature change over time. Specifically, the Student’s t-test tests the hypothesis that the means of two groups of observations are equal. This test assumes that each of the two groups consists of independent and normally distributed observations. If either set of temperature data is not normally distributed, an appropriate analogous test, such as the Mann-Whitney U test, will be used. The larger the data set, the finer the precision in determining whether a material increase in stream temperature has occurred.

Currently the MPCA is evaluating only cold water fisheries for temperature caused impairment because of the special sensitivity of cold water fish to elevations in temperature, and because increases in temperature appear to be a major factor in the degradation of stream trout populations.

2. Data requirements and determination of impaired condition
The same information is used to assess conventional pollutants for both 305(b) use support and 303(d) impaired waters determinations (Table 5). Reaches assessed using the impairment thresholds listed in Table 5 as not supporting for the integrated narrative report are identified as candidates for the 303(d) list. These reaches are presented to the appropriate professional judgment team for the basin in which the reach is located. The professional judgment team reviews the monitoring data for the most recent 10 years, and any information they have about actions taken in the watershed that might invalidate earlier data. They also consider the times of year and the number of years monitoring was done, and the magnitude and duration of any violations noted, and information about naturally occurring conditions known to influence water quality (see Section V.E). The MPCA makes a final determination on use support for integrated narrative reporting, and for inclusion on the 303(d) list.

The 10 percent and 25 percent exceedance thresholds for conventional pollutants (Table 5) are based on EPA guidance (EPA 1997) and have been used by the MPCA in assessments for many years. The MPCA feels these thresholds are appropriate for the “conventional” category of pollutants for several reasons. None is “toxic” (or bioaccumulative) in the traditional sense, unlike the toxicants discussed in Section VIII. All are subject to periodic “exceedances” because of natural
causes. For example, turbidity typically increases in streams after a rain event even in relatively undisturbed parts of the state and dissolved oxygen can drop below the standard in rivers and streams for reasons that have nothing to do with pollution. These potential pollutants are also natural characteristics of surface waters, the fluctuations of which aquatic organisms have adapted to cope with over eons of time. The extent of these natural exceedances will be considered by the professional judgment teams as part of the assessments.

In the 2006 assessment, the judgment teams solidified an approach to assessing full support on streams with data sets that are limited to only one or a few types of data. Subject to the judgment of the team considering all the usual factors, an index of biotic integrity (IBI) score or a turbidity [“turbidity” includes transparency tube data with corroboration and total suspended solids data for the WCBP and NGP, and NCHF eco-regions] or dissolved oxygen dataset will each be sufficient alone to make an assessment of full support. Temperature, pH, ammonia, chloride, etc. are each not enough alone. Any combination is sufficient if it includes an IBI score, or turbidity or dissolved oxygen. If the PJG is aware that the timing of collection in a particular dataset might not well represent the conditions for that parameter, it could decide to “not assess”.

This approach improves both consistency and efficiency as the number of reaches under consideration has increased dramatically. In order to use all readily accessible and credible data, the assessment process includes data sets that contain any one of the measurements for which water quality standards are in place. Data sets with few types, or only one type, of measurement, such as ammonia, are valuable for recognizing impairments, but are relatively independent of other influences, and may not be adequate alone to make an assessment of supporting simply because there are not many exceedances. Some types of water quality data better reflect overall aquatic biota health in a stream, while others is usually inadequate alone. In general, a fully supporting IBI score or turbidity or dissolved oxygen data set can reflect a complex of common degradation factors in Minnesota streams.

Table 5. Summary of data requirements and exceedance thresholds for assessment of conventional pollutants and water quality characteristics for the integrated narrative report and the 303d list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points</th>
<th>Use Support or Listing Category Based on Chronic Standard Exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Standard Exceedance Thresholds</td>
<td>&lt;= 10 %</td>
<td>10 – 25 %</td>
</tr>
<tr>
<td>Most recent 10 years</td>
<td>20</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

C. Other numeric water quality standards

Other toxic or conventional pollutants that are found to exceed water quality standards will be assessed following equivalent methodologies discussed in this Guidance, depending on the type of pollutant. Chloride, for example, did not appear in a 303(d) list until 1998, at which time adequate data were available to support impairment assessments for waterbodies.
VIII. Assessment Based on Numeric and Narrative Standards for Protection of Human Health: Drinking Water & Aquatic Consumption

As stated, protection of aquatic life includes the protection of human (and wildlife) consumers of fish as well as the protection of the aquatic community itself. This section of the Guidance deals with the assessment of water quality for pollutants that have human health-based standards. Standards based on protection to humans include: not only the Class 2 chronic standard (CS) as most frequently applied in the impaired waters assessment program, but also narrative standards based on the Minnesota Department of Health’s Fish Consumption Advisory program and Class 1 Drinking Consumption (DC) standards. An overview of these standards and their application for assessment are discussed below.

A. Pollutants with Class 2 human health-based chronic standards

As described in Section II. Water Quality Standards, Class 2 CSs are set only after determining the water column concentration that will be protective for long-term or chronic exposure for aquatic organisms, human health, and fish-eating wildlife (Minn. R. ch. 7052 only). The most protective CS is then listed in the rule under each beneficial use classification (2A, 2B, or 2Bd). This section discusses the development of human health protective numeric CSs.

1. Algorithms for human health-based chronic standards

The methods used to develop human health-based CSs depend on the beneficial use classification and toxicological profile of the pollutant. All Class 2 CSs ensure protection for fish consumption. For Class 2A and Class 2Bd surface waters, protection also includes the use of these water as a source of or potential to influence drinking water. Therefore, development of Class 2A and 2Bd CSs have to include drinking water intake and fish consumption intake rates into the algorithm. The generic algorithm is:

Class 2A or 2Bd CS

\[
= \text{Toxicological value (Reference dose or Cancer risk level/Cancer slope factor)} \\
+ \text{Drinking water intake rate} + \text{(Fish consumption intake rate x Bioaccumulation factor)}
\]

Class 2B surface waters are not used as a source of drinking water, but instead base possible ingestion on a “mouthful” of water that may be incidentally consumed while swimming. This intake rate is much lower then drinking water intakes; therefore, the CS for these waters is generally driven by the fish consumption intake rates.

Class 2B CS

\[
= \text{Toxicological value (Reference dose or Cancer risk level/Cancer slope factor)} \\
+ \text{Incidental water intake rate} + \text{(Fish consumption intake rate x Bioaccumulation Factor)}
\]

It is important to distinguish the basis for human health protection in the Class 2 subclasses as they are critical to understanding the exposure pathways included and to distinguish from the Class 1 DC standards that are further discussed in Section VIII. C.

2. Key pollutant properties in understanding human health-based chronic standards: bioaccumulatives and carcinogens

Chemicals that persist in the environment and “build up” in the tissues of aquatic organisms to higher concentrations than the concentrations in the surrounding water are called bioaccumulative chemicals. Chemicals bioaccumulate in biota by direct uptake of the chemical through the skin and gill tissues and also by uptake through the organism’s diet (food chain). Uptake through the food chain means that at each step up the chain, from plants to prey to predator, the concentrations in the biota increase at each step. This “biomagnification” as it is called is a concern because many game
fish (e.g., walleye and northern pike) are at the top of the aquatic food chain and they typically carry the highest tissue concentrations of the chemical in the aquatic system. The bioaccumulation factor (BAF) is the ratio between the concentration of the chemical in the biota and the concentration of the chemical in the water. BAFs can exceed one million for very highly bioaccumulative chemicals.

A BAF must be determined to calculate a human health-based water quality standard. (MPCA, 2000e). For pollutants with high BAFs, generally > 1000, the CSs are very low water column concentrations in order to limit their concentration in fish tissue; this means human health protection is the basis for these CSs as the concentrations are more stringent than those for aquatic organism protection (Appendix A, Tables A-2, A-3 and A-6). For these chemicals (such as mercury, PCBs, and dioxins), exposure from the fish consumption pathway also far exceeds that from drinking water consumption. Based on EPA guidance, MPCA adopted a fish tissue criterion for mercury in 2008 to provide a more accurate and directly usable standard to protect fish consumers (for further discussion, see VIII.B.)

Another important pollutant characteristic usually seen for human health-based CSs is their classification as carcinogens. The methods for protecting human health from increased risk of cancer from environmental pollutants has been undergoing many changes since EPA published human health criteria for carcinogens in the 1980s (EPA 2000b); however one important tenant has remained - that for some carcinogens any exposure can lead to some risk of developing cancer. To protect humans from these exposures, cancer slope factors used in calculating water quality standards can be very large values, resulting in CSs that are very low. The method, called linear, low-dose extrapolation, is used as the default approach when chemical-specific data are not available to better define cancer risk. It is also important to note that many bioaccumulative pollutants (e.g. PCBs and dioxin/furans) are also carcinogens.

**Pollutants**

The pollutants that have human health-based CSs that are most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

**a) Mercury**

Mercury is the classic example of a bioaccumulative element; it never degrades, it can bioaccumulate through the food chain to toxic levels from benign water concentrations, and it can cause serious health effects. To make the situation worse, it is unusually mobile in the environment and it readily moves from one medium to another. Atmospheric transport of mercury can be over short (meters) or long (global) distances. Mercury numeric water quality standards are based on total concentrations and, thus, total mercury measurements are used in assessments. Minnesota has two water column human health-based Class 2 water quality standards for total mercury, the statewide standard in Minn. R. ch. 7050 and the standard applicable to just the waters of the Lake Superior basin in Minn. R. ch. 7052. These standards are shown below:

- 6.9 ng/L. chronic standard, Minn. R. ch.7050.0222
- 1.3 ng/L. chronic standard, Minn. R. ch. 7052.0100
  (ng/L = nanogram per liter, or parts per trillion)

In 2008, MPCA also adopted a fish tissue mercury standard into Minn. R. ch. 7050:

- 0.2 mg/kg, total in edible fish tissue

The MPCA began using clean sampling techniques for mercury and other trace metals in 1996, and only data collected in this manner will be used (EPA Method 1631 or equivalent). Mercury levels are assessed by comparing concentrations in water to the ambient standards shown above, and by assessing the mercury in fish tissue directly, as outlined in Section VIII.B. where mercury is further discussed.
b) **Polychlorinated biphenyls**

Polychlorinated biphenyls (PCBs) constitute a group of chlorinated organic compounds distributed world-wide. Their extensive use combined with their persistence, bioaccumulative properties, and cancer and non-cancer toxicity, make them very serious environmental pollutants. PCB residues are found globally in animal tissues, including humans. The manufacture and distribution of PCBs was banned in Minnesota in 1976, and they are no longer manufactured in the United States. PCBs were used extensively in the electrical industry as transformer and capacitor fluids; they were also used as hydraulic fluids, plasticizers, and lubricants.

PCBs elicit a variety of toxic effects on animals and humans, including birth defects, reproductive failure, developmental impairment, liver damage, and death. Concentrations of PCBs in water are very low (typically less than one part per trillion) and difficult to measure. But, because they bioaccumulate as much as a million fold or more in fish and other animals, they are readily measured in animal tissues. Thus, PCBs are usually assessed for the 303(d) list on the basis of their presence in fish, resulting in advice to anglers to limit their consumption of certain fish (see Section VIII.B.). The MPCA has adopted human health-based water quality standards for total PCBs. Statewide standards are in Minn. R. ch. 7050 and standards applicable only to waters of the Lake Superior basin are in Minn. R. ch. 7052, as listed below:

Minn. R. ch. 7050.0222
- 14 pg/L, Class 2A chronic
- 29 pg/L, Class 2Bd, 2B, 2C and 2D chronic

Minn. R. ch. 7052.0100
- 4.5 pg/L, Lake Superior chronic
- 6.3 pg/L, Class 2A chronic
- 25 pg/L, Class 2Bd, 2B, 2C and 2D chronic

(pg/L = picogram per liter, or parts per quadrillion)

Since the manufacture and sale of polychlorinated biphenyls (PCB) were banned in 1976, measured concentrations in fish tissue have decreased by 90 percent in some fish species in the Mississippi River and by 75 percent in Lake Superior lake trout. It is anticipated that, with time, natural volatilization and sedimentation processes in lakes and streams will further reduce fish exposure to PCBs in the environment at most locations. The total PCB concentrations in Lake Superior water dropped from about 2.4 ng/L in 1980 to 0.18 ng/L in 1992, mostly because of volatilization (Jeremiason et al. 1994). The fish tissue concentration thresholds for PCB consumption advice are shown in Table 7 (also in Section VIII.B.4.).

c) **Dioxins and chlorinated pesticides**

Dioxins, particularly 2,3,7,8-tetrachlorodibenzo-p-dioxin, are probably the most toxic chemicals the MPCA has dealt with. Dioxins are similar to PCBs in many respects. Both represent a family of chlorinated organic chemicals, some of which are very persistent, bioaccumulative and toxic, as well as global in their distribution. The major difference between the two groups of chemicals is that, unlike PCBs, dioxins were never intentionally manufactured. The major sources of dioxins are combustion, chlorine bleaching of pulp wood (now largely phased out), and trace contaminants in other manufactured organic compounds, included PCBs. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) has been shown to be carcinogenic in animals at extremely low doses. The EPA completed an exhaustive review of TCDD toxicity in 2000 which confirmed its developmental and reproductive toxicity and carcinogenicity at low exposure rates. The MPCA has Class 2 human health-based water quality standards for 2,3,7,8-TCDD in Minn. R. ch. 7052, applicable only to waters in the Lake Superior basin. The only 2,3,7,8-TCDD standard in Minn. R. ch. 7050 is the EPA drinking water standard of 30 pg/L. These are shown below:

- 0.0014 pg/L, Lake Superior chronic
- 0.0020 pg/L, Class 2A chronic
• 0.0080 pg/L, Class 2Bd, 2B, 2C and 2D chronic
  (pg/L = picogram per liter, or parts per quadrillion)

Organochlorine pesticides, such as DDT, Dieldrin, and toxaphene are the classic examples of the “good and bad” associated with the widespread use of this class of pesticides in the 20th century. The extensive use of DDT for the control of lice and mosquitoes during and in the years just following World War II is credited with saving millions of lives from typhus, malaria and other diseases. Yet, their persistence, bioaccumulative characteristics, and reproductive toxicity to non-target organisms represented an environmental disaster, as foretold in Rachel Carson’s Silent Spring. The role these insecticides played in the population declines of many species of birds of prey has been well documented. The use of most organochlorine pesticides is banned in the United States and in most countries world-wide (EPA 2001b). Like PCBs, concentrations of these pesticides in the Great Lakes have declined since the early 1970s.

The MPCA evaluates waters for dioxins or organochlorine pesticides only at site-specific locations where contamination is suspected or where data are needed to support remedial efforts. Measuring concentrations in water requires special sampling procedures and analytical capabilities. The MPCA human health-based water quality standards for chlordane, DDT, Dieldrin, heptachlor (and its primary metabolite, heptachlor epoxide), lindane, and toxaphene are listed in Tables A-2 and A-6 in Appendix A.

3. Data requirements and determination of impaired condition

The data requirements for assessing waterbodies for exceedances of human health-based CSs are essentially the same as for chemicals with toxicity-based standards (Section VII. A.) The major difference is that data compared to the chronic standard are “averaged” over a 30-day period (rather than 4-day for aquatic-toxicity-based CSs), if more than one sample was taken in the 30-day period. Samples taken in a once-per-month sampling regime occasionally result in two samples collected within 30 days. Such samples should be considered separately and not be averaged together unless the samples were taken within 21 days of each other, in which case they are averaged. A 30-day arithmetic mean is used, unless the data are not normally distributed, in which case a geometric mean, log mean or median should be used.

Water quality data in STORET for the most recent 10 year period are used. Exceedances are assessed over consecutive three year periods. Two exceedances of the chronic standard or a single exceedance of the maximum standard (see aquatic toxicity-based standards VII), in three years, indicate impairment. A minimum of five data points is needed for each three-year period.

The data requirements and protocol for assessments are the same for the integrated narrative report and 303(d) list (Table 6). Examples of data collected and used in 303 (d) assessments include the Lake Superior and Duluth Harbor Toxics Loading Study (MPCA 1999) and MDA’s pesticide monitoring. River or stream reaches with fewer than five data points, but with one exceedance of the chronic or, especially, the maximum standard, will be given a high priority for follow-up sampling. These will be flagged by the professional review teams, and placed on an internal MPCA list of waters needing further monitoring and assessment.

The MPCA has implemented several special programs or strategies for reducing environmental release of these chemicals, even at very low concentrations. Minn. R. ch. 7052, the Great Lakes Initiative, focuses many of its provisions on the reduction of bioaccumulative toxic chemicals in the Great Lakes ecosystem as a whole.
Table 6. Summary of data requirements and exceedance thresholds for assessment of pollutants with human health-based and wildlife-based standards for the integrated narrative report and the 303d list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points*</th>
<th>Use Support or Listing Category Based on Exceedances of Chronic Standard**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Standard Exceedance Threshold: No more than 1 in 3 yrs. within a 3-yr. period</td>
<td>5, within a 3-yr. period</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

* 30-day central values
** One exceedance of the maximum standard in three years is considered Not Supporting

4. Pollutants with human health-based and toxicity-based standards or criteria values

As described in the Water Quality Standards Section of this Guidance, the MPCA calculates both a toxicity-based and a human health-based chronic criterion, and the more restrictive of the two is adopted into Minn. R. chs. 7050 or 7052 as the applicable chronic standard. For some pollutants, the aquatic toxicity-based and human health-based values are similar, but only the most stringent is established as the CS. Because of the different averaging times used when comparing human health-based or aquatic toxicity-based standards to monitoring data, a complete impaired waters assessment would require comparisons of monitoring data to both values. Minn. R. chs. 7050 and 7052 will only list the more stringent CS, but the MPCA retains a record of all calculated criteria values.

a) Pollutants

Table A-3 lists three pollutants - atrazine, cobalt, and pentachlorophenol - that have human health-based and toxicity-based standards or criterions that have similar values. Cadmium, lindane, and 2,4,6-trichlorophenol are other pollutants in this category.

Of the pollutants in this category, atrazine data are collected by the MDA for assessments for some stream reaches. The chronic standard for atrazine is 3.4 µg/L for Class 2A and 2Bd waters. While this human health-based standard is lower than the aquatic toxicity-based criterion of 10 µg/L, the aquatic-toxicity value is applicable to all waters to ensure protection of aquatic organisms. Because Class 2B waters are not protected for drinking water, the aquatic toxicity criterion of 10 µg/L becomes the most stringent value and is the basis for the chronic standard. The human health-based criterion value for Class 2B waters is 100 µg/L, to protect people who eat fish.

Monitoring data available on atrazine often includes atrazine degradates. In most cases, not enough information is available to determine a water quality standard for degradates, but available human health and aquatic toxicity reviews are considered by the PJG when assessing waters for impairment. Pesticide reviews by MDH and EPA have provided guidance on factoring in toxicity of degradates.

b) Data requirements and determination of impaired condition

The data requirements for assessing waterbodies for exceedances of pollutants like atrazine are the same as those for human health-based standards and toxicity-based standards (Section VII. A & B). Thirty-day and four-day averages are calculated for those periods where exceedances of the standard are observed and compared against the human health-based standard and aquatic toxicity-based standard/criterion, respectively.

Water quality data for the most recent 10 years is assessed over consecutive three-year periods. Two exceedances of the human health-based standard or the aquatic toxicity-based standard within three years indicate impairment. Based on additional information on the timing and magnitude of an exceedance, the PJG would evaluate on a case-by-case basis the appropriateness of listing waters.
with one exceedance of each standard at different times within a three-year period. One exceedance of the maximum standard indicates impairment.

B. Protection for human consumption of fish

In the context of water quality standards, support of the aquatic life beneficial use means that the concentrations of toxicants in water must be low enough that:

- the aquatic community is healthy, diverse and successfully reproducing
- the fish and other aquatic organisms are safe for people and wildlife to eat

In the context of the integrated narrative report and 303(d) list assessments, however, 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. Toxicants may be at levels that have no ill effects on aquatic life (fully supporting), but because of bioaccumulation, the fish are not safe to eat (impaired). Also, different data and protocols are used in the assessments. Impairment because of fish contaminants has been discussed in a narrative section of recent 305(b) reports (1996 – 2002) to provide information to the public. Individual waterbodies impaired because of fish contaminants were included in the 303(d) lists since 2002.

This section describes the assessment of fish for human consumption based on fish contaminant data. The data used in the MPCA assessments is the same data used by the MDH to issue the Fish Consumption Advisories.

To ensure the continued good health of people that eat fish in Minnesota, the MDH issues guidelines for how often certain fish can be safely eaten. This is called the Minnesota Fish Consumption Advisory (MFCA) (MDH 2001; in Section VIII.B.1 for the MFCA Web site). The MDH, with the help of extensive EPA toxicity and risk assessments for mercury and polychlorinated biphenyls (PCBs), establishes the concentrations of contaminants in fish that trigger the various levels of advice – from “unlimited consumption” to “do not eat”. As an advisory, the goal of the MFCA is to help people make intelligent decisions on which fish to eat and which to avoid. The advice is not mandatory or regulatory. In contrast, the 303(d) list is a list of waterbodies that do not meet legally enforceable water quality standards, and for which a remedial plan may be required. While mindful of these differences in purpose and function of the MFCA and the 303(d) list, the MPCA strives for consistency between the protocols MDH uses to assess data for the MFCA and the protocols MPCA uses to assess data for determination of impairment.

An important caveat is that one can not assume, because a particular waterbody does not appear on the 303(d) list, the fish in that waterbody are safe for unlimited consumption. Most likely it means the fish from that waterbody have not been tested. Only those waterbodies from which the fish have been tested and found to exceed the impairment thresholds will be put on the 303(d) list. The MFCA should be consulted for general advice on fish consumption and health risks (MDH 2001).

The fish contaminant program is a multi-agency program: the MPCA, the MDNR, the MDA, as well as the MDH, have a role. Minnesota has been collecting fish for mercury and PCB tissue analysis since the late 1960s. Over the years other bioaccumulative pollutants, such as DDT, dioxins and toxaphene have been analyzed in fish tissue samples, but only at very limited locations where potential problems were suspected. 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.

Since 2005, another class of chemicals was found to be of concern for fish consumers: perfluorochemicals (PFCs); PFCs have been analyzed in fish from selected lakes and rivers. PFCs are a group of fully-fluorinated carbon-based compounds that repel oil and water. They have contaminated groundwater, surface waters, and biota because of their resistance to degradation in the environment. The analytical results of PFCs in fish tissue showed that perfluorooctane sulfonate (PFOS) was the most abundant PFC in fish tissue and has led to additional fish consumption advisories.

Fish from some waterbodies may contain multiple measured contaminants. The consumption advice and the determination of an impaired condition consider all measured pollutants. The majority of consumption advisories on lakes are because of mercury contamination. Fish from urban lakes seem
more likely to have PCB-based consumption advice than fish from non-urban lakes. About 40 percent of the river advisories reflect both mercury and PCB contamination; the rest are due mainly to mercury. Expanding studies of lakes of rivers and lakes has not identified a pattern for PFOS impacted waters, but the list of impaired waters is increasing. Fish contaminant data are also used by the MPCA to determine where site-specific studies are needed, to help identify sources of pollutants, and to look for trends in fish tissue levels.

Contaminants in fish can be a threat to wildlife consumers of fish and other aquatic organisms as well as humans. However, at the time this Guidance was prepared, the MPCA does not have a program to analyze whole fish samples for the purpose of assessing risks to wildlife.

1. Basis for assessment of fish contaminants: narrative standard

The basis for assessing the contaminants in fish tissue is the narrative water quality standards and assessment factors in Minn. R. ch. 7050.0150, subp. 7 which states the following:

Subp. 7. Impairment of waters relating to fish for human consumption. In evaluating whether the narrative standards in subpart 3, which prevent harmful pesticide or other residues in aquatic flora or fauna, are being met, the commissioner will use the residue levels in fish muscle tissue established by the Minnesota Department of Health to identify surface waters supporting fish for which the Minnesota Department of Health recommends a reduced frequency of fish consumption for the protection of public health. A water body will be considered impaired when the recommended consumption frequency is less than one meal per week, such as one meal per month, for any member of the population. That is, a water body will not be considered impaired if the recommended consumption frequency is one meal per week, or any less restrictive recommendation such as two meals per week, for all members of the population. The impaired condition must be supported with measured data on the contaminant levels in the indigenous fish.

2. MDH thresholds for consumption advice

The determination of fish consumption advice and water quality standards for mercury, PCBs, and PFOS (MPCA water quality criteria) depends on two elements - toxicity and exposure. Toxicity refers to the harmful effects of the substance on humans at various doses. Exposure refers to the sources of the toxicant to humans—exposure is discussed in the next section. MDH toxicologists have lead the toxicological assessments for fish contaminants and base their MFCA on peer-reviewed studies and EPA recommended values, when available, to determine the toxicity of mercury, PCBs, and PFOS to humans. MPCA uses MDH toxicological assessments when setting water quality standards to ensure consistency in human health protection. The end result of these toxicity assessments for mercury and PFOS (non-carcinogens) is the “reference dose”, and the end result for PCBs (a carcinogen) is a “cancer potency slope”. Reference dose, expressed in units of daily dose, is an estimate of the daily exposure to human populations, including sensitive sub-populations, that is likely to be without appreciable risk of deleterious effects over a lifetime. Cancer potency slope is the upper 95th percentile confidence limit of the slope from a linear non-threshold model of incremental cancer risk, expressed in days times kilogram body weight per milligram of toxicant.

The MDH has established concentrations of mercury, total PCBs, and PFOS in fish tissue that corresponds to meal frequency recommendations (Table 7). Mercury concentrations in Table 7 are for consumption by the more sensitive life stage, young children, and sub-populations, women who are pregnant or may become pregnant. The concentrations for PCBs and PFOS apply to all humans. These concentration thresholds are derived from health-based estimates of exposure to the contaminants through fish consumption that are likely to be without appreciable risk of harmful effects on humans (assuming the advice is followed). The mercury advice of interest to 303(d) listing targets the most sensitive individuals in the population including, but not limited to, children, pregnant women, and their fetuses. It is not necessarily protective of hypersensitive individuals.
Table 7. Fish tissue concentrations (in ppm) for levels of consumption advice established by MDH for mercury, total PCBs, and PFOS (April 2008)

<table>
<thead>
<tr>
<th>Consumption Advice:</th>
<th>Unrestricted</th>
<th>1 meal per week</th>
<th>1 meal per month</th>
<th>1 meal per 2 months</th>
<th>Do not eat</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mercury (mg/kg)</td>
<td>≤ 0.05</td>
<td>&gt;0.05 - 0.22</td>
<td>&gt;0.22** - 0.95</td>
<td>&gt; 0.95</td>
<td></td>
</tr>
<tr>
<td>Total PCBs (mg/kg)</td>
<td>≤ 0.05</td>
<td>&gt;0.05 - 0.22</td>
<td>&gt;0.22 - 0.95</td>
<td>&gt;0.95 - 1.89</td>
<td>&gt; 1.89</td>
</tr>
<tr>
<td>PFOS (mg/kg)</td>
<td>≤ 0.040</td>
<td>&gt;0.040 – 0.200</td>
<td>&gt;0.200 – 0.800</td>
<td>&gt; 0.800</td>
<td></td>
</tr>
</tbody>
</table>

http://www.health.state.mn.us/divs/eh/fish/eating/mealadvicetables.pdf

*Consumption advice for young children and women who are pregnant or may become pregnant.
Shaded cells indicate consumption advice that corresponds to non-support and an impaired condition.
**With MDH’s revised thresholds for MFCA for mercury, the mercury fish tissue criterion of 0.2 ppm adopted into Minn. R. ch. 7050 in 2008 is more stringent and is the applicable numeric standards for assessing mercury impairments in fish (See discussion in 4).

3. Selection of single fish meal-per-week impairment threshold

As discussed in Section VIII.A. on human health-based water quality protection, the consumption of fish is an important route of exposure for bioaccumulative pollutants, such as mercury, PCBs, and PFOS. Exposure varies with how often people eat fish and with the contaminant concentrations in the fish they eat. While the MPCA readily accepts the assessments of mercury, PCB, and PFOS toxicity to humans by the experts within MDH and EPA, we have departed from EPA policy with regard to assumptions about fish consumption (exposure). This is based on the prevalence and importance of sport fishing in Minnesota. The EPA assumes people eat 17.5 grams per day for purposes of calculating their human health-based aquatic life criteria (EPA 2000b). This generic assumption applies to everybody in the United States. Minnesota human health-based water quality standards are calculated assuming people eat 30 grams of fish per day. Thirty grams per day is the 80th percentile fish consumption rate of sport-caught fish for the angling population based on several surveys of the fish eating habits of upper Midwest anglers (not the population as a whole) (MPCA 2000e). Thirty grams per day equals about a half-pound meal per week (0.463 pounds/week).

The single fish meal-per-week consumption rate (or 30 g/d) is the basis for all Minnesota human health-based water quality standards in both Minn. R. chs. 7050 and 7052. Therefore, for purposes of assessing support of the “fish consumption” use, that use is judged to be supported if it is safe to eat one fish meal per week (over a life time), consistent with the assumption inherent in the numeric water quality standards. In other words, advice to limit consumption to “no more than one meal-per-week” (or any advice that allows more consumption) is not considered an exceedance of water quality standards, and waterbodies with such advice will not be listed as impaired. Advice to limit consumption to less than one meal per week, such as one meal per month, for any member of the population is an indication of impairment (see Tables 15 and 16).


If reliable data are available to show that localized populations in Minnesota consistently eat more (or less) than 30 g/d, Minn. R. ch. 7050.0222, subp. 8 allows the MPCA to recalculate an existing standard using the local fish consumption data. The resulting site-specific standard may be more stringent or more lenient than the standard based on 30 g/d.

4. Mercury: numeric fish tissue standard

Minnesota’s mercury water quality standards are briefly discussed in Section VII.B.2.a. In 2008, the MPCA promulgated a new mercury standard based on EPA’s revised human health-based water
quality criterion for methylmercury (EPA 2001a). This new criterion is unique among all EPA (Clean Water Act section 304(a)) criteria in that the environmental medium for the acceptable mercury concentration is fish tissue rather than water. A fish tissue criterion for mercury is logical because it is fish that are the main source of methylmercury exposure to both humans and wildlife. Also, a tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation which can be a significant source of uncertainty. The new EPA criterion is 0.3 mg/kg (ppm) methylmercury in fish muscle tissue. Since nearly 100 percent of the mercury in fish muscle is methylmercury, the criterion can be assumed to be a total mercury criterion.

For the Minnesota fish tissue mercury standard, the EPA criterion was re-calculated assuming people eat 30 g/day of fish, resulting in the criterion 0.17 ppm. This EPA criterion and the MFCA are both based on the same EPA-derived reference dose of 0.1 μg/kg/day. The difference between the MDH value of 0.22 ppm from Table 7 and the re-calculated EPA criterion of 0.17 ppm, both of which assume a single half pound meal of fish per week, has to do with how the consumption of marine fish is taken into account (and new MDH policy in April 2008 to use two significant figures). The MFCA is advice about eating fish from any source, sport-caught, store-bought, marine, or freshwater. The EPA aquatic life criteria (applicable in Minnesota) apply only to freshwater habitats. But, in the calculation of freshwater criteria, EPA assumes people eat a certain amount of marine fish in addition to the 17.5 g/d of freshwater fish. As a result, the freshwater criterion is lowered to allow for this “outside” source of mercury (this is standard procedure in EPA criteria and MPCA standard calculations). Thus, the re-calculated mercury criterion is 0.17 rather than 0.2 ppm. Considering the points listed below, the MPCA believes that the use of 0.2, rather than 0.17 ppm as the basis for impairment decisions is appropriate:

- EPA rounded the reference dose of 0.1 μg/kg/day to one significant figure; thus, 0.17 and 0.2 ppm could be considered essentially the same number
- the use by MPCA of the more protective fish consumption amount (30 g/d)
- the use of safety factors in the criterion calculation (again, standard procedure)
- uncertainties inherent in criteria development
- the importance of maintaining consistency in the MPCA/MDH approaches

5. Data requirements and determination of impaired condition

Assessment of mercury, PCBs, and PFOS in fish tissue has relied on the species “size class means” compiled by the MDH for public fish consumption advisories. Size class means were calculated for each size class of each species in each water body where data were available. As of 2008, size classes are no longer used by MDH for the fish consumption advisories; instead, a regression approach is used to determine consumption advice for variable size ranges. MDH continues to use the advisory threshold concentrations summarized in Table 7, applied to the most recent five years of data from a waterbody. Impairments for PCBs are based on a fish tissue concentration exceeding 0.22 ppm, which is the upper threshold for one meal per week fish consumption advisory for the sensitive population (pregnant women, women who may become pregnant, and children under age 15). Accordingly, impairments for PFOS are based on tissue concentrations exceeding 0.200 ppm (see Table 7). For mercury, this procedure has been superseded by the described in remainder of this section.

As a result of comments received on the draft statewide mercury TMDL, the MPCA agreed to remove from the TMDL those waters with any size class mean fish-Hg greater than 0.57 ppm – the concentration that would achieve 0.2 ppm with a 65 percent reduction. Prior to this reassessment the fish consumption advisory results were accepted as is and did not get the same scrutiny of other water quality data (see guidance document). Unlike the water quality data assessments, fish-Hg impairment could be based on only one sample. The purpose of this revised assessment is to treat fish-Hg data as similar as possible to other water quality data. Although this new protocol uncouples the impairment assessment from the fish consumption advisory, the 0.2 ppm fish-Hg concentration remains the threshold for determining impairment and, as of 2008, is codified as a Minnesota water quality standard for total mercury in fish tissue. A waterbody is defined as impaired if more than 10
percent of the fish in a species are greater than 0.2 ppm. This is equivalent to saying the water is impaired if the 90th percentile for any fish species is >0.2 ppm.

To determine which waters are impaired for fish-Hg, the Minnesota Fish Contaminant Monitoring Program database is queried for the following criteria:

- fish collected in the last 10 years
- filet with or without skin on; no whole fish
- at least five fish in a species, including fish within a composite sample
- 90th percentile fish-Hg is greater than 0.2 ppm (i.e., more than 10 percent are greater than 0.2 ppm)

Whole fish were not used for this process because they are not used for the fish consumption advisory. If a waterbody-species had less than five fish, but at least one fish sample was greater than 1.0 ppm Hg, it was assigned to a separate list for further consideration; five fish with one fish of 1.0 ppm would have an average greater than 0.2 ppm.

The 90th percentile rank was calculated by multiplying the number of fish (N) by 0.9 and rounding to the nearest whole number. The 90th percentile fish-Hg was determined for each waterbody-species by (1) ranking the samples within each waterbody-species from low to high Hg, (2) Hg concentration of a composite sample was treated as the concentration for all fish within the composite, (3) if the 90th percentile ranked fish was >0.2 ppm or is in a composite that is >0.2 ppm, it was marked as impaired. For example, given five individual fish samples for a species and the fifth one has Hg concentration greater than 0.2, the species for that waterbody is labeled as impaired. Or if there are two samples, each a composite of three fish, if one of the samples is greater than 0.2 ppm, the species is marked as impaired. This evaluation did not consider waterbodies that are impaired for only water column mercury.

**C. Class 1 drinking consumption standards for nitrate and nitrogen**

Class 1 waters are protected as a source of drinking water. In Minnesota, all groundwater and selected surface waters are designated Class 1. The assessment of groundwater (Class 1A) for potential impairment of the drinking water use is outside the scope of this Guidance. However, the assessment of Class 1B and 1C listed surface waters for potential impairment by nitrate nitrogen is discussed in this Section. Incorporated by reference, the federal Safe Drinking Water standards apply to these waters (Minn. R. ch. 7050.0221).

1. **Nitrate nitrogen**

Nitrate nitrogen poses a risk to human health at concentrations exceeding 10 mg/L in drinking water. Humans who are exposed to nitrate in drinking water at concentrations exceeding the 10 mg/L federal drinking water standard, especially infants under six months of age, can develop methemoglobinemia, a blood disorder that interferes with the ability of blood to carry oxygen. The 10 mg/L federal drinking water standard is an acute toxicity standard. Long term, chronic exposure to nitrate in drinking water is less well understood but has been linked to the development of cancer, thyroid disease, and diabetes in humans.

Monitoring data collected from 80 surface water monitoring stations located around the state over several decades show that nitrate concentrations in Minnesota streams are increasing. While most Minnesotans (about 75 percent statewide) obtain their drinking water from groundwater rather than streams, groundwater and surface water are interconnected resources. Groundwater and surface water are particularly well connected in Southeast Minnesota, where limestone bedrock prevails near the ground surface. Caves, sinkholes, and fractures are commonplace in the soluble limestone; these karst features help feed the numerous cold water trout streams (Class 2A) found in this part of the state. Class 2A cold water trout streams are also designated Class 1B streams that are protected for drinking water.
In recognition of the trend of increasing nitrate concentrations in Minnesota streams and the public health and economic impact arising from elevated nitrate concentrations in drinking water (a particular concern in Southeast Minnesota’s karst region), the MPCA will assess Class 1B and 1C designated surface waters for potential impairment by nitrate nitrogen.

2. Data requirements and determination of impaired condition

The Class 1 DC standard for nitrate nitrogen is based on protecting infants from acute toxicity as manifested in blue baby syndrome (methemoglobinemia). The DC standard is incorporated into Minn. R. ch. 7050 from the Safe Drinking Water Act (SDWA) primary drinking water standard (also known as Maximum Contaminant Levels or MCLs); the durations applied in the assessment process for nitrate will be based in the durations used in that program. In the SDWA, the nitrate nitrogen MCL is applied as 24-hour or daily averages.

When assessing drinking water-protected surface waters Class 1B and 1C (listed under Class 2A and 2Bd designations in Minn. R. ch. 7050.0470), MPCA will determine 24-hour average nitrate concentrations and compare to the 10 mg/L DC standard. Two 24-hour averages exceeding 10 mg/L within a three years window would indicate an impairment. Water quality data in STORET for the most recent 10 year period are used. Exceedances are assessed over consecutive three-year periods. A minimum of five data points is needed for each three-year period.

The data requirements and protocol for assessments are the same for the integrated narrative report and 303(d) list (Table 8). River or stream reaches with fewer than five data points, but with one exceedance of the nitrate nitrogen standard will be given a high priority for follow-up sampling. These will be flagged by the professional judgment groups, and placed on an internal MPCA list of waters needing further monitoring and assessment.

Table 8. Summary of data requirements and exceedance thresholds for assessment of nitrate nitrogen, Class 1 Drinking Consumption standard for the integrated narrative report and the 303d list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points</th>
<th>Use Support or Listing Category Based on Exceedances of Drinking Consumption Standard (10 mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Acute Standard*</td>
<td>No more than 1 in 3 yrs.</td>
<td>2 or more in 3 yrs.</td>
</tr>
<tr>
<td>Exceedance Threshold →</td>
<td>Not Listed</td>
<td>Listed</td>
</tr>
<tr>
<td>Most recent 10 years</td>
<td>5, within a 3-yr. period</td>
<td></td>
</tr>
</tbody>
</table>

* 24-hour central value

D. Other numeric water quality standards

Other toxic or conventional pollutants that are found to exceed water quality standards will be assessed following equivalent methodologies discussed in this Guidance, depending on the type of pollutant. Chloride, for example, did not appear in a 303(d) list until 1998, at which time adequate data were available to support impairment assessments for waterbodies.
IX. Pollutants with Wildlife-Based Water Quality Standards

Protection of the aquatic life use includes the protection of wildlife consumers of aquatic organisms. Minnesota has four wildlife-based water quality standards – all in Minn. R. ch. 7052. Minn. R. ch. 7052 is the Great Lakes Water Quality Initiative (GLI). The GLI was mandated by a 1987 amendment to the CWA; it was promulgated as a federal rule by EPA in 1995 and adopted in Minnesota in 1998. The GLI has been adopted by all six Great Lakes states. The GLI rule focuses on the reduction of bioaccumulative toxic chemicals in the Great Lakes ecosystem as a whole. The standards in Minn. R. ch. 7052 are applicable only to the surface waters of the Lake Superior basin in Minnesota. The GLI chronic wildlife-based standards are listed below:

- DDT – 11 pg/L
- Mercury – 1300 pg/L
- PCBs – 122 pg/L (GLI human health-based standards for PCBs are more stringent than the wildlife based standard)
- 2,3,7,8-TCDD – 0.0031 pg/L  (GLI human health-based standards for dioxin are more stringent than the wildlife based standard for Lake Superior and Class 2A waters, but not for Class 2Bd and 2B,C&D waters)

The assessment of waterbodies for compliance with the GLI wildlife-based standards follows the same protocols used to assess waterbodies for human health-based standards, as described in the previous section (Table 6). The pollutants that have wildlife-based standards were also discussed in the previous section.
X. Assessment Based on Numeric Standard for Protection of Aquatic Recreation

A. *E. coli* bacteria

1. Introduction

Maintaining Minnesota’s lakes, rivers and streams in a swimmable condition, where this use is attainable, is the other half of the national CWA goal of providing fishable/ swimmable waters. To protect surface waters for water recreation, it is useful to divide recreational activities into two categories: primary and secondary body contact. Primary body contact includes swimming, diving, water skiing, windsurfing, or any form of water recreation where immersion in the water and the possibility of inadvertently ingesting some water is likely.

Secondary body contact recreation includes forms of water recreation where the likelihood of ingesting water is much smaller. Secondary body contact recreation typically includes boating, fishing, sailing, canoeing, and wading by adults. Wading in surface waters by children can be considered primary body contact recreation because children are more likely to put their hands in their mouths, wade in “too far” or fall in. Whitewater kayaking and riding personal water craft are usually considered secondary body contact even though the chances of ingesting water is probably greater than it is with typical boating or canoeing.

The numeric standards in Minn. R. ch. 7050 that directly protects for primary and secondary body contact are the *E. coli* standards shown in Table 10. *E. coli* standards are applicable only during the warm months since there is very little swimming in Minnesota in the non-summer months. Exceedances of the *E. coli* standard mean the recreational use is not being met.

The MPCA has replaced the fecal coliform standard with an *E. coli* (*Escherichia coli*) standard based on a geometric mean EPA criterion of 126 *E. coli* colony forming units (cfu) per 100ml. *E. coli* has been determined by EPA to be the preferred indicator of the potential presence of waterborne pathogens. The *E. coli* standard is in Minnesota rule, and there is a considerable amount of *E. coli* data available. For assessment purposes, only *E. coli* measurements will be used. This change has been made because of the variability in the *E. coli*/fecal coliform statistical relationship and to emphasize that current and future monitoring for aquatic recreations use support should be based on the newly adopted *E. coli* standard. Exceptions to the exclusive use of *E. coli* data will be made only in special cases, using a ratio of 200 to 126 to convert fecal coliform to *E. coli*. Given recent monitoring data, this ratio is felt to be conservative and should result in relatively few false positive indications of impairment.

Research is underway in Minnesota and elsewhere in the United States on the use of DNA “fingerprinting” techniques to identify the source of *E. coli* bacteria. The goal of this work is an affordable method to determine if the *E. coli* bacteria in surface waters originated from humans or from animals. If this tool can be perfected, it will be very valuable in helping to direct *E. coli* contamination reduction efforts where they will be most effective.

Given the fact that the *E. coli* standard is a geometric mean of not less than five samples collected in a month, and that typical monitoring programs very rarely sample more often than once per month, a method of data assessment was needed that maximized the usefulness of the available data. An analysis of all fecal coliform data was done to determine the impact of collecting fewer than five samples per month (Markus 1999). This analysis showed that, for any given monitoring site, there was less variability for a given month across years than there was for all months within a year. The conclusion was that, although the most desirable approach was to collect at least five samples per month, we could reflect the intent of the standard using our current resources by aggregating data for a given month across all years.
Table 9. E. coli water quality standards for Class 2 and Class 7 waters.

<table>
<thead>
<tr>
<th>Use Class</th>
<th>Standard Number of Organisms Per 100 mL of Water</th>
<th>Applicable Season</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monthly Geometric Mean*</td>
<td>10 % of Samples Maximum**</td>
<td>Body Contact</td>
</tr>
<tr>
<td>2A, trout streams and lakes</td>
<td>126</td>
<td>April 1 – October 31</td>
<td>Primary</td>
</tr>
<tr>
<td>2Bd, 2B, 2C, non-trout (warm) waters</td>
<td>126</td>
<td>April 1 – October 31</td>
<td>Primary</td>
</tr>
<tr>
<td>2D, wetlands</td>
<td>126</td>
<td>April 1 – October 31</td>
<td>Primary, if the use is suitable</td>
</tr>
<tr>
<td>7, limited resource value waters</td>
<td>630</td>
<td>May 1 – October 31</td>
<td>Secondary</td>
</tr>
</tbody>
</table>

* Not to be exceeded as the geometric mean of not less than 5 samples in a calendar month.
** Not to be exceeded by 10% of all samples taken in a calendar month, individually.

2. Data requirements and determination of impaired condition

The MPCA uses E. coli data collected by the MPCA, other government agencies, and by volunteers. All data used must satisfy QA/QC requirements, meet EPA guidelines, and be analyzed using an EPA approved method. The data must be entered into STORET.

Where multiple bacteria/pathogen samples have been taken on the same day on an assessment unit, then the geometric mean of all the measurements will be used for the assessment analysis.

Data over the full 10-year period are aggregated by individual month, as mentioned above (e.g., all April values for all 10 years, all May values, etc.). A minimum of five values for each month is ideal, but is not always necessary to make a determination. If the geometric mean of the aggregated monthly values for one or more months exceed 126 organisms per 100 mL, that reach is placed on the 305(b) not supporting list and on the 303(d) impaired list. Also, a waterbody is considered impaired if more than 10 percent of individual values over the 10-year period (independent of month) exceed 1260 organisms per 100 mL. This assessment methodology more closely approximates the five-samples-per-month requirement of the standard while recognizing typical sampling frequencies, which rarely provide five samples in a single month and usually only one. Table 10 summarizes the assessment process.

Table 10. Assessment of waterbodies for impairment of swimming use - data requirements and exceedance thresholds for E. coli bacteria for the integrated narrative report and the 303d list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points</th>
<th>Use Support or Listing Category Based on Exceedances of the E. coli Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Exceedance Thresholds → Monthly geometric mean &gt; 126 orgs/100 mL (Class 2)</td>
<td>No months</td>
<td>1 or 2 months</td>
</tr>
<tr>
<td>Most recent 10 years</td>
<td>see text</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Standard Exceedance Thresholds → Exceeds 1260 orgs/100 mL*</td>
<td>&lt; 10 %</td>
<td>10 - 25 %</td>
</tr>
<tr>
<td>Most recent 10 years</td>
<td>10</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

* In full data set over 10 years.

Professional judgment review of the data provides a further evaluation. If at least five values are available for each month, the determination directly follows the assessment methodology outlined in the previous paragraph. When fewer than five values are available for most or all months, the individual data are reviewed. Considerations in making the impairment determinations include the following:

- dates of sample collection (years and months)
- variability of data within a month
- magnitude of exceedances
- ‘remark’ codes associated with individual values

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In some circumstances where four values are available for some or all months, a mathematical analysis is done to determine the potential for a monthly geometric mean to exceed the 126 organisms/100mL standard. All assessments are reviewed by a subset of the professional judgment team for each basin.

**Large datasets:**

Aggregating data by month across years for very large datasets diminishes the value of the data and assessment, making it less likely that periodic E. coli exceedances will be identified that indicate impairment. Data aggregation should be held to a minimum, no more than necessary to have sufficient data to satisfy the requirements for determining exceedances.

Alternative methods of data analysis may be used based on a professional judgment review of the data. Where there are five values per individual month or 30 day time period, the data will not be aggregated and individual monthly or 30 day geometric means may be calculated. Alternatively, data may be aggregated by month across consecutive two year or five year time periods. If more than 10 percent of the geometric means calculated exceed the 126 org/100 mL standard, the AUID is assessed as not supporting for 305b and is placed on the 303d impaired list.

**B. Lake eutrophication**

1. **Introduction**

   In Minnesota, as is the case nationwide, excess plant nutrients (nitrogen and phosphorus) from anthropogenic sources contribute to cultural eutrophication of lakes. Eutrophication of waters caused by excessive nutrient loads is one of the primary causes of non-attainment of aquatic recreational use in lakes across the nation. Excessive nutrient loads, in particular TP, lead to increased algae blooms and reduced transparency – both of which may significantly impair or prohibit the use of lakes for aquatic recreation. In Minnesota this led the MPCA to develop assessment methodologies, conduct extensive sampling of lakes, development of TP guidelines, and ultimately promulgate ecoregion-based lake eutrophication standards (Heiskary and Wilson, 2005). The ecoregion-based standards (as noted in Minn. R. ch. 7050.0222, subparts 3 and 3a) that were promulgated by MPCA and approved by EPA in 2008 are presented in Table 11. These standards are the primary basis for aquatic recreational use assessments.
2. Data requirements and determination of use assessment

a) Minimum data requirements

The data for lake assessments are drawn from STORET; as such certain "data quality" filters are already in place and are not addressed here. Rather, the quality of data for lake assessments was based on the relative amounts of information available for the assessment. In the case of our assessments for aquatic recreational use (primary contact), we use TP, chlorophyll-\(\alpha\) corrected for pheophytin (corrected chl-\(\alpha\)), and Secchi transparency to make the assessments. This typically implies two or more summers of monitoring on the lake.

Four categories for categorizing data quality are as follows:

- **excellent** - lake has 8 or more paired TP, corrected chl-\(\alpha\), and Secchi measurements collected over a minimum of 2 years within the most recent 10 years
- **good** – lake has <8 but >4 paired TP, corrected chl-\(\alpha\), and Secchi measurements collected within the most recent 10 years
- **fair** - lake has at least 4 TP measurements upon which to assess the lake and some corrected chl-\(\alpha\) and Secchi measurements within the most recent 10 years
- **poor** - lake has less than 4 TP measurements (often only Secchi data available for the lake) within the most recent 10 years

All assessments are based on data collected over the most recent 10-year period. Data collected by parties outside the MPCA may be used as long as it meets acceptable QA/QC requirements. Any data used should have QA/QC information readily available and meet the requirements for entry into STORET. Data from all sources should be entered into STORET so that a permanent record is established and data may be merged or considered in light of other data available for that lake.

b) Lake assessment determinations

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>TP</th>
<th>Chl-(\alpha)</th>
<th>Secchi</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLF – Lake trout (Class 2A)</td>
<td>&lt; 12</td>
<td>&lt; 3</td>
<td>&gt; 4.8</td>
</tr>
<tr>
<td>NLF – Stream trout (Class 2A)</td>
<td>&lt; 20</td>
<td>&lt; 6</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>NLF – Aquatic Rec. Use (Class 2B)</td>
<td>&lt; 30</td>
<td>&lt; 9</td>
<td>&gt; 2.0</td>
</tr>
<tr>
<td>NCHF – Stream trout (Class 2a)</td>
<td>&lt; 20</td>
<td>&lt; 6</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>NCHF – Aquatic Rec. Use (Class 2b)</td>
<td>&lt; 40</td>
<td>&lt; 14</td>
<td>&gt; 1.4</td>
</tr>
<tr>
<td>NCHF – Aquatic Rec. Use (Class 2b) Shallow lakes</td>
<td>&lt; 60</td>
<td>&lt; 20</td>
<td>&gt; 1.0</td>
</tr>
<tr>
<td>WCBP &amp; NGP – Aquatic Rec. Use (Class 2B)</td>
<td>&lt; 65</td>
<td>&lt; 22</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>WCBP &amp; NGP – Aquatic Rec. Use (Class 2b) Shallow lakes</td>
<td>&lt; 90</td>
<td>&lt; 30</td>
<td>&gt; 0.7</td>
</tr>
</tbody>
</table>

The first step in the assessment process is to determine whether the waterbody is a lake, which means it has the following attributes:
Standards vary based on depth and ecoregion. Four of the seven ecoregions in Minnesota have specific standards (98 percent of the lakes in the state). The remaining 2 percent of lakes reside in one of three ecoregions; land use and lake morphometry will be used to determine the proper ecoregion-based standard to address these lakes (Heiskary and Wilson 2005).

The standards also require determining whether the lake is a “deep”, “shallow”, or is more accurately classified as a wetland. A formal definition of “deep” versus “shallow” is drawn directly from chapter 7050 as follows:

- "Lake" means an enclosed basin filled or partially filled with standing fresh water with a maximum depth greater than 15 feet. Lakes may have no inlet or outlet, an inlet or outlet, or both an inlet and outlet.
- "Shallow lake" means an enclosed basin filled or partially filled with standing fresh water with a maximum depth of 15 feet or less or with 80 percent or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (the littoral zone). It is uncommon for shallow lakes to thermally stratify during the summer. The quality of shallow lakes will permit the propagation and maintenance of a healthy indigenous aquatic community and they will be suitable for boating and other forms of aquatic recreation for which they may be usable.

In some cases it may be difficult to differentiate shallow lakes from wetlands. For example, some lakes, while listed as “W” in the Protected Waters Inventory (PWI), may be characterized as lakes by local watershed management organizations (WMOs), actively managed as lakes by MDNR Fisheries (as evidenced through lake survey data and fish stocking documented on their web site), and/or there is a weight of evidence that suggests the public perceives the waterbody as a lake based on presence of public access, boating and fishing usage. A series of questions (factors) have been assembled in Table 12 that may help in resolving the appropriate classification of waterbodies for purposes of 303(d) assessment. When there is a question on whether the waterbody is best classified as a lake or as a wetland, for the purpose of 303(d) assessment, review of MDNR web-based information, consultation with local resource managers and a site visit to the lake(s) in question are recommended to help determine what the most appropriate characterization might be. Those determined to be wetlands will be assessed through the wetland assessment methodology. Once these decisions are made, the data can be applied to the proper standard.

If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the ten year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made (Table 11). Lakes where TP and at least one of the response variables (corrected chl-a or Secchi) exceed the standards are considered impaired in the integrated narrative report and are also included on the draft 303(d) list. For lakes with “excellent” data quality and where all parameters are better than the standards, an assessment of full support is made. Lakes with “good” quality data may be considered for full support assessment as well. In this case the assessment thresholds have been adjusted by 20 percent (made more stringent) and lakes with “good” quality data that meet these thresholds (Table 12) will be considered fully supporting This modification of the thresholds provides a margin of safety to ensure that lakes with lesser amounts of data are sufficiently below the water quality standards and provides additional assurance that the lake is in compliance. This use of a “margin of safety” is similar to an approach used in Europe in the management of the Rhine River (Stoks 2007 presentation at Enhancing State Lakes Management Programs, April 2007, Chicago, IL). For 2010 on lakes wholly within the Boundary Water Canoe Area Wilderness, remote sensing inferred Secchi transparency will be

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used to determine full support of aquatic recreation use. Transparency at 5 year intervals over the past 25 years will be reviewed and those that are above the more stringent thresholds (20 percent) on all dates will be considered to be fully supporting.

### Table 12. Some of the factors used to separate lakes, shallow lakes, and wetlands are as follows:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Lakes</th>
<th>Shallow lakes</th>
<th>Wetlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected Waters Inventory Code</td>
<td>Typically coded as “L or LP” in PWI</td>
<td>May be coded as either “L, LP or LW” in PWI</td>
<td>Typically coded as a “LW” in PWI</td>
</tr>
<tr>
<td>Depth, maximum</td>
<td>Typically &gt;15 feet</td>
<td>Typically &lt;15 feet</td>
<td>Typically &lt; 7 feet</td>
</tr>
<tr>
<td>Littoral area</td>
<td>Typically &lt;80%</td>
<td>Typically &gt;80%</td>
<td>Typically 100%</td>
</tr>
<tr>
<td>Area (minimum)</td>
<td>&gt; 10 acres (Bulletin 25)</td>
<td>&gt; 10 acres (Bulletin 25)</td>
<td>No minimum</td>
</tr>
<tr>
<td>Thermal stratification (summer)</td>
<td>Stratification common but dependant upon depth, size and fetch</td>
<td>Typically do not thermally stratify</td>
<td>Typically do not stratify.</td>
</tr>
<tr>
<td>Fetch</td>
<td>Significant fetch depending on size &amp; shape</td>
<td>Fetch is variable depending on size &amp; shape</td>
<td>Rarely has a significant fetch</td>
</tr>
<tr>
<td>Substrate</td>
<td>Consolidated sand/silt/gravel</td>
<td>Consolidated to mucky</td>
<td>Mucky to unconsolidated</td>
</tr>
<tr>
<td>Shoreline features</td>
<td>Generally wave formed, often sand, gravel or rock</td>
<td>Generally wave formed, often sand, gravel or rock</td>
<td>Generally dominated by emergents</td>
</tr>
<tr>
<td>Emergent vegetation &amp; relative amount of open water</td>
<td>Shoreline may have ring of emergents; vast majority of basin open water.</td>
<td>Emergents common, may cover much of fringe of lake; basin often has high percentage of open water.</td>
<td>Emergents often dominate much of basin; often minimal open water.</td>
</tr>
<tr>
<td>Submergent vegetation</td>
<td>Common in littoral fringe, extent dependant on transparency</td>
<td>Abundant in clear lakes; however may be lacking in algal-dominated turbid lakes.</td>
<td>Common unless dominated by an emergent like cattail.</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>Aerobic epilimnion; hypolimnion often anoxic by midsummer</td>
<td>Aerobic epilimnion but wide diurnal flux possible</td>
<td>Diurnal flux &amp; anaerobic conditions common</td>
</tr>
<tr>
<td>Fishery</td>
<td>Typically managed for a sport/game fishery. May be stocked. MDNR fishery assessments typically available.</td>
<td>May or may not be managed for a sport fishery. If so, fishery assessment should be available. Winter aeration often used to minimize winterkill potential.</td>
<td>Typically not managed for a sport fishery. Little or no MDNR fishery information. Seldom aerated. May be managed to remove fish &amp; promote waterfowl.</td>
</tr>
<tr>
<td>Uses</td>
<td>Wide range of uses including boating, swimming, skiing, fishing; boat ramps &amp; beaches common</td>
<td>Boating, fishing, waterfowl production, hunting, aesthetics; limited swimming; may have boat ramp, beaches uncommon</td>
<td>Waterfowl &amp; wildlife production, hunting, aesthetics. Unimproved boat ramp if any. No beaches.</td>
</tr>
</tbody>
</table>

c) **Insufficient data**

For lakes that do not meet minimum data requirements (e.g. fair or poor quality) and use support cannot be determined, a determination of Insufficient Data will be made. In some instances, a lake may have fair or good quality data but only one of the thresholds is exceeded (e.g. TP or corrected chl-a or Secchi), while the other two are in compliance with the standards. In this instance, the lake will be considered to have insufficient data to determine impairment. These lakes are good candidates for Surface Water Assessment Grant or Citizen Lake Monitoring Plus Program activities and local groups should be encouraged to participate in these or similar programs.

d) **Reservoirs and other special situations**

Sampling design and assessments for aquatic recreational use for reservoirs may be different from those used for lakes. Since reservoirs typically exhibit distinct zones, often referred to as inflow segment, transitional segment, and near-dam segment, calculation of “whole reservoir” mean TP may or may not be an appropriate basis for assessing aquatic recreational use. Rather, the MPCA may want to evaluate the status of the reservoir based on a specific segment – most likely the near-dam segment. Also, water residence time may vary substantially as a function of river flow (e.g., Lake Pepin, Heiskary and Walker 1995) and may influence algal response to available nutrients. In addition, reservoirs often have very large watersheds that may drain portions of one or more ecoregion. Hence ecoregion-based standards, based on where the reservoir is located, may not always be the best basis for evaluating use support.
Lakes with distinct bays, such as Lake Minnetonka, may present a similar situation. The bays (basins) may need to be assessed on an individual basis (data is stored by specific basin, not by whole lake). In some instances a single bay may exceed the listing thresholds while other bays in the lake do not. In this case it should be determined whether the entire lake should be listed (e.g., there is distinct interaction between the bays) or simply the individual bay. This will likely require knowledge of flow-through patterns in the lake and assistance from local cooperators to make an appropriate determination.

e) Assessment documentation

Notes from these reviews are assembled in an electronic database that summarizes the lake assessment process. This database will be made available to the public via PDF documents on the internet and will include such information as assessment decision, lake vs. wetland determination, ecoregion standards used, and deep versus shallow lake. Any additional information used in the assessment will be documented in a notes column in this database. This is replacing previously written memos detailing the assessment process.

f) Additional assessment factors: narrative standards

Prior to the development of the lake eutrophication standards, Minnesota relied on the narrative water quality standards and assessment factors in Minn. R. ch. 7050.0150. The most relevant part, Minn. R. ch. 7050.0150, subp.5 is quoted below:

Subp. 5. Impairment of water due to excess algae or plant growth. In evaluating whether the narrative standards in subpart 3, which prohibits any material increase in undesirable slime growths or aquatic plants are being met, the commissioner will use all readily available and reliable data and information for the following factors of use impairment, including “D. any other scientifically objective credible, and supportable factor.”

Lakes have been listed in the past based on proof of toxic blue-green algae events in which toxins were measured that are associated with blue-green algae (they prosper in nutrient-rich environments and are the primary form of algae associated with aquatic recreation problems) and/or a documented animal death or fish kill occurred that could be tied to a blue-green algal bloom (i.e. autopsy). In either event, available water chemistry data was used to help determine its suitability for impairment; if TP and one of the response variables (corrected chl-a or Secchi depth) exceeded the standards, the lakes are included on the draft 303(d) list. This still remains a part of Minn. R. ch. 7050.0150 and is available for use in the assessment process.
Figure 2. Map of Minnesota’s ecoregions

- Driftless Area
- Lake Agassiz Plain
- Northern Minnesota Wetlands
- Northern Lakes and Forests
- Northern Glaciated Plains
- North Central Hardwoods
- Western Corn Belt Plains
- Driftless Area
XI. Assessment Based on Numeric Standard for Protection of Limited Resource Value Waters (Class 7)

Limited resource value waters include surface waters of the state that have been subject to a use attainability analysis and have been found to have limited value as a water resource. These waters are specifically listed in rule (Minn. R. ch. 7050.0470) and are protected so as to allow secondary body contact use, to preserve the groundwater for use as a potable water supply, and to protect aesthetic qualities of the water.

Standards for limited resource value waters include the following:

- *Escherichia (E.) coli*: Not to exceed 630 organisms per 100 mL as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1260 organisms per 100 mL. The standard applies between May 1 and October 31. Assessment methodology is described in detail in Section X. Assessment Based on Numeric Standard for Protection of Aquatic Recreation A. *E.coli* bacteria.

- Dissolved Oxygen: At concentrations which will avoid odors or putrid conditions or at concentrations not less than 1 mg/L as a daily average, provided that measurable concentrations are present at all times.

- pH: minimum value 6.0    maximum value 9.0

- Toxic pollutants not allowed in such quantities or concentrations that will impair the specified uses.

Application of toxic standards to Class 7 waters includes applying the Maximum Standard (MS) for most pollutants or 100 times the Chronic Standard (CS), whichever is lower (Minn. R. ch. 7050.0222 subp.7, item E). However, for bioaccumulative pollutants (BCF>5000) the CS would apply. Because Class 7 waters may be used by game fish for spawning and/or maintaining minnow populations during brief periods in the spring, a special protection against bioaccumulative pollutants is needed.

Ammonia example: The chronic standard for un-ionized ammonia is 0.04 mg/L. There is no FAV in rule, but an FAV value of 1 mg/L un-ionized was derived from data at pH 8 for a number of different fish species. Because the MS is equal to one half the FAV, a value of 0.5 mg/L un-ionized was used for determining the assessment status of Class 7 waters.

Chloride example: The chronic standard for chloride is 230 mg/L, the maximum standard is 860 mg/L, and the FAV is 1720 mg/L. The maximum standard of 860 mg/L was used for determining the assessment status for Class 7 waters.

For more details, please contact Carol Sinden at carol.sinden@state.mn.us or 651-757-2727.
II. Assessment Based on Narrative Standards

A. Impairment of the biological community

1. Introduction

The presence of a healthy, diverse, and reproducing aquatic community, including invertebrates and plants as well as fish, in a waterbody is a good indication that pollutant concentrations are below levels that would measurably stress the community. The health of the aquatic community can be measured using standardized sampling and assessment tools. Ideally, if the community is found to be healthy, it would indicate as well that pollutant levels are below water quality standards. However, in some situations one or more water quality standards may be exceeded and the biological community still shows no impairment. This may be because of properties in the water that tend to mitigate the toxic effects of a pollutant that the water quality standard does not account for or that the biological community under study is not particularly sensitive to that pollutant.

The opposite situation can occur as well, where chemical analyses show no impairment and the biological community does. Nevertheless, biological monitoring (bio-monitoring) is a direct means to assess aquatic life use support. The aquatic community tends to “integrate” the effects of pollutants over time because excessive pollutant concentrations on one day may be manifested by some or all members of the community for weeks, months or longer. In contrast, a water sample taken for chemical analysis only indicates the conditions at that moment. For this reason, biological, chemical, and physical data will be carefully assessed together by professionals using a weight of evidence approach when determining impairment (see Section V.E.3).

The MPCA is using water quality assessment indices of biological integrity (defined below) based on fish and invertebrate communities in rivers and streams, and invertebrate and plant communities in wetlands. Sampling fish communities in lakes is done by the MDNR as part of their responsibility to manage a sport fishery and is outside the scope of the MPCA bio-monitoring program.

2. Basis for assessment of biological community - narrative standards

The basis for assessing the biological community for impairment is the narrative water quality standards and assessment factors in Minn. R. ch. 7050.0150. The most relevant part, Minn. R. ch. 7050.0150, subp. 6 is quoted below:

Subp. 6. Impairment of biological community and aquatic habitat. In evaluating whether the narrative standards in subpart 3, which prohibit serious impairment of the normal fisheries and lower aquatic biota upon which they are dependent and the use thereof; material alteration of the species composition, material degradation of stream beds, and the prevention or hindrance of the propagation and migration of fish and other biota normally present, are being met, the commissioner will consider all readily available and reliable data and information for the following factors of use impairment:

A. An index of biological integrity calculated from measurements of attributes of the resident fish community, including measurements of:
   (1) species diversity and composition;
   (2) feeding and reproduction characteristics; and
   (3) fish abundance and condition.

B. An index of biological integrity calculated from measurements of attributes of the resident aquatic invertebrate community, including measurements of:
   (1) species diversity and composition;
   (2) feeding characteristics; and
   (3) species abundance and condition.
C. An index of biological integrity calculated from measurements of attributes of the resident aquatic plant community, including measurements of:
   (1) species diversity and composition, including algae; and
   (2) species abundance and condition.

D. A quantitative or qualitative assessment of habitat quality, determined by an assessment of:
   (1) stream morphological features that provide spawning, nursery, and refuge areas for fish and invertebrates;
   (2) bottom substrate size and variety;
   (3) variations in water depth;
   (4) sinuosity of the stream course;
   (5) physical or hydrological alterations of the stream bed including excessive sedimentation;
   (6) types of land use in the watershed; and
   (7) other scientifically accepted and valid factors of habitat quality.

E. Any other scientifically objective, credible, and supportable factors.

A finding of an impaired condition must be supported by data for the factors listed in at least one of items A to C. The biological quality of any given surface water body will be assessed by comparison to the biological conditions determined for a set of reference water bodies which best represents the most natural condition for that surface water body type within a geographic region.

Additional language supporting the use of narrative water quality standards in wetlands is found in Minn. R. ch. 7050.0222, subp. 6, which defines the protection of Class 2D waters (wetlands) as follow:

“The quality of Class 2D wetlands such as to permit the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable. This class of surface water is not protected as a source of drinking water. ...”

The aquatic life use support assessment methodology described in this Guidance fully supports this narrative standard and protects the biological integrity of rivers, streams, and wetlands by:

- measuring attainment directly through sampling of the aquatic biota
- controlling biological and sampling variability through regionalization, classification and strict adherence to sampling protocol
- establishing impairment thresholds based on data collected from reference (least-disturbed) waters of the same class
- incorporating a confidence limit (based on the repeatability of the IBI) to account for variability within the aquatic community because of natural spatial and temporal differences and sampling or method errors

3. Index of biotic integrity and reference conditions

a) Introduction

The MPCA uses an IBI as an initial biological impairment determinant for rivers, streams, and wetlands. The IBI is one of the most common and widely accepted analytical tools used to measure the integrity of aquatic communities. The IBI relies on multiple attributes of the aquatic community, called “metrics”, to evaluate a complex biological system. Each metric is based upon a structural (e.g., species composition) or functional (e.g., feeding habits) aspect of the aquatic community that changes in a predictable way in response to human disturbance.
The IBI incorporates professional judgment in a systematic and sound manner but sets quantitative criteria that enable determination of a continuum between very poor and excellent biotic conditions. Since the metrics are differentially sensitive to various perturbations (e.g. siltation, toxic chemicals, etc.) as well as various degrees or levels of change within the range of integrity, conditions at a site can be determined with considerable accuracy. Table 12 shows an example of the fish community metrics used to evaluate small streams in the St. Croix River basin (Niemela and Feist 2000).

For the IBI to be effective in detecting disturbances because of human influence, it is necessary to identify and partition the factors that contribute to natural variability (Fausch et al. 1984). On a regional scale, differences in climate, topography, geology, and other geophysical characteristics of an area influence aquatic communities. On a reach or wetland level scale, factors such as stream size and temperature or wetland type may influence aquatic communities. For this reason it is necessary to classify waterbodies into distinct groups (e.g. small warm water streams, depressional wetlands) and develop different IBIs for separate regions of Minnesota and for different waterbody types. It is not necessary, nor is it possible, to eliminate all of the variability within the IBI because of natural occurring factors. Instead, the variability must be quantified and decisions concerning resource integrity must take into account the natural variability that is not captured through the classification process.

Table 13. Scoring criteria for nine metrics used to calculate IBI scores for fish communities in small streams, 20 to 54 Mi² drainage areas.

<table>
<thead>
<tr>
<th>Metric For Fish Communities**</th>
<th>Numeric Score Assigned to Condition:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td><strong>Species Richness and Composition Metrics</strong></td>
<td></td>
</tr>
<tr>
<td>Total number of species</td>
<td>15 or more</td>
</tr>
<tr>
<td>Number of intolerant species</td>
<td>4 or more</td>
</tr>
<tr>
<td>Number of minnow species***</td>
<td>6 or more</td>
</tr>
<tr>
<td>Percent tolerant species</td>
<td>0-40</td>
</tr>
<tr>
<td>Percent dominant two species</td>
<td>0-44</td>
</tr>
<tr>
<td><strong>Trophic Composition and Reproductive Metrics</strong></td>
<td></td>
</tr>
<tr>
<td>Number of benthic insectivore species</td>
<td>4</td>
</tr>
<tr>
<td>Percent simple lithophils</td>
<td>49-100</td>
</tr>
<tr>
<td><strong>Abundance and Condition Metrics</strong></td>
<td></td>
</tr>
<tr>
<td>Number of fish per 100 meters***</td>
<td>11 or more</td>
</tr>
<tr>
<td>Percent DELT anomalies</td>
<td>0-1</td>
</tr>
</tbody>
</table>

*The sum of the 9 metrics for headwater streams must be multiplied by 1.11 to obtain the final IBI score (0 to 100 point scale).

**Definitions:
Benthic insectivore means fish that feed on insects living in or on the bottom substrate.
Lithophil means fish that prefer large substrates as a place to live and reproduce.
DELT means Deformities, Eroded fins, Lesions or Tumors.

***Number of minnow species and number of fish per 100 meters metrics do not include tolerant species.

b) Sampling methods and reference conditions
The stream fish community is sampled using widely accepted procedures. For the fish community assessments, all wadable streams are sampled following procedures outlined in Lyons (1992). Fish community sampling in unwadable streams follows USGS guidance (Meador, et al. 1993).
The stream invertebrate community is sampled using a multi-habitat method similar to that used by the Florida Department of Environmental Protection (Barbour et. al., 1996). Invertebrates are not currently sampled in unwadable streams.

In depressional wetlands, the invertebrate community is sampled using activity traps and a standardized dip net method in the near shore emergent zone. Emergent vegetation is sampled in the near shore zone using standard plant community releve sampling methods (Gernes and Helgen 1999).

The MPCA uses a regional reference site approach to develop and calibrate the IBI for specific regions of Minnesota (Hughes 1995, EPA 1996). The selected reference sites represent a specific region of Minnesota within a specified waterbody class. Properly defined reference conditions provide a benchmark for comparison to measure the degree of water quality degradation. The term “reference” denotes sites that are least impacted by human influence. Reference sites are not necessarily pristine, and in fact rarely are. Many reference sites reflect at least a small degree of impairment resulting from centuries of settlement and land use. The following land use characteristics are used to help guide the reference site selection process. In the process of locating reference sites an attempt is made to meet as many of the following criteria in the sampling site as possible:

**Streams:**
- land within the watershed is primarily in a natural state (forest, wetlands, meadow)
- stream morphology (i.e., riffles, runs, pool sequence) in the stream reach and upstream watershed is in a natural condition (e.g., the stream has not been channelized or dredged)
- continuous riparian area within the upstream watershed and along the reach (e.g., land use is consistent laterally, soils and vegetation are undisturbed)
- stream fish community has not been altered through stocking of forage or game fish species or chemically treated to remove rough fish
- no point source discharges, ditches, or drainage canals within the watershed and stream reach
- stream morphological characteristics in stream reach representative of upstream and downstream reaches
- no stream habitat “improvements” within the stream reach (i.e., wing dams, rip rap, etc.)
- reach has not been snagged (e.g., removal of woody debris to promote drainage)
- no dams or diversions upstream or downstream, or if present not within two replications of major morphological units (i.e., riffles, runs, pool sequence)
- no bridges upstream of the reach, or if present within the watershed not within two meander cycles or two replications of major morphological units

**Wetlands:**
- no history of drainage, filling, or excavation activities within the natural extent of the wetland
- well buffered by natural vegetation around the perimeter of the wetland
- no direct discharges from municipalities or industries
- no indication of recent silvicultural activities within the drainage area
- no agricultural runoff, and no direct runoff from deicing compounds from streets or highways
- no history of aquaculture, including fish rearing or stocking
- no known history of or ongoing active pesticide (e.g. mosquitoes), herbicide, or algicide treatments within the wetland or watershed
- nonnative invasive species are not present or are at a low level of abundance where they cause little or no impact to native biological communities

In addition to reference sites, the sites selected for development of an IBI must span a gradient or range of human disturbance from minimal to severe (Karr and Chu 1999). Land use information is used during the site selection process to identify the potential impairment level of each site.
Human disturbance within the watershed of each stream reach is quantified by examining geographical information within the watershed concerning land use, riparian vegetation, point source discharges, feedlots, and ditching. Habitat information collected at each stream reach is used to examine in-stream disturbance factors. For wetlands, habitat and hydrologic modifications are documented during site visits and this information is used in conjunction with surrounding land use (within a 500 meter buffer) to characterize human disturbance at each site.

c) Impairment threshold defined by narrative description of fish community
Karr et al. (1986) provides a narrative description (e.g., excellent, good, etc.) of the fish community along the IBI scoring range (Table 14). The narratives describe the general attributes of the fish community in moderately sized (3 to 10 meter wide) warm water streams. The scoring range for each class and the narrative descriptions that describe each class are appropriate for similar type streams in Minnesota but do not necessarily apply to other stream classes (i.e., cold water streams, headwater streams).

With the inception of the bio-monitoring program in the 1980s, the first watersheds to be assessed were the Minnesota River basin (Bailey et al. 1992) and the Red River basin (Niemela et al. 1998). The IBI scores developed for these first two basins are based on the scoring system employed by Karr (1981). In Karr’s (1981) system, the IBI scores range from 12 to 60 (shown in Table 14). IBI scores showing an “excellent”, “good”, or “fair” fish community are considered indicative of support of the aquatic life use. The narrative guidelines from Karr et al. (1986) shown in Table 14 have been superseded by IBI thresholds based on reference site conditions (described below). The MPCA will continue to use the Karr threshold levels to make use support determinations for these watersheds until they can be revisited.

d) Reference site-based IBI thresholds
The MPCA bio-monitoring and assessment methods have evolved and matured as the program has gained experience and acquired more data from a range of watersheds and ecoregions in Minnesota. Beginning in the St. Croix River basin in 2000, the MPCA began developing IBI scores for stream fish and invertebrate communities based on a zero to 100 point scoring system. The rationale for switching to the 100 point system was that it was more understandable to people not familiar with the IBI. The IBIs developed for invertebrate and plant communities of wetlands in the NCHF ecoregion in 1999 originally used a 10 to 50 point scoring system. Subsequently, the metric scoring procedure has been modified such that wetland IBIs are now also based on a zero to 100 point scoring system.

Table 14. Guidelines for interpreting overall fish community IBI scores using the 60 point system, from Karr et al. 1986.

<table>
<thead>
<tr>
<th>Overall IBI Score: 60 Point System</th>
<th>Biological Integrity Rating</th>
<th>Fish Community Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-51 Excellent</td>
<td></td>
<td>Comparable to the best situation with minimal human disturbance; all regionally expected species for habitat and stream size, including the most intolerant forms, are present with a full array of age and size classes; balanced trophic structure</td>
</tr>
<tr>
<td>50-41 Good</td>
<td></td>
<td>Species richness somewhat below expectations, especially because of the loss of the most intolerant forms; some species are present with less than optimal abundance, or size/age distributions; trophic structure show signs of imbalance</td>
</tr>
<tr>
<td>40-31 Fair</td>
<td></td>
<td>Signs of additional deterioration include decreased species richness, loss of intolerant forms, reduction in simple lithophils, increased abundance of tolerant species, and/or highly skewed trophic structure (e.g., increasing number of omnivore species and less specialized feeding species); older age classes of top carnivores rare or absent</td>
</tr>
<tr>
<td>30-21 Poor</td>
<td></td>
<td>Relatively few species; dominated by tolerant forms, habitat generalists, and omnivores; few or no top carnivores or simple lithophilic spawners; growth rates and condition factors sometimes depressed; hybrids sometimes common</td>
</tr>
</tbody>
</table>
20-12 Very poor Very few species present, mostly tolerant forms, hybrids, or exotics; few large or older fish; DELT fish sometimes common
No Score Very poor Thorough sampling finds few fish or no fish; impossible to calculate an IBI

In this new method, impairment thresholds are based on the range of IBI scores measured at the reference sites within each stream or wetland class. The reference site data are used to define impairment thresholds that are more appropriate for each class of waterbody being considered. For example, in cool water streams in the St. Croix River basin the bottom of the range of IBI scores for very small (0-20 mi^2 drainage area), small (20-55 mi^2 drainage area), and moderate sized streams (55-270 mi^2 drainage area) are 46, 68, and 69 respectively (Figure 7). The lowest IBI score in the range of all IBI scores measured at reference sites is an appropriate threshold for biogeographically similar areas of the state because reference streams or wetlands within similar regions are likely to exhibit similar departures from pre-settlement conditions. This departure, or lack there of, shows what can be expected in a least impacted condition for a given area.

As in the example above, the rivers and stream of the St. Croix River basin are relatively unimpacted by human activities. However, for other regions in Minnesota, the threshold IBI score may need to be adjusted upward (i.e., an IBI score within the range of all reference site IBI scores) to take into consideration the degree that the reference sites within the region have already been impaired. For example, Ohio EPA uses the lower 25th percentile from the range of IBI scores measured at reference sites as an appropriate threshold level given the amount of disturbance that has taken place at their reference sites (Ohio EPA 1988). Use of the 25th percentile of the IBI range, or other percentile value, may be appropriate for some Minnesota watersheds. The MPCA will make these threshold determinations as additional watersheds are monitored and data from several watersheds can be compared. Professional judgment teams will be part of this process.

An error term is calculated around the selected reference site-based threshold IBI score (Figure 8). The error term delineates a range in IBI scores that fall within the 95 percent confidence limits. The error term is generated from replicate samples. The confidence limits account for variability because of natural temporal changes within the biological community as well as method error. Figures 8a and 8b show the same IBI impairment thresholds shown in Figure 7 for St. Croix basin streams, but with the 95 percent confidence limits around the thresholds, in the context of land use and habitat ratings. As the MPCA reference site database expands to include sites from different time periods, the confidence limits may be reduced or eliminated altogether.

4. Data requirements and determination of impaired condition

Biological data are used to assess stream reaches and depressional wetlands for impaired biological conditions for both the integrated narrative 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.

Table 14 shows the relationship between IBI scores and use support categories based on impairment thresholds defined by the narrative description of the fish community or by the range of IBI scores exhibited by sampled reference sites. 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.

As stated, the narrative guidelines from Karr et al. (1986) shown in Table 14 were used as threshold levels to indicate impairment of streams in the Red and Minnesota River basins. Sites that scored in the “poor” or “very poor” range are listed as non-supporting for purposes of 305b reporting and 303(d) listing. This conservative impairment threshold was used in the earlier stages of IBI development before enough data had been collected at reference sites to switch to a more refined method. Sites with IBI scores that fall within the “poor” or “very poor” narrative classes have significantly impaired aquatic communities. The MPCA will continue to use this threshold level to make use support determinations for streams within these watersheds until they can be revisited.
As described above, 95 percent confidence limits have been applied to reference site-based IBI impairment thresholds (Figure 8). Sites with IBI scores above the 95 percent confidence limit are very likely to be un-impaired and those with IBI scores below the 95 percent confidence limit are very likely to be impaired. Sites with IBI scores within the confidence limits will be further evaluated by professional judgment teams. Stream reaches or individual wetlands that do not support their aquatic life use are identified as candidates for the 303(d) list (Table 15).

Table 15. Summary of data requirements and IBI thresholds for assessment of biological communities for the integrated narrative report and the 303(d) list.

<table>
<thead>
<tr>
<th>Period of Record</th>
<th>Minimum No. of Data Points</th>
<th>Use Support or Listing Category Based on IBI Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>305(b)</td>
<td>Most recent 10 years</td>
<td>Full Support</td>
</tr>
<tr>
<td>303(d)</td>
<td>Most recent 10 years</td>
<td>Non-Support</td>
</tr>
<tr>
<td>IBI Thresholds for streams defined by narrative description of the fish community</td>
<td>1</td>
<td>Not Listed</td>
</tr>
<tr>
<td>(Old method, Red and Minnesota Rivers)</td>
<td>Excellent, Good or Fair</td>
<td>Listed</td>
</tr>
<tr>
<td>IBI Thresholds for streams and wetlands defined by the reference condition</td>
<td>IBI ≥ impairment threshold**</td>
<td>IBI &lt; impairment threshold**</td>
</tr>
<tr>
<td>(New method; e.g., St. Croix River)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Impairment threshold is based on IBI scores from regional reference sites. Threshold levels are dependent on region, stream size and stream or wetland classification (see text).

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 or adjacent wetlands, local land use information, and other watershed data. If multiple samples taken at different locations within the same assessment unit yield discrepant results (i.e., some sites are supporting and others are not), evaluation of all available information at this time will be used to produce a final assessment. The MPCA will present this information to the appropriate professional judgment group for the basin in which the reach is located to help make final determinations on use support for 303(d) listing.

To help refine the approach for assessing biological communities, the EPA is encouraging states to develop and adopt biological criteria and a tiered aquatic life use system (TALUS) for their waters. The MPCA will complete the development of a statewide IBI framework in the winter of 2009/2010. The new IBIs will form the foundation of the biological criteria that will be used to conduct biological assessments using the TALUS model. Until completion of the statewide IBI framework, new biological listings are being deferred. The MPCA will begin assessing rivers and streams for biology under the new framework in the 2012 listing cycle. Until TALUS is developed, the biological assessments will consider the interim clean water act goal only in making use support determination.

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. That approach was extended to the 2008 and 2010 assessment and listing cycles.

5. Listing of impaired wetlands

In previous guidance manuals (2004 & 2006), the concept of wetland assessment for the purpose of identifying impaired wetlands was introduced. The 2006 Guidance Manual noted that the MPCA needed input from key stakeholders prior to assessing and listing wetland biological impairments. During 2006 and 2007 the MPCA communicated with and received input from key stakeholders.
From these meetings and discussions, it has been recommended that the MPCA’s initial focus for listing impaired wetlands be on wetlands with direct, hydrologic connections to downstream impaired waters. The MPCA still needs to better understand how wetland biological TMDL pollution reduction plans can be achieved through the use of the EPA’s Stressor Identification Guidance Manual. Focusing on hydrologically connected wetlands will allow the MPCA to complete a limited number of pilot study wetland TMDL plans to improve our understanding. This approach to addressing wetland impairments will occur in a coordinated effort with the schedule to address the impairments of the downstream water bodies, so that wetland impairments are considered at the same time that downstream lake or stream impairments are addressed.
Figure 7. Box plots of IBI scores for reference streams, showing use support and impairment thresholds at lower end of IBI range, for three stream size classes in the St. Croix River basin for A) fish and B) inverts. Box plots show the median (50th Percentile), upper quartile (75th percentile), lower quartile (25th percentile), maximum and minimum. (Text box points to impairment threshold for moderately sized stream as an example.)
Figure 8a. Impairment thresholds for: A. very small (0-20 mi²), B. small (20-55 mi²), and C. moderate (55-270 mi²) Streams in the St. Croix River basin. Open ovals represent IBI scores for individual sampling sites. Horizontal dotted line is IBI impairment threshold for each size class. Shaded area represents 95 percent confidence limit around impairment thresholds.
Figure 8b. Impairment thresholds for: A. small riffle-run (0-50 mi²), B. large riffle-run (50-500 mi²), and C. glide-pool (0-500 mi²) streams in the St. Croix River basin. Open ovals represent IBI scores for individual sampling sites. Horizontal dotted line is IBI impairment threshold for each size class. Shaded area represents 95 percent confidence limit around impairment thresholds.
XIII. Removal of Waterbodies from 303(d) List

There are three basic ways in which waterbodies are removed from the 303(d) list:

1. If, during the development of the TMDL study, new and reliable data or information indicates that the waterbody is no longer impaired and is meeting water quality standards. Such a waterbody would be de-listed before a TMDL plan was completed.
2. If a TMDL assessment and preliminary plan for reducing the sources of pollution is completed and approved by the EPA.
3. If the sources of impairment are determined to be essentially entirely non-anthropogenic in origin.

A. Waterbody no longer impaired

1. Numeric standards

In general, waterbodies will be assessed and listing or de-listing decisions will be made using the methods described in this Guidance. In practice, there will usually be more data available for the “de-listing” assessment than was available for the “listing” assessment, because an early step in the TMDL process is additional monitoring. New and old data will be considered together in the re-assessments, unless tangible improvements of sufficient dimension to change impairment status have taken place in the reach, in which case only new data will be used in the de-listing assessment. Improvements could include implementation of best management practices to reduce nonpoint sources, improvements in wastewater treatment, or some combination of nonpoint and point source reductions. If the new data show the waterbody to be un-impaired, either because the original, smaller data set provided a false indication of impairment, or because conditions have in fact improved, the MPCA will recommend that the EPA to de-list the waterbody. It is possible, however, that even with the improvements; the new data may still show impairment. In this case the waterbody is not de-listed.

All de-listing decisions are subject to review by the appropriate professional judgment teams (see Section V.E.). Information about watershed improvements should be brought to the professional judgment team for consideration. The MPCA will make a final determination on whether the reach can be considered no longer impaired, and should be submitted to the EPA for de-listing.

As stated, generally the same standards, guidelines, and thresholds are used to remove a waterbody from an impaired waters list that were used to place it on the list. The same period of record relative to the de-listing review date, minimum data requirements, and impairment thresholds for the various categories of pollutants applies (see Tables 4, 5, 6, 8, 9, 11, 14 and 16 and the appropriate sections of the Guidance for details).

It is essential that data used in the de-listing assessment be collected under appropriate conditions. For dissolved oxygen and for pollutants with toxicity- and human health-based water quality standards, data should be from observations taken during critical conditions, i.e. those conditions most likely to result in exceedances of the standard. For example, if a waterbody was listed as impaired because of low dissolved oxygen, the measurements used to support de-listing would likely need to be collected in the early morning (generally no later than two hours after sunrise, so as to reflect the daily minimum) during periods of very low flow. For other pollutants, data should be from observations that provide an accurate representation of the overall period of time under consideration and are not biased by, for example, being collected only during a certain season or under certain flow conditions.

The following is a summary of the specific data and assessment requirements needed to consider removing a waterbody from the 303(d) list, impaired because of exceedances of numeric standards:

**Turbidity** must have:
- at least 20 observations (new and old data) in the most recent 10 years, of which at least 10 observations (new and old data) are in the most recent 5 years
- at least 20 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status, and in either case, there must be fewer than 10 percent of samples exceeding the water quality standard
Dissolved Oxygen must have:

- at least 20 observations (new and old data) in the most recent 10 years, of which at least 10 observations (new and old data) are in the most recent 5 years, or at least 20 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status
- in either case, there must be fewer than 10 percent of samples exceeding the water quality standard

Un-ionized Ammonia and Chloride must have:

- at least 5 observations (new and old data) for any 3-year interval in the most recent 10 years, or
- at least 5 observations (new data) for any 3-year interval in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status
- in either case, no more than one exceedance of the chronic water quality standard in any 3-year interval (chronic standard is a 4-day average)

Mercury, water column data must have:

- at least 5 observations for any 3-year interval in the most recent 10 years
- no more than one exceedance of the chronic water quality standard in any 3-year interval (chronic standard is a 30-day average)

E. coli bacteria must have for step two:

- at least 20 observations over a two year period in the most recent 10 years
- at least 5 observations per applicable month (April - October) – data are combined for each month over most recent 10 years, unless there are a sufficient number of observations to aggregate data by month over consecutive two year time periods or to calculate individual monthly or 30 day geometric means
- at least 5 observations per applicable month (April - October) – data are combined for each month over most recent years since corrective actions were taken in the watershed of sufficient dimension to change impairment status, unless there are a sufficient number of observations to aggregate data by month over consecutive two year time periods or to calculate individual monthly or 30 day geometric means
- in either case, no exceedance of the monthly mean standard (126 organisms per liter) by the geometric mean in any of those months for 10 year aggregated data or less than 10 percent of months exceed the standard for two year aggregated or individual monthly or 30 day geometric means
- in either case, fewer than 10 percent of sample observations exceed “maximum” standard (126 organisms per liter)

Lake nutrient eutrophication must have:

- at least 8 paired TP, corrected chl-a, and Secchi measurements (June to September) over a minimum of 2 years for the most recent 10 years
- TP and either corrected chl-a or Secchi must be within the standards to be removed from the list.

2. Narrative standards

Streams with impaired aquatic communities can be de-listed if additional bio-monitoring indicates that the community is no longer impaired when compared to the threshold IBI. Streams listed as impaired using the earlier narrative IBIs (Karr et al. 1986, Table 14) can be de-listed using the same narrative IBIs if watershed-specific, reference site-based, IBIs have not been determined for that reach. Otherwise, streams will be de-listed using the reference site-based threshold IBIs (in Section XIII).

Lakes and rivers listed as impaired because of fish tissue contaminants will be de-listed when additional sampling and analysis show that the fish tissue concentrations, by species and size class, are below 0.2 mg/kg (ppm) for either mercury or PCBs (in Section VIII).
B. EPA-approved TMDL plan

The second major way waters are de-listed is through the completion of the TMDL study. Under the current federal TMDL regulation, the TMDL process must progress through the step where an EPA-approved plan is in place that indicates in general how the river reach or lake is to be brought back into compliance with water quality standards. That is, under current EPA regulations, the waterbody does not need to be brought back to an un-impaired condition to be de-listed. Irrespective of this EPA regulation, the MPCA is committed, with the help of local entities, to improving the water quality in all impaired waters so beneficial uses are restored, where restoration is possible. To that end a water body that has an approved TMDL plan for a pollutant no longer appears on the 303(d) list, but remains on an impaired inventory list where impaired water body/pollutant combinations are tracked until they are no longer impaired.

C. Waterbody impaired because of natural causes/conditions

A third pathway for removing a waterbody from the impaired waters list is to determine that there are essentially no anthropogenic sources contributing to the impairment. Thus, the sources of the impairment are all natural. According to EPA’s Consolidated Assessment and Listing Methodology, these waters are impaired but no TMDL pollution reduction study plan is required.
XIV. Sources of Information and MPCA Contacts

The readers of this document are encouraged to access the sources of information listed in this section. Included are e-mail addresses and phone numbers of MPCA staff that work in areas relevant to the protocols and procedures in this Guidance. They are listed alphabetically by subject area. Also provided are some pertinent Web sites, listed by agency.

A. MPCA staff

1. 303(d) list, general questions and comments. Howard Markus at howard.markus@pca.state.mn.us or 651-757-2551
2. Integrated Assessment [ADB] coordinator. Douglas Hansen at douglas.hansen@pca.state.mn.us or 651-757-2406
3. Integrated narrative report, preparation. Elizabeth Brinsmade at elizabeth.brinsmade@pca.state.mn.us or 651-757-2244
4. Basin or watershed planning questions. Glenn Skuta at glenn.skuta@pca.state.mn.us or 651-757-2730
5. Biological impairment. Scott Niemela at scott.niemela@pca.state.mn.us or 1-218-828-6076
6. Citizen lake monitoring program. Johanna Schussler at johanna.schussler@pca.state.mn.us or 651-757-2705
7. Citizen stream monitoring program. Laurie Sovell at laurie.sovell@pca.state.mn.us or 651-757-2750
8. Effluent limits for toxic pollutants and temperature standard for cold water fisheries. Gary Kimball at gary.kimball@pca.state.mn.us or 651-757-2495
9. Fish consumption advice. Minnesota Department of Health at 800-657-3908. Patricia Mccann at Patricia.Mccann@state.mn.us
10. Lake eutrophication methodology. Pam Anderson at pam.anderson@pca.state.mn.us or 651-757-2190 or Steve Heiskary at steve.heiskary@pca.state.mn.us or 651-757-2419
11. Monitoring and data management. Louise Hotka at louise.hotka@pca.state.mn.us or 651-757-2450
12. Quality assurance and quality control for surface water sampling and analysis. Roger Fisher at roger.fisher@pca.state.mn.us or 651-757-2360
13. TMDL process, general questions and comments. Jeff Risberg at jeff.risberg@pca.state.mn.us or 651-757-2670 or Celine Lyman at celine.lyman@pca.state.mn.us or 651-757-2541
14. Water quality data for specific waterbodies. Louise Hotka at louise.hotka@pca.state.mn.us or 651-757-2450
15. Water quality standards. Angela Preimesberger at angela.preimesberger@pca.state.mn.us or 651-757-2656

All MPCA staff can also be reached toll free at 800-657-3864

B. Web sites

The MPCA and other agencies maintain a number of Web sites that provide information on aspects covered in this Guidance; some of the more pertinent sites are listed below:

1. **MPCA Web sites**
   - The MPCA home page is at [http://www.pca.state.mn.us](http://www.pca.state.mn.us). From this site the reader can link to all the MPCA Web sites listed below and many more.
     2. 305(b) Report:
        - Rivers: [http://www.pca.state.mn.us/water/basins/305briver.html](http://www.pca.state.mn.us/water/basins/305briver.html)
        - Lakes: [http://www.pca.state.mn.us/water/basins/305blake.html](http://www.pca.state.mn.us/water/basins/305blake.html)
     3. Lake protection, including Citizen Lake Monitoring Program and lake water quality: [http://www.pca.state.mn.us/water/lake.html](http://www.pca.state.mn.us/water/lake.html)

5. Phosphorus strategy: http://www.pca.state.mn.us/water/phosphorus.html

6. Quality assurance and quality control requirements for water quality sampling and data assessment for lakes and streams: http://www.pca.state.mn.us/programs/qa_p.html

7. TMDLs and the 303(d) list: http://www.pca.state.mn.us/water/tmdl/index.html

8. Water quality standards and water quality rules; select Minn. R. ch. 7050, Minn. R. ch. 7052 or other rule from list: http://www.pca.state.mn.us/water/standards/index.html


10. Data Access Website with environmental data on surface waters statewide: http://www.pca.state.mn.us/data/eda

2. Minnesota Department of Health Web sites, fish consumption advice

   1. Fish consumption advice, general: http://www.health.state.mn.us/divs/eh/fish/
   2. Site-specific advice: http://health.state.mn.us/divs/eh/eating/sitespecific.html

3. EPA Web sites

   The EPA main office in Washington D.C. maintains many relevant Web sites; their home page for water related topics is: http://www.epa.gov/owow/. The EPA Region 5 office in Chicago has their own relevant Web sites; their home page for water is: http://www.epa.gov/r5water/. Minnesota is in EPA Region 5.

   1. EPA Region 5, TMDLs: http://www.epa.gov/region5/water/wshednps/topic_tmdls.htm
   2. EPA Region 5, water quality monitoring and assessment: http://www.epa.gov/r5water/
XV. Summary of Data Requirements and Methods for Use Support and Impairment Determinations

Tables 17 and 18 summarize the fundamental data and information requirements for 305(b) and 303(d) use support and impairment determinations for all categories of pollutants. Exceedance thresholds listed for non-bioaccumulative and bioaccumulative toxics are for the chronic standards. This summary should not be considered a definitive description of the assessment methods for the various pollutant categories. For the complete description of data and information requirements, as well as the assessment protocols and supportive discussion, the reader must consult the appropriate section of the Guidance. Data for the most recent 10-year period are used in the assessments for all pollutant categories, except for the contamination of fish tissue with mercury (all data can be used). The pollutant categories treated in the Guidance are as follows:

1. pollutants with toxicity-based standards
2. pollutants with human health-based standards
3. conventional pollutants and water quality characteristics
4. fecal coliform bacteria
5. eutrophication of lakes (effects of excess nutrients)
6. impairment of the biological community (fish)
7. fish tissue contaminants

Table 16. Summary of data needed for water quality assessments for use support and impairment determinations, for pollutants with numeric standards.

<table>
<thead>
<tr>
<th>Pollutant Category</th>
<th>Minimum Number of Values* and Data Treatment</th>
<th>Exceedance Thresholds: Number or Percent Exceedances of Chronic Standards Use Support or Listing Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pollutants with Toxicity-based Standards</strong></td>
<td>Number of Exceedances $\rightarrow$</td>
<td>$\leq 1$</td>
</tr>
<tr>
<td>5 values in 3 years</td>
<td>Not listed</td>
<td>na</td>
</tr>
<tr>
<td><strong>Pollutants with Human Health-based Standards</strong></td>
<td>Number of Exceedances $\rightarrow$</td>
<td>$\leq 1$</td>
</tr>
<tr>
<td>5 values in 3 years</td>
<td>Not listed</td>
<td>na</td>
</tr>
<tr>
<td><strong>Conventional Pollutants and Water Quality Characteristics</strong></td>
<td>Percent Exceedance $\rightarrow$</td>
<td>$&lt; 10%$</td>
</tr>
<tr>
<td>303(d)</td>
<td>20 values in 10 years</td>
<td>Not listed</td>
</tr>
<tr>
<td><strong>E. coli</strong></td>
<td>Number of months with Exceedances $\rightarrow$ (geometric mean)</td>
<td>No months</td>
</tr>
<tr>
<td>1260 orgs./100 ml</td>
<td>Geometric mean of 5 values over 10 years for each month</td>
<td>Not listed</td>
</tr>
<tr>
<td>303(d)</td>
<td>10 values in 10 years</td>
<td>Not listed</td>
</tr>
</tbody>
</table>

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise.
na = not applicable. There is no “review” category for toxics and fish tissue contaminants, nor specific minimum data requirements for biological and fish tissue contaminant assessments.
Table 17. Summary of data needed for water quality assessments for use support and impairment determinations, for pollutants with narrative standards.

<table>
<thead>
<tr>
<th>Pollutant Category Integrated Report</th>
<th>Minimum Number of Values* and Data Treatment</th>
<th>Exceedance Thresholds: Eutrophication Guideline values IBI Scores Contaminant Levels in Fish Tissue Use Support or Listing Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IBI Scores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contaminant Levels in Fish Tissue Use Support or Listing Category</td>
</tr>
<tr>
<td>Eutrophication (lakes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Lakes and Forests Ecoregion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total phosphorus ⇒</td>
<td>&lt; 30 μg/L</td>
<td>30 – 35 μg/L</td>
</tr>
<tr>
<td>Corrected chl-a ⇒</td>
<td>&lt; 10 μg/L</td>
<td>10 – 12 μg/L</td>
</tr>
<tr>
<td>Secchi disk ⇒</td>
<td>≥ 1.6 meters</td>
<td>1.6 – 1.4 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 1.4 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 total phosphorus, 10 corrected chl-a and 10 Secchi disk</td>
<td>Not listed</td>
<td>Review, to determine to list or not list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Listed</td>
</tr>
<tr>
<td>Eutrophication (lakes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Central Hardwood Forests Ecoregion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total phosphorus ⇒</td>
<td>&lt; 40 μg/L</td>
<td>40 – 45 μg/L</td>
</tr>
<tr>
<td>Corrected chl-a ⇒</td>
<td>&lt; 15 μg/L</td>
<td>15 – 18 μg/L</td>
</tr>
<tr>
<td>Secchi disk ⇒</td>
<td>≥ 1.2 meters</td>
<td>1.2 – 1.1 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 1.1 meters</td>
</tr>
<tr>
<td>10 total phosphorus, 10 corrected chl-a and 10 Secchi disk</td>
<td>Not listed</td>
<td>Review, to determine to list or not list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Listed</td>
</tr>
<tr>
<td>Eutrophication (lakes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Glaciated Plains and Western Corn Belt Plains Ecoregions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total phosphorus ⇒</td>
<td>&lt; 70 μg/L</td>
<td>70 – 90 μg/L</td>
</tr>
<tr>
<td>Corrected chl-a ⇒</td>
<td>&lt; 24 μg/L</td>
<td>24 – 32 μg/L</td>
</tr>
<tr>
<td>Secchi disk ⇒</td>
<td>≥ 1.0 meters</td>
<td>1.0 – 0.7 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 0.7 meters</td>
</tr>
<tr>
<td>10 total phosphorus, 10 corrected chl-a and 10 Secchi disk</td>
<td>Not listed</td>
<td>Review, to determine to list or not list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Listed</td>
</tr>
</tbody>
</table>

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise. na = not applicable. There is no “review” category for toxics and fish tissue contaminants nor specific minimum data requirements for biological and fish tissue contaminant assessments.

<table>
<thead>
<tr>
<th>Pollutant Category Integrated Report</th>
<th>Minimum Number of Values*, and Data Treatment</th>
<th>Exceedance Thresholds: IBI Scores Contaminant Levels in Fish Tissue Use Support or Listing Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Community (fish)</td>
<td>IBI score ⇒ (old method)</td>
<td>Excellent, good or fair</td>
</tr>
<tr>
<td></td>
<td>IBI score ⇒ (new method)</td>
<td>IBI ≥ basin-specific threshold IBI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discrepant results within stream segment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IBI &lt; basin-specific threshold IBI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>See Section XII.A.</td>
<td>Not listed</td>
<td>Listed</td>
</tr>
<tr>
<td>Fish Tissue Contaminants</td>
<td>Tissue concentration ⇒</td>
<td>≤ 0.2 ppm Hg or PCBs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>mean concentration, by lake by species by size, over most recent 5-year period having data</td>
<td>&gt; 0.2 ppm Hg or PCBs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not listed</td>
<td>Listed</td>
</tr>
</tbody>
</table>

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise. na = not applicable. There is no “review” category for toxics and fish tissue contaminants nor specific minimum data requirements for biological and fish tissue contaminant assessments.
XVI. Literature Cited


EPA. 2005. Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, July 29, 2005.


Gernes, M. and J. Helgen. 1999. Indexes of Biotic Integrity (IBI) for wetlands: vegetation and invertebrate IBI’s. MPCA final report to EPA #CD995525.01


Introduction

One of the goals of the Clean Water Legacy Act (CWLA) is to identify impaired waters and those waters in need of additional protection so as to protect, restore, and preserve the quality of Minnesota's surface waters. The MPCA is identified in the CWLA as the state agency responsible for establishing a strategy for monitoring and assessment and identifying impaired waters under the CWA. This is accomplished through MPCA monitoring efforts and the efforts of local, state and federal agencies and citizens that also monitor the condition of Minnesota water resources.

The MPCA has established a strategy and goal, recognized by the legislature and Clean Water Council, to assess the condition of Minnesota’s waters via a 10-year cycle. The key organizing approach used in this strategy is that of the “major,” or 8-digit hydrologic unit code (HUC), watershed. There are 81 major watersheds in Minnesota (see Figure 3). This document outlines the watershed approach to monitoring and explains the 10-year cycle for this effort.

Figure 3. Minnesota’s major watersheds.

Overview of the watershed approach

During the last three years, the MPCA has been piloting a watershed approach to its stream monitoring efforts. The pilot studies have shown that this approach integrates water monitoring efforts to provide a more complete assessment of water quality and facilitates data collection for the development of TMDL’s and protection strategies. While the effort began with streams, the MPCA intends to include lake monitoring in this watershed monitoring framework.
The idea behind the watershed approach is to intensively monitor the streams and lakes within a major watershed to determine the overall health of the water resources, identify impaired waters, and identify those waters in need of additional protection efforts to prevent impairments. Follow-up monitoring is then done in biologically impaired subwatersheds to determine the cause(s) of the impairments (the “stressors” impacting the biological community) and to begin to identify pollutant sources.

The intensive nature of this monitoring (i.e. the good coverage of sites within the watershed) leads to one of the significant benefits of the approach – the identification of most, if not all, of the impairment problems at one time. Consequently, there is an opportunity to address the impairments in a watershed through a coordinated TMDL process. This is much different than past monitoring efforts, when limited monitoring resources were not concentrated in defined areas. As a result, MPCA often identified one impairment during one year, and another impairment at the same site a couple years later during follow-up monitoring for the TMDL study, necessitating a separate TMDL study or slowing the progress of the one underway. In the same way, impairments on upstream or downstream segments of the same stream were not always identified at the same time, making it difficult to achieve the CWLA goal of developing TMDL studies on a watershed scale.

Another benefit of this watershed approach is that it provides an opportunity for citizens and local government to proactively engage in the monitoring work through volunteer and local monitoring activities. This up-front engagement helps set the stage for local involvement in any ensuing TMDLs or protection strategies, and enhances the information available for good planning efforts and successful implementation of restoration/protection strategies.

Finally, the major watershed approach provides predictability in the monitoring schedule. By establishing a schedule for monitoring all of the state’s major watersheds every 10 years, the state can accomplish the following:

- provide advance notice to interested stakeholders, local governments and volunteers regarding monitoring plans
- assist local groups in ramping-up their monitoring efforts to provide data in advance or in-between agency monitoring efforts
- provide stakeholders a head’s up as to when they can expect the TMDL study or protection strategy work to begin in their area
- insure that comprehensive information on the status of water quality – and water quality management efforts – is collected, evaluated and provided to state and local partners at least one each decade

Components of the watershed monitoring approach

As noted above, the watershed approach can be applied to stream and lake assessment monitoring, and can also help to organize and encourage local and citizen monitoring efforts. Figure 1 illustrates the relationships between these monitoring components, and how they inform watershed planning (including TMDL development) and implementation activities. The following paragraphs provide more details on each of the monitoring components of the watershed approach.
Major Watershed Load Monitoring Network

The first component of this effort is the major watershed load network, which involves permanent flow and chemistry monitoring stations at the outlets (also referred to as “pour points”) of each of the state’s major watersheds. This partnership effort between the MPCA and the MDNR, along with the USGS and the Metropolitan Council, is a cornerstone of the watershed approach in that it involves continuous flow and water quality data collection with the computation of an annual load for each site, each year.

The load defines the amount of a parameter passing through a site per unit time. Loads determined at the outlet (pour point) of watersheds make it possible to compare watersheds across basin and ecoregion boundaries. Watershed loads can also be used to assess trends in the water quality of a specific watershed over time, and to see how data from a given year compares to the long-term record for a watershed. This will be particularly helpful in putting the intensive watershed monitoring data (see below) into a longer-term context, given that the intensive monitoring will occur once every 10 years.

Intensive Watershed Monitoring

The intensive watershed monitoring of rivers/streams aggregates watersheds from a coarse to a fine scale. The foundation of this approach is the 81 major watersheds. Sampling occurs in each major watershed once every 10 years. In this approach, intermediate-sized (approx. 11-digit HUC) and “minor” (14-digit HUC) watersheds are sampled along with the major watershed outlet to provide a complete assessment of water quality. Sites are selected near the outlet or “pour point” at all watershed scales. This approach provides robust assessment coverage of rivers and streams without monitoring every single stream reach (See Figure 6 for an illustration of the monitoring site coverage within a major watershed).
The outlet of the major watershed (purple dot in Figure 6) is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic consumption, and aquatic recreation use-support. Each 11-digit HUC pour point (green dots in Figure 6) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use-support. Watersheds at this scale generally consist of major tributary streams with drainage areas ranging from 75 to 150 square miles. Lastly, most minor watersheds (typically 10-20 square miles) are sampled for biology to assess for aquatic life use-support (red dots in Figure 6). Figure 4 provides an illustration of the year that each eight-digit HUC is scheduled for intensive watershed monitoring.
The second step of the intensive watershed monitoring effort consists of follow-up monitoring at all 11-digit HUC’s determined to have impaired waters. This follow-up monitoring is designed to identify the source(s) and cause(s) of impairment.

In addition to the MPCA’s intensive watershed monitoring effort described above, the MDA monitors pesticides in Minnesota water resources to identify surface water pesticides of concern, trends over time, provide information on the effectiveness of pesticide management plans and best management practices, and provide data needed by the MPCA to assess water quality. This information can also be factored into the watershed framework, further enhancing our understanding of water quality within each watershed.

Lake Assessment Monitoring
Lake assessment monitoring activities are focused on assessing the recreational use-support of lakes and identifying trends over time. MPCA also assesses aquatic consumption use-support based on fish-tissue and water-column concentrations of toxic pollutants; the fish-tissue data is provided from monitoring conducted by the MDNR and MPCA. Currently the MPCA does not assess aquatic life use-support as methods are not available, but the MDNR is working to develop such methods (lake indices of biotic integrity).

Minnesota has about 12,200 lakes greater than 10 acres in size. Of those, about 2,300 are between 100 and 500 acres, and about 700 are 500 acres or larger. Since it would be prohibitively expensive to monitor and assess all the lakes in Minnesota – just like it would be to sample every stream reach – the state must develop an approach for selecting which lakes to sample, and rely on other indices (such as remote sensing information) to provide a snapshot of the water quality of lakes that are not sampled.

The MPCA has a goal of assessing all lakes 500 acres or larger for recreational use support over the next 10 years, and at least 25 percent of smaller lakes. Many of these smaller lakes are monitored by local units of government and volunteers, through MPCA and other agency programs (including the work of the Metropolitan Council), or through independent local efforts. Two keys to the success of the lake assessment monitoring effort, then, are 1) the ability to identify priority lakes for monitoring, and 2) the ability to support and engage local lake monitoring efforts on priority lakes.

The MPCA is in the process of aligning its lake monitoring efforts with the major watershed monitoring schedule. The Agency intends to schedule its lake monitoring and assessment efforts so that once a major watershed is intensively monitored and assessed for stream water quality, the key lakes within that watershed have also been monitored and assessed. The Agency will also explore how to target its local and volunteer monitoring grants to complement the 10-year watershed monitoring cycle. In that way, the lake and stream data can be considered together to provide a comprehensive picture of water quality status, and a determination can be made regarding how best to proceed to develop TMDL(s) and protection strategies, rather than being forced by the monitoring timing to address lakes and streams separately.

For lakes 500 acres and larger, the Agency will complete its lake monitoring/assessment work in each major watershed by the time the stream monitoring and assessment is complete. For smaller lakes, the MPCA and MDNR need to work together to identify priority sites for monitoring and assessment and to engage local governments and volunteers.

The first step in this prioritization process will involve the use of remote sensing and citizen volunteer Secchi disk monitoring data to provide an initial picture of lake water quality. Lakes with significantly better water clarity than state standards (likely 20 percent or more) will be identified as “unimpaired” for recreational use support. Lakes where the water clarity is below standards or is borderline, or where historical data suggests impaired conditions, will be prioritized within each major watershed for follow-up monitoring. The goal is to generate enough data on lake water quality within each major watershed to identify which subwatersheds/lakesheds contribute to impaired lakes and streams, and which do not (see Figure 5 for an illustration).
Citizen/Local Monitoring

As is evident in the description of lake assessment monitoring above, citizen and local monitoring are important components of the watershed monitoring approach. Like the permanent load monitoring network that will be established at watershed pour points, citizen/local monitoring efforts can provide the long-term picture needed to help evaluate current status and trends. For example, long-term Secchi disk records for many Minnesota lakes represent the best and most valuable water-quality data available for those lakes. Data from citizen and local monitoring programs is also used to help prioritize waters for follow-up sampling and to support assessment decisions. Many local groups also conduct detailed sampling efforts following established monitoring protocols, providing data that is used directly in assessments. For example, groups funded through the FY2008 CWLA Surface Water Assessment Grants will sample more than 375 lakes and 90 stream sites to collect data for assessment purposes. Volunteers also provide weather and lake level data necessary for the proper interpretation of monitoring results and the application of lake and watershed models.

One of the challenges in enhancing citizen and local monitoring efforts is recruiting new volunteers. To date, the MPCA and MDNR have generally taken a “broadcast” approach to recruitment (with a couple exceptions). While this approach helps to inform the public of opportunities to volunteer, it doesn’t always do a great job matching volunteers with key lakes and stream reaches that are in need of monitoring. Coordinating with local groups to focus monitoring efforts where it will most effective for Clean Water Legacy planning and tracking purposes will help local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change.

A key benefit of the watershed approach involves the advance identification of lake and stream sites that will be sampled by agency staff. This provides an opportunity to actively recruit volunteers to monitor those sites, too, so that water quality data is available for the years before and after the intensive monitoring effort, and the needed weather and lake-level data is also available. This local/citizen-collected data will help agency staff interpret the results from the intensive monitoring effort, which only occurs once every 10 years. It will also allow interested parties to track any water quality changes that occur in the years between intensive monitoring events.

The watershed approach also provides a framework for encouraging participation in the CWLA Surface Water Assessment Grant program, which provides grants to local governments, educational institutions and nonprofits to monitor lakes and streams. Each year the Request for Proposals (RFP) can identify the major watersheds that are scheduled for intensive monitoring in the next year or two, and additional points can be given to proposals that will monitor lakes and streams in those watersheds. As a result, an even more robust dataset will be available for the watershed planning effort that follows the monitoring (including TMDL development and protection strategy development). In watersheds without active volunteer groups or local...
monitoring efforts, work can be done in advance of the RFP to generate local interest, train volunteers, and get them up to speed for the application process.

Another opportunity created by the watershed approach involves refining agency volunteer recruitment goals so they align with the data needs for each watershed. In the case of the MPCA, the agency currently has a goal of recruiting volunteers to monitor Secchi disk transparency on all lakes larger than 100 acres (as of 2007, about 1,260 lakes have active volunteers). This has proved challenging, given that not all of those lakes have public accesses or developed shoreline. The identification of priority lakes for monitoring as described above will allow the MPCA to recruit volunteers for specific lakes in addition to the broadcast approach to recruitment. The overall recruitment goal can then be revised to reflect the watershed approach, resulting in a more realistic target and better assurance that key data needs are being met along with the realization of the other benefits of volunteer monitoring, such as increased awareness and engagement. This same approach will also benefit stream transparency tube monitoring, and recruitment of weather and lake level observers.

The watershed approach and schedule also provide a communication tool for informing local government and other interested parties about agency monitoring efforts, and for identifying opportunities for partnership. For example, in the first three years of the intensive watershed monitoring pilot, planning for the monitoring effort in specific watersheds has resulted in a better understanding of local monitoring efforts by state agencies, with the result that local and state monitoring efforts are now better coordinated in those watersheds. Advance knowledge of the monitoring schedule and sites will also allow the Clean Water Council to assist in recruitment and communication efforts for agency monitoring programs and grant opportunities. The Clean Water Council consists of representatives from diverse CWLA stakeholders, presenting a great opportunity for getting the word out about monitoring needs.

Finally, it is important to note that citizen volunteers and local groups (including local governments) are not just interested in collecting monitoring data. They also want to see that the data is used. One outcome of the watershed monitoring effort will be the use of citizen and local data in the identification of impaired and “at-risk” lakes and streams and the subsequent initiation of TMDL studies and protection planning efforts. A second likely outcome of the intensive watershed monitoring will be the development of watershed-specific monitoring reports. These reports can include local and volunteer monitoring results in addition to agency monitoring results. Both of these outcomes will further illustrate the connection between local, citizen and agency monitoring efforts, and show how all of this work is important to our understanding of water quality.

**Watershed monitoring schedule**

The MPCA has developed an initial schedule for intensively monitoring all of the major watersheds once every 10 years to aid in the transition to the watershed approach. The first ten-year schedule was drafted by the MPCA based on the following criteria, which include the CWLA prioritization criteria and additional factors identified by agency watershed staff:

- risk to human and aquatic health
- probability of impairment based on existing data (including land-use information)
- alignment with TMDL schedules
- readiness of partners to follow-up on impaired watersheds
- collaboration opportunities (local, neighbor state, federal)
- staff, partner, or contractor workload
- basin priorities & partner input

MPCA staff sought input from the Clean Water Council on these priorities prior to developing the schedule. In many cases MPCA regional staff also consulted with basin partners as the schedule was developed. The initial draft schedule is as follows:
As noted above, the MPCA is in the process of aligning its lake monitoring efforts with the major watershed monitoring schedule. The intent is to identify priority lake-monitoring sites within each watershed at least two years prior to the scheduled intensive watershed monitoring effort to allow time to recruit volunteers and build local monitoring efforts; it will likely take a couple years to transition to this watershed approach for lake monitoring.

The Agency anticipates working with the Clean Water Council, other state agencies, and other stakeholders to conduct an annual review and refinement of the initial draft to take into account any new information that might suggest a change to the schedule. Weather events will also play a role, as droughts and floods may affect the ability to sample a particular watershed in a given year.

Other monitoring efforts

It is important to note that the activities described above do not encompass all of the condition monitoring activities underway in Minnesota. Other ongoing monitoring efforts include:

- Monitoring the concentration of various water quality indicators at designated river sites over a long period of time, following a rotating-basin approach. Some of the sites have data back to the 1950’s.
- Probabilistic (random) surveys of Minnesota lakes, streams and wetlands to determine water quality condition and trends over time on a statewide, ecoregion or basin scale. Probabilistic studies allow the MPCA and others to gather in-depth information on sites that are representative of the state, ecoregion or basin as a whole.
- Special studies designed to answer specific questions, such as the nutrient concentrations of shallow lakes, or the concentrations of trace metals in Minnesota rivers and streams.

The data from these activities can also be factored into the watershed framework.

Summary

The watershed monitoring approach presents a number of opportunities to further the CWLA goal of protecting, restoring, and preserving the quality of Minnesota's surface waters. It provides a framework for implementing the 10-year monitoring cycle, and for identifying key monitoring sites. Most importantly, it provides a communication tool that can inform stakeholders, engage volunteers, and help coordinate local/state/federal monitoring efforts so the data necessary for effective water resource planning is
available, citizens and stakeholders are engaged in the process, and citizens and governments across Minnesota can evaluate the progress that is being made on a regular basis.
Appendix B - List of Class 2 numeric water quality standards for toxicants

Minnesota Class 2 numeric water quality standards for toxic substances are listed in Tables B-1 through B-7. For the complete list of Class 2 water quality standards, and standards for the other use classes, the reader should consult Minn. R. chs. 7050 and 7052. All the Class 2 standards in Minn. R. ch. 7052, which are applicable only to the Lake Superior basin, are repeated here; but the reader is advised to consult both rules for definitive lists of all standards.

The standards are organized in the tables as follows:

**Minn. R. ch.7050**
Table B-1, toxicity-based chronic and maximum standards
Table B-2, human health-based chronic standards and bioaccumulation factors (BAF)
Table B-3, toxicity- or human health-based chronic standards and BAFs
Table B-4, toxicity-based chronic and maximum standards that vary with hardness or pH

**Minn. R. ch.7052 (Lake Superior basin)**
Table B-5, toxicity-based chronic and maximum standards
Table B-6, human health- and wildlife-based chronic standards and BAFs
Table B-7, toxicity-based chronic and maximum standards that vary with hardness or pH
Table B-1. Chronic and maximum toxicity-based water quality standards for Minnesota Class 2 waters, from Minn. R. ch. 7050.0222. See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Units</th>
<th>Chronic Standard For Subclass</th>
<th>Maximum Std. For Subclass</th>
<th>Total to Dissolved Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acetochlor</td>
<td>μg/L</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
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<tr>
<td>2</td>
<td>Aluminum, t</td>
<td>μg/L</td>
<td>87</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>3</td>
<td>Ammonia, un-ionized</td>
<td>μg/L</td>
<td>16</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Anthracene</td>
<td>μg/L</td>
<td>0.035</td>
<td>0.035</td>
<td>0.035</td>
</tr>
<tr>
<td>5</td>
<td>*Cadmium, t</td>
<td>μg/L</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>6</td>
<td>Chloride</td>
<td>mg/L</td>
<td>230</td>
<td>230</td>
<td>230</td>
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<tr>
<td>7</td>
<td>Chlorine</td>
<td>μg/L</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>Chlorpyrifos</td>
<td>μg/L</td>
<td>0.041</td>
<td>0.041</td>
<td>0.041</td>
</tr>
<tr>
<td>9</td>
<td>*Chromium III, t</td>
<td>μg/L</td>
<td>207</td>
<td>207</td>
<td>207</td>
</tr>
<tr>
<td>10</td>
<td>*Copper, t</td>
<td>μg/L</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
</tr>
<tr>
<td>11</td>
<td>Cyanide, free</td>
<td>μg/L</td>
<td>5.2</td>
<td>5.2</td>
<td>5.2</td>
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<tr>
<td>12</td>
<td>Di-n-octyl phthalate</td>
<td>μg/L</td>
<td>30</td>
<td>30</td>
<td>30</td>
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<tr>
<td>13</td>
<td>Ethylbenzene</td>
<td>μg/L</td>
<td>68</td>
<td>68</td>
<td>68</td>
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<tr>
<td>14</td>
<td>Fluoranthene</td>
<td>μg/L</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>15</td>
<td>*Lead, t</td>
<td>μg/L</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>16</td>
<td>Metalochlor</td>
<td>μg/L</td>
<td>23</td>
<td>23</td>
<td>23</td>
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<tr>
<td>17</td>
<td>Parathion</td>
<td>μg/L</td>
<td>0.013</td>
<td>0.013</td>
<td>0.013</td>
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<tr>
<td>18</td>
<td>Phenanthrene</td>
<td>μg/L</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
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<tr>
<td>19</td>
<td>Phenol</td>
<td>μg/L</td>
<td>123</td>
<td>123</td>
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<tr>
<td>20</td>
<td>Selenium, t</td>
<td>μg/L</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
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<tr>
<td>21</td>
<td>*Silver, t</td>
<td>μg/L</td>
<td>0.12</td>
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<td>1.0</td>
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<tr>
<td>22</td>
<td>Toluene</td>
<td>μg/L</td>
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<td>253</td>
<td>253</td>
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<tr>
<td>23</td>
<td>1,1,1-Trichloroethane</td>
<td>μg/L</td>
<td>329</td>
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<tr>
<td>24</td>
<td>Xylene (m, p &amp; o)</td>
<td>μg/L</td>
<td>166</td>
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<tr>
<td>25</td>
<td>*Zinc, t</td>
<td>μg/L</td>
<td>106</td>
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Standards for trace metals are listed as total metal (t), but are converted to dissolved metal for implementation using “total to dissolved factors” (total metal standard times factor = dissolved metal standard).
*Chronic and maximum standards vary with ambient total hardness (as CaCO3); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-4.
na = Not applicable
<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Units</th>
<th>Chronic Standard for Subclass</th>
<th>Bioaccumulation Factor for Subclass*</th>
<th>Type</th>
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<td></td>
<td>2A</td>
<td>2Bd</td>
<td>2B/C/D</td>
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<tr>
<td>1</td>
<td>Acenaphthene</td>
<td>μg/L</td>
<td>20</td>
<td>20</td>
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<tr>
<td>2</td>
<td>Acrylonitrile</td>
<td>μg/L</td>
<td>0.38</td>
<td>0.38</td>
<td>0.89</td>
</tr>
<tr>
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<td>Arsenic</td>
<td>μg/L</td>
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<td>2.0</td>
<td>53</td>
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<tr>
<td>4</td>
<td>Bromoform</td>
<td>μg/L</td>
<td>33</td>
<td>41</td>
<td>466</td>
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<td>5</td>
<td>Carbon tetrachloride</td>
<td>μg/L</td>
<td>1.9</td>
<td>1.9</td>
<td>5.9</td>
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<tr>
<td>6</td>
<td>Chlordane</td>
<td>pg/L</td>
<td>73</td>
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<td>290</td>
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<tr>
<td>7</td>
<td>Chlorobenzene</td>
<td>μg/L</td>
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<td>20</td>
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<tr>
<td>8</td>
<td>DDT</td>
<td>pg/L</td>
<td>110</td>
<td>1700</td>
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<td>1,2-Dichloroethane</td>
<td>μg/L</td>
<td>3.5</td>
<td>3.8</td>
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<td>10</td>
<td>Dieldrin</td>
<td>pg/L</td>
<td>6.5</td>
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<td>11</td>
<td>Di-2-ethylhexyl phthalate</td>
<td>μg/L</td>
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<td>1.9</td>
<td>2.1</td>
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<td>Endosulfan</td>
<td>μg/L</td>
<td>0.0076</td>
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<td>Heptachlor</td>
<td>pg/L</td>
<td>100</td>
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<td>390</td>
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<td>Heptachlor epoxide</td>
<td>pg/L</td>
<td>12</td>
<td>480</td>
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<td>16</td>
<td>Hexachlorobenzene</td>
<td>pg/L</td>
<td>61</td>
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<tr>
<td>17</td>
<td>Lindane</td>
<td>μg/L</td>
<td>0.0087</td>
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<td>0.036</td>
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<td>Mercury</td>
<td>μg/L</td>
<td>0.0069</td>
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<td>19</td>
<td>Methylene chloride</td>
<td>μg/L</td>
<td>45</td>
<td>46</td>
<td>1940</td>
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<td>PCBs, t</td>
<td>pg/L</td>
<td>14</td>
<td>29</td>
<td>29</td>
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<td>1,1,2,2-Tetrachloroethane</td>
<td>μg/L</td>
<td>1.1</td>
<td>1.5</td>
<td>13</td>
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<td>22</td>
<td>Tetrachloroethylene</td>
<td>μg/L</td>
<td>3.8</td>
<td>3.8</td>
<td>428</td>
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<td>Toxaphene</td>
<td>pg/L</td>
<td>310</td>
<td>1300</td>
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<tr>
<td>24</td>
<td>Thallium</td>
<td>μg/L</td>
<td>0.28</td>
<td>0.28</td>
<td>0.56</td>
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<td>25</td>
<td>1,1,2-Trichloroethylene</td>
<td>μg/L</td>
<td>25</td>
<td>25</td>
<td>120</td>
</tr>
<tr>
<td>26</td>
<td>2,4,6-Trichlorophenol</td>
<td>μg/L</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>27</td>
<td>Vinyl chloride</td>
<td>μg/L</td>
<td>0.17</td>
<td>0.18</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Type = Type of human toxicant; C = chemical is considered a carcinogen; S = chemical is considered a systemic toxicant; org. = organoleptic, i.e., chemical imparts a disagreeable taste or odor to fish flesh.

* Bioaccumulation factors shown calculated assuming 6.0 % lipid for fish in Class 2A waters, and 1.5 % lipid for fish in Class 2B/C/D waters. Toxicants with bioaccumulation factors greater than 5000 for any Class 2 water are considered highly bioaccumulative.
Table B-3. Chronic and maximum water quality standards for Minnesota Class 2 waters, for which the lowest and applicable chronic standard is either human health-based or toxicity-based, depending on the subclass of Class 2 waters, from Minn. R. ch. 7050.0222. All concentrations in \( \mu g/L \). See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Chronic Standard Basis for Subclass</th>
<th>Maximum Std.</th>
<th>Bioaccumulation Factor</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2A</td>
<td>2Bd</td>
<td>2B/C/D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Applicable) #</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Alachlor | 3.8 H | 4.2 H | 59 T | 800 | 10 | 2.5 | C |

2. Antimony | 5.5 H | 5.5 H | 31 T | 90 | 1 | 1 | S |

3. Atrazine | 3.4 H | 3.4 H | 10 T | 323 | 2 | 2 | C |

4. Benzene | 5.5 H | 6.0 H | 98 H | 4487 | 16 | 4 | C |

5. Chloroform | 53 H | 53 H | 155 T | 1392 | 6 | 6 | C |

6. Cobalt | 2.8 H | 2.8 H | 5.0 T | 436 | 1 | 1 | S |

7. Naphthalene | 65 H | 81 T | 81 T | 409 | 78 | 39 | S |

8. *Nickel, t | 158 T | 158 T | 158 T | 1418 | 1 | 1 | S |

9. **Pentachlorophenol | 0.93 H | 1.9 H | 5.5 H | 9.1 | 142 | 35 | C |

**Chronic Standard Basis:** Subscript H = human health-based; subscript T = toxicity-based. 
Type = Type of human toxicant; C = chemical is considered a carcinogen; S = chemical is considered a systemic toxicant.

*Nickel:
1. Toxicity-based standards, listed as total metal (t), are converted to dissolved metal for implementation using a "total to dissolved factor" of 0.997 (chronic) and 0.998 (maximum) (total metal standard times factor = dissolved metal standard).
2. Chronic and maximum toxicity-based standards vary with ambient total hardness (as CaCO3); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-4.
3. Class 2A and Class 2Bd chronic standards are not to exceed human health-based standard of 297 \( \mu g/L \) as total nickel. The Class 2B/C/D chronic standards are always toxicity-based and have no human health-based "cap".

**Pentachlorophenol:**
1. Toxicity-based standards vary with ambient pH; maximum standard shown is for a pH value of 7.0. PH dependant formulas are shown in Table A-4.
2. Class 2A and 2Bd chronic standards are always human health-based regardless of pH.
3. Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 \( \mu g/L \).

# Note the following:
1. According to Minn. R. ch. 7050.0222, subpart 7, item E, if the maximum standard (MS) is more than 100 times the chronic standard (CS), the applicable MS is not the calculated toxicity-based MS, but 100 times the CS.
2. The aquatic-toxicity standard for atrazine of 10 \( \mu g/L \) is applicable as a criterion value to Class 2A and 2Bd waters for protection of aquatic life.
3. The aquatic-toxicity standard for cobalt of 5 \( \mu g/L \) is applicable as a criterion value to Class 2A and 2Bd waters for protection of aquatic life.
4. Like the human health-based standard, the aquatic-toxicity criterion for pentachlorophenol is pH dependent. These values are similar, for example in a Class 2B waters at a pH of 7 the human health-based standard is 5.5 \( \mu g/L \) and the toxicity-based criterion is 5.7 \( \mu g/L \). The toxicity-based criterion value is applicable for all Class 2 waters to protect aquatic life.
Table B-4. Chronic and maximum water quality standards for Minnesota Class 2 waters that vary with ambient total hardness (as CaCO₃), or pH. See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Class 2 Subclass</th>
<th>Chronic Standard Where: see notes</th>
<th>Maximum Standard Where: see notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cadmium, t</td>
<td>2A</td>
<td>Exp.(0.7852(ln TH)-3.490)</td>
<td>Exp.(1.128(ln TH)-3.828)</td>
</tr>
<tr>
<td></td>
<td>Cadmium, t</td>
<td>2Bd/B/C &amp;D</td>
<td>Exp.(0.7852(ln TH)-3.490)</td>
<td>Exp.(1.128(ln TH)-1.685)</td>
</tr>
<tr>
<td>2</td>
<td>Chromium III, t</td>
<td>All</td>
<td>Exp.(0.819(ln TH+1.561)</td>
<td>Exp.(0.819(ln TH)+3.688)</td>
</tr>
<tr>
<td>3</td>
<td>Copper, t</td>
<td>All</td>
<td>Exp.(0.620(ln TH)-0.570)</td>
<td>Exp.(0.9422(ln TH)-1.464)</td>
</tr>
<tr>
<td>4</td>
<td>Lead, t</td>
<td>All</td>
<td>Exp.(1.273(ln TH)-4.705)</td>
<td>Exp.(1.273(ln TH)-1.460)</td>
</tr>
<tr>
<td>5</td>
<td>*Nickel, t</td>
<td>All</td>
<td>Exp.(0.846(ln TH)+1.1645)</td>
<td>Exp.(0.846(ln TH)+3.3612)</td>
</tr>
<tr>
<td>6</td>
<td>Silver, t</td>
<td>All</td>
<td>na</td>
<td>Exp.(1.720(ln TH)-7.2156)</td>
</tr>
<tr>
<td>7</td>
<td>Zinc, t</td>
<td>All</td>
<td>Exp.(0.8473(ln TH)+0.7615)</td>
<td>Exp.(0.8473(ln TH)+0.8604)</td>
</tr>
<tr>
<td>8</td>
<td>**Pentachlorophenol</td>
<td>2A/2Bd</td>
<td>na</td>
<td>Exp.(1.005(pH)-4.830)</td>
</tr>
<tr>
<td></td>
<td>**Pentachlorophenol</td>
<td>2B/C/D</td>
<td>Exp.(1.005(pH)-5.290)</td>
<td>Exp.(1.005(pH)-4.830)</td>
</tr>
</tbody>
</table>

Where: Exp. = the natural antilogarithm of the expression in parentheses

ln = natural logarithm

TH = Total hardness as CaCO₃ in mg/L

pH = pH in standard units

Results in μg/L

*Nickel: Class 2A and Class 2Bd chronic standards are not to exceed human health-based standard of 297 μg/L as total nickel. The Class 2B/C/D chronic standards are always toxicity-based and have no human health-based “cap”.

**Pentachlorophenol: Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 μg/L.

Table B-5. Chronic and maximum toxicity-based water quality standards for Minnesota Class 2 waters in the Lake Superior basin, from Minn. R. ch. 7052.0100. All concentrations in μg/L. See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Chronic Standard For Subclass</th>
<th>Maximum Std.</th>
<th>Total to Dissolved Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lake Superior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>*Cadmium, t</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>Chlorobenzene</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>*Chromium III, t</td>
<td>86</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>4</td>
<td>Chromium VI, t</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>*Copper, t</td>
<td>9.3</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>6</td>
<td>Cyanide, free</td>
<td>5.2</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>7</td>
<td>2,4-Dimethylphenol</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>*Nickel</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>9</td>
<td>Parathion</td>
<td>0.013</td>
<td>0.013</td>
<td>0.013</td>
</tr>
<tr>
<td>1</td>
<td>Selenium, t</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>*Zinc, t</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

Standards for trace metals are listed as total metal (t), but are converted to dissolved metal for implementation using “total to dissolved factors” in Minn. R. ch. 7052.0360 (total metal standard times factor = dissolved metal standard).

*Chronic and maximum standards vary with ambient total hardness (as CaCO₃); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-7.

na = Not applicable
Table B-6. Chronic human health-based and wildlife-based water quality standards for Minnesota Class 2 waters in the Lake Superior basin, from Minn. R. ch. 7052.0100; showing bioaccumulative factors. See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Units</th>
<th>Chronic Standard For Subclass</th>
<th>Bioaccumulation Factor - 1 % Lipid**</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lake Sup. 2A 2Bd 2B/C/D</td>
<td>Trophic Level 3 Trophic Level 4</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Arsenic</td>
<td>μg/L</td>
<td>2.0 2.0 2.0 53</td>
<td>2.3 2.3</td>
<td>S</td>
</tr>
<tr>
<td>2</td>
<td>Benzene</td>
<td>μg/L</td>
<td>10 (5.3)** 5.5* 6.0* 98*</td>
<td>1.4 1.4</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>Chlordane</td>
<td>pg/L</td>
<td>40 56 225 225</td>
<td>79,430 61,660</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>DDT</td>
<td>pg/L</td>
<td>11 11 11 11</td>
<td>346,700 602,600</td>
<td>W</td>
</tr>
<tr>
<td>5</td>
<td>Dieldrin</td>
<td>pg/L</td>
<td>1.2 1.6 6.5 6.5</td>
<td>41,800 193,000</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>2,4-Dinitrophenol</td>
<td>μg/L</td>
<td>53 53 55 1982*</td>
<td>0.4 0.4</td>
<td>S</td>
</tr>
<tr>
<td>7</td>
<td>Endrin</td>
<td>μg/L</td>
<td>0.0039 0.0039 0.016 na</td>
<td>5960</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hexachlorobenzene</td>
<td>pg/L</td>
<td>74 105 418 419</td>
<td>26,300 25,120</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>Hexachloroethane</td>
<td>μg/L</td>
<td>1.0 1.5 5.0 6.2</td>
<td>204 172</td>
<td>C</td>
</tr>
<tr>
<td>1</td>
<td>Lindane</td>
<td>μg/L</td>
<td>0.08 0.11 0.4 0.46</td>
<td>1059 8511</td>
<td>S</td>
</tr>
<tr>
<td>2</td>
<td>Mercury</td>
<td>μg/L</td>
<td>0.0013 0.0013 0.013 0.0013</td>
<td>27,900** 140,000**</td>
<td>W</td>
</tr>
<tr>
<td>3</td>
<td>Methylene chloride</td>
<td>μg/L</td>
<td>46 46 47 1994*</td>
<td>0.2 0.2</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>PCBs, t</td>
<td>pg/L</td>
<td>4.5 6.3 25 25</td>
<td>552,800 1,166,000</td>
<td>C</td>
</tr>
<tr>
<td>5</td>
<td>Pentachlorophenol</td>
<td>μg/L</td>
<td>0.93 0.93 1.9 13</td>
<td>na 6</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>2,3,7,8-TCDD</td>
<td>pg/L</td>
<td>0.0014 0.0020 0.031 0.0031</td>
<td>93,600 90,000 C/W</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trichloroethylene</td>
<td>μg/L</td>
<td>22 24 29 330</td>
<td>3.4 3.4</td>
<td>C</td>
</tr>
</tbody>
</table>

Type = Type of toxicant, or basis for the applicable chronic standard; C = chemical is considered a human carcinogen; S = chemical is considered a human systemic toxicant; W = Wildlife-based standard; C/W = Lake Superior and Class 2A standards are human health-based (cancer), Class 2Bd/B/C/D standards are wildlife-based, for 2,3,7,8-TCDD.

**Bioaccumulation Factors (BAF):**

1. BAFs for organic chemicals shown at 1% lipid; These BAFs are multiplied by 8.5, 6.0 and 1.5% lipid (for both trophic levels 3 and 4) to determine Lake Superior, Class 2A and Class 2Bd/B/C/D standards, respectively.
2. BAFs for mercury are not lipid-based
3. Toxicants with bioaccumulation factors greater than 1000 for any Class 2 water are considered Bioaccumulative Chemicals of Concern in the Lake Superior basin.

**More stringent human health-based standards promulgated into the statewide rule, Minn. R. ch. 7050 would be applicable in the Lake Superior Basin.**
Table B-7. Chronic and maximum water quality standards for Minnesota Class 2 waters in the Lake Superior basin that vary with ambient total hardness (as CaCO₃), or pH, from Minn. R. ch. 7052.0100. See notes below.

<table>
<thead>
<tr>
<th>#</th>
<th>Toxicant</th>
<th>Class 2 Subclass</th>
<th>Chronic Standard Where: see notes</th>
<th>Maximum Standard Where: see notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cadmium, t</td>
<td>All</td>
<td>( \text{Exp.}(0.7852(\ln \text{TH})-2.715) )</td>
<td>( \text{Exp.}(1.128(\ln \text{TH})-3.6867) )</td>
</tr>
<tr>
<td>2</td>
<td>Chromium III, t</td>
<td>All</td>
<td>( \text{Exp.}(0.819(\ln \text{TH}+0.6848)) )</td>
<td>( \text{Exp.}(0.819(\ln \text{TH})+3.7256) )</td>
</tr>
<tr>
<td>3</td>
<td>Copper, t</td>
<td>All</td>
<td>( \text{Exp.}(0.8545(\ln \text{TH})-1.702) )</td>
<td>( \text{Exp.}(0.9422(\ln \text{TH})-1.700) )</td>
</tr>
<tr>
<td>4</td>
<td>Nickel, t</td>
<td>All</td>
<td>( \text{Exp.}(0.846(\ln \text{TH}+0.0584)) )</td>
<td>( \text{Exp.}(0.846(\ln \text{TH})+2.255) )</td>
</tr>
<tr>
<td>5</td>
<td>Zinc, t</td>
<td>All</td>
<td>( \text{Exp.}(0.8473(\ln \text{TH})+0.884) )</td>
<td>( \text{Exp.}(0.8473(\ln \text{TH})+0.884) )</td>
</tr>
<tr>
<td>6</td>
<td>*Pentachlorophenol</td>
<td>2A/2Bd</td>
<td>na</td>
<td>( \text{Exp.}(1.005(\text{pH})-4.869) )</td>
</tr>
<tr>
<td></td>
<td>*Pentachlorophenol</td>
<td>2/B/C/D</td>
<td>( \text{Exp.}(1.005(\text{pH})-5.134) )</td>
<td>( \text{Exp.}(1.005(\text{pH})-4.869) )</td>
</tr>
</tbody>
</table>

Where:  
- \( \text{Exp.} \) = the natural antilogarithm of the expression in parentheses  
- \( \ln \) = natural logarithm  
- TH = Total hardness as CaCO₃ in mg/L  
- pH = pH in standard units  
- Results in \( \mu \text{g/L} \)  

*Pentachlorophenol: Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 \( \mu \text{g/L} \).  
na = Not applicable
Appendix C - Method detection limits for trace metals

Limits of detection (method detection limits) and limits of quantification for the MDH laboratory for certain trace metals analyzed using EPA 200.8 and EPA 1631E are shown in Table C-1.

Over the 10-year data period used for the 2010 cycle assessments, the MPCA has contracted with the Wisconsin State Laboratory of Hygiene (1995-2002), Frontier Laboratory (2003-2005), and the MDH laboratory (2006), all of which meet QA/QC requirements for the analysis of water samples analyzed using EPA 1631E and collected using “ultra-clean” techniques (EPA method 1638 and 1669). The MDH laboratory detection and reporting capabilities are shown as an example.

Table C-1. Limits of detection and limits of quantification.

<table>
<thead>
<tr>
<th>Substance</th>
<th>LOD</th>
<th>LOQ</th>
<th>Units</th>
<th>Sample Size Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace Metals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.1</td>
<td>na</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.01</td>
<td>0.03</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Copper</td>
<td>0.01</td>
<td>0.04</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Lead</td>
<td>0.005</td>
<td>0.015</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.09</td>
<td>0.3</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.04</td>
<td>na</td>
<td>μg/L</td>
<td>250 milliliter</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.2</td>
<td>0.5</td>
<td>ng/L</td>
<td>500 milliliter</td>
</tr>
<tr>
<td>Chlorinated Organics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lindane (gamma-BHC)</td>
<td>0.025</td>
<td>0.082</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>alpha-Chlordane</td>
<td>0.011</td>
<td>0.037</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>gamma-Chlordane</td>
<td>0.010</td>
<td>0.033</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>p,p'DDT</td>
<td>0.025</td>
<td>0.082</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>p,p'DDD</td>
<td>0.025</td>
<td>0.082</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>p,p'DDE</td>
<td>0.015</td>
<td>0.050</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>5</td>
<td>16</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>0.0030</td>
<td>0.010</td>
<td>ng/L</td>
<td>160 Liter</td>
</tr>
</tbody>
</table>

na = not available

Two “detection limits” are listed, the limit of detection (LOD) and limit of quantification (LOQ). The limit of detection is the ultimate capability of the analytical method to detect and measure the substance in water. The limit of quantification is the ability of the method to measure the substance in water during routine laboratory operating conditions with a specified level of confidence that the amount reported is accurate. To gain the confidence provided by the LOQ, results must be reported at a level greater than the LOD. The MPCA uses the LOQs to define “less-than values”.

Guidance Manual for Assessing the Quality of Minnesota Surface Waters

Minnesota Pollution Control Agency

October 2009
### Appendix D - Professional judgment group transparency form for assessed streams - four examples

<table>
<thead>
<tr>
<th>AUID:</th>
<th>Assessment Cycle:</th>
</tr>
</thead>
<tbody>
<tr>
<td>07010103-501</td>
<td>2006</td>
</tr>
<tr>
<td>Aq Rec Result:</td>
<td>NA</td>
</tr>
<tr>
<td>Aq Rec Comments:</td>
<td>Assess Quality:</td>
</tr>
</tbody>
</table>

**Aq Rec Result:** NA  
**Aq Rec Comments:** Assess Quality

**Main Comments:** Need more monitoring for turbidity and DO.

**Aq Rec Result:** NA

**Aq Rec Comments:** Assess Quality

---

<table>
<thead>
<tr>
<th>AUID:</th>
<th>Assessment Cycle:</th>
</tr>
</thead>
<tbody>
<tr>
<td>07010103-502</td>
<td>2006</td>
</tr>
<tr>
<td>Aq Rec Result:</td>
<td>FS</td>
</tr>
<tr>
<td>Impairment ID:</td>
<td>413</td>
</tr>
<tr>
<td>Impairment Name:</td>
<td>Turbidity</td>
</tr>
</tbody>
</table>

**Main Comments:** Additional turbidity Sonde data has been collected and summarized, but still needs to be entered into STORET. Consider delisting for turbidity.  
**Aq Rec Result:** FS

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<tr>
<td>07010203-505</td>
<td>2006</td>
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<tr>
<td>Aq Rec Result:</td>
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<td>Assess Quality:</td>
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</table>

**Main Comments:** No assessment for turbidity because the CSMP data set is relatively small, single year, and not corroborated.  
**PJG follow-up for DO:**  
**Assessment Data summary showed DO PS 4/18 (22%)**  
**Data time range 2000-2004**  
**Stations: S003-007 & S002-952 (these are actually at the same location CSAH 15 southwest of Zimmerman)**  
**Recommend not listing for DO impairment at this time and doing additional monitoring because the dataset is small and the AUID is very long. Also may want to evaluate whether the AUID needs to be split.**  
**Total of 18 observations, exceedances on four dates**  
06-20-01  3.33 mg/L  
07-02-02  1.25 mg/L  
09-17-02  2.73 mg/L  
06-14-04  3.75 mg/L  
**Note that this AUID is 72 miles long and this station is at the downstream end of the AUID.**  
**Aq Rec Result:** NA

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<td>Assess Quality:</td>
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</table>

**Main Comments:** Follow up on transparency tube corroboration is included below. The corroboration is from Sherburne County SWCD.  
**Agree with the FS for TTube assessment.**
"Sherburne SWCD collected TSS data for one site in this reach. Number of samples: 14. Average TSS = 8 mg/L. The HBI for one macroinvertebrate sampling was determined for 2 sites. Values were 5.24 and 4.67 (Sherburne and Benton SWCD data).
Appendix E - Case examples of lake impairment determinations

These case-specific examples illustrate the impairment determination process.

1. Case Example: Lake which lacks trophic status data or does not have MDNR ID number
   a. Rice Lake (1-0067) Aitkin County
      Rice Lake is a 4,422 acre lake near McGregor in Aitkin County. No trophic status data was available for lake and was not included in our 305(b) assessment. Subsequently the lake was not evaluated.

2. Case Example: Lake with insufficient or old data
   a. Island Lake (58-0062) Pine County
      Island Lake is a 546 acre lake with a maximum depth of 35 feet. It is a highly developed and highly used lake in this part of Pine County. A LAP study was done on the lake in the early 1990’s. The lake exhibited mean TP of 44 µg/L, corrected chl-a of 19 µg/L, and Secchi of 2.1 m. The TP and corrected chl-a values are well above thresholds for the NLF ecoregion, however the data is based on only eight observations. Subsequently the lake was not listed.

3. Case Example: Lake which does not exceed causal and response thresholds

4. Case Example: Lake near TP threshold (Review category)
   a. Cedar Lake (27-0039) Hennepin County
      Cedar Lake is 170 acre lake with a maximum depth of 51 feet. It is a part of the “Minneapolis Chain of Lakes.” In the 305(b) assessment it had a mean TP of 44 µg/L, corrected chl-a of 12 µg/L and Secchi of 2.8 m. Since its TP is near the threshold value of 40 µg/L it is subject to review for the TMDL list.

      A review of long-term data indicates a Secchi of 2.5 m based on _ years of data. Recent trophic status data from monitoring done as a part of the Chain of Lakes CWP project reveal a mean TP of 33 µg/L, corrected chl-a of 9.2 µg/L and Secchi of 2.8 m in 1996 (Derby et al. 1997). Further improvement in trophic status of the lake has occurred since that time as a result of extensive CWP and Minneapolis Parks project (Lee, 2001, personal communication). Based on the currently low TP and trend toward improving trophic status Cedar Lake should not be listed.

   b. Clearwater Lake (86-0252) Wright County
      Clearwater Lake is a large (3,182 acre) and highly used lake in Wright County. It was the focus of Clean Lakes Phase I and II efforts in the 1970’s and 1980’s. BMP’s and wetland restorations were implemented as a part of the CLP. A review of data reveals recent improvements in trophic status with Secchi averaging 2.3 m over the past 10 years and a significant improvement overall based on 24 years of data. Recent TP and corrected chl-a over this period averaged 37 and 11 µg/L, respectively. Further review suggested 1995 data may contain outliers based on a mean TP of 157 µg/L, high standard error, and a mean corrected chl-a of 12.8 µg/L. Subsequently the lake was not listed.

   b. Leven Lake (61-0066) Pope County
      Leven Lake is located in northern Pope County directly north of Villard Lake. Leven Lake is fed by a stream that enters the northeastern part of the lake and its watershed extends into Douglas County. It has a total surface area of 283 acres and a maximum depth of 10 meters.

      Based on the 305(b) assessment it has a TP of 61 µg/L, corrected chl-a of 16 µg/L and a Secchi of 1.6 m. The TP is well above the threshold, however corrected chl-a is low and Secchi is high relative to the TP value. Based on Pope County water plan monitoring from 1994 – 1997 TP exceeded 40 µg/L in all four years and was over 100 µg/L in 1994. Corrected chl-a data were available for only two years. Monitoring by MPCA in 2000 revealed a summer-mean TP of 136 µg/L, corrected chl-a of 21 µg/L, and Secchi of 1.8 m. Algae samples, collected as a part of that effort were dominated by blue-green algae which often float near the surface and may allow for deeper transparency than would be expected based on TP or corrected chl-a measurements.
Based on the elevated TP measured in Pope County and MPCA monitoring and high corrected chl-a and dominance by blue-green algae noted in 2000 we would recommend listing Leven Lake. However, a review is appropriate and local resource managers should be asked to comment on locally collected data and offer any other insights they may have on the lake.

6. Case Example: Impaired lake with sufficient data

a. Long Lake (62-0067) Ramsey County

Long Lake is a 184-acre lake with a maximum depth of 27 feet and mean depth of 14 feet. It is located near the city of New Brighton in Ramsey County and is located in a region of the state referred to as the NCHF ecoregion. Based on its morphometric characteristics it is near the median for lakes in the North Central Hardwood Forests ecoregion (based on sample sizes of about 700-800 assessed lakes). Long Lake - Rush Lake Regional Park is a 200-acre park on the east side of Long Lake that includes a staffed swimming beach. The park also includes a public boat launch on the south end of the lake.

A Clean Lakes Project was implemented from 1978 – 1987. The project was funded by the EPA, the state of Minnesota through the Legislative Commission on Minnesota Resources and the Rice Creek Watershed District. This project was directed at improving the water quality of Long Lake. Specifically the project was to reduce sediment loading and delta formation in the lake and improve water clarity. As reported in the final project report implementation activities have been successful at reducing sediment loads to the lake such that delta formation has not recurred. However, water clarity remains unchanged and nuisance algal blooms persist. This points to the need for additional actions to improve lake water quality.

Lake water quality assessment data for Long Lake, as summarized in our most recent assessment (MPCA 2000) are summarized in Table E-1. These data were summarized as part of our integrated narrative reporting efforts and published on our Web site. These particular data represent summer-mean (June through September) surface water measurements collected between 1989 and 1998. These samples have been collected by a variety of agencies (organizations) and persons during this period of time. In the raw data table the “site” identification code describes the agency, organization or program responsible for collection of the data. For example sites with a “100” prefix were collected by MPCA staff, while the “200” code is used for CLMP participants. Our discussion will follow the order in the proposed methodology.

Table E-1. Long Lake water quality assessment data

<table>
<thead>
<tr>
<th></th>
<th>Total phosphorus</th>
<th>Corrected chl-a</th>
<th>Secchi</th>
<th>TSI-TP</th>
<th>TSI-Chl-a</th>
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<tbody>
<tr>
<td>µg/L</td>
<td>µg/L</td>
<td>µg/L</td>
<td>m</td>
<td></td>
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</tr>
<tr>
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<td>40</td>
<td>43</td>
<td>40</td>
<td>1.0</td>
<td>108</td>
<td>72</td>
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Data considerations: The minimum data set for TMDL assessment purposes is defined as 12 or more TP measurements, 12 or more Secchi measurements, and 12 or more corrected chl-a measurements for the assessment period. All assessments should be based on current data that is defined as data collected between 1989 and 1998 for this assessment. Long Lake surpasses all four data considerations.

Initial lake impairment determinations: Minnesota’s ecoregion-based TP guidelines provide the initial basis for determining the impairment status of the lake. These guidelines were developed based upon a combination of information that considered: a) phosphorus impacts on lake condition (as measured by corrected chl-a, algal bloom frequency, transparency, and hypolimnetic oxygen depletion); b) impacts on lake user (aesthetics, recreation, fisheries, water supply, etc.); and c) attainability (as related to watershed characteristics, regional phosphorus export values, lake morphometry, etc.). Background information on the development of the guidelines is well-documented in peer-reviewed literature as noted in the proposed listing methodology. And similar methods are currently being used in EPA guidance documents for nutrient criteria development (EPA 2000) and in protocol for developing nutrient TMDLs (EPA 1999a and 1999b).
The TP guideline for full support of swimmable use in the NCHF ecoregion has been set at 40 µg/L as a summer-mean. NCHF lakes with TP < 40 µg/L will typically exhibit a low frequency of algal blooms and adequately high transparency to support swimmable use throughout the summer. A level of TP between 40 µg/L and 50 µg/L has been used as a basis for describing “partial support” of swimmable use. Lakes with TP concentrations in this range will exhibit periodic algal blooms and reduced transparency that may interfere with swimmable use. Lakes with TP concentrations above 50µg/L are classified as “not-supporting.” Long Lake at 105 µg/L exceeds both these thresholds. In addition to exceeding this assessment threshold we believe “response” thresholds should be considered as well prior to listing a lake. One method is a comparison of the corrected chl-a and Secchi data to the TP data by means of Carlson’s TSI as noted in the methodology. In this case the corresponding TSI values for TP, corrected chl-a and Secchi are as follows: 71, 68, 60. All three of these measures indicate “eutrophic to hypereutrophic” conditions for Long Lake. Correspondence of the three values is relatively good considering the high mean TP for the lake. A mean corrected chl-a concentration of 43 µg/L would rank near the 25th percentile (75 percent have lower concentration) based on 559 NCHF assessed lakes and a mean Secchi of 1.0 meters would rank between the 10th-25th percentile based on 853 NCHF lakes. Also, at a mean corrected chl-a concentration of 43 µg/L “nuisance” blooms (corrected chl-a > 20 µg/L) would occur about 80-90 percent of the summer and “severe nuisance” blooms (corrected chl-a > 30 µg/L) would occur about 60-65 percent of the summer. These levels of algae combined with low transparency would typically be associated with swimming impaired conditions for lakes in the NCHF.

Based on all of the above, the lake is impaired and should be listed.

b. Case Example: impaired lake with sufficient data – bayed lake

7. Case example: Reservoir with sufficient data

a. Lake Byllesby (19-0006) Dakota County

Lake Byllesby is located on the Cannon River, downstream from the confluence of the Straight River and the outlet of Cannon Lake. Its watershed is quite large with the Cannon Lake portion draining primarily from the NCHF ecoregion and the Straight River portion from the WCBP. It has two county parks (Dakota and Goodhue), swimming beaches and multiple boat accesses.

A LAP study was conducted on the lake in 1996. Data from that study revealed a lakewide mean TP of 258 µg/L, corrected chl-a of 63 µg/L and Secchi of 0.75 m. Corrected chl-a in the near-dam segment (where the beaches are located) peaked at 207 µg/L. Blue-green algae were dominant from June through September. The data from this study and historical data are well above the thresholds for the NCHF or WCBP ecoregions that comprise the lake’s watershed. As a result Lake Byllesby should be listed.

Literature cited


