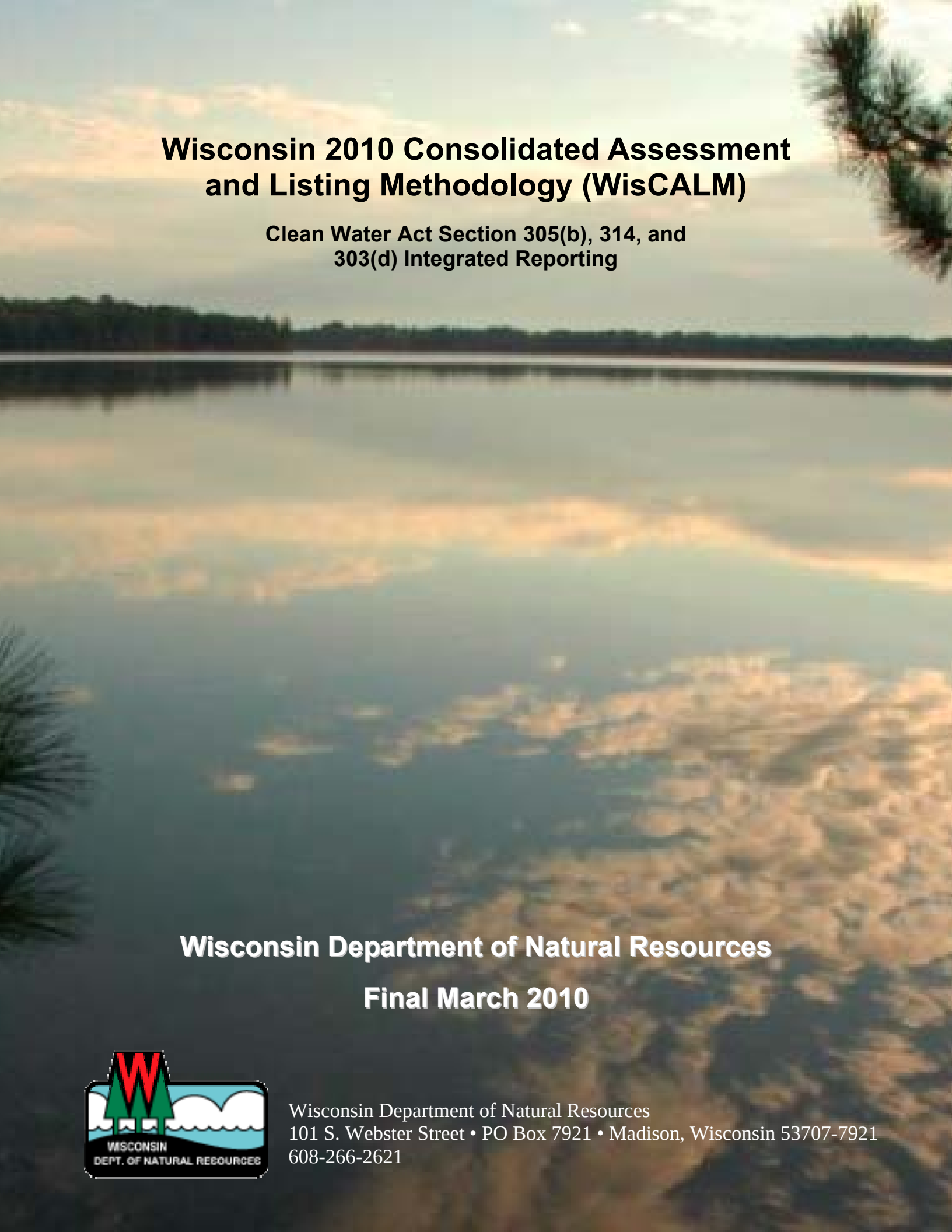

Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM)

Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting

Wisconsin Department of Natural Resources

Final March 2010

Wisconsin Department of Natural Resources
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Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM)

Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting

Wisconsin Department of Natural Resources
Water Division
PUB WT- 913 2009

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1.0 Introduction

1.1. Background

Over 15,000 lakes and 84,000 miles of rivers and streams in Wisconsin are managed on an ongoing basis to ensure that their condition, or quality, meets state and federal water quality standards. Water quality standards are the foundation of Wisconsin's water quality management program and they serve to define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants.

Through *monitoring* studies, waters are sampled to collect data or results at the water site. Monitored waters are then *assessed* by comparing monitoring data to guidelines designed to evaluate water condition against water quality standards. A two-step process may be used to assess the water. First, a general assessment is conducted to identify the current status of the water (the federal Clean Water Act Section "305(b) assessment"). The general assessment may place waters in four different categories: poor, fair, good and excellent. Waters placed in each category are reviewed by WDNR biologists and specific assessments are conducted to determine whether or not a waterbody is impaired, or not meeting water quality standards.

Based on the results of condition assessments, water quality biologists and managers determine which actions may be needed to ensure that water quality standards are met, including anti-degradation, or maintenance, of existing water quality condition (particularly for high quality or "excellent condition" waters), as well as restoration of water condition for those considered "impaired." Both the monitoring results and the assessment data are stored in state and federal databases and the majority of data are available online to agencies and the public.

Waters that do not meet water quality standards are placed on Wisconsin's Impaired Waters List ("the 303(d) List") under the Federal Clean Water Act, Section 303(d). Every two years, states are required to submit list updates to the United States Environmental Protection Agency (U.S. EPA) for approval. The WDNR previously submitted impaired waters lists in 1996 and updates in 1998, 2002, 2004, 2006, and 2008[1]. WDNR did not submit, and U.S.EPA did not require, a list in 2000.

Each state must document the methodology used to assess waters for Clean Water Act submittals, which includes how the state makes decisions to add or delete waters from the existing 303(d) List. In Wisconsin, a waterbody or segment of water is documented as impaired if it is not meeting water quality standards. Waters that are removed from the list ("de-listed") can be removed by providing data that supports the restoration of the designated use (i.e., the water is meeting water quality standards). The same methodology must be used to de-list a lake, stream or river as was used to list the water.

1.2. Changes from 2008 CWA Section 305(b)/303(d) Methods

Through 2006, WDNR provided its general assessment submittal in the form of a dataset and narrative Water Quality Assessment Report to Congress and its 303(d) List as two separate products. In 2008 the Department worked with U.S. EPA to integrate its mainframe database for general and impaired water assessment submittals. This complex data integration process was the first step for Wisconsin to provide a truly integrated assessment and listing report. For this 2010 submittal, the WDNR is building upon its 2008 work by using this new Consolidated Assessment

[1] Wisconsin's 2008 Impaired Waters List is pending approval by U.S. EPA.

and Listing Methodology (WisCALM) to conduct general and specific assessments for determining the attainment of designated uses.

2.0 Water Quality Standards: Three Elements

Wisconsin's assessment process begins with water quality standards. The Department is authorized to establish water quality standards that are consistent with the Federal Clean Water Act (Public Law 92-500) through Chapter 281 of the Wisconsin Statutes. These water quality standards are explained in detail in Chapters NR 102, NR 103, NR 104, NR 105, and NR 207 of the Wisconsin Administrative Code.

The water quality standards described in the Wisconsin Administrative Code rely on three elements to collectively meet the goal of protecting and enhancing the state's surface waters:

- *Use designations*, which define the goals for a waterbody by designating its uses,
- *Water quality criteria*, which are set to protect the water body's designated uses, and
- *Anti-degradation provisions* to protect water quality from declining.

Waters not meeting one or more of these water quality elements are to be included on the impaired waters list.

2.1 Designated Uses

Designated uses are goals or intended uses for surface waterbodies in Wisconsin which are classified into the categories of: recreation, public health and welfare, wildlife, and fish and aquatic life. The following designated uses are described in Chapter NR102 (Wisc. Adm. Code).

- *Recreational Use:* All surface waters are considered appropriate for recreational use unless a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion.
- *Public Health and Welfare:* All surface waters are considered appropriate to protect for incidental contact and ingestion by humans. All waters of the Great Lakes as well as a small number of inland water bodies are also identified as public water supplies and have associated water quality criteria to account for human consumption[2].
- *Wildlife:* All surface waters are considered appropriate for the protection of wildlife that relies directly on the water to exist or rely on it to provide food for existence.
- *Fish and Aquatic Life:* All surface waters are considered appropriate for the protection of fish and other aquatic life. Surface waters vary naturally with respect to factors like temperature, flow, habitat, and water chemistry. This variation allows different types of fish and aquatic life communities to be supported. This category has subcategories as described below.

Currently, Wisconsin recognizes the following Fish and Aquatic Life Use Designation sub-categories:

[2] Distinct water quality criteria are specified for public water supply and non-public water supply waters. Wisconsin does not currently have a formal "Drinking Water" use designation in its standards. Establishment of a "Drinking Water" use designation may be considered as part of a future standards change. If so, specific drinking water use assessment procedures will be included in future updates to the WisCALM document.

- *Coldwater Community:* Streams capable of supporting a cold water sport fishery, or serving as a spawning area for salmonids and other cold water fish species. Representative aquatic life communities, associated with these waters, generally require cold temperatures and concentrations of dissolved oxygen that remain above 6 mg/L. Since these waters are capable of supporting natural reproduction, a minimum dissolved oxygen concentration of 7 mg/L is required during times of active spawning and support of early life stages of newly-hatched fish.

- *Warmwater Sport Fish Community:* Streams capable of supporting a warm water-dependent sport fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of dissolved oxygen that do not drop below 5 mg/L.

- *Warmwater Forage Fish Community:* Streams capable of supporting a warm water-dependent forage fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of dissolved oxygen that do not drop below 5 mg/L.

- *Limited Forage Fish Community:* Streams capable of supporting small populations of forage fish or tolerant macro-invertebrates that are tolerant of organic pollution. Typically limited due to naturally poor water quality or habitat deficiencies. Representative aquatic life communities associated with these waters generally require warm temperatures and concentrations of dissolved oxygen that remain above 3 mg/L.

- *Limited Aquatic Life Community:* Streams capable of supporting macro-invertebrates or occasionally fish that are tolerant of organic pollution. Typically small streams with very low-flow and very limited habitat. Certain marshy ditches, concrete line-drainage channels, and other intermittent streams. Representative aquatic life communities associated with these waters are tolerant of many extreme conditions, but typically require concentrations of dissolved oxygen that remain about 1 mg/L.

2.2 Water Quality Criteria – Numeric and Narrative

Water quality criteria are specified numeric or narrative requirements relating to each of the use designations recognized by Wisconsin. Each designated use has its own set of requirements that must be met to protect the intended use. Some of these requirements relate to the amount of the physical (e.g., temperature) or chemical (e.g., dissolved oxygen) conditions that must be met to avoid causing harm. Other requirements relate to allowable maximum concentrations of chemical compounds or levels of bacteria. Wisconsin's water quality criteria may be either numeric (quantitative) or narrative (qualitative) and are authorized by state statutes and enumerated in the Wisconsin Administrative Code – namely in Natural Resource Chapters NR 102, NR 104, and NR 105.

Numeric criteria: Numeric criteria are quantitative and are expressed as a particular concentration of a substance or an acceptable range for a substance. For example, the pH value shall be from 6-9 standard units. Numeric surface water quality criteria have been established for conventional parameters (e.g., dissolved oxygen, pH, temperature), toxics (e.g., metals, organics, unionized ammonia), and pathogens (e.g., *E. coli*, fecal coliform). These numeric criteria are established for each designated use.

Narrative criteria: All waterbodies must meet a set of narrative criteria which qualitatively describe the conditions that should be achieved. A narrative water quality criterion is a statement that prohibits unacceptable conditions in or upon the water, such as floating solids, scum, or nuisance algae blooms that interfere with public rights. These standards protect surface waters and aquatic biota from eutrophication, algae blooms, and turbidity, among other things. The association between a narrative criterion and a waterbody's designated use is less well defined than it is for numeric criteria; however, most narrative standards protect aesthetic or aquatic life designated uses. Wisconsin's narrative criteria are found in Ch. NR 102.04(1).

2.3 Anti-degradation

Wisconsin's anti-degradation policy is intended to maintain and protect existing uses and high quality waters. This part of a waterbody quality standard is intended to prevent water quality from slipping backwards and becoming poorer without cause, especially when reasonable control measures are available. The anti-degradation policy in Wisconsin is stated in NR 102.05(1) of the Wisconsin Administrative Code:

> "No waters of the state shall be lowered in quality unless it has been affirmatively demonstrated to the Department that such a change is justified as a result of necessary economic and social development, provided that no new or increased effluent interferes with or becomes injurious to any assigned uses made of or presently possible in such waters."

One component of Wisconsin's anti-degradation policy is the designation of Outstanding Resource Waters and Exceptional Resource Waters. These are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. Outstanding Resource Waters typically do not have any dischargers, while Exceptional Resource Water designation offers a limited exception for increased discharge if human health would otherwise be compromised.

This guidance addresses the assessment of all waters of the state—and listing those that do not meet water quality standards. Inherent in this process is the application of anti-degradation provisions. Anti-degradation is an important aspect of pollution control because preventing deterioration of surface waters is less costly to society than attempting to restore waters once they have become degraded.

3.0 Monitoring and Data Management

Wisconsin DNR's Water Division Monitoring Strategy is available for review on the Department's website at http://dnr.wi.gov/org/water/monitoring/strategy.htm

3.1 Types of Monitoring

The Department's Water Monitoring Strategy (*Strategy*) directs monitoring efforts in a manner that efficiently addresses the wide variety of management information needs, while providing adequate depth of knowledge to support management decisions. The *Strategy* employs a three-tiered approach to information gathering. This careful investment in monitoring effort ensures that the status of Wisconsin's water resources can be determined in a comprehensive manner without depleting the capacity to conduct in-depth analysis and problem-solving where needed. There are three tiers of the monitoring strategy.

Tier 1 – Statewide Baseline Monitoring: *Trends establishment*

Under Tier 1 of the S*trategy*, staff and partners collect baseline condition information to help satisfy Water Division information needs at a broad spatial scale. This level of monitoring helps determine water quality status and trends for specific water types, accounting for inherent variation in ecological landscapes. This analysis is critical for identifying potential problem areas. Results from Tier 1 (or baseline) monitoring can be used to provide statistically valid statewide assessments of broad categories of waters. This procedure is helpful when water resources are too numerous to evaluate individually. Wisconsin's over 84,000 stream miles, for example, call for this dispersed sampling effort which provides, through inference, technically rigorous and credible 'snapshot' of statewide water conditions.

The power of the Tier 1 dataset lies in its cumulative picture of resource condition with respect to land type variability and inherent aquatic potential of representative stream types. Tier 1 data is collected on random, stratified sample locations and by itself may be used to trigger more detailed analysis, but on its own a Tier 1 site does not provide the minimum number of samples needed to understand aquatic ecosystem health. Tier 1 monitoring or other credible sources of information may be used to identify problem areas that will be prioritized for further study under Tier 2. For the current year's report, Tier 1 results were used in concert with other datasets to make impairment decisions. However, supplemental data was collected to provide the minimum number of sampling results spatially or temporally.

Tier 2 – Targeted Evaluation Monitoring: *Site-specific monitoring of targeted areas*

Waterbodies identified under Tier 1 as not meeting minimum levels for core indicators (fair or poor) are prioritized and monitored more intensively under Tier 2. Under this tier, confirmation of the problem is made, along with documentation of the cause(s). Thus, it is a more comprehensive evaluation of individual waterbodies, often requiring cross-program collaboration. Tier 2 monitoring is often used to verify whether waterbodies should be placed on the Impaired Waters List ("303(d) List") and to develop comprehensive water quality management plans such as Total Maximum Daily Loads (TMDLs) for specific waterbodies. It may also provide the pre-data for determining how well a waterbody responds to management, as evaluated under Tier 3. Monitoring in response to episodic events such as fish kills, where the cause and extent of the problem must be determined, also falls under Tier 2, as do short-term, one-time research projects.

Tier 3 – Management Effectiveness and Compliance Monitoring: *Determining effectiveness of management measures and permit conditions*

Tier 3 monitoring provides follow-up analysis of management plans that have been implemented for problem waterbodies, and evaluates permit compliance and the effectiveness of permit conditions. Monitoring under this tier evaluates how well core indicators have responded to management actions. Effectiveness of water-specific management actions is determined using core indicators from the more intensive sampling designs under Tier 2 that are specific to the problem being addressed. The chosen indicators are compared before and after management actions are implemented.

Regulatory monitoring of permitted entities is also included in Tier 3. Effluent monitoring helps WDNR determine whether permitted entities are meeting their permit conditions and state regulations, and to assess the health of waters receiving effluent. Monitoring of public drinking water wells is also carried out under Tier 3 to ensure that surface and groundwater meet federal public health standards for contaminants in drinking water.

3.2 Sample Collection – Tier 1 or Baseline Monitoring

Monitoring for the purpose of obtaining a broad-scale, statewide characterization of Wisconsin's waters is conducted under baseline or "Tier 1" monitoring documented in the *Wisconsin DNR Water Division Monitoring Strategy*. Baseline monitoring work provides core information for the state's Clean Water Act general assessment work; however, the terms "Tier 1 monitoring" and "general assessments" are not synonymous. A *general assessment* is simply the consistent application of key parameters and minimum results to waters within a given area during the desk top evaluation. This broad screening-level analysis will often be followed by specific or 'targeted' assessments. Tier 1 "Baseline Monitoring" represents monitoring work designed to provide a minimum level of information for creating statewide characterizations of waters.

Under the tiered approached, metrics collected through the baseline monitoring protocols may include:

Lakes

- Trophic Status Index (TSI)*
- Aquatic Macrophyte Community Index (AMCI) *
- Contaminants in fish tissue—mercury and PCBs*
- Pathogen indicators *
- Game fish population dynamics

Rivers

- Macroinvertebrate samples*
- Fish assemblage characteristics*
- Water chemistry*
- Contaminants in fish tissue—mercury and PCBs *
- Pathogen indicators*
- Gamefish, Endangered, & Threatened species surveys
- Habitat assessment

Streams

- Macroinvertebrate samples*
- Fish community characteristics*
- Water chemistry*
- Game fish population dynamics
- Habitat assessment

** Metrics used in the general assessment steps described in Section 5.2 of this document*

In Wisconsin, rivers are characterized as flowing water bodies that are not wadeable, and streams are flowing waters that are wadeable.

3.3 Sample Collection – Tier 2 Monitoring

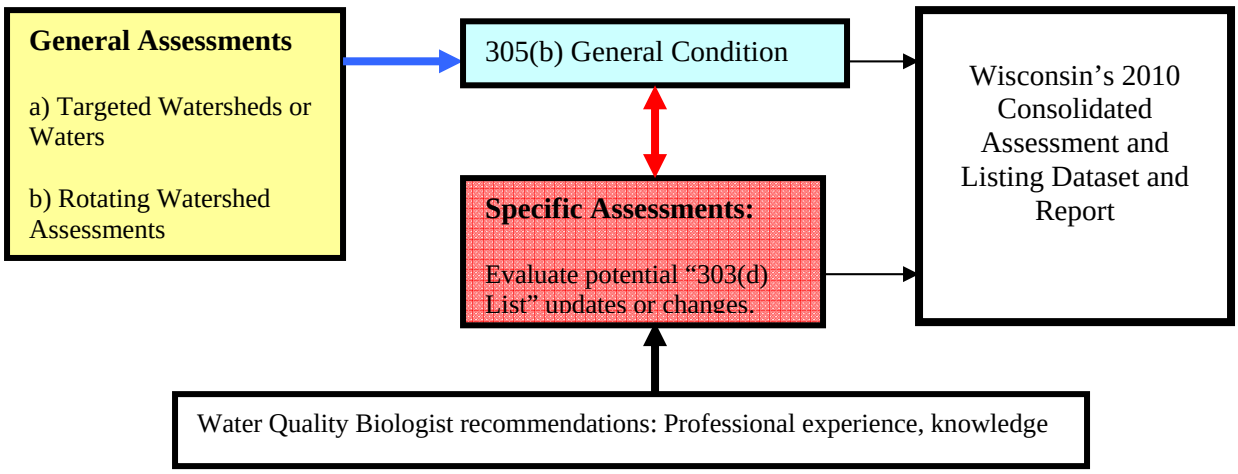
Modifications to the status of waters on the 303(d) list are the result of Tier 1 monitoring and subsequent specific assessments (Figure 1, below). For the past several years, DNR has been validating listings or preparing new listings or de-listings through conducting targeted monitoring. This work has resulted in a number of specific projects or de-listing analyses as well as the incorporation of minimum data requirements and formal documentation protocols.

In 2010, updates or changes to the 303(d) list have originated from both targeted watershed assessment and planning update, which involves conducting general assessments of all waters in a given watershed, as well as evaluating follow-up data and through specific assessments for those

waters that warrant a more detailed evaluation (waters indicated as “fair” or “poor” during the general assessment).

As stated above, a general assessment is simply the consistent application of key parameters and minimum results to all waters during evaluation; this broad, screening level analysis will often be followed by specific or ‘targeted’ assessments. Due to minimum data requirements and documentation standards, the majority of 2010 list updates will likely originate from planned, detailed specific assessments that have been studied by WDNR water quality biologists over time.

Figure 1. 2010 Data Assessment Flow Diagram



3.4 Use of Data from Other Sources

Non-Department Data Sources

In addition to Department-generated data, the Department biennially seeks information from partners and the public to use in its assessment of waterbodies. Partners include federal agencies such at the U.S. Geological Survey, the U.S. EPA and the U.S. Fish and Wildlife Service, other state agencies and Universities, regional planning commissions and major municipal sewerage districts. The Department issued a news release on June 9, 2009, notifying the public of their opportunity to submit applicable data no later than July 17, 2009. Guidance was also released at this time to explain how to submit third party data. If a third party has applicable data, Department staff review the data, the procedures used to collect the data and the procedures used to analyze the data.

The Department will review information provided by any individual or group at any time; however, the data used for listing purposes must have been obtained using documented quality assurance procedures that meet or exceed WDNR procedures. WDNR has an internal website that outlines our State Quality Management Plan. Data submitters outside of WDNR are referred to USEPA’s site for questions on quality assurance project plans at http://www.epa.gov/QUALITY/qapps.html.

Agencies and individuals submitting data for assessment purposes must show that a minimum number of samples were collected at appropriate sites and at critical periods, and that certified laboratories were used for sample analysis. If the quality assurance procedures are not adequate, staff will not be able to use the data for decision making in the current listing period but may consider collecting additional data to evaluate the water for possible listing in the future. If quality assurance procedures are adequate, WDNR will use this data, along with any additional data by DNR to evaluate and assess the water body for possible listing.

The Department may also assist outside groups in the design and implementation of data quality procedures necessary for data to be used by the Department. Department staff will consult with U.S. EPA water quality criteria guidance, state water quality standards, and use professional judgment to interpret the results of field sampling to determine whether or not water quality standards are being achieved. Groups outside of WDNR who regularly collect and submit data to WDNR may work with staff at Central Office to upload data into the SWIMS database to be considered as part of our evaluation and assessment process.

WDNR also supports a Citizen Based Monitoring Program (for streams and lakes). As stated in the DNR's Water Resources Monitoring Strategy for Wisconsin, "If citizens follow defined methodology and quality assurance procedures their data will be stored in a Department database and used in the same manner as any Department-collected data for status and trends monitoring defined in the Strategy." Level 2 stream monitoring data may be used to: 1) provide broader spatial and temporal coverage in stream water quality, 2) characterize a reference monitoring site, 3) assess water quality trends, and 4) contribute to Clean Water Act objectives.
Citizen data are currently used for general, Tier 1 water quality assessments, including broad-scale statewide assessments. If these data indicate a potential water quality problem at a specific site, additional data are collected by Department staff to verify the extent of the problem and determine if a waterbody should be placed on the impaired waters list.

Information Not Used to Add Waters or to De-list Waters

Information that is not considered representative of current conditions or that does not follow the Department's Quality Management Plan cannot be used in preparation of the 303(d) list. When this type of information is received by the Department, it is evaluated but is not considered sufficient for modifying the impaired waters list. The Department classifies these types of data as "evaluated" information. Information that the WDNR considers "evaluated" includes:

- Information provided by groups, other agencies or individuals where collection methods are not documented and thus the quality of the data cannot be assured,
- Projected stream or lake conditions based on changes in land use with no corresponding in-water data (i.e., desktop analyses).
- Visual observations that are not part of a structured evaluation; and
- Anecdotal reports.

Though not used directly to update the impaired waters list, "evaluated" data may potentially be used to flag areas where further monitoring may be needed for future listing cycles.

3.5 Quality Assurance and Laboratory Analysis

For all Tier 1 (baseline) monitoring supporting general and statewide assessments, quality assurance measures are described within each applicable chapter of the *Wisconsin DNR Water Division Monitoring Strategy*. For laboratory or sample analysis, the Department uses only

certified laboratories, primarily the State Lab of Hygiene and the University of Wisconsin Stevens Point Aquatic Entomology Laboratory. For targeted, or special, monitoring studies which are frequently used to discern impairment prior to listing a waterbody, quality assurance protocols, such as field blanks, duplicates or spikes, are incorporated as funds allow.

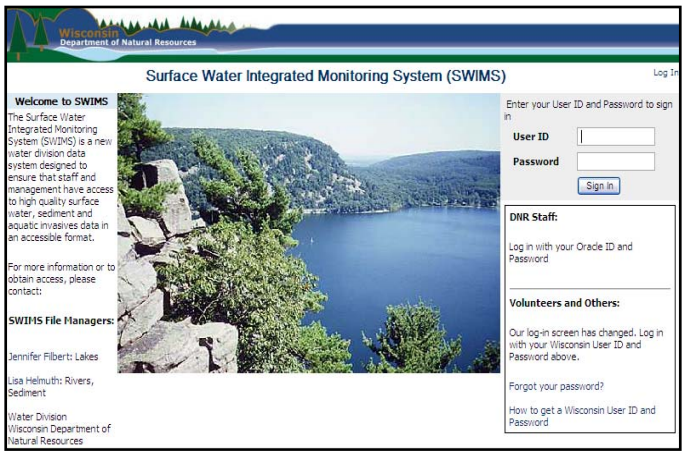
3.6 Data Management

Well organized and readily accessible data is fundamental to a smooth functioning, scientifically grounded Water Quality Standards Program. The WDNR has invested many resources into building and maintaining monitoring and assessment databases.

3.6.1 Monitoring Data - SWIMS

The Surface Water Integrated Monitoring System (SWIMS) (Figure 2) is a WDNR information system that holds chemistry (water, sediment), physical (flow), and biological (macroinvertebrate, aquatic invasive) data.

Figure 2. SWIMS Screen



SWIMS is the state's repository for water and sediment monitoring data collected for Clean Water Act work and is the source of data sharing through the federal Water Quality Exchange Network, which is an online federal repository for all states' water monitoring data. WDNR Fisheries and Water Quality Biologists use the system to document monitoring stations for both Watershed and Fisheries Program datasets, providing a gateway to fisheries management datasets housed at the U.S. Geological Survey.

The SWIMS database supports Citizen Based Stream Monitoring (CBSM) Level 2 Program volunteers. Level 2 volunteers come into the program with previous water monitoring experience, most volunteers having participated in the CBSM Level 1 Program. The Level 2 training focuses on the proper use of DNR field methods and specialized equipment, such as transparency tubes, DO and pH meters. The Level 2 Program Coordinator travels around the state and teaches volunteers to properly calibrate the instruments, use and store the equipment, record the data, etc. Volunteers chose monitoring locations on nearby streams with input from DNR staff. The data collected by Level 2 volunteers are entered into the SWIMS database and QA/QC'd by DNR staff. SWIMS also supports the Citizen Lake Monitoring Network (CLMN) datasets, which are collected by citizen volunteers and used directly for lake general assessment work.

3.6.2 Assessment Data -- WATERS

The Water Assessment, Tracking and Electronic Reporting System (WATERS), created in 2002 and put in full production in 2004, holds the following water program items:

- Water Division Objectives, Goals, Performance Measures, and Success Stories,
- Clean Water Act Use Designations and Classifications (NR102, NR104),
- Outstanding and Exceptional Resource Waters Designations (NR102),
- Clean Water Act assessment data, including decisions regarding a waterbody meeting its attainable use or whether or not the water body is considered "impaired"

- impaired waters tracking information, including the methodology used for listing, the status of the TMDL creation, and restoration implementation work;
- Fisheries Trout Classifications (Administrative Code, NR 1.02(7)), and
- Watershed planning recommendations, decisions, and related documents.

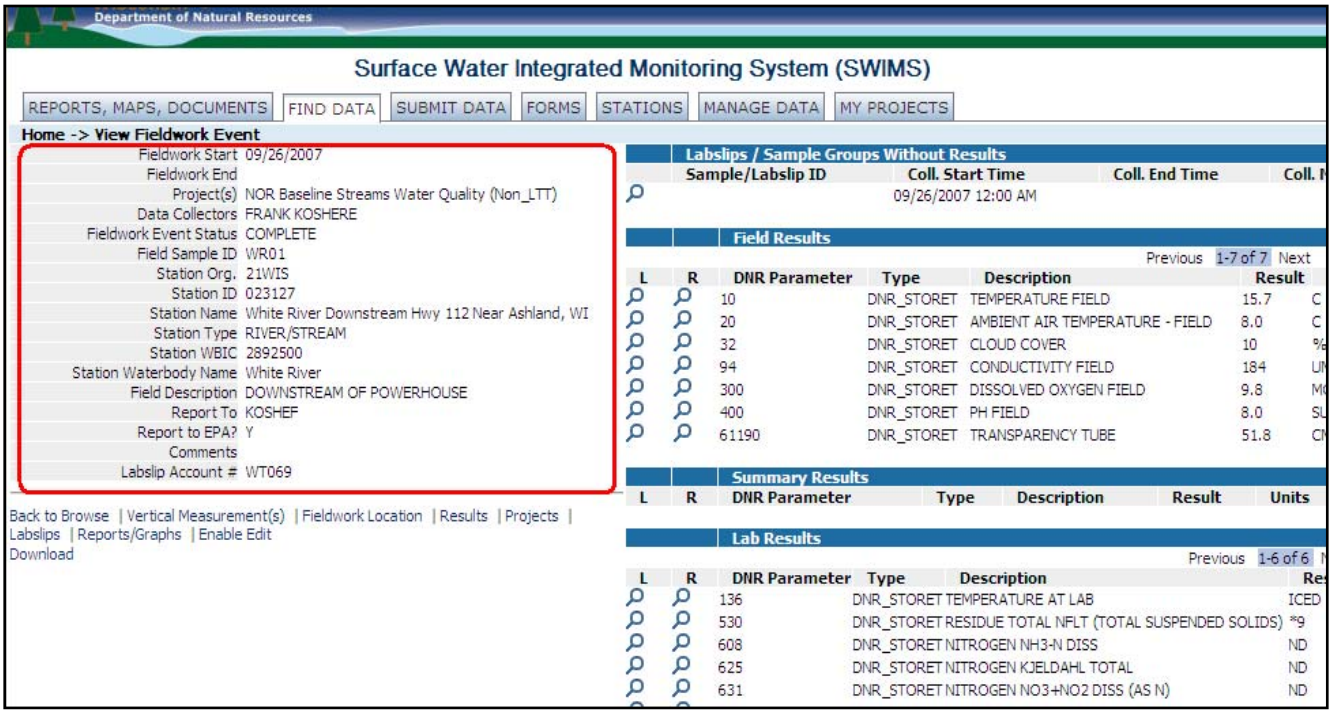
The WATERS system is closely integrated with the Surface Water Integrated Monitoring System (SWIMS).

4.0 Use and Interpretation of Data

4.1 Data Quality, Documentation

The creation of enterprise data systems for monitoring and assessment data has helped to provide a systematic location and process for documenting decision making behind general and specific assessments. The Surface Water Integrated Monitoring System (SWIMS) holds key information about monitoring data behind an assessment decision (Figure 3). Associated with each fieldwork event is the project, or reason behind the monitoring, as well as a place to hold equipment used,

Figure 3. Data Documentation

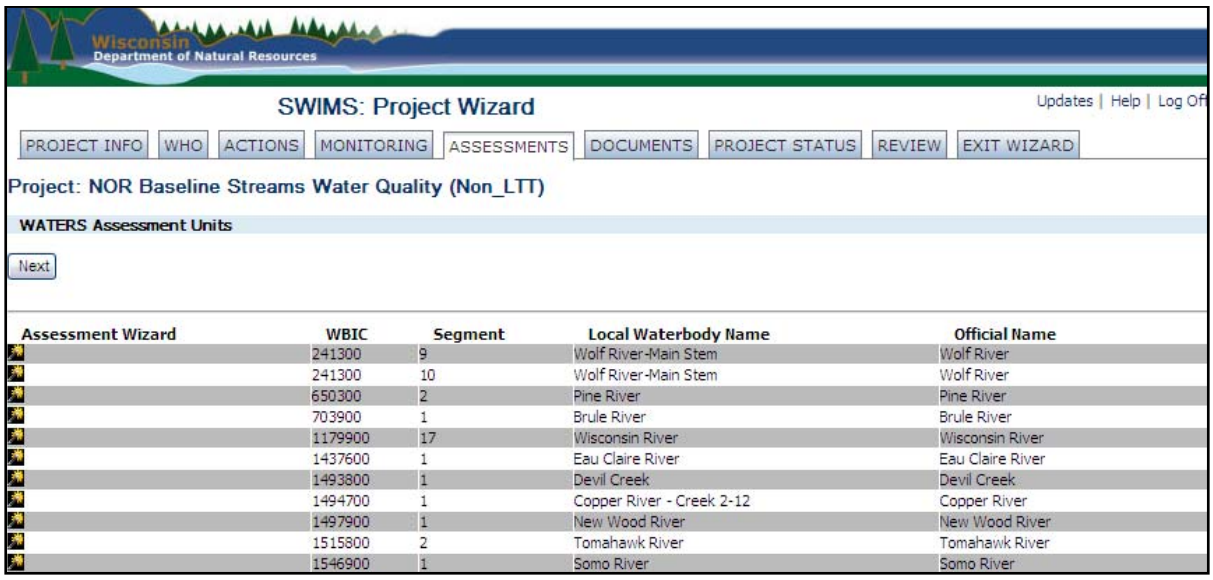


field procedures or collection methods, and associated documents or final reports.

In addition, within the Waterbody Assessment Tracking and Electronic Reporting System (WATERS), summary values and specific information behind the assessment decision are linked directly to the monitored waters (Figure 4). For example, the sample result above, through a database connection, is directly linked to the studied rivers and streams in the WATERS system. The picture below shows that when a monitoring station is documented in the Northern Region Baseline Streams Water Quality Study, the system links to assessment units in WATERS that are monitored. Through this association, individuals reviewing data and information in WATERS to

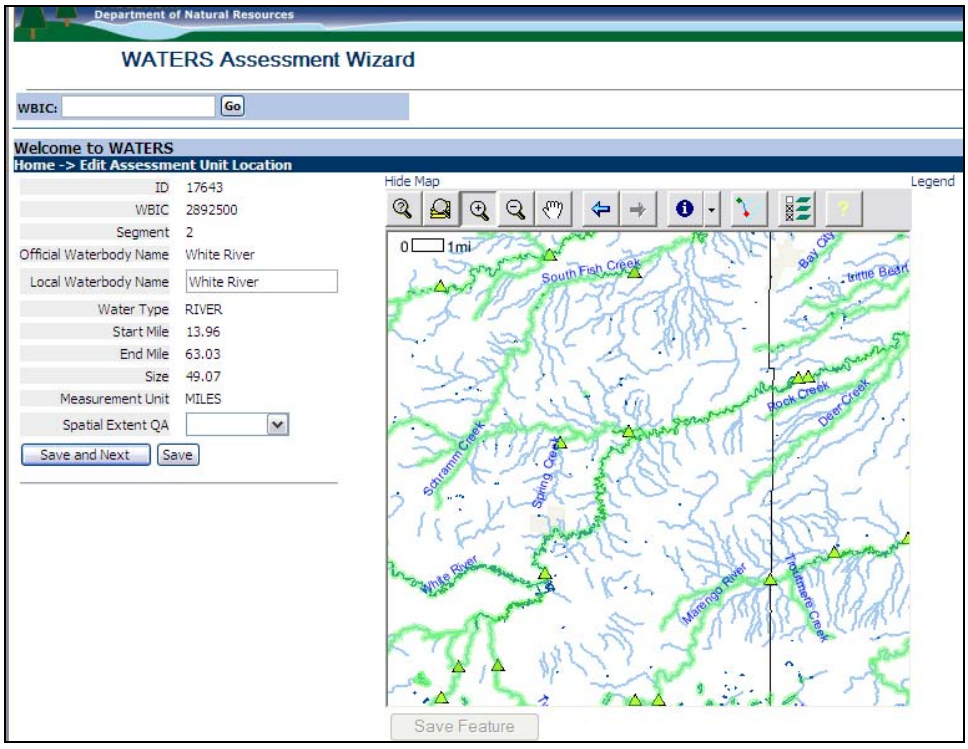
update assessment decisions can more readily find monitoring data and the purpose behind and methods used for that data collection effort.
By clicking on the assessment wizard icon in the monitoring system, the investigator is taken directly to the assessment unit in WATERS (Figure 5). The picture below shows the White River where the sample above was taken. The yellow triangles are monitoring stations; the bright triangles show monitoring data collected within the last 5 years. A more muted yellow indicates data collected from 5 to 10 years ago.

Figure 4. Link to Assessments



Assessment Wizard	WBIC	Segment	Local Waterbody Name	Official Name
	241300	9	Wolf River-Main Stem	Wolf River
	241300	10	Wolf River-Main Stem	Wolf River
	650300	2	Pine River	Pine River
	703900	1	Brule River	Brule River
	1179900	17	Wisconsin River	Wisconsin River
	1437600	1	Eau Claire River	Eau Claire River
	1493800	1	Devil Creek	Devil Creek
	1494700	1	Copper River - Creek 2-12	Copper River
	1497900	1	New Wood River	New Wood River
	1515800	2	Tomahawk River	Tomahawk River
	1546900	1	Somo River	Somo River

Figure 5. Assessed Water



Data contained in WATERS is available for the public via the WDNR 'Surface Water Data Viewer' located at: http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer. Information such as monitoring stations, WPDES permits, impaired reaches, etc. can be accessed from this site. Over the next few years, WDNR hopes to have dynamic webpages created for Impaired Waters where the public can find water quality monitoring data, the pollutants of concern and corresponding impairments, whether not a TMDL has been developed, and what possible management solutions are for restoring the waterbody. These pages will be directly linked to WATERS, so when a waterbody is updated in the WATERS database, it will automatically be changed on the webpage.

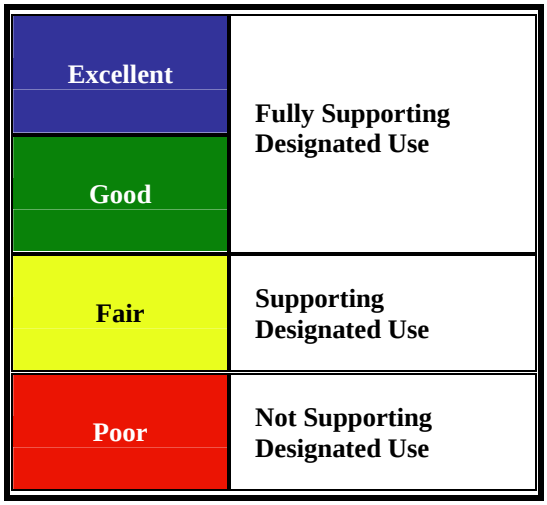
4.2 Condition Documentation Policies

In 2006 the WDNR began requiring the creation of data documentation sheets for all waters listed as impaired or proposed for inclusion on 303(d) List (Appendix A). With over 500 waters in the state currently on the list of impaired waters, this challenging documentation requirement is still underway. However, it is the goal of the WDNR to have these data documentation sheets available and accessible as soon as possible, given resource constraints.

5.0 General Aspects of Data Assessment

For 2010 WDNR has prioritized the creation and use of clearly defined, publicly accessible methods for collection and analysis of data to ensure defensible decisions regarding water quality. In the creation of this document, WDNR relied heavily upon the U.S. EPA *Consolidated Assessment and Listing Methodology (CALM)* (2002), as well as guidance documents prepared by other states including: Michigan, Minnesota, North Carolina, Ohio, Oklahoma, Pennsylvania, and Washington.

Figure 6. General Water Condition Continuum



Data collected under WDNR's tiered monitoring system are used to identify where a specific river or stream falls on a continuum of water condition, which is the core *assessment* to determine if a waterbody is attaining its applicable designated uses.

WDNR uses four levels of water condition to represent water's placement in the overall water quality continuum (Figure 6). Waters described as *excellent* and *good* clearly attain each assessed designated use; waters described as *fair* are also meeting their designated uses, but may be in a state that warrants additional monitoring in the future to assure water conditions are not declining. Waters that are described as *poor* **may** be considered *impaired,* and may warrant placement on Wisconsin's Impaired Waters List in accordance with Section 303(d) of the federal Clean Water Act.

Staff will make a conscious decision to determine if available data are representative of the conditions (e.g. trout IBI for a warm water stream indicating "poor" would not be applicable). Additionally, the decision of whether or not a Use Attainability Analysis should be considered to justify an alternative use. If DNR staff chooses to exclude data, these decisions will be well documented within our database, along with recommendations for management actions.

This section outlines minimum data requirements, indicators and associated thresholds to measure attainment status of Wisconsin lakes, rivers, and streams. For purposes of this guidance, the term "*indicator*" is used to describe the various measures of water quality, including those that represent physical, chemical, biological, habitat, toxicity, and body tissue data. The term "*threshold*" is used to address the numeric value or narrative description that distinguishes attainment of the water quality standards versus values that indicate impairment. In the simplest sense, a waterbody is defined as "impaired" when it is not achieving any of its designated uses – generally as a result of some human-induced activity that prevents the use from being fully attained.

5.1 Data Requirements

A minimum data requirement has been established for most each indicators including: a) period of record, b) sampling period (e.g., season, month, time of day) where appropriate, c) sample type, and d) sample size. Two key goals of establishing these requirements are to allow WDNR staff to: 1) collect representative data as efficiently as possible with limited staff and fiscal resources; and 2) use those data in a manner that minimizes the chance of incorrectly characterizing that attainment status of any particular water while recognizing that extremely large datasets are neither available nor necessary for many water bodies in the state.

Period of Record: Data from **the most recent 10-year period** are to be used when making use assessments. Such a window ensures that the data are representative of a wide range of factors that affect water quality (i.e., weather and flow) while still being contemporary enough to document "current" water quality conditions. Further, this 10-year window also increases the chance that the preferred minimum data conditions are satisfied allowing for a more robust and defensible assessment decision. The Department is not obligated to use all data that fall within the 10-year time frame if those data are determined to be unrepresentative of the stressors and normal characteristics of any given water. For example, a biological parameter such as an IBI may have been calculated on stream characterized as a warm water forage fishery. However, the IBI calculated was a coldwater IBI; therefore that data is no longer applicable to that waterbody. Within the 10-year window, decisions using data from within the last 5 years are considered to be based on "monitored" data and decisions made from data between the 5 to 10 year windows, as per U.S. EPA guidance, are considered "evaluated". If a consolidated dataset from a slightly different timeframe, such as from two to eight years old is available and if the biologist determines that the dataset represents the water's current conditions, then this water may be considered "monitored" for the purposes of the state assessment program.

Sampling Period: The sampling period required for assessment decisions depends upon the subject parameter and water feature involved. For example, collecting macroinvertebrate samples in spring, though possible, heightens the likelihood that individuals will be missed; sampling in fall is a preferred sampling period for this indicator. Each assessment below (fish and aquatic life – lakes, streams; recreation, etc.) identifies the preferred sampling period.

Sample Type: The indicator being evaluated will dictate what type of samples should be used for an assessment decision. In some cases, samples may be collected as instantaneous measurements vs. continuous measurements. In other cases, the choice may be between a grab sample and a composite sample. In either case, the selection of the values should result in using the most representative data available.

Sample Size: Sample size is a much studied topic among water quality managers seeking to achieve balance between collecting enough data to make sound decisions while not collecting so

much that scant resources are expended without adding significant value to the resulting decision. In U.S. EPA's CALM Guidance (2002), it is suggested that a sample size of 30 or more values (for water chemistry parameters) has good power of detecting exceedance values of water quality standards. U.S. EPA acknowledges that state agencies may use small data sets to make assessment decisions, but encourages a commitment to collection of enough data to support data quality objectives. In fact, a review of other state assessment methods reveals that many states require sampling sizes of as few as 10 values and even 5 in some instances.

WDNR will make assessment decisions based on smaller, representative datasets. Minimum data set requirements are generally higher for indicators that exhibit high degrees of variability (e.g., temperature). When making assessment recommendations, staff should use all representative data available to ensure that the minimum data requirements are met. It is important that data are collected to determine a definitive pattern and response in the biological community. However, in those cases where the minimum data requirement is not met, a waterbody may still be identified as impaired if the available data provide overwhelming evidence of impairment. More information on how to make assessment decisions in those cases is available in the professional judgment section.

5.2 Key Indicators

General Assessments

The choice of indicators to assess a waterbody's condition was based on the Department's *Water Division Monitoring Strategy* – a program that relies on a *tiered* approach to monitoring to maximize statewide coverage of sampling effort while doing so as efficiently as reasonably possible (more information available at http://dnr.wi.gov/org/water/monitoring/strategy.htm)

Examples of General Assessment data include fish and macroinvertebrate IBI's, at a minimum of one per stream segment. Fish surveys are most valuable when conducted in summer, and macroinvertebrate sampling is best in fall. For lakes, TSI Values (based on Secchi disk or chlorophyll-a data) are determined by satellite-inferred or in-lake data during the summer index period of July 15th – September 15th. At these three samples per season per parameter are needed in a 5-year period for in-lake data. If satellite-inferred, then 1 value from each of 3 different years. Other parameters may also be used in general assessments such as *E. coli* to assess recreational uses and fish tissue sampling to determine specific Fish Consumption Advice.

Specific Assessments

Detailed assessments are tailored to the specific concerns for a waterbody. The assessment can include any or all of the parameters. Indicators are sub-divided into the following categories:

- Conventional physical-chemical indicators
- Toxicity-based indicators
- Biological indicators
- Lake eutrophication indicators

During Specific Assessments, more detailed information is collected to determine relationships between pollutants, impairments, and stressors and may include a watershed inventory to identify possible sources of pollutants.

5.3 Assessment Thresholds

When it is determined that a waterbody should be placed within a particular condition group (excellent, good, fair, or poor), the assessment threshold will be applied when placing waters on

the Impaired Waters List. These thresholds are based on numeric water quality criteria included in Chapters NR 102-105 (Wis. Adm. Code), WDNR technical documents, and federal guidance. In some cases, qualitative thresholds based upon narrative standards may be used to make assessment decisions. In those cases, a thoroughly documented analysis of the contextual information should be used in conjunction with professional judgment to collectively support a decision.

5.4 Exceedance Frequency

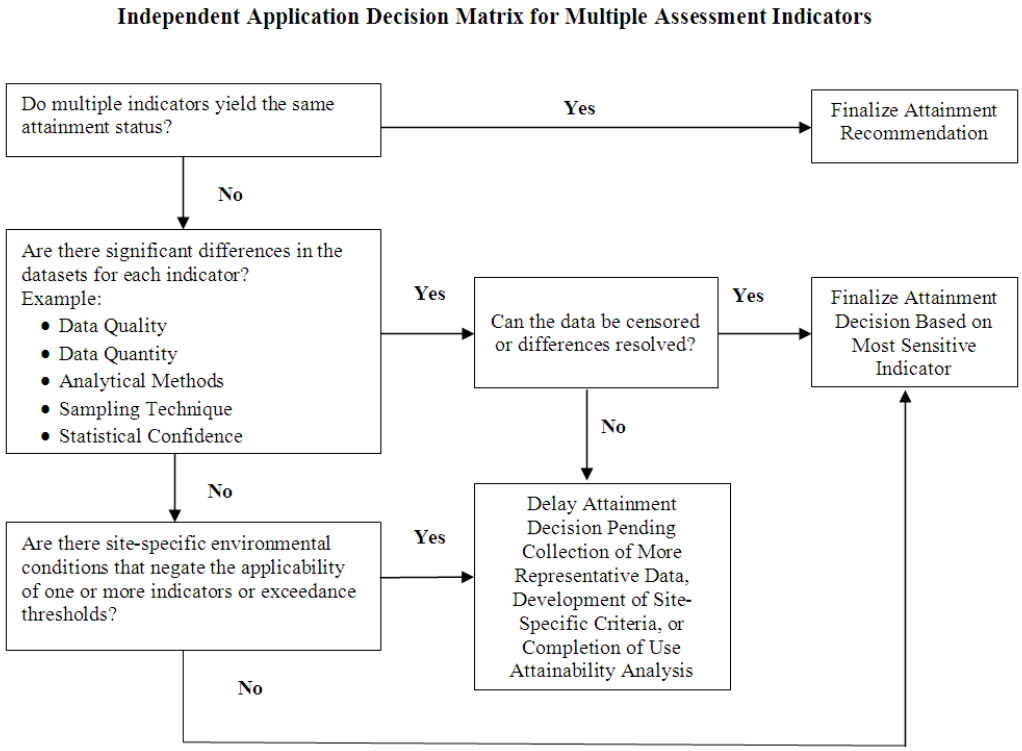
The numbers of times a water quality standard may be exceeded over a period of time and still provide the desired level of protection is referred to as the *exceedance frequency. A* complete and representative data set for each parameter is required to make an assessment decision. When those data are evaluated, exceedance frequency should be used to make a final assessment decision. The exceedance frequency varies for each indicator and under ideal circumstances would be representative of the relationship between *a number of exceedance and the time it takes for a lake, river, or stream community to recover from an exceedance event.* The exceedance frequencies for each parameter are defined in Table 6 and Table 10 for FAL uses and determined partially on U.S.EPA guidance. Very few models can accurately predict the recovery rate of any particular aquatic community**.** Best professional judgment is also encouraged to make an assessment decision.

5.5 Independent Applicability

When minimum data requirements have been met and available data are representative of current water quality, water should be considered "impaired" if the attainment threshold for any single indicator has been exceeded. This decision philosophy is referred to as *independent applicability* and is consistent with the Clean Water Act requirements to protect biological, chemical, and physical integrity of surface waters. There are exceptions to this philosophy which encourages further investigation into the reasons why data may not agree with each other before making an attainment decision. When there are conflicting results from multiple datasets, WDNR staff should review all available data and determine if there are significant issues with any of the data sets that preclude a decision from being reached when one indicator suggests non-attainment. In limited cases, *a hierarchy of the indicators may be appropriate*. For example, biological indicators (e.g., fish or macroinvertebrate IBI) for assessment of fish & aquatic life use may have precedence over chemical indicators in the impairment decision process. However, this hierarchical approach should be used with caution, knowing that exceedance of chemical indicators may correspond to a more recent event that was not reflected in the biological community data due to differences in collection periods or delays in community response. In such a case, a decision to rely on a hierarchical approach would be inappropriate.

A decision matrix is described in Figure 7 to describe the process for not making attainment decisions using independent application. Cases where this process is used will be rare and will be well documented in the 303(d) Impaired Waters Data Documentation Form for that waterbody.

Figure 7. Independent Application Matrix



5.6 Professional Judgment

Staff most familiar with a waterbody should be directly involved in the assessment decision. Their knowledge and experience with the factors that influence water quality should be considered when reviewing and interpreting available data. Professional staff should consider a myriad of issues to determine the most relevant and appropriate data to use for attainment decisions, including: data quality, frequency and magnitude of exceedances, weather and flow conditions during sample collection, anthropogenic or natural influences on water quality in the watershed, etc. If professional judgment results in the censoring of any available data, clear documentation of the reasons for doing so must be included in the final attainment decision. Again, whether a waterbody is listed as impaired, or the decision has been made not to list a waterbody, all decisions will be ***well documented*** within our database and future management recommendations will be requested on waters that were not listed (for example, a formal use designation change is needed in order to list the water as impaired, and a recommendation would be made in WATERS to reflect this need).

Some questions to be considered include:

- Were samples collected and analyzed in accordance with established QA/QC protocols?
- Is the data representative of current water quality conditions?
- Are the data from a wide range of weather and flow conditions, or are they limited for critical hydrological regimes (low and high flows)?
- Have land uses or point sources changed substantially since the data were collected?

- Are data representative of the entire period of record or are they clustered and non-representative?
- Are the minimum data requirements met? If not, do the limited data provide overwhelming evidence of impairment (e.g. not enough data collected, but evident fish kills and blue green algae blooms have been documented)?
- What are the duration, frequency, magnitude and timing of threshold exceedances?
- Is there any contextual information (e.g., naturally occurring conditions) that would explain the exceedance?

5.7 Weight of Evidence

Except where alternative procedures are specified in administrative rules, Department staff review all available data relating to numeric and narrative criteria to determine if those criteria are not being met. Staff takes into account the following:

- The applicability of data to critical periods. For example, data collected during the summer months are most appropriate for lakes with severe algae conditions.
- The frequency and duration of a criteria violation. In some cases, there is a natural variability that occurs that may cause criteria not to be met for a short period of time. In other cases, an "event" such as a large amount of runoff during a rainfall or snowmelt may cause a periodic excursion from a criterion.
- The likelihood of stress on aquatic communities, including fish, insects, mussels, snail, plants or other biota.

Dissolved oxygen again provides a good way of describing how the factors of frequency, duration and magnitude may result in a decision about whether or not to include a waterbody on the impaired waters list. In waters where measured dissolved oxygen is very low (magnitude) and data are available to indicate this occurs often (frequency), the Department would be inclined to recommend a waterbody as "impaired." In some cases, the time during which the dissolved oxygen actually falls below the criterion may be measured in minutes (duration) while in others, it could occur for hours at a time. This is not uncommon for those streams that exhibit what is known as a diel fluctuation. This occurs in streams where higher densities of plants and algae create very high concentrations of dissolved oxygen during the day when photosynthesis is active, but the concentrations drop to very low levels at night into dawn when respiration is consuming oxygen instead of producing it. Diel fluctuations may occur regularly during a summer—especially in waters where there may be excessive nutrients. Such diel fluctuations coupled with exceedances of high magnitude may cause stress on the aquatic community and result in the Department recommending the water as "impaired." In contrast, the Department may not recommend a waterbody for listing when data indicate dissolved oxygen concentrations below the criterion occur very infrequently and only last for a short period of time; this is not uncommon when a stream receives stormwater runoff during a rainfall or snowmelt event. In these cases, the stress to aquatic life may be minimal.

In all cases, Department staff will look for corroborating information, such as the various biological indices that can be used to measure stress within a fish and aquatic life community. Data indicating the type and number of species of fish, macroinvertebrates (such as insects or snails), plants, or algae are evaluated. The state has available a number of datasets, including fish assessment data, habitat assessment data, and macroinvertebrate data. These datasets provide a quantitative approach to be used when determining whether a waterbody should be listed.

In addition, researchers have access to water chemistry data that include dissolved oxygen, phosphorus, pH, temperature, toxic substances, and others. If the suite of available data does not suggest an evident impairment, then the water will not be listed, but will be recommended for additional monitoring through Tier 2, as resources allow. The Department will provide a rationale for those cases where data are available that show that a water quality criterion has been exceeded, but the water has not been recommending for the impaired waters list. In most cases, the indicator has not reached the magnitude, duration or frequency to warrant placing a waterbody on the list.

5.8 Data Quality

Information used for purposes of general or specific assessments must be consistent with the WDNR Quality Management Plan or have been obtained using comparable quality assurance procedures. Proposed changes to the 303(d) List must be based on the specific assessment methods identified and used by Department staff or equivalent, documented methods. Specific assessments must be based on monitored data that are site-specific and considered representative of current conditions.

In general, monitored information contained in the Department's databases will be used, unless more recent information is available. These data will be used unless experts determine that the data are no longer representative of current conditions. Department staff will determine if changes in the watershed have occurred, such as significant changes in land use, decreases of nonpoint source controls, or increases in the amount of pollutants discharged from point sources. If significant changes have not occurred, available database results will be used.

Previously Listed Waters

With the exception noted below, all water bodies included on a previous Impaired Waters List will remain on the list even if the methodology for listing contained in this document is not satisfied. When the Department proposes to remove a waterbody from the Impaired Waters List, it will do so only after it has had an opportunity to monitor the water or has access to contemporary, representative, and high quality data that warrant a "de-listing." However, when a change to a water quality standard has been approved and an exceedance of that standard is the reason a waterbody was included on the Impaired Waters List, the Department may propose to remove the water from future lists if the revised standard is achieved – even if the conditions of the WisCALM methodology are not satisfied.

5.9 Attainment Decisions and Associated Documentation

The end result of this assessment effort is to determine the appropriate water quality condition for each water in Wisconsin. Ultimately decisions on whether or not a waterbody is impaired will be made based on this information. When minimum data requirements are met, an attainment decision should be made and documented unless there are circumstances that warrant a non-decision. When a decision is made to not list the water due to few or insufficient data, that water should be included on a list of waters to be monitored as soon as reasonably possible in order to allow sufficient data to be available for the next 303(d) listing cycle.

Regardless of the attainment decision, it is critical that a well-documented and easily accessible description of the data used and the conclusions reached be prepared and included in WDNR files. A data documentation sheet is completed for all assessments.

5.10 Waters Not to Be Included on the 303(d) List

In Wisconsin's database, many waterbodies characterized as poor or fair may be meeting water quality standards. These waterbodies appear to have water quality conditions that meet the minimum requirements for a designated use. However, it may be possible that *implementation of certain stream management practices may enhance the overall biological productivity or ecological condition of some of these waterbodies.* These waters will be flagged to be closely monitored to determine a change in water quality or biological productivity, as resources allow. For example, a coldwater stream may meet state water quality standards designated use criteria for a cold water stream; however, runoff problems may be reducing the biological productivity of this stream. While this water may be put on a watch list to monitor trends and conduct follow up evaluations, the water would not be considered impaired.

5.11 Waters to Be Included on the 303(d) List

Waters will be added to the 303(d) Impaired Waters List when water quality standards are not being met. A waterbody may be considered impaired if a numeric or narrative water quality criterion is not met. These criteria are specified in NR 102, 103, and 105 of the Wisconsin Administrative Code for water quality indicators and/or several pollutants. For example, Wisconsin's numeric water quality criteria state that a stream that supports a warm water sport fish community should be able to maintain a minimum dissolved oxygen concentration of 5.0 mg/L. In contrast, a stream that supports a cold water community may not be able to tolerate anything less than 7.0 mg/L during times of spawning or during the egg incubation period for many species of fish.

In this example, dissolved oxygen is not a pollutant, rather, it is the impairment or indicator value that changes when the level of pollution in a stream changes. In the case of dissolved oxygen, a lower number or concentration generally indicates stress and indicates that there is less oxygen available to fish and other aquatic life that live in the stream.

A rigorous assessment and 303(d) listing process is necessary as there are implications of a listing a waterbody as impaired. All waters on the 303(d) List must undergo a Total Maximum Daily Load (TMDL) analysis or other equivalent water quality management plan. Waters that are listed may also require potential restrictions for Wisconsin Pollutant Discharge Elimination System (WPDES) and other State permits.

6.0 Assessment Methods

The assessment of whether a waterbody is meeting a specific designated use inherently requires comparison to a water quality criterion or a well-defined reference or attainable use as a guide for narrative standards if numeric criteria do not exist. For some assessments, the WDNR applies the same water quality criterion or threshold across all resource types. An example is the use of the same fish tissue mercury concentration for all our lakes and rivers in the assessment of Fish Consumption Uses (Public Health and Welfare).

For other assessments methods, a single criterion or threshold is not applicable across all the different waterbody types. For example, large shallow lakes in the southern portion of the state have naturally higher nutrient concentrations then the small shallow lakes in the northern part of the state. For these types of assessments, an initial classification analysis is required to ensure the assessment process applies the correct "attainable" threshold.

Sections 6.2 through 6.4 provide assessment methods for Fish and Aquatic Life Use for lakes, streams and rivers. For some assessments, similar evaluation tools are used. For example, where applicable, the WDNR uses the same macroinvertebrate metric (Macroinvertebrate Index of Biological Integrity or M-IBI) to assess different sizes or types of streams. For other waterbody types, different tools are used that account for inherent differences in water condition. For example, the WDNR uses **three** different fish community index tools for wadeable streams depending on the type, or classification, of the stream – one for cold water, one for warm water, and one for small warm water streams.

Section 6.6 details the assessment methods that do not vary with waterbody type – for example Public Health and Welfare (or Fish Consumption) applies statewide fish tissue contaminant criteria across all waterbody types for Public Health and Welfare (fish consumption).

6.1 Lakes: Fish and Aquatic Life Assessment Methods

6.1.1 Lake Classification

WDNR has classified or grouped similar lake types based upon physical data. Specifically, lake size, stratification characteristics, hydrology and watershed size are identified as the primary influences to a lake and, to a large degree, these determine the natural communities each lake type supports. Using this information, lakes should fall into one of 10 natural community types (Table 1).

Table 1. Lake Natural Communities

Natural Community	Stratification Status	Hydrology
Lakes <10 acres – Small	Variable	Any
Lakes ≥10 acres		
• Shallow Seepage	Mixed	Seepage
• Shallow Headwater	Mixed	Headwater Drainage
• Shallow Lowland	Mixed	Lowland Drainage
• Deep Seepage	Stratified	Seepage
• Deep Headwater	Stratified	Headwater Drainage
• Deep Lowland	Stratified	Lowland Drainage
Other Classification (any size)		
• Spring Ponds	Variable	Spring Hydrology
• Two-Story Lakes	Stratified	Any
• Impounded Flowing Waters	Variable	Headwater or Lowland Drainage

The WDNR recognizes that lakes may vary geographically. Spatial data are available for each of the lakes. Regional differences in soils, climate and land use may explain additional variation in the bio-indicator metrics used in the classification of lakes[3]. However, WDNR has determined that lake size, hydrology and depth are more critical factors for initial classification of lakes, and that regional differences are secondary.

[3] Past Wisconsin studies have used eco-regions to explain landscape variability and EPA has proposed using this framework for assessment (Omernik 1987).

Size: Small vs. Large - Lake classification begins by first separating lakes into those 10 acres and greater and those less than 10 acres.

Small Lakes – Lakes less than 10 acres are classified into the Small Lake community. These lakes are uniquely different from communities in larger lakes but there is limited monitoring data available in Wisconsin. Currently there are no quality thresholds set for water quality, fisheries, or aquatic plants for lakes less than 10 acres. Therefore the 10 acre threshold reflects the limited availability of monitoring data with which to set thresholds for assessment. To address these small lakes in the future, Wisconsin may look to emerging wetland assessment tools for guidance.

Large Lakes – Lakes 10 acres or more are classified as Large Lakes. Large Lakes are further subdivided, by stratification status, hydrology, and watershed size, as shown below.

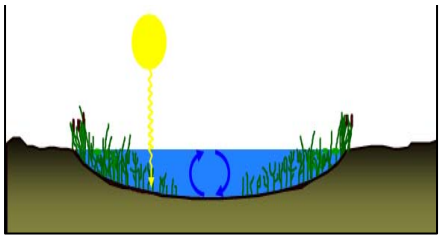
Stratification Status: Shallow (Mixed) vs. Deep (Stratified) – Lakes that are 10 acres or greater may be further characterized by their tendency to mix or stratify thermally. Stratification is an important factor in determining overall lake water quality and availability of suitable habitat for fish and aquatic life. An equation developed by WDNR Researchers (Lathrop and Lillie, 1980) is used by WDNR to identify whether a lake is categorized as Deep (Stratified) or Shallow (Mixed)[4]. Although this model is used to automatically generate lake classifications from the WDNR database, staff is encouraged to use field data on depth, area, residence time and temperature profiles to refine the model-based lake classifications.

The Lathrop/Lillie equation is represented by a ratio calculated as follows:

$$\frac{\text{Maximum Depth (meters)} - 0.1}{\text{Log 10 Lake Area (hectares)}} \quad \text{or} \quad \frac{\text{Maximum Depth (feet)}*0.3048 - 0.1}{\text{Log 10 Lake Area (acres)}*0.40469}$$

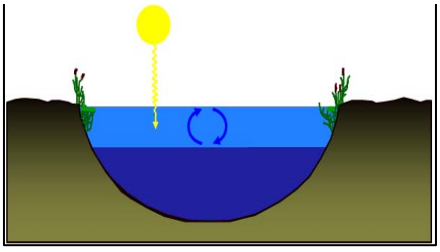
Shallow (Mixed) – When using the Lathrop/Lillie Equation, any value <3.8 predicts a mixed lake, which is placed in the Shallow category. Mixed lakes tend to be shallow, well-oxygenated, and may be impacted by sediment re-suspension. In addition, shallow lakes have the potential to support rooted aquatic plants across the entire bottom of the lake (Figure 8).

Figure 8. Shallow, Mixed Lake



Deep (Stratified) –When using the Lathrop/Lillie Equation, any value >3.8 predicts a stratified lake, which is placed in the Deep category. Stratified lakes tend to be deep, with a cold water refuge for fish, and the potential for anoxic conditions (without oxygen) in the bottom layer which may release nutrients from sediments into the water column. Aquatic plants are typically confined to shallow (littoral) waters around the perimeter of the lake (Figure 9). Stratified lakes exhibit thermal layering throughout the summer or they undergo intermittent stratification.

Figure 9. Deep, Stratified Lake

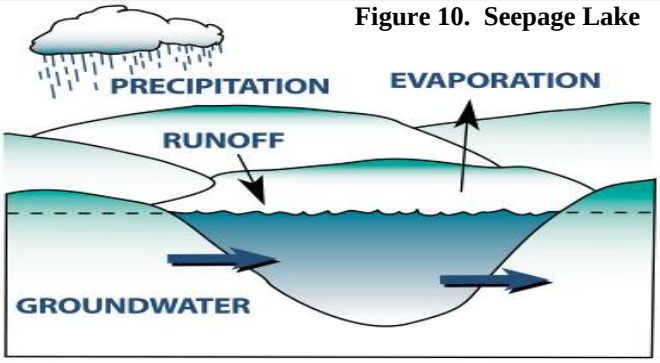


[4] WDNR's decision to use the Lillie/Lathrop equation to determine stratification status also examined several other models for predicting lake stratification based on depth and area. These included work by Emmons et al. (1999), the Osgood Index (Osgood 1988), a Minnesota "lake geometry ratio" (Heiskary and Wilson 2005) and a model by WDNR Researchers (Lathrop and Lillie, 1980). The Lathrop/Lillie Equation was selected because it better distinguishes between clearly stratified and mixed lakes.

Hydrology and Watershed Size – Lake hydrology is the measure of the relative inflow/outflow of surface water compared to direct precipitation and groundwater inputs. Lake hydrology and lake watershed size are two other critical factors in lake classification. Both Deep and Shallow Lakes are further divided based on hydrology. The terms "seepage" or "drainage" are best used to describe the appropriate hydrologic category for lakes.

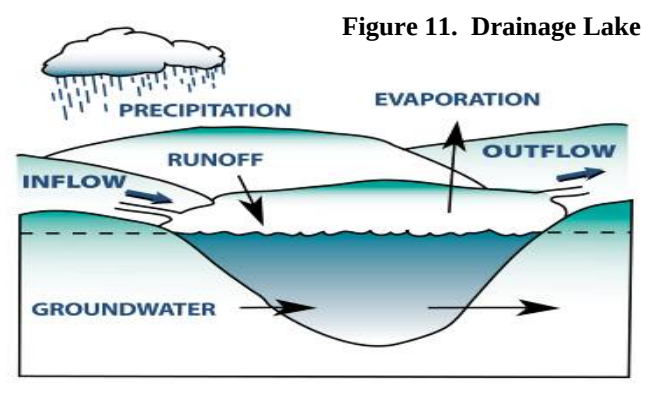
Seepage Lakes – A lake with no surface water inflow or outflow is considered a seepage lake (Figure 10). A seepage lake is receiving water from two sources: primarily from precipitation, both as overland sheet flow to the lake and directly onto the lake and seepage into the lake from groundwater. Seepage lakes tend to have lower nutrient concentrations, due to relatively small catchment areas, and may be poorly buffered against acid deposition.

Figure 10. Seepage Lake



Drainage Lakes – A lake is classified as a drainage lake if there is surface water flow into and/or out of a lake from a river or stream (Figure 11). Drainage lakes tend to have more variable water quality and nutrient levels, depending upon the amount of land area drained by the lake's watershed. For this reason, watershed size also plays a key role in the classification of Drainage Lakes, as shown below (Emmons, et al, 1999).

Figure 11. Drainage Lake



- Headwater Drainage Lakes: If the watershed draining to the lake is less than 4 square miles, the lake is classified as a Headwater Drainage Lake.
- Lowland Drainage Lakes: If the watershed draining to the lake is greater than or equal to 4 square miles, the lake is classified as a Lowland Drainage Lake.

Figure 12. Distribution of Shallow Lake Types

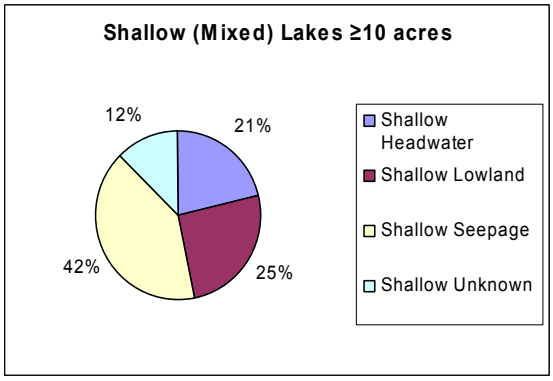
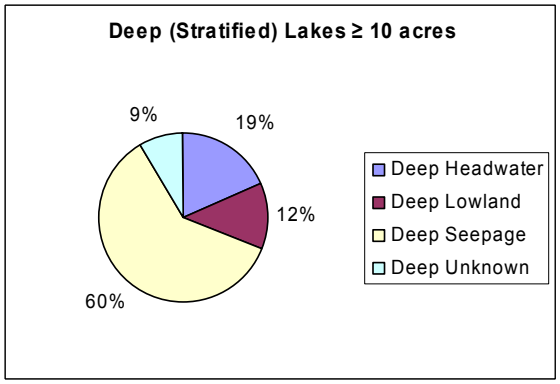


Figure 13. Distribution of Deep Lake Types



Other Classifications (any size) – Three other classes representing unique natural communities are recognized in this classification scheme: Spring Ponds, Two Story Lakes, and Impounded Flowing Waters.

Spring Ponds –Spring ponds typically contain cold surface water and support coldwater fish species and are most often shallow headwater lakes. In order to be included in this category there must be documentation of a current or historical cold water fishery (e.g. stream trout) and evidence of spring hydrology.

Two Story Lakes – Two-story lakes are often more than 50 feet deep and are always stratified in the summer. They have the potential for an oxygenated hypolimnion during summer stratification and therefore the potential to support coldwater fish species in the hypolimnion. In order to be included in this category, documentation of a current or historical native cold water fishery (e.g. cisco, lake trout) will be necessary.

Impounded Flowing Waters – This classification includes waterbodies created by dams (mill ponds, reservoirs, flowages, and other impoundments) with a residence time of 14 days or more (under summer (June – Sept) mean low flow conditions with a 1 in 10 year recurrence interval (US EPA 2000)). Many natural lakes also have dams or water level control structures. However, to be included in the Impounded Flowing Waters category, the dam or water level control structure, must account for more than half of a waterbody's maximum depth. Impoundments with a residence time of less than 14 days should be covered under the rivers and stream assessment methodology process.

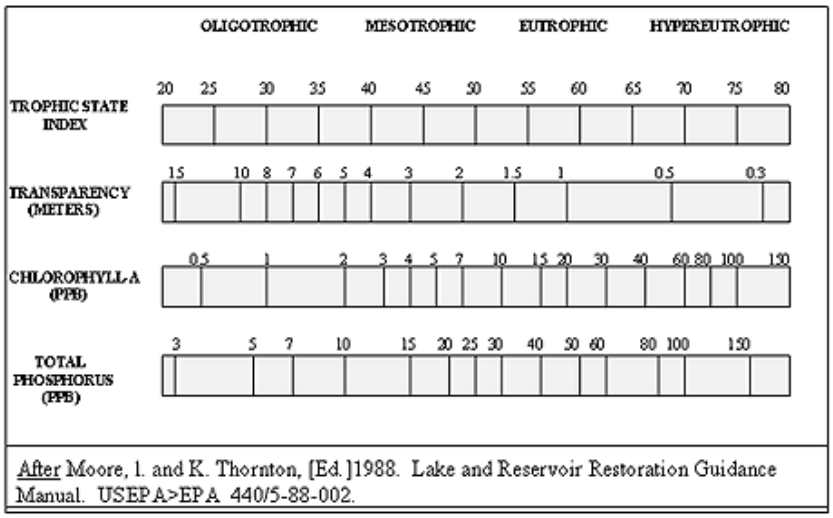
6.1.2. Lake Fish and Aquatic Life Assessment Methods

The WDNR focuses on in-lake water quality metrics to assess a specific lake's fish and aquatic life designated use. These in-lake parameters correlate strongly with fish and other aquatic life communities (macro-invertebrates, aquatic plants, etc.) within in a lake.

General Condition Assessment – Trophic State Index

A number of different metrics use various in-lake parameters to assess the health of lakes across the nation and world. The most commonly used index of lake productivity is the Carlson's Trophic State Index (TSI) which provides separate, but relatively equivalent, TSI calculations based on either chlorophyll-*a* concentration (CHL) or Secchi depth (SD, for which Wisconsin also uses satellite clarity data as a surrogate)[5]. Because TSI is a prediction of algal biomass, typically the **chlorophyll-*a* value** is a better predictor than Secchi or satellite data. Water clarity as measured by Secchi depth or

Figure 14. Continuum of Lake Trophic States in relation to Carlson Trophic Status Index



After Moore, l. and K. Thornton, [Ed.]1988. Lake and Reservoir Restoration Guidance Manual. USEPA>EPA 440/5-88-002.

[5] Carlson also provides an equation to convert total phosphorus concentration to TSI, but WDNR is not using that equation for purposes of water quality assessments or 303(d) Impaired Waters Listing.

satellite is a practical measure of algal production and water color. Algal production is known to be highly correlated with nutrient levels (especially phosphorus). High levels of nutrients can lead to eutrophication and blue-green algae blooms. This in turn limits the amount of available light to macrophytes and adversely affects other aquatic organisms. Information from each of these parameters is valuable because the interrelationships between them can be used to identify other environmental factors that may influence algal biomass.

TSI values range from low (<30), representing very clear, nutrient-poor lakes, to high (>70) for extremely productive, nutrient-rich lakes (Figure 14). Very few lakes in Wisconsin would fall into the category of "very clear, nutrient poor lakes." The cutoff for excellent TSI values would certainly include these lakes (Table 2) but also includes some lakes in the mesotrophic category, based on sediment core data which indicates that some lakes are naturally more productive than others.

Calculating & prioritizing TSI values
The following three steps are generated automatically through the department's data systems. The results are used for both General Condition Assessments and review of lakes for Impaired Waters listing.

1) Download all chlorophyll a, Secchi, and satellite data that meet minimum data requirements. These requirements are set to provide enough data to account for the average lake condition during the summer index period (when the lake responds to nutrient inputs and achieves maximum aquatic plant growth) over several years to account for unusual weather (dry, wet, hot, cold).

For chlorophyll a and Secchi data, download data that meet all of the following:

- Collected between July 15 – Sept 15
- Collected at Deep Hole or Mid-lake
- Sampled within top 2 m of water column (for chl a)
- Sampled within the last 5 years (2004-2008)

At least 2 samples are required per year in at least 3 different years, within the most recent five year period (6 values minimum). For each year for which the minimum data is available, first convert values to TSI and then calculate a yearly average of those data points. Finally average all available yearly averages from the last five years for a multi-year average.

For satellite clarity data, download data that meet all of the following:

- Collected between July 1 – Sept 30
- Collected within the last 5 years (2004-2008)

At least one satellite inferred clarity reading is required in each of 3 years within the most recent 5 year period (3 values minimum). (Note: satellite readings are automatically converted to clarity values (equivalent to Secchi depth) in SWIMS.) If there are multiple readings for any year, first convert values to TSI and then calculate a yearly average of those data points. Finally average all available yearly averages from the last five years for a multi-year average.

2) Calculate TSI *separately* for each of the following parameters that has sufficient data[6].

[6] Although Carlson's Trophic State Index also provides a calculation for TSI based on total phosphorus (TP), Wisconsin does not calculate TSI based on phosphorus for General Condition Assessments. TP concentrations are used to determine whether a waterbody exceeds thresholds for 303(d) listing as a pollutant.

TSI_{CHL} = 9.81 ln (CHL) + 30.6
TSI_{SD} = 60 – 14.41 ln (SD) (satellite inferred clarity data can also be used in lieu of Secchi data in this equation)

Where:
TSI = Trophic Status Index
SD = Secchi depth (meters)
CHL = Chlorophyll-*a* concentration (µg/L)
ln = natural log

3) Select which TSI value to use. Historically, there has been a tendency to average the three TSI values, but research suggests that this generally is not a good practice (Carlson and Simpson 1996). Therefore, Wisconsin has instituted a prioritization system for selecting which TSI score to use. When more than one TSI score is available, whichever TSI score is based on the most direct measure of algal biomass will be used, as follows:

- TSI based on chlorophyll a will be used if available, since this is the most direct measure of trophic state.
- TSI based on measured Secchi data is the second preference; Secchi depth readings measures clarity as a surrogate for trophic state.
- TSI based on satellite data is the third preference, as it infers water clarity rather than measuring water clarity directly.

General Condition Assessment Thresholds based on Trophic State Index

Using the TSI metric, the next step in the lakes Fish and Aquatic Life assessment is to compare lake-specific TSI values to lake condition assessment threshold TSI values established for each of the different lake classification categories. As described previously, the lake condition assessment thresholds create four categories: Excellent, Good, Fair and Poor.

Table 2. Trophic Status Index (TSI) Thresholds - Assessment of Lake Natural Communities

Condition Level	Shallow			Deep			
	Headwater	Lowland	Seepage	Headwater	Lowland	Seepage	Two-Story
Excellent	< 53	< 53	< 45	< 48	< 47	< 43	< 43
Good	53 – 61	53 – 61	45 – 57	48 – 55	47 – 54	43 – 52	43 – 47
Fair	62 – 70	62 – 70	58 – 70	56 – 62	55 – 62	53 – 62	48 – 52
Poor	≥ 71	≥ 71	≥ 71	≥ 63	≥ 63	≥ 63	≥ 53

Note: Although TSI thresholds are not yet available for three natural communities: 1) Small Lakes; 2) Spring Ponds; and 3) Impounded Flowing Waters, by default assessments are completed for the most similar natural community for which thresholds are currently available.

How TSI Condition Thresholds were Established

Excellent Condition

To establish the excellent range for TSI conditions, WDNR uses excellent or "reference" conditions inferred from total phosphorus values based upon preserved diatom communities from pre-settlement times found in lake bottom sediment cores.

Sediment cores measure fossilized diatom communities allowing a comparison of historical (pre-settlement) conditions and recent water condition. This allows the comparison of current water clarity measurements to historical conditions with changes represented by the changes in algae conditions over time. Diatoms are a type of algae containing siliceous cell walls that fossilize in lake sediments. Diatom taxa are known to prefer narrow ranges of water quality. Therefore,

inferences about historical water condition can be made from fossilized diatom communities at the bottom of the sediment core. These inferred concentrations, when converted to TSI values using the Carlson equations, can be used as reference values. This approach will not work for impoundments or raised wetland lakes since these lakes are artificial and pre-settlement conditions do not exist. WDNR has not yet developed criteria for impoundments or raised wetland lakes and will use lowland drainage thresholds for now.

WDNR has sediment core data spanning each of the 6 natural lake community types (Table 3) and derives excellent TSI thresholds from these data (Garrison, unpublished data*). The transition between excellent and good for each natural community is based on the 75th percentile of the TSI values calculated from sediment core bottom inferred phosphorus concentrations.* The bottom sediment core values represent reference lake conditions and using the 75th percentile gives some margin for lakes to have changed since the bottom of the sediment core accumulated (Table 3).

Sediment cores are not available for small lakes or spring ponds and are not appropriate for impounded flowing waters. Since adequate sediment core data from two-story lakes is not available, the 75th percentile value for deep seepage lakes was used for the threshold between excellent and good condition (Table 2). Ideally, sediment core data should be collected whenever monitoring is conducted on two-story lakes.

Table 3. Mean and Median inferred total phosphorus values calculated from top and bottom segments of sediment cores from 87 Wisconsin lakes (Garrison, unpublished data)

Lake Class	Natural Community	N	Mean TP (µg/L)		Median TP (µg/L)		75th Percentile (µg/L) (Bottom	TSI Threshold
			Top	Bottom	Top	Bottom		
1	Shallow Headwater	17	27	24	26	19	30.3	53
2	Deep Headwater	19	24	18	21	14	20.5	48
3	Shallow Lowland	11	28	25	28	24	30.5	53
4	Deep Lowland	43	25	19	20	15	20.0	47
5	Shallow Seepage	15	17	16	16	14	17.0	45
6	Deep Seepage	29	15	13	12	11	15.3	43

Poor Condition

Setting the threshold for Poor Condition was approached differently for each lake type, as most appropriate for the specific conditions exhibited by those lakes:

Shallow Lakes: The transition between a fair and poor condition for shallow lakes was set at a TSI of 71 (corresponding to total phosphorus of 100 µg/L) because this approximates total phosphorus concentrations that lead to a switch from aquatic plant dominated to algal dominated ecosystems in shallow lakes (Jeppesen et al. 1990). This represents a major ecosystem change and once it occurs, it is very difficult to restore to the aquatic plant dominated state.

Deep Lakes: The fair to poor transition threshold for deep lakes was set using a TSI value known to cause increased frequency of algal blooms, high amounts of blue-green algae and/or hypolimnetic oxygen depletion. A TSI of 63 (corresponding to total phosphorus of 60 µg/L) was chosen because it represents the threshold between eutrophic and hyper-eutrophic lakes (Carlson 1977).

Two-Story Lakes: TSI values that cause significant hypolimnetic oxygen depletion should be used as the threshold for two-story lakes since this habitat component is critical for maintaining coldwater fisheries. This value will be highly dependent upon the lake's morphometry.

Hypolimnetic oxygen demand is largely from the sediment; therefore, the greater the ratio of *sediment area to hypolimnetic water volume* the higher the hypolimnetic oxygen demand. That makes setting this threshold very difficult. A conservative TSI value of 53 (corresponding to a total phosphorus of 30 µg/L) is recommended. Further research on these relationships is needed to derive accurate values for two-story lakes.

Good and Fair Condition
The transition value between the condition of "fair" and "good" for each natural community was selected as a mid-point between the excellent and poor TSI values (Table 2).

6.1.3. Impairment Assessment
Not all waters categorized as Poor in the General Condition Assessment should be considered Impaired or warrant 303(d) listing. Whether or not a waterbody should be listed as impaired is dependent on the strength of the data used to make the assessment. To submit a lake for the 303(d) List, it must exceed certain numeric listing thresholds or meet narrative listing criteria. A General Condition Assessment status of "Poor" or "Fair" based on TSI score serves as a flag that TSI values and other parameters such as total phosphorus, temperature, dissolved oxygen, and pH should be evaluated against the additional impairment thresholds outlined in Table 6.

Because chlorophyll a is the most direct measure of trophic status, TSI-chlorophyll values may be used for listing. The TSI-chlorophyll threshold for generating a "Poor" general assessment status is equivalent to the threshold for 303(d) listing, so if a waterbody has a "Poor" TIS-chlorophyll status it will automatically be recommended for 303(d) listing unless otherwise justified. However, if the TSI value indicating poor condition was generated using satellite-based data or Secchi depth in lieu of having chlorophyll-*a* data, that data is not sufficient for 303(d) listing. Further monitoring may need to be conducted to collect enough in-situ chlorophyll a data to recalculate the TSI and reassess the waterbody. As before, field collected chlorophyll-*a*, must be collected at least twice during the summer index period (July 15th – September 15th) from three different years. An average of summer values will be calculated for the most recent 5 year period. The TSI based on chlorophyll a will be used to determine if a lake is a candidate for the impaired waters list.

Lakes may be listed for parameters other than TSI, such as total phosphorus, low dissolved oxygen, high temperatures, or pH exceedances. General assessment results of "Fair" based on TSI-chlorophyll, or "Poor" or "Fair" based on Secchi or satellite data serve as a flag indicating that the biologists should further evaluate these other parameters. In addition, best professional judgment may be needed for certain parameters (such as TSS and turbidity), or unique natural communities (such as two-story lakes and impounded flowing waters) for which there are currently no thresholds or criteria.

When assessing lake condition, researchers should evaluate if multiple stressors are influencing ambient conditions. Additional review of existing data or monitoring— above and beyond that conducted for a general assessment of a lake– is often warranted. Those investigations may include a variety of different parameters typically not included in the TSI evaluations described above. A summary of the additional parameters is included in Table 4.

Determining Pollutants & Impairments
It is important to determine the relationship between the pollutant and impairment when placing a waterbody on Wisconsin's Impaired Waters List. There are a number of field-measurements that can be taken to more clearly define the condition of a lake and determine what specific pollutants and impairments may be present. Selecting the correct indicators is an important part of

understanding the underlying causes of water quality problems (Table 4). Collectively, the type of data collected and the frequency of sampling is critical for accurate listing and the development of a successful management strategy. Guidance on how to make attainment decisions for some of the more common pollutants or stressors observed in Wisconsin lakes is provided below.

1. **Select which lakes to review: those that have an evident impairment or suspected possible impairment, as shown in Categories A and B below.**

*Category A) Lakes assessed as **Poor** based on **chlorophyll TSI**:*
Because these waters exceed the listing thresholds for chlorophyll TSI, this qualifies as an identified impairment, and they should be the top priority lakes for biologists to review.

- Review raw data for each lake as described below to confirm that the lake should be recommended for listing as impaired, and to determine which Pollutant(s) and Impairment(s) it should be listed for.
- If there is reason to believe the water should not be listed, it should instead be flagged as high priority in WATERS for further monitoring.

*Category B) Lakes assessed as **Fair** based on **chlorophyll TSI**:*
These lakes have not exceeded listing thresholds for TSI, and are therefore not automatically assumed to be impaired. However, biologists should review additional data for these waters as described below to determine whether total phosphorus, temp, pH, or DO listing thresholds are exceeded (see Table 6, WisCALM guidance). They should also determine whether supplemental data or best professional judgment would indicate these lakes are impaired.

- If data for any parameters exceed thresholds for listing, **and** there is evidence of an impairment of Fish and Aquatic Life Use (using supplementary data or best professional judgment), the water should be recommended as Impaired.
- If not, the water should be flagged in WATERS as medium priority for further monitoring.

For Categories A & B above, do the following:
1. Examine Total Phosphorus, temperature, and DO data for each lake*. To find this data, biologists can go to the following link: http://dnr.wi.gov/lakes/data/choosewbic.asp. Data may be available to the public if requested. Data can be compared to the impairment thresholds in Table 6, to determine whether any of these additional parameters exceed the listing thresholds.

Table 4. Potential Stressor Identification Monitoring Parameters for Each Lake Use Designation

Use Designation	Parameter for Assessment Consideration
Fish & Aquatic Life	Temperature pH Turbidity Total Suspended Solids Dissolved Oxygen Total Phosphorus (including diatom-inferred phosphorus from a sediment core) Toxic Substances in Tables 1-6 of Chapter NR 105 Acute & Chronic Toxicity Tests Miscellaneous Emerging Pollutants
Recreational	Fecal Coliforms *Escherichia coli* Blue-green Algae and/or Associated Toxins. Toxic Substances in Tables 8 & 9 of Chapter NR 105 Miscellaneous Emerging Pollutants
Fish Consumption	Taste & Odor Compound in Table 1 of Chapter NR 102 Mercury Polychlorinated Biphenyls (PCBs) 2,3,7,8-Tetrachlorodibenzo-p Dioxin (TCDD) Miscellaneous Emerging Pollutants

2. Determine which Pollutant(s) and Impairment(s) to list for. Based on an examination of the raw data, determine which of the following Pollutant/Impairment listings are appropriate.

- *Pollutant: Total Phosphorus*— See Table 5 for the standardized method of calculating Average TP. If TP exceeds the listing thresholds, list phosphorus as the pollutant unless sediment core data indicates that high P levels are naturally occurring (e.g., pre-settlement TP levels were similar to current high levels).
  Impairments associated with TP— Impairments commonly listed in relation to TP as a pollutant are: Eutrophication, pH, Low DO, Elevated Water Temperature. For consistency in listing decisions, please use one of these Impairments if appropriate and supported by data. If high TP levels lead to severe blue green algae blooms, they may also cause Recreational Use impairments (see Recreational Uses Section below).

- *Pollutant: Sediment*— Biologists may consider listing for sediment as the pollutant using the narrative criteria (there are currently no numeric listing thresholds for sediment). In this case, biologists should provide justification for their recommendation using data such as TSS, turbidity, Aquatic Macrophyte Community Index (AMCI)[7], or the maximum rooting depth portion of the AMCI. Since the AMCI is developed from measurements of multiple parameters, an exceedance requires a further calculation to determine the source. If the maximum rooting depth component of the AMCI is low, then the lake may be impaired by sediment in the form of coarser solids covering habitat and limiting rooted vegetation.
  Impairments associated with Sediment— Impairments commonly listed in relation to Sediment as a pollutant are: Eutrophication, pH, or Elevated Water Temperature. For

[7] Although a process for using AMCI data is not available for the 2010 listing cycle, Wisconsin hopes to develop such a tool for subsequent listings. An AMCI for Wisconsin has been developed by Nichols et. al. (2000) and has been shown to illustrate disturbance. The AMCI is a multi-metric parameter that combines: maximum depth of plant growth, aerial coverage of plants, species richness and diversity, and relative area covered by submersed plant species, sensitive plant species and exotic plant species.

consistency in listing decisions, please use one of these Impairments if appropriate and supported by data.

- *Pollutant: BOD/Sediment Oxygen Demand*— If water or sediment samples were analyzed for BOD or SOD, then biologists could consider listing for BOD/SOD. *Impairments associated with BOD/SOD*— Low DO is the impairment commonly listed with a BOD/SOD Pollutant.

3. Deciding not to list. Consider whether there is a justifiable reason that any waters that exceed listing thresholds should not be recommended as impaired (data errors, outliers, QA/QC problems, impairment attributed to natural causes, etc).

Natural causes suspected
If a lake has evidence of both a pollutant and impairment, but it is suspected that these may be due to natural causes, should it be listed?

➔ If there is no documentation to determine that the pollutant/impairment is indeed from natural causes, then the lake should be listed and more monitoring should be done to determine the causes.

➔ If there is documentation to show that the pollutant/impairment is due to natural causes, then the lake should not be listed. A Use Attainability Analysis should be done in the future. Appropriate documentation would include items such as the following:
- Sediment core data showing that pre-settlement phosphorus concentrations were similar to current levels.
- Hydrologic data showing that groundwater levels are naturally high in phosphorus.
- Reports showing that geological features contribute high levels of phosphorus.
- The watershed is entirely in its natural state, with no anthropogenic sources.

➔ If there is a current study underway to determine whether the pollutants/impairments are due to natural causes, listing may be postponed to when the study results are available.

Available data differs from minimum requirements
If there is not enough data to meet minimum data requirements for listing a lake, but the biologist feels it is impaired, should it be listed?

➔ In most cases, the lake should not be listed. The purpose of minimum data requirements is to provide consistent decisions across the state based on similar levels of information.

➔ However, if the available data clearly indicates impairment, and/or there is other supplemental information to support a listing, then the lake may be considered for listing based on biologists' best professional judgment.

Table 5. Average Total Phosphorus – Standard Calculation

1. Select the appropriate data and download to Excel.

    a) Select only data from the most recent five-year period. For this listing cycle that will be 2004-2008, since not all 2009 samples have been analyzed yet.* Separate the data for different years, in order to be able to average each year separately.

    b) Remove any dates outside the season of May-Oct. (you can gray them out in the table rather than deleting).

    c) Remove any data points that are not from epilimnetic (surface) samples.

    d) Remove any data points that are not from the Deep Hole station(s). Most lakes will only have one deep hole station, but more than one deep hole station may be used if each station has at least 3 values per year.

    e) Determine whether there are enough data points for each year to meet minimum data requirements: at least 3 values (from a given station) for each of two years. If a year does not have at least 3 values from one station, put "NA" into the cell where you'd normally calculate its average.

2. Calculate ‘annual average’ and ‘multi-year average’.

    a) Calculate the 'annual average' for each year separately by calculating the average for each deep hole station, and averaging the deep hole stations averages together for each year.

    b) Calculate a 'multi-year average' for all years from 2004-2008 combined.

    c) If values are in ug/l, convert to mg/l.

3. Compare to impairment thresholds.

    a) Document which natural community and which impairment threshold are appropriate for that lake. (Natural Communities are found in the Lakes spreadsheets that were given to you; impairment thresholds are in Table 7, 2010 WisCALM)

    b) Compare average TP concentrations against the appropriate threshold.

    c) Document whether the lake does or does not exceed the threshold.

4. Save your file with calculations, clearly noting the water’s name, WBIC, and stations.

5. Document the justification for LISTING or NOT LISTING.

NOTES:
* If there is not enough data from 2004-2008 to meet minimum data requirements but the 2009 data provide enough additional data to do so, then you can also include 2009 data.

Table 6. Impairment Thresholds for Lake Natural Communities – Fish & Aquatic Life Use

Note: All data used should be from within the most recent 5 year period.

TBA Indicators	Min. Data Requirement	Exceedance Frequency	Impairment Threshold - LAKES - Fish & Aquatic Life Use						
			Shallow			Deep			
			Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Two-story fishery lake
Eutrophication indicators									
TSI (Trophic State Index based on Chl *a*)	2 Chl *a* values collected during summer (July 15 - Sept. 15) from 3 different years	1 TSI value	≥71	≥71	≥71	≥63	≥63	≥63	≥53
Conventional physico-chemical indicators									
Total Phosphorus[5]	3 monthly values for 2 years (May - October)	Mean	≥0.04 mg/l	≥0.04 mg/l	≥0.04 mg/L	≥0.03 mg/L	≥0.03 mg/L	≥0.02 mg/L	≥0.015 mg/L
Dissolved oxygen	10 discrete[1] epilimnetic values (May – October)	10% or more of all values	< 5 mg/L						(value TBD; based on DO profile)
Temperature	20 discrete[1] values	Vary (see thresholds)	Daily (mean) and seasonal T° fluctuations (min. & max. daily mean) [2] not maintained; and Maximum T° increase exceeding 3°F above natural temperature[2]						
pH	10 discrete[1] values	Vary (see thresholds)	- Outside the range of 6.0-9.0 - Change greater than 0.5 units outside natural seasonal maximum (mean) & minimum (mean) [2]						
Turbidity	10 discrete[1] values	*(to be determined)*	*(reserved until sufficient data available)*						
TSS	10 discrete[1] values	*(to be determined)*	*(reserved until sufficient data available)*						
Aquatic Toxicity-based indicators									
Acute aquatic toxicity	8 values [3]	Maximum daily concentration not exceeded more than once every 3 years	≥ values provided in Tables A & B below						
Chronic aquatic toxicity		Maximum 4-day concentration not exceeded more than once every 3 years	≥ values provided in Tables A & B below						
Biological indicators									
AMCI (aquatic macrophyte community index)[6]	1 AMCI value	1 AMCI value	< 52	< 36	< 49	< 50	< 45	< 49	< 49

(1) Discrete values refer to samples collected on separate calendar days. Dissolved oxygen, temperature and pH criteria are taken from Wisconsin State Administrative Code NR 102.04, Water Quality Standards for Wisconsin Surface Waters.

(2) Based on historical data or reference site.

(3) Toxicity tests with 1 or more species in at least 8 different families provided that of the 8 species specified in NR 105.05(1); OR calculate secondary acute values according to NR 105.05(4) if 8 values not met.

(4) Toxicity tests with 1 or more species in at least 8 different families provided that of the 8 species specified in NR 105.06(1); OR calculate secondary chronic values according to NR 105.06(6) if 8 values not met.

(5) Total phosphorus thresholds are based on draft proposed nutrient criteria under internal review (February 2008)

(6) There was enough not representative data collected on lakes to allow listing based on AMCI in this iteration. Additional plant data has been collected and revised criteria will be available for the next cycle.

*Table A. Acute Toxicity Thresholds (ug/L) for Lakes with Toxicity Related to Hardness or pH **			
Substance	**Acute Thresholds at various hardness (ppm) levels ***		
	50	**100**	**200**
Cadmium, total recoverable			
- Lake Superior and Lake Michigan; and any lakes classified as "trout waters"	1.97	4.36	9.65
- All other lakes	4.65	10.31	22.83
Chromium $^{+3}$, total recoverable			
- All lakes	1022	1803	3181
Copper, total recoverable			
- All lakes	9.29	16.82	30.45
Lead, total recoverable			
- All lakes	54.73	106.92	208.9
Nickel, total recoverable			
- All lakes	642.7	1361	2219
Zinc, total recoverable			
- All lakes	65.66	120.4	220.7
	Acute Thresholds at various pH levels*		
	6.5	**7.8**	**8.8**
Pentachlorophenol			
- All lakes	5.25	19.4	53.01
	Acute Thresholds at various pH levels*		
	7.5	**8.0**	**8.5**
Ammonia			
- Lake Superior and Lake Michigan; and any lakes corresponding to "CW Categories 1 or 4"	13.28	5.62	2.14
- Any lakes corresponding to "CW Categories 2 or 3"	16.59	7.01	2.67
- All other lakes	19.89	8.41	3.20

* See Table 2 in NR 105.06 for calculation of acute thresholds with specific hardness or pH values
CW Category 1 = Default category of cold water classification. This category includes all fish. [Note: CW Category 1 is always applicable in Lake Superior, Lake

Michigan, and Green Bay north of 44° 32' 30" north latitude.]

CW Category 2 = Inland lakes with populations of cisco, lake trout, brook trout or brown trout, but no other trout or salmonid species. This category excludes data on genus Onchorhynchus.
CW Category 3 = Inland lakes with populations of cisco, but no trout or salmonid species. This category excludes data on genera Onchorhynchus, Salmo, and Salvelinus.
CW Category 4 = Inland trout waters with brook, brown, or rainbow trout, but no whitefish or cisco. This category excludes data on genus Prosopium.

CW Category 5 = Inland trout waters with brook and brown trout, but no whitefish, cisco, or other trout or salmonid species. This category excludes data on genera Prosopium and Onchorhynchus.

Table B. Acute and Chronic Toxicity Thresholds (ug/L) for Lakes with Toxicity Unrelated to Water Quality

Substance	Thresholds (ug/L)	
	Acute toxicity	Chronic toxicity
Arsenic $^{+3}$, total recoverable		
- Lake Superior and Lake Michigan; and lakes classified as "trout waters"	339.8	148
- All other lakes	339.8	152.2
Chromium $^{+6}$, total recoverable		
- All lakes	16.02	10.98
Mercury $^{+2}$, total recoverable		
- All lakes	0.83	0.44
Cyanide, free		
- Lake Superior and Lake Michigan; and lakes classified as "trout waters"	22.4	5.22
- All other lakes	45.8	11.47
Chloride		
- All lakes	757,000	395,000
Chlorine, total residual		
- All lakes	19.03	7.28
Gamma - BHC		.
- All lakes	0.96	n.a.
Dieldrin		
- Lake Superior and Lake Michigan; and lakes classified as "trout waters"	0.24	0.055
- All other lakes	0.24	0.077
Endrin		
- All lakes	0.086	0.072
Toxaphene		
- All lakes	0.73	n.a.
Chlorpyrifos		
- All lakes	0.041	n.a.
Parathion		
- All lakes	0.057	0.011

Table C. Chronic Toxicity Threshold (ug/L) for Lakes with Toxicity Related to Hardness or pH*

Substance	**Chronic Thresholds at various hardness (ppm) levels ***		
	50	**100**	**175**
Cadmium, total recoverable			
- All lakes	1.43	2.46	3.82
Chromium $^{+3}$, total recoverable			
- Lake Superior and Lake Michigan; and lakes classified as "trout waters"	48.86	86.21	n.a.
- All other lakes	74.88	132.1	n.a.
Copper, total recoverable			
- All lakes	6.58	11.91	n.a.
Lead, total recoverable			
- All lakes	14.33	28.01	n.a.
Nickel, total recoverable			
- All lakes	71.5	151.5	n.a.
Zinc, total recoverable			
- All lakes	65.66	120.4	n.a.
Chronic Thresholds at various pH levels *			
	6.5	7.8	8.8
Pentachlorophenol			
- Lake Superior and Lake Michigan; and lakes classified as "trout waters"	4.43	14.81	40.48
- All other lakes	5.33	17.82	48.7
Chronic Thresholds at various pH levels*			
	7.5	8.0	8.5
Ammonia			
All lakes (early life stages present) (1)			
- @ 25 ˚C	2.22	1.24	0.55
- @ 14.5 ˚C or less	4.36	2.43	1.09
All lakes (early life stages absent) (1)			
- @ 25 ˚C	2.22	1.24	0.55
- @ 7 ˚C or less	7.09	3.95	1.77

** See Tab. 4 (Cadmium), 4b (Ammonia) & 6 (all other substances) in NR 105.06 for calculation of thresholds with specific hardness or pH values*

(1) The terms "early life stage present" and "early life stage absent" are defined in subch. III of ch. NR 106.

6.2 Streams & Rivers: Fish and Aquatic Life Assessment Methods

6.2.1 Stream & River Classification

WDNR has identified five different types of stream classes based upon the water temperature and the capacity of the stream or river to support a diverse and healthy fish community.

A. *Coldwater Community:* Streams capable of supporting a cold water sport fishery, or serving as a spawning area for salmonids and other cold water fish species. Representative aquatic life communities associated with these waters generally require cold temperatures and concentrations of dissolved oxygen that remain above 6 mg/L. Since these waters are capable of supporting natural reproduction, a minimum dissolved oxygen concentration of 7 mg/L is required during times of active spawning and support of early life stages of newly-hatched fish.

B. *Warmwater Sport Fish Community:* Streams capable of supporting a warm water-dependent sport fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of dissolved oxygen that do not drop below 5 mg/L.

C. *Warmwater Forage Fish Community:* Streams capable of supporting a warm water-dependent forage fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of dissolved oxygen that do not drop below 5 mg/L.

D. *Limited Forage Fish Community:* Streams capable of supporting small populations of forage fish or tolerant macro-invertebrates that are tolerant of organic pollution. Typically limited due to naturally poor water quality or habitat deficiencies. Representative aquatic life communities associated with these waters generally require warm temperatures and concentrations of dissolved oxygen that remain above 3 mg/L.

E. *Limited Aquatic Life Community:* Streams capable of supporting macro-invertebrates or occasionally fish that are tolerant of organic pollution. Typically small streams with very low-flow and very limited habitat. Certain marshy ditches, concrete line-drainage channels, and other intermittent streams. Representative aquatic life communities associated with these waters are tolerant of many extreme conditions, but typically require concentrations of dissolved oxygen that remain about 1 mg/L.

The Fish and Aquatic Life Use Designation of a stream is identified by a specific citation in Chapter NR 102 or 104 (Wisconsin Administrative Code). In some cases, the specific water is named in the code, particularly for the waterbodies listed in ch. NR 104. In other cases, it may be *codified by reference* especially for coldwater communities that are referenced in what is commonly referred to as the 1980 Trout Book (Wisconsin Trout Streams – Publication 6-3600(80)). Finally, those waterbodies that are not referenced in code are considered to be "default" waters and are assumed to support either a coldwater community, a warmwater sport fish community, or a warmwater forage fish community, depending on water specific temperature and habitat limitations.

For purposes of the 2010 303(d) list, where a "default" fish and aquatic life use designation is applicable, the particular subcategory will be determined as follows:

- For waters identified by the Department after the publication of the 1980 Trout Book as Class I or Class II trout streams, a subcategory of "coldwater community" will be used as the designated use.
- All other waters, including those waters listed as Class III trout streams after the publication of the 1980 Trout Book, will be considered the equivalent of a warmwater sport fish community.

Assignment of designated use for the protection of fish and aquatic life has been an iterative process dating back to the late 1960's. While the Department strives to maintain a contemporary list of designated uses, it cannot visit each stream, river or lake very often. In fact, many of the designated uses that are included in the Wisconsin Administrative Code date back to the 1980s.

To facilitate the determination of a designated use to reflect the most current understanding of stream/river ecology, the Department published updated guidance in 2004. The guidance is included in a document entitled, "Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters" (WDNR PUBL- WT-807-04). The guidance is used by biologists who monitor Wisconsin's stream and river communities. It provides a framework for the collection and assessment of field data to recommend which fish and aquatic life category or subcategory a particular water or segment best fits. Some of the community features that are used in making these recommendations are included in Table 7, which is adapted from Appendix 2 of the Use Designation Guidelines. The guidance suggests that new sub-categories for fish and aquatic life use may be included in future revisions to Ch. NR 102, Wis. Admin. Code. However, until new sub-categories are promulgated in code, current sub-categories will continue to be used.

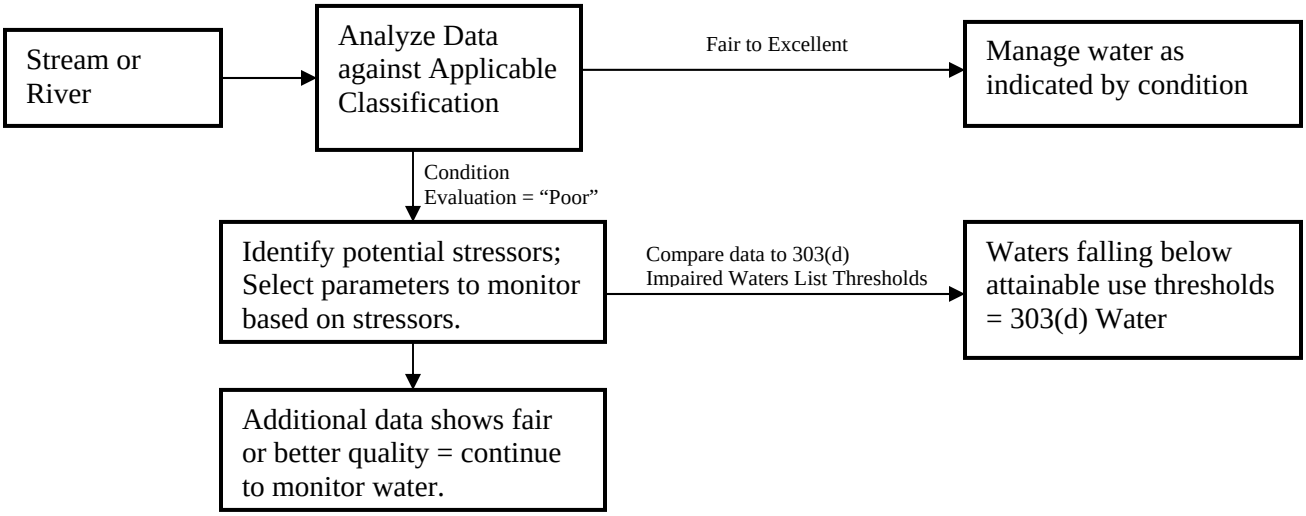
Table 7. Fish and Aquatic Life Use Sub-Category Minimum Expectations. Modified from Appendix 2 of "Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters" (WDNR PUBL-WT-807-04)

Fish and Aquatic Life Subcategory with *Proposed New Subcategory Names in Italics*	**Minimum Dissolved Oxygen**	**Minimum Stream Community Expectations**
Coldwater Community *(Coldwater A)*	6 mg/L or 7 mg/L during periods of spawning or nursery activity	**Potential to meet all expectations** 1. Naturally reproducing salmonid community containing more than one age group above the age of one year. 2. Year-to-year salmonid survival. 3. Will typically maintain good water quality and habitat. 4. Generally continuous stream flow. 5. More than 2 individual salmonids per 100 meters. 6. Maximum daily mean temperature approximately 22º C (77º F)
Coldwater Community *(Coldwater B)*	6 mg/L	**Potential to meet all expectations** 1. No natural salmonid reproduction with community sustained by stocking or migration. 2. More than 2 individual salmonids per 100 meters. 3. Will typically maintain good water quality and habitat. 4. Maximum daily mean temperature approximately 22º C (77º F)
Warmwater Sport Fish Community & Warmwater Forage Fish Community *(Diverse Fish & Aquatic Life)*	5 mg/L	**Potential to meet one or more expectations** 1. Game fish community with more than 2 individuals per 100 meters (except Green Sunfish, Black Bullheads and Yellow Bullheads). 2. Non-game fish community with 5 to 25% or more of the individuals present characterized as being not tolerant of low dissolved oxygen. 3. Macroinvertebrate community with a significant number of individuals (5 to 25% or more) belonging to taxa with HBI tolerance values of 5 or less. 4. Any fish, macro-invertebrates or other aquatic or semi-aquatic species listed as endangered, threatened or special concern species.
Limited Forage Fish *(Tolerant Aquatic Life)*	3 mg/L	**Potential to meet one or more expectations** 1. No potential to meet above criteria. 2. Non-game fish community dominated by individuals (75 to 100%) belonging to species that are tolerant to low dissolved oxygen. 3. Macroinvertebrate community with a significant number of individuals (numerically 75 to 100%) belonging to species with HBI tolerance values of greater than 5.
Limited Aquatic Life *(Very Tolerant Aquatic Life)*	1 mg/L	1. No potential to meet the above criteria. 2. No potential to contain a fish community. 3. Any macroinvertebrate community is dominated (75 to 100%) by individuals belonging to species with an HBI tolerance value of greater than 8.

6.2.2 Stream & River Assessment Methods

Like many other states, WDNR relies on biological indicator metrics to assess the fish and aquatic life condition characteristics of streams and rivers in Wisconsin including a number of fish indices of biological integrity and a macroinvertebrate index of biological integrity. The development and verification procedures for all of the IBIs have been published in peer reviewed journals. The process through which a waterbody is identified as fully supporting versus impaired is summarized below (Figure 15).

Figure 15. Overview of Assessment Process for Streams, Rivers - General and Specific Assessments



Condition Assessments and Thresholds – Fish IBI

Whereas the lakes assessment methods use the same TSI metric and prescribe different threshold values for lake condition rating for different lake classes; WDNR fisheries research staff have developed specific fish IBI (F-IBI) for different stream and river classes. Currently there are three different F-IBI used to assess wadeable stream condition and one IBI used to assess non-wadeable river condition. The three wadeable stream F-IBIs have been developed for cold, warm and small warm/cool water streams.

All of the fish IBIs are designed to assess the quality of fish assemblages in Wisconsin's specific rivers. The indices are developed using a large statewide database of standardized fish assemblage samples from numerous reaches with different levels of human impact. An objective procedure is used to select and score the metrics that compose the IBI, choosing metrics that represent a variety of the structural, compositional, and functional attributes of large-river fish assemblages (Lyons et al. 2001).

The cold water F-IBI is used for streams with maximum daily mean temperatures < 22^{o}C for any size watershed or stream gradient. The cold water wadeable Index of Biological Integrity (Cold F-IBI) was developed using five fisheries metrics (Lyons 1996) including the following:

- number of intolerant species
- percent of tolerant species
- percent of top carnivore species
- percent of native or exotic stenothermal coldwater or coolwater species,
- percent of salmonid individuals that are brook trout

The warm water fish IBI was developed and verified for streams with maximum mean daily temperature greater than 22^{o}C, stream widths between 2.5 m and 50 m, and few areas greater than 1.25 m in depth. The warm water wadeable Index of Biological Integrity (Warm F-IBI) was developed using ten fisheries metrics (Lyons 1992) including the following:

- Total number of native species
- Number of darter species
- Number of sucker species
- Number of sunfish species
- Number of intolerant species.
- Percent tolerant species
- Percent omnivores
- Percent insectivores
- Percent top carnivores
- Percent simple Hthophils
- Number of individuals per 300 m2
- Percent diseased fish

The small stream fish IBI (Small F-IBI) was developed and verified for streams with watersheds between 4 km^2 and 41 km^2 with a maximum mean daily temperature greater than 22^{o}C. The intermediate-small wadeable Index of Biological Integrity (Small F-IBI) was developed using ten fisheries metrics (Lyons 2003) including the following:

- Number of native species
- Number of intolerant species
- Number of minnow species
- Number of headwater species
- Total catch per 100m, excluding tolerant species
- Catch per 100 m of brook stickleback
- % of diseased fish

Large rivers are defined as having at least 3 km of contiguous river channel too deep to be sampled effectively by wading. By this definition, Wisconsin has at least 40 large rivers with a combined length of over 4,000 km – all of which are considered warm water streams. A Non-wadeable (River) Index of Biological Integrity (River F-IBI) was developed using ten fisheries metrics (Lyons 2001) including the following:

- Weight Biomass PUE
- Native species
- Sucker species
- Intolerant species
- Riverine species
- % Fish Diseased
- % Riverine
- % Lithophils
- % Insectivore
- % Round suckers

It is important to note that a fish IBI has not been developed and validated for any of the small streams lacking enough perennial flow to support a fish community (Wisconsin Limited Aquatic Life stream class). A cool water fish IBI for streams with mean summer temperatures between 17.5^{o}C and 21^{o}C is currently in press and will be available for use as an assessment tool in the future (Lyons personal comm..).

Condition Assessments and Thresholds - Macroinvertebrate IBI

Data derived from aquatic macroinvertebrate samples provide valuable information on the physical, chemical and biological condition of streams, which along with stream habitat and fish community data permits a comprehensive assessment of stream health. Most aquatic macroinvertebrates such as immature insects live for one or more years in streams, integrating the effects of various environmental stressors over time. Since the majority of aquatic invertebrates have limited mobility (relative to fish), they can be good indicators of localized conditions, upstream land impacts and water quality degradation.

Various metrics and indices are used to interpret macroinvertebrate sample data. Historically, the WDNR used Hilsenhoff Biotic Index (HBI) extensively as an indicator of low dissolved oxygen concentrations

resulting from organic pollution (Hilsenhoff 1987). WDNR recently switch to primarily using a Macroinvertebrate IBI developed by Weigel (2003). The M-IBI metric responds to the watershed scale impacts of agricultural and urban land uses, riparian habitat degradation, sedimentation problems, and scouring.

The Macroinvertebrate Index of Biological Integrity (M-IBI) was developed using fourteen macroinvertebrate metrics (Weigel 2003) including the following:

- Species richness
- Margalef's Diversity Index
- Ephemeroptera–Plecoptera– Trichoptera
- Hilsenhoff's Biotic Index
- Mean Pollution Tolerance Value
- Proportion of Depositional Taxa
- Proportion of Diptera (Dipt),
- Proportion of Chironomidae (Chir),
- Proportion of Amphipoda
- Proportion of Isopoda (Isop)
- Proportion of Shredders (Shr),
- Proportion of Scrapers (Scr), and
- Proportion of Filterers (Fil)
- Proportion of Gatherers (Gath)

In general, as the level of environmental degradation increases within a stream there is a corresponding decrease in a number of environmentally sensitive macroinvertebrate species and an increase in a few environmentally tolerant species. The condition gradient (excellent, good, fair, poor) and the corresponding M-IBI score is shown in Table 8.

It's important to note that the M-IBI was developed and validated for cold and warm water wadeable streams and cannot be used as an assessment tool for non-wadeable rivers or small streams without perennial flow (Weigel pers. comm.).

Table 8. Fish and Aquatic Life – Streams and Rivers General Assessment Thresholds

Designated Use	Condition Gradient	Management Recommendation	Fish IBI	Macroinvertebrate IBI
Cold Stream Stream Supports coldwater fish and macroinvertebrate species	Excellent	Consider O/ERW Listing	Cold IBI 90-100	7.5-10.0
	Good	Maintain Condition	Cold IBI 60-80	5.0-7.4
	Fair	Restoration	Cold IBI 30-50	2.6-4.9
	Poor	Consider 303(d) Listing	Cold IBI 0-20	0-2.5
Small Cold Stream Trout absent, but other coldwater fishes/inverts self-sustaining.	Excellent	Consider O/ERW Listing	Cold IBI 50-60	7.5-10.0
	Good	Maintain Condition	Cold IBI 30-40	5.0-7.4
	Fair	Restoration	Cold IBI 10-20	2.6-4.9
	Poor	Consider 303(d) Listing	Cold IBI 0-10	0-2.5
Warm Water Sport Fish*River or Non Wadeable Stream* WWSF	Excellent	Consider O/ERW Listing	Large River IBI 80-100	
	Good	Maintain Condition	Large River IBI 60-79	
	Fair	Restoration	Large River IBI 40-69	
	Poor	Consider 303(d) Listing	Large River IBI 0-39	
Warm Water Sport Fish *Wadeable Stream* WWSF	Excellent	Consider O/ERW Listing	Warm IBI 65-100	7.5-10.0
	Good	Maintain Condition	Warm IBI 50-64	5.0-7.4
	Fair	Restoration	Warm IBI 30-49	2.6-4.9
	Poor	Consider 303(d) Listing	Warm IBI 0-29	0-2.5
Warm Water Forage Fish Stream WWFF	Excellent	Consider O/ERW Listing	Small Stream IBI 100	7.5-10.0
	Good	Maintain Condition	Small Stream IBI 70-90	5.0-7.4
	Fair	Restoration	Small Stream IBI 40-60	2.6-4.9
	Poor	Consider 303(d) Listing	Small Stream IBI 0-30	0-2.5
Limited Forage Fish Stream LFF	Attaining	Consider O/ERW Listing	Small Stream IBI 40-100	2.6-10.0
	Not-Attaining	Maintain Condition	Small Stream IBI 0-30	0-2.5
Limited Aquatic Life Stream LAL	Attaining	Consider O/ERW Listing		2.6-10.0
	Not-Attaining	Maintain Condition		0-2.5

6.2.3. Impairment Assessments

If after a stream or river has been assigned to a stream community and a general assessment results in a poor F-IBI and/or M-IBI values, additional assessment work is required prior to submitting the waterway as a potential 303(d) impaired water.

If additional monitoring is required, the selection of indicators should be based on the nature of the stream or river issues known to the biologist. The available metrics may be expanded as resources allow. In addition to the collection of supplemental F-IBI and M-IBI data, studies may be designed to collect data over a larger river or stream reach and/or to evaluate other factors influencing water condition. Some of the additional indictors that can be evaluated are listed in Table 9.

Table 9. Potential Indicators for Specific River & Stream Assessments

Indicator	Indicator
Alkalinity	Organic Compounds*
Ammonia*	Periphyton
Biochemical Oxygen Demand	pH*
Chlorides*	Phosphorus – Ortho
Dissolved Oxygen*	Phosphorus – Total%
Exotic Species – Abundance	Sediment Chemistry
Exotic Species – Presence/Absence	Solids – Total Suspended
Flow	Solids – Settleable
Habitat – Qualitative	Specific Conductivity
Habitat – Quantitative	Temperature%
Hardness	Toxicity – Ambient*
Heavy Metals*	Toxicity – Sediment
Land Use	Transparency
Nitrogen – Total Kjeldahl	
Nitrogen – (Nitrate & Nitrite)	

* = Numeric Water Quality Criteria are available in Ch. NR 102 or NR 105 (Wis. Adm. Code)
% = Numeric Water Quality Criteria under development.

Parameter Thresholds Linked to Water Condition Gradients

To date, many of the parameters listed above to not have established threshold criteria and WDNR staff must use targeted monitoring information from reference sites and/or apply professional judgment. As condition gradients are developed for those indicators, additional assessment tools will be available to decision makers. WDNR Biologists have extensive knowledge of the factors that influence community response in rivers and streams. Those insights should be considered when selecting what indicators to collect or when scheduling supplement monitoring and proposing assessment decisions. Attainment decisions should made based on an exceedance of specified thresholds for indicators listed in Table 10 as long as the applicable data requirements are met and decisions follow the guidance on independent application provided in this methodology guidance document.

Stream & River Stressors and Related Indictors

When supplemental monitoring work is proposed, choosing indicators related to specific stressors is critical. Below are guidelines that may be useful in evaluating three categories of stressors that are often observed in Wisconsin river and stream communities:

1. *Habitat impairment due to excessive sedimentation*. Monitoring should be considered for the following parameters: Habitat, Total Suspended Solids, Transparency, Flow, and Temperature.

2. *Dissolved oxygen depletion due to excessive nutrients.* Monitoring should be considered for the following parameters: Phosphorus or Nitrogen Series (Ammonia, Kjeldahl, $N0_2 + NO_3$), Dissolved oxygen, pH, and Temperature.

3. *Aquatic toxicity due to presence of elevated toxic substances.* Monitoring should be considered for the following parameters: Ambient Toxicity Tests (Acute & Chronic), pH, Ammonia, and Temperature, Toxic Metals, Pesticides, and/or Sediment Toxicity Tests.

Table 10. Impairment Thresholds for Rivers/Streams

Indicators/Parameters	Minimum Data Requirement	Exceedance Frequency	Cold Waters	Warm Waters (WWSF, WWFF)	Limited Forage Fish	Limited Aquatic Life
Conventional physical and chemical indicators						
Temperature**	20 discrete daily values (May through October) * Samples must be collected at a frequency of no less than 1 sample per hour with a continuous recording thermograph or thermistor.	10% of Mean Daily Temperature values exceeds specified maximum for applicable use designation (Mean Daily Temperature is the arithmetic mean of all equally spaced samples colleted within a 24-hour period)	>73°F	>86°F	>86°F	>86°F
			Mississippi R., Rock R., Wisconsin R: >86°F Lower Fox River: >87°F Inland Lakes North of State Highway 10: >86°F Inland Lakes South of State Highway 10: >87°F Green Bay – South: >83°F Green Bay – North: >78°F Lake Michigan – South: >76°F Lake Michigan – North: >73°F Lake Superior: >73°F Chequamegon Bay: >76°F			
pH	10 discrete * values	10% or more of all values within a continuous sampling period or for instantaneous w/in season	Outside the range of 6-0 to 9.0 or if a change is greater than 0.5 units outside natural seasonal maximum (mean) and minimum (mean)			
Dissolved oxygen	3 days of continuous measurements (no less than 1 sample per hour) in July or August; minimum of 3 years of data	10% or more of all values	<6.0 mg/L and <7.0 mg/L during spawning season	<5.0 mg/L	<3.0 mg/L	<1.0 mg/L
Total Phosphorus	10 base flow values (May - October)	Median or 10% or more of all values	≥0.100 mg/l for rivers listed in proposed rule NR 102.06(3); ≥0.075 mg/l for other rivers or streams			
Flow conditions	11 base flow values (May - October)	Annual 90% exceedance flow (2)	≤0.03	≤0.03	N\A	N\A
Biological indicators						
Fish IBI	2 Fish IBI Values	Either in 1 value per 2 consecutive field seasons or 2 or more studies within one field season with corroborating data.	See associated Natural Community/ Designated Use - Fish IBI Chart			
Macroinvertebrate IBI	3 Macroinvertebrate IBI Values	Either in 1 value per 2 consecutive field seasons or 2 or more studies within one field season with corroborating data.	See associated Natural Community/ Designated Use – Macroinvertebrate IBI Chart			

Aquatic Toxicity-Based indicators			
Acute aquatic toxicity indicators			
Cadmium*, Chromium$^{(3+)}$*, Copper*, Lead*, Nickel*, Zinc*, Pentachlorophenol, and Ammonia *(*total recoverable form)*	8 values [3]	Maximum daily concentration not exceeded more than once every 3 years	≥ values provided in Table A below
Arsenic$^{(+3)}$*, Chromium$^{(+6)}$*, Mercury$^{(+2)}$*, free Cyanide, Chloride, Chlorine (total residual), Gamma - BHC, Dieldrin, Endrin, Toxaphene, Chlorpyrifos, and Parathion (*total recoverable form)*			≥ values provided in Table B below
Chronic aquatic toxicity indicators			
Cadmium*, Chromium$^{(3+)}$ *, Copper*, Lead*, Nickel*, Zinc*, Ammonia and Pentachlorophenol *(*total recoverable form)*	8 values [3]	Maximum 4-day concentration not exceeded more than once every 3 years	≥ values provided in Table C below
Arsenic$^{(+3)}$*, Chromium$^{(+6)}$*, Mercury$^{(+2)}$*, free Cyanide, Chloride, Chlorine (total residual), Dieldrin, Endrin, and Parathion (*total recoverable form)*			≥ values provided in Table B below

** Discrete values refer to samples collected on separate calendar days*

*** Temperature values represent maximum temperatures as proposed in subch. 5 of ch. NR 102, as of June 2009.*

Table A. Acute Aquatic Toxicity Thresholds for Rivers & Streams with Toxicity Related to Hardness and pH*

Substance	**Acute Thresholds at Various Hardness (ppm) Levels***		
	50	**100**	**200**
Cadmium, total recoverable			
- Cold Waters	1.97	4.36	9.65
- Warm Waters & Limited Forage Fish	4.65	10.31	22.83
- Limited Aquatic Life	13.03	28.87	63.92
Chromium $^{+3}$, total recoverable			
- All flowing waters	1022	1803	3181
Copper, total recoverable			
- All flowing waters	9.29	16.82	30.45
Lead, total recoverable			
- All flowing waters	54.73	106.92	208.9
Nickel, total recoverable			
- All flowing waters	642.7	1361	2219
Zinc, total recoverable			
- All flowing waters	65.66	120.4	220.7
	Acute Thresholds at various pH levels*		
	6.5	**7.8**	**8.8**
Pentachlorophenol			
- All flowing waters	5.25	19.4	53.01
	Acute Thresholds at various pH levels*		
	7.5	**8.0**	**8.5**
Ammonia			
- Cold Waters	13.28	5.62	2.14
- Warm Waters & Limited Forage Fish	19.89	8.41	3.2
- Limited Aquatic Life	30.64	12.95	4.93

** See Table 2 in NR 105.06 for calculation of acute thresholds with specific hardness or pH values*

Table B. Acute, Chronic Toxicity Thresholds (ug/L) Rivers & Streams Unrelated to Water Quality

Substance	Thresholds (ug/L)	
	Acute toxicity	**Chronic toxicity**
Arsenic $^{+3}$, total recoverable		
- Cold Waters	339.8	148
- Warm Waters, Limited Forage Fish, & Limited Aquatic Life	339.8	152.2
Chromium $^{+6}$, total recoverable		
- All flowing waters	16.02	10.98
Mercury $^{+2}$, total recoverable		
- All flowing waters	0.83	0.44
Cyanide, free		
- Cold Waters	22.4	5.22
- Warm Waters, Limited Forage Fish, & Limited Aquatic Life	45.8	11.47
Chloride		
- All flowing waters	757,000	395,000
Chlorine, total residual		
- All flowing waters	19.03	7.28
Gamma - BHC		.
- All flowing waters	0.96	n.a.
Dieldrin		
- Cold Waters	0.24	0.055
- Warm Waters, Limited Forage Fish, & Limited Aquatic Life	0.24	0.077
Endrin		
- Cold Waters, Warm Waters, & Limited Forage Fish.	0.086	0.072
- Limited Aquatic Life	0.12	0.10
Toxaphene		
- All flowing waters	0.73	n.a.
Chlorpyrifos		
- All flowing waters	0.041	n.a.
Parathion		
- All flowing waters	0.057	0.011

Table C. Chronic Toxicity Threshold (ug/L) for Rivers & Streams with Toxicity Related to Hardness or pH*

Substance	50	100	175
Cadmium, total recoverable			
All flowing waters	1.43	2.46	3.82
Chromium $^{(+3)}$, total recoverable			
Cold Waters	48.86	86.21	n.a.
Warm Waters, Limited Forage Fish, & Limited Aquatic Life	74.88	132.1	n.a.
Copper, total recoverable			
All flowing waters	6.58	11.91	n.a.
Lead, total recoverable			
All flowing waters	14.33	28.01	n.a.
Nickel, total recoverable			
All flowing waters	71.5	151.5	n.a.
Zinc, total recoverable			
All flowing waters	65.66	120.4	n.a.
Chronic Thresholds at various pH levels *			
	6.5	7.8	8.8
Pentachlorophenol			
Cold Waters	4.43	14.81	40.48
Warm Waters, Limited Forage Fish, & Limited Aquatic Life	5.33	17.82	48.7
Chronic Thresholds at various pH levels*			
	7.5	8.0	8.5
Ammonia			
Cold Waters and Warm Waters (early life stages present) $^{(1)}$			
- @ 25 ˚C	2.22	1.24	0.55
- @ 14.5 ˚C or less	4.36	2.43	1.09
Cold Waters and Warm Waters (early life stages absent) $^{(1)}$			
- @ 25 ˚C	2.22	1.24	0.55
- @ 7 ˚C or less	7.09	3.95	1.77
Limited Forage Fish (early life stages present) $^{(1)}$			
- @ 27 ˚C	5.54	3.09	1.38
Limited Forage Fish (early life stages absent) $^{(1)}$			
- @ 25 ˚C	6.69	3.73	1.67
- @ 7 ˚C or less	21.34	11.9	5.33
Limited Aquatic Life			
- @ 25 ˚C	14.5	8.09	3.62
- @ 7 ˚C or less	46.29	25.82	11.56

(1) The terms "early life stage present" and "early life stage absent" are defined in subch. III of ch. NR 106.

6.3 Recreational Use Assessment Method

Beaches

Many, but not all, beaches are evaluated for Recreational Uses in Wisconsin. Federal criteria for *Escherichia coli* (*E. coli*) are applicable to the open waters of the Great Lakes – including beaches. In Wisconsin, inland beaches follow the same monitoring and assessment protocol as the Great Lakes beaches. *E. coli* is a species of bacteria that serves as an indicator of the presence of fecal matter in the water – suggesting that there may be harmful bacteria, viruses, or protozoans present that elevate risk to humans.

Monitoring for *E. coli* at many public beaches along the shorelines of Lake Michigan and Lake Superior is conducted in accordance with the Beach Environmental Assessment and Coastal Health Act of 2000 (the BEACH Act). Since 2003, approximately 122 monitoring sites[8] at public beaches in Wisconsin are sampled for *E. coli* for implementation of the BEACH Act. Beaches included in the monitoring program get sampled between 1 and 4 times per week depending on the priority given to the beach. For more information on Wisconsin's Beach Program please visit: www.wibeaches.us.

Although *E. coli* may not be representative of the pathogen strains that result in illness to humans, its presence suggests that fecal matter may be in the water and that other pathogens may be present. It is often these and other pathogens that result in water borne illnesses in humans. Data from this effort are used to make decisions on which beaches are impaired – namely due to chronic closure problems due to the presence of high counts of *E. coli* bacteria.

U.S. EPA has established two different water quality criteria for *E. coli* – a single sample maximum of 235 cfu[9]/100 mL and a long-term geometric mean maximum of 126 cfu/100 mL. Beach closure decisions are routinely made considering the single sample value. However, when evaluating *E. coli* data to determine if a beach should be included on the Impaired Waters List, the Department relies on data collected throughout the entire beach season because of the variability of *E. coli* populations in a beach environment on a day-to-day or hour-to-hour basis. Accordingly, the Department requires a minimum of 15 samples collected during a beach season to calculate a long-term geometric mean as described in the following paragraph. Datasets with fewer than 15 samples are considered insufficient. This threshold was selected to represent the number of weekly samples typically collected during a Wisconsin "beach season." In Wisconsin, the typical swimming season lasts about 15 weeks – Memorial Day through Labor Day.

Calculating a geometric mean (geomean):

A geometric mean is a measure of central tendency calculated by multiplying a series of numbers and taking the n^{th} root of the product, where n is the number of items in the series. Only the results from each individual calendar year are used to calculate geometric means. For example, the last two results from one year and the first three results from the next year would not be used to calculate a geometric mean. Using this method, a single year with data for 15 weeks yields 11 unique geometric means. The 1^{st} through 5^{th} individual results would be used to calculate the first geometric mean. The 2^{nd} through 6^{th} results would be used to calculate the second geometric mean, and so on through the eleventh geometric mean which would represent the final five results in the data set (11^{th} through 15^{th}). The resulting geometric means are then compared to the U.S. EPA threshold value (126 cfu/100mL) according to the progression described in Table 11.

[8] A few beaches in Wisconsin have beaches large enough that multiple sites are sampled at the beach. In these cases, samples from multiple sites on one beach are often combined to make up a composite sample.

[9] CFU = colony forming unit. This is the standard unit of measurement of bacteria in a laboratory test.

Table 11. Beach Listing Thresholds for Rolling Geometric Mean

Years of Information Available	Beach Listed If:
1 year of data	>35% of geomeans exceed 126 cfu/100 mL
2 years of data	>25% of geomeans exceed 126 cfu/100 mL
3 years of data	>15% of geomeans exceed 126 cfu/100 mL

In summary, listing decisions are determined when:

1) There are 3 years of representative data and more than 15% of the calculated geomeans exceed 126 cfu/100 mLs.

2) There are 2 years of representative data and more than 25% of the calculated geomeans exceed 126 cfu/100 mLs.

3) There is 1 year of representative data and more than 35% of the calculated geomeans exceed 126 cfu/100 mLs.

When a beach is included on the proposed Impaired Waters List, the pollutant is listed as *E. coli* and the impairment is identified as "Recreational Restrictions – Pathogens." The Department believes this is an appropriate way of recognizing chronic risk to human health associated with recreational activities in water with long-term elevated levels of *E. coli.*

The Department will propose to remove a beach from the Impaired Waters List when the most recent 3 years of representative data that meet the 15 samples per year requirement (within the last 5 years) shows that **less than 15%** of the calculated geomeans exceed 126 cfu/100 mLs.

Streams and Rivers

Federal criteria for *E. coli* were developed after consideration of risk to the swimming public. All of the data used to establish the federal criteria were collected from swimming beaches. In general, flowing rivers and streams in Wisconsin do not provide comparable recreational activities for full body immersion. For those water bodies, the Department utilizes that the long-standing water quality criterion for fecal coliform that is reflected in Chapter NR 102.04(5) of the Wisconsin Administrative Code. That section reads:

> (a) *Bacteriological guidelines.* The membrane filter fecal coliform count may not exceed 200 per 100 ml as a geometric mean based on not less than 5 samples per month, nor exceed 400 per 100 ml in more than 10% of all samples during any month.

When a flowing stretch of a river or stream is included on the proposed Impaired Waters List, the pollutant is listed as fecal coliform and the impairment is identified as "Recreational Restrictions – Pathogens." In many instances where fecal coliform counts are high, *E. coli* data or other pathogen data are also collected for streams and rivers and may be used in lieu of or supplementary to fecal coliform data to make best professional judgment decisions to list or not list the waterbody as impaired.

Lakes (Recreational Restrictions – Blue-green Algal Blooms)

Blue-green algae are natural occurring organisms found throughout the state and are an important part of Wisconsin's freshwater ecosystem. However, excessive nutrient loading (particularly phosphorus) can cause blue-green algae populations to grow rapidly under certain environmental conditions and form "blooms" that can impact water quality and pose health risks to people, pets, and livestock. Most species of blue-green algae are buoyant and when populations reach bloom densities, they float to the surface where they form scum layers or floating mats. In Wisconsin, blue-green algae blooms generally occur

between mid-June and late September, although in rare instances, blooms have been observed in winter, even under the ice.

Blue-green algae blooms can cause many water quality problems including: a) reduce light penetration affecting the ability of macrophytes to thrive; b) discoloration of water; c) taste and odor concerns, and d) reduction of dissolved oxygen concentrations due to massive decomposition of the cells when they die-off. Another important consequence of blue-green algae is their ability to produce naturally-occurring toxins.

Algal toxins can be harmful to humans and animals alike through skin contact, inhalation, or ingestion. Some of the species commonly found in Wisconsin that produce algal toxins include, *Anabaena* sp., *Aphanizomenon* sp., *Microcystis* sp., and *Planktothrix* sp. Where monitoring of blue-green algae occurs, notices are provided to local public health agencies when concentrations are presumed to exceed 100,000 cells/mL. That value represents the threshold for moderate risk to humans as established by the World Health Organization (WHO). Illnesses related to blue-green algae can occur in both humans and pets. People may be exposed to these toxins through contact with the skin (e.g., when swimming), through inhalation (e.g., when motor boating or water skiing), or by swallowing contaminated water. In 2009, the Wisconsin Department of Health Services documented over 41 cases statewide of human health exposure related to blue-green algae blooms including respiratory ailments (coughing), watery eyes and rashes. Animals can be even more susceptible to risks by drinking water directly from water bodies with dense algal blooms or by licking their fur after swimming.

When a waterbody is proposed to be included on the Impaired Waters List due to frequent and elevated algal cell counts, and data are available suggesting high total phosphorus concentrations, the pollutant is listed as Total Phosphorus and the impairment is identified as "Recreational Restrictions – Blue-green Algae." In the absence of meeting minimum data requirements for total phosphorus, the professional judgment of the Regional Biologist should be used to consider listing any waterbody that experiences frequent and severe blue-green algal blooms where there is strong reason to believe that nutrient levels may be contributing to such blooms.

6.4 Fish Consumption Use Assessment Method

Waterbodies are listed for fish consumption advisories due to atmospheric deposition of mercury, PCBs, dioxin and furan congeners, and Perfluoroctane sulfonate or PFOs. IN 1998, 241 waters were added to the 303(d) list in category 5B "Waters Impaired by Atmospheric Deposition of Mercury," using the criterion that mercury-based fish consumption advisories had been issued for these specific waterbodies. Since that time, all waters in the state fall under the general fish consumption advisory which recognizes that most fish from most waters in the state contain mercury in at least low levels of concentration. Since 2002, waters have been added to the 303(d) list as they are added to the fish consumption advisory publication for specific advisories, and de-listed where the special fish consumption advisory publication advisory no longer applies.

When specific data are available for certain game and panfish species for individual water bodies, the Department will use the following fish consumption program guidance to include those waters on the impaired list:

- ***Mercury:*** If a waterbody has special mercury based consumption advice of one meal per month or less frequent for panfish (applied when panfish concentrations reach 0.21 to 1 parts per million (ppm), or is "do not eat" for gamefish (applied when gamefish concentrations exceed 1 ppm).

- ***Polychlorinated Biphenyls (PCBs):*** if a waterbody has special PCB-based fish consumption advice of one meal per week or less frequent for panfish species or one meal per month or less frequent for gamefish (applied when PCB concentrations reach total PCB concentration in the range of 0.21 ppm or >2 ppm). Some of these sites are due to general residual environmental PCB contamination and some are due to specific deposits of PCBs.

- ***Dioxin and Furan Congeners:*** if a waterbody has special dioxin/furan based advice of "do not eat" (applied when dioxin equivalents exceed 10 parts per trillion and (ppt) based on 2, 3, 7, 8-substituted dioxin and furan congeners).

- ***Perfluoroctane sulfonate (PFOS):*** if a waterbody has a special PFOS-based fish consumption advice of one meal per week or less frequent for panfish species or one meal per month or less frequent for game fish species. A segment of the Mississippi River is being added for PFOs in 2008, making it the only water on the list for PFOs.

Specific waters will be proposed for de-listed where fish are collected and analyzed but no longer meet the criteria for specific fish consumption advice for mercury, PCBs, or other chemicals. The general, statewide fish consumption advisory will still apply to these waters but they will no longer be included on the 303(d) list.

Monitoring fish consumption advisories depends on the pollutant and the waterbody. WDNR staff conduct the fish sampling and WDNR pays for the fish tissue analyses. Some U.S. EPA funds are used through the fisheries program for supplies, lab and freezer rentals, advisory publications, and special analyses. More information on the number of fish sampled, frequency of sampling and number of sites in Wisconsin is detailed in Wisconsin's monitoring strategy:
http://dnr.wi.gov/org/water/monitoring/strategydetail_T1.htm
More information about the specific consumption advisory can be found in the publication: Choose Wisely, A Healthy Guide for Eating Fish in Wisconsin (PUB-FH-824 2007.) It is available on line at http://dnr.wi.gov/fish/consumption/.

Contaminated Sediments
The Department will include those water bodies with sediment deposits that are known to have toxic substances that exceed state water quality criteria for ambient water as specified in ch. NR 105, Wis. Adm. Code. These waters may be identified through various monitoring activities, including routine water quality monitoring, sediment analysis, and collection of fish tissue. In addition to a comparison to the water quality criteria found in NR 105, the Department compares the concentrations of commonly found, in place contaminants to the values outlined in a sediment quality guidance document *Consensus-Based Sediment Quality Guidelines, WT PUB- 732, 2003.*
http://www.dnr.state.wi.us/org/water/wm/sms/documents.html. The guidance was developed through an assimilation of results from multiple published effects-based toxicity testing to freshwater benthos, and serves as part of a tiered approach to evaluating potential ecological and human health risks at sites under evaluation for various reasons.

7.0 Integrated Listing Details

One of the defining elements of an "Integrated Report" for the state's water quality assessment program is the use of integrated reporting categories to communicate assessment efforts conducted behind a given assessment decision. These categories help communicate work conducted under the use designation, assessment and restoration elements of the water quality standards program. Wisconsin's Integrated Reporting Categories follow the federal categories identified in the 2008 U.S. EPA Integrated Reporting Guidance document. In Wisconsin, one category is assigned per water or water segment to reflect the summary of designated use assessment status.

7.1 Integrated Listing Categories

The categories listed below are used by Wisconsin DNR.

Table 12. Integrated Listing Categories

Integrated Reporting Category	Description / How this is applied in Wisconsin
Category 1	All designated uses are met, no use is threatened, and the anti-degradation policy is supported. This category requires that all designated uses have been assessed for a given water.
Category 2	Available data and/or information indicate designated uses are met. This category is applied to waters that have been assessed and considered fully meeting one or more designated uses and is usually applied in Wisconsin to waters that have been restored and removed from the impaired waters list.
Category 3	There is insufficient available data and/or information to assess whether a specific designated use is being met or if the anti-degradation policy is supported. This category is also used for situations where the state has not yet had time or resources to analyze available data.
Category 4: Waters where a development of a Total Maximum Daily Load (TMDL) is not or no longer needed.	
Category 4A	All TMDLs needed for attainment of water quality standards have been approved or established by EPA. Implementation and monitoring schedules should then be supplied to U.S. EPA. This category is used for situations where one or more of the designated uses has been identified as impaired and **TMDL has been created and approved.** This does not mean that all other designated uses have been evaluated and found to be meeting their designated use. These waters were previously stored in Category 5C.
Category 4B	Alternative Project to TMDL: Required control measures are expected to achieve attainment of water quality standards in a reasonable period of time. States are required to provide adequate documentation that the proposed control mechanisms will address all major pollutant sources and establish a clear link between the control mechanisms and water quality standards[10].
Category 4C	A waterbody where the impairment is not caused by a pollutant. Pollution is defined by U.S. EPA as the human-made or human-induced alteration of the chemical, physical, biological, and radiological integrity of water (Section 502(19)).
Category 5: A TMDL is required.	
Category 5A	Available data and/or information indicate that at least one designated use is not met or is threatened and/or the anti-degradation policy is not supported, and one or more TMDL are still needed. The majority of Wisconsin impaired waters fall in this category.
Category 5B	Available data and/or information indicate that atmospheric deposition of mercury has caused the impairment of the water. The water is listed for a specific advisory and no in-water source is known other than atmospheric deposition.

[10] In Wisconsin, Environmental Accountablity Projects remain in 5A until a waterbody is restored and delisted.

7.1.1 Placing Assessment Units in Categories

The state of Wisconsin places waters in Category 3 unless additional data or information are available to move the water from a category 3 to a different group. Waters that are known to meet one or more designated uses -- and which have been removed from the Impaired Waters List for one or more designated uses – will be included in Category 2. For example, if an assessment for fish and aquatic life results in the water being listed, restored, and removed from the impaired waters list, it may then be placed in Category 2, indicating that the water has been assessed and considered fully meeting one or more designated uses (with "unknowns" or no information available for the other use designations-unknowns could refer to unknown designated uses or pollutants/impairments.) This category can not be used for situations where a use designation has been restored but a 2nd or 3rd use designation remains impaired.

Waters will only be placed in Category 2 after the state's new assessment methodology (WisCALM) has been applied through the watershed planning and targeted water assessment process initiated in 2009 OR if the water has been fully assessed through an impaired waters listing and de-listing process.

7.1.2 Moving Assessment Units between Categories

Waters are moved from one category to another during updates to the assessment database by water quality biologists and program coordinators. Once an assessment has been conducted the water will be moved from category 3, which is the state's default category, to the updated category. This process usually occurs once a year during the update of the state's water assessments during basin plan updates.

7.1.3 Assessment Units with multiple pollutant/impairment listings

Wisconsin uses one category per water, as opposed to tracking a category for each pollutant/impairment listing combination. Because of this, the water will be placed in the more protective or restrictive category available. If a waterbody is listed for two use designation pollutant/impairment combinations (fish and aquatic life and recreation) and one of the two remain impaired and the other is restored, the water will remain in the impaired water "category" such as 5a or 5b or if applicable, 4a, 4b, or 4c.

7.2 Identifying Causes and Sources of Non-attainment (303(d) List)

When WDNR Water Quality Biologists identify a waterbody as possibly impaired, much thought and experience goes into identifying potential causes and sources of non-attainment. These causes and sources directly affect which parameters are monitored and what type of management or restoration activities might be needed. Section 6 discusses consideration of stream or river stressors and related indicators using habitat impairment, dissolved oxygen depletion, and aquatic toxicity as example areas. Water Quality Biologists identify the pollutant/impairment combinations in the WATERS system and these potential data elements are needed for 303(d) listing.

7.3 De-listing Assessment Unit/Pollutant Combinations

Waters are de-listed from the state's impaired waters list as the state and the U.S. EPA document and declare that the waters are no longer impaired. This process usually happens during the biennial data system update, which occurs every other year on even numbered years.

7.3.1 Water No Longer Impaired

WDNR de-lists waters that have been restored. New monitoring data will be collected through Tier 3 monitoring to evaluate the response of the waterbody to some sort of implementation or restoration strategy. Waters will be assessed through the same process identified as listing a waterbody on the 303(d) Impaired Waters List and must meet water quality standards to be removed from the list. This situation is often related to discrete, single sources of impairment listings where the immediate source has been

managed or removed, such as stream bank pasturing on trout water; if the cows are removed from the stream, the water often recovers rapidly.

7.3.2 Water Listing Validation Found No Impairment

WDNR has identified some waters on the state's historical 303(d) List that may be inappropriately listed. Common reasons include improper documentation of a past assessment, misidentification of a waterbody, and/or incorrect description of the reach and its specific location within a watershed. In those cases, contemporary information will be documented and WDNR may propose to de-list those waters if the most recent assessment indicates all designated uses are achieved.

7.3.3 EPA Approved TMDL

When U.S. EPA approves of a TMDL, the water is removed from the list of impaired waters that 'need a TMDL created'. For Wisconsin, the water is still considered impaired until its water quality standards have been met. However, for the purposes of listing the stream and managing the stream or lakes that require a TMDL, the water is moved from a category 5A or 5B to Category 4A waterbody. Once the water is restored, it may move to a Category 1 or Category 2 water.

7.4 Managing TMDL Data

When a waterbody is placed on the 303(d) list, a TMDL analysis is required. The TMDL determines the maximum amount of a pollutant a waterbody can assimilate and still meet water quality standards. A TMDL is the sum of the waste loads from point sources, nonpoint sources (including natural background levels of the pollutant), and a margin of safety. This is generally described by the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

Where the:

Wasteload Allocation (WLA) is the total pollutant load from all point sources discharging to the downstream impaired water

Load Allocation (LA) is the total pollutant load from nonpoint sources

Margin of Safety (MOS) 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 help connect designated uses, water quality standards, and water quality monitoring data. Because of the regulatory ramifications of being placed on the 303(d) list and subsequent TMDLs, it is important for Wisconsin to make consistent decisions. The protocols described in this WisCALM guidance are designed to facilitate this decision making process.

7.4.1 Impaired Waters Categories

Atmospheric Deposition: This category includes waters with fish consumption advisories (FCAs) caused by atmospheric deposition of mercury. To a very limited extent, it also includes waters with advisories due to polychlorinated biphenyls (PCBs) where there are no discrete sediment deposits. In 1998, 241 waters were listed in this category. In 2002, in accordance with U.S. EPA guidance, the Department switched to a statewide general fish consumption advisory (See "Safe Eating Guidelines") that categorically recognized the ***potential*** for certain contaminants to be present in fish tissue. This approach is very conservative and is an acknowledgement that the Department cannot sample fish from every lake or stream in the state. That same year, the Department listed 92 waters specifically for mercury since actual measurements of mercury in fish tissue were available. In 2006, 26 waters were de-listed for mercury or PCBs based on new data. Although all Wisconsin waters are covered under the statewide

consumption advisory, waters are not included on the impaired waters list unless they are also covered under by waterbody-specific fish consumption advice as well.

The Department will continue to add waters to the 303(d) list that are listed in the latest FCA publication, and de-list those where the specific advisory no longer applies. When specific data are available for certain game and pan fish species, the Department will use fish consumption program guidance to include those waters on the impaired waters list. More information about the specific fish consumption advisory can be found in the publication: *Choose Wisely, A Health Guide for Eating Fish in Wisconsin* (PUB-FH-824 2005) at http://dnr.wi.gov/org/water/fhp/fish/pages/consumption/choosewisely05.pdf.

Specific waters will be proposed for de-listing where fish are collected and analyzed but no longer require specific FCAs for mercury or PCBs. The general, statewide FCA will still apply to these waters.

Contaminated Sediment: The Department will include those water bodies with sediment deposits that are known to have toxic substances that exceed state water quality criteria for ambient water as specified in ch. NR 105, Wis. Adm. Code. These waters may be identified through various monitoring activities, including routine water quality monitoring, sediment core analysis, and collection of fish tissue. In addition to a comparison to the water quality criteria found in NR 105, the Department compares actual sediment concentrations of pollutants to the guidance provided in a document prepared in 2002 entitled “Consensus-Based Sediment Quality Guidelines: Recommendations for Use and Application;” these guidlines identify the concentration of pollutants that will cause “probable effects” in biological organisms that occupy the contaminated sediment area.

Physical Habitat: This category includes waters where codified designated uses are not being met due to a physical structure, such as a dam. For example, if a codified designated use is not being met in an upstream segment due to the presence of a dam preventing fish movement, some portion of the segment is deemed to be impaired.

Point Source Dominated: Waters (usually waterbody segments) in which the impairment is a result of a current discharge from an existing point source are categorized as point source dominated. The Wisconsin Pollutant Discharge Elimination System (WPDES) Permit Program issues and evaluates permits for point sources to assure the attainment of standards at the time of permit issuance. Existing law and rules including the water quality standards and WPDES permit rules preclude the issuance of a permit if it will not attain water quality standards. Waters in this category are likely between permit cycles, or may have obtained a variance to the water quality standards under current law.

Nonpoint Source (NPS) Dominated: These are waters in which the impairment is present primarily as a result of nonpoint source runoff or from the destruction of habitat caused by nonpoint sources. Many of these waters are headwater segments, or *subwatershed* areas. Others are large bodies of water at the downstream end of large drainage basins. TMDLs for waters affected by nonpoint sources will, therefore, vary according to the system impacting the impaired waterbody. The implementation strategy for NPS impairments includes the following: the priority watershed program for watershed size or small scale projects selected prior to 1998 through cost-sharing incentives based on voluntary participation by landowners and other participants; enforcement of nonpoint source controls implemented through the designation of "critical sites"; the NPS program established under Act 27, Laws of 1997, which includes options for site and waterbody designation based on application through WPDES permit issuance and need; application of standards of performance; and other statutory requirements. All urban stormwater sources are included as nonpoint sources for purposes of this list.

Nonpoint Source/Point Source Blend: These include waters in which nonattainment of standards is substantially due to both point source contributions and nonpoint source runoff. Listing a waterbody which is impacted by a point source does not imply that the source is not meeting all the requirements in

its discharge permit, but only indicates that additional analyses are needed to determine relative contributions by the sources and what additional requirement, if any, might be needed. Development of TMDLs will be based upon the waterbody specific evaluation and could include specific segments, watersheds, subwatersheds or sites. Segment-based modeling and assessments, watershed level analyses, or other analyses specific to the individual waters, will be used as necessary. Implementation will be through the permit program and the nonpoint programs described above, potentially using innovative approaches such as pollutant trading or other cost-effective strategies.

Other: This category includes beaches with chronic closure problems due to the presence of high counts of *E. coli* bacteria – a bacterium that serves as an indicator of fecal contamination. Although *E. coli* may not result in illness to humans, its presence suggests that fecal matter may be in the water and that other pathogens may be present. It is often these other pathogens that result in water borne illnesses in humans.

When evaluating *E. coli* data, Department staff will calculate a rolling geometric mean per U.S. EPA guidance when there are fifteen or more samples taken in a year. If there are fewer than 15 samples, the year is considered to have insufficient data. This data threshold was selected to represent the number of samples typically collected during a Wisconsin "beach season." In Wisconsin, the typical swimming season lasts about 15 weeks – Memorial Day through Labor Day weekend. Samples are collected weekly during this time period for beaches that are heavily used. Stream and river samples are rarely considered due to limited data. Waters are proposed to be added to the list where the rolling geometric mean exceeds the U.S. EPA threshold value of 126cfu/100mL, or colony forming units per milliliter.

7.4.2 Ranking Assessment Units for TMDL Development

When submitting the 303(d) List a "priority rank" is included to indicate the relative timeframe for when a TMDL will be developed. A TMDL is an analysis that determines how much of a pollutant a waterbody can assimilate before it exceeds water quality standards. Federal law requires that TMDLs be developed for water bodies listed on the impaired waters list.

Each water in the 2010 303(d) list includes a status ranking of "high," "medium" or "low." Rankings will be evaluated during each listing cycle to determine if TMDL development can be completed based on staff and fiscal resources. If a TMDL is already in development, and completion of the report should occur within the next two years (i.e. before the 2012 list), we will rank the waterbody as a "high" priority. A ranking of "medium" indicates that the water is currently being monitored to gather data to develop a TMDL within two to five years dependent on staff and fiscal resources. A ranking of "low" indicates that a TMDL will likely be completed in the future.

Selection of new waters for which TMDLs may be developed considers the following factors:

- **Availability of information**: Large amounts of data are needed to develop a TMDL. Some waters already have some water quality data that can be used while others have little to no data to determine pollutant sources or loading. Waters with readily available data will more likely be a candidate for TMDL development within two to five years and assigned a "medium" or "high" priority ranking.
- **Likelihood to respond:** The Department may consider the likelihood of the water to respond to management actions when assigning a rank.
- **Severity of the impairment:** The Department will also consider the severity of the impairment in assigning a priority. In some cases, extreme conditions may be present that need attention more quickly than those that are not so extreme. Waters with frequent fish kills or acute toxicity issues are examples of this concern.
- **Pubic health concerns:** Waters with issues that may affect human health can be considered "high" priority if development and implementation of a TMDL can result in improving water quality.

7.4.3 Updating the TMDL Schedule

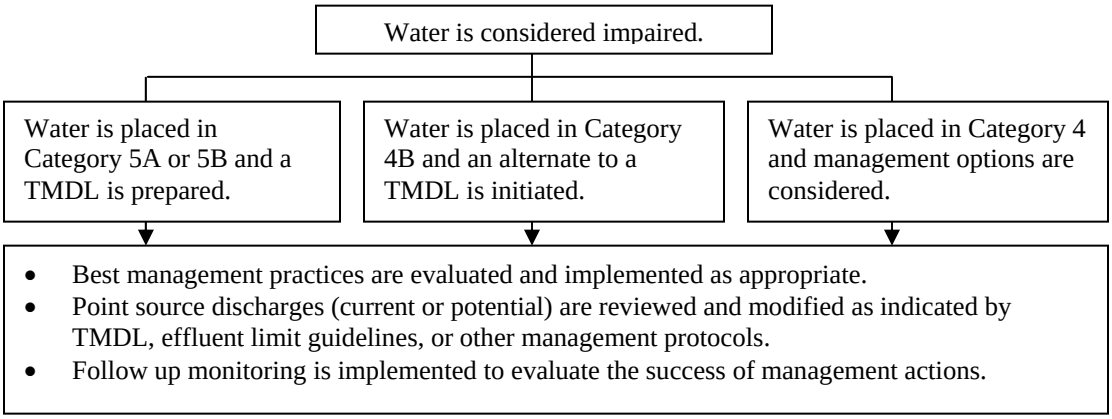
Given the number of factors and the varying importance between the short-term and the long-term reporting periods, the process used for assigning priorities is both complex and subjective. High priority waters for TMDL development can be characterized as waters where adequate information for TMDL development is available and where the department is likely to be able to take advantage of opportunities provided by other activities. Both high and medium priority TMDLs take advantage of Tier 1 and Tier 2 monitoring throughout the state. Every two years when the 303(d) list is evaluated, waters are evaluated for TMDL development and their status is updated as needed.

8.0 Methods to Determine Management Options for Assessment Units

8.1 Management Options for Assessment Units that do not attain uses

Waters that do not attain water quality standards and for which no water quality standards variance or UAA has been approved are placed on the Impaired Waters List. The follow up management actions once water is placed on the list may vary, but the fundamental listing of a waterbody as impaired does not vary.

Figure 16. Management Options for Impaired Waters



As Figure 16 above shows, management approaches for waters that do not attain uses *may include:*

- → preparing a TMDL analysis and related TMDL implementation plan,
- → placing the water on the list of Environmental Accountability Projects (EAPs), or
- → obtaining a specific variance classification under NR104. Variance classifications are those in which the water condition is designated as a limited forage fishery (LFF) or limited aquatic life (LAL) aquatic community.

Environmental Accountability Projects (EAPs)

Alternatives to a TMDL can be prepared for waters on the 303(d) list. These alternatives are referred to as "Environmental Accountability Projects" or EAPs. These are any planned implementation actions on the impaired water that will result in that water meeting water quality standards. EAPs are commonly used when the source of an impairment and the appropriate management action are readily identifiable, and the situation is not complex enough to require a TMDL analysis to identify multiple sources and management actions.

Examples of EAP actions are nonpoint source projects or activities, remedial actions under Superfund, or dam removals. Acceptable EAPs must meet a minimum of nine required elements prescribed for water quality-based plans in federal program guidance for Section 319 of the Clean Water Act. Wisconsin currently has several projects that may have an EAP prepared to address specific pollutants and impairments instead of a TMDL. In 2010, Bass Lake is the only EAP resulting in a delisting. It is likely that more waterbodies will be delisted in the future as a result of having an EAP project implemented.

8.2 Management Options for Assessment Units that do attain uses

Waters that are not considered impaired may still be in need of management actions. For example, waters identified as "excellent" during the general assessment process may be considered for further evaluation for outstanding resource water or exceptional resource water listing. Management goals for waters considered "good" include maintaining existing condition (anti-degradation) and those considered "fair" will be placed on a list of waters for further monitoring and evaluation and may receive higher priority for grant funding through programs that offer cost-share incentives for restoration projects. If the water is degraded in part due to runoff related problems, the water may be ranked 'high' for nonpoint source ranking and the watershed as a whole may be evaluated or reassessed for this watershed nonpoint source rank score. Table 8 outlines some of these management options for the different stream types analyzed through the assessment process.

9.0 Public Participation

Public involvement in the 2010 integrated assessment and 303(d) listing process is very important because ultimately for water quality restoration to occur, citizens of Wisconsin must be part of the solution. Public involvement is also required to obtain U.S. EPA approval of the state's Integrated Report – in particular the state's Year 2010 303(d) list updates and changes. The public has several opportunities to comment on the Integrated Report as it is developed:

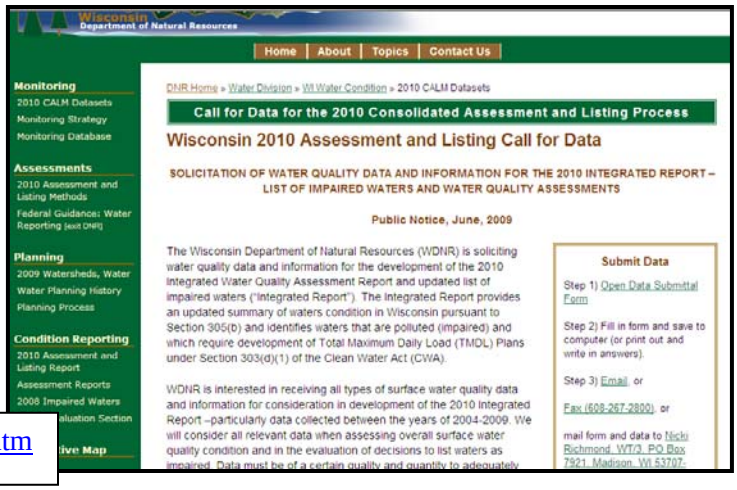
- Calls for data as public noticed by the Department.
- As resources allow, the state may provide informal meetings with multiple interested parties or "one on one" discussions of specific waters or issues.
- Statewide public informational meetings to discuss the draft list of impaired waters and the WisCALM document used to determine impairments.
- Draft 305(b) report and 303(d) list as public noticed by the Department with request for comments.
- Supporting documentation will be available upon request for the public notice period.
- Public comments must be sent to WDNR during the formal comment period to be considered in the listing decision submittal. However, comments may be sent to WDNR or directly to EPA about WDNR's Integrated Report at anytime during the process.

U.S. EPA must take an action on the Impaired Waters List of Wisconsin's Integrated Report. 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 Clean Water Act. Once the Integrated Report and 303(d) list are approved by EPA, the TMDL process may begin for newly listed impaired waters, depending on resources and staff availability. At this stage, there are additional opportunities for the public to comment as TMDL development moves forward.

9.1 Requests for Data

The WDNR is providing an opportunity for the public, partners and stakeholders to submit datasets for general and specific analyses including recommendations for impaired waters listings or changes to listings. This comment period will begin June 17th.

The website provides an online downloadable form for individuals or agencies to fill out when they submit their datasets or recommendations.

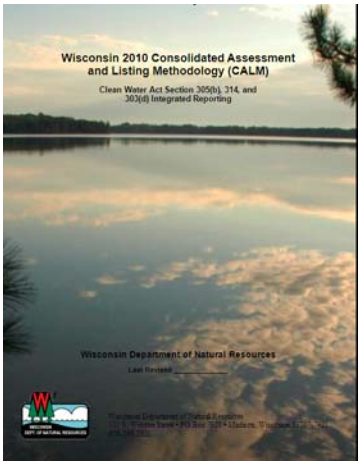


http://dnr.wi.gov/org/water/condition/2010_Data.htm

9.2 Public Comment on Consolidated Assessment and Listing Methodology

During fall 2009 public comment will be requested for the state's general and impaired waters assessments and for the Wisconsin Consolidated Assessment and Listing Methodology (WisCALM).

WDNR will provide easily accessible online tools and methods to provide comments on this document in final form and the general and specific assessments, which will be posted on the DNR website prior to public informational meetings.



http://dnr.wi.gov/org/water/condition/wiscalm.htm

9.3 Informational Meetings on Draft Integrated Report, General Assessment and Proposed Updates to the 303(d) Impaired Waters List

From December 1st through January 15th,2010, the WDNR will provide opportunities for public comment on the state's 2010 updates to the general (305(b)) assessment updates conducted in 2008-09 by WDNR biologists and water resource specialists, as well as the modifications to the Wisconsin 303(d) List of Impaired Waters proposed for 2010. The following information will be posted for public review:

- **Updates to the state's Water Quality Management Plans** ("Watershed Plans") which will include general assessment information gathered for the 2010 reporting period. (See list of targeted watersheds at: http://dnr.wi.gov/org/water/condition/wtplans/),
- **Statewide maps and analyses** to be presented in the Wisconsin 2010 Consolidated Assessment and Listing Report ("Integrated Report") which will be located here: http://dnr.wi.gov/org/water/condition/2010_IR/index.htm ,

- **Proposed modifications for the 2010 Impaired Waters List,** highlighting changes from the 2008 list, which will be linked to or posted on this page: http://dnr.wi.gov/org/water/wm/watersummary/Waterqualityassessment.html and

9.4 U.S. EPA Review, Comment and Administrative Decision on Wisconsin's Integrated Report/Data Submittal

Wisconsin will provide the U.S. EPA with an integrated dataset, a narrative report, GIS files and a list of updates to the state's impaired waters on or before April 1st, 2010. When this occurs, the WDNR will post the final submittal package on the agency's website for public informational purposes.

Comments must be submitted to Wisconsin Department of Natural Resources for review and copies can be submitted to U.S. EPA Region 5 Watersheds and Wetlands Branch. To review the comments and responses see: http://dnr.wi.gov/org/water/wm/wqs/303d/303d.html.

Author:		Date Prepared:
Waterbody Name:		Watershed Code and Name:
WADRS ID:	WBIC:	If you don't know the ID numbers, go to i-SWDV (CRTL + Click) to find them.

Choose from the following to indicate what you are recommending:

_____ Proposed new listing

_____ Proposed changes for water already on 303(d) list (check type of change below) ➔ TMDL ID Number: _____

_____ Proposed change to existing list (new pollutants, impairments, mileages, etc.)

_____ Proposed for de-listing (a report may be needed depending on the reasons)

_____ General 303(d) documentation for water already on list

Description of waterbody segment

Start Mile: _____ Detail (describe segment using road crossings, convergence with other waterbodies, etc.):

End Mile: _____

Total miles: _____

Lake Acres: _____

Use Designation Categories **List use designation & data source for each category.**

Current (Existing) Fish & Aquatic Life Use: (Aquatic Community) _____

Attainable (Potential) Fish & Aquatic Life Use: (Aquatic Community) _____

Designated (Codified) Fish & Aquatic Life Use: _____

Is it supporting its FAL Attainable Use? _____ Fully supporting _____ Supporting _____ Not supporting
Is it supporting its Recreational Use? _____ Fully supporting _____ Supporting _____ Not supporting

Does a *Specific* Fish Advisory Exist? (This is different from the statewide mercury advisory.) ___ Yes ____ No ___ Don't know

If so, what is the specific advisory:

Pollutants & Impairments

Pollutants (Place an X next to all pollutants that you are recommending for listing, de-listing or monitoring needs. If you are recommending adding a new pollutant to a waterbody that is already on the list, write ADD.)

_____ Phosphorus _____ Sediment _____ Bacteria _____ PAHs _____ PCBs

_____ NH3 (Ammonia) _____ Thermal (elevated temp.) _____ Hg _____ Creosote _____ Metals

Other Pollutants:

Impairments (Place an X next to all impairments that you are recommending for listing, de-listing, or monitoring needs. If you are recommending adding a new pollutant to a waterbody that is already on the list, write ADD.)

_____ Degraded Habitat _____ Eutrophication _____ Temperature

_____ Contaminated Fish Tissue _____ Chronic Toxicity _____ Aquatic Toxicity

_____ Low Dissolved Oxygen _____ Aquatic Invasives _____ Recreational Restrictions

Other Impairments:

Source of impairment (Place an X next to the source category.) if you need an explanation of source categories., see http://dnr.wi.gov/org/water/wm/wqs/303d/categories.html .

_____ NPS Dominated _____ NPS/Pt. Source Blend _____ Point Source

_____ Contaminated Sediment _____ Atmospheric Deposition _____ Physical Habitat

_____ Unknown Other: _____

Specific causes of impairment (Describe to the best of your ability what you think is contributing to the impairment.)

Information is based on:

Monitoring data (specific data) less than 5 years old (Circle One) YES NO

Map

When possible, please create a map of your waterbody and submit it with this form. It is easy to create a 8.5 x 11 map of the area you are describing. Go to the go to the Intranet Surface Water Viewer i-SWDV (CRTL + Click). Choose "Find Location" to find the waterbody, then "Layers" to choose "Standards, Monitoring and Assessment". If it is already on the 303(d) list, then click "Impaired Waters 303d". If you want to show the monitoring stations, also click on "SWIMS Station Points". Then choose "Print" (this will create a pdf map), add a title under "Map Title" and your name and date under "Map Notes", click "OK" and then "Open Map" at the next screen. Save the file and attach it when you send in this sheet. For additional help on how to make a map, check out page 12-14 on the website
http://www.dnr.state.wi.us/org/water/SWDV/help/documents/SWDV_Basic_User_Guide_%209_07.pdf

Monitoring & Listing Data

1. Monitoring Study, Date, Results. List water quality exceedences indicating magnitude, duration and frequency.

Stations:

Parameters:

Database where data is stored (Fish Database, SWIMS, FishSED, Personal PC):

2. Monitoring Study, Date, Results. List water quality exceedences indicating magnitude, duration and frequency.

Stations:

Parameters:

Database where data is stored (Fish Database, SWIMS, FishSED, Personal PC):

3. Monitoring Study, Date, Results. List water quality exceedences indicating magnitude, duration and frequency.

Stations:

Parameters:

Database where data is stored (Fish Database, SWIMS, FishSED, Personal PC):

Narrative on why you are proposing this waterbody to be listed or de-listed?

List and Attach any additional reports, updated watershed tables, analyses etc. including use designation survey.

1.

2.

3.

4.

5.