Water Quality Assessment Methodology for North Dakota's Surface Waters

North Dakota Department of Health
Division of Water Quality

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Doug Burgum, Governor
Mylynn Tufte, State Health Officer

North Dakota Department of Health
Division of Water Quality
Gold Seal Center, 4th Floor
918 East Divide Avenue
Bismarck, ND 58501-1947

701.328.5210

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I. INTRODUCTION

A. Background

The federal Clean Water Act (CWA) provides the regulatory context and mandate for state water quality monitoring and assessment programs. The North Dakota Department of Health (NDDoH) has been designated as the state water pollution control agency for purposes of the federal CWA and, as such, is authorized to take all actions necessary or appropriate to secure for the state all benefits of the CWA and similar federal acts (NDCC 61-28-04). State law establishes policy to protect, maintain, and improve the quality of waters of state, while the overall goal of the federal CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

Various sections in the CWA require states to conduct specific activities to monitor, assess, and protect their waters. These activities include:

- Develop and adopt water quality standards designed to protect designated beneficial uses (Section 303);
- Establish and maintain monitoring programs to collect and analyze water quality data (Section 106). Reporting on the status of waters and the degree to which designated beneficial uses are supported (Section 305[b]);
- Identify and prioritize waters that are not meeting water quality standards (Section 303[d]);
- Assess the status and trends of water quality in lakes and identifying and classifying lakes according to trophic condition (Section 314); and
- Identify waters impaired due to nonpoint sources of pollution as well as identifying those sources and causes of nonpoint source pollution (Section 319).

B. North Dakota's Surface Water Resources

The NDDoH currently recognizes 295 public lakes and reservoirs. Of the 295 public lakes and reservoirs recognized as public waters and included in the ATTAINS database (see section III. ATTAINS), only 200 lakes and reservoirs totaling 622,381.6 acres that are specifically listed in the state's water quality standards as classified lakes and therefore are assigned designated beneficial uses.

Of the 295 public lakes and reservoirs included in ATTAINS, there are 146 are manmade reservoirs and 149 are natural lakes. All lakes and reservoirs included in this assessment are considered significantly publicly owned. Based on surface area estimates entered into ATTAINS for each reservoir, the 146 reservoirs have an aerial surface of 476,709 acres. Reservoirs comprise about 67 percent of North Dakota's total lake/reservoir surface acres. Of these, 411,498 acres or 58 percent of the state's entire lake and reservoir acres are contained within the two mainstem Missouri River reservoirs (Lake Sakakawea and Lake Oahe). The remaining 144 reservoirs share 65,211 acres, with an average surface area of 453 acres.

The 149 natural lakes in North Dakota cover 239,237 acres, with approximately 102,376 acres or 43 percent attributed to Devils Lake. The remaining 148 lakes average 924.74 acres, with approximately 40 percent being smaller than 250 acres.

There are 56,644 miles of rivers and streams in the state. Estimates of river stream miles in the state are based on river and stream waterbodies entered into the ATTAINS database that are reach indexed to a modified version of the 1:100,000 National Hydrography Dataset (NHD plus) and include ephemeral, intermittent and perennial rivers and streams.

One of the most significant water resource types in the state are wetlands. There are an estimated 2.5 million acres of wetlands in the state. The majority of these wetlands are temporary, seasonal, semi-permanent and permanent depressional wetlands located in what is commonly called the Prairie Pothole Region.

C. Purpose and Scope

Water quality standards provide the fundamental benchmarks by which the quality of all surface waters are measured. It is the water quality standards that are used to determine impairment. As a general policy, the assessment procedures described in this methodology are consistent with the NDDoH's interpretation of the state's water quality standards.

For purposes of Section 305(b) reporting and Section 303(d) listing, the US Environmental Protection Agency (EPA) encourages states to submit an integrated report (IR) and to follow its integrated reporting guidance, including EPA's 2006 IR guidance, which is supplemented by EPA's 2008, 2010, 2012, 2014, 2016 and 2018 IR guidance memos (http://www.epa.gov/tmdl/integrated-reporting-guidance). Key to integrated reporting is an assessment of all of the state's waters and placement of those waters into one of five assessment categories. The categories represent varying levels of water quality standards attainment, ranging from Category 1, where all of a waterbody's designated uses are fully supporting, to Category 5, where a pollutant impairs a waterbody and a TMDL is required (Table 1). These category determinations are based on consideration of all existing and readily available data and information consistent with the state's water quality assessment methodology.

The purpose of this document is to describe the assessment methodology used in the state's biennial integrated report. This information, which is summarized by specific lake, reservoir, river reach or sub-watershed, is integrated as beneficial use assessments that are entered into a water quality assessment "accounting"/database management system developed by EPA. This system, which provides a standard format for water quality assessment and reporting, is termed the Assessment Total Maximum Daily Load Tracking and Implementation System (ATTAINS).

Table 1. Assessment Categories for the Integrated Report

Assessment Category	Assessment Category Description
Category 1	All of the waterbody's designated uses have been assessed and are fully supporting.
Category 2	Some of the waterbody's designated uses are fully supporting, but there is insufficient data to determine if remaining designated uses are fully supporting.
Category 3	Insufficient data to determine whether any of the waterbody's designated uses are met.
Category 4	At least one of the waterbody's beneficial uses is not supported or has been assessed as fully supporting, but threatened, but a TMDL is not needed. This category has been further sub-categorized as: • 4A - waterbodies that are impaired or threatened, but TMDLs needed to restore beneficial uses have been approved or established by EPA; • 4B - waterbodies that are impaired or threatened, but do not require TMDLs because the state can demonstrate that "other pollution control requirements (e.g., BMPs) required by local, state or federal authority" • (see 40 CFR 130.7[b][1][iii]) are expected to address all waterbody-pollutant combinations and attain all water quality standards in a reasonable period of time; and • 4C - waterbodies that are impaired or threatened, but the impairment is not due to a pollutant.
Category 5	At least one of the waterbody's beneficial uses is not supported or has been assessed as fully supporting, but threatened, and a TMDL is needed. • 5A – waterbodies currently listed on the Section 303(d) list, but are targeted for additional monitoring and assessment during the next two to four years. **Note:** This also includes waterbodies which are assessed as impaired based on biological data alone and for which there are no known pollutant causes of the impairment. These impaired waterbodies will be target for additional stressor identification monitoring and assessment.

II. WATER QUALITY STANDARDS

A. Background

As stated previously, water quality standards are the fundamental benchmarks by which the quality of all of the state's surface waters are assessed. It is the state's water quality standards that are ultimately used to determine beneficial use impairment status.

Water quality standards were first adopted into North Dakota administrative code beginning in the late 1960's. "Water quality standards" is a term which is used in both a broad and narrow sense. In its broadest sense, water quality standards include all the provisions and requirements in water quality rules and regulations, including minimum wastewater treatment requirements and effluent limits for point source dischargers. In the more narrow sense, water quality standards define the specific uses we make of waters of the state and set forth specific criteria, both numeric and narrative, that define acceptable conditions for the protection of these uses, including antidegradation provisions (Appendix A). The term "water quality standards" is used in the more narrow sense throughout this document.

Water quality reporting requirements under Sections 305(b) and 303(d) of the CWA require states to assess the extent to which their lakes, reservoirs, rivers, and streams are meeting water quality standards applicable to their waters, including beneficial uses as defined in their state water quality standards. In addition to beneficial uses, applicable water quality standards also include narrative and numeric standards and antidegradation policies and procedures. While

Section 305(b) requires states and tribes to provide only a statewide water quality summary, Section 303(d) takes this reporting a step further by requiring states to identify and list the individual waterbodies that are not meeting applicable water quality standards and to develop TMDLs for those waters. Both Section 305(b) reporting and Section 303(d) listing accomplish this assessment by determining whether a waterbody is supporting its designated beneficial uses.

B. Beneficial Use Designation

The protected beneficial uses of the state's surface waters are defined in the *Standards of Quality for Waters of the State* (Appendix A). The state's water quality standards provide for four stream classes (I, IA, II, and III) and five lake classes (1-5). While considered "waters of the state" and protected under the state's narrative standards, the state's water quality standards do not define beneficial uses for wetlands.

All classified lakes, reservoirs, rivers, and streams in the state are protected for aquatic life and recreation. Protection for aquatic life means surface waters are suitable for the propagation and support of fish and other aquatic biota, including aquatic macroinvertebrates, and that these waters will not adversely affect wildlife in the area. Protection of all surface waters, except wetlands, for recreation means waters should be suitable for direct body contact activities such as bathing and swimming and for secondary contact activities such as boating, fishing, and wading.

Class I, IA, and II rivers and streams and all classified lakes and reservoirs are designated for use as municipal and drinking water supplies. Specifically, these waters shall be suitable for use as a source of water supply for drinking and culinary purposes after treatment to a level approved by the NDDoH.

While not specifically identified in state water quality standards, fish consumption is protected through both narrative and numeric human health criteria specified in the state's water quality standards (Appendix A). The state's narrative water quality standards provide that surface waters shall be "free from materials attributable to municipal, industrial, or other discharges or agricultural practices" which will "render any undesirable taste to fish flesh or, in any way, make fish inedible." In addition, the state's statewide fish consumption advisory applies to all waters known to provide a sport fishery.

Other beneficial uses identified in the state's water quality standards are agriculture (e.g., stock watering and irrigation) and industrial (e.g., washing and cooling). These uses apply to all classified rivers, streams, lakes, and reservoirs.

Four beneficial uses (aquatic life, recreation, drinking water, and fish consumption) are typically assessed for purposes of Section 305(b) reporting and Section 303(d) listing. All waterbodies included in the assessment database (ADB) and, therefore, all stream classes (I, IA, II, and III) and all lake classes (1-5) are assigned aquatic life and recreation beneficial uses. All Class I, IA, and II rivers and streams and all classified lakes and reservoirs are assigned the drinking water beneficial use. Fish consumption use is assumed to apply to all Class I, IA, and II rivers and streams, to those Class III streams known to provide a sport fishery, and to all Class 1 through 4 lakes and reservoirs.

C. Numeric Water Quality Standards

A numeric water quality standard is considered a safe concentration of a pollutant in water, associated with a specific beneficial use. Numeric standards are associated with all use classes. Ideally, if the numeric standard is not exceeded, the use will be protected. However, nature is very complex and variable, and the NDDoH may use a variety of assessment tools (e.g., chemical and biological monitoring) to fully assess beneficial uses. With few exceptions, protection for aquatic life and/or drinking water uses will also provide protection for less sensitive uses (e.g., agriculture and industrial uses). For some pollutants, numeric standards may applicable to more than one use and may be more stringent for one use than another. For example, the drinking water standard for selenium is 50 µg/L, while the chronic aquatic life standard is 5 µg/L.

As is the case for most states, the state of North Dakota's numeric standards for toxic pollutants are based on the EPA's aquatic life criteria. The EPA develops and publishes these criteria as required by Section 304(a) of the CWA. Most numeric standards have two parts, a chronic value and an acute value. The chronic standard is the highest concentration of a toxicant to which organisms can be exposed indefinitely with no harmful effects, including growth and reproduction. The acute standard protects aquatic organisms from potential lethal effects of a short-term "spike" in the concentration of the toxicant.

In the development of aquatic life criteria and associated standards, the EPA and the NDDoH have addressed some of the many toxicological, water chemistry, and practical realities the affect a toxicant's impact on aquatic biota. For example, pollutant concentrations and flow volumes vary in effluents and in receiving streams over time, aquatic organisms generally can tolerate higher concentrations of toxicants for shorter periods of time, and the sensitivity of aquatic organisms to toxicants often varies over their lifespan. EPA's approach for expressing water quality standards addresses varying toxicant concentrations, length of an averaging period for the standard, and the number of acceptable exceedances over time. These concepts are highly relevant to the interpretation of water quality standards and the assessment of waterbodies based on available data. In the development and implementation of numeric water quality standards, these concepts are referred to as:

- Magnitude;
- Duration; and
- Frequency.

Magnitude refers to the concentration of a given pollutant and is represented by the numeric standard. For example, the chronic and acute standards for copper are 14.0 and 9.3 µg/L, respectively. This is the "magnitude" of copper that, if not exceeded in water, will protect aquatic biota from chronic and acute effects.

Duration refers to the period of time the measured concentration of a toxicant can be averaged and still provide the desired level of protection to the aquatic community. In the context of toxicity to aquatic organisms, it would be unrealistic to consider a standard as an instantaneous maximum concentration never to be exceeded. On the other hand, toxicant concentrations averaged over too long a time could be under-protective, if it allowed exceedingly high lethal concentrations to be masked by the average. In general, EPA recommends a 4-day averaging period for chronic standards and a 1-hour averaging period for acute standards.

Frequency refers to the number of times a standard may be exceeded over a prescribed time period and still provide adequate protection. EPA guidance and state water quality standards specify that the numeric standards, both chronic and acute, should not be exceeded more than once in three years. The three year time frame is based on studies of the time its takes for aquatic communities to recover from a major disturbance.

D. Narrative Water Quality Standards

A narrative water quality standard is a statement(s) that prohibits unacceptable conditions from occurring in or upon surface waters, such as floating debris, oil, scum, garbage, cans, trash, or any unwanted or discarded material. Narrative standards also prohibit the discharge of pollutants, which alone or in combination with other substances, can 1) cause a public health hazard or injury to the environment; 2) impair existing or reasonable beneficial uses of surface waters; or 3) directly or indirectly cause concentrations of pollutants to exceed applicable standards. Narrative standards are often referred to as “free froms” because they help keep surface waters free from very fundamental and basic forms of water pollution (e.g., sediment and nutrients).

The association between narrative standards and beneficial use impairment is less well defined than it is for numeric standards. Because narrative standards are not quantitative, the determination that one has been exceeded typically requires a “weight-of-evidence” approach to the assessment showing a consistent pattern of water quality standards violations. The narrative standards relevant to this guidance document are found in state water quality standards Section 33-16-02.1-08 (Appendix A). These standards protect surface waters and aquatic biota from:

- Eutrophication (particularly lakes and reservoirs);
- Impairment of the biological community (exemplified by the Index of Biotic Integrity); and
- Impairment of fish for human consumption.

E. Antidegradation Policies and Procedures

In addition to numeric and narrative standards and the beneficial uses they protect, a third element of water quality standards is antidegradation. The fundamental concept of antidegradation is the protection of waterbodies whose water quality is currently better than applicable standards. Antidegradation policies and procedures are in place to maintain high quality water resources and prevent them from being degraded down to the level of water quality standards.

State water quality standards has established three categories or tiers of antidegradation protection (Appendix A). Category 1 is a very high level of protection and automatically applies to all Class I and IA rivers and streams, all Class 1, 2, and 3 lakes and reservoirs, and wetlands that are functioning at their optimal level. Category 1 may also apply to some Class II and III rivers and streams, but only if it can be demonstrated that there is remaining pollutant assimilative capacity, and both aquatic life and recreation uses are currently being supported. Category 2 antidegradation protection applies to Class 4 and 5 lakes and reservoirs and to Class II and III rivers and streams not meeting the criteria for Category 1. Category 3 is the highest level of protection and is reserved for Outstanding State Resource Waters. Waterbodies may only be designated Category 3 after they have been determined to have exceptional value for present and prospective future use for public water supplies, propagation of fish or aquatic biota, wildlife, recreational purposes, or agricultural, industrial, or other legitimate beneficial uses.

III. ATTAINS DATABASE

With an estimated 56,644 miles of rivers and streams and 715,946 acres of lakes and reservoirs in the state, it is impractical to adequately assess each and every mile of stream or every acre of lake. However, the NDDoH believes it is important to: 1) accurately assess those waters for which beneficial use assessment information is available; and 2) account for those stream miles and lake acres that are not assessed or for which there are insufficient data to conduct an assessment. As a result, the NDDoH has adopted the Assessment and Total Maximum Daily Load Tracking and ImplementatioN System (ATTAINS) database to manage water quality assessment information for the state's rivers, streams, lakes, and reservoirs. Developed by EPA, ATTAINS is a web based "accounting"/database management system that provides a standard format for water quality assessment information. It includes a web interface for adding and editing assessment data. Assessment data, as compared to raw monitoring data, describes the overall health or condition of the waterbody by describing beneficial use impairment(s) and, for those waterbodies where beneficial uses are impaired or threatened, the causes of pollution affecting the beneficial use. ATTAINS also allows the user to track and report on TMDL-listed waters, including their development and approval status and de-listing rationale.

For the 2018 Integrated Reporting cycle, there are 1,791 discreet assessment units (AUs) entered into the ATTAINS database for North Dakota which represent 56,384 miles of rivers and streams (1495 AUs) and 295 lakes and reservoirs (296 AUs) (Note, Lake Sakakawea is represented by two assessment units in ATTAINS, one for the main reservoirs and one for the Little Missouri Bay segment of the reservoir.). While each lake or reservoir is an individual AU in ATTAINS, river and stream AUs may be represented by a single stream reach or by multiple stream reaches representing a catchment or sub-watershed. Within ATTAINS, designated uses are defined for each AU (i.e., river or stream reach and lake or reservoir) based on the state's water quality standards. Each AUs is then assessed individually, based on the availability of sufficient and credible chemical, physical and/or biological data. In order to delineate and define AUs used in ATTAINS, the NDDoH follows a general set of guidelines:

1. Each AU is within the eight-digit USGS hydrologic unit.

2. Each river and stream AU is composed of stream reaches of the same water quality standards classification (I, IA, II or III).

3. To the extent practical, each AU is within a contiguous Level IV ecoregion.

4. Mainstem perennial rivers are delineated as separate AUs. Where these rivers join with another major river or stream within the eight-digit hydrologic unit, the river was further delineated into two or more AUs.

5. Tributary rivers and streams, which are named on USGS 1:100,000 scale planimetric maps or the National Hydrography Dataset (NHD), are delineated as separate AUs. These AUs may be further delineated, based on stream order or water quality standards classification.

6. Unnamed ephemeral tributaries to a delineated AU are consolidated into one unique AU. This is done primarily for accounting purposes so that all tributary stream reaches identified in the NHD are included in ATTAINS.

7. Stream reaches, which are identified in the NHD and on USGS 1:24,000 scale maps and which do not form either an indirect or direct hydrologic connection with a perennial stream or classified lake, are not included in ATTAINS. This would include small drainages that originate and flow into closed basin lakes or wetlands. (Note: These delineation criteria do not apply to tributaries to Devils Lake)

ATTAINS provides an efficient accounting and data management system. It also allows for the graphical presentation of water quality assessment information by linking assessments contained in the ATTAINS to the NHD file through “reach indexing” and geographic information systems (GIS). In order to facilitate the GIS data link, the NDDoH has “reach-indexed” each AU in ATTAINS to the NHD file. The product of this process is a GIS coverage that can be used to graphically display water quality assessment data entered in ATTAINS. An example can be seen in Figure 1, which depicts each of the reach-indexed AUs delineated in the Knife River Sub-basin (10130201).

Assessments completed and entered into ATTAINS also form the basis for the state’s Section 319 Nonpoint Source (NPS) Assessment Report and Management Plan. Because of the way the NDDoH’s Surface Watershed Management Program is structured, there is complete integration of the state’s Section 305(b) Water Quality Assessment Report, the Section 303(d) TMDL List and the Section 319 NPS Assessment Report and Management Plan.

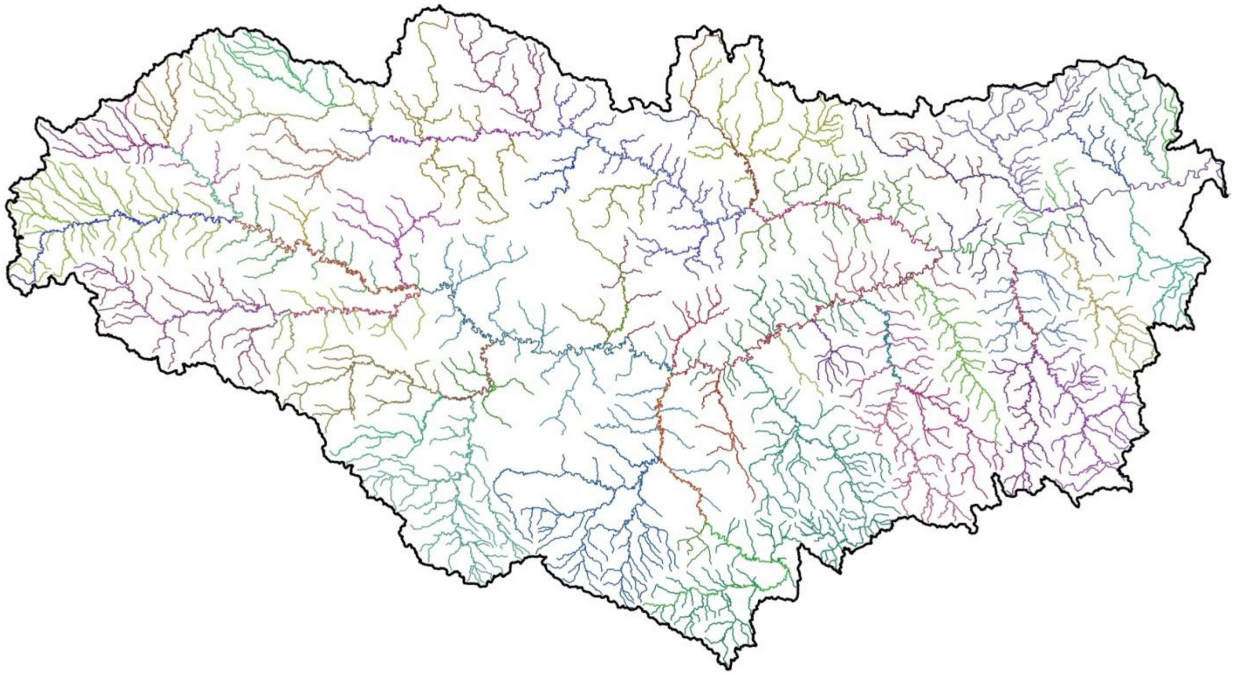

Figure 1. Map of Reach-Indexed Assessment Units Delineated in the Knife River Sub-basin (10130201).

IV. SUFFICIENT AND CREDIBLE DATA REQUIREMENTS AND OVERWHELMING EVIDENCE

A. Sufficient and Credible Data Requirements

For water quality assessments, including those done for purposes of Section 305(b) assessment and reporting and 303(d) listing, the NDDoH will use only what it considers to be sufficient and credible data. Sufficient and credible data are chemical, physical, and biological data that, at a minimum, meet the following criteria:

- Data collection and analysis followed known and documented quality assurance/quality control procedures. This would include citizens or volunteer monitoring data or data submitted by third parties.

- Water column chemical, biological or fish tissue data are 10 years old or less for rivers and streams and lakes and reservoirs, unless there is adequate justification to use older data (e.g., land use, watershed, or climatic conditions have not changed). Years of record are based on the USGS water year. Water years are from October 1 in one year through September 30 of the following year. It should be noted that it is preferable to split the year in the fall when hydrologic conditions are stable, rather than to use calendar years. Data for all 10 years of the period are not required to make an assessment.

- There is a minimum of 10 chemical samples collected in the 10-year period for rivers and streams. The 10 samples may range from one sample collected in each of 10 years or 10 samples collected all in one year.

- There should be a minimum of two samples collected from lakes or reservoirs collected during the growing season, April-November. The samples may consist of two samples collected the same year or samples collected in separate years.

- A minimum of five E. coli samples are collected during any 30-day consecutive period (e.g., calendar month) from May through September. The five samples per month may consist of five samples collected during the month in the same year or five samples collected during the same calendar month, but pooled across multiple years (e.g., two samples collected in May 2012, two samples collected in May 2013 and one sample collected in May 2017).

- For all chemical criteria that are expressed as a 30-day arithmetic average (e.g., chloride, sulfate, radium 226 and 228, and boron) a minimum of four daily samples must be collected during any consecutive 30-day period. Samples collected during the same day shall be averaged and treated as one daily sample.

- A minimum of two biological samples (fish and/or macroinvertebrate) are necessary in the most recent 10-year period per assessment unit. Samples may be collected from multiple sites within the assessment stream reach, multiple samples collected within the same year, or individual samples collected during multiple years. Samples may consist of a minimum of two fish samples, two macroinvertebrate samples, or one fish and one macroinvertebrate sample. Samples should be collected from sites considered to be representative of the AU. At a minimum one site should be located at the downstream end of the assessed stream reach.

- The mean methyl-mercury concentration is estimated from a minimum of 3 composite samples (preferred) or 9 individual fish samples representative of the filet. When composite samples are used, each composite sample should consist of a minimum of three individual fish per composite with the smallest fish in the composite no less than 75% of the largest fish by length. Each composite sample should also be representative of a distinct age class of the target fish species in the waterbody. In other words, if three composite samples are collected, one composite should represent small fish, one representing medium sized fish and one representing large fish in the population.

- If individual fish samples are collected then a minimum of 9 fish samples should be used to estimate the mean methyl-mercury concentration. The same criteria used to collect a composite sample should be used for individual fish samples where fish should be representative of at least three size classes and a minimum of three fish should be collected per size class (3 size classes times 3 fish per size class equals 9 fish). In cases where individual fish samples are used, then the number of fish per size class should be equal.

B. Overwhelming Evidence

There are situations where a single set of data is all that is needed to make a use support determination. For example, a single set of water chemistry data may be sufficient to establish that a waterbody is not supporting aquatic life use. In such situations where a single data set irrefutably proves that impairment exists, an impairment determination may be based on this "overwhelming evidence."

A number of factors are evaluated when making a determination as to whether data can be used as a basis for an "overwhelming evidence" assessment. Factors include the technical soundness of the methods used to collect the data and the spatial and temporal coverage of the data as it relates to the waterbody being assessed. Data quality and data currency (i.e., how old are the data?) are also factors which are considered.

Data cannot be overwhelming evidence unless the methods used for collection and analysis meets the most stringent standards for reliability and validity. The person evaluating the data must be certain that the data are representative of actual current waterbody conditions. The data must be representative of the spatial extent of the waterbody and of relevant temporal patterns. Data more than three or four years old should not be used as overwhelming evidence unless there is a strong basis for concluding that conditions have not changed since the data were collected.

V. BENEFICIAL USE ASSESSMENT METHODOLOGY

A. Aquatic Life Use Assessment Methodology for Rivers and Streams

The following is a description of the assessment methodology or decision criteria used to assess aquatic life and recreation uses where they are assigned to rivers and streams in the state. The methodologies used to assess drinking water and fish consumption uses are the same for both rivers and lakes and are provided in separate sections of this document.

All water quality assessments entered into ATTAINS for Section 305(b) reporting and Section 303(d) TMDL listing are based on "sufficient and credible" monitoring data. Physical and chemical monitoring data used for these assessments includes conventional pollutant (e.g., dissolved oxygen, pH, temperature, ammonia, fecal coliform bacteria, and E. coli bacteria) and toxic pollutant (e.g., trace elements and pesticides) data collected for the most recent 10-year period. Biological monitoring data used for assessment includes fish and macroinvertebrate data collected by the NDDoH during the last 10 years (i.e., 2008-2017), EPA National River and Stream Assessment data collected in 2008 and 2009, and Red River mainstem biological assessment data collected in 2010.

As stated previously, use impairment for the state's rivers and streams is assessed for aquatic life and recreation. The following is the beneficial use decision criteria utilized for these assessments.

The NDDoH uses both chemical and biological data when assessing aquatic life use support for the state's rivers and streams. In some cases, both chemical data and biological data are used to make an assessment determination for an AU. Where both data are available, the NDDoH uses a weight-of-evidence approach in making an assessment decision. For example, if there are chemical data that do not show an aquatic life use impairment, but there are sufficient and credible biological data to show an impairment to the aquatic community, then the use-support decision will be to list the river or stream AU as “not supporting.”

1. Chemical Assessment Criteria

In general, aquatic life use determinations utilizing chemical data are based on the number of exceedances of the current *Standards of Quality for Waters of the State* (Appendix A) for DO, pH, and temperature and on the number of exceedances of the acute or chronic standards for ammonia, aluminum, arsenic, cadmium, copper, cyanide, lead, nickel, selenium, silver, zinc, and chromium. The acute and chronic water quality standards for trace metals are expressed as total recoverable metals and not as dissolved metals. However, where dissolved metals data are available, use support assessments are made by applying the dissolved metals data to the water quality standards expressed as the total recoverable fraction. Further, for acute and chronic criteria that are hardness dependent (i.e., cadmium, copper, chromium (III), lead, nickel, silver, and zinc), where hardness of the sample is greater than 400 mg/L, the hardness value used in the criteria calculation will be capped at 400 mg/L.

The following are the use support decision criteria that the NDDoH uses to assess aquatic life use based on chemical data:

- *Fully Supporting:*

  For the conventional pollutants DO, pH, and temperature, the standards of 5 mg/L (daily minimum) for DO, 7.0 to 9.0 (Class I and IA streams and all lakes) and 6.0 to 9.0 (Class II and III streams) for pH and 29.4 °C (85 °F) (maximum) for temperature are not exceeded in the AU. Consistent with state water quality standards (Appendix A), if the DO or pH standard is exceeded, but in 10 percent or less of the samples and there is no record of lethality to aquatic biota, then the AU is also assessed as “fully supporting”.

  For ammonia and other toxic pollutants (e.g., trace elements and organics), aquatic life is assessed as “fully supporting” if the acute or chronic standard is not exceeded during any consecutive three-year period.

- *Fully Supporting but Threatened*:

  For DO and pH, one or more standards were exceeded in greater than 10 percent to 25 percent of the measurements taken during the 10-year assessment period. The temperature standard is exceeded, but in 10 percent or less of the measurements taken during the 10-year assessment period.

  For ammonia and other toxic pollutants, the acute or chronic standard was exceeded once or twice during any consecutive three-year period during the 10-year assessment period.

- *Not Supporting*:

  For DO and pH, one or more standards were exceeded in greater than 25 percent of the measurements taken during the 10-year assessment period. The temperature standard is exceeded in greater than 10 percent of the measurements taken during the 10-year assessment period.

For ammonia and other toxic pollutants, the acute or chronic standard was exceeded three or more times during any consecutive three-year period during the 10-year assessment period.

2. Biological Assessment Criteria

Aquatic-life use, or biological integrity, can be defined as “the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitats of the region.” (Karr, 1981) When the aquatic community (e.g., fish and macroinvertebrates) is similar to that of “least disturbed” habitats in the region, termed “reference condition,” aquatic life use can be assessed as fully supporting. When the aquatic community deviates significantly from reference condition, it is assessed as not supporting aquatic life use.

While chemical data provides an indirect assessment of aquatic life use impairment, direct measures of the biological community are believed to be a more accurate assessment of aquatic-life use or biological integrity. The state water quality standards (Appendix A) describe a narrative biological goal that “the biological condition of surface waters shall be similar to that of sites or waterbodies determined by the NDDoH to be regional reference sites.” This narrative standard also states that it is the intent of the state, in adopting this narrative goal, “to provide an additional assessment method that can be used to identify impaired surface waters.”

IBI Development

The NDDoH began a stream biological monitoring and assessment program in 1993. In order to interpret these biological data and to develop a biological assessment methodology, the NDDoH has adopted the “multi-metric” index of biological integrity (IBI) approach to assess biological integrity or aquatic-life use support for rivers and streams. The multi-metric index approach assumes that various measures of the biological community (e.g., species richness, species composition, trophic structure, and individual health) respond to human-induced stressors (e.g., pollutant loadings or habitat alterations). Each measure of the biological community, termed a “metric,” is evaluated and scored on a scale of 0-100 . The higher the score, the better the biological condition and, presumably, the lower the pollutant or habitat impact.

Final metrics which go into each IBI are selected after a large set of candidate metrics go through a series of data reduction steps. First, each of the candidate metrics are evaluated through the use of histograms, to ensure each has an adequate range of data. The second step includes a “signal to noise analysis” to evaluate the variation of each metric. Values of less than 1 are eliminated from further consideration. The third step involves tests for responsiveness, including subjecting candidate metrics to the Mann-Whitney U Test and evaluating box plots used to distinguish metric scores from “reference” and “disturbed” sites. A Mann-Whitney U Test is a nonparametric test that evaluates the difference between the medians of two independent data sets (i.e., reference and disturbed sites). Metrics with $p > 0.20$ are eliminated due to a lack of response. Metrics with p values less than 0.20 are retained for further evaluation and subjected to box plot analysis. If the box plots for the metric does not distinguish between reference and disturbed, that metric is eliminated. Finally, a correlation matrix is completed using all remaining metrics that are not eliminated due to low responsiveness or other poor predictive characteristics. When metric pairs are highly correlated (r>0.80) one of the pair is eliminated to reduce redundancy within the final set of metrics.

Once the final metrics are determined for an IBI, raw metric values are transformed into standardized metric scores. All metric scores are computed using the following equations developed by Minns et al. (1994) that standardizes metrics on a scale of 0 to 100.

Metrics that decrease with impairment:

$$Ms = (M_R/M_{MAX}) \times 100$$

Metrics that increase with impairment:

$$Ms = (M_{MAX} - M_R) / (M_{MAX} - M_{MIN}) \times 100;$$

Where Ms = standardized metric value;
M_R = the raw metric value;
M_{MAX} = the maximum value; and
M_{MIN} = the minimum metric value.

Maximum (M_{MAX}) and minimum (M_{MIN}) values for each metric are set at the 95th and 5th percentiles, respectively, of the entire data set. The overall IBI score is then calculated as the mean of all standardized metric scores.

To date, the NDDoH has developed final multi-metric IBIs for fish in the Lake Agassiz Plain ecoregion and macroinveretebrates in the Lake Agassiz Plain (48) and Northern Glaciated Plain (46) level III ecoregions (Figure 2).

A revised fish IBI for the Lake Agassiz Plain ecoregion was published in a report entitled *Fish Index of Biotic Integrity for Wadable Streams in the Lake Agassiz Plain (48) Ecoregion* (NDDoH, 2011a). This IBI is based on 7 metrics (Table 2).

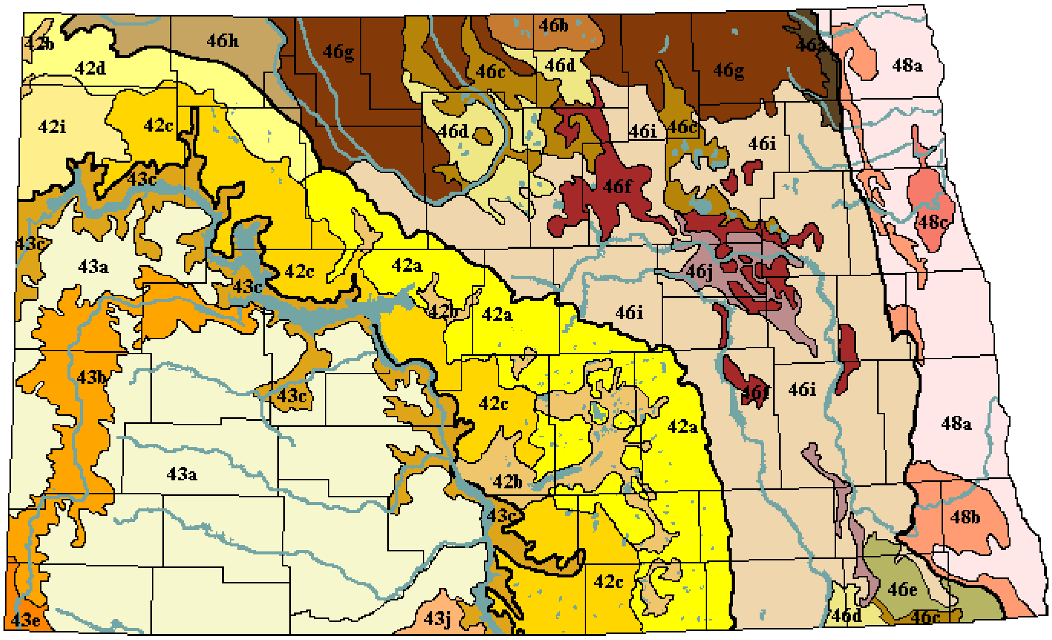

Figure 2. Map Depicting Ecoregions in North Dakota (Lake Agassiz Plain [48], Northern Glaciated Plain [46], Northwestern Glaciated Plain [42], Northwestern Great Plain [43]).

Table 2. Lake Agassiz Plain (48) Ecoregion Fish IBI Metrics.

Final Metric	**Category**	**Response to Perturbation**
CPUE (Fish/Minute)	Abundance	Decrease
Percent Dominant Taxon	Composition	Increase
Percent Generalist, Omnivore Individuals	Trophic	Increase
Percent Insectivore Biomass	Trophic	Decrease
Percent Lithophilic Individuals	Reproductive	Decrease
Percent Minnow and Darter Taxa	Richness	Decrease
Total Taxa	Richness	Decrease

The macroinvertebrate IBI which was developed for the Lake Agassiz Plain (48) ecoregion was published in a report entitled *Macroinvertebrate Index of Biotic Integrity for the Lake Agassiz Plain Ecoregion (48) of North Dakota* (NDDoH, 2011b). The macroinvertebrate IBI for the Lake Agassiz Plain ecoregion is based on 7 metrics (Table 3). The macroinvertebrate IBI which was developed for the Northern Glaciated Plain (46) ecoregion was published in the report entitled *Macroinvertebrate Index of Biotic Integrity for the Northern Glaciated Plain Ecoregion (46) of North Dakota* (NDDoH, 2010). The macroinvertebrate IBI for the Northern Glaciated Plain ecoregion is based on 6 metrics (Table 4).

Table 3. Lake Agassiz Plain (48) Ecoregion Macroinvertebrate IBI Metrics.

Final Metric	Category	Response to Perturbation
Diptera Taxa	Richness	Decrease
Hilsenhoff Biotic Index	Tolerance	Increase
Percent EPT	Composition	Decrease
Scraper Taxa	Trophic	Decrease
Shannon Weiner Index	Composition	Decrease
Sprawler Taxa	Habit	Decrease
Total Taxa	Richness	Decrease

Table 4. Northern Glaciated Plain (46) Ecoregion Macroinvertebrate IBI Metrics.

Final Metric	Category	Response to Perturbation
Percent EPT	Composition	Decrease
Percent Non-Insect Individuals	Composition	Increase
Percent Univoltine Individuals	Life Cycle/Composition	Decrease
Tolerant Taxa	Tolerance	Increase
Hilsenhoff Biotic Index (HBI)	Tolerance	Increase
Swimmer Taxa	Habit	Increase

Beneficial Use Assessment Scoring Thresholds

In order to assess biological condition or aquatic life support of rivers and streams, we need to be able to compare what we are measuring to some estimate what would be expected to be good biological condition or fully supporting aquatic life use for the river or stream. This is also referred to as the river or stream's "biological potential." Setting reasonable expectations for a biological indicator, like an IBI, is one of the greatest challenges to making an assessment of biological condition. Is it appropriate to take a historical perspective, and try to compare current conditions to some estimate of pre-Columbian conditions, or to pre-industrial conditions, or to some other point in history? Or is it acceptable to assume that some level of anthropogenic disturbance is a given, and simply use the best of today's conditions as the measuring stick against which everything else is assessed? The answers to all these questions relate to the concept of "reference condition" (Bailey et al. 2004, Stoddard et al. 2006).

Due to the difficulty of estimating historical conditions for most biological indicators, the Department has adopted the "least-disturbed condition" as the operational definition of reference condition. "Least-disturbed condition" is found in conjunction with the best available physical, chemical and biological habitat conditions for a given area or region (e.g., ecoregion) given the current state of the landscape. "Reference" or "least-disturbed" condition is described by evaluating data collected at sites selected based on a set of explicit criteria defining what is "best" or "least-disturbed" by human activities. These criteria vary from ecoregion to ecoregion in the state, and are developed iteratively with the goal of identifying a set of sites which are influenced the least by human activities. The Department's procedure for selecting reference sites is described in Appendix B.

Once a set of "reference sites" are selected for a given ecoregion in the state, they are sampled using the same methods employed at sites used to develop the IBI or where assessments are conducted. The range of conditions (e.g., habitat variables, chemical concentrations, or IBI scores) found at these "reference sites" describes a distribution of values , and extremes of this distribution are used to set thresholds which are used to distinguish sites that are in relatively good condition from those that are clearly not. One common approach, and the one used by the Department, is to examine the range or statistical distribution of IBI scores for a set of reference sites within an ecoregion (Barbour et al. 1999), and, depending on the reference site sample size, to use the 5th or 10th percentile of this distribution to separate the most disturbed (i.e., poor biological condition) sites from moderately disturbed (i.e., fair biological condition) sites. Similarly, the 25th or 50th percentile of the distribution is used to distinguish between moderately disturbed sites and those in "least-disturbed condition." Details on how these thresholds were set for each multi-metric IBI developed by the Department are available in each of the three IBI reports referenced above, while the IBI scoring thresholds for each biological condition class and use support category are provided in Tables 5, 6 and 7.

Table 5. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Lake Agassiz Plain Ecoregion Fish IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
≥71	Good	Fully Supporting
<71 and ≥48	Fair	Fully Supporting, but Threatened
<48	Poor	Not Supporting

Table 6. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Lake Agassiz Plain Ecoregion Macroinvertebrate IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
≥76	Good	Fully Supporting
<76 and ≥45	Fair	Fully Supporting, but Threatened
<45	Poor	Not Supporting

Table 7. Scoring Thresholds by Biological Condition Class and Aquatic Life Use Support Category for the Northern Glaciated Plain Ecoregion Macroinvertebrate IBI.

IBI Score	Biological Condition Class	Aquatic Life Use Support
≥66	Good	Fully Supporting
<66 and ≥40	Fair	Fully Supporting, but Threatened
<40	Poor	Not Supporting

Aquatic Life Use Support Assessment

Site and Data Requirements

For Section 305(b) assessment and Section 303(d) listing purposes, use assessments based on biological data should ideally be done at the Assessment Unit (AU) scale. The number of sites and samples necessary to conduct an assessment depends on the spatial and temporal variability inherent to the AU. For AUs that are represented by a relatively small, homogeneous stream reach, one site located on the AU may be sufficient. For larger more complex AUs, multiple sample sites with multiple samples collected over time may be necessary. When the number of sites located within an AU is limited, it may be necessary to split the AU into smaller segments and then to assess the smaller AU segment represented by the site. In general, best professional judgment should be used to determine the adequacy of sites and samples when making a use support decision for an AU based on biological data, but as a rule of thumb one should follow these general guidelines.

1. Sites should be located within the AU such that each site represents a homogeneous reach within the AU.

2. At least one site should be located near the downstream end of the assessed stream reach.

3. Additional sites should be located a minimum of 2.5 miles (4 km) apart or where there are significant changes in the hydrology or geomorphology of the stream, or where there is a significant change in landuse adjacent to the stream.

4. When the AU consists of a mainstem segment and tributaries, sites should be located on the mainstem above and below the tributaries as well as on the tributary stream(s).

While it may be possible to conduct an assessment based on one site located within the AU, a minimum of two samples are required to conduct an assessment. Samples should be collected within the last 10 years and may consist of two or more samples collected at one site or one sample collected each at two or more sites. For assessment purposes, a sample consists of one biological assemblage sampled at one point in time. Therefore, two samples may be represented by two biological assemblages (e.g., fish and macroinvertebrates) sampled at the same time or the same biological assemblage sampled at the same site twice. When the same biological assemblage is sampled at the same site, samples should be collected at least 30 days apart.

Using the appropriate biological condition and aquatic life use support scoring thresholds for the biological assemblage and ecoregion, an aquatic life use support assessment is made for each sample collected within the AU. Using each sample aquatic life use support assessment, an overall assessment of the AU is made using the following use support decision criteria:

- *Fully Supporting*:

  Use support assessments for all samples are fully supporting.

- *Fully Supporting, but Threatened*:

  Use support assessment for all samples are fully supporting, but threatened; or

  Use support assessment for at least one sample is fully supporting, and use support assessments for all other samples are not supporting.

- *Not Supporting*:

  Use support assessments for all samples are not supporting.

Section 303(d) Listing Criteria

When biological data results in an aquatic life use support decision that the AU is either fully supporting, but threatened or not supporting and if there are no other chemical or habitat data which can be used to list a pollutant cause, then the AU should be listed on the 303(d) list as category 5A (Table 1), but with the condition that it will be targeted for further stressor identification monitoring and assessment. Only after a stressor identification assessment is completed will the AU be targeted for TMDL development.

<u>Other Biological Assessment Data</u>

The NDDoH recognizes that there may be biological data that are available for waterbodies in the state that meet the sufficient and credible data requirements. Where these data are available the NDDoH encourages the use of this information to make aquatic life use support decisions. While it is not possible to assess these sites or waterbodies as fully supporting, sites that are exemplified by low taxa richness, presence of pollutant tolerant taxa and/or low density, can be assessed as not supporting aquatic life use.

B. Recreation Use Assessment Methodology for Rivers, Streams, Lakes and Reservoirs

Recreation use is any activity that relies on water for sport or enjoyment. Recreation use includes primary contact activities such as swimming and bathing and secondary contact activities such as boating, fishing, and wading. Recreation use in rivers, streams, lakes and reservoirs is considered fully supporting when there is little or no risk of illness through either primary or secondary contact with the water. The state's recreation use support assessment methodology for rivers, streams, lakes and reservoirs is based on the state's numeric water quality standards for E. coli bacteria (Appendix A).

For each assessment based on E. coli data, the following criteria are used:

- Assessment Criterion 1: For each assessment unit, the geometric mean of samples collected during any 30-day consecutive period (e.g., calendar month) from May 1 through September 30 does not exceed a density of 126 CFUs per 100 mL. A minimum of five samples collected during a 30-day consecutive period (e.g., calendar month) is required to compute the geometric mean. If necessary, samples may be pooled by calendar month across years.

- Assessment Criterion 2: For each assessment unit, less than 10 percent of samples collected during any 30-day consecutive period (e.g., calendar month) from May 1 through September 30 exceed a density of 409 CFUs per 100 ml. A minimum of ten samples collected during a 30-day consecutive period is required to compute the percent of samples exceeding the criteria. If necessary, samples may be pooled by calendar month across years.

  The two criteria are then applied using the following use support decision criteria:

  - Fully Supporting: Both criteria 1 and 2 are met.
  - Fully Supporting but Threatened: Criterion 1 is met, but 2 is not.
  - Not Supporting: Criterion 1 is not met. Criteria 2 may or may not be met.

C. Aquatic Life and Recreation Use Assessment Methodology for Lakes and Reservoirs

The following is a description of the assessment methodology or decision criteria used to assess aquatic life and recreation uses for lakes and reservoirs. The primary indicators used to assess aquatic life and recreation uses for lakes and reservoirs in the state are measures of trophic condition. In addition, the presence of Harmful Algal Blooms are also used to assess recreation use. The methodology used to assess the drinking water, fish consumption, agricultural, and industrial uses is the same for both rivers and lakes and is provided in a separate section of the document.

1. Aquatic Life and Recreation Use Assessment Using Trophic Condition Indicators

The state's narrative water quality standards (Appendix A) form the basis for aquatic life and recreation use assessment for Section 305(b) reporting and the Section 303(d) TMDL list. State water quality standards contain narrative criteria that require lakes and reservoirs to be "free from" substances "which are toxic or harmful to humans, animals, plants, or resident aquatic biota" or are "in sufficient amounts to be unsightly or deleterious." Narrative standards also prohibit the "discharge of pollutants" (e.g., organic enrichment, nutrients, or sediment), "which alone or in combination with other substances, shall impair existing or reasonable beneficial uses of the receiving waters."

Trophic status indicators are used by the NDDoH as the primary means to assess whether a lake or reservoir is meeting the narrative standards. Trophic status is a measure of the productivity of a lake or reservoir and is directly related to the level of nutrients (i.e., phosphorus and nitrogen) entering the lake or reservoir from its watershed and/or from the internal recycling of nutrients. Highly productive lakes, termed "hypereutrophic," contain excessive phosphorus and are characterized by large growths of weeds, cyanobacteria (i.e., blue-green algal) blooms, low transparency, and low dissolved oxygen (DO) concentrations. These lakes experience frequent fish kills and are generally characterized as having excessive rough fish populations (carp, bullhead, and sucker) and poor sport fisheries. Due to the frequent algal blooms and excessive weed growth, these lakes are also undesirable for recreational uses such as swimming and boating.

Mesotrophic and eutrophic lakes, on the other hand, have lower phosphorus concentrations, low to moderate levels of algae and aquatic plant growth, high transparency, and adequate DO concentrations throughout the year. Mesotrophic lakes do not experience algal blooms, while eutrophic lakes may occasionally experience algal blooms of short duration, typically a few days to a week.

Due to the relationship between trophic status indicators and the aquatic community (as reflected by the fishery) or between trophic status indicators and the frequency of algal blooms, trophic status becomes an effective indicator of aquatic life and recreation use support in lakes and reservoirs. For purposes of this assessment methodology, it is assumed that hypereutrophic lakes do not fully support a sustainable sport fishery and are limited in recreational uses, whereas mesotrophic lakes fully support both aquatic life and recreation use. Eutrophic lakes may be assessed as fully supporting, fully supporting but threatened, or not supporting their uses for aquatic life or recreation.

Eutrophic lakes are further assessed based on: 1) the lake or reservoir's water quality standards fishery classification; 2) information provided by North Dakota Game and Fish Department Fisheries Division staff, local water resource managers and the public; 3) the knowledge of land use in the lake's watershed; and/or 4) the relative degree of eutrophication. For example, a eutrophic lake, which has a well-balanced sport fishery and experiences infrequent algal blooms, is assessed as fully supporting with respect to aquatic life and recreation use. A eutrophic lake, which experiences periodic algal blooms and limited swimming use, would be assessed as not supporting recreation use. A lake fully supporting its aquatic life and/or recreation use, but for which monitoring has shown a decline in its trophic status (i.e., increasing phosphorus concentrations over time), would be assessed as fully supporting, but threatened.

It is recognized that this assessment procedure ignores the fact that, through natural succession, some lakes and reservoirs may display naturally high phosphorus concentrations and experience high productivity. While natural succession or eutrophication can cause high phosphorus concentrations, research suggests that these lakes are typically eutrophic and that lakes classified as hypereutrophic are reflecting external nutrient loading in excess of that occurring naturally.

Since trophic status indicators specific to North Dakota waters have not been developed, Carlson's trophic status index (TSI) (Carlson, 1977) has been chosen to assess the trophic status of lakes or reservoirs. To create a numerical TSI value, Carlson's TSI uses a mathematical relationship based on three indicators: 1) Secchi Disk Transparency in meters (m); 2) surface total phosphorus concentration expressed as µg/ L; and 3) chlorophyll-a concentration expressed as µg/L.

This numerical value, ranging from 0-100, corresponds to a trophic condition with increasing values indicating a more eutrophic (degraded) condition. Carlson's TSI estimates are calculated using the following equations and is also depicted graphically in Figure 3.

- Trophic status based on Secchi Disk Transparency (TSIS):
  TSIS = 60 - 14.41 ln (SD)
  Where SD = Secchi disk transparency in meters.

- Trophic status based on total phosphorus (TSIP):
  TSIP = 14.20 ln (TP) + 4.15
  Where TP = Total phosphorus concentration in µg L^{-1}.

- Trophic status based on chlorophyll-a (TSIC):
  TSIC = 9.81 ln (TC) + 30.60
  Where TC = Chlorophyll-a concentrations in µg L^{-1}.

In general, of the three indicators, it is believed that chlorophyll-a is the best indicator of trophic status, since it is a direct measure of lake productivity. Secchi disk transparency should be used next, followed by phosphorus concentration. In theory, for a given lake or reservoir, the measures of chlorophyll-a, Secchi disk transparency, and phosphorus concentration are all interrelated and should yield similar trophic status index values. This, however, is usually not the case. Many lakes and reservoirs in the state are shallow and windswept causing non-algal turbidity to limit light penetration. This situation may result in a lake having a high phosphorus concentration, low Secchi disk transparency, and low chlorophyll-a concentration. In other instances, other micronutrients may be limiting algal growth even though excessive phosphorus is present.

When conducting an aquatic life and recreation use assessment for a lake or reservoir, the average trophic status index score should be calculated for each indicator. When the trophic status index scores for each indicator (chlorophyll-a, Secchi disk transparency, and phosphorus concentration) each result in a different trophic status assessment then the assessment should be based first on chlorophyll-a, followed by Secchi disk transparency. Only when there are not adequate chlorophyll-a and/or Secchi disk transparency data available to make an assessment should phosphorus concentration data be used.

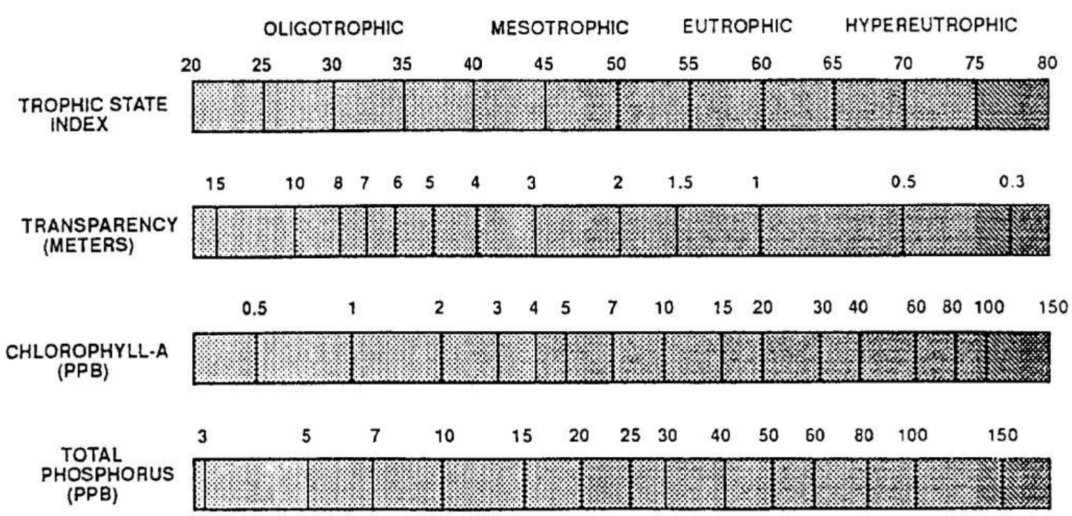

Figure 3. A Graphic Representation of Carlson's TSI.

2. Lake and Reservoir Use Assessment Using Harmful Algal Bloom Advisories and Warnings

Harmful Algal Blooms (HABs) are caused by the excessive growth of cyanobacteria (i.e., blue-green algae). Some species of cyanobacteria (e.g., Anabaena sp., Aphanizomenon sp., and Microcystis sp.) can produce cyanotoxins that are harmful to people and animals.

Beginning in 2016, and again in 2017, the NDDoH conducted a HABs surveillance and advisory program for lakes and reservoirs in the state. Typically, the NDDoH, would receive a report of a potential cyanobacteria bloom by phone, email or through the NDDoH web site (https://www.ndhealth.gov/WQ/SW/HABs). Following the report, NDDoH personnel investigated the lake to confirm the presence a bloom. If a bloom was confirmed, then testing was done in the field for microcystin using Abraxis® test strips. If the test strips confirmed the presence of cyanotoxin, then samples were collected from the lake, usually along the shoreline near a boat ramp, swimming beach or other public access area, and sent to a laboratory for analysis. If the laboratory microcystin concentration exceeded the NDDoH's threshold for recreation risk of 10 µg/L (ppb) in one or more samples collected from the lake, an advisory or warning was posted. In most cases, an advisory was posted which recommended that only those areas of the lake where the bloom was concentrated be avoided (e.g., swimming beach). In a few cases, when the bloom extended throughout the lake, was a warning posted. Warnings that were posted recommended the entire lake be avoided. Following the posting, the NDDoH continued to sample the lake weekly or bi-weekly until the bloom diminished and no toxin was deteted. At that time the advisory or warning posting was removed.

As a water quality assessment tool, HABs postings will be flagged in ATTAINS as lakes or reservoirs where additional water quality monitoring is needed to verify a use impairment. These lakes and reservoirs will be targeted for intensive monitoring and trophic status assessment through the NDDoH's Lake Water Quality Assessment Program (LWQA). Final recreation and aquatic life use assessment determinations will be made based the lake or reservoir's trophic status condition using the LWQA data (see previous section).

D. Drinking Water Supply Use Assessment Methodology for Rivers, Lakes, and Reservoirs

Drinking water is defined as "waters that are suitable for use as a source of water supply for drinking and culinary purposes, after treatment to a level approved by the NDDoH" (Appendix A). All Class I, IA, and II rivers and streams, with the exception of the Sheyenne River from its headwaters to 0.1 mile downstream from Baldhill Dam, and all lakes and reservoirs classified in the state water quality standards (Appendix A), with the exception of Lake George in Kidder County, are assigned the drinking water supply beneficial use. While most lakes and reservoirs are assigned this use, few currently are used as a drinking water supply. Lake Sakakawea is the current drinking water supply for the Southwest Water Pipeline and the cities of Garrison, Parshall, Pick City, and Riverdale.

Drinking water use is assessed by comparing ambient water quality data to the state water quality standards (Tables 1 and 2 in Appendix A). Ambient water chemistry data are compared to the water quality standards for chloride, sulfate, and nitrate (Table 8) and to the human health standards for Class I, IA, and II rivers and streams (see Table 2 in Appendix A). Drinking water supply is not a designated use for Class III rivers and streams or for the Sheyenne River from its headwaters to 0.1 mile downstream from Baldhill Dam. The human health standard for Class I, IA, and II rivers and streams considers two means of exposure: 1) ingestion of contaminated aquatic organisms; and 2) ingestion of contaminated drinking water.

Drinking water use is also protected through the state's narrative water quality standards. To paraphrase, narrative standards provide language that waters of the state shall be free from materials that produce a color or odor, or other conditions to such a degree as to create a nuisance. Further, state narrative standards provide language that states that waters of the state shall be "free from substances….in concentrations or combinations which are toxic or harmful to **humans**, animals, plants, or resident biota." There shall also be "no discharge of pollutants, which …..shall cause a public health hazard or injury to environmental resources."

Table 8. State Water Quality Standards for Chloride, Sulfate, and Nitrate (Appendix A).

Stream Classification	Water Quality Standards (mg/L)		
	Chloride[1]	Sulfate[1]	Nitrate[2]
Class I	100	250	10
Class IA	175	450[3]	10
Class II	250	450	10

[1]Expressed as a 30-day arithmetic average based on a minimum of four daily samples collected during the 30-day period.
[2]The water quality standard for nitrite of 1 mg/L shall also not be exceeded.
[3] The site specific sulfate standard for the Sheyenne River from its headwaters to 0.1 mile downstream from Baldhill Dam is 750 mg/L.

In order to make beneficial use determinations for drinking water, the following decision criteria are used:

- *Fully Supporting:*

  Based on Numeric Standards: No exceedances of the water quality standard for nitrate, one or fewer exceedances of the 30-day average standards for chloride or sulfate, and no exceedances of any of the human health standards.

  Based on Narrative Standards: No drinking water complaints on record in the last two years.

- *Fully Supporting but Threatened:*

  Based on Numeric Standards: The fully supporting, but threatened use assessment designation is not applied to the drinking water use. Waters are either assessed as fully supporting or not supporting based on chemical data applied to the numeric standards.

  Based on Narrative Criteria: No impairment based on the numeric criteria, but a declining trend in water quality over time suggests a measurable increase in the cost to treat water for drinking water supply may occur if the trend continues.

- *Not Supporting*:

  Based on Numeric Criteria: One or more exceedances of the water quality standard for nitrate, two or more exceedances of the 30-day average criteria for chloride or sulfate, or one or more exceedances of any of the human health standards.

  Based on Narrative Criteria: Knowledge of taste and odor problems or increased treatment costs have been associated with pollutants.

E. Fish Consumption Use Assessment Methodology for Rivers, Lakes and Reservoirs

As stated previously, the state's narrative water quality standards provide that surface waters shall be "free from materials attributable to municipal, industrial, or other discharges or agricultural practices" which will "render any undesirable taste to fish flesh or, in any way, make fish inedible." Fish consumption use is assumed to apply to all Class I, IA, and II rivers and streams, to those Class III streams known to provide a sport fishery and to all Class 1 through 4 lakes and reservoirs.

The beneficial use assessment methodology for fish consumption is based on the U.S. Environmental Protection Agency's (EPA) recommended methylmercury fish tissue criterion of 0.3 µg/g (EPA, 2001), and is consistent with the state's fish advisory guidelines for the general population. The EPA recommended mercury criterion is based on a reference dose (based on noncancer human health effects) of 0.0001 mg methylemercury/kg body weight-day minus the relative source contribution which is estimated to be 2.7×10^{-5} mg methylmercury/kg body weight-day. The EPA criterion assumes an average human body weight default value of 70 kg (154 pounds) for adults and an average meal size of 0.0175 kg (6 ounces).

The Department's assessment methodology for fish consumption is also based on the US EPA's "Guidance for Implementing the January 2001 Methylymercury Water Quality Criterion, Final" (EPA, 2009) and "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories", volume 1 (EPA, 2000). Based on these two guidance documents a waterbody is assessed for fish consumption use using the mean concentration of at least one piscivorous game fish species (e.g., walleye, sauger, northern pike, catfish, largemouth bass, or small mouth bass) found in the waterbody. The mean methylemercury concentration is estimated from a minimum of 3 composite samples (preferred) or 9 individual fish samples representative of the filet. When composite samples are used, each composite sample should consist of a minimum of three individual fish per composite with the smallest fish in the composite no less than 75% of the largest fish by length. Each composite sample should also be representative of a distinct age class of the target fish species in the waterbody. In other words, if three composite samples are collected, one composite should represent small fish, one representing medium sized fish and one representing large fish in the population.

If individual fish samples are collected then a minimum of 9 fish samples should be used to estimate the mean methylmercury concentration. The same criteria used to collect a composite sample should be used for individual fish samples where fish should be representative of at least three size classes and a minimum of three fish should be collected per size class (3 size classes times 3 fish per size class equals 9 fish). In cases where individual fish samples are used, then the number of fish per size class should be equal.

The EPA recommends using the t-test to determine whether the mean methylmercury concentration in fish tissue samples in a waterbody exceeds the criterion with statistical significance. The t-statistic is used to test the null hypothesis that the mean concentration of methylmercury in fish is equal to or less than the fish tissue criterion of 0.3 µg/g. The alternate hypothesis is that the mean concentration of methylmercury in fish is greater than the criterion. Where the null hypothesis is true the result is an assessment where fish consumption is "fully supporting." Where the null hypothesis is rejected in favor of the alternative hypothesis then fish consumption use is assessed as "not supporting." For purposes of the state's assessment methodology the 0.05 significance level ($p \leq 0.05$) has been selected. This means there is a 5% chance of rejecting the null hypothesis when it is really true (Type I error).

The t-test (t_c) is calculated from the sample mean (z) and variance (s^2) from the sample data as:

$$t_c = (z-c) / s$$

Where,

t_c = test statistic;

z = mean methylmercury concentration;

c = methylmercury criterion; and

s = standard deviation of the mean.

The null hypothesis of no difference is rejected in favor of the alternative hypothesis of exceedance if:

$$t_c > t_{\alpha,n-1}$$

Where, $t_{\alpha,n-1}$ is the tabulated value of the Student-t distribution corresponding to the level of significance $\alpha=0.05$ and n-1 degrees of freedom (n=sample size) (Table 9).

Table 9. One-sided Student-t Distribution Values for α=0.05 and n-1 Degrees of Freedom.

	n-1 degrees of freedom									
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Student-t value	2.920	2.353	2.132	2.015	1.943	1.895	1.860	1.833	1.812	1.796

Fish Consumption Use Assessment Example

A sample of nine individual walleye representing three size classes (three fish per class) were collected from Jensen Lake and analyzed for mercury. The mercury samples were collected as dorsal plugs and are assumed to represent the concentration of mercury in the filet of each fish.

Size Class	Length (inches)	Mercury Concentration (µg/g)
Small	12	0.23
	12.5	0.24
	13.6	0.27
Medium	16.5	0.33
	17.1	0.36
	18.0	0.38
Large	23	0.45
	23.5	0.46
	24.2	0.47

The mean concentration (z) for the nine samples (n=9) is 0.35 with a variance (s^2) equal to 0.008828. Based in this mean and variance the test statistic is calculated as:

$$t_c = (z-c) / s$$

$$t_c = (0.35-0.3)/0.09396$$

$$t_c = 0.532$$

The null hypothesis of no difference between the mean and the criterion is accepted if $t_c > t_{\alpha,n-1}$, where α=0.05 and n-1=8. Since t_c = 0.532 is not greater than $t_{\alpha,n-1}$ = 1.860 (Table 1) then the null hypothesis is rejected in favor of the alternative hypothesis that the mean methylmercury concentration is greater than the criterion and fish consumption use for Jensen Lake is assessed as not supporting.

F. Agricultural Use Assessment Methodology for Rivers, Lakes and Reservoirs

Agricultural uses are defined in the state water quality standards as " waters suitable for irrigation, stock watering, and other agricultural uses, but not suitable for use as a source of domestic supply for the farm unless satisfactory treatment is provided." While not specifically stated in state water quality standards, the numeric standards for pH (6.0-9.0), boron (750 µg/L as a 30-day average), sodium (less than 50% of cation based on mEq/L), and radium (5 pCi/L as a 30-day average) are intended for the protection of agricultural uses. Further, state water quality standards provide for the protection of agricultural uses by providing language that states that waters of the state shall be "free from substances….in concentrations or combinations which are toxic or harmful to humans, **animals, plants**, or resident biota."

In order to make beneficial use determinations for agricultural uses, the following decision criteria are used:

- *Fully Supporting:*

  Based on Numeric Standards: Ten percent or less of the samples exceed the water quality standard for pH or sodium and one or fewer exceedances of the 30-day average criteria for boron or radium.

  Based on Narrative Standards: Water supply supports normal crop and livestock production.

- *Fully Supporting but Threatened:*

  Based on Numeric Standards: The fully supporting, but threatened use assessment designation is not applied to agricultural use. Waters are either assessed as fully supporting or not supporting based on chemical data applied to the numeric standards.

  Based on Narrative Standards: No impairment based on the numeric criteria, but a declining trend in water quality over time suggests a measurable decrease in crop and/or livestock production may occur if the trend continues.

- *Not Supporting*:

  Based on Numeric Standards: Greater than 10 percent of samples are exceeded for the water quality standard for pH or sodium, or two or more exceedances of the 30-day average criteria for boron or radium.

  Based on Narrative Standards: At least on pollutant has been demonstrated to cause a measurable decrease in crop or livestock production.

G. Industrial Use Assessment Methodology for Rivers, Lakes and Reservoirs

Industrial uses are defined in the state water quality standards as “waters suitable for industrial purposes, including food processing, after treatment.” While there are no specific numeric criteria in the state’s water quality standards intended to protect industrial uses, it is assumed that if the state’s narrative standards are met, or if other numeric water quality standards are met, the beneficial uses for industry will also be met.

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Appendix A

Standards of Quality for Waters of the State

CHAPTER 33-16-02.1
STANDARDS OF QUALITY FOR WATERS OF THE STATE

Section
33-16-02.1-01 Authority
33-16-02.1-02 Purpose
33-16-02.1-03 Applicability
33-16-02.1-04 Definitions
33-16-02.1-05 Variances
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33-16-02.1-07 Classification of Waters of the State
33-16-02.1-08 General Water Quality Standards
33-16-02.1-09 Surface Water Classifications, Mixing Zones, and Numeric Standards
33-16-02.1-10 Ground Water Classifications and Standards
33-16-02.1-11 Discharge of Wastes

33-16-02.1-01. Authority. These rules are promulgated pursuant to North Dakota Century Code chapters 61-28 and 23-33; specifically, sections 61-28-04 and 23-33-05, respectively.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-02. Purpose.

1. The purposes of this chapter are to establish a system for classifying waters of the state; provide standards of water quality for waters of the state; and protect existing and potential beneficial uses of waters of the state.

2. The state and public policy is to maintain or improve, or both, the quality of the waters of the state and to maintain and protect existing uses. Classifications and standards are established for the protection of public health and environmental resources and for the enjoyment of these waters, to ensure the propagation and well-being of resident fish, wildlife, and all biota associated with, or dependent upon, these waters; and to safeguard social, economical, and industrial development. Waters not being put to use shall be protected for all reasonable uses for which these waters are suitable. All known and reasonable methods to control and prevent pollution of the waters of this state are required, including improvement in quality of these waters, when feasible.

   a. The "quality of the waters" shall be the quality of record existing at the time the first standards were established in 1967, or later records if these indicate an improved quality. Waters with existing quality that is higher than established standards will be maintained at the higher quality unless affirmatively demonstrated, after full satisfaction of the intergovernmental coordination and public participation provisions of the continuing planning process, that a change in quality is necessary to accommodate important social or economic development in the area in which the waters are located. In allowing the lowering of existing quality, the department shall assure that existing uses are fully protected and that the highest statutory and regulatory requirements for all point sources and cost-effective and reasonable best management practices for nonpoint sources are achieved.

b. Waters of the state having unique or high quality characteristics that may constitute an outstanding state resource shall be maintained and protected.

c. Any public or private project or development which constitutes a source of pollution shall provide the best degree of treatment as designated by the department in the North Dakota pollutant discharge elimination system. If review of data and public input indicates any detrimental water quality changes, appropriate actions will be taken by the department following procedures approved by the environmental protection agency. (North Dakota Antidegradation Implementation Procedure, Appendix IV.)

History: Effective June 1, 2001; amended effective April 1, 2014.
General Authority: NDCC 61-28-04, 61-28-05
Law Implemented: NDCC 23-33, 61-28-04

33-16-02.1-03. Applicability. Nothing in this chapter may be construed to limit or interfere with the jurisdiction, duties, or authorities of other North Dakota state agencies.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-04. Definitions. The terms used in this chapter have the same meaning as in North Dakota Century Code chapter 61-28, except:

1. "Acute standard" means the one-hour average concentration does not exceed the listed concentration more than once every three years.

2. "Best management practices" are methods, measures, or procedures selected by the department to control nonpoint source pollution. Best management practices include, but are not limited to, structural and nonstructural measures and operation and maintenance procedures.

3. "Chronic standard" means the four-day average concentration does not exceed the listed concentration more than once every three years.

4. "Consecutive thirty-day average" is the average of samples taken during any consecutive thirty-day period. It is not a requirement for thirty consecutive daily samples.

5. "Department" means the North Dakota state department of health.

6. A standard defined as "dissolved" means the total quantity of a given material present in a filtered water sample, regardless of the form or nature of its occurrence.

7. "Pollution" means such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor. Pollution includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state that will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare; domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses; or livestock, wild animals, birds, fish, or other aquatic biota.

8. "Site-specific standards" mean water quality criteria developed to reflect local environmental conditions to protect the uses of a specific water body.

9. A standard defined as "total" means the entire quantity of a given material present in an unfiltered water sample regardless of the form or nature of its occurrence. This includes both dissolved and suspended forms of a substance, including the entire amount of the substance present as a constituent of the particulate material. Total recoverable is the quantity of a given material in an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid.

10. "Water usage". The best usage for the waters shall be those uses determined to be the most consistent with present and potential uses in accordance with the economic and social development of the area. Present principal best uses are those defined in subdivisions a, b, c, d, and e. These are not to be construed to be the only possible usages.

    a. Municipal and domestic water. Waters suitable for use as a source of water supply for drinking and culinary purposes after treatment to a level approved by the department.

    b. Fish and aquatic biota. Waters suitable for the propagation and support of fish and other aquatic biota and waters that will not adversely affect wildlife in the area. Low flows or natural physical and chemical conditions in some waters may limit their value for fish propagation or aquatic biota.

c. Recreation. Primary recreational waters are suitable for recreation where direct body contact is involved, such as bathing and swimming, and where secondary recreational activities such as boating, fishing, and wading are involved. Natural high turbidities in some waters and physical characteristics of banks and streambeds of many streams are factors that limit their value for bathing.

d. Agricultural uses. Waters suitable for irrigation, stock watering, and other agricultural uses, but not suitable for use as a source of domestic supply for the farm unless satisfactory treatment is provided.

e. Industrial water. Waters suitable for industrial purposes, including food processing, after treatment. Treatment may include that necessary for prevention of boiler scale and corrosion.

History: Effective June 1, 2001; amended effective October 1, 2006; April 1, 2014.
General Authority: NDCC 61-28-04, 61-28-05
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-05. Variances. Upon written application by the responsible discharger, the department finds that by reason of substantial and widespread economic and social impacts the strict enforcement of state water quality criteria is not feasible, the department can permit a variance to the water quality standard for the affected segment. The department can set conditions and time limitations with the intent that progress toward improvements in water quality will be made. This can include interim criteria which must be reviewed at least once every three years. A variance will be granted only after fulfillment of public participation requirements and environmental protection agency approval. A variance will not preclude an existing use.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04, 61-28-05
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-06. Severability. The rules contained in this chapter are severable. If any rules, or part thereof, or the application of such rules to any person or circumstance are declared invalid, that invalidity does not affect the validity of any remaining portion of this chapter.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-07. Classification of waters of the state. General. Classification of waters of the state shall be used to maintain and protect the present and future beneficial uses of these waters. Classification of waters of the state shall be made or changed whenever new or additional data warrant the classification or a change of an existing classification.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-08. General water quality standards.

1. **Narrative standards.**

   a. The following minimum conditions are applicable to all waters of the state except for class II ground waters. All waters of the state shall be:

      (1) Free from substances attributable to municipal, industrial, or other discharges or agricultural practices that will cause the formation of putrescent or otherwise objectionable sludge deposits.

      (2) Free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges or agricultural practices in sufficient amounts to be unsightly or deleterious.

      (3) Free from materials attributable to municipal, industrial, or other discharges or agricultural practices producing color, odor, or other conditions to such a degree as to create a nuisance or render any undesirable taste to fish flesh or, in any way, make fish inedible.

      (4) Free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to humans, animals, plants, or resident aquatic biota. For surface water, this standard will be enforced in part through appropriate whole effluent toxicity requirements in North Dakota pollutant discharge elimination system permits.

      (5) Free from oil or grease residue attributable to wastewater, which causes a visible film or sheen upon the waters or any discoloration of the surface of adjoining shoreline or causes a sludge or emulsion to be deposited beneath the surface of the water or upon the adjoining shorelines or prevents classified uses of such waters.

   b. There shall be no materials such as garbage, rubbish, offal, trash, cans, bottles, drums, or any unwanted or discarded material disposed of into the waters of the state.

c. There shall be no disposal of livestock or domestic animals in waters of the state.

d. The department shall propose and submit to the state engineer the minimum streamflows of major rivers in the state necessary to protect the public health and welfare. The department's determination shall address the present and prospective future use of the rivers for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses.

e. No discharge of pollutants, which alone or in combination with other substances, shall:

   (1) Cause a public health hazard or injury to environmental resources;

   (2) Impair existing or reasonable beneficial uses of the receiving waters; or

   (3) Directly or indirectly cause concentrations of pollutants to exceed applicable standards of the receiving waters.

f. If the department determines that site-specific criteria are necessary and appropriate for the protection of designated uses, procedures described in the environmental protection agency's Water Quality Standards Handbook 1994 or other defensible methods may be utilized to determine maximum limits. Where natural chemical, physical, and biological characteristics result in exceedences of the limits set forth in this section, the department may derive site-specific criteria based on the natural background level or condition. All available information shall be examined, and all possible sources of a contaminant will be identified in determining the naturally occurring concentration. All site-specific criteria shall be noticed for public comment and subjected to other applicable public participation requirements prior to being adopted.

2. **Narrative biological goal.**

a. Goal. The biological condition of surface waters shall be similar to that of sites or water bodies determined by the department to be regional reference sites.

b. Definitions.

   (1) "Assemblage" means an association of aquatic organisms of similar taxonomic classification living in the same area. Examples of assemblages include fish, macroinvertebrates, algae, and vascular plants.

(2) "Aquatic organism" means any plant or animal which lives at least part of its life cycle in water.

(3) "Biological condition" means the taxonomic composition, richness, and functional organization of an assemblage of aquatic organisms at a site or within a water body.

(4) "Functional organization" means the number of species or abundance of organisms within an assemblage which perform the same or similar ecological functions.

(5) "Metric" means an expression of biological community composition, richness, or function which displays a predictable, measurable change in value along a gradient of pollution or other anthropogenic disturbance.

(6) "Regional reference sites" are sites or water bodies which are determined by the department to be representative of sites or water bodies of similar type (e.g., hydrology and ecoregion) and are least impaired with respect to habitat, water quality, watershed land use, and riparian and biological condition.

(7) "Richness" means the absolute number of taxa in an assemblage at a site or within a water body.

(8) "Taxonomic composition" means the identity and abundance of species or taxonomic groupings within an assemblage at a site or within a water body.

c. Implementation. The intent of the state in adopting a narrative biological goal is solely to provide an additional assessment method that can be used to identify impaired surface waters. Regulatory or enforcement actions based solely on a narrative biological goal, such as the development and enforcement of North Dakota pollutant discharge elimination system permit limits, are not authorized. However, adequate and representative biological assessment information may be used in combination with other information to assist in determining whether designated uses are attained and to assist in determining whether new or revised chemical-specific permit limitations may be needed. Implementation will be based on the comparison of current biological conditions at a particular site to the biological conditions deemed attainable based on regional reference sites. In implementing a narrative biological goal, biological condition may be expressed through an index composed of multiple metrics or through appropriate statistical procedures.

History: Effective June 1, 2001.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

33-16-02.1-09. Surface water classifications, mixing zones, and numeric standards.

1. **Surface water classifications.** Procedures for the classifications of streams and lakes of the state shall follow this subsection. Classifications of streams and lakes are listed in appendix I and appendix II, respectively.

   a. Class I streams. The quality of the waters in this class shall be suitable for the propagation or protection, or both, of resident fish species and other aquatic biota and for swimming, boating, and other water recreation. The quality of the waters shall be suitable for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use.

   b. Class IA streams. The quality of the waters in this class shall be the same as the quality of class I streams, except that where natural conditions exceed class I criteria for municipal and domestic use, the availability of softening or other treatment methods may be considered in determining whether ambient water quality meets the drinking water requirements of the department.

      The Sheyenne River from its headwaters to one-tenth mile downstream from Baldhill Dam is not classified for municipal or domestic use.

   c. Class II streams. The quality of the waters in this class shall be the same as the quality of class I streams, except that additional treatment may be required to meet the drinking water requirements of the department. Streams in this classification may be intermittent in nature which would make these waters of limited value for beneficial uses such as municipal water, fish life, irrigation, bathing, or swimming.

   d. Class III streams. The quality of the waters in this class shall be suitable for agricultural and industrial uses. Streams in this class generally have low average flows with prolonged periods of no flow. During periods of no flow, they are of limited value for recreation and fish and aquatic biota. The quality of these waters must be maintained to protect secondary contact recreation uses (e.g., wading), fish and aquatic biota, and wildlife uses.

e. Wetlands. These water bodies, including isolated ponds, sloughs, and marshes, are to be considered waters of the state and will be protected under section 33-16-02.1-08.

f. Lakes and reservoirs. The type of fishery a lake or reservoir may be capable of supporting is based on the lake's or reservoir's geophysical characteristics. The capability of a lake or reservoir to support a fishery may be affected by seasonal or climatic variability or other natural occurrences, which may alter the physical and chemical characteristics of the lake or reservoir.

Class	Characteristics
1	Cold water fishery. Waters capable of supporting growth of cold water fish species (e.g., salmonids) and associated aquatic biota.
2	Cool water fishery. Waters capable of supporting natural reproduction and growth of cool water fishes (e.g., northern pike and walleye) and associated aquatic biota. These waters are also capable of supporting the growth and marginal survival of cold water species and associated biota.
3	Warm water fishery. Waters capable of supporting natural reproduction and growth of warm water fishes (e.g., largemouth bass and bluegill) and associated aquatic biota. Some cool water species may also be present.
4	Marginal fishery. Waters capable of supporting a fishery on a short-term or seasonal basis (generally a "put and take" fishery).
5	Not capable of supporting a fishery due to high salinity.

2. **Mixing zones.** North Dakota mixing zone and dilution policy is contained in appendix III.

3. **Numeric standards.**

a. Class I streams. Unless stated otherwise, maximum limits for class I streams are listed in table 1 and table 2.

b. Class IA streams. The physical and chemical criteria shall be those for class I, with the following exceptions:

Substance or Characteristic	Maximum Limit
Chlorides (total)	175 mg/l (30-day arithmetic average)
Sodium	60% of total cations as mEq/l
Sulfate (total)	450 mg/l (30-day arithmetic average)

Site-Specific Sulfate (total) Standard

The following site-specific standard applies to the Sheyenne River from its headwaters to one-tenth mile downstream from Baldhill Dam.

Sulfate (total)	750 mg/l

131.10(b) requirement

The water quality standards for the Red River and the portions of the Sheyenne River located downstream from the segment of the Sheyenne River to which the site-specific sulfate standard applies must continue to be maintained. The Sheyenne River from 0.1 mile downstream from Baldhill Dam to the confluence with the Red River shall not exceed 450 mg/l sulfate (total) 30-day arithmetic average and the Red River shall not exceed 250 mg/l sulfate (total 30-day arithmetic average after mixing, downstream from the confluence of the Sheyenne River. Regulated pollution control efforts must be developed to achieve compliance with these water quality standards.

c. Class II streams. The physical and chemical criteria shall be those for class IA, with the following exceptions:

Substance or Characteristic	Maximum Limit
Chlorides (total)	250 mg/l (30-day arithmetic average)
pH	6.0-9.0 (up to 10% of representative samples collected during any 3-year period may exceed this range provided that lethal conditions are avoided)

d. Class III streams. The physical and chemical criteria shall be those for class II, with the following exceptions:

Substance or Characteristic	Maximum Limit
Sulfate (total)	750 mg/l (30-day arithmetic average)

e. Lakes and reservoirs.

(1) The beneficial uses and parameter limitations designated for class I streams shall apply to all classified lakes or reservoirs. However, specific background studies and information may require that the department revise a standard for any specific parameter.

(2) In addition, a guideline for use as a goal in any lake or reservoir improvement or maintenance program is a growing season (April through November) average chlorophyll-a concentration of 20.0 µg/l.

(3) The temperature standard for class I streams does not apply to Nelson Lake in Oliver County. The temperature of any discharge to Nelson Lake shall not have an adverse effect on fish, aquatic biota, recreation, and wildlife.

(4) A numeric temperature standard of not greater than fifty-nine degrees Fahrenheit [15 degrees Celsius] shall be maintained in the hypolimnion of class I lakes and reservoirs during periods of thermal stratification.

(5) The numeric dissolved oxygen standard of five mg/l as a daily minimum does not apply to the hypolimnion of class III and IV lakes and reservoirs during periods of thermal stratification.

(6) Lake Sakakawea must maintain a minimum volume of water of five hundred thousand-acre feet [61674-hectare meters] that has a temperature of fifty-nine degrees Fahrenheit [15 degrees Celsius] or less and a dissolved oxygen concentration of not less than five mg/l.

History: Effective June 1, 2001; amended effective October 1, 2006; July 1, 2010; April 1, 2014.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

TABLE 1

MAXIMUM LIMITS FOR SUBSTANCES IN
OR CHARACTERISTICS OF CLASS I STREAMS

CAS[1] No.	Substance or Characteristic	Maximum Limit
		Acute Standard
7429905	Aluminum	750 ug/l
		Chronic Standard
		87 ug/l Where the pH is equal to or greater than 7.0, and the hardness is equal to or greater than 50 mg/l as $CaCO_3$ in the receiving water after mixing, the 87 ug/l chronic total recoverable aluminum criterion will not apply, and aluminum will be regulated based on compliance with the 750 ug/l acute total recoverable aluminum criterion.
		Acute Standard
7446-41-7	Ammonia (Total as N)	The one-hour average concentration of total ammonia (expressed as N in mg/l) does not exceed, more often than once every three years on the average, the numerical value given by the following formula: $\frac{0.411}{1 + 10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$, where salmonids are absent; or $\frac{0.275}{1 + 10^{7.204-pH}} + \frac{39.0}{1 + 10^{pH-7.204}}$, where salmonids are present.
		Chronic Standard
		The 30-day average concentration of total ammonia (expressed as N in mg/l) does not exceed, more often than once every three years on the average, the numerical value given by the following formula; and the highest 4-day average concentration of total ammonia within the 30-day averaging period does not exceed 2.5 times the numerical value given by the following formula:

CAS[1] No.	Substance or Characteristic	Maximum Limit
		$= \left(\frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \right) \bullet$ Criteria Variable (CV); where CV = 2.85, when T ≤ 14° C; or $CV = 1.45 \times 10^{0.028 \cdot (25-T)}$, when T > 14° C. **Site-Specific Chronic Standard** The following site-specific standard applies to the Red River of the North beginning at the 12th Avenue North bridge in Fargo, North Dakota, and extending approximately 32 miles downstream to its confluence with the Buffalo River, Minnesota. This site-specific standard applies only during the months of October, November, December, January, and February. During the months of March through September, the statewide chronic ammonia standard applies. The 30-day average concentration of total ammonia (expressed as N in mg/l) does not exceed, more often than once every three years on the average, the numerical value given by the following formula; and the highest 4-day average concentration of total ammonia within the 30-day averaging period does not exceed 2.5 times the numerical value given by the following formula: $= \left(\frac{0.0577}{1 + 10^{7.688-pH}} + \frac{2.487}{1 + 10^{pH-7.688}} \right) \bullet CV;$ where CV = 4.63, when T ≤ 7° C; or $CV = 1.45 \times 10^{0.028 \cdot (25-T)}$, when T > 7° C.
7440-39-3	Barium (Total)	1.0 mg/l (one-day arithmetic average)
	Boron (Total)	.75 mg/l (30-day arithmetic average)
16887-00-6	Chlorides (Total)	100 mg/l (30-day arithmetic average)
7782-50-5	Chlorine Residual (Total)	Acute .019 mg/l Chronic .011 mg/l

CAS[1] No.	Substance or Characteristic	Maximum Limit
7782-44-7	Dissolved Oxygen	5 mg/l as a daily minimum (up to 10% of representative samples collected during any 3-year period may be less than this value provided that lethal conditions are avoided)
	E. coli[3]	Not to exceed 126 organisms per 100 ml as a geometric mean of representative samples collected during any 30-day consecutive period, nor shall more than 10 percent of samples collected during any 30-day consecutive period individually exceed 409 organisms per 100 ml. For assessment purposes, the 30-day consecutive period shall follow the calendar month. This standard shall apply only during the recreation season May 1 to September 30.
14797-55-8	Nitrates (N) (Diss.)[2]	1.0 mg/l (up to 10% of samples may exceed)
	pH	7.0-9.0 (up to 10% of representative samples collected during any three-year period may exceed this range, provided that lethal conditions are avoided)
108-95-2	Phenols (Total)	0.3 mg/l (organoleptic criterion) (one-day arithmetic average)
	Sodium	50 percent of total cations as mEq/l
	Sulfates (Total as SO_4)	250 mg/l (30-day arithmetic average)
	Temperature	Eighty-five degrees Fahrenheit [29.44 degrees Celsius]. The maximum increase shall not be greater than five degrees Fahrenheit [2.78 degrees Celsius] above natural background conditions.
	Combined radium 226 and radium 228 (Total)	5 pCi/l (30-day arithmetic average)

CAS[1] No.	Substance or Characteristic	Maximum Limit
	Gross alpha particle activity, including radium 226, but excluding radon and uranium	15 pCi/l (30-day arithmetic average)

[1] CAS No. is the chemical abstract service registry number. The registry database contains records for specific substances identified by the chemical abstract service.

[2] The standard for nitrates (N) is intended as an interim guideline limit. Since each stream or lake has unique characteristics which determine the concentration of this constituent that will cause excessive plant growth (eutrophication), the department reserves the right to review this standard after additional study and to set specific limitations on any waters of the state. However, in no case shall the concentration for nitrate plus nitrite N exceed 10 mg/l for any waters used as a municipal or domestic drinking water supply.

[3] Where the E. coli criteria are exceeded and there are natural sources, the criteria may be considered attained, provided there is reasonable basis for concluding that the indicator bacteria density attributable to anthropogenic sources is consistent with the level of water quality required by the criteria. This may be the situation, for example, in headwater streams that are minimally affected by anthropogenic activities.

TABLE 2

WATER QUALITY CRITERIA[1]
(MICROGRAMS PER LITER)

		Aquatic Life Value Classes I, IA, II, III		Human Health Value	
CAS No.	Pollutant	Acute	Chronic	Classes I, IA, II[2]	Class III[3]
83-32-9	Acenaphthene			670	990
107-02-8	Acrolein	3.0	3.0	6	9
107-13-1	Acrylonitrile[4]			0.051	0.25
71-43-2	Benzene[4]			2.2	51
92-87-5	Benzidine[4]			0.000086	0.00020
63-25-2	Carbaryl (1-naphthyl-N-methycarbamate)	2.1	2.1		
56-23-5	Carbon tetrachloride[4] (Tetrachloromethane)			0.23	1.6
108-90-7	Chlorobenzene (Monochlorobenzene)			100[7]	1,600
2921-88-2	Chlorpyrifos	0.083	0.041		
120-82-1	1,2,4-Trichlorobenzene			35	70
118-74-1	Hexachlorobenzene[4]			0.00028	0.00029
107-06-2	1,2-Dichloroethane[4]			0.38	37
71-55-6	1,1,1-Trichloroethane			200[7]	
67-72-1	Hexachloroethane[4]			1.4	3.3
79-00-5	1,1,2-Trichloroethane[4]			0.59	16
79-34-5	1,1,2,2-Tetrachloroethane[4]			0.17	4.0
111-44-4	Bis(2-chloroethyl) ether[4]			0.030	0.53
91-58-7	2-Chloronaphthalene			1,000	1,600
88-06-2	2,4,6-Trichlorophenol[4]			1.4	2.4
59-50-7	p-Chloro-m-cresol (4-Chloro-3-methylphenol)			3000	
67-66-3	Chloroform (HM)[4] (Trichloromethane)			5.7	470
95-57-8	2-Chlorophenol			81	150
95-50-1	1,2-Dichlorobenzene[7]			420	1,300
541-73-1	1,3-Dichlorobenzene			320	960
106-46-7	1,4-Dichlorobenzene[7]			63	190
91-94-1	3,3'-Dichlorobenzidine[4]			0.021	0.028
75-35-4	1,1-Dichloroethylene[4]			7[7]	7,100
156-60-5	1,2-trans-Dichloroethylene[7]			100[7]	10,000
120-83-2	2,4-Dichlorophenol			77	290
542-75-6	1,3-Dichloropropylene (1,3-Dichloropropene) (cis and trans isomers)			0.34	21
78-87-5	1,2-Dichloropropane			0.50	15
105-67-9	2,4-Dimethylphenol			380	850

		Aquatic Life Value Classes I, IA, II, III		Human Health Value	
CAS No.	Pollutant	Acute	Chronic	Classes I, IA, II[2]	Class III[3]
121-14-2	2,4-Dinitrotoluene[4]			0.11	3.4
122-66-7	1,2-Diphenylhydrazine[4]			0.036	0.20
100-41-4	Ethylbenzene[7]			530	2,100
206-44-0	Fluoranthene			130	140
108-60-1	Bis(2-chloroisopropyl) ether			1400	65,000
75-09-2	Methylene chloride (HM)[4] (Dichloromethane)			4.6	590
74-83-9	Methyl bromide (HM) (Bromomethane)			47	1,500
75-25-2	Bromoform (HM)[5] (Tribromomethane)			4.3	140
75-27-4	Dichlorobromomethane (HM)[5]			0.55	17
124-48-1	Chlorodibromomethane (HM)[5]			0.40	13
87-68-3	Hexachlorobutadiene[4]			0.44	18
77-47-4	Hexachlorocyclopentadiene			40	1,100
78-59-1	Isophorone[4]			35	960
98-95-3	Nitrobenzene			17	690
51-28-5	2,4-Dinitrophenol			69	5,300
534-52-1	4,6-Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)			13	280
62-75-9	N-Nitrosodimethylamine[4]			0.00069	3.0
86-30-6	N-Nitrosodiphenylamine[4]			3.3	6.0
621-64-7	N-Nitrosodi-n-propylamine[4]			0.005	0.51
87-86-5	Pentachlorophenol	19[8]	15[8]	0.27	3.0
108-95-2	Phenol			10,000	860,000
117-81-7	Bis(2-ethylhexyl)phthalate[4]			1.2	2.2
85-68-7	Butyl benzyl phthalate			1,500	1,900
84-74-2	Di-n-butyl phthalate			2,000	4,500
84-66-2	Diethyl phthalate			17,000	44,000
131-11-3	Dimethyl phthalate			270,000	1,100,000
56-55-3	Benzo(a)anthracene (PAH)[4] (1,2-Benzanthracene)			0.0038	0.018
50-32-8	Benzo(a)pyrene (PAH)[4] (3,4-Benzopyrene)			0.0038	0.018
205-99-2	Benzo(b)fluoranthene (PAH)[4] (3,4-Benzofluoranthene)			0.0038	0.018
207-08-9	Benzo(k)fluoranthene (PAH)[4] (11,12-Benzofluoranthene)			0.0038	0.018
218-01-9	Chrysene (PAH)[4]			0.0038	0.018
120-12-7	Anthracene (PAH)[5]			8,300	40,000
86-73-7	Fluorene (PAH)[5]			1,100	5,300
53-70-3	Dibenzo(a,h)anthracene (PAH)[4] (1,2,5,6-Dibenzanthracene)			0.0038	0.018

		Aquatic Life Value Classes I, IA, II, III		Human Health Value	
CAS No.	Pollutant	Acute	Chronic	Classes I, IA, II[2]	Class III[3]
193-39-5	Indeno(1,2,3-cd)pyrene (PAH)[4]			0.0038	0.018
129-00-0	Pyrene (PAH)[5]			830	4,000
127-18-4	Tetrachloroethylene[4]			0.69	3.3
108-88-3	Toluene			1,000[7]	15,000
79-01-6	Trichloroethylene[4]			2.5	30
75-01-4	Vinyl chloride[4] (Cloroethylene)			0.025	2.4
309-00-2	Aldrin[4]	1.5		0.000049	0.000050
60-57-1	Dieldrin[4]	0.24	0.056	0.000052	0.000054
57-74-9	Chlordane[4]	1.2	0.0043	0.00080	0.00081
50-29-3	4,4'-DDT[4]	0.55[12]	0.001[12]	0.00022	0.00022
75-55-9	4,4'-DDE[4]			0.00022	0.00022
72-54-8	4,4'-DDD[4]			0.00031	0.00031
959-98-8	alpha-Endosulfan	0.11[11]	0.056[11]	62	89
33213-65-9	beta-Endosulfan	0.11[11]	0.056[11]	62	89
1031-07-8	Endosulfan sulfate			62	89
72-20-8	Endrin	0.09	0.036	0.059	0.060
7421-93-4	Endrin aldehyde			0.29	0.30
76-44-8	Heptachlor[4]	0.26	0.0038	0.000079	0.000079
1024-57-3	Heptachlor epoxide[4]	0.26	0.0038	0.000039	0.000039
319-84-6	alpha-BHC[4] (Hexachlorocyclohexane-alpha)			0.0026	0.0049
319-85-7	beta-BHC[4] (Hexachlorocyclohexane-beta)			0.0091	0.017
58-89-9	gamma-BHC (Lindane)[4] (Hexachlorocyclohexane-gamma)	0.95		0.2[7]	1.8
319-86-8	delta-BHC[4] (Hexachlorocyclohexane-delta)				
53469-21-9	PCB 1242 (Arochlor 1242)[4]		0.014[10]	0.000064[10]	0.000064[10]
11097-69-1	PCB-1254 (Arochlor 1254)[4]		0.014[10]	0.000064[10]	0.000064[10]
11104-28-2	PCB-1221 (Arochlor 1221)[4]		0.014[10]	0.000064[10]	0.000064[10]
11141-16-5	PCB-1232 (Arochlor 1232)[4]		0.014[10]	0.000064[10]	0.000064[10]
12672-29-6	PCB-1248 (Arochlor 1248)[4]		0.014[10]	0.000064[10]	0.000064[10]
11096-82-5	PCB-1260 (Arochlor 1260)[4]		0.014[10]	0.000064[10]	0.000064[10]
12674-11-2	PCB-1016 (Arochlor 1016)[4]		0.014[10]	0.000064[10]	0.000064[10]
8001-35-2	Toxaphene[4]	0.73	0.0002	0.00028	0.00028
7440-36-0	Antimony			5.6	640
7440-38-2	Arsenic[7]	340[9]	150[9]	10[7]	
1332-21-4	Asbestos[4 7]			7,000,000 f/l	7000000 f/l
7440-41-7	Beryllium[4]			4[7]	
7440-43-9	Cadmium	2.1[6,15]	0.27[6,15]	5[7]	

		Aquatic Life Value Classes I, IA, II, III		Human Health Value	
CAS No.	Pollutant	Acute	Chronic	Classes I, IA, II[2]	Class III[3]
16065-83-1	Chromium (III)	1800[6,15]	86[6,15]	100(total)[7]	
18540-29-9	Chromium (VI)	16	11	100(total)[7]	
7440-50-8	Copper	14.0[6,15]	9.3[6,15]	1000	
57-12-5	Cyanide (total)	22	5.2	140	140
7439-92-1	Lead	82[6]	3.2[6]	15[7]	
7439-97-6	Mercury	1.7	0.012	0.050	0.051
7440-02-0	Nickel	470[6,15]	52[6,15]	100[7]	4,200
7782-49-2	Selenium	20	5	50[7]	
7440-22-4	Silver	3.8[6,15]			
7440-28-0	Thallium			0.24	0.47
7440-66-6	Zinc	120[6,15]	120[6,15]	7,400	26,000
688-73-3	Tributyltin	0.46	0.072		
1746-01-6	Dioxin (2,3,7,8-TCDD)[4]			5.0E-9	5.1E-9
15972-60-8	Alachlor			2[7]	
1912-24-9	Atrazine			3[7]	
56-38-2	Parathion	0.065	0.013		
1563-66-2	Carbofuran			40[7]	
94-75-7	2,4-D			70[7]	
75-99-0	Dalapon			200[7]	
103-23-1	Di(2-ethylhexyl)adipate			400[7]	
333-41-5	Diazinon	0.17	0.17		
84852-15-3	Nonylphenol (Isomer mixture)[13]	28	6.6		
67708-83-2	Dibromochloropropane			0.2[7]	
156-59-2	Dichloroethylene (cis-1,2-)			70[7]	
88-85-7	Dinoseb			7[7]	
85-00-7	Diquat			20[7]	
145-73-3	Endothall			100[7]	
106-93-4	Ethylene dibromide (EDB)			0.05[7]	
1071-83-6	Glyphosate			700[7]	
72-43-5	Methoxychlor			40[7]	
23135-22-0	Oxamyl (Vydate)			200[7]	
1918-02-1	Picloram			500[7]	
122-34-9	Simazine			4[7]	
100-42-5	Styrene			100[7]	
1330-20-7	Xylenes			10,000[7]	
7782-41-4	Fluoride			4,000[7]	
14797-65-0	Nitrite			1,000[7]	
12587-47-2	Beta/photon emitters			4 mrem/yr[7]	
7440-61-1	Uranium			30[7]	

		Aquatic Life Value Classes I, IA, II, III		Human Health Value	
CAS No.	Pollutant	Acute	Chronic	Classes I, IA, II[2]	Class III[3]
15541-45-4	Bromate			10[7]	
14998-27-7	Chlorite			1,000[7]	
	Halocetic acids[14]			60[7]	

1 Except for the aquatic life values for metals, the values given in this appendix refer to the total (dissolved plus suspended) amount of each substance. For the aquatic life values for metals, the values refer to the total recoverable method for ambient metals analyses.

2 Based on two routes of exposure - ingestion of contaminated aquatic organisms and drinking water.

3 Based on one route of exposure - ingestion of contaminated aquatic organisms only.

4 Substance classified as a carcinogen, with the value based on an incremental risk of one additional instance of cancer in one million persons.

5 Chemicals which are not individually classified as carcinogens but which are contained within a class of chemicals, with carcinogenicity as the basis for the criteria derivation for that class of chemicals; an individual carcinogenicity assessment for these chemicals is pending.

6 Hardness dependent criteria. Value given is an example only and is based on a $CaCO_3$ hardness of 100 mg/l. Criteria for each case must be calculated using the following formula:

For the Criterion Maximum Concentration (CMC):

Cadmium	$CMC = e^{(1.0166[\ln (hardness)] - 3.9240)}$
Chromum (III)	$CMC = e^{(0.8190[\ln (hardness)] +3.7256)}$
Copper	$CMC = e^{(0.9422[\ln (hardness)] - 1.7000)}$
Lead	$CMC = e^{(1.2730[\ln (hardness)] - 1.4600)}$
Nickel	$CMC = e^{(0.8460[\ln (hardness)] +2.2550)}$
Silver	$CMC = e^{(1.7200[\ln (hardness)] - 6.5900)}$
Zinc	$CMC = e^{(0.8473[\ln (hardness)] +0.8840)}$

CMC = Criterion Continuous Concentration (acute exposure value)
The threshold value at or below which there should be no unacceptable effects to freshwater aquatic organisms and their uses if the one-hour concentration does not exceed that CMC value more than once every three years on the average.

For the Criterion Continuous Concentration (CCC):

Cadmium	$CMC = e^{(0.7409[\ln (hardness)] - 4.7190)}$
Chromium (III)	$CMC = e^{(0.8190[\ln (hardness)] +0.6848)}$
Copper	$CMC = e^{(0.8545[\ln (hardness)] - 1.7020)}$
Lead	$CMC = e^{(1.2730[\ln (hardness)] - 4.7050)}$
Nickel	$CMC = e^{(0.8460[\ln (hardness)] +0.0584)}$
Silver	No CCC criterion for silver
Zinc	$CMC = e^{(0.8473[\ln (hardness)] +0.8840)}$

CCC = Criterion Continuous Concentration (chronic exposure value)
The threshold value at or below which there should be no unacceptable effects to freshwater aquatic organisms and their uses if the four-day concentration does not exceed that CCC value more than once every three years on the average.

7 Safe Drinking Water Act (MCL).

[8] Freshwater aquatic life criteria for pentachlorophenol are expressed as a function of pH. Values displayed in the table correspond to a pH of 7.8 and are calculated as follows:

CMC =exp [1.005 (pH) - 4.869]   CCC = exp [1.005 (pH) - 5.134]

[9] This criterion applies to total arsenic.

[10] This criterion applies to total PCBs (i.e., the sum of all congener or all isomer or homolog or Arochlor analyses).

[11] This criterion applies to the sum of alpha-endosulfan and beta-endosulfan.

[12] This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

[13] The nonylphenol criteria address CAS numbers 84852-15-3 and 25154-52-3.

[14] The criterion is for a total measurement of 5 haloacetic acids, dichloroacetic acid, trichloroacetic acid, monochloroacetic acid, bromoacetic acid, and dibromoacetic acid.

[15] Hardness values shall be no greater than 400 mg/l. For waters with hardness concentrations greater than 400 mg/l. The actual ambient hardness may be used where a site-specific water effect ratio has been determined consistent with the environmental protection agency's water effect ratio procedure.

33-16-02.1-10. Ground water classifications and standards.

1. Class I ground waters. Class I ground waters shall have a total dissolved solids concentration of less than 10,000 mg/l. Class I ground waters are not exempt under the North Dakota underground injection control program in section 33-25-01-05.

2. Class II ground waters. Class II ground waters shall have a total dissolved solids concentration of 10,000 mg/l or greater. Class II ground waters are exempt under the North Dakota underground injection control program in section 33-25-01-05.

History: Effective June 1, 2001; amended effective April 1, 2014.
General Authority: NDCC 61-28-04, 61-28-05
Law Implemented: NDCC 61-28-04

33-16-02.1-11. Discharge of wastes. On-surface discharges. The following are general requirements for all waste discharges or chemical additions:

1. No untreated domestic sewage shall be discharged into the waters of the state.

2. No untreated industrial wastes or other wastes which contain substances or organisms which may endanger public health or degrade the water quality of water usage shall be discharged into the waters of the state.

3. The department must be notified at least twenty days prior to the application of any herbicide or pesticide to surface waters of the state for control of aquatic pests. Only certified applicators are allowed to apply chemicals. The notification must include the following information:

   a. Chemical name and composition.

b. Map which identifies the area of application and aerial extent (e.g., acres or square feet).

c. A list of target species of aquatic biota the applicant desires to control.

d. The calculated concentration of the active ingredient in surface waters immediately after application.

e. Name, address, and telephone number of the certified applicator.

4. Any spill or discharge of waste which causes or is likely to cause pollution of waters of the state must be reported immediately. The owner, operator, or person responsible for a spill or discharge must notify the department as soon as possible (701-328-5210) or the North Dakota hazardous materials emergency assistance and spill reporting number (1-800-472-2121) and provide all relevant information about the spill. Depending on the severity of the spill or accidental discharge, the department may require the owner or operator to:

   a. Take immediate remedial measures;

   b. Determine the extent of pollution to waters of the state;

   c. Provide alternate water sources to water users impacted by the spill or accidental discharge; or

   d. Any other actions necessary to comply with this chapter.

History: Effective June 1, 2001; amended effective October 1, 2006; July 1, 2010.
General Authority: NDCC 61-28-04
Law Implemented: NDCC 23-33, 61-28

APPENDIX I

STREAM CLASSIFICATIONS

The following intrastate and interstate streams are classified as the class of water quality which is to be maintained in the specified stream or segments noted. There are a number of minor or intermittently flowing watercourses, unnamed creeks, or draws, etc., which are not listed. All tributaries not specifically mentioned are classified as Class III streams.

RIVER BASINS, SUBBASINS, AND TRIBUTARIES	CLASSIFICATION
Missouri River, including Lake Sakakawea and Oahe Reservoir	I
Yellowstone	I
Little Muddy Creek near Williston	II
White Earth River	II
Little Missouri River	II
Knife River	II
Spring Creek	IA
Square Butte Creek below Nelson Lake	IA
Heart River	IA
Green River	IA
Antelope Creek	II
Muddy Creek	II
Apple Creek	II
Cannonball River	II
Cedar Creek	II
Beaver Creek near Linton	II
Grand River	IA
Spring Creek	II
Souris River	IA

RIVER BASINS, SUBBASINS, AND TRIBUTARIES	CLASSIFICATION
Des Lacs River	II
Willow Creek	II
Deep River	III
Mauvais Coulee	I
James River	IA
Pipestem	IA
Cottonwood Creek	II
Beaver Creek	II
Elm River	II
Maple River	II
Bois de Sioux	I
Red River	I
Wild Rice River	II
Antelope Creek	III
Sheyenne River (except as noted below)	IA
Baldhill Creek	II
Maple River	II
Rush River	III
Elm River	II
Goose River	IA
Turtle River	II
Forest River	II
North Branch	III
Park River	II
North Branch	III

RIVER BASINS, SUBBASINS, AND TRIBUTARIES	CLASSIFICATION
South Branch	II
Middle Branch	III
Cart Creek	III
Pembina River	IA
Tongue River	II

The Sheyenne River from its headwaters to 0.1 mile downstream from Baldhill Dam is not classified for municipal or domestic use.

APPENDIX II

LAKE AND RESERVOIR CLASSIFICATION

Lakes and reservoirs are classified according to the water characteristics which are to be maintained in the specified lakes and reservoirs. The beneficial water uses and parameter limitations designated for Class I streams shall apply to all classified lakes and reservoirs. For lakes not listed, the following default classification applies: Class 4.

COUNTY	LAKE	CLASSIFICATION
Adams	Mirror Lake	3
Adams	N. Lemmon Lake	1
Barnes	Lake Ashtabula	3
Barnes	Moon Lake	2
Barnes	Clausen Springs	3
Benson	Wood Lake	2
Benson	Graves	3
Benson	Reeves	3
Bottineau	Lake Metigoshe	2
Bottineau	Long Lake	2
Bottineau	Pelican Lake	3
Bottineau	Carbury Dam	2
Bottineau	Cassidy Lake	4
Bottineau	Strawberry Lake	2
Bowman	Bowman-Haley Dam	3

COUNTY	LAKE	CLASSIFICATION
Bowman	Gascoyne Lake	3
Bowman	Kalina Dam	3
Bowman	Lutz Dam	2
Bowman	Spring Lake	3
Burke	Powers Lake	3
Burke	Short Creek Dam	2
Burke	Smishek Dam	2
Burke	Northgate Dam	2
Burleigh	McDowell Dam	3
Burleigh	Mitchell Lake	3
Burleigh	New Johns Lake	2
Cass	Casselton Reservoir	3
Cass	Brewer Lake	2
Cavalier	Mt. Carmel Dam	2
Dickey	Moores Lake	3
Dickey	Pheasant Lake	3
Dickey	Wilson Dam	3
Divide	Baukol-Noonan Dam	2
Divide	Baukol-Noonan East Mine Pond	2

COUNTY	LAKE	CLASSIFICATION
Divide	Skjermo Dam	2
Dunn	Lake Ilo	3
Eddy	Battle Lake	3
Eddy	Warsing Dam	3
Emmons	Braddock Dam	3
Emmons	Nieuwsma Dam	2
Emmons	Rice Lake	3
Foster	Juanita Lake	3
Golden Valley	South Buffalo Gap Dam	4
Golden Valley	Camel Hump Dam	1
Golden Valley	Odland Dam	3
Grand Forks	Fordville Dam	2
Grand Forks	Kolding Dam	3
Grand Forks	Larimore Dam	2
Grant	Heart Butte Dam (Lake Tschida)	2
Grant	Niagara Dam	3
Grant	Raleigh Reservoir	2
Grant	Sheep Creek Dam	2
Griggs	Carlson-Tande Dam	3

COUNTY	LAKE	CLASSIFICATION
Griggs	Red Willow Lake	2
Hettinger	Blickensderfer Dam	2
Hettinger	Castle Rock Dam	4
Hettinger	Indian Creek	2
Hettinger	Larson Lake	3
Hettinger	Mott Watershed Dam	3
Kidder	Alkaline Lake	2
Kidder	Cherry Lake	3
Kidder	Crystal Springs	3
Kidder	Frettim Lake	2
Kidder	George Lake	5
Kidder	Horsehead Lake	2
Kidder	Lake Isabel	3
Kidder	Lake Josephine	2
Kidder	Lake Williams	3
Kidder	Round Lake	2
LaMoure	Heinrich-Martin Dam	3
LaMoure	Kalmbach Lake	3
LaMoure	Kulm-Edgeley Dam	3

COUNTY	LAKE	CLASSIFICATION
LaMoure	Lake LaMoure	3
LaMoure	Lehr Dam	3
LaMoure	Limesand-Seefeldt Dam	3
LaMoure	Schlecht-Thom Dam	3
LaMoure	Schlecht-Weix Dam	3
Logan	Beaver Lake	3
Logan	Mundt Lake	3
Logan	Rudolph Lake	3
McHenry	Cottonwood Lake	3
McHenry	George Lake	3
McHenry	Round Lake	3
McHenry	Buffalo Lodge Lake	3
McIntosh	Blumhardt Dam	2
McIntosh	Clear Lake	3
McIntosh	Coldwater Lake	3
McIntosh	Dry Lake	2
McIntosh	Green Lake	2
McIntosh	Lake Hoskins	3
McKenzie	Arnegard Dam	4
McKenzie	Leland Dam	2

COUNTY	LAKE	CLASSIFICATION
McKenzie	Sather Dam	2
McLean	Brush Lake	3
McLean	Crooked Lake	3
McLean	Custer Mine Pond	2
McLean	East Park Lake	2
McLean	Lake Audubon	2
McLean	Lake Brekken	2
McLean	Lake Holmes	2
McLean	Lightning Lake	1
McLean	Long Lake	4
McLean	Riverdale Spillway Lake	1
McLean	Strawberry Lake	3
McLean	West Park Lake	2
Mercer	Harmony Lake	3
Morton	Crown Butte Dam	3
Morton	Danzig Dam	3
Morton	Fish Creek Dam	1
Morton	Harmon Lake	3
Morton	Nygren Dam	2

COUNTY	LAKE	CLASSIFICATION
Morton	Sweetbriar Dam	2
Mountrail	Clearwater Lake	3
Mountrail	Stanley City Pond	3
Mountrail	Stanley Reservoir	3
Mountrail	White Earth Dam	2
Nelson	McVille Dam	2
Nelson	Tolna Dam	2
Nelson	Whitman Dam	2
Oliver	East Arroda Lake	2
Oliver	Nelson Lake	3
Oliver	West Arroda Lake	2
Pembina	Renwick Dam	3
Pierce	Balta Dam	3
Pierce	Buffalo Lake	3
Ramsey	Cavanaugh Lake	3
Ramsey	Devils Lake	2
Ransom	Dead Colt Creek Dam	3
Renville	Lake Darling	2
Richland	Lake Elsie	3
Richland	Mooreton Pond	3

COUNTY	LAKE	CLASSIFICATION
Rolette	Belcourt Lake	2
Rolette	Carpenter Lake	2
Rolette	Dion Lake	2
Rolette	Gordon Lake	2
Rolette	Gravel Lake	2
Rolette	Hooker Lake	2
Rolette	Island Lake	3
Rolette	Jensen Lake	3
Rolette	School Section Lake	2
Rolette	Upsilon Lake	2
Rolette	Shutte Lake	2
Sargent	Alkali Lake	3
Sargent	Buffalo Lake	3
Sargent	Lake Tewaukon	3
Sargent	Silver Lake	3
Sargent	Sprague Lake	3
Sheridan	Hecker Lake	2
Sheridan	South McClusky Lake (Hoffer Lake)	2
Sioux	Froelich Dam	2

COUNTY	LAKE	CLASSIFICATION
Slope	Cedar Lake	3
Slope	Davis Dam	2
Slope	Stewart Lake	3
Stark	Belfield Pond	1
Stark	Dickinson Dike	1
Stark	Patterson Lake	3
Steele	North Golden Lake	3
Steele	North Tobiason Lake	3
Steele	South Golden Lake	3
Stutsman	Arrowwood Lake	4
Stutsman	Bader Lake	3
Stutsman	Barnes Lake	3
Stutsman	Clark Lake	3
Stutsman	Crystal Springs	3
Stutsman	Hehn-Schaffer Lake	3
Stutsman	Jamestown Reservoir	3
Stutsman	Jim Lake	4
Stutsman	Spiritwood Lake	3
Stutsman	Pipestem Reservoir	3

COUNTY	LAKE	CLASSIFICATION
Towner	Armourdale Dam	2
Towner	Bisbee Dam	2
Walsh	Bylin Dam	3
Walsh	Homme Dam	3
Walsh	Matejcek Dam	3
Ward	Hiddenwood Lake	3
Ward	Makoti Lake	4
Ward	North-Carlson Lake	3
Ward	Rice Lake	3
Ward	Velva Sportsmans Pond	1
Wells	Harvey Dam	3
Wells	Lake Hiawatha (Sykeston Dam)	4
Williams	Blacktail Dam	3
Williams	Cottonwood Lake	3
Williams	East Spring Lake Pond	3
Williams	Epping-Springbrook Dam	3
Williams	Iverson Dam	2
Williams	Kettle Lake	2
Williams	Kota-Ray Dam	1

COUNTY	LAKE	CLASSIFICATION
Williams	McCleod (Ray) Reservoir	3
Williams	McGregor Dam	1
Williams	Tioga Dam	3
Williams	Trenton Lake	2
Williams	West Spring Lake Pond	3
	Lake Oahe	1
	Lake Sakakawea	1

APPENDIX III

MIXING ZONE AND DILUTION POLICY
AND
IMPLEMENTATION PROCEDURE

PURPOSE

This policy addresses how mixing and dilution of point source discharges with receiving waters will be addressed in developing chemical-specific and whole effluent toxicity discharge limitations for point source discharges. Depending upon site-specific mixing patterns and environmental concerns, some pollutants/criteria may be allowed a mixing zone or dilution while others may not. In all cases, mixing zone and dilution allowances shall be limited, as necessary, to protect the integrity of the receiving water's ecosystem and designated uses.

MIXING ZONES

Where dilution is available and the discharge does not mix at a near instantaneous and complete rate with the receiving water (incomplete mixing), an appropriate mixing zone may be designated. In addition, a mixing zone may only be designated if it is not possible to achieve chemical-specific standards and whole effluent toxicity objectives at the end-of-pipe with no allowance for dilution. The size and shape of a mixing zone will be determined on a case-by-case basis. At a maximum, mixing zones for streams and rivers shall not exceed one-half the cross-sectional area or a length 10 times the stream width at critical low flows, whichever is more limiting. Also, at a maximum, mixing zones in lakes shall not exceed 5 percent of lake surface area or 200 feet in radius, whichever is more limiting. Individual mixing zones may be limited or denied in consideration of designated beneficial uses or presence of the following concerns in the area affected by the discharge:

1) There is the potential for bioaccumulation in fish tissues or wildlife.
2) The area is biologically important, such as fish spawning/nursery areas.
3) The pollutant of concern exhibits a low acute to chronic ratio.
4) There is a potential for human exposure to pollutants resulting from drinking water use or recreational activities.
5) The effluent and resultant mixing zone results in an attraction of aquatic life to the effluent plume.
6) The pollutant of concern is extremely toxic and persistent in the environment.
7) The mixing zone would prohibit a zone of passage for migrating fish or other species (including access to tributaries).
8) There are cumulative effects of multiple discharges and their mixing zones.

Within the mixing zone designated for a particular pollutant, certain numeric water quality criteria for that substance may not apply. However, all mixing zones shall meet the general conditions set forth in Section 33-16-02-08 of the State Water Quality Standards.

While exceedences of acute chemical specific numeric standards are not allowed within the entire mixing zone, a portion of the mixing zone (the zone of initial dilution or ZID) may exceed acute chemical-specific numeric standards established for the protection of aquatic life. The ZID shall be determined on a case-by-case basis where the statement of basis for the discharge permit includes a rationale for concluding that a zone of initial dilution poses no unacceptable risks to aquatic life. Acute whole effluent toxicity (WET) limits shall be achieved at the end-of-pipe with no allowance for a ZID.

DILUTION ALLOWANCES

An appropriate dilution allowance may be provided in calculating chemical-specific acute and chronic and WET discharge limitations where: 1) the discharge is to a river or stream, 2) dilution is available at low-flow conditions, and 3) available information is sufficient to reasonably conclude that there is near instantaneous and complete mixing of the discharge with the receiving water (complete mixing). The basis for concluding that such near instantaneous and complete mixing is occurring shall be documented in the statement of basis for the NDPDES permit. In the case of field studies, the dilution allowance for continuous dischargers shall be based on the critical low flow (or some portion of the critical low flow). The requirements and environmental concerns identified in the paragraphs above may be considered in deciding the portion of the critical low flow to provide as dilution. The following critical low flows shall be used for streams and effluents:

Stream Flows	
Aquatic life, chronic	4-day, 3-year flow (biologically based*)**
Aquatic life, acute	1-day, 3-year flow (biologically based)
Human health (carcinogens)	harmonic mean flow
Human health (non-carcinogens)	4-day, 3-year flow (biologically based) or 1-day, 3-year flow (biologically based)

Effluent Flows	
Aquatic life, chronic	Mean daily flow
Aquatic life, acute	Maximum daily flow
Human health (all)	Mean daily flow

* Biologically based refers to the biologically based design flow method developed by EPA. It differs from the hydrologically based design flow method in that it directly uses the averaging periods and frequencies specified in the aquatic life water quality criteria for individual pollutants and whole effluents for determining design flows.

** A 30-day, 10-year flow (biologically based) can be used for ammonia or other chronic standard with a 30-day averaging period.

For chemical-specific and chronic WET limits, an appropriate dilution allowance may also be provided for certain minor publicly owned treatment works (POTWs) where allowing such dilution will pose insignificant environmental risks. For acute WET limits, an allowance for dilution is authorized only where dilution is available and mixing is complete.

For controlled discharges, such as lagoon facilities that discharge during high ambient flows, the stream flow to be used in the mixing zone analysis should be the lowest statistical flow expected to occur during the period of discharge.

Where a discharger has installed a diffuser in the receiving water, all or a portion of the critical low stream flow may be provided as a dilution allowance. The determination shall depend on the diffuser design and on the requirements and potential environmental concerns identified in the above paragraphs. Where a diffuser is installed across the entire river/stream width (at critical low flow), it will generally be presumed that near instantaneous and complete mixing is achieved and that providing the entire critical low flow as dilution is appropriate.

OTHER CONSIDERATIONS

Where dilution flow is not available at critical conditions (i.e., the water body is dry), the discharge limits will be based on achieving applicable water quality criteria (i.e., narrative and numeric, chronic and acute) at the end-of-pipe; neither a mixing zone or an allowance for dilution will be provided.

All mixing zone dilution assumptions are subject to review and revision as information on the nature and impacts of the discharge becomes available (e.g., chemical or biological monitoring at the mixing zone boundary). At a minimum, mixing zone and dilution decisions are subject to review and revision, along with all other aspects of the discharge permit upon expiration of the permit.

For certain pollutants (e.g., ammonia, dissolved oxygen, metals) that may exhibit increased toxicity or other effects on water quality after dilution and complete mixing is achieved, the waste load allocation shall address such effects on water quality, as necessary, to fully protect designated and existing uses. In other words, the point of compliance may be something other than the mixing zone boundary or the point where complete mixing is achieved.

The discharge will be consistent with the Antidegradation Procedure.

IMPLEMENTATION PROCEDURE

This procedure describes how dilution and mixing of point source discharges with receiving waters will be addressed in developing discharge limitations for point source discharges. For the purposes of this procedure, a mixing zone is defined as a designated area or volume of water surrounding or downstream of a point source discharge where the discharge is progressively diluted by the receiving water and numerical water quality criteria may not apply. Based on site-specific considerations, such a mixing zone may be designated in the context of an individual permit decision. Discharges may also be provided an allowance for dilution where it is determined that the discharge mixes with the receiving water in near instantaneous and complete fashion. Such mixing zones and allowances for dilution will be granted on a parameter-by-parameter and criterion-by-criterion basis as necessary to fully protect existing and designated uses.

The procedure to be followed is composed of six individual elements or steps. The relationship of the six steps and an overview of the mixing zone/dilution procedure is shown in Figure 1.

Step 1 - No Dilution Available During Critical Conditions

Where dilution flow is not available at critical low flow conditions, discharge limitations will be based on achieving applicable narrative and numeric water quality criteria at the end-of-pipe.

Step 2 - Dilution Categorically Prohibited for Wetland Discharges

Permit limitations for discharges to a wetland shall be based on achieving all applicable water quality criteria (i.e., narrative and numeric, chronic and acute) at end-of-pipe.

Step 3 - Procedure for Certain Minor POTWs

Minor POTWs that discharge to a lake or to a river/stream at a dilution greater than 50:1 qualify for this procedure. Minor POTWs with dilution ratios less than 50:1 may also qualify (at the discretion of the permit writer) where it can be adequately demonstrated that this procedure poses insignificant environmental risks. For the purposes of this procedure, the river/stream dilution ratio is defined as the chronic low flow of the segment upstream of the POTW discharge divided by the mean daily flow of the POTW. For controlled discharges from lagoon facilities (discharging during high flows), the river/stream dilution ratio is defined as the lowest upstream flow expected during the period of discharge divided by the mean daily flow of the discharge.

For minor POTWs that qualify for this procedure and discharge to lakes, the allowance for dilution for chemical-specific and chronic WET limits will be determined on a case-by-case basis. Dilution up to 19:1 (5 percent effluent) may be provided.

For minor POTWs that qualify for this procedure and discharge to a river/stream segment, dilution up to the full chronic aquatic life, acute aquatic life, and human health critical flows may be provided.

Step 4 - Site-Specific Risk Considerations

Where allowing a mixing zone or a dilution allowance would pose unacceptable environmental risks, the discharge limitations will be based on achieving applicable narrative and numeric water quality criteria at the end-of-pipe. The existence of environmental risks may also be the basis for a site-specific mixing zone or dilution allowance. Such risk determinations will be made on a case-by-case and parameter-by-parameter basis. These decisions will take into account the designated and existing uses and all relevant site-specific environmental concerns, including the following:

1. Bioaccummulation in fish tissues or wildlife
2. Biologically important areas such as fish spawning areas
3. Low acute to chronic ratio
4. Potential human exposure to pollutants resulting from drinking water or recreational areas
5. Attraction of aquatic life to the effluent plume
6. Toxicity/persistence of the substance discharged
7. Zone of passage for migrating fish or other species (including access to tributaries)
8. Cumulative effects of multiple discharges and mixing zones

Step 5 - Complete Mix Procedures

For point source discharges to rivers/streams where available data are adequate to support a conclusion that there is near instantaneous and complete mixing of the discharge with the receiving water (complete mix) the full critical low flow or a portion thereof may be provided as dilution for chemical-specific and WET limitations. Such determinations of complete mixing will be made on a case-by-case basis using best professional judgement. Presence of an effluent diffuser that covers the entire river/stream width at critical low flow will generally be assumed to provide complete mixing. Also, where the mean daily flow of the discharge exceeds the chronic low stream flow of the receiving water, complete mixing will generally be assumed. In addition, where the mean daily flow of the discharge is less than or equal to the chronic low flow of the receiving water, it will generally be assumed that complete mixing does not occur unless otherwise demonstrated by the permittee. Demonstrations for complete mixing should be consistent with the study plan developed in cooperation with the states/tribes and EPA Region VIII. Near instantaneous and complete mixing is defined as no more than a 10 percent difference in bank-to-bank concentrations within a longitudinal distance not greater than two river/stream widths. For controlled discharges (lagoon facilities), the test of near instantaneous and complete mixing will be made using the expected rate of effluent discharge and the lowest upstream flow expected to occur during the period of discharge.

The following critical low flows shall be applied for streams and effluents:

Stream Flows

Aquatic life, chronic	4-day, 3-year flow (biologically based*)**
Aquatic life, acute	1-day, 3-year flow (biologically based)
Human health (carcinogens)	Harmonic mean flow
Human health (non-carcinogens)	4-day, 3-year flow (biologically based) or 1-day, 3-year flow (biologically based)

Effluent Flows

Aquatic life, chronic	Mean daily flow
Aquatic life, acute	Maximum daily flow
Human health (all)	Mean daily flow

* Biologically based refers to the biologically based design flow method developed by EPA. It differs from the hydrologically based design flow method in that it directly uses the averaging periods and frequencies specified in the aquatic life water quality criteria for individual pollutants and whole effluents for determining design flows.

** A 30-day, 10-year flow (biologically based) can be used for ammonia or other chronic standard with a 30-day averaging period.

Where complete mixing can be concluded and the environmental concerns identified in step 4 do not justify denying dilution, but are nevertheless significant, some portion of the critical low flows identified above may be provided as dilution. Such decisions will take site-specific environmental concerns into account as necessary to ensure adequate protection of designated and existing uses.

Step 6 - Incomplete Mix Procedures

This step addresses point source discharges that exhibit incomplete mixing. Because acute WET limits are achieved at the end-of-pipe in incomplete mix situations, this step provides mixing zone procedures for chronic aquatic life, human health, and WET limits, and ZID procedures for acute chemical-specific limits. Where a ZID is allowed for chemical limits, the size of the ZID shall be limited as follows:

Lakes:	The ZID volume shall not exceed 10 percent of the volume of the chronic mixing zone.
Rivers and Streams:	The ZID shall not exceed 10 percent of the chronic mixing zone volume or flow, nor shall the ZID exceed a maximum downstream length of 100 feet, whichever is more restrictive.

The following provides guidelines for determining the amount of dilution available for dischargers that exhibit incomplete mixing.

Default Method

This method addresses situations where information needed for modeling is not available or there are concerns about potential environmental impacts of allowing a mixing zone. The default method provides a conservative dilution allowance.

Stream/River Dischargers: Dilution calculation which uses up to 10 percent of the critical low flow for chronic aquatic life limits or human health limits. However, this allowance may be adjusted downward on a case-by-case basis depending upon relevant site-specific information, designed and existing uses of the segment, and especially the uses of the segment portion affected by the discharge.

Lake/Reservoir Dischargers: Dilution up to 4:1 ratio (20 percent effluent) may be provided for chronic aquatic life analyses or human health analyses. However, this allowance may be adjusted downward on a case-by-case basis depending upon discharge flow, lake size, lake flushing potential, designated and existing uses of the lake, and uses of the lake portion affected by the discharge.

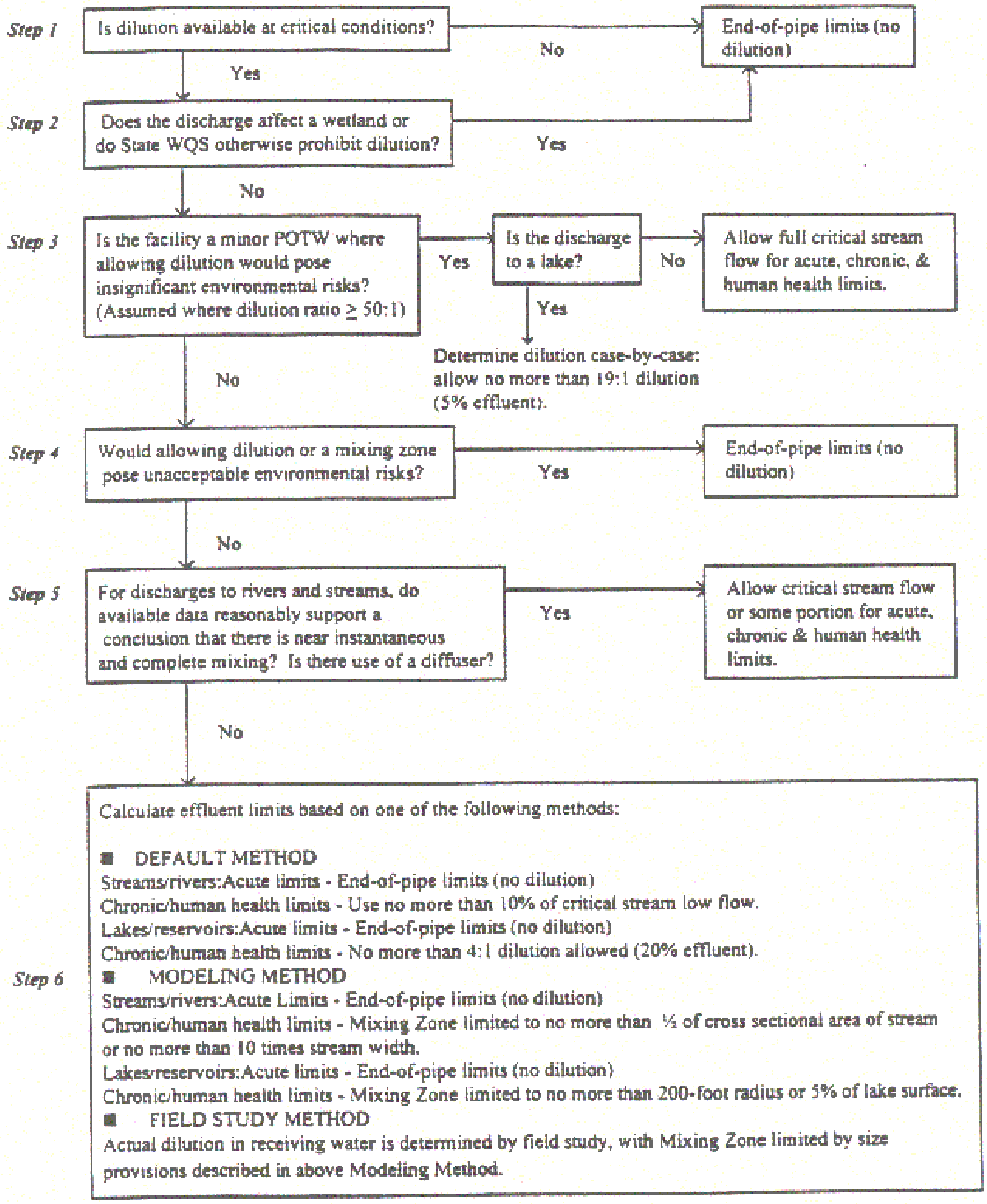
Modeling Method

An appropriate mixing zone model is used to calculate the dilution flow that will allow mixing zone limits to be achieved at the critical low flow. Prior to initiating modeling studies, it should be determined that compliance with criteria at the end-of-pipe is not practicable.

Field Study Method

Field studies which document the actual mixing characteristics in the receiving water are used to determine the dilution flow that will allow mixing zone size limits to be achieved at the critical low flow. For the purposes of field studies, "near instantaneous and complete mixing" is operationally defined as no more than a 10 percent difference in bank-to-bank concentrations within a longitudinal distance not greater than two stream/river widths.

FIGURE 1
NORTH DAKOTA MODEL MIXING ZONE/DILUTION PROCEDURE*



* This procedure is applied to both chemical-specific and WET limits. In the case of complex discharges, the dilution or mixing zone may vary parameter-by-parameter.

APPENDIX IV

NORTH DAKOTA ANTIDEGRADATION PROCEDURE

I. INTRODUCTION

This antidegradation implementation procedure delineates the process that will be followed by the North Dakota State Department of Health for implementing the antidegradation policy found in the Standards of Water Quality for the State of North Dakota, Rule 33-16-02.

Under this implementation procedure, all waters of the state are afforded one of three different levels of antidegradation protection. All existing uses, and the water quality necessary for those uses, shall be maintained and protected. Antidegradation requirements are necessary whenever a regulated activity is proposed that may have some effect on water quality. Regulated actions include permits issued under Section 402 (NDPDES) and 404 (Dredge and Fill) of the Clean Water Act (CWA), and any other activity requiring Section 401 water quality certification. Nonpoint sources of pollution are not included. When reviewing 404 nationwide permits, the department will issue 401 certifications only where it determines that the conditions imposed by such permits are expected to result in attainment of the applicable water quality standards, including the antidegradation requirements. However, it is anticipated that the department will exclude certain nationwide permits from the antidegradation procedures for Category 1 waters on the basis that the category of activities covered by the permit is not expected to have significant permanent effects on the quality and beneficial uses of those waters, or the effects will be appropriately minimized and temporary.

II. EXISTING USE PROTECTION FOR CATEGORY 1, 2, AND 3 WATERS

Existing use means a use that was actually attained in the water body on or after 1967, whether or not it is included in the water quality standards. This procedure presumes that attainment of the criteria assigned to protect the current water body classification will serve to maintain and protect all existing uses. However, where an existing use has water quality requirements that are clearly defined, but are not addressed by the current classification and criteria, the department will ensure that such existing uses are protected fully, based on implementation of appropriate numeric or narrative water quality criteria or criteria guidance. In some cases, water quality may have improved in the segment since the classification was assigned, resulting in attainment of a higher use. In other cases, the classification may have been assigned based on inadequate information, resulting in a classification that does not describe or adequately protect actual uses of the segment. In such cases, the department will develop requirements necessary to protect the existing uses and, where appropriate, recommend reclassification of the segment.

III. ANTIDEGRADATION REVIEW PROCEDURE

The department will complete an antidegradation review for all proposed regulated activities. The findings of these reviews will be summarized using an antidegradation worksheet. A statement of basis for all conclusions will be attached to the completed worksheet. The level of detail of the review will depend upon the antidegradation protection applicable to the various classes of water.

In conducting an antidegradation review, the Division of Water Quality will sequentially apply the following steps:

A. Determine which level of antidegradation applies.

B. Determine whether authorizing the proposed regulated activity is consistent with antidegradation requirements.

C. Review existing water quality data and other information submitted by the project applicant.

D. Determine if additional information or assessment is necessary to make a decision.

E. A preliminary decision is made by the department and subsequently distributed for public participation and intergovernmental coordination.

- The content of public notices will be determined case by case. In preparing a public notice, the department may address: a) the department's preliminary antidegradation review conclusions; b) a request for public input on particular aspects of the antidegradation review that might be improved based on public input (e.g., existing uses of a segment that needs to be protected); c) notice of the availability of the antidegradation review worksheet; d) notice of the availability of general information regarding the state antidegradation program; and e) a reference to the state antidegradation policy.

- The antidegradation review findings will be available for public comment; however, publication of a separate notice for purposes of antidegradation is not necessary. For example, the antidegradation preliminary findings may be included in the public notice issued for purposes of an NDPDES permit or CWA § 401 certification.

The department will ensure appropriate intergovernmental coordination on all antidegradation reviews. At a minimum, the department will provide copies of the completed antidegradation review worksheet and/or the public notice to appropriate local, state, and federal government agencies, along with a written request to provide comments by the public comment deadline.

F. Comments are considered.

G. The department determines if the change in quality is necessary to accommodate important economic or social development.

H. The department makes a final decision.

The level of antidegradation protection afforded each water body in the state is consistent with beneficial uses of those water bodies. Appendix I and Appendix II of the Standards of Water Quality for the State of North Dakota identify rivers, streams, and lakes in the state with their classification. The classification shall be consistent with the following categories:

Category 1: Very high level of protection that automatically applies to Class I and Class IA streams and Class I, II, and III lakes, and wetlands that are functioning at their optimal level. In addition, Category 1 is presumed to apply to Class II and Class III streams. Particular Class II and Class III streams may be excluded from Category 1 if, at the time of the antidegradation review, it is determined that one or both of the following criteria are applicable: 1) there is no remaining assimilative capacity for any of the parameters that may potentially be affected by the proposed regulated activity in the segment in question, or 2) an evaluation submitted by the project applicant demonstrates (based on adequate and representative chemical, physical, and biological data) that aquatic life and primary contact recreation uses are not currently being attained because of stressors that will require a long-term effort to remedy. Evaluations in response to Criterion #2 must include more than an identification of current water quality levels. They must include evidence of the current status of the aquatic life and primary contact recreation uses of the segment.

Category 2: Class IV and Class V lakes and particular wetlands after antidegradation review. In addition, Class II and Class III streams or wetlands meeting one of the criteria identified above at the time of the antidegradation review shall be included in Category 2.

Category 3: Highest level of protection; Outstanding State Resource Waters.

Procedures for Category 1 Waters

Regulated activities that result in a new or expanded source of pollutants to this category of water are subject to the review process, unless the source would have no significant permanent effect on the quality and beneficial uses of those waters, or if the effects will be appropriately minimized and temporary.

- Proposed activities that would lower the ambient quality in a water body of any parameter by more than 15 percent, reduce the available assimilative capacity by more than 15 percent, or increase permitted pollutant loadings to a water body by more than 15 percent will be deemed to have significant effects.

- The department will identify and eliminate from further review those proposed activities that will have no significant effect on water quality or beneficial uses. Category 1 reviews will be conducted where significant effects are projected for one or more water quality parameters. Findings of significant effects may be based on the following factors: a) percent change in ambient concentrations predicted at the appropriate conditions; b) percent change in loadings for the individual discharge or to the segment from all discharges; c) reduction in available assimilative capacity; d) nature, persistence, and potential effects of the parameter; e) potential for cumulative effects; f) predicted impacts to aquatic biota; and g) degree of confidence in any modeling techniques utilized.

- The applicant may be required to provide available monitoring data or other information about the affected water body and/or proposed activity to help determine the significance of the proposed degradation for specific parameters. The information includes recent ambient chemical, physical, or biological monitoring data sufficient to characterize, during the appropriate conditions, the spatial and temporal variability of existing background quality of the segment for the parameters that would be affected by the proposed activity. The information would also describe the water quality that would result if the proposed activity were authorized.

The project applicant is required to provide an evaluation of the water quality effects of the project. This evaluation may consist of the following components:

1. Pollution prevention measures.

2. Reduction in scale of the project.

3. Water recycle or reuse.

4. Process changes.

5. Alternative treatment technology.

6. Advanced treatment technology.

7. Seasonal or controlled discharge options to avoid critical water quality periods.

8. Improved operation and maintenance of existing facilities.

9. Alternative discharge locations.

The primary emphasis of the Category 1 reviews will be to determine whether reasonable nondegrading or less-degrading alternatives to the proposed degradation are available. The department will first evaluate any alternatives analysis submitted by the applicant for adherence to the minimum requirements described below. If an acceptable analysis of alternatives was completed and submitted to the department as part of the initial project proposal, no further evaluation of alternatives will be required of the applicant. If an acceptable alternatives analysis has not been completed, the department will work with the project applicant to ensure that an acceptable alternatives analysis is developed.

Once the department has determined that feasible alternatives to allowing the degradation have been adequately evaluated, the department shall make a preliminary determination regarding whether reasonable nondegrading or less-degrading alternatives are available. This determination will be based primarily on the alternatives analysis developed by the project applicant, but may be supplemented with other information or data. As a rule-of-thumb, nondegrading or less-degrading pollution control alternatives with costs that are similar to the costs of the applicant's favored alternative shall be considered reasonable. If the department determines that reasonable alternatives to allowing the degradation do not exist, the department shall continue with the antidegradation review and document the basis for the preliminary determination.

If the department makes a preliminary determination that one or more reasonable alternatives exist, the department will work with the applicant to revise the project design. If a mutually acceptable resolution cannot be reached, the department will document the alternative analysis findings and provide public notice of a preliminary decision to deny the activity.

Although it is recognized that any activity resulting in a discharge to surface waters may have positive and negative aspects, the applicant must show that any discharge or increased discharge will be of economic or social importance in the area. Where there are existing regulated sources located in the area, the department will assure that those sources are complying with applicable requirements prior to authorizing the proposed regulated activity. New sources of a particular parameter will not be allowed where there are existing unresolved compliance problems (involving the same parameter) in the zone of influence of the proposed activity. The "zone of influence" is determined as appropriate for the parameter of concern, the characteristics of the receiving water body (e.g., lake versus river, etc.), and other relevant factors. Where available, a Total Maximum Daily Load analysis or other watershed-scale plan will be the basis for identifying the appropriate zone of influence. The department may conclude that such compliance has not been achieved where existing sources are violating their NPDES permit limits. However, the existence of a compliance schedule in the NPDES permit may be taken into consideration in such cases. Required controls on existing regulated sources need not be finally achieved prior to authorizing a proposed activity provided there is reasonable assurance of future compliance.

Procedures for Category 2 Waters

Regulated activities that result in a permanent or temporary, new or expanded source of pollution to this category of water are permitted if the following conditions are met:

1. The classified uses of the water would be maintained.

2. The assimilative capacity of the water is available for the parameters that would be affected by the regulated activity, and existing uses would be protected as discussed in Section II.

A decision will be made on a case-by-case basis, using available data and best professional judgment. The applicant may be required to provide additional information necessary for the department to characterize or otherwise predict changes to the physical, chemical, and/or biological condition of the water.

Procedures for Category 3 Waters

Outstanding State Resource Waters - Eligibility. Outstanding state resource waters may be designated Category 3 waters only after they have been determined to have exceptional value for present or prospective future use for public water supplies, propagation of fish or aquatic life, wildlife, recreational purposes, or agricultural, industrial, or other legitimate beneficial uses. The factors that may be considered in determining whether a water body is eligible for inclusion in Category 3 include the following: a) location, b) previous special designations, c) existing water quality, d) physical characteristics, e) ecological value, and f) recreational value.

Nomination. Any person may nominate any waters of the state for designation as outstanding state resource waters. The nomination must be made in writing to the department, must describe its specific location and present uses, and must state the reasons why the resource has exceptional value for present or prospective future beneficial use.

Review Process. The department with cooperation of the State Water Commission shall review any nomination to determine whether the nominated waters of the state are eligible, clearly defined, and identify beneficial uses of exceptional value for present or prospective future use. The State Department of Health with cooperation of the State Water Commission shall provide as a part of its assessment: 1) a verification of the uses, properties, and attributes that define the proposed "exceptional" value; 2) an evaluation of the current and historical condition of the water with respect to the proposed value using the best data available; and 3) an estimate of likely regulatory measures needed to achieve the desired level of protection. If the identified waters of the state are eligible, clearly defined, and appear to identify beneficial uses of exceptional value for present or prospective future use, the Water Pollution Control Board, the department, and the State Water Commission will solicit public comment and/or hold a public hearing regarding the nomination. The Water Pollution Control Board will review the application record and the public comments, and make a recommendation to the department. After reviewing the board's recommendation, the department jointly with the State Water Commission will make a decision on whether to designate the defined water body as an Outstanding State Water Resource. If both the department and the State Water Commission agree that the defined water body should be designated as an Outstanding State Water Resource, the department shall submit the recommendation to the State Health Council as part of the water quality standard revision process. The designation, if made, may be reviewed on a periodic basis.

Implementation Process. Effects on Category 3 waters resulting from regulated activity will be determined by appropriate evaluation and assessment techniques and best professional judgment. Any proposed regulated activity that would result in a new or expanded source of pollutants to a segment located in or upstream of a Category 3 segment will be allowed only if there are appropriate restrictions to maintain and protect existing water quality. Reductions in water quality may be allowed only if they are temporary and negligible. Factors that may be considered in judging whether the quality of a Category 3 water would be affected include: a) percent change in ambient concentrations predicted at the appropriate critical conditions; b) percent change in loadings; c) percent reduction in available assimilative capacity; d) nature, persistence, and potential effects of the parameter; e) potential for cumulative effects; and f) degree of confidence in any modeling techniques utilized.

Appendix B

Standard Operating Procedure for the Selection of Reference and Disturbed Sites for Biological Monitoring in North Dakota

STANDARD OPERATING PROCEDURE FOR THE SELECTION OF REFERENCE AND DISTURBED SITES FOR BIOLOGICAL MONITORING IN NORTH DAKOTA

Summary

The North Dakota Department of Health (NDDH) utilizes reference (least impaired) and disturbed (most impaired) physical conditions to provide an estimate of natural and human induced variability in biological community structure and in stream habitat quality. Sites are also used to develop threshold values and compile Indices of Biological Integrity (IBI). When selecting reference or disturbed conditions the NDDH Surface Water Quality Management Program (SWQMP) must account for natural and climatic variability across the state of North Dakota. To account for environmental variability in North Dakota, the state's total land area was separated into four regions by US Geological Survey Level III Ecoregions and each area was evaluated individually.

The first step in site selection involves a remote sensing component which utilizes an ESRI ArcView Geographic Information System (GIS), ArcView extensions and various GIS data layers. The Analytical Tool Interface for Landscape Assessments (ATtILA) extension allows users to calculate many common landscape metrics including: landscape characteristics, riparian characteristics, human stressors and physical characteristics. Grouped metrics are used to estimate anthropogenic stressors in a 1000 meter (m) circular buffer around distinct sampling points located on perennial flowing waters of the state. Ultimately a final site score is calculated based on the varying metric scores in the buffer. The most disturbed points are classified with the highest scores while the least disturbed points receive the lowest scores. The highest scoring disturbed sites and lowest scoring reference sites then move to the second evaluation step.

The second screening step is to evaluate each site individually by using additional GIS layers. Sites are plotted and examined for landscape attributes which may result in the site not being suitable for sample collection (e.g. water was too deep). Layers used in screening step two include but are not limited to: roads; aerial photos; public and private land ownership; township, range and section grids; county boundaries; and dam structures. The remaining viable sampling locations are then evaluated with another level of screening.

The third screening step involves site reconnaissance, also known as 'ground truthing'. During this step, SWQMP personnel visit sites to evaluate reference or disturbed using best professional judgment. Some important features to consider while 'ground truthing' are stream geomorphology, stream habitat alterations (e.g. dams, rip-rap), land use in or adjacent to the riparian zone, and other human influences at or near site locations.

<u>Software and Data Layers/Sources</u>
___ ArcView 3.X (ArcView version 3.2a or higher recommended)

Extensions:
___ ArcView 3.X Spatial Analyst Extension
___ Analytical Tool Interface for Landscape Assessments (ATtILA2004v1.0) Extension (EPA)
___ Buffer Theme Builder Extension
___ Display Points Lat/Long Extension
___ Divided line by adding points evenly Extension
___ Grid & Theme Projector version 2 Extension
___ XTools Extension (9/15/03)

Datasets and Layers:
___ Ecoregion GIS Layer (USGS)
___ National Agriculture Imagery Program (NAIP) 2005 Aerial Photography (NRCS) <u>or</u> Digital Orthophoto Quarter Quadrangles (DOQQ) (USGS)
___ National Elevation Dataset (NED) (USGS)
___ National Hydrography Dataset (NHD) (USGS)
___ National Land Cover Data (NLCD) (USGS)
___ North Dakota Public Land Ownership Layer
___ State and County Roads GIS Layer (North Dakota GIS Hub)
___ Township, Range and Section Grid

<u>Procedures</u>

Step 1: Remote Sensing

1. Create a new ArcView 3.X GIS project. Set the map coordinate system to *Universal Transverse Mercator* (UTM) zone 14N (North). Set map coordinate units to decimal degrees. Set map distance units to meters.

2. Select stream reaches in the NHD shapefile that fall inside the target watershed or study area. Create a new shapefile with the selected features. Perennial streams should be selected using the following F_CODEs in the NHD attribute table: 33400, 33600, 46003, 46006, and 55800.

3. Use the *Divide Line by Adding Points Evenly* extension to add points along the NHD shapefile features at intervals of 2000 meters.

4. Make sure the map coordinate system is set to UTM zone 14N. Next use the *Display Points Lat & Long Extension* to add Latitude and Longitude coordinates for each point to the shapefile's attribute table.

5. Use the *Buffer Theme Builder*'s "Create Buffer Theme" button to produce a shapefile of 1000 meter buffers around each potential sampling site in the point shapefile created in step 3.

6. Create a slope grid in percent from a statewide NED grid. Use the map calculator in spatial analyst and the function *[grid].slope (zFactor, percentRise)* to derive slopes where *zFactor* is the conversion factor if x, y, and z are in different units and *percentRise* equals true for percent slope and false for degree slope.

7. With the new Buffer Theme selected as the reporting unit, select and calculate the desired metrics in each of the four groups: landscape characteristics, riparian characteristics, human stressors and physical characteristics. Metric scores result from the evaluation of the NLCD grid, a roads layer, precipitation, and population density. Metrics should be chosen for their sensitivity. The most sensitive metrics will have the most variability in scores and will make site characteristic differentiation simpler.

8. Once the most sensitive metrics are chosen, use ATtILA to calculate an index score for each assessment unit. Scores are based on a summation of quantile rankings. The number of quantiles is user-defined.

9. Select the assessment units with the lowest and highest index scores, which are a measure of human disturbance. Lowest scores will be the least disturbed reference assessment units or "best available" sites in the study population and the highest scores will be the most disturbed sites.

Step 2: Digital Media Screening

10. Use aerial photography, GIS layers and best professional judgment to evaluate land uses within the selected assessment units. This screening step is mainly used to exclude best available sites with obvious landuse and waterbody characteristics that may disrupt or prohibit sample collection.

Characteristics of Concern

Reference Sites

- Animal feeding operations near the waterbody
- Heavily grazed or degraded riparian area
- Debris or trash in the water body riparian area
- Stream banks with large areas of mass wasting

Reference and Disturbed Sites

- Areas with significant human alteration (e.g. concrete channels)
- Dam structures creating deep pools

GIS Layers used:

- National Agriculture Imagery Program (NAIP) 2005 Aerial Photography (NRCS) <u>or</u> Digital Orthophoto Quarter Quadrangles (DOQQ) (USGS)
- Federal and State Highways, County Roads and Township Roads
- Designated Public Lands and Township, Range, and Sections Grids
- Dam Structures Point Features

Step 3: Landowner Verification and Site Visitation

11. Before a site visit is scheduled, it is advisable to research the identity of the person(s) or group(s) that own land adjacent to or around a potential monitoring location. The inquiry into the property ownership may prove more useful than waiting to contact local residents during an initial site visit and reduce the time expended to obtain permission to access the site. If the land is determined to be held publicly, an effort should be made to contact any and all renters (e.g., producers renting North Dakota State Land Department School Sections).

12. Once permission to access a site is obtained, a site visit should be scheduled. When first arriving at a site it is important to observe any property ownership signage or placards declaring “No Trespassing” or that hazardous conditions are present. If permission to access has been granted, proceed to the site coordinates.

13. Upon reaching the site coordinates, begin to verify the Level 2 assessment screening of GIS layers and aerial photography. Characteristics of the site location that should be examined include but are not limited to; landuse(s) in and around the stream, stream geomorphology, water depth and obstructions to the flow of water. The site investigator should keep a log of notes pertaining to site characteristics and comment on any features present in aerial photos, county maps, or landowner atlases that could be used during future sampling visits.

    A useful tool for examining stream conditions is the Rapid Geomorphic Assessment (RGA) which was developed by the United States Department of Agriculture. The RGA method classifies stream channel stability and the habitat quality of riparian areas and may be used calculate a general stream and habitat score to classify potential Reference and Disturbed sampling locations. The RGA form and instructions for its completion can be found on the following pages.

RAPID GEOMORPHIC ASSESSMENT (RGA) FORM CHANNEL STABILITY & HABITAT RANKING SCHEME

Station Name: ____

Station Description: ______________________________________

Date: __________ Time: ________ Slope: ______% Pattern: meander/ straight/ braided

Crew: ________________________ Pictures (circle): u/s, d/s, x-sec, LB, RB

1. Primary bed material

Bedrock	Boulder/Cobble	Gravel	Sand	Silt/Clay
0	1	2	3	4

2. Bed/bank protection

Yes	No	(with)	1 bank	2 banks
0	1		2	3

3. Degree of incision (relative elev. of "normal" low water if floodplain/terrace is 100%)

0-10%	11-25%	26-50%	51-75%	76-100%
4	3	2	1	0

4. Degree of constriction (relative decrease in top-bank width from up to downstream)

0-10%	11-25%	26-50%	51-75%	76-100%
0	1	2	3	4

5. Streambank erosion (dominant process each bank)

	None	Fluvial	Mass Wasting (failures)
Inside or left	0	1	2
Outside or right	0	1	2

6. Streambank instability (percent of each bank failing)

	0-10%	11-25%	26-50%	51-75%	76-100%
Inside or left	0	0.5	1	1.5	2
Outside or right	0	0.5	1	1.5	2

7. Established riparian vegetative cover (woody or stabilizing perennial grasses each bank)

	0-10%	11-25%	26-50%	51-75%	76-100%
Inside or left	2	1.5	1	0.5	0
Outside or right	2	1.5	1	0.5	0

8. Occurrence of bank accretion (percent of each bank with fluvial deposition)

	0-10%	11-25%	26-50%	51-75%	76-100%
Inside or left	2	1.5	1	0.5	0
Outside or right	2	1.5	1	0.5	0

9. Sum of All Values [ ]

<u>Instructions for Completion of a Rapid Geomorphic Assessment Form</u>

Define a representative reach 6-20 channel widths long.

1. **Primary bed material**

Bedrock — The parent material that underlies all other material. In some cases this becomes exposed at the surface. Bedrock can be identified as large slabs of rock, parts of which may be covered by other surficial material.

Boulder/Cobble — All rocks greater than 64 mm median diameter.

Gravel — All particles with a median diameter between 64.0 — 2.00 mm

Sand — All Particles with a median diameter between 2.00 — 0.063 mm

Silt-Clay — All fine particles with a median diameter of less than 0.063 mm

2. Bed/bank protection

Yes — Mark if the channel bed is artificially protected, such as rip rap or concrete.

No — Mark if the channel bed is not artificially protected and is composed of natural material.

Protection

1 Bank — Mark if one bank is artificially protected, such as with rip rap or concrete.

2 Banks — Mark if two banks are artificially protected.

3. Degree of incision (Relative elevation of "normal" low water; floodplain/terrace @ 100%)

Calculated by measuring water depth at deepest point across channel, divided by bank height from bank top to bank base (where slope breaks to become channel bed). This ratio is given as a percentage and the appropriate category marked.

4. Degree of constriction (Relative decrease in top-bank width from up to downstream)

Often found where obstructions or artificial protection are present within the channel. Taking the reach length into consideration, channel width at the upstream and downstream parts of the reach is measured and the relative difference calculated.

5. Stream bank erosion (Each bank)

The dominant form of bank erosion is marked separately for each bank, left and right, facing in a downstream direction.

If the reach is a meandering reach, the banks are viewed in terms of 'Inside, Outside' as opposed to 'Left, Right' (appropriate for questions *5-8).* Inside bank, being the inner bank of the meander, if the stream bends to the left as you face downstream, this would be the left bank. Outside bank, being the outer bank, on your right as you face downstream in a stream meandering left.

None — No erosion

Fluvial — Fluvial processes, such as undercutting of the bank toe, cause erosion.

Mass Wasting — Mass movement of large amounts of material from the bank is the method of bank erosion. Mass Wasting is characterized by high, steep banks with shear bank faces. Debris at the bank toe appears to have fallen from higher up in the bank face. Includes, rotational slip failures and block failures.

6. Stream bank instability (Percent of each bank failing)

If the bank exhibits mass wasting, mark percentage of bank with failures over the length of the reach. If more than 50% failures are marked, the dominant process is mass wasting (see question *5)*.

7. Established riparian woody-vegetative cover (Each bank)

Riparian woody-vegetative cover represents most permanent vegetation that grows on the stream banks. Distinguished by its woody stem, this includes trees and bushes but does not include grasses. Grasses grow and die annually with the summer and thus do not provide any form of bank protection during winter months whilst permanent vegetation does.

8. Occurrence of bank accretion (Percent of each bank with fluvial deposition)

The percentage of the reach length with fluvial deposition of material (often sand, also includes fines and gravels) is marked.

9. Sum of All Values

Sum all category values for question one through eight. Lower aggregate scores indicate more stable geomorphology and improved habitat. Higher scores indicate unstable geomorphology and decreased habitat.