Methodology for Iowa's 2016 Water Quality Assessment, Listing, and Reporting Pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act.

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Introduction

Iowa's 2016 assessment and listing methodology attempts to incorporate recommendations in U.S. EPA's historical [305(b)/303(d)/Integrated Reporting] guidance as well as the current guidance for the 2016 assessment, listing, and reporting requirements pursuant to Sections 303(d) and 305(b) of the federal Clean Water Act (U.S. EPA 2015). EPA guidance establishes the formats for an "integrated report" (IR) that satisfies the listing requirements of Section 303(d) and the reporting requirements of Sections 305(b) and 314 of the Clean Water Act (CWA). The current EPA (2015) guidance replaces all previous guidance pertaining to Sections 305(b) and 303(d) except EPA's Consolidated Assessment and Listing Methodology (CALM) (U.S. EPA 2002). Due to the continued lack of details regarding the mechanics of CWA-related water quality assessment in more recent EPA guidance (e.g., U.S. EPA 2002), IDNR continues to use assessment methods described and recommended in previous EPA guidance for Section 305(b) reporting (U.S. EPA 1997). IDNR uses the 1997 guidance only in cases where EPA's more recent guidance is inadequate. Iowa's 2016 methodology meets the requirements of CWA, Section 303(d)(1)(a) and 40 CFR Section 130.24 and incorporates requirements of Iowa's credible data law. The changes in methodology between the 2014 and 2016 listing cycles are summarized in Table 1 and are explained throughout this document.

Overview of the assessment and listing process:

The process of assessing water quality and adding waterbodies to the state list of "impaired" waters involves three interrelated program areas of the federal Clean Water Act (CWA): (1) establishment of state water quality standards that identify beneficial uses for the state's waterbodies and that identify criteria to determine whether each use is being achieved, (2) development of water quality assessments by comparing water quality information to water quality standards to determine whether or not beneficial uses are being achieved, and (3) addition of the appropriate waters assessed as "not fully supporting" beneficial uses (i.e., "impaired") to the state's Section 303(d) list. The state's 303(d) list is thus a public accounting of all assessed waterbodies determined to be impaired where a total maximum daily load (TMDL) needs to be developed. Any waterbody that is placed on the 303(d) list has been assessed as not fully meeting water quality standards including designated uses (e.g., for primary contact recreation, aquatic life, as a source of drinking water for a public water supply, and/or for fish consumption). The failure to fully meet state standards can result from the following: violations of numeric criteria, violations of narrative criteria, failure to meet anti-degradation requirements as defined in U.S. EPA's regulations regarding violations of water quality standards (40 CFR 131), and/or a determination that a specific designated use cannot be achieved. The violations of water quality standards might be due to an individual pollutant, multiple pollutants, or an unknown cause of impairment. As provided for in U.S.

EPA's guidance for integrated reporting, other waterbodies may be assessed as impaired but not included on the 303(d) list. These waters will be included in Category 4 of the Integrated Report (Table 1). IR Category 4 includes three types of impaired waterbodies that do not require development of a TMDL: (1) waters for which a TMDL has been completed but water quality standards have not yet been attained (IR Category 4a); (2) waters where other required control measures are expected to result in attainment of water quality standards in a reasonable period of time (IR Category 4b); and (3) the impairment or threat is not caused by a "pollutant" as defined by U.S. EPA (IR Category 4c). In addition, Iowa waters assessed as impaired by pollutant-caused fish kills are placed in IR Category 4d if the IDNR fish kill investigation identified the person responsible for the kill and monetary restitution for the value of the fish killed and cost of investigation has been sought.

The *Iowa Water Quality Standards*:

According to U.S. EPA, a water quality standard is composed of three components: (1) a description of beneficial use, (2) water quality criteria to protect this use, and (3) an anti-degradation policy that ensures protection of water quality where water quality exceeds levels necessary to protect fish and wildlife propagation and recreation in and on the water. Thus, the basis for a state's Section 305(b) assessments and Section 303(d) lists of impaired waters is ultimately the state's water quality standards. That is, the state water quality standards contain the benchmarks (criteria) to which water quality data are compared to determine the degree to which beneficial uses are supported. The versions of the *Iowa Water Quality Standards* and the accompanying *Surface Water Classification* with the effective date of June 17, 2015, were used as the basis for water quality assessments prepared for this (2016) assessment and listing cycle. This version of the *Standards* was the most recent EPA-approved version available during the period of time covered by the 2016 assessment and listing cycle (2012 through 2014). These versions of the standards and surface water classification are available upon request from Iowa DNR's Water Quality Monitoring and Assessment Section.

The Total Maximum Daily Load (TMDL):

The Water Quality Monitoring & Assessment Section of the Iowa DNR's Water Quality Bureau conducts water quality assessments as required by Clean Water Act Section 305(b). Based on these assessments, section staff identify waterbodies in the state of Iowa that may require a total maximum daily load (TMDL) allocation to address the causes and sources of pollutants contributing to impairment of a designated use or other applicable beneficial use. These waters are placed into Category 5 of Iowa's Integrated Report. The waters in this category constitute Iowa's Section 303(d) list of impaired waters. In general terms, a TMDL defines the level of water quality needed to support a water quality standard, including the designated uses, water quality criteria, and the anti-degradation policy that comprise the standard. Conceptually, a TMDL is the maximum pollutant load from point sources and nonpoint sources, plus a load allocated to a "margin of safety" that a waterbody can receive and continue to meet water quality standards. The margin of safety accounts for the lack of understanding of the relationship between pollutant loads and water quality.

Deadlines:

According to current EPA regulations, the Section 303(d) list of impaired waterbodies must be submitted to EPA by April 1 of every even numbered year. Thus, this methodology was designed to meet the deadline for submission of the list to be submitted to U.S. EPA in April 2016.

The "integrated report":

Based on previous guidance from U.S. EPA (e.g., U.S. EPA 1997), most states, including Iowa, had historically produced separate Section 305(b) reports and Section 303(d) lists. Section 305(b) reports have attempted to characterize water quality statewide and thus identified not only designated use impairments but also water quality concerns that are worthy of note and further investigation but do not constitute Section 303(d)-type water quality impairments. The 303(d) lists, on the other hand, have represented the subset of waterbodies assessed for Section 305(b) reporting with known and reasonably verifiable impairments of a designated use or general use as defined in the *Iowa Water Quality Standards* that are appropriate for Section 303(d) listing. Based on development of revised guidance by U.S. EPA (2003), however, an "integrated report" was prepared for Iowa's 2004 cycle that incorporated elements of both the Section 305(b) report and Section 303(d) list. Based on updated guidance from U.S. EPA (2005, 2015), IDNR has continued to use the integrated reporting format.

In their guidance for the integrated assessment, reporting, and listing cycles, U.S. recommends that reporting requirements of Sections 305(b) and 303(d) be "integrated" into a report that contains five assessment categories and associated subcategories:

- Category 1: All designated uses are met.
- Category 2: Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met.
- Category 3: Insufficient data exist to determine whether any designated uses are met.

- Category 4: Water is impaired or threatened but a TMDL is not needed because one of the following occur:
  - 4a. A TMDL has been completed;
  - 4b: Other required control measures are expected to result in attainment of water quality standards in a reasonable period of time;
  - 4c: The impairment or threat is not caused by a "pollutant."
- Category 5: Water is impaired or threatened and a TMDL is needed [IR Category 5 is the state's Section 303(d) list].

The five categories of EPA's integrated reporting and listing format used for Iowa's integrated reports since the 2004 reporting cycle are further explained below and are summarized in Table 2. In the descriptions below, the text in italics is taken directly from U.S. EPA's (2005) guidance for integrated reporting. The notes that follow these excerpts contain IDNR's interpretations and modifications of EPA's guidance.

Category 1 waterbodies: *Waters belong in Category 1 if they are attaining all designated uses and no use is threatened. Segments should be listed in this category if there are data and information that are consistent with the State's methodology and this guidance, and support a determination that all WQSs* [water quality standards] *are attained and no designated use is threatened.*

Iowa DNR has made no modifications to the definition or intent of IR Category 1.

Category 2 waterbodies: *Waters should be placed in Category 2 if there are data and information that meet the requirements of the State's assessment and listing methodology that support a determination that some, but not all, designated uses are attained and none are threatened. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water consistent with the State's listing methodology.*

In Iowa's previous IR cycles, Iowa DNR defined a subcategory (IR 2b)
Iowa DNR made the following modifications to IR Category 2: the renaming of EPA's Category 2 as Category 2a and the addition of Category 2b where at least one use was assessed as "fully supported" and at least one other use was assessed as "potentially impaired". For the 2016 cycle, waters formerly placed in Iowa DNR's IR 2b subcategory are moved to the IR 3b subcategory (at least one use is assessed as potentially impaired

based on an "evaluated" assessment). With the elimination of the IR 2b subcategory, Iowa DNR's IR subcategory 2a is now synonymous with U.S. EPA's IR Category 2:

Category 2a: Some uses supported; insufficient information to determine whether other uses are supported. This wording is consistent with U.S. EPA's definition of IR Category 2.

Category 3 waterbodies: *Waters belong in Category 3 if there are insufficient or no data and information to determine, consistent with the State's listing methodology, if any designated use is attained. To assess the attainment status of these waters, States should schedule monitoring on a priority basis to obtain data and should also make efforts obtain information necessary to move these waters into Categories 1, 2, 4, and 5.*

Iowa DNR has made the following modifications to IR Category 3: the renaming of EPA Category 3 to Category 3a and the addition of Category 3b.

Category 3a: Insufficient data exist to determine whether any uses are met; no uses are assessed [either "evaluated" or "monitored"]. This wording is consistent with U.S. EPA's definition of IR Category 3.

Category 3b: At least one use is assessed as potentially impaired based on an "evaluated" assessment. This subcategory allows tracking of the "impaired/evaluated" waterbodies. Waters placed into subcategory 3b will be added to Iowa's list of "waters in need of further investigation." Waters in subcategory 3b are considered "not assessed" for purposes of Integrated Reporting.

Also, as part of revisions to its biological assessment protocol for the 2010 Integrated Reporting cycle, IDNR added the following subcategories to IR subcategory 3b to improve IDNR's ability to better target follow-up monitoring on streams and rivers where potential biological impairments have been identified. That is, these subcategories were added to allow IDNR to track potentially impaired streams and rivers that (1) are within the calibration watershed size of Iowa's biological assessment protocol (watersheds from ~ 10 to 500 square miles) and (2) are outside this calibration range (i.e., watersheds too small or too large). The following subcategories were added for the 2010 cycle:

3b-c [calibrated]: the aquatic life use of a stream segment within the calibrated range of the biological assessment protocol has been assessed as potentially impaired;

3b-u [un-calibrated]: the aquatic life use of a stream segment with a watershed size outside the calibrated range of the biological assessment protocol has been assessed as potentially impaired.

Category 4 waterbodies: *Waters belong in Category 4 if one or more designated uses are impaired or threatened but establishment of a TMDL is not required. States may place an impaired or threatened water that does not require a TMDL in one of the following three subcategories:*

- *<u>Category 4a: a TMDL has been completed for the water-pollutant combination.</u> Waters should only be placed in Category 4a when all TMDLs needed to result in attainment of all applicable WQ Standards have been approved or established by EPA. Current regulations do not require TMDLs for all waters.*

- *<u>Category 4b: other required control measures are expected to result in the attainment of WQSs in a reasonable period of time.</u> Some waters may be excluded from Category 5, and placed into Category 4b. In order to meet the requirements to place these waters into Category 4b, the State must demonstrate that "other pollution control requirements (e.g., best management practices) required by local, State or Federal authority" (see 40 CFR 130.7(b)(1)(iii)) are expected to address all water-pollutant combinations and attain all WQ Standards in a reasonable period of time. EPA expects that States will provide adequate documentation that the required control mechanisms will address all major pollutant sources and establish a clear link between the control mechanisms and WQ Standards.*

- *<u>Category 4c: the impairment or threat is not caused by a pollutant.</u> Waters should be listed in Category 4c when an impairment is not caused by a pollutant. "Pollution," as defined by the Clean Water Act, is the "man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water." In some cases, the pollution is caused by the presence of a pollutant and a TMDL is required. In other cases, pollution does not result from a pollutant and a TMDL is not required. An example of a pollutant stressor would be copper; an example of a non-pollutant stressor ("pollution") would be "low flow."*

Iowa DNR made no modifications to the definitions or intents of IR Categories 4a, 4b, or 4c. Iowa DNR did, however, make the following modification to IR Category 4: the addition of Category 4d.

<u>Category 4d: Water is impaired due to a pollutant-caused fish kill and enforcement actions were taken against the party responsible for the kill: a TMDL is neither appropriate nor needed.</u> For purposes of Section 305(b) assessments in Iowa, all waters affected by a fish kill caused by a known pollutant or a suspected pollutant are assessed as impaired. Those kills where a pollutant cause was identified are placed into either Category 4d (responsible party identified and enforcement action taken: TMDL not required) or Category 5 (no responsible party identified; enforcement action not taken: a pollutant problem may remain and a TMDL is potentially needed).

Category 5 waterbodies: *This category constitutes the Section 303(d) list that EPA will approve or disapprove under the CWA. Waters should be placed in Category 5 when it is determined, in accordance with the State's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause an impairment or threat. If that impairment or threat is due to a pollutant, the water should be placed in Category 5 and the pollutant causing the impairment identified.*

Iowa DNR made the following modifications to IR Category 5: the renaming of EPA's Category 5 to Category 5a and the addition of categories 5b and 5p.

<u>Category 5a: Water is impaired or threatened by a pollutant stressor and a TMDL is needed.</u> This wording is consistent with U.S. EPA's definition of IR Category 5.

<u>Category 5b: Impairment is based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified.</u> The biological assessment adequately demonstrates that an impairment exists, but either the cause or the source of the impairment is unknown. The primary use of this subcategory is for biologically-based (biomonitoring) impairments with the cause listed as "unknown" and for fish kill-based impairments where a pollutant cause was identified but no source was

found. Additional monitoring/investigation, such as that conducted as part of IDNR's stressor identification procedure, is needed to determine causes or sources before the TMDL can be developed.

As part of revisions to its biological assessment protocol for the 2010 Integrated Reporting cycle, IDNR added the following subcategories to IR Subcategory 5b to improve IDNR's ability to track the impairment status of streams and rivers and to better target follow-up monitoring where both biological impairments and potential de-listings have been identified.

> **5b-t [tentative]:** The aquatic life uses of a stream segment with a watershed size within the calibration range of the IDNR biological assessment protocol (~10 to 500 square miles) are assessed as Section 303(d)-impaired based on <u>an evaluated assessment</u>. The reasons for residency in this subcategory include: 1) data quantity (only one of the two biological samples needed to identify an impairment have been collected), 2) data age (data older than five years), 3) data quality (marginal sampling conditions for biota), and 4) sampling frequency (multiple samples collected in same year, not multiple years).

> **5b-v [verified]:** The aquatic life uses of a stream with a watershed size within the calibration range of IDNR biological assessment protocol (~10 to 500 square miles) are assessed as Section 303(d)-impaired based on results of the required two or more biological sampling events in multiple years within the previous five years needed to confirm the existence of a biological impairment.

<u>Category 5p: Impairment occurs on a waterbody presumptively designated for Class A1 primary contact recreation use or Class B(WW1) aquatic life use.</u> Due to changes in the *Iowa Water Quality Standards* that became effective in March 2006, all perennially-flowing streams and intermittent streams with perennial pools are presumed to be capable of supporting the highest level of primary contact recreation use (Class A1) and the highest level of aquatic life use [Class B(WW1)]. These changes to the *Iowa Water Quality Standards* were approved by U.S. EPA in February 2008. Under this approach to stream classification, the Class A1

(primary contact recreation) use is presumptively applied to all of Iowa's perennial rivers and streams and to intermittent streams with perennial pools, and the Class B(WW1) aquatic life use is similarly applied to all of Iowa's perennial rivers and streams and intermittent streams with perennial pools unless the water is already designated for Class B(WW2) or Class B(WW3) uses in Iowa's Surface Water Classification. A "use attainability analysis" or UAA must be conducted, including field investigations, to determine whether a presumptively-applied use is, in fact, the appropriate designated use for the stream segment in question. Until the time when a UAA has been conducted and the appropriate designated uses have been applied and approved by U.S. EPA, any impairments on presumptively-designated Iowa streams will be placed in IR Category 5p. Note: The upstream and downstream boundaries for most stream/river waterbodies in Iowa's 305(b) assessment database (ADBNet) are not consistent with results of DNR-proposed and EPA-approved changes in designated uses based on results of the UAA process as reflected in Iowa's Surface Water Classification.

According to U.S. EPA's (2005) guidance, the Section 303(d) list is composed of waters included in IR Category 5 of the Integrated Report which includes those waters for which a TMDL needs to be developed. This list includes waterbodies impaired by "pollutants" such as nitrate and indicator bacteria. The source of impairment might be from point sources, nonpoint sources, groundwater or atmospheric deposition. Some sources of impairment of Iowa waterbodies originate outside of the state. Historically, Iowa has listed impaired waterbodies regardless of whether the source of pollutant is known and regardless of whether the pollutant source(s) can be legally controlled or acted upon by the state of Iowa. This methodology is consistent with that history.

As specified in Iowa's credible data law, waterbodies where the assessment indicates a potential impairment, but where sufficient and credible data are lacking, will not be included on the state's 303(d) list (IR Category 5). According to this methodology, these waters will be included in IR subcategory 3b and placed on the state list of "waters in need of further investigation" as provided for by Iowa's credible data legislation.

Changes in methodology since the 2014 reporting/listing cycle

The changes in IDNR's assessment and listing methodology between the 2014 and current (2016) cycles are summarized in Table 1. The following change was made.

(1) The elimination of Iowa DNR's IR 2b subcategory:

Prior to Iowa's 2016 IR cycle, the 2b subcategory was used to identify a potentially-impaired designated use in a waterbody where at least one other use was assessed as "fully supporting". Iowa DNR's 3b subcategory is very similar and is used to identify a potentially-impaired designated use where no other uses are assessed as "fully supporting". Iowa DNR staff feel that, for purposes of tracking potentially-impaired designated uses, the IR 3b subcategory is sufficient.

(2) Development of a new system for waterbody identification:

Due to revisions and updates of the structure of Iowa DNR's water quality assessment database (ADBNet), a new convention for waterbody identification (WB ID) was implemented for the 2016 assessment/listing cycle. The change in waterbody identification is explained below.

Field:	**Legacy (pre-2016) waterbody ID system**	**New waterbody ID system:**
River example: Rock Creek	*IA 01-MAQ-0010_1*	*01-MAQ-2*
Lake example: Easter Lake	*IA 04-LDM-00490-L_0*	*04-LDM-1024*
State	State identifier ("IA") included	Not used
Major river basin identifier	01 = Northeast Iowa basins 02 = Iowa Cedar basin 03=Skunk basin 04= Des Moines & Raccoon basins 05 = southern Iowa basins 06= western Iowa basins	No change
Subbasin identifier	Three-letter code. Example: YEL indicates the Yellow River subbasin in the Northeast Iowa basins	No change

Field:	Legacy (pre-2016) waterbody ID system	New waterbody ID system:
Hydrological position	A four to six-digit number indicating relative position of the waterbody in the subbasin.	Not used; rather, consecutive numbers are used.
Identified or lake & wetland waterbodies	A simple abbreviation ("L") used to denote a lake or wetland waterbody.	Not used.

ADBNet allows searching by either the old (legacy) or new WB ID number.

The Assessment and Listing Process

Preparation of Iowa's integrated [305(b)/303(d)] report includes the following basic steps:

- Assemble all existing and readily available water quality-related data and information not previously used for 305(b) water quality assessments;
- Identify water quality-related data and information of sufficient quality and quantity for purposes of developing scientifically defensible water quality assessments;
- Compare these water quality-related data and information to state water quality standards to determine the degree to which assessed waters meet these standards;
- Identify Section 303(d) impairments that are based on water quality-related data and information that meet the state's requirements for data quantity and data quality (Table 6);
- Place all waters into one of the five categories specified in U.S. EPA's (2003, 2005) "integrated report" guidance for water quality assessment and listing;
- Prepare the state list of waters in need of further investigation as required by state law;
- Prioritize the waterbodies on the draft Section 303(d) list (Category 5) for TMDL development (see Attachment 7);
- Provide the draft integrated report, including the draft Section 303(d) list (Category 5), to the public for review and comment;
- Revise and finalize the integrated report based on new information and public input;
- Submit the final integrated report, including the Section 303(d) list, to U.S. EPA for approval/disapproval;
- Develop a schedule for development of TMDLs for Section 303(d)-listed (IR Category 5) waterbodies.

<u>Sources of existing and readily available water quality-related data and information:</u>

As specified in U.S. EPA's current (1992) TMDL rule (40 CFR 130.7), sources of existing and readily available water quality-related data and information to be considered as part of Section 303(d) listing include, but are not limited to, the following:

- the state's most recent CWA Section 305(b) assessments;
- CWA Section 319 nonpoint source assessments;
- dilution calculations, trend analyses, or predictive models for determining the physical, chemical, or biological integrity of streams, rivers, lakes, and estuaries;
- water quality-related data and water-related information from local, State, Territorial, or Federal agencies (especially the U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) and National Stream Quality Accounting Network (NASQAN)), Tribal governments, members of the public, and academic institutions.

Historically, the majority of information used by IDNR to develop Iowa's Section 303(d) list of impaired waters has been taken from its Section 305(b) assessments. Data sources used to assess water quality conditions in Iowa for purposes of Section 305(b) assessment include, but are not limited to, the following:

- Physical, chemical, and biological data from ambient fixed station water quality monitoring networks conducted by IDNR and other agencies (e.g., U.S. Geological Survey; U.S. Army Corps of Engineers);
- Data from water quality monitoring conducted by adjacent states on border rivers and waters flowing into the state;
- Data from Iowa DNR's ambient biological monitoring program as conducted in cooperation with the State Hygienic Laboratory at The University of Iowa (SHL);
- Data from the ongoing IDNR-sponsored statewide lake monitoring project conducted by Iowa State University and SHL;
- Data from monitoring of bacterial indicators in rivers and at beaches of publicly-owned lakes;
- Data from programs to monitor fish tissue for toxic contaminants;
- Reports of pollutant-caused fish kills;
- Where readily available, data from public water supplies on the quality of raw and finished water;
- Drinking water-related source water assessments under Section 1453 of the Safe Drinking Water Act;

- Data from special studies of water quality and aquatic communities;
- Best professional judgment of IDNR staff;
- Results of volunteer monitoring (e.g., by IOWATER-trained volunteers);
- Water-related information received from the public.

The cutoff date for the data collection period for Iowa's 2016 Integrated Report is the end of the calendar year 2014. This is a general guideline used by IDNR. More recent information may be used for some types of water quality information that becomes available infrequently or at irregular intervals (e.g., fish consumption advisories and reports of pollution-caused fish kills). Large amounts of staff time are needed to summarize monitoring data from the various monitoring agencies, compare the summarized results to water quality standards, develop the waterbody-specific assessments of the degree to which designated uses are supported, and to solicit and respond to public comments on the draft Section 303(d) list. Also, water quality data generated by the various agencies are not available immediately following sample collection: a lag time from a few months up to a year or more is associated with obtaining results of water quality monitoring networks. Given these time requirements, and given the other work responsibilities of IDNR staff that prepare Iowa's Integrated Report, the allowance of a 15-month window for report preparation prior to the April deadline is not excessive.

For purposes of developing stream/river water quality assessments for integrated reporting, three years of water quality data from streams and rivers are typically used for both conventional pollutant parameters (e.g., indicator bacteria) and the less frequently monitored toxic parameters (e.g., toxic metals). This is the seventh consecutive 305(b)/303(d) cycle for which IDNR has used a three-year data gathering period. Prior to the 2004 cycle, only two years of data were used for Iowa's Section 305(b) reports. For most assessments, the use of three years of data increases the number of samples upon which the decision on use support is based and helps address the problem of weather-related year-to-year fluctuations in water quality. More recent data and information are used where appropriate to supplement the current assessment. Older data, up to five years old (i.e., data collected prior to 2012 for the 2016 Integrated Report cycle), are used to supplement data from the current assessment period for water quality parameters with low collection frequency (e.g., toxic metals).

Due to the lower sampling frequency in Iowa's ambient lake monitoring programs, five years of data (2010-2014 for the 2016 IR) are used for developing Section 305(b) assessments and for identifying Section 303(d) listings for Iowa lakes.

As specified in Iowa's credible data law, and based on the uncertainty inherent in using old data to characterize current water quality conditions, data between five and ten years old are used for Section 305(b) assessments but are not used for purposes of adding waters to Iowa's Section 303(d) list of impaired waters (i.e., Category 5 of the Integrated Report). Chemical/physical data older than five years are generally believed to be less reflective of current ambient water quality than are more recent data (U.S EPA 1997, pages 1-5 and 1-9). Of course, nearly all recent water quality data from Iowa waters have already been used for Section 305(b) assessments and thus have already been considered for Section 303(d) listings. Also, a listed waterbody will not be removed from the state's Section 303(d) list simply because the data upon which the impairment was based have aged beyond five or ten years. Thus, the restrictions placed on use of old water quality data by Iowa's credible data law have little effect on impaired waters listings or de-listings in Iowa.

The sources of water quality data used for water quality assessments and impaired waters listings in Iowa are discussed in more detail below.

- **Physical, chemical, and biological data from ambient fixed station water quality monitoring networks conducted in Iowa by IDNR and other agencies**

  IDNR, in cooperation with the State Hygienic Laboratory, has conducted statewide routine ambient monitoring of river water quality in Iowa since the early 1980s. Due to resource constraints, the majority of this monitoring prior to 1999 was limited to relatively few (16) locations. An appropriation from the Iowa Legislature, however, allowed a significant expansion of this monitoring program beginning in October 1999. Iowa rivers are now monitored monthly at approximately 60 sites for a variety of physical, chemical, and bacterial parameters through a contract with the SHL which provides both data collection and laboratory services. These sites are classified as ambient (background) sites and are distributed throughout every major river basin in an effort to provide good geographic coverage of the state. For more information on the IDNR's ambient and city monitoring programs see the following web site:

  http://www.iowadnr.gov/Environment/WaterQuality/WaterMonitoring/MonitoringPrograms.aspx.

  Long-term ambient water-quality monitoring has also been conducted in Iowa by the following agencies: U.S. Army Corps of Engineers, U.S. Geological Survey (USGS), and water utilities such as the Des Moines Water Works, the Cedar Rapids Water Department, and the Rathbun Rural Water Association. The monitoring networks in Iowa conducted by agencies other than IDNR are typically designed to answer questions specific to drinking water sources or to the effects of in-stream structures or large facilities on water quality (e.g., flood control reservoirs or power generating facilities). For example, networks have been established by the U.S. Army Corps of Engineers on the Des Moines, Raccoon, and Iowa rivers to evaluate changes in water quality caused by Saylorville, Red Rock, and Coralville reservoirs (see Lutz 2011, 2012, 2013). In general, stations in these networks have remained fixed for approximately four decades, and they have been monitored more frequently than stations in the IDNR/SHL network. Thus, these networks provide a relatively long-term database that can be used to characterize water quality conditions. For information on the monitoring networks on the Des Moines and Raccoon rivers, see the following web site: *http://home.eng.iastate.edu/~dslutz/dmrwqn/dmrwqn.html*.

Currently, USGS conducts routine water quality monitoring at three fixed stations in Iowa: the Mississippi River at Clinton, the Missouri River at Omaha, and the Missouri River downstream from Council Bluffs. The Clinton and Omaha sites are remnants of the USGS National Stream Quality Accounting Network (NASQAN). During the 2012-2014 data gathering period for the current (2016) Integrated Reporting cycle, the following streams were routinely monitored by USGS such that 10 or more samples were collected over the three-year period:

	USGS Monitoring Location:	**Station**
1.	Boyer River at Logan, Harrison Co.	06609500
2.	Cedar River at Edgewood Road, Cedar Rapids, Linn Co.	05464480
3.	Des Moines River at Keosauqua, Van Buren Co.	05490500
4.	Iowa River at Wapello, Louisa Co.	05465500
5.	Little Sioux River at Turin, Monona Co.	06607500
6.	Maquoketa River at Spragueville, Jackson Co.	05418600
7.	Nishnabotna River at Hamburg, Fremont Co.	06810000
8.	Skunk River at Augusta, Lee Co.	05474000
9.	South Fork Iowa River NE of New Providence, Hardin Co.	05451210
10	Turkey River at Garber, Clayton Co.	05412500
11	Wapsipinicon River near DeWitt, Clinton Co.	05422000
12	Wapsipinicon River near Tripoli, Bremer Co.	05420680

Data from USGS monitoring in Iowa are available at the following web site: *http://waterdata.usgs.gov/nwis/sw*.

- **Data for Iowa tributaries of the Upper Mississippi River generated by the Long Term Resource Monitoring Program**

  Intensive water quality monitoring of Pool 13 of the Upper Mississippi River and several Iowa tributaries is conducted by Iowa DNR staff at Bellevue, Iowa, as part of the Long-Term Resource Monitoring Program (LTRMP). The LTRMP was authorized under the Water Resources Development Act of 1986 as an element of the U.S. Army Corps of Engineers "Environmental Management Program" (EMP) and is currently being implemented by the U.S. Geological Survey in cooperation with the five Upper Mississippi River basin states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin). State staff at six field stations in the Upper Mississippi River system conduct monitoring of fisheries and vegetation, as well as water quality on specified reaches of the river. Water quality monitoring by the LTRMP began in 1988 and continues. LTRMP stations with chemical data used for Section 305(b) water quality assessments and Section 303(d) listings in Iowa are summarized in Table 3. Data from this network are available from the Upper Midwest Environmental Sciences Center (see http://www.umesc.usgs.gov/data_library/water_quality/water_quality_data_page.html).

- **Data from water quality monitoring conducted by adjacent states on border rivers and waters flowing into the state**

  States adjacent to Iowa (South Dakota, Minnesota, Wisconsin, Illinois, Missouri, and Nebraska) also have fixed station ambient water quality monitoring programs that generate data useful for purposes of water quality assessments in Iowa. Data from these monitoring networks are available either through the U.S. EPA's national water quality database "STORET and WQX" [*http://www.epa.gov/storet/*] or through personal contacts with water quality monitoring staff of environmental agencies in these states. These data are used with the guidelines described in this document to assess the degree to which the relevant *Iowa Water Quality Standards* are being met. In addition, decisions on assessment and listing for interstate waters are coordinated to the extent possible with water quality staff from the adjacent states. For example, assessments and listings for the Iowa portion of the Upper Mississippi River are made in consultation with the states of Minnesota, Wisconsin, Illinois, and Missouri as part of ongoing interstate 305(b)/303(d) consultations through the Upper Mississippi River Basin Association's *Water Quality Task*

Force (*http://www.umrba.org/wq.htm*). UMRBA consultations and coordination or assessments and listings are based on a uniform set of assessment reaches for the Upper Mississippi River that was adopted by all five UMR states in 2004 (Table 4).

- **Data from ambient biological monitoring being conducted by IDNR in cooperation with the State Hygienic Lab**

Biological criteria or "biocriteria" are narrative or numeric expressions that describe the best attainable biological integrity (reference condition) of aquatic communities inhabiting waters of a given designated aquatic life use. In order to develop biocriteria, knowledge of the variation in the ecological and biological conditions within a state is necessary. Ecoregions--generally defined as regions of relative homogeneity in ecological systems and relationships between organisms and their environments--have been used by several states when developing biocriteria for their water quality standards. Biological reference sites are located on the least impacted streams within an ecoregion. Monitoring results from regional reference sites can thus serve as benchmarks to which other streams in the region can be compared.

In Iowa, a list of wadeable warm water (WW) candidate stream reference sites was generated in the early 1990s for the state's ten ecoregions and subecoregions. Sampling of these WW reference sites began in 1994 and continues; the current rate of sampling is 25 sites per year with the goal of sampling the complete set of reference sites every five years. A list of cold water (CW) reference sites was developed in 2010 for the CW streams of the northeastern corner of Iowa; the current rate of sampling is four sites per year with the goal of sampling the complete set of reference sites every five years.

Stream biological sampling is conducted from July 15 to October 15. In addition to reference site sampling, sampling at "survey" sites is conducted to determine how much a stream's biological health is impacted by disturbances such as channelization, livestock grazing, manure spills, wastewater discharges and urban runoff. Currently, approximately 8-10 survey sites are sampled per year. At both reference sites and survey sites, standard sampling procedures are used so that data from all sites are comparable. The samples measure how many types of benthic macroinvertebrates and fish are present and the abundance of each type in relation to the whole sample. Benthic macroinvertebrates are collected from several types of habitat including aquatic vegetation, boulders, leaf packs, overhanging vegetation, rocks, root mats and woody debris. Fish are sampled in one pass through the sampling area using electrofishing gear. The data from the sampling of reference sites and survey sites are being used to develop indicators of stream biological integrity that will form the basis for establishment of numeric biocriteria that will be used for assessments of aquatic life use support as part of Integrated Reporting. See Attachment 2 for details on Iowa DNR's bioassessment methodology.

- **Data from the IDNR-sponsored lake monitoring conducted by Iowa State University and the University of Iowa Hygienic Laboratory**

  Historically, data from statewide surveys of Iowa lakes completed in the early 1980s (110 lakes) and early 1990s (115 lakes) by Iowa State University served as the basis for assessments of lake water quality in Iowa. Beginning in 2000, however, 131 lakes throughout Iowa were monitored annually as part of an IDNR-sponsored five-year project to assess their condition and measure the temporal variability in lake water quality. This monitoring was conducted by Iowa State University. All lakes assessed as part of the early 1990s statewide lake surveys were sampled as well as 16 additional lakes. This monitoring program was extended beyond the original five-year timeframe to become a long-term annual ambient lake water quality monitoring network. This network was designed to provide multiple years of data that can be used to better characterize lake water quality than was possible with the limited data from previous (1980s and 1990s) surveys.

  Each lake is sampled three times during the summer season to assess seasonal variability. Lakes are sampled at the lake's historic deep point. Lake depth profiles of temperature, dissolved oxygen, specific conductivity, total dissolved solids, pH, and turbidity are collected and used to determine if a lake is stratified (the presence or absence of a thermocline) during each sampling event. Water chemistry and phytoplankton samples are collected using an upper mixed zone integrated water column sampler (sampled above the thermocline when present; maximum sampler depth of 2 meters or approximately 6.5 feet).

- **Data from monitoring of bacterial indicators in rivers and at beaches of publicly-owned lakes**

  Indicator bacteria, such as fecal coliform bacteria and *E. coli*, are commonly monitored by state environmental agencies to indicate the degree to which surface waters support their designated uses for primary contact recreation. High levels of these indicator bacteria suggest that using a river or lake for either primary contact recreation (e.g., swimming or water skiing) or secondary contact recreation (e.g., wading while fishing) presents a health risk due to the potential for users contracting a waterborne disease. As part of fixed station monitoring networks in Iowa, river and stream reaches designated for primary or secondary contact recreation uses are monitored for bacterial indicators on a monthly basis.

Historically, this type of monitoring had not been conducted at Iowa's lakes. In 1999, however, the IDNR Division of Parks, Recreation and Preserves monitored ten of Iowa's public beaches for indicator bacteria. In 2000, beach monitoring was expanded to thirty-one Iowa beaches and was placed under the direction of IDNR's Water Quality Monitoring and Assessment Section. From May through September, these beaches were monitored weekly. Since 2001, annual monitoring at approximately thirty-five beaches at state-owned lakes as been conducted on a weekly basis during summer recreational seasons.

In addition, 32 beaches at 28 city and county-owned lakes were monitored for indicator bacteria during the period 2012 through 2014. The data from this monitoring is available in the Iowa STORET/WQX water quality database (*http://programs.iowadnr.gov/iastoret/).* These data will also be evaluated to determine the degree to which primary contact recreation (Class A1) uses are supported. The Iowa beaches monitored for indicator bacteria during the 2012-2014 period, including state-owned as well as city and county-owned beaches, can be found in Table 5.

- **Data from programs to monitor fish tissue for toxic contaminants**

  Annual, routine monitoring for bioaccumulative toxics in Iowa fish tissue is conducted as part of three long-term programs: (1) Iowa DNR fish contaminant monitoring, (2) water quality studies of the Des Moines River near Saylorville and Red Rock reservoirs conducted by Iowa State University under contract with the U.S. Army Corps of Engineers, and (3) water quality studies of the Iowa River near Coralville Reservoir also conducted under contract with the U.S. Army Corps of Engineers.

  Iowa DNR has conducted annual fish collection and analysis activities in Iowa since 1980. Prior to 2014, this monitoring was conducted as part of the U.S. EPA Region VII's *Regional Ambient Fish Tissue (RAFT) Monitoring Program*. Each year in late summer, IDNR fisheries biologists collected fillet samples of both bottom-feeding fish (Common

Carp (*Cyprinus carpio*) or Channel Catfish (*Ictalurus punctatus*)) and predator fish (usually Largemouth Bass (*Micropterus salmoides*), Crappie (*Pomoxis* spp.), or Walleye (*Sander vitreus*)) from approximately 30 locations on rivers and lakes in Iowa. Selection of sample sites was based on the level of fishing use and date of the most recent fish tissue sampling. In recent years, RAFT samples had been analyzed for 19 pesticides, four organic compounds, and four metals. The RAFT program also involved (1) monitoring for trends in levels of toxics in bottom feeding fish (Common Carp) at ten fixed sites on Iowa's larger rivers as well as (2) follow-up monitoring designed to verify the existence of high contaminant levels and to determine whether the issuance of consumption advisories is justified. Annual reports for RAFT monitoring in Iowa can be found at *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/Fish-Tissue*.

In 2013, Iowa DNR was notified that U.S. EPA Region 7 would no longer be able to support the RAFT program. Thus, Iowa DNR has assumed the responsibility and cost of continuing to monitor for toxic contaminants in Iowa fish. This program is called the Iowa Fish Tissue Monitoring Program (IFTMP). While the number of sample sites has remained the same as during the RAFT program (~30 sites), the number of parameters monitored has been reduced to five: mercury, PCBs, chlordane, DDE, and dieldrin.

Iowa State University (Department of Civil Engineering, Environmental Engineering Section) conducts annual fish contaminant monitoring for bottom-feeding fish (Common Carp) at Saylorville and Red Rock reservoirs as part of a U.S. Army Corps of Engineers water quality monitoring program (see *http://home.eng.iastate.edu/~dslutz/dmrwqn/dmrwqn.html*). The University of Iowa and Iowa State University have conducted fish contaminant monitoring as part of a similar program at Coralville Reservoir.

Also, fish contaminant monitoring was conducted over a 13-year period (1988-2000) in Pool 15 of the Upper Mississippi River near Davenport, Iowa, in response to a PCB contamination problem (URS Greiner Woodward Clyde 2000). Follow-up fish contaminant monitoring has also been conducted in Pool 15 (URS 2012).

- **Reports of pollutant-caused fish kills**

  IDNR routinely receives reports of fish kills that are investigated by IDNR staff from the Fisheries Bureau and/or the Compliance & Enforcement Bureau. Information from the reports of these kills, including location, the cause and source of the kill, the size of waterbody affected, and the number of fish killed, is entered into the IDNR Fish Kill Database (see *http://www.iowadnr.gov/Environment/WaterQuality/WaterMonitoring/FishKills.aspx*).

- **Data from public water supplies on the quality of surface water sources and finished water**

  The IDNR Environmental Services Division administers the public drinking water program in Iowa under delegation of authority from the U.S. Environmental Protection Agency. As required by the Safe Drinking Water Act of 1996, IDNR prepares an annual report of violations of national primary (finished) drinking water standards by public water supplies in the state (reports are available at *http://www.iowadnr.gov/InsideDNR/RegulatoryWater/DrinkingWaterCompliance/AnnualComplianceReport.aspx*). For the 2016 assessment/listing cycle, reports for 2012 through 2014 were reviewed for violations (IDNR/WQB 2013, 2014, & 2015).

  In addition, several public water supplies using surface water sources in Iowa have generated long-term databases for the quality of raw water used at their facilities. For example, the municipal water supplies at Cedar Rapids and Des Moines routinely collect data on levels of toxic contaminants in the Cedar River and the Raccoon/Des Moines rivers, respectively, which can influence their water treatment processes. These data are routinely incorporated into IDNR's Integrated Reporting assessment/listing cycles.

- **Data from special studies of water quality and aquatic communities**

  Special/intensive studies of water quality are typically conducted over a finite time period and are targeted toward understanding or characterizing specific water quality issues. This type of study differs from "routine" monitoring that is conducted over a long timeframe and that typically generates information necessary to describe general water quality conditions. The sampling protocol for intensive studies is site-specific and is based on the contaminant(s) of concern. These studies typically require multiple samples per site over a relatively short timeframe. If the contaminants of concern have significant seasonal or daily variation, season of the year and time of day variation are accounted for in sampling design. The number of sampling sites, sampling frequency and parameters vary depending on the study.

Each year, a number of special water quality studies are conducted in the state; these studies include monitoring conducted in support of TMDL development and watershed monitoring projects. Results of special studies may be summarized in the form of a published document, an unpublished report, or may exist only as raw data. Surveys of aquatic communities are occasionally conducted by IDNR staff as part of special studies. Special water quality studies conducted by colleges and universities as part of undergraduate and graduate projects are also potential sources of water quality data and other water-related information.

- **Best professional judgment of IDNR staff**

  IDNR utilizes observations of professional staff of the IDNR bureaus of Fisheries and Wildlife, as well as professional staff in other agencies, to assess support of aquatic life uses in certain types of Iowa waterbodies that have historically lacked chemical, physical, and/or biological water quality data. For example, due to the lack of relevant criteria for assessing wetland quality, water quality assessments for these waterbodies have historically been based primarily on observations of biologists in the IDNR Wildlife Bureau. Although wetland water quality sampling was conducted during the 2010-2014 period, and although several wetland assessments were based on results of this monitoring, the majority of Iowa wetland assessments remains based primarily on best professional judgment.

- **Results of volunteer monitoring**

  The Iowa volunteer monitoring program (IOWATER) was established in 1999 by the IDNR. This program provides training, equipment and supplies to volunteers for monitoring streams throughout Iowa. A review of the IOWATER database by IDNR staff in 2002 showed considerable variation in data quality within this database. Due to the often unexplained variation, IDNR staff decided not to use results of volunteer monitoring for Section 305(b) assessments. In addition, Iowa's credible data law passed in 2000 resulted in state regulations that place restrictions on the use of volunteer data for purposes of adding waterbodies to Iowa's Section 303(d) list. For purposes of Section 303(d) listing, these regulations became effective in 2003. These regulations can be found under "Volunteer Monitoring Data Requirements" in the *Iowa Water Quality Standards* (IAC 2014). These restrictions include a requirement for preparation of a monitoring plan by the volunteer monitor and review and approval of this plan by IDNR before the volunteer data can be used for purposes of Section 303(d) listing. If, however, volunteer monitors encounter and document instances of gross pollution such that water quality conditions that appear to violate Iowa's narrative water quality standards at IAC 61.3(2) (Table 9), IDNR will consider use of this information for purposes of Section 303(d) listing as described in the section of this methodology on "overwhelming evidence of impairment." IDNR staff that direct the IOWATER program are consulted to help identify instances of gross pollution discovered through IOWATER monitoring. Also, any data collected by volunteer monitors that meet Iowa's credible data requirements will be considered for identifying Section 303(d) impairments.

Identifying impairments:

As specified in U.S. EPA's regulations for TMDLs (40 CFR 130.7), sources of existing and readily available water quality-related data and information to be considered as part of Section 303(d) listing include but are not limited to the following:

- the state's most recent CWA Section 305(b) report;
- CWA Section 319 nonpoint source assessments;
- dilution calculations, trend analyses, or predictive models for determining the physical, chemical or biological integrity of streams, rivers, lakes, and estuaries; and
- water quality-related data and information from local, State, Territorial, or Federal agencies [in Iowa, especially the U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) and National Stream Quality Accounting Network (NASQAN)), tribal governments, members of the public, and academic institutions].

The majority of information used by IDNR to develop the Section 303(d) list of impaired waters (IR Category 5) is taken from the most recent Section 305(b) assessments for the state of Iowa. As noted in this methodology, IDNR staff attempt to utilize water quality data and related information from a variety of sources. IDNR has not, however, used results of dilution calculations or predictive models to add waterbodies to Iowa's Section 303(d) list. Due to the importance of data quality and quantity in developing accurate assessments, and due to requirements of Iowa's credible data law that require site-specific, high-quality data upon which to base listings, only a subset of the available 305(b) information is used for purposes of placing waters into Category 5. The process of determining whether or not data from the above data sources are appropriate for placing waterbodies in Category 5 is described below.

<u>Types of Assessments: *Evaluated* and *Monitored*:</u>

For purposes of developing Section 305(b) assessments, the existing and readily available water quality data described above are used to make two types of water quality assessments: "evaluated" and "monitored." As described in guidelines for Section 305(b) reporting (U.S. EPA 1997, pages 1-5 and 1-9:

Evaluated waters are

> *those for which the use support decision is based on water quality information other than current site-specific data such as data on land use, location of sources, predictive modeling using estimated input values, and some questionnaire surveys of fish and game biologists. As a general rule, if an assessment is based on older ambient data (e.g., older than five years), the State should also consider it "evaluated."*

For example, water quality assessments based on results from only a few grab samples or on professional judgment of local biologists, in the absence of any supporting data, would be considered "evaluated" assessments.

Monitored waters are

> *those for which the use support decision is principally based on current, [five years old or less] site-specific ambient monitoring data believed to accurately portray water quality conditions. Waters with data from biosurveys should be included in this category along with waters monitored by fixed-station chemical/physical monitoring or toxicity testing. To be considered "monitored" based on fixed station chemical/physical monitoring, waters generally should be sampled quarterly or more frequently.*

Although EPA's more recent guidelines for integrated reporting (U.S. EPA 2005) do not distinguish between "monitored" and "evaluated" assessments, Iowa DNR feels that the distinction remains important for determining the relative scientific strength and confidence of the water quality assessments developed. In addition, this distinction (monitored versus evaluated) allows IDNR to better target assessed waters for additional monitoring, and is the basis for identifying waters in need of additional monitoring. Thus the on-line Iowa DNR assessment database (ADBNet]) is designed to track "monitored" versus "evaluated" assessments while still complying with the integrated reporting format recommended by U.S. EPA (2005).

In terms of the ability of Section 305(b) assessments to characterize current water quality conditions, IDNR considers <u>evaluated</u> assessments as having relatively lower confidence while <u>monitored</u> assessments are of relatively higher confidence. This approach is consistent with guidance from U.S. EPA (U.S. EPA 1997). IDNR considers <u>monitored</u> assessments as sufficiently accurate to be appropriate for both Section 305(b) assessment and Section 303(d) listing (i.e., for placing waters into

Category 5 of the integrated report). The lower confidence evaluated assessments, however, are viewed as appropriate only for Section 305(b) reporting. Thus, any waters "evaluated" as "impaired" are placed in IR Categories 2b or 3b (i.e., categories for potentially impaired waterbodies with insufficient information for determining whether uses are met). Such waters are added to Iowa's list of "waters in need of further investigation" (WINOFI list) as provided for in Iowa's credible data law and will be considered for follow-up monitoring to better determine current water quality conditions and the existence of any impairments.

Magnitude of Impairment:

In addition to IDNR's retention of the distinction between "monitored" and "evaluated" waters, IDNR continues to follow the assessment protocol in U.S. EPA (1997) of tracking of the degree to which the assessed use is supported: *fully*, *partially*, or *not supporting*. In addition, a magnitude of impairment (slight, moderate, or severe) is identified for each cause of impairment. This information is useful for improved communication on the relative severity of water quality problems and for prioritization for TMDL development. Information on the degree of impairment and on the magnitude of the cause of impairment is available in Iowa DNR's Assessment Database (ADBNet). Iowa DNR uses the following impairment levels:

Fully supported/threatened (=303(d) impaired): Water continues to fully support the designated use but an adverse water quality trend is evident such that the water will likely fail to fully support the designated use by the time of the next listing cycle.

Partially supported (=303(d) impaired): A slight to moderate impairment suggested by occurrence in the lower impairment range. The following examples would result in an impairment magnitude of "partially supported": a water quality criteria violation frequency significantly greater than 10% but less than 25%; the score for only one of the two indexes of biotic integrity (fish and aquatic macroinvertebrates) is in the impairment range; one pollutant-caused fish kill occurred during the triennial period; the lower tier of fish consumption advisories (one meal/week) is in effect; the geometric mean for *E. coli* is greater than the respective criterion but is less than eight times the criterion.

Not supported (=303(d) impaired): A severe impairment suggested by occurrence in the middle to upper impairment range (e.g., a water quality criteria violation frequency greater than 25%; scores for both indexes of biotic integrity (fish and aquatic macroinvertebrates) in the impairment range; more than one pollutant-caused fish kill during the triennial period; upper tier of fish consumption advisories ("do not eat") in effect; geometric mean for *E. coli* greater than eight times the respective criterion (i.e., greater than 1,000 *E. coli* orgs/100 ml for primary contact recreation (Class A1) uses).

Data *quantity* considerations ("data completeness" guidelines):

For purposes of Section 303(d) listing in Iowa (i.e., placing waters in Category 5 of the Integrated Report), data quantity issues are addressed in this methodology. Beginning with Iowa's Section 305(b) report for 1990, IDNR staff developed "data completeness" guidelines to avoid basing water quality assessments on inadequate amounts of water quality data and to reduce errors in assessments (for example, incorrectly concluding that an impairment exists). For the various parameters used to develop water quality assessments, these guidelines establish the minimum number of data points needed over a given assessment period to adequately determine whether the applicable water quality standards are being met. Assessments that meet these data completeness guidelines are of relatively high confidence and are considered "monitored." Assessments based on an insufficient amount of data to meet these guidelines are of relatively low confidence and are thus considered "evaluated." IDNR's interpretations of the terms "evaluated" and "monitored" are identical to those of U.S. EPA (1997). IDNR's Section 305(b) data completeness guidelines are presented in Table 6. The significance of data completeness guidelines and Iowa's credible data law to Iowa's Section 305(b) water quality assessments and Section 303(d) listings is summarized in Figure 1.

Data *quality* considerations ("credible data" requirements):

As defined by U.S. EPA, *data quality objectives* are qualitative and quantitative statements that clarify objectives, define appropriate types of data, and specify levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support assessment decisions. In this context, Iowa's credible data law defines the appropriate types of data for developing the state's Section 303(d) listings. These objectives are as follows:

- "*Credible data*" means scientifically valid chemical, physical, or biological monitoring data collected under a scientifically accepted sampling and analysis plan, including quality control and quality assurance procedures.

- Data dated more than five years before the department's date of listing or other determination under section 455B.194, subsection 1 (Iowa's credible data law), shall be presumed not to be credible data unless the department identifies compelling reasons as to why the data is credible.

As stated in the 2001 Iowa Code, Section 455B.194, subsection 1, the department shall use "credible data" when doing any of the following:

- Developing and reviewing any water quality standard.
- Developing any statewide water quality inventory or other water assessment report. (Note: Iowa's Section 305(b) assessments are <u>not</u> subject to the provisions of Iowa's credible data law.)
- Determining whether any water of the state is to be placed on or removed from any Section 303(d) list.
- Determining whether any water of the state is supporting its designated use or other classification. (Note: the credible data law does <u>not</u> require the use of credible data for establishment of a designated use or other classification of a water of the state.)
- Determining any degradation of a water of the state under 40 CFR 131.12 (anti-degradation policy).
- Establishing a total maximum daily load (TMDL) for any water of the state.

The credible data law has occasionally been criticized as being an obstacle to the addition of impaired waters to Iowa's Section 303(d) list. This criticism is often directed at the requirement that data older than five years are presumed not to be credible. Because, however, all readily-available water quality data are reviewed biennially and assessed for Section 303(d) impairments as the data become available, and because most water quality data in Iowa are generated by Iowa DNR, its designees, or other government agencies, the credible data requirements rarely influence IDNR's listing decisions. Thus, such criticism is largely unfounded.

<u>Rationale for any decision not to use existing and readily available data for Section 303(d) listings:</u>

IDNR reviews all existing and readily available water quality-related data and information for purposes of water quality reporting and impaired waters listing as required by Sections 305(b) and 303(d) of the Clean Water Act (see section on *<u>Sources of Existing and Readily Available Water Quality Data</u>* in this methodology). Certain categories of water quality information, however, do not meet requirements of either Iowa's credible data law or IDNR's data completeness guidelines for water quality assessments and impaired waters listings. The ultimate reasons for not using certain "existing and readily available data" are (1) the need for reasonably accurate assessments of water quality and (2) the desire to add only waterbodies to the state's Section 303(d) list (Category 5) that are actually "impaired." Placing waters on the state's Section 303(d) list on the basis of inaccurate and/or incomplete data increases the risk that the department's limited resources, including staff time and monitoring dollars, will be used unwisely. Examples of water quality information that typically would not be considered appropriate as the basis for Section 303(d) listing include the following:

- **Best professional judgment of IDNR staff:** IDNR utilizes observations of professional staff of the IDNR bureaus of Fisheries and Wildlife, as well as professional staff in other agencies for purposes of water quality (Section 305(b)) reporting. Best professional judgment is used to assess support of aquatic life uses for certain types of Iowa waterbodies that have historically lacked chemical, physical, and/or biological water quality data (primarily wetlands). To be added to Iowa's list of impaired waters (Category 5), all assessments of impairment based solely on best professional judgment will need to be further investigated to better document any failure to meet water quality standards. Past experience with impairment decisions based primarily on best professional judgment (e.g., for wetlands) has demonstrated that such follow-up investigations are necessary to (1) better determine whether a Section 303(d) water quality impairment actually exists and (2) more accurately identify the causes and sources of any existing impairment. Field biologists and other field staff are extremely knowledgeable regarding the water resources they manage but are much less knowledgeable regarding the intent and basis for Clean Water Act Section 303(d) listing. Waters assessed as "impaired" solely on the basis of best professional judgment will be added to Subcategory 3b of the Integrated Report; this subcategory comprises the list of "waters in need of further investigation" (WINOFI list) as provided for in Iowa's credible data law.

- **Data or information older than five years from the end of the most recent Section 305(b) reporting cycle:** Data dated more than five years before the end of the current (2016) Section 305(b) data consideration period (the end of calendar year 2014; i.e., data collected before 2009) are presumed under state law to be "not credible" unless IDNR identifies compelling reasons as to why these older data are credible. This provision of Iowa's credible data law was based on and is consistent with U.S. EPA's (1997) recommendation that data older than five years should not be used to make the type of water quality assessment (a "monitored" assessment) that is believed to accurately portray site-specific water quality conditions. Data older than five years, however, may be used for identifying water quality trends for any water of the state for which credible data exist. Historically, data older than five years have been routinely used for Section 305(b) reporting in Iowa, but these data have not been used to identify new Section 303(d) listings. All such assessments are considered "evaluated" and are thus of relatively lower confidence than "monitored" assessments which are based primarily on recent, site-specific ambient monitoring.

As the data upon which non-303(d) assessments are based age beyond five years—and if more recent data are not available—the assessment type is changed from "monitored" (higher confidence) to "evaluated" (lower confidence) as part of the biennial Section 305(b) assessment process. Once placed in IR Category 5 (i.e., once placed on the state's Section 303(d) list), however, a waterbody will not be moved to a non-TMDL category without "good cause" as defined by U.S. EPA regulations at 40 CFR 130.7 (e.g., a TMDL for the waterbody is approved by EPA or new monitoring data suggest that the impairment no longer exists). U.S. EPA regulations do not consider the age of the data used to impair a waterbody as a "good cause" for removing a Section 303(d) impairment.

The issue of "old data" is seldom relevant to Section 303(d) listing in Iowa. Water quality data are used for developing the biennial Section 305(b) assessments as they become available and are thus considered for Section 303(d) listing when the data most likely represent current water quality conditions. This process occurs long before the data age beyond their ability to accurately represent current water quality conditions. As the data age beyond five years, the Section 305(b) assessment type is changed from "monitored" to "evaluated" to reflect the lowered level of confidence in assessments based on older data that potentially may not represent current water quality conditions. Any non-303(d) Section 305(b) assessments based on data that have aged beyond 10 years (i.e., collected before 2004 for the current (2016 IR) are not included in the current assessment cycle. The previous assessments based on these old data, however, remain in IDNR's on-line assessment database (Iowa ADBNet).

- **Data that do not meet "completeness guidelines" developed for Section 305(b) reporting:** In order to improve the accuracy of water quality assessments, IDNR has identified "data completeness guidelines" for using results of routine water quality monitoring for Section 305(b) reporting (Table 6). These guidelines identify the numbers of samples needed for water quality assessments that can support Section 303(d) listings (i.e., *monitored* assessments). These guidelines also identify assessments appropriate only for Section 305(b) reporting (i.e., *evaluated* assessments). These criteria were first developed for Iowa's 1990 Section 305(b) report and are designed to improve—within the constraints of (1) resources available for monitoring and (2) the designs of existing monitoring networks—the accuracy of Section 305(b) water quality assessments. The improvement in assessment accuracy increases the confidence with which waterbodies are added to Iowa's Section 303(d) list. Although IDNR ambient water quality monitoring networks and networks of other agencies are designed to produce sufficient data to meet Iowa's "completeness guidelines," not all monitoring networks are so-designed. Thus, the use of these guidelines will eliminate certain data from consideration for Section 303(d) listing. Any waterbodies assessed as "impaired" only on the basis of incomplete data, however, will be placed in IR Subcategory 3b and will be added to the state list of waters in need of further investigation (WINOFI list) as provided for in Iowa's credible data law.

- **Results of volunteer monitoring that do not meet requirements specified in Iowa's credible data legislation and/or Section 305(b) data completeness guidelines:** Results from volunteer monitoring can only be used for Section 303(d) listing if requirements of Iowa's credible data law are met or if overwhelming evidence of impairment is indicated. To be considered for Section 303(d) listing, IDNR rules [IAC 61.10 through IA 61.13 (455B)] require that volunteer monitoring must be supported by an IDNR-approved sampling and analysis plan that includes quality control and quality assurance procedures. Waterbodies assessed as "impaired" only the basis of volunteer data from non-qualified volunteers will not be added the Iowa's Section 303(d) list but may be added to the state list of waters in need of further investigation. If, however, results of volunteer monitoring show the existence of gross pollution such that Iowa's narrative criteria are violated, such waters can be added to Iowa's Section 303(d) list due to overwhelming evidence of impairment.

- **Results of habitat assessment:** Although detailed information on the quality of aquatic habitats is collected as part of biological monitoring conducted for the IDNR/SHL stream biocriteria and REMAP projects, this information is not directly used to identify Section 303(d) impairments of aquatic life uses. IDNR does, however, incorporate observations on the quality of aquatic habitat into Section 305(b) water quality assessments and biologically-based Section 303(d) listings. This information is also used as part of the stressor identification process to identify the causes and sources of impairments of aquatic life uses identified through biological monitoring. DNR staff, however, are working on a methodology for identifying habitat-related causes of biological impairment.

- **Assessments of headwater stream segments.** As explained below, Section 303(d) impairments based on results of chemical/physical water quality monitoring on headwater stream segments will be added to Iowa's Section 303(d) list. Due to the lack of a calibrated biological assessment protocol, however, impairments based on results of biological monitoring in headwater segments will not be placed on the Section 303(d) list but will be placed into IR Subcategory 3b and added to Iowa's list of waters in need of further investigation.

The aquatic environment of most of Iowa's small headwater streams is one of extremes ranging from flood-flow to no-flow; from completely frozen in winter to extremely warm water temperatures in summer. Due to their position in relation to sources of groundwater, many headwater stream reaches experience no-flow conditions at least once per year. These extremes are sometimes reflected in results of water quality monitoring and biological assessments that suggest impairment. For example, as streams move toward no-flow conditions during summer due to low amounts of precipitation, chemical water quality can degrade drastically, especially regarding levels of dissolved oxygen and pH. As stream flow ceases and the only remaining water exists as isolated and shrinking pools, violations of water quality criteria for dissolved oxygen and/or pH become more common, often with sufficient frequency to suggest impairment of aquatic life uses. Also, due to seasonally reoccurring intermittent flow, the types of aquatic life that inhabit general use streams are often only those able to withstand extremes environmental conditions (the so-called "pioneer species"). Consequently, headwater stream segments tend to have water quality and biological diversity that are low relative to the larger and more ecologically stable stream environments.

Historically, Iowa's headwater stream reaches were typically not designated for protection of either primary contact recreation or aquatic life uses but were instead classified only for protection of "general uses" such as livestock and wildlife watering, aquatic life, noncontact recreation, crop irrigation, and industrial, agricultural, domestic and other incidental water withdrawal uses (Table 9). According to the *Iowa Water Quality Standards* (Section 61.3(2)), general use waters are protected by narrative criteria designed to prevent aesthetically objectionable/nuisance conditions, and other forms of gross pollution attributable to pollution sources. In contrast, Class A and Class B waters are also protected by numeric criteria designed to protect human health from recreationally-related waterborne diseases and to protect aquatic life from chronically toxic conditions as well as acutely toxic conditions.

Due, however, to changes in the *Iowa Water Quality Standards* that became effective in March 2006 and that were approved by U.S. EPA in February 2008, all perennially-flowing streams and intermittent streams with perennial pools are now presumed to be capable to supporting the highest level of primary contact recreation use and the highest level of aquatic life use (see explanations of "presumed use" at *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Quality-Standards*. This approach to applying designated uses is called the "rebuttable presumption". Under this approach, the Class A1 (primary contact recreation) use is presumptively applied to all of Iowa's perennial rivers and streams and intermittent streams with perennial pools, and the Class B(WW1) aquatic life use is presumptively applied to all of Iowa's perennial rivers and streams and intermittent streams with perennial pools unless the water is already designated for Class B(WW2) or Class B(WW3) uses in Iowa's surface water classification (see *http://www.iowadnr.gov/Portals/idnr/uploads/water/standards/files/swcdoc2.pdf*). A "use attainability analysis" or UAA must be conducted, including field investigations, to determine whether the presumptively-applied use is, in fact, the appropriate designated use for the stream segment in question.

Assessments of headwater stream segments based on chemical/physical water quality data: Because the distinction between a truly intermittent (and thus, general use-only) stream and an "intermittent stream with perennial pools" is currently poorly defined, monitoring data from all currently non-designated and formerly "general use" headwater stream segments will be assessed against the presumptively-applied Class A1/Class B(WW1) water quality criteria for purposes of Section 305(b) assessments and Section 303(d) listings. Any Section 303(d) impairments identified for a presumptively designated stream segment will be placed into state-defined Subcategory 5p (i.e., "5-presumptive") of Iowa's Integrated Report. IDNR staff that prepare Iowa's Section 303(d) list will coordinate with IDNR Water Quality Standards Section staff to determine, to the degree possible, whether UAAs have been conducted for the presumptively-impaired stream segments. If the appropriate uses have been determined through a UAA, the impairment will be placed in IR Category 5a (pollutant-caused impairment) as appropriate.

Assessments of headwater stream segments based on biological data: Biological monitoring is occasionally conducted on Iowa's headwater stream segments (i.e., having watersheds draining less than about 10 square miles). Thus, the use of biological assessment methods developed and calibrated for the larger, more stable, and more diverse streams to assess headwater segments will likely overstate the existence of impairment. For this reason, headwater stream segments that show impairment based on a failure to meet regional expectations for aquatic biota (fish or aquatic macroinvertebrates) of Class B(WW2) streams, will not be added to Iowa's Section 303(d) list of impaired waters. The assessment type for these waters will be considered "evaluated" (indicating an assessment with relatively lower confidence) as opposed to "monitored" (indicating an assessment with relatively higher confidence). Such waters will be placed in Subcategory 3b-u (i.e., potentially impaired based on un-calibrated assessment) and will be added to the state's list of "waters in need of further investigation" as provided for in Iowa's credible data law. Once on this list, the assessments can be reviewed to better determine the nature of the water quality problems suggested by biological monitoring and to determine whether follow-up monitoring is justified. See Attachment 2 of this methodology for additional information on IDNR's approach for biological assessment of Iowa's wadeable streams. IDNR staff continue to pursue development of a biological assessment protocol for headwater streams segments.

List of waters in need of further investigation:

Although not appropriate for identifying Category 5 (Section 303(d)) waters, the above types of water-related information can be used for Section 305(b) water quality assessments and thus can be used to place waterbodies on a separate list of Iowa waterbodies in need of further investigation (WINOFI list). As provided for in Iowa's credible data law, the WINOFI list is not part of the Section 303(d) process in Iowa and includes waterbodies where limited information suggests, but does not credibly demonstrate, a water quality impairment. The state's WINOFI list is comprised of those waterbodies assessed (evaluated) as potentially "impaired"; that is, the assessment of a designated use in these waterbodies as "impaired" is based on less than complete information; thus, the assessment is of relatively low confidence and is not appropriate for addition to the list of Section 303(d) waterbodies. These potentially-impaired waters are thus placed in Subcategory 3b of the Integrated Report which comprises the list of waters in need of further investigation. Category 3 is for waters where sufficient information is lacking to assess any designated use. If the results of further investigative monitoring demonstrate with credible data that a water quality impairment exists, the affected waterbody can be added to Iowa's Section 303(d) list (IR Category 5).

Overwhelming evidence of impairment:

Situations exist where reliable information can accurately indicate a Section 303(d) impairment of designated beneficial uses even though this information does not meet the IDNR requirements for Section 303(d) listing (Table 6). Such waterbodies would be considered for addition to IR Category 5 (=Section 303(d) list) of Iowa's integrated assessment/listing report. The following are examples of instances where overwhelming evidence justifies determination of impairment in the absence of complete data:

- Presence of reoccurring, man-made circumstances that result in acutely toxic conditions for aquatic life. For example, the addition of untreated septic waste is to a stream via an illegal connection to a storm sewer such that the aquatic community is being severely impacted would constitute overwhelming evidence of impairment.

- Man-made alterations of hydrology, flow, or habitat that degrade the quality of aquatic habitats as reflected in significant, adverse deviations in biotic integrity from the reference condition or from the pre-modification aquatic communities. For example, an illegal channel change that adversely affects the aquatic community of a stream reach would constitute overwhelming evidence of impairment.

- Chronic de-watering of a considerable section of a waterbody related to man-made alterations of local hydrology. For example, an illegal water withdrawal for irrigation that severely impacts or eliminates the aquatic life of a stream or river constitutes overwhelming evidence of impairment.

- Presence of exotic species (e.g., Common Carp or purple loosestrife (*Lythrum salicaria*)) at levels that are believed to impair one or more designated uses. For example, the infestation of a wetland with the invasive exotic plant purple loosestrife such that the value of a wetland for use by waterfowl is degraded constitutes overwhelming evidence of impairment.

- Summer median trophic state index (Carlson 1977, 1991) values for chlorophyll-a or Secchi depth that are based on less than three years of data but that are more than five TSI points greater than the TSI value used to identify impairment with a complete dataset (a "complete dataset" is three or more years of data resulting from three to five samplings per year). For example, if a lake's median based summer chlorophyll-a TSI value from one year's monitoring (minimum of three samples) exceeds the IDNR's trigger value of TSI = 65 by more than five points, the lake would be assessed as Section 303(d) impaired due to overwhelming evidence of impairment (for more information on IDNR's use of Carlson's trophic state index, see Attachment 3 of this methodology).

- The *E. coli* geometric mean of at least five samples collected at regular intervals over a summer recreational season, and that meet credible data requirements, would exceed Iowa's geometric mean criterion even if the remainder of the 10 samples needed for a high-confidence ("monitored") assessment all had less than the IDNR's detection level for *E. coli* (i.e., 10 orgs/100 ml).

How water quality data and other water-related information are summarized to determine whether waters are Section 303(d) "impaired":

- **Physical, chemical, and bacterial data from fixed station water quality monitoring networks:**

  These types of data are used with methods for Section 305(b) water quality assessments developed by U.S. EPA, with some of these methods being modified by IDNR (see Tables 6 through 12).

  Conventional Parameters: U.S. EPA's (1997) Section 305(b) assessment guidelines specify that aquatic life uses of surface waters with more than 10% of samples in violation of state water quality criteria for conventional parameters (for example, dissolved oxygen, ammonia, pH, and temperature) should be assessed as "impaired." This assessment approach is sometimes referred to as "the 10 percent rule". IDNR has historically not used the 10-percent rule to assess water quality with datasets of less than 10 samples due to the large degree of uncertainty associated with basing impairment decisions on small datasets. The IDNR requirement for at least 10 samples was based on the resultant improvement in the ability of U.S. EPA's recommended assessment approach to accurately identify an impairment based on a critical value of 10% violation. For example, at sample sizes less than 10, the probability of incorrectly concluding that impairment exists (Type 1 error) with U.S. EPA's approach is approximately 60%; with 10 samples, the probability of this type of error decreases to approximately 30% (Smith et al. 2001). Despite this approach, the probability of a Type I error remains high (30%). In addition, comparison of raw percentages to water quality criteria have often been problematic in that they seem to give a contradictory signal of impairment. The most common scenario is the following: more than 10 percent of samples exceed the criterion for pH or dissolved oxygen (thus indicating "impairment") while all other water quality indicators suggest "full support."

  Alternative assessment approaches have been developed that (1) avoid the need to compare raw percentage values to state criteria to identify impairments and (2) incorporate estimates of the numbers of samples and the corresponding number of violations that represent a significant exceedance of the 10 percent rule. The state of Nebraska (NDEQ 2006), drawing on information from Lin et al. (2000), adopted an assessment approach where the sample sizes and the corresponding number of violations needed to identify a significant exceedance of the 10%-rule with greater than 90 percent confidence are specified. This approach is based on the binomial method for estimating the probability of committing Type I and Type II errors (see Table 12). IDNR first used this binomial-based approach for identifying impairments based on violations of the 10% rule for the 2006 assessment/listing cycle and continues to use this approach.

***Toxic parameters**:* U.S EPA (1997) guidelines state that, for toxic parameters (e.g., toxic metals and pesticides; see *http://water.epa.gov/scitech/methods/cwa/pollutants.cfm*), more than one violation of an acute or chronic water quality criterion over a three-year period suggests impairment of aquatic life uses. IDNR has historically used these U.S. EPA guidelines for identifying impairments due to toxic parameters. Based on discussions in 2007 with other states in U.S. EPA Region 7 (i.e., NE and KS) and with U.S. EPA headquarters staff, however, IDNR's approach for identifying impairments due to violations of chronic criteria was changed for the 2008 listing cycle. Impairments due to violations of chronic criteria for toxic parameters were identified for waterbodies where significantly greater than 10 percent of the samples exceed a chronic criterion over a three-year period. Identification of impairments due to violations of acute criteria for toxics remained based on the occurrence of more than one violation of a toxic criterion over a three-year period. This approach was also used for the 2010 listing cycle.

For the 2012 listing cycle, however, U.S. EPA Region 7, however, informed its states that use of the 10% rule for violations of chronic criteria for toxic parameters was no longer acceptable. Rather, states were instructed to examine the flow regime during which a violation of a chronic criterion occurred. If the flow regime was more or less "stable," the violation of a chronic criterion can be considered represent a chronic exposure of a toxic to aquatic life. If more than one such violation occurred in a three-year period, the aquatic life uses should be assessed as Section 303(d) impaired. If, however, the sample with a violation of a chronic criterion was collected during short-lived high-flow event, the exposure may have been short-term and thus may not represent a chronic exposure. Thus, this violation would not count toward the identification of a toxic-based Section 303(d) impairment. IDNR has attempted to incorporate this assessment approach into its listing methodology. The determination of what constitutes a "short-lived flow event", however, is problematic. Thus, for purposes of identifying candidates for Section 303(d) listing, Iowa will simply consider any violation of a criterion of a toxic parameter, whether chronic or acute, to be equivalent to violation of an acute criterion.

U.S. EPA (1997, 2002) has also developed separate assessment methodologies for using results of fixed station and other ambient monitoring to determine support of drinking water uses. IDNR has modified U.S. EPA's Section 305(b) water quality assessment guidelines for assessing drinking water uses with data for nitrate in surface water sources (see Table 11). Also, IDNR has developed assessment methods for toxic data types and assessment categories for which U.S. EPA does not provide specific assessment methods (e.g., using fish kill information).

Chloride, sulfate, and total dissolved solids: Prior to rulemaking efforts by Iowa DNR in 2009, the *Iowa Water Quality Standards* did not contain criteria for protection of aquatic life from either chloride or sulfate. The only related parameter with a numeric criterion was total dissolved solids (TDS): Iowa's general use criteria specified that levels of TDS should not exceed 750 mg/L in any Iowa lake, impoundment, or stream with a flow rate equal to or greater than three times the flow rate of upstream point source discharges. Based on information supplied to IDNR from wastewater permittees, the TDS criterion was changed in 2004 to a site-specific approach: This approach specified an in-stream threshold for TDS of 1,000 mg/L. If a facility facility's discharge exceeded 1,000 mg/L TDS, toxicity testing would then be required to ensure that the level of TDS being discharged was not toxic to aquatic life. Results of this testing would be used to establish an effluent limit that would be included in the NPDES permit for the facility.

An IDNR rulemaking effort in 2009 resulted in adoption of acute and chronic aquatic life criteria for chloride and sulfate. These new criteria are seen as better indicators of aquatic life health than the previous criterion for TDS which is a measure of all ionic constituents in waters including chloride and sulfate. As part of Iowa's 2012 IR cycle, monitoring data for chloride and sulfate generated during the 2010-2012 period were compared to these newly-adopted criteria. Because chloride and sulfate are not considered priority pollutant toxics (see *http://water.epa.gov/scitech/methods/cwa/pollutants.cfm*), assessments of support of aquatic life based on data for these parameters will be determined using the 10% rule.

- **Data from biological monitoring being conducted by IDNR in cooperation with the state hygienic lab (SHL)**

  Benthic macroinvertebrate and fish sampling data from the IDNR/SHL stream biocriteria and REMAP sampling sites are used to identify impairments of warmwater stream aquatic life uses. IDNR uses a benthic macroinvertebrate index of biotic integrity (BMIBI) and a fish Index of biotic integrity (FIBI) to summarize biological sampling data. The BMIBI and FIBI combine several quantitative measurements or "metrics" that provide a broad assessment of stream biological conditions. A metric is a characteristic of the biological community that can be measured reliably and responds predictably to changes in stream quality. The BMIBI and FIBI each contain twelve metrics that relate to species diversity, relative abundance of sensitive and tolerant organisms, and the proportion of individuals belonging to specific feeding and habitat groups. The metrics are numerically ranked and their scores are totaled to obtain an index rating from 0 (poor) – 100 (optimum). Qualitative scoring ranges of poor, fair, good, and excellent have been established that reflect the biological community characteristics found at each level. The category of "poor" indicates an impairment of the aquatic life use. The category of "fair," however, may or may not indicate impairment. A framework for using these data to assess support of aquatic life uses was first developed for Iowa's 2000 Section 305(b) reporting cycle. This same basic framework has been used for subsequent reporting/listing cycles. Several modifications to the process of identifying Section 303(d) biological impairments were made for the 2010 cycle including a more rigorous approach for identifying Section 303(d) biological impairments; these modifications remain in-place. The most significant of these modifications was incorporation of an EPA recommendation to require two independent samplings within a five-year period to determine support of aquatic life use. A detailed description of the framework used for Iowa's IR cycles is included in this methodology as Attachment 2.

- **Data from the IDNR-sponsored lake monitoring conducted by Iowa State University and SHL**

The IDNR–sponsored statewide lake water quality monitoring program began in 2000 and continues. Each of 131 lakes is sampled at least three times during summer seasons to assess seasonal variability of chemical, physical, and biological parameters (e.g., plankton populations). Samples are taken at the deepest point in each lake basin.

Due to year-to-year variability in lake water quality, state limnologists participating in the U.S. EPA Region 7 technical assistance group (RTAG) for nutrient criteria development recommended that the combined data from at least three years of monitoring results from this type of lake survey is needed to identify nutrient-related water quality impairments.

Thus, IDNR uses overall median water quality values from a three to five-year period to calculate a trophic state index (TSI) (Carlson 1977). Median-based TSI values are used with the lake assessment framework described in Attachment 3 to determine the existence of an impairment. This framework is based on using the TSI as a numeric translator for Iowa's existing narrative water quality criteria protecting against aesthetically objectionable conditions and/or nuisance aquatic life. For the 2016 reporting/listing cycle, lake data for the five-year period from 2010 through 2014 were used to identify lake water quality impairments. The 2016 assessment/listing cycle is the eighth biennial cycle in which the trophic state index has been used to identify Section 303(d) impairments at Iowa lakes.

- **Data from IDNR-sponsored monitoring at Iowa's shallow natural lakes**

  Historically, shallow lakes have not been included in Iowa's water quality monitoring programs. Thus, IDNR relied on best professional judgment of IDNR biologists and field staff for assessments of the degree to which wetlands and shallow natural lakes of glacial origin in the northern portion of the state supported their designated aquatic life (Class B(LW)) uses.

  In 2006, IDNR began conducting water quality monitoring on several of Iowa's shallow natural lakes; this monitoring has continued. Due to the availability of sufficient data, results of monitoring for chlorophyll-a and total suspended solids from this monitoring have been used to assess support of aquatic life uses at these waterbodies. Data for chlorophyll-a are used with Carlson's trophic state index (TSI) to identify shallow lakes that exceed the TSI impairment threshold of 65. Data for total suspended solids are used with a protocol developed by the Upper Mississippi River Conservation Committee's water quality technical section (UMRCC 2003) for protecting growth of submersed aquatic vegetation (SAV). This protocol is designed to identify waters where light penetration is insufficient to support SAV growth. Shallow lakes where growing season average levels of total suspended solids are greater than 30 mg/L are considered impaired and will be considered for addition to Iowa's Section 303(d) list. Impairments suggested by either the TSI or SAV protocol will be supplemented with information from IDNR field staff responsible for management of the respective shallow lake. See Attachment 4 for a detailed explanation of IDNR's approach to assessing support of aquatic life uses at Iowa's shallow lakes.

- **Data from monitoring of bacterial indicators in rivers, lakes, and beach areas**

  In July 2003, Iowa DNR adopted criteria for *E. coli* in place of the previous criterion for fecal coliform bacteria into the *Iowa Water Quality Standards* (Table 8). This change was a response to a long-standing recommendation from U.S. EPA. In addition, a proposal was made to subdivide the Class A (primary contact) use designation into three designations:

  - Class A1 (primary contact recreation) (same as the previous Class A designation),
  - Class A2 (secondary contact recreational use),
  - Class A3 (children's recreational use).

  With the adoption of this proposal into the *Iowa Water Quality Standards*, the state of Iowa now considers Class A1 and Class A3 waters with geometric mean levels of *E. coli* greater than 126 organisms per 100 ml to present an unacceptable risk of waterborne disease to swimmers, water skiers, and other persons using surface waters for primary body contact recreational activities where ingestion of water is likely to occur (Section 61.3(3), *Iowa Water Quality Standards*). In addition, Class A2 waters with geometric mean levels of *E. coli* greater than 630 organisms per 100 ml present an unacceptable risk of waterborne disease to persons using surface waters for secondary body contact recreational activities (Section 61.3(3), *Iowa Water Quality Standards*). Secondary body contact includes limited and incidental contact with the water that may occur during activities such as fishing and recreational boating.

  Temporal correlation of *E. coli* samples: Several *E. coli* datasets that are reviewed for violations of Iowa's Class A water quality criteria contain *E. coli* data for multiple samples collected on the same day or for samples collected on consecutive days. A study of temporal variations in *E. coli* concentrations in the Raccoon River in central Iowa showed a temporal correlation of *E. coli* concentrations within a span of about four days (Schilling et al. 2009). Failure to account for this correlation could result in calculations of geometric means that are biased due to inclusion of temporally correlated repeated measures of either high levels or low levels of bacteria in samples collected within this four-day period. Thus, mean (average) values are calculated for multiple *E. coli* samples collected within a four-day period. This average value is considered an independent estimate of the bacterial concentration during that four-day period, and this average is then used to calculate the geometric mean for the dataset being reviewed. This approach was incorporated into Iowa's 2010 IR methodology and is continued.

Identifying bacterial impairments:
Prior to the 2012 Integrated Report cycle, IDNR used different methods to assess support of contact recreation uses at lakes versus rivers. The differences in assessment approach were based on the differences in *E. coli* monitoring frequencies, with lake swimming beaches monitored weekly and river/stream segments typically monitored on a monthly or less frequent basis. For the 2012 IR cycle, however, U.S. EPA Region 7 recommended that assessments of contact recreation uses at both lakes and streams/rivers be based on annual recreation season geometric means and on the percentage of *E. coli* samples during a recreation season that exceeds Iowa's single-sample maximum criteria. This change in assessment methodology is consistent with the *Iowa Water Quality Standards* and does not impact the way IDNR assesses beaches for closure to protect the recreating public in the short term.

To be assessed as "fully supporting" the designated Class A1 or Class A3 primary contact uses, the following conditions should be met: (1) the recreation season geometric means of at least seven *E. coli* samples collected during any of the three recreational seasons (March 15 to November 15) of the current data gathering period (calendar years 2012 through 2014 for streams, and 2010-2014 for lakes) should not exceed the respective water quality criterion of 126 *E. coli* organisms per 100 ml of *E. coli* and (2) the percentage of the combined number of samples collected over the three recreation seasons that exceeds Iowa's single sample maximum allowable density of 235 *E. coli* organisms per 100 ml should not be significantly greater that 10%. In addition, no swimming area closures can have been issued during the three-year assessment period. IDNR will continue to use the binomial assessment approach for implementing the 10-percent rule that accounts for uncertainty in the use of small sample sizes to identify impairments (see Lin et al. 2000). If a recreation season geometric mean exceeds the Class A1/A3 criterion, or if significantly greater than 10 percent of the samples collected over three recreation seasons exceeds Iowa's single-sample maximum criterion, the assessed segment will be considered for Section 303(d) listing.

Full support of the Class A2 (secondary contact recreation) uses will be assessed in a similar manner: (1) the recreation season geometric mean of at least seven samples collected during any one of the three recreational seasons (March 15 to November 15) of the current data gathering period (calendar years 2012 through 2014) should not exceed the respective Class A2 water quality criterion of 630 *E. coli* organisms per 100 ml and (2) no more than 10 percent of these samples (as determined with the binomial method of Lin et al. 2000)) collected over the three recreation seasons should exceed Iowa's Class A2 single sample maximum allowable density of 2,880 *E. coli* organisms per 100 ml. Failure to meet either condition indicates an impairment of the Class A2 uses and consideration for addition to Iowa's Section 303(d) list.

In the event that a lake's swimming beach was closed to swimming during the 2012-2014 period, the Class A1 uses would be assessed as "not supporting." However, levels of indicator bacteria that result in IDNR's posting of signs at beaches warning about increased health risk associated with swimming—including both the "Caution: Water Quality Advisory" and the "Water Quality Notice" signs—do not constitute impairment of the Class A1 uses. Neither of these signs is intended to indicate closure of beaches but is posted to warn swimmers of the potential for an increased health risk from swimming. See *https://s-iihr34.iihr.uiowa.edu/publications/uploads/wfs-2010-03.pdf* for a description of IDNR's beach advisory policy. For additional information on how IDNR determines support of primary contact and secondary contact recreation uses, see Table 11.

- **Data from programs to monitor fish tissue for toxic contaminants**

  The existence of, or potential for, a fish consumption advisory has been, and remains, the primary basis for Section 305(b) assessments of support of the "human health/fish consumption" use in Iowa's rivers and lakes. If a waterbody is covered by a consumption advisory, the fish consumption use is assessed as "impaired" (Table 11). Prior to 2006, IDNR used action levels for PCBs, mercury, and chlordane published by the U.S Food and Drug Administration to determine whether consumption advisories should be issued for fish caught as part of recreational fishing in Iowa. By that time, however, most states had abandoned the use of the FDA action levels in favor of a more protective "risk-based" approach. Thus, in late 2005, the Iowa Department of Public Health (IDPH), in an effort to make Iowa's advisory protocol more protective and more compatible with the various protocols used by adjacent states, developed the following revised advisory protocol for Iowa that covers these contaminants:

Contaminant	Concentration in Fish	Consumption Advice:
Methylmercury	0 to <0.3 ppm*	Unrestricted consumption
	0.3 to <1.0 ppm	One meal per week
	1.0 ppm and over	Do not eat
PCBs (sum of Aroclors 1248, 1254 and 1260)	0 to <0.2 ppm	Unrestricted consumption
	0.2 to <2.0 ppm	One meal per week
	2.0 ppm and over	Do not eat
Technical Chlordane	0 to <0.6 ppm	Unrestricted consumption
	0.6 to <5.0 ppm	One meal per week
	5.0 ppm and over	Do not eat
**The level of 0.3 ppm methylmercury in fish tissue is the also the EPA recommended fish tissue residue criteria to be utilized in the determination of impaired waters.*		

See Table 13, IDPH (2007) and *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/Fish-Tissue* for more information on Iowa's revised fish consumption advisory protocol.

Other than the changes to a risk-based advisory levels and the addition of a "restricted consumption" category, the steps in issuing a consumption advisory in Iowa remain the same:

- Decisions to issue consumption advisories remain based on results of annual fish contaminant monitoring conducted either as part of the IDNR fish tissue monitoring program or as part of other fish tissue contaminant monitoring programs in Iowa.

- Due to the large amount of variation in contaminant levels within fish populations, two consecutive samplings showing that an average contaminant level in the edible portion of a fish tissue sample is greater than an IDNR/IDPH advisory trigger level is needed to justify issuance of an advisory and to identify a Section 303(d) impairment.

- Similarly, two consecutive samplings showing that average contaminant levels are less than the IDNR/IDPH advisory level are needed to remove a consumption advisory and to remove the Section 303(d) impairment.

- [Note: *average contaminant level* in the context of fish contaminants refers to either the arithmetic sample average of tissue plug concentrations or to the contaminant concentration in a composite sample of from three to five individual fish.

In general, these "consecutive" samples are collected in consecutive years as part of Iowa DNR's fish tissue monitoring program or as part of special follow-up studies conducted by IDNR. Waterbodies covered by consumption advisories are re-sampled periodically as part of "follow-up" monitoring to identify any changes in contaminant levels and to justify the need to continue or rescind the advisory.

- **Reports of pollutant-caused fish kills**

Occurrence of a single pollutant-caused fish kill or a fish kill of unknown origin on a waterbody or waterbody reach during the most recent three-year period (2013-2015) indicates a severe stress to the aquatic community and suggests that the aquatic life uses should be assessed as "impaired". If a cause of the kill was not identified during the IDNR investigation, or if the kill was attributed to non-pollutant causes (e.g., winterkill), the assessment type will be considered "evaluated." Such assessments, although suitable for Section 305(b) reporting, either are inappropriate for state Section 303(d) listing (no pollutant load to allocate) or lack the degree of confidence to support addition to the state's Section 303(d) list of impaired waters. Waterbodies affected by such fish kills will be placed in IR Subcategory 3b and will be added to the state list of waters in need of further investigation.

If, however, a cause of the kill is identified, and the cause is either known, or suspected, to be a "pollutant", the assessment type is considered "monitored" and the affected waterbody becomes a candidate for Section 303(d) listing. Waterbodies affected by this type of kill will be handled as follows:

- TMDLs will not be developed for kills caused by a one-time illegal or unauthorized release of manure or other toxic substance where enforcement actions were taken. The rationale for this approach is as follows:

(1) As a result of the kill, a consent order has been issued to the party responsible for the kill and monetary restitution has been sought for the fish

killed. A consent order is issued in settlement of an administrative order or as an alternative to issuing an administrative order. A consent order indicates that IDNR has voluntarily entered into a legally enforceable agreement with the other party. IDNR feels that these enforcement actions are more appropriate, efficient, and effective for addressing a spill-related impairment than is the TMDL process.

(2) No daily load allocation process is possible with a pollutant that is discharged only once.

Such waterbodies will be placed into Integrated Report subcategory 4d as defined by IDNR. In this way, the impairment status of the affected waterbody remains highlighted.

- Fish kills attributed to a pollutant but where a source of the pollutant was not identified, and where no IDNR enforcement actions were taken, will be placed into Integrated Report subcategory 5b. The intent of placing these waterbodies into Category 5 is not to necessarily require a TMDL but to keep the impairment highlighted due to the potential for similar future kills from the unaddressed causes and/or sources.

- Fish kills attributed to authorized discharges (e.g., a wastewater discharge meeting permit limits) are considered for Section 303(d) listing (subcategory 5a) as the existing, required pollution control measures are not adequate to address this impairment, and a TMDL is needed.

The following approach is used for the de-listing of fish kill impairments in Iowa:

Fish kill-impairments identified on wadeable streams will remain in IR category 5 and on Iowa's Section 303(d) lists until either IDNR biological monitoring or IDNR "fish kill follow-up" monitoring has been conducted.

- If IDNR biological monitoring is conducted such that two sample events within a five-year period show "full support" of aquatic life uses, the fish kill impairment will be de-listed due to existence of "new data" and the assessment will be moved to a non-impairment ("fully supporting") category (IR 1 or IR 2a). Because, however, IDNR lacks biological assessment protocols for intermittent streams, non-wadeable (large) streams/rivers, and for lakes, the fish kill-related impairments for these waterbody types will remain on Iowa's Section 303(d) list until such assessment protocols are developed and until biological monitoring is conducted in the affected water.

- If IDNR fish kill follow-up monitoring is conducted, and if the results of this monitoring indicate recovery of the fish community from the fish kill event, the impairment will be moved from IR Category 5 to a non-assessed category of the Integrated Report (IR 3a). Although capable of identifying recovery of the fish community, IDNR's fish kill follow-up monitoring protocol lacks the assessment rigor to identify "full support" of aquatic life uses. See Attachment 5 for a description of IDNR's fish kill follow-up methodology.

For IR Category 4d waters (i.e., a fish kill-impaired water where enforcement actions were taken against the party responsible for the kill), if no additional fish kills have been reported over at least five years subsequent to the kill, any impact from the fish kill upon which the impairment was based likely has long-ago dissipated (see Wilton (2002) for more information on recovery of fish kill streams in Iowa). The IR category for the kill will be changed from 4d to 3b (potentially impaired) and added to the state list of waters in need of further investigation. If no additional kills have been reported for an additional five-year period, the IR category will be changed from IR 3b to 3a (water not assessed).

Iowa DNR's 2016 listing/de-listing timetable for fish kills is summarized in Table 14.

- **Data from the statewide survey of freshwater mussels**

  Information from *Statewide Assessment of Freshwater Mussels (Bivalva: Unionidae) in Iowa Streams: Final Report* (Arbuckle et al. 2000) will again be used for the 2016 IR to assess support of aquatic life uses of Iowa streams and rivers. Until 2011, only a limited number of localized mussel surveys had been conducted since the statewide survey of Arbuckle et al. (2000). In 2011, however, Iowa DNR began a multi-year distributional study of Iowa's freshwater mussels. Results from this ongoing study will be used to update existing assessments of aquatic life use support.

The methodology used to develop assessments of aquatic life use support based on freshwater mussel communities is as follows. The survey conducted by Arbuckle et al. (2000) involved re-sampling of sites visited in the mid-1980s by Frest (1987). For purposes of identifying candidates for Section 303(d) listing, the number of mussel species reported for a given waterbody by Frest was compared to the number of species reported for the same waterbody by Arbuckle et al. The degree to which the aquatic life use was supported was based on the percent change in the number of mussel species from the 1984-85 period to the 1998-99 period. If the mean waterbody species richness (SR) was four or greater in the 1984-1985 survey period, then the following assessment approach using percent change from the 1984-85 to 1998-99 survey periods was used to identify candidates for Section 303(d) listing:

If species richness (SR) in 1984-85 is ≥ 4, and the percent decline in SR from 1984-85 to 1998-99 is:	**Then use support category is:**	**Integrated Report Category**
< 25%	Fully Supporting	1
26-50%	Fully Supporting or Fully Supporting / Threatened with a declining trend (potentially "impaired")	1 or 5b
51%-75%	Partially Supporting ("impaired")	5b
> 75%	Not Supporting ("impaired")	5b

The decision to consider only those sites having four or more species reported in the 1984-85 survey is based on (1) a review of the historical distributions of freshwater mussels in Iowa as shown by Cummings and Mayer (1992) and (2) the framework (i.e., percent decline approach) described in table above. For the Iowa ecoregions that show historical presence of a stream/river community of freshwater mussels (i.e., all ecoregions except 47e and the portions of ecoregions 47f and 40 in the Missouri River drainage), a species richness of approximately four appears to characterize average species richness from the 1984-85 survey by Frest. The decision to identify a waterbody as impaired due to a decline in species richness between the 1984-85 and 1998-99 survey periods is based on quartiles (i.e., from a 25% to 50% decline: "fully supported/threatened with a declining trend"; from a 50% to 75% decline, "partially supported"; more than a 75% decline, "not supported"). Any decision to add a waterbody to the state list of impaired waters based on a percent decline of between 26 and 50 percent will be made on a case-by-case basis, with impairment and listing more likely as the percent decline approaches 50 percent. Using four species as a minimum for this assessment approach allows for some apparent decline between the survey periods without identifying the waterbody as "impaired." Such declines may be due to problems with sampling efficiency as opposed to the actual elimination of species.

As presented by Arbuckle et al. (2000), the potential causes of declines in species richness of Iowa's freshwater mussels include siltation, destabilization of stream substrate, stream flow instability, and high in-stream levels of nutrients (phosphorus and nitrogen). Their study also suggested the importance of stream shading provided by riparian vegetation to mussel species richness. For purposes of Section 305(b) reporting and Section 303(d) listing, the following causes and sources will be identified for all waters assessed as "impaired" due to declines in the mussel community: siltation from agricultural and natural sources; flow modification due to hydromodification of the watershed; and nutrients from agricultural and natural sources. Because site-specific causes and sources of these impairments were not identified by Arbuckle et al. (2000), any waters assessed as impaired due to declines in the freshwater mussel community will be placed into subcategory 5b. As is typical for Section 305(b) water quality assessments, the sources of impairment identified for Iowa's freshwater mussel community are only *potential* sources. The logistics of a statewide water quality assessment process does not often allow precise site-specific determinations of pollutant sources. More accurate information on sources would typically be gathered during the stressor identification phase of TMDL development.

The following approach is used for <u>de-listing freshwater mussel impairments</u> in Iowa:

- If a follow-up mussel survey is conducted by IDNR or other natural resource agency staff, and if the species richness from the follow-up survey is greater than 50 percent of the species richness from the Frest (1987) surveys of the mid-1980s, the impairment will be de-listed. Similar to the process for listing a mussel impairment, only one follow-up sampling is needed to justify a de-listing. All de-listing decisions will be reviewed by IDNR mussel experts to ensure that the results of the follow-up survey show recovery from the original impairment.

- Because IDNR lacks a protocol for identifying biological thresholds that indicate a "fully supporting" mussel community, recovery of the species richness of the mussel community from a previous decline does not necessarily indicate "full support" of the designated Class B aquatic life uses. Rather, the results of such surveys indicate only that the mussel community has recovered to approximately the baseline condition found during the surveys in the mid-1980s (which is the basis for identifying mussel impairments). Thus, segments where mussel impairments have been de-listed (removed from IR Categories 4 or 5) are most appropriate for placement in IR Subcategory 3a (insufficient information is available to determine whether the designated use is supported).

- **Data from public water supplies on the quality of raw and finished water**

  Data for the quality of raw (untreated) water from a surface water source will be used with the methodology for identifying impairments in Class C (drinking water use) waters described in Table 11. Three types of contaminants are considered as part of Section 305(b) assessments to determine the degree to which the designated Class C uses are supported: metals, pesticides, and inorganics (nitrate). Impairment of Class C uses for these classes of toxic contaminants will be determined as follows:

  Data for metals or pesticides (except atrazine) in the raw water source:
  Impairment of the Class C (drinking water) use will be identified if average levels of toxic metals or pesticides over the three-year Integrated Reporting assessment period exceed the respective human health criteria (HH) or maximum contaminant levels (MCLs) as specified in the *Iowa Water Quality Standards*.

  Data for atrazine in the raw water source:
  For routine sampling frequencies of quarterly or more frequent, where sampling frequency is similar throughout the year, moving annual average values for the three-year assessment period will be compared to the respective Class C criterion (see Table 7). If any moving annual average exceeds the Class C criterion, the Class C uses will be assessed as impaired (not supported). When calculating moving annual averages, non-detect values will be set equal to the IDNR ambient monitoring non-detect level. Situations where non-detect levels exceed water quality criteria will be handled on a case-by-case basis.

When sampling frequency is biased toward certain times of year such that calculating meaningful annual averages is not possible, an atrazine impairment of the Class C uses will be identified if significantly greater than 10% of the samples exceed the MCL. The methodology of Lin et al. (2000) (Table 12) will be used to determine whether significantly more than 10 percent of the samples exceed the MCL.

Data for inorganics (i.e., nitrate) in the raw water source:

If, over the three-year assessment period, significantly more than 10 percent of the samples violate Iowa's Class C criterion for nitrate for drinking water use (i.e., the maximum contaminant level (MCL)), impairment of the Class C uses will be identified. The methodology of Lin et al. (2000) (Table 12) will be used to determine whether significantly more than 10 percent of the samples exceed the MCL.

Impairments related to the quality of finished (treated) water will be determined through review of annual IDNR public drinking water program compliance reports (e.g., IDNR/WQB 2013, 2014, 2015) available at *http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Supply-Engineering/Annual-Compliance-Report*). Information from these reports on violations of Class C water quality criteria and issuance of drinking water advisories will be used with methods described in Table 11 to determine the existence of impairment of drinking water uses.

- **Data from special studies of water quality and aquatic communities**

  Results of special water quality studies that meet all requirements of Iowa's "credible data" law, including the availability of a quality assurance project plan (or equivalent plan or methodology for sampling and analysis), will be considered on a case-by-case basis. IDNR will review all relevant quality assurance/project plans for special studies prior to the decision to use study results for purposes of Section 303(d) listing. Results from special studies that meet "credible data" requirements will be compared to water quality criteria as specified in the *Iowa Water Quality Standards* with the methods described in this document.

- **Data from results of continuous monitoring for dissolved oxygen:**

  Iowa DNR staff have long used results of monitoring of dissolved oxygen generated through analysis of grab samples to assess support of aquatic life uses. Historically, if significantly more than 10% of the dissolved oxygen values generated through routine ambient monitoring violated the applicable state water quality criteria, the aquatic life uses would be assessed as "impaired". The data generated through continuous (24-hour) monitoring for dissolved oxygen, however, are not directly applicable to this method of identifying impairments of aquatic life uses. Thus, a separate methodology was developed by Iowa DNR staff for the 2014 IR cycle that is designed to identify impairments of aquatic life uses due to low levels of dissolved oxygen (see Attachment 6).

- **Results of volunteer monitoring that meet "credible data" requirements**

  Results of volunteer monitoring that meet all requirements of Iowa's "credible data" law, including the availability of a DNR-approved quality assurance project plan (or equivalent plan or methodology for sampling and analysis), will be considered on a case-by-case basis. IDNR will review all relevant quality assurance/project plans for volunteer monitoring studies prior to the decision to use study results for purposes of Section 303(d) listing. Results from volunteer monitoring studies that meet "credible data" requirements will be compared to the appropriate water quality criteria as specified in the *Iowa Water Quality Standards* with the methods described in this document.

Removal (de-listing) of waters from the 2014 Section 303(d) list:

According to U.S. EPA regulations (40 CFR 130.7), a state must demonstrate "good cause" for exclusion of previously impaired waterbodies. According to these regulations, "good cause" includes, but is not limited to, more recent or accurate data; more sophisticated water quality modeling; flaws in the original analysis that led to the water being listed; or changes in conditions; e.g., new control equipment or the elimination of discharges. Thus, the following can be used to demonstrate good cause for removing a previously-listed waterbody from the Section 303(d) list or to decrease the scope of impairment to a listed waterbody:

- **More recent or accurate data**. Additional monitoring data or information from a waterbody may demonstrate that it now meets applicable water quality standards. In general, removal of an existing impairment due to violation of Iowa's numeric water quality criteria requires that data show full support of the previously impaired beneficial use for two consecutive Integrated Report cycles. These data must be generated from monitoring studies and programs consistent with Iowa's credible data law and must be in sufficient quantity to be used with Section 305(b) water quality assessment procedures (see Table 6). Special conditions for de-listing impairments include the following:

1. Chlorophyll-a and Secchi depth: For Iowa lakes, median-based trophic state index (TSI) values for both chlorophyll-a and Secchi depth must be 63 or less for two consecutive Section 305(b)/303(d) [Integrated Reporting] cycles before a lake can be removed from the state's Section 303(d) list (IR Category 5) (see Attachment 3 of this methodology for more information). A TSI value of 63 indicates a chlorophyll-a concentration of approximately 27 µg/L and a Secchi depth of approximately 0.8 meters.

2. Indicator bacteria: For waters with contact recreation uses assessed as impaired by indicator bacteria—and assuming that sufficient and credible new data are available—recreation season geometric mean levels of *E. coli* must all be less than the applicable state water quality criterion for two consecutive listing cycles prior to de-listing. Two consecutive listing cycles for Iowa's stream/river encompasses five years and encompasses seven years for lakes. Also, the percentage of samples that exceed the state's single-sample maximum *E. coli* criterion must not be significantly greater than 10 percent for two consecutive listing cycles. Requiring that geometric means and single-sample maximum values meet applicable water quality criteria for two consecutive listing cycles is designed to avoid impairment flip-flopping that can occur with high-variability and weather-influenced parameters such as indicator bacteria.

3. Atrazine: For waters with drinking water uses assessed as impaired by atrazine, all moving annual averages must be less than the atrazine MCL for two consecutive Section 303(d) listing cycles before a de-listing due to more recent data. If the atrazine impairment was based on significantly greater than 10% of the samples exceeding the atrazine MCL, de-listing of the impairment requires two consecutive 303(d) listing cycles where the number of MCL violations is not significantly greater than 10%. Atrazine in surface waters, and especially in lakes, can exhibit wide fluctuation from year to year. IDNR assessment/listing staff will review the historic atrazine data to determine any trends in levels and to determine whether de-listing is justified.

4. Biological impairments, fish and macroinvertebrates: The protocol for identifying a biological impairment based on results of IBIs for fish and/or macroinvertebrates from Iowa

DNR's biological monitoring program requires two samplings within a five-year period that show biological impairment. Conversely, the protocol for de-listing these biological impairments requires two samplings within a five-year period that show "full support" of aquatic life uses.

5. Biological impairments, freshwater mussels: Both the listing and de-listing of a biological impairment based on freshwater mussels requires only one sampling. While Iowa DNR's biological monitoring program is a routine ambient monitoring program, data for freshwater mussels are generated through special studies and one-time statewide surveys that typically do not provide for re-sampling of sites.

6. Fish kill impairments: Occurrence of a single pollutant-caused fish kill or a kill of unknown origin on an Iowa waterbody indicates a severe stress to the aquatic community and suggests that the Class B aquatic life uses should be assessed as "impaired". The de-listing of fish kill impairments can occur through either of the following:

    i. Results of two Iowa DNR biological assessment sampling events within a five-year period that both suggest "full support" of the Class B aquatic life uses of the fish kill-affected wadeable stream. The de-listed stream segment is moved to IR Categories 1 or 2a ("fully supporting").

    ii. Results of a single Iowa DNR fish kill follow-up sampling that show recovery of the impaired waterbody's fish community to levels typical for the respective Level IV ecoregion. The de-listed stream segment is moved to IR subcategory 3a (not assessed).

- **Flaws in original analysis or errors in listing**. Errors in the data or flaws in assessment procedures used to list the waterbody invalidate the basis for listing. Changes in assessment methodology can be considered as correcting flaws in analysis or errors in listing.

- **New conditions.** Examples of new conditions include revised water quality standards, the elimination of discharges, and new control equipment such that a listed waterbody no longer meets the criteria for Section 303(d) listing.

All waters removed from Iowa's 2014 Section 303(d) list will be summarized in a table posted at the Iowa DNR impaired waters web site (*http://www.iowadnr.gov/Environment/WaterQuality/WaterMonitoring/ImpairedWaters.aspx*). For any waterbody listed on the final EPA-approved 2014 Section 303(d) list and not included on IDNR's 2016 list, a waterbody-specific rationale for the exclusion or de-listing will be incorporated into Iowa DNR's on-line Section 305(b) assessment database (ADBNet).

Waterbodies added to an Iowa 303(d) list will be placed on subsequent lists unless (1) there are sufficient credible data to reassess the waterbody and demonstrate that 303(d) listing is not appropriate or (2) some other "good cause" is demonstrated for not including the water on the 303(d) list. Age of data alone is not an adequate justification for omitting a previously-listed water on a new list of impaired waters. This provision is especially relevant to waterbodies included on lists based on results of one-time surveys (e.g., results of biological assessments conducted as part of biocriteria development or faunal surveys (e.g., freshwater mussels)). For example, if a waterbody was added to Iowa's 2004 303(d) list based on a biological assessment conducted in 2002, this waterbody should remain on Iowa's subsequent 303(d) lists until (1) a TMDL is completed, (2) additional monitoring is conducted that shows "full support" of aquatic life uses, or (3) a flaw in the original data analysis or assessment is discovered.

In addition, lack of sufficient new data to develop a "monitored" assessment for a previously-listed waterbody is not adequate justification for excluding a waterbody from Section 303(d) listing. For example, if a routinely-monitored waterbody was added to Iowa's 2004 303(d) list based on a "monitored" assessment showing violations of the Iowa water quality criterion for indicator bacteria, this waterbody should remain on Iowa's impaired waters lists until (1) adequate data are available to develop a high-confidence ("monitored") assessment, (2) the newly developed assessment shows "full support" of the impaired use, or (3) there is some other "good cause" for de-listing this impairment.

Prioritization and scheduling of waters for TMDL development:

In response to U.S. EPA's efforts to develop a new long-term vision for the Clean Water Act Section 303(d) program, Iowa DNR developed a revised system of prioritization for waterbodies included in Category 5 of the Integrated Report was developed for the 2014 IR cycle by the IDNR (Berckes 2015). See Attachment 7 for an updated version of this prioritization framework (Berckes 2017). As shown in the following figure, TMDLs are prioritized based on the relative social impacts/benefits and complexity levels of the TMDLs needed.

Social Impact	**Complexity / Cost:** **Low**	**Complexity / Cost:** **High**
High	**Priority Group I** ***[High Priority]*** Impairments with relatively *high* social impact and relatively low complexity &/or cost for development. Example: • Smaller Eutrophic Lake Systems • River Nitrate	**Priority Group II** ***[Intermediate/High Priority]*** Impairments with relatively high social impact and a relatively high complexity &/or cost for development. Example: • Larger / Complex Lake Systems • Protection TMDLs (e.g., OIW) • Statewide TMDL
Low	**Priority Group III** ***[Intermediate/Low Priority]*** Impairments with relatively low social impact and a relatively low complexity &/or cost for development. Example: • Stream Bacteria	**Priority Group IV** ***[Low Priority]*** Impairments with relatively low social impact and a relatively high complexity &/or cost for development. Example: • Biological impairments • Lake Mercury impairments • Metals impairments

This system of prioritization favors TMDLs that can realistically address impairments on waterbodies where water quality improvement will have a high level of social impact and benefit (Priority Group I). Thus, TMDLs will focus on high-use recreational lake systems that are impaired by nutrient-related factors such as algae, turbidity, and pH. TMDLs with high levels of complexity and low expectations for positive social impact/benefits will be considered "low priority" (Priority Group IV). The TMDL priority identified for a waterbody does not indicate, and has no relationship, to the relative severity of the impairment.

Addressing interstate inconsistencies in Section 303(d) lists:

Inconsistency in the Section 303(d) listings of border rivers and other interstate waters is a long-standing national problem (see GAO 2002). IDNR faces potential listing consistency issues with the following states and rivers that border Iowa: South Dakota (Big Sioux River), Nebraska (Missouri River), Missouri (Des Moines River), and Illinois and Wisconsin (Upper Mississippi River). Thus, IDNR will either (1) request and/or review the draft 303(d) lists of, or (2) consult directly with, states with which Iowa shares border waters. The results of the between-state comparison of impairments for the 2016 IR cycle are summarized in Attachment 8.

The Upper Mississippi River Basin Association's *Water Quality Task Force* has provided, and continues to provide, a forum for improving listing consistency for the Upper Mississippi River for the states of Illinois, Iowa, Minnesota, Missouri and Wisconsin (see UMRBA-WQTF 2004). In addition to the face-to-face consultations provided in the UMRBA *Water Quality Task Force*, interstate consistency can also be addressed through viewing web-available integrated reports and Section 303(d) lists of adjacent states. For the 2016 listing cycle, integrated reporting web sites for Nebraska, South Dakota, Minnesota, and Missouri will be visited to, as much as possible, resolve interstate listing issues. IDNR will also review the Section 303(d) listings from adjacent states for waters that either enter Iowa from Minnesota or leave Iowa into Minnesota or Missouri (e.g., the Cedar River in Mitchell County and the Chariton River in Appanoose County), or that are shared with Iowa by either state (e.g., Tuttle Lake in Emmet County).

Where the listing in another state is different than in Iowa, the IDNR will review the assessment data, supporting information, and assessment methodology that support the listing in the other state. These data will be reviewed and applied to Iowa's Section 303(d) listing methodology outlined in this document. If a listing from another state for a border river is based on water quality standards that are consistent with the *Iowa Water Quality Standards*, the Iowa listing will be changed to reflect that listing.

Where Section 303(d) listing decisions differ across a state line, the supporting assessment data and methodology will be requested from the appropriate state. IDNR will review these data using Iowa's Section 303(d) listing methodology outlined in this document to determine whether modifications to Iowa's Section 303(d) list are justified.

This process of reviewing Section 303(d) listings for waters that border or are shared with adjacent states is designed to reduce between-state inconsistencies in Section 303(d) listings and to provide a basis for cooperation on future development of TMDLs for these interstate waters.

Public participation:

A draft of this methodology is provided to the public for review and comment as part of the public comment period for the draft 2016 Section 303(d) list. The draft methodology is available in hard copy by contacting the IDNR. The draft is also available at the IDNR website at *http://www.iowadnr.gov/Environment/WaterQuality/WaterMonitoring/ImpairedWaters.aspx*. Comments on the draft methodology are received for a period of thirty days.

The methods used to assess water quality are always changing due both to recommendations from U.S. EPA and due to changes at the state level (e.g., changes in the *Iowa Water Quality Standards*). Thus, IDNR will accept comments at any time regarding this methodology.

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Table 1. Summary of changes in Iowa DNR's Section 303(d) listing methodology between the 2014 and 2016 listing cycles.

Change in Methodology:	2014 Listing Cycle	2016 Listing Cycle
Revision of Iowa DNR-defined IR subcategories	Iowa DNR used subcategories 2b, 2b-u and 2b-c to identify potentially impaired waters.	Iowa DNR subcategories 2b, 2b-u and 2b-c eliminated & folded into IR Category 3b

Table 2. Summary of U.S. EPA's "integrated reporting" (IR) format as used for Iowa's 2016 Section 305(b) and Section 303(d) cycle.

IR Category	Source of Category	Description of Category
1	U.S. EPA	All designated uses are met.
2a	U.S. EPA	Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met.
3a	U.S. EPA	Insufficient data to determine whether any designated uses are met.
3b	IDNR	Insufficient data exist to determine whether any designated uses are met, but at least one use is potentially impaired based on an "evaluated" assessment. This subcategory forms the state list of waters in need of further investigation.
3b-c	IDNR	Potential biological impairment on stream with watershed size within calibration range of assessment protocol. The aquatic life use of a stream segment within the calibrated range of the biological assessment protocol has been assessed as potentially impaired; no other uses are assessed due to lack of water quality information;
3b-u	IDNR	Potential biological impairment on stream with watershed size outside of calibration range of assessment protocol. The aquatic life use of a stream segment with a watershed size outside the calibrated range of the biological assessment protocol has been assessed as potentially impaired; no other uses are assessed due to lack of water quality information;
4a	U.S. EPA	Water is assessed as impaired or threatened but a TMDL is not needed because a TMDL has been completed.
4b	U.S. EPA	Water is assessed as impaired but a TMDL is not needed because other required control measures are expected to result in attainment of water quality standards in a reasonable period of time.
4c	U.S. EPA	Water is assessed as impaired but a TMDL is not needed because the impairment or threat is not caused by a "pollutant."
4d	IDNR	Water is assessed as impaired due to a pollutant-caused fish kill but a TMDL is not needed because enforcement actions were taken against, and monetary restitution sought from, the party responsible for the kill.
5a	U.S. EPA	Water is assessed as impaired or threatened by a pollutant stressor and a TMDL is needed [along with IR categories 5b and 5p, the state's Section 303(d) list].
5b	IDNR	Water is assessed as impaired or threatened based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified [along with IR categories 5a and 5p, the state's Section 303(d) list].
5b-t	IDNR	Tentative biological impairment: The aquatic life uses of a stream segment with a watershed size within the calibration range of the IDNR biological assessment protocol are assessed as Section 303(d)-impaired based on only one of the two biological sampling events needed to confirm the existence of a biological impairment.
5b-v	IDNR	Verified biological impairment: The aquatic life uses of a stream with a watershed size within the calibration range of IDNR biological assessment protocol are assessed as Section 303(d)-impaired based on results of the required two or more biological sampling events in multiple years within the previous five years needed to confirm the existence of a biological impairment.
5p	IDNR	A presumptively-applied designated use is assessed as 303(d) impaired or threatened. [Along with IR categories 5a and 5b, the state's Section 303(d) list.]

Table 3. Monitoring stations on the Iowa portion of the Upper Mississippi River and associated tributaries sampled from 2004 through 2014 as part of the USGS Long-Term Resource Monitoring Program (LTRMP).

No.	Waterbody, Location	Designated Uses**	Waterbody ID Number	County	Dates of First and Last Sampling	LTRMP Station No.
1.	Catfish Cr., near mouth,	A1,B(WW1)	IA 01-TRK-0100_1	Dubuque	Mar. 25, 1998 to Sep. 21, 2004	CF00.3M
2.	Elk R., near mouth	A1,B(WW1)	IA 01-MAQ-0030_1	Clinton	Sep. 20, 1997 to Sep. 20, 2004	ER02.4M
3.	Maquoketa R., near mouth	A1,B(WW1)	IA 01-MAQ-0050_1	Jackson	May 5, 1993 to Nov. 12, 2014	MQ02.1M
4.	Mill Cr. near mouth	A1,B(WW2)	IA 01-TRK-0030_1	Jackson	Mar. 26, 1998 to Sep. 20, 2004	MC01.0M
5.	Upper Mississippi R. at Le Claire	A1,B(WW1)	IA 01-NEM-0010_2	Scott	May 19, 1993 to Sep. 22, 2004	M497.2B
6.	Upper Mississippi R. at Camanche	A1,B(WW1)	IA 01-NEM-0010_4	Clinton	May 5, 1993 to Sep. 22, 2004	M511.4B
7.	Upper Mississippi R., upstream L&D 13	A1,B(WW1)	IA 01-NEM-0010_4	Clinton	Aug. 9, 1988 to Nov. 10, 2014	M525.5L
8.	Upper Mississippi R. upper Browns Lake	A1,B(WW1)	IA 01-NEM-0020_1	Jackson	Sep. 4, 1989 to Nov. 10, 2014	M545.5B
9.	Upper Mississippi R. L&D 12 tailwater, Bellevue	A1,B(WW1)	IA 01-NEM-0020_1	Jackson	Oct. 15, 1990 to Nov. 10, 2014	M556.4A
10.	Upper Mississippi R, L&D 11 tailwater, Dubuque	A1,B(WW1)	IA 01-NEM-0020_2	Dubuque	May 6, 1993 to Sep. 21, 2004	M582.5B
11.	Upper Mississippi R, L&D 10 tailwater, Guttenberg	A1,B(WW1)	IA 01-NEM-0030_2	Clayton	Jun. 22, 1998 to Sep. 21, 2004	M615.2B
12.	Upper Mississippi River at Gordon's Bay Landing	A1,B(WW1)	A 01-NEM-0040_1	Allamakee	Sep. 21, 2001 to Jun. 16, 2006	M646.9X
13.	Upper Mississippi R. Big Slough at Lansing Bridge	A1,B(WW1)	IA 01-NEM-0040_2	Allamakee	Apr. 19, 1996 to Jun. 16, 2006	M663.4E
14.	Rock Cr., near mouth	A1,B(WW2)	IA 01-MAQ-0010_1	Clinton	Jun. 11, 1996 to Nov. 12, 2014	RK00.1M
15.	Rock Cr., upstream PCS Nitrogen	A1,B(WW2)	IA 01-MAQ-0010_2	Clinton	Jun. 11, 1996 to Nov. 12, 2014	RK03.7M
16.	Shrickers Slough	A1,B(WW1)	IA 01-MAQ-0005-L_0	Clinton	May 5, 1993 to Nov. 12, 2014	M508.1F
17.	Tete de Mortes Cr.	A1,B(WW1)	IA 01-TRK-0090_1	Jackson	Jun. 24, 1997 to Sep. 21, 2004	TM4.1M
18.	Turkey R., near mouth	A1,B(WW1)	IA 01-TRK-0200_0	Clayton	Jun. 22, 1998 to Sep. 21, 2004	TK04.8M
19.	Upper Iowa R. near mouth	A1,B(WW1)	IA 01-UIA-0090_0; IA 01-UIA-0100_0	Allamakee	Jun. 26, 1996 to Nov. 12, 2008	UI02.9M
20.	Wapsipinicon R., near mouth,	A1,B(WW1)	IA 01-WPS-0010_1	Clinton	May 5, 1993 to Nov. 12, 2014	WP02.6M
21.	Yellow R, near mouth	A1,B(WW1)	IA 01-YEL-0070_0	Allamakee	Apr. 19, 1996 to June 16, 2006	YL01.5M

**Designated Uses (from *Iowa Water Quality Standards* (IAC 2014)):

Class A1 = primary human contact/recreation;

Class B(WW1) = Waters in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrate species.

Class B(WW2) = Waters in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations.;

Table 4. Comparison of Iowa DNR's assessment reaches for the Upper Mississippi River to those agreed upon in 2004 by the Upper Mississippi River Basin Association (UMRBA) as part of the memorandum of understanding on interstate assessment reaches developed by the UMRBA Water Quality Task Force.

IDNR Waterbody ID Number	Waterbody Description	Length (miles)	UMRBA Assessment Reach	Segment Description	Length (miles)*	Hydrologic Unit Code (HUC)
IA 03-SKM-0010-1	Iowa/Missouri state line (Des Moines R.) to Sugar Cr. nr. Ft. Madison	17.3	Flint-Henderson	Des Moines R. to Iowa R.	74.75	07080104
IA 03-SKM-0010-2	Sugar Cr. to Skunk R.	19.5				
IA 02-ICM-0010-1	Skunk R. to water supply intake at Burlington	8.75				
IA 02-ICM-0010-2	Burlington water supply intake to Iowa R.	29.2				
IA 01-NEM-0010-1	Iowa R. to L&D 15 at Davenport	49.3	Copperas-Duck	Iowa R. to Lock & Dam 13 at Clinton	89.3	07080101
IA 01-NEM-0010-2	L&D 15 to L&D 14 at LeClaire	10.7				
IA 01-NEM-0010-3	L&D 14 to Wapsipinicon R.	13.1				
IA 01-NEM-0010-4	Wapsipinicon R. to L&D 13 at Clinton	16.2				
IA 01-NEM-0020-1	L&D 13 to Catfish Cr. at Dubuque	54.0	Apple-Plum	Lock & Dam 13 to Lock & Dam 11	59.68	07060005
IA 01-NEM-0020-2	Catfish Cr. to L&D 11 at Dubuque	5.68				
IA 01-NEM-0030-1	L&D 11 to L&D 10 at Guttenberg	30.9	Grant-Maquoketa	Lock & Dam 11 to Wisconsin R.	46.0	07060003
IA 01-NEM-0030-2	L&D 10 to Wisconsin R.	15.1				
IA 01-NEM-0040-1	Wisconsin R. to L&D 9 at Harpers Ferry	19.0	Coon-Yellow	Wisconsin R. to Root R.	42.9	07060001
IA 01-NEM-0040-2	L&D 9 to IA/MN state line	23.9				

*The length of the UMRBA assessment reaches was adjusted to correspond to the total mileage in the respective IDNR assessment reaches.

Table 5. Iowa beaches monitored by DNR/SHL or by local cooperators for indicator bacteria during recreational seasons from 2012-2014. Each group of beaches is listed alphabetically by lake name.

State-owned beaches 32 lakes; 38 beaches			**City/county-owned beaches 28 lakes and 32 beaches**	
Lake Name	**County**		**Lake Name**	**County**
Ahquabi	Warren		Big Sioux Recreational Area Beach	Sioux
Anita	Cass		Browns	Woodbury
Backbone	Delaware		Carter	Pottawattamie
Beeds	Franklin		Central Park	Jones
Big Creek	Polk		Cornelia	Wright
Big Spirit (Crandall's; Marble)	Dickinson		Crystal	Hancock
Black Hawk	Sac		Don Williams	Boone
Blue	Monona		Easter	Polk
Brushy Creek	Webster		Eldred-Sherwood	Hancock
Clear Lake (McIntosh Woods; Clear Lake)	Cerro Gordo		Fairfield	Jefferson
Geode	Henry		F.W. Kent Park Lake	Johnson
George Wyth	Black Hawk		Gabrielson Park	Buena Vista
Green Valley	Union		Grays	Polk
Keomah	Mahaska		Hickory Grove	Story
Honey Creek State Park (Lake Rathbun)	Appanoose		Little River	Decatur
Lacey Keosauqua	Van Buren		Little Sioux Park Lake	Woodbury
Lake Darling	Washington		Lost Island	Palo Alto
MacBride	Johnson		Malone	Clinton
Manawa	Pottawattamie		Mormon Trail	Adair
Nine Eagles	Decatur		Oldham	Monona
North Twin (east and west)	Calhoun		Pahoja	Lyon
Pine (Lower)	Hardin		Pollmiller	Lee
Pleasant Creek	Linn		Sandy Hollow Park Beach	Sioux
Prairie Rose	Shelby		Sturchler	Buena Vista
Red Haw	Lucas		Swan	Carroll
Rock Creek	Jasper		Storm Lake (Old Water Plant, Edson Park, Casino, Bel Air, & Awaysis beaches	Buena Vista
Springbrook	Guthrie		West Lake	Clarke
Three Fires	Taylor			
Union Grove	Tama			
Viking	Montgomery			
Wapello	Davis			
West Okoboji (Emerson, Gull Point, Pikes Point, Triboji)	Dickinson			

Table 6. Data completeness guidelines for using results of routine ambient water quality monitoring to make "monitored" assessments of designated beneficial uses for Section 305(b) water quality assessments in Iowa. "Monitored" assessments are used to place waters in Category 4 (impaired but TMDL not required) and Category 5 (impaired and TMDL required, the Section 303(d) list) of Iowa's Integrated List/Report). Descriptions of "data required" have been modified to reflect the data gathering timeframe of the 2016 Section 303(d) listing cycle.		
DESIGNATED USE	**TYPE OF INFORMATION**	**DATA REQUIRED**
Aquatic Life	Data for levels of toxics in waterbodies	Data collected quarterly or more frequently during calendar years 2012-2014; a minimum of 10 samples is needed.
	Data for levels of conventional pollutants (DO, pH, temp.)	Data collected monthly or more frequently during calendar years 2012-2014; a minimum of 10 samples is needed.
	Data from DNR biocriteria sampling at reference, test, and watershed sites.	At least two valid fish index of biotic integrity (IBI) or macroinvertebrate IBI's for calibrated segments sampled during the most recent 5 complete calendar years (see Attachment 2 for more information).
	Data from the ISU/Iowa DNR statewide lake survey	Data collected at least 3 times per summer for at least 3 years (minimum of 9 samples).
	Results of fish kill investigations	Reports of pollutant-caused fish kills from 2012-2015.
Fish Consumption	Data for site-specific levels of toxic contaminants in fish tissue	All data on levels of toxic contaminants in fish tissue during the period covered by the 2016 assessment cycle (2012-2014).
Primary Contact Recreation	Data for levels of indicator bacteria (*E. coli*) from river waterbodies or non-beach areas of publicly-owned lakes or flood control reservoirs	Data collected monthly or more frequently during recreation seasons (March 15 through November 15) of 2012-2014; at least 7 temporally independent samples need to be collected per recreation season.
	Data for levels of indicator bacteria (*E. coli*) from beach areas of publicly-owned lakes and flood control reservoirs	Data collected approximately weekly during recreation seasons (March 15 through November 15) of 2010-2014.
	Data from the IDNR-sponsored ISU/SHL statewide lake surveys for chlorophyll-a and Secchi depth	Data collected at least 3 times per summer for at least 3 consecutive years (minimum of 9 samples).
	Data from IDNR-sponsored snapshot monitoring	Data from at least 10 recreation season sampling events (i.e., 10 independent samples) over a five-year period (2010-2014).
Drinking Water	Data for levels of <u>toxics</u>	Data collected **quarterly** or more frequently during calendar years 2012-2014; a minimum of 10 samples is needed.
	Data for levels of <u>nitrate</u>	Data collected **monthly** or more frequently during calendar years 2012-2014; a minimum of 10 samples is needed.

*Data that do not meet IDNR's completeness guidelines can be used to develop "<u>evaluated</u>" (versus "monitored") assessments for purposes of Section 305(b) water quality reporting. These "evaluated" assessments, however, are of generally lower confidence and are not appropriate for adding waters to IR Categories 4 or 5 (impairment categories) of the Integrated Report (IR). Evaluated assessments are, however, appropriate for adding waters to IR Categories 1, 2 and 3.

Table 7. Summary of Iowa water quality criteria used to make assessments of support of beneficial designated uses of Iowa surface waters for purposes of the 2016 Section 305(b) / Section 303(d) reporting/listing cycles. The criteria listed are only for those parameters used for the 2016 Section 305(b)/303(d) assessment/listing cycle. For a complete list and description of Iowa water quality criteria, see the *Iowa Water Quality Standards (IAC 2014)*.

	DESIGNATED USE							
PARAMETER	**Class A1, A2 and A3: swimmable**	**Class B(WW1): aquatic life**	**Class B(WW2) & B(WW3) aquatic life**	**Class B(CW1): coldwater aquatic life**	**Class B(CW2): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**	**HH (Human Health)**
dissolved oxygen (mg/L) 16-hour minimum / 24-hour minimum)	none	5.0 / 5.0	5.0 / 4.0	7.0 / 5.0	7.0 / 5.0	5.0 / 5.0	none	none
temperature (added heat)	none	no increase > 3 C; increase < 1 C / hr; no increase above 32 C	no increase > 3 C; increase < 1 C / hr; no increase above 32 C	no increase > 2 C; increase < 1 C / hr; no increase above 20 C	no increase > 2 C; increase < 1 C / hr; no increase above 20 C	no increase > 2 C; increase < 1 C / hr; no increase above 32 C	none	none
pH	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	none	none
ammonia-nitrogen (mg/L)	none	criteria are dependent on the pH and temperature of the lake, stream or river; see Tables 3a through 3c of the *Iowa Water Quality Standards* (IAC 2014) for criteria for Class B(WW1), B(WW2), B(WW3), B(CW1), B(CW2), and B(LW) waters.					none	none
nitrate-nitrogen (mg/L)	none	none	none	none	none	none	10	none

Table 7 (continued)								
	DESIGNATED USE							
PARAMETER	**Class A1, A2 & A3: swimmable**	**Class B(WW1): aquatic life**	**Class B(WW2) & B(WW3) aquatic life**	**Class B(CW1): coldwater aquatic life**	**Class B(CW2): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**	**HH (Human Health): fish / fish & water**
chloride (mg/L)**	none	389 / 629	389 / 629	389 / 629	389 / 629	389 / 629	250	none
fluoride (µg/L)	none	none	none	none	none	none	4000	none
E. coli (indicator bacteria)	[See Table 8]	none	none	none	none	none	none	none
TOXIC METALS (all values in µg/L; chronic / acute criteria are given for Class B designations; NA = value not applicable)								
Aluminum	None	87 / 750	87 / 750	87 / 1106	none	748 / 983	None	none
Arsenic	none	150 / 340	150 / 340	200 / 360	none	200 / 360	None	50 / 0.18
Cadmium*	none	0.45 / 4.32	0.45 / 4.32	1 / 4	none	1 / 4	5	168 / NA
chromium (VI)	none	11 / 16	11 / 16	40 / 60	none	10 / 15	100	3365 / NA
Copper*	none	16.9 / 26.9	16.9 / 26.9	20 / 30	none	10 / 20	none	1000 / 1300
Cyanide	none	5.2 / 22	5.2 / 22	5 / 20	none	10 / 45	none	140 / 140
Lead*	none	7.7 / 197	7.7 / 197	3 / 80	none	3 / 80	50	None
Mercury	none	0.9 / 1.64	0.9 / 1.64	3.5 / 6.5	none	0.9 / 1.7	none	0.15 / 0.05
Selenium	none	5 / 19.3	5 / 19.3	10 / 15	none	70 / 100	none	170 / 4200
Zinc*	none	215 / 215	215 / 215	200 / 220	none	100 / 110	none	2600 / 740
PESTICIDES (all values in µg/L; chronic / acute / human health criteria (HHC) are given; NA = value not applicable)								
2,4-D	none	none	none	none	none	none	none	100
2,4,5-TP (Silvex)	none	none	none	none	none	none	MCL: 10	none
Alachlor	none	none	none	none	none	none	MCL: 2	none
Atrazine	none	none	none	none	none	none	MCL: 3	none

*Criteria are based on a hardness of 200 mg/L using the respective equations in the *Iowa Water Quality Standards* (IAC 2014)

**Acute and chronic criteria are based on a hardness of 200 mg/L as $CaCO_3$ and a sulfate concentration of 63 mg/L (see IAC 2014:18).

Table 7 (continued)								
	DESIGNATED USE							
PARAMETER	**Class A1, A2 & A3: swimmable**	**Class B(WW1): aquatic life**	**Class B(WW2) & B(WW3) aquatic life**	**Class B(CW1): coldwater aquatic life**	**Class B(CW2): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**	**HH (Human Health)**
Carbofuran	none	none	none	none	none	none	40	none
Chlorpyrifos	none	0.041 / 0.083	0.041 / 0.083	0.041 / 0.083	none	0.041 / 0.083	none	none
DDT+DDD+DDE	none	0.001 / 1.1	0.001 / 1.1	0.001 / 0.9	none	0.001 / 0.55	none	0.0022 / 0.0022
Dieldrin	none	0.056 / 0.24	0.056 / 0.24	0.056 / 0.24	none	0.056 / 0.24	none	0.00054 / 0.00052
Dinoseb	none	none	none	none	none	none	7	none
Lindane	none	NA / 0.95	NA / 0.95	NA / 0.95	none	NA / 0.95	none	1.8 / 0.98
Parathion	none	0.13 / 0.65	0.13 / 0.65	0.13 / 0.65	none	0.13 / 0.65	none	none
Picloram	none	none	none	none	none	none	500	none
Simazine	none	none	none	none	none	none	4	none

Table 8. Summary of Iowa water quality criteria for indicator bacteria (*E. coli*) in surface waters designated in the *Iowa Water Quality Standards* (IAC 2014) for either primary contact recreation, secondary contact recreation, or children's recreational use. The *E. coli* content shall not exceed the following levels when the Class A uses can reasonably be expected to occur.

	Class A1: primary contact recreational use*	**Class A2: secondary contact recreational use***	**Class A3: children's recreational use***
Geometric Mean (No. of *E. coli* organisms/100 ml of water)	126	630	126
Sample Maximum (No. of *E. coli* organisms/100 ml of water)	235	2,880	235

* Criteria apply from March 15 through November 15 (i.e., the "recreational season") except year-round for Class A2 waters that are also designated for Class B(CW1) [coldwater aquatic life] uses.

Table 9. General water quality criteria to protect beneficial general uses for all Iowa surface waters (from the *Iowa Water Quality Standards*, IAC, Section 61.3(2)).
The following criteria are applicable to all surface waters including general use and designated use waters, at all places and at all times, to protect livestock and wildlife watering, aquatic life, noncontact recreation, crop irrigation, and industrial, domestic, agricultural, and other incidental water withdrawal uses not protected by specific numerical criteria in the subrule 61.3(3) of the *Iowa Water Quality Standards (IAC 2014)*:
1. All waters of the state shall be "free from" the following:
▪ substances attributable to point source wastewater dischargers that will settle to form sludge deposits;
▪ floating debris, oil, grease, scum and other materials from wastewater discharges or agricultural practices in amounts sufficient to create a nuisance;
▪ materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions;
▪ substances attributable to wastewater discharges or agricultural practices in concentrations or combinations which are acutely toxic to human, animal, or plant life;
▪ substances attributable to wastewater discharges or agricultural practices in quantities which would produce undesirable or nuisance aquatic life;
2. The turbidity of a receiving water shall not be increased by more than 25 nephelometric turbidity units by any point source discharge;
3. Cations and anions guideline values to protect livestock watering may be found in the *Supporting Document for Iowa Water Quality Management Plans, Chapter IV, July 1976*, as revised on November 11, 2009.
4. The *Escherichia coli* content of water which enters a sinkhole or losing stream segment, regardless of the waterbody's designated use, shall not exceed a geometric mean of 126 organisms per 100 ml or a sample maximum of 235 organisms/100 ml. No new wastewater discharges will be allowed on watercourses which directly or indirectly enter sinkholes or losing stream segments.

Table 10. Methods for determining support of **AQUATIC LIFE USES** for general use and designated use surface waters in Iowa for 2016 Section 305(b) reporting and 303(d) listing. For shallow lakes, TSI = trophic state index of Carlson (1977).

Type of waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting (moderate impairment)	Not Supporting (severe impairment)
Rivers, streams, lakes & flood control reservoirs	Data from ambient water quality monitoring during current reporting period.	Up to one violation of acute or chronic toxicity criteria* if grab samples are collected quarterly or more frequently. Criteria for conventional pollutants exceeded in $\leq$ 10% of samples.	Criteria for conventional pollutants are exceeded in no more than 10% of samples but levels are trending such that future impairment is likely.	Criteria for conventional pollutants exceeded in from 11-25% of samples (90% confidence level).	More than one violation of acute or chronic toxicity criteria* if samples collected quarterly or more often; or, criteria for conventionals exceeded in more than 25% of samples.
Shallow lakes (see Attachment 4)	IDNR water quality monitoring, 2008-12	TSI values for chlorophyll-a are < 65, and water clarity guidelines for protection of submersed aquatic vegetation (SAV) (median TSS < 30 mg/L) are met.	TSI values and SAV guidelines are met but at least one parameter exhibits an adverse trend over time such that impairment is likely to occur.	TSI values for chlorophyll-a are equal to or greater than 65 but less than 70, or water clarity guidelines for protection of submersed aquatic vegetation (SAV) are not met (average TSS $\geq$ 30 mg/L but < 50 mg/L).	TSI values for chlorophyll-a are equal to or greater than 70, or water clarity guidelines for SAV are not met (average TSS $\geq$ 50 mg/L).
Warmwater Streams and Rivers	Stream biocriteria sampling data (see Attachment 2)	Scores for fish or macroinvertebrate indexes of biotic integrity equal or exceed the ecoregion / subecoregion biological impairment criterion.	[Category not used for Section 305(b) reporting in Iowa.]	Scores for one of the indexes of biotic integrity (fish or macroinvertebrate) significantly less than the ecoregion / subecoregion biological impairment criterion.	Scores for both indexes of biotic integrity (fish and macroinvertebrate) significantly less than the ecoregion / subecoregion biological impairment criterion.
Coldwater Streams	Stream biocriteria sampling data (See Attachment 2)	Two or less of the eight biological indicators less than the 25^{th} percentile of the respective indicator value for Iowa coldwater streams.	[Category not used for Section 305(b) reporting in Iowa.]	From five to six of the eight biological indicators less than the 25^{th} percentile of the respective indicator value for Iowa coldwater streams.	From seven to eight of the eight biological indicators less than the 25^{th} percentile of the respective indicator value for Iowa coldwater streams.
Rivers, streams, lakes & flood control reservoirs	Fish kill reports*	No pollutant-caused fish kills reported within last 10 years.	[Category not used for Section 305(b) reporting in Iowa.]	One pollutant-caused fish kill reported within last five years.	More than one pollutant-caused reported within last five years.

*See Attachment 1: Using remarked (estimated) data for toxics for purposes of 305(b)/303(d).

Table 11. Methods for determining support of classified, beneficial uses for **FISH CONSUMPTION, PRIMARY CONTACT RECREATION, and DRINKING WATER** for surface waters in Iowa for 2016 Section 305(b) reporting and 303(d) listing. Note: TSI = trophic state index of Carlson (1977).

Type of Waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting (moderate impairment)	Not Supporting (severe impairment)
HUMAN HEALTH/FISH CONSUMPTION USES					
Streams, rivers, lakes, & flood control reservoirs	monitoring of levels of toxic contaminants in fish tissue	Results of monitoring show that levels of contaminants do not justify issuance of a consumption advisory.	Results of monitoring have not resulted in issuance of an advisory but results of monitoring show an adverse trend suggesting that issuance of an advisory is imminent.	Levels of one or more toxics have exceeded the respective IDNR/IDPH advisory trigger levels in two consecutive samplings and a "one meal/week" advisory is in effect for the general population.	Levels of one or more toxics have exceeded the respective IDNR/IDPH advisory trigger levels in two consecutive samplings and a "do not eat" advisory is in effect for the general population
	monitoring of levels of toxics in water	Average levels of toxic metals or pesticides are less than human health (HH) criteria.**	Average levels of toxics < HH criteria**, but the average level of at least one toxic is trending upward toward its respective HH criterion; waterbody is considered "impaired"	[Category not used.]	Average level of toxics greater than the respective HH criterion**.
CLASS A1 and A3 PRIMARY CONTACT RECREATION (SWIMMABLE) USES					
Streams, rivers, lakes, & flood control reservoirs	monitoring data for indicator bacteria	All recreation season geometric means of *E. coli* samples $\leq$ 126 orgs / 100 ml and $\leq$ 10% of samples exceed 235 orgs/100 ml for all recreation seasons.	All recreation season geometric means of *E. coli* samples $\leq$ 126 orgs / 100 ml and $\leq$ 10% of samples > 235 orgs/100 ml but worsening trend suggests that future impairment is likely.	At least one recreation season geometric mean of *E. coli* samples > 126 orgs/100 ml but $\leq$ 1,000 orgs/100 ml <u>or</u> more than 10% of samples exceed 235 orgs/100 ml (90% CL).	At least one recreation season geometric mean of *E. coli* samples > 1,000 orgs/100 ml.
Lakes (see Attachment 3)	ISU & SHL ambient lake monitoring, 2006-2010	TSI values for both chlorophyll-a and Secchi depth are $\leq$ 65	TSI values for both chlorophyll-a or Secchi depth are $\leq$ 65 but at least one parameter exhibits an adverse trend over time such that impairment is likely to occur.	TSI values for either chlorophyll-a or Secchi depth are equal to or greater than 65 but less than 70.	TSI values for both chlorophyll-a and Secchi depth are equal to or greater than 65, or the TSI value for either parameter is equal to or greater than 70.
Streams, rivers, lakes, & flood control reservoirs	Closure* of beaches and other swimming areas	No swimming area closures in effect during the assessment period	[Category not used.]	One swimming area closure of less than one week duration during the assessment period	More than one swimming area closure, or one swimming area closure of more than one week duration during the biennial period

*Elevated levels of indicator bacteria at beaches of Iowa's state-owned lakes can trigger the posting of a "swimming is not recommended" sign. The posting of this sign, however, does not mean that the beach is closed. IDNR can, and will, close beaches in case of an emergency health risk such as a wastewater bypass, spill of a hazardous chemical, or a localized outbreak of an infectious disease (see the IDNR beach policy at http://www.iowadnr.gov/Recreation/BeachMonitoring/BeachAdvisoryPolicy.aspx).
** See Attachment 1: Using remarked (estimated) data for toxics for purposes of 305(b)/303(d).

Table 11. (continued).

Type of Waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting (moderate impairment)	Not Supporting (severe impairment)
CLASS A2 SECONDARY CONTACT RECREATION (SWIMMABLE) USES					
Streams, rivers, lakes, & flood control reservoirs	monitoring data for indicator bacteria	All recreation season geometric means of *E. coli* samples ≤ 630 orgs / 100 ml and ≤ 10% of samples exceed 2,880 orgs/100 ml (90% CL) for all recreation seasons.	All recreation season geometric mean of *E. coli* samples ≤ 630 orgs / 100 ml and ≤ 10% of samples > 2,880 orgs/100 ml (90% CL) but worsening trend suggests that future impairment is likely.	At least one recreation season geometric mean of *E. coli* samples > 630 orgs/100 ml but ≤ 1,000 orgs/100 ml, or more than 10% of samples exceed 2,880 orgs/100 ml (90% CL).	At least one recreation season geometric mean of *E. coli* samples > 1000 orgs/100.
DRINKING WATER USES					
Waterbodies designated for use as a source of potable water (=raw water source)	ambient monitoring data for toxics	Average levels of toxic metals or pesticides are less than human health criteria (HH) or maximum contaminant levels (MCLs).	Average levels of toxic metals or pesticides ≤ HH criteria or MCLs, but the average levels of at least one toxic is trending upward toward its respective HH criteria or MCL; waterbody is considered "impaired"	[category not used for Section 305(b) reporting]	Average level of toxic metals or pesticides greater than the respective HH criterion or MCL.
Waterbodies designated for use as a source of potable water (=raw water source)	ambient monitoring data for atrazine	All moving annual average levels of atrazine are less than the maximum contaminant level (MCL) of 3 µg/L.	All moving annual average levels are less than the MCL, but average levels are trending upward toward the MCL; waterbody is considered "impaired"	[category not used for Section 305(b) reporting]	One or more of the moving annual average levels exceed the MCL.
Waterbodies designated for use as a source of potable water (=raw water source)	ambient monitoring data for nitrate	No more than 10% of samples violate the maximum contaminant level (MCL) for nitrate.	No more than 10% of samples violate the MCL for nitrate but nitrate levels are trending upward such that impairment is likely.	Significantly greater than 10% of the samples violate the MCL for nitrate (90% CL).	More than 25% of samples exceed the MCL for nitrate.
Municipal drinking water (=finished water)	public water supplies using surface waters	No drinking water supply closures or advisories in effect; water not treated beyond reasonable levels.	[Category not used for Section 305(b) reporting or 303(d) listing.]	One drinking water advisory lasting 30 days or less per year, or other problems not requiring closure but affecting treatment costs	One or more drinking water supply advisory lasting more than 30 days per year, or one or more drinking water supply closures per year

Table 12. Sample size and number of exceedances required to determine an impaired beneficial use (10% exceedance) to maintain a greater than 90 percent confidence level as reported by Lin et al. (2000) (table excerpted from NDEQ 2006).

Minimum number of exceedances required to maintain a >90% confidence that a designated use is impaired (10% exceedance).					
Sample Size (n)	Number of observations exceeding required to define an impaired use	Confidence Level	Sample Size (n)	Number of observations exceeding required to define an impaired use	Confidence Level
10	3	0.930	56	10	0.951
11	3	0.910	57	10	0.945
12	4	0.974	58	10	0.940
13	4	0.966	59	10	0.933
14	4	0.956	60	10	0.927
15	4	0.944	61	10	0.920
16	4	0.932	62	10	0.913
17	4	0.917	63	10	0.905
18	4	0.911	64	11	0.948
19	5	0.965	65	11	0.943
20	5	0.957	66	11	0.938
21	5	0.948	67	11	0.932
22	5	0.938	68	11	0.926
23	5	0.927	69	11	0.920
24	5	0.915	70	11	0.913
25	5	0.902	71	11	0.906
26	6	0.960	72	12	0.947
27	6	0.953	73	12	0.942
28	6	0.945	74	12	0.937
29	6	0.936	75	12	0.931
30	6	0.927	76	12	0.926
31	6	0.917	77	12	0.920
32	6	0.906	78	12	0.913
33	7	0.958	79	12	0.907
34	7	0.952	80	13	0.946
35	7	0.945	81	13	0.942
36	7	0.937	82	13	0.937
37	7	0.929	83	13	0.931
38	7	0.920	84	13	0.926
39	7	0.911	85	13	0.920
40	7	0.900	86	13	0.914
41	8	0.952	87	13	0.908
42	8	0.946	88	13	0.901
43	8	0.939	89	14	0.941
44	8	0.932	90	14	0.937
45	8	0.924	91	14	0.932
46	8	0.916	92	14	0.927
47	8	0.907	93	14	0.921
48	9	0.954	94	14	0.915
49	9	0.948	95	14	0.910
50	9	0.942	96	14	0.903
51	9	0.936	97	15	0.941
52	9	0.929	98	15	0.937
53	9	0.922	99	15	0.932
54	9	0.914	100	15	0.927
55	9	0.906			

Table 13. Summary of Iowa's protocol for issuing fish consumption advisories. Issuance of an advisory requires two consecutive samplings that show contaminant levels above advisory trigger levels. This protocol was developed by the Iowa Department of Public Health in cooperation with IDNR (IDPH 2007).

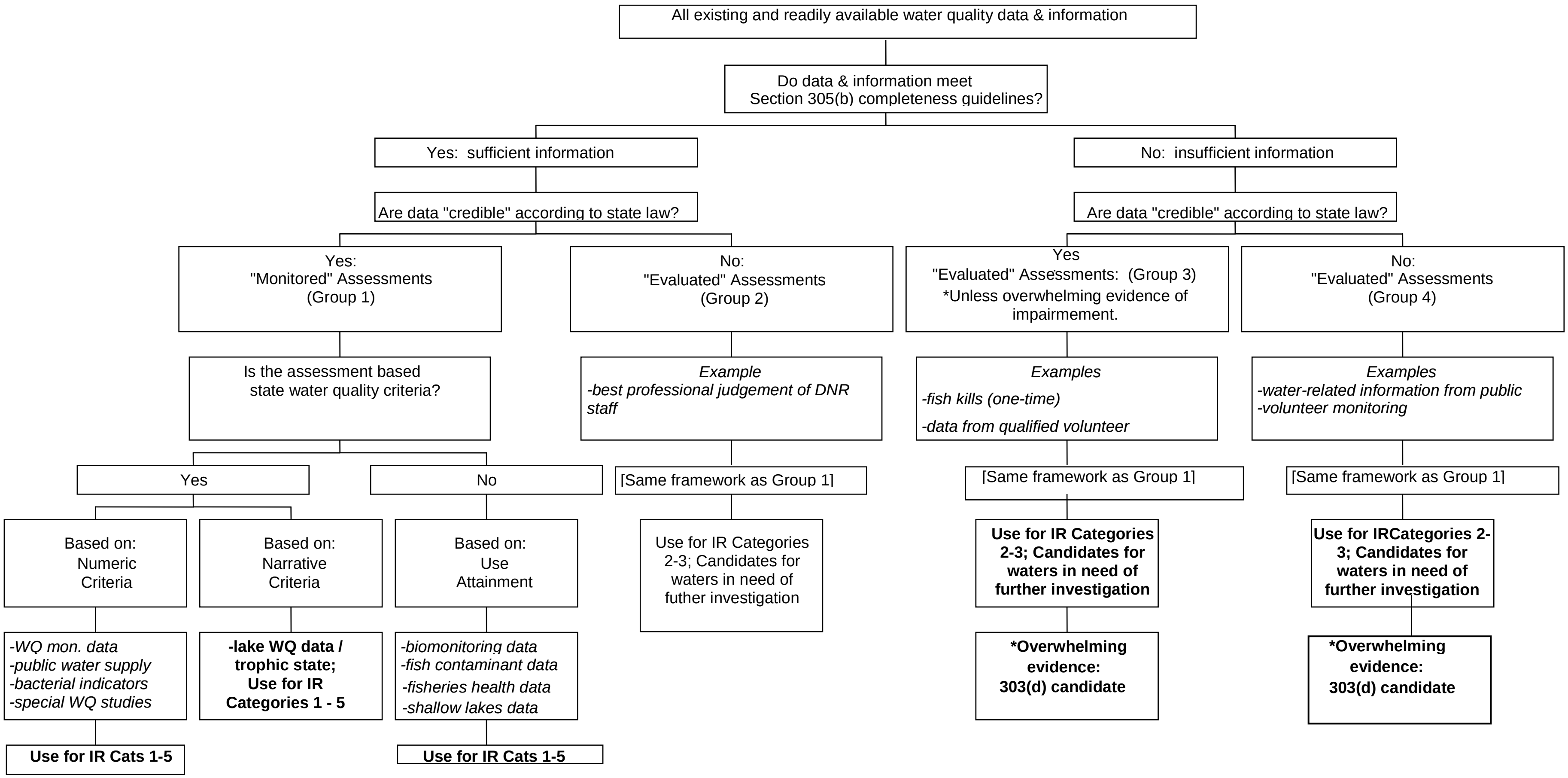
Parameter	**Contaminant Concentrations in fish fillets:**		
	Unrestricted consumption	**Limit consumption to one meal per week**	**Do not eat**
PCBs	0 to 0.2 ppm	>0.2 to 2.0 ppm	> 2.0 ppm
Mercury	0. to 0.3 ppm	>0.3 to 1.0 ppm	> 1.0 ppm
Chlordane	0. to 0.6 ppm	>0.6 to 5.0 ppm	> 5.0 ppm

Table 14. Placement of fish kill-affected waters into IR categories for Iowa's 2016 Integrated Reporting cycle.

Year of kill:	**Years without a reported kill:**	**Pollutant-caused kill; no restitution sought**	**Pollutant-caused kill; restitution sought**	**No cause identified; or non-pollutant / natural kill**	**Fish kill follow-up monitoring conducted; regional ; expectation met**
2015	0	5a/5b	4d	2b/3b	NA*
2014	1	5a/5b	4d	2b/3b	NA
2013	2	5a/5b	4d	2b/3b	NA
2012	3	5a/5b	4d	2b/3b	NA
2011	4	5a/5b	4d	2b/3b	NA
2010	5	5a/5b	4d	2b/3b	NA
2009	6	5a/5b	2b/3b	2b/3b	3a
2008	7	5a/5b	2b/3b	2b/3b	3a
2007	8	5a/5b	2b/3b	2b/3b	3a
2006	9	5a/5b	2b/3b	2b/3b	3a
2005	10	5a/5b	2b/3b	2b/3b	3a
2004	11	5a/5b	3a	3a	3a
2003	12	5a/5b	3a	3a	3a

*NA: fish kill follow-up monitoring is appropriate only for waters where a pollutant-caused kill occurred at least five-years ago. See Attachment 5 for details of IDNR's fish kill follow-up methodology.

Figure 1. Use of water quality data and information for Iowa's Integrated Report (Section 305(b)/303(d) report/list).



Attachment 1.

<u>Using remarked (estimated) data for toxics for purposes of 305(b)/303(d)</u>

Prior to the 2014 Integrated Reporting cycle, all estimated data values were considered as valid data for comparison to water quality criteria for the purpose of identifying Section 303(d) impairments. Based on information from USGS (Oblinger et al. 1999) and based on comments from IDNR staff that existing impairments for toxic metals had been incorrectly identified, this approach was modified for the 2014 IR cycle as follows:

<u>Scenario 1:</u> If the water quality criterion is less than the practical quantitation limit (PQL, aka, reporting limit) but greater than the method detection level, any data values above the water quality criterion but below the PQL (i.e., "estimated values") will not be considered as a violation of the water quality criterion. That is, <u>the concentrations of toxic contaminants of estimated values are of relatively low confidence</u> (Oblinger et al. 1999) and may or may not be above the water quality criterion. In contrast, data values above the PQL are of relatively high confidence and are appropriate for use in making regulatory decisions. The following figures are intended to show this scenario.

>Practical Quantitation Level	Violation
Practical Quantitation Level	Estimated Data:
>Water Quality Criterion	Not a violation
Water Quality Criterion	
>Method Detection Level	
Method Detection Level	
Zero	

<u>Scenario 2:</u> If the WQC is below the Method Detection Level (MDL), any data values reported above the MDL will be considered as violations of Iowa's water quality criteria.

>PQL	
PQL	Violations
>MDL	
MDL	
>WQC	Not Violations
WQC	
Zero	

Scenario 3: If the Water Quality Criterion (WQC) is above the Practical Quantitation Level (PQL), all remarked (estimated) data will be less than the WQC, and these data will be considered a violation of WQC.

> WQC	Violations
WQC	Not violations
>PQL	
PQL	
>MDL	
MDL	
zero	

This change was incorporated into the assessment and listing process for Iowa's 2014 Integrated Reporting cycle, and this approach will continue to be used for Iowa's future Integrated Reports.

Attachment 2

GUIDELINES FOR DETERMINING SECTION 305(B) AQUATIC LIFE USE SUPPORT (ALUS) USING STREAM BIOCRITERIA SAMPLING DATA FOR THE SECTION 305(b) REPORTING AND SECTION 303(d) LISTING CYCLES

Introduction:

Since the late 1980s, U.S. EPA has encouraged states to develop and adopt narrative and biological criteria (biocriteria) for surface waters. Biocriteria are narrative or numeric expressions that describe the best attainable biological integrity (reference condition) of aquatic communities inhabiting waters of a given designated aquatic life use (U.S. EPA 1990a). Supported by a water quality planning grant from the U.S. EPA Region VII, geographers of the U.S. EPA Corvallis Environmental Research Laboratory collaborated with IDNR staff to revise and subdivide the ecoregions in Iowa (Figure 2-1, see also Omernik et al. 1993; Griffith et al. 1994). As part of this effort, a list of candidate stream reference sites in Iowa was generated. Reference sites are located on the least impacted streams within an ecoregion or subecoregion. Reference sites can thus serve as benchmarks to which water quality-impaired streams can be compared. A pilot reference site sampling study was conducted in 1994 to develop standardized data collection procedures for assessing the quality of aquatic habitat and for sampling benthic macroinvertebrate and fish communities (Wilton 1996). Approximately 100 reference sites were sampled during the initial reference site sampling period 1994-1998; an additional 75 sites were sampled with the biocriteria sampling protocol as part of test site sampling and sampling for watershed projects. These data, as well as more recent reference site sampling data from 1999-2004, were used to develop and calibrate indicators of stream biological integrity (Wilton 2004) and biological assessment criteria used in assessments of aquatic life use support for the 2006 Section 305(b) report and all subsequent reports.

The warmwater bioassessment indicators were calibrated for assessing support of Class B(WW-1) and Class B(WW-2) warmwater aquatic life uses in wadeable stream segments. The warmwater indicators were not calibrated for small headwater General Use streams, Class B(WW-3) streams or non-wadeable warmwater rivers having watershed drainage areas > 500 mi^2. In the absence of specifically calibrated indicators for these types of warmwater lotic systems, the current warmwater indicators and criteria have been applied; however, these assessments are considered "evaluated" rather than "monitored" to reflect a greater degree of uncertainty in the assessment conclusions. A Coldwater Benthic Index (CBI) that was developed in 2012 which, along with trout reproduction data from the IDNR Fisheries Bureau, is used for determining the level of support for the Class B(CW-1) aquatic life uses in designated coldwater streams of northeastern Iowa. For smaller Class B(CW-2) systems, the current coldwater indicators and criteria are applied; however, these assessments are considered "evaluated" rather than "monitored" to reflect a greater degree of uncertainty in the assessment conclusions. IDNR is currently developing indicators for both small warmwater headwater and coldwater streams and large warmwater rivers for use in aquatic life use assessments.

Uses designated for individual stream and river reaches in Iowa were updated by the Iowa Department of Natural Resources (IDNR) in 2006 and approved by U.S. EPA in 2008. These updated uses are summarized in Iowa's Surface Water Classification document (http://www.iowadnr.gov/Portals/idnr/uploads/water/standards/files/swcdoc2.pdf). Definitions of designated uses [e.g., Class B(WW1), Class B(WW2), and Class B(CW1)] are presented in the *Iowa Water Quality Standards* (IAC 2014).

The IDNR uses a warmwater Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI), a warmwater Fish Index of Biotic Integrity (FIBI) and a Coldwater Benthic Index (CBI) to summarize biological sampling data. The BMIBI, FIBI and CBI combine several quantitative measurements or "metrics" that provide a broad assessment of stream biological conditions. A metric is a characteristic of the biological community that can be measured reliably and responds predictably to changes in stream quality. The BMIBI and FIBI each contain twelve metrics and the CBI contains nine metrics that relate to species diversity, relative abundance of sensitive and tolerant organisms, and the proportion of individuals belonging to specific feeding and habitat groups. The metrics are numerically ranked and their scores are totaled to obtain an index rating from 0 (poor) – 100 (optimum). Qualitative scoring ranges for the BMIBI and FIBI of poor, fair, good, and excellent have been established that reflect the biological community characteristics found at each level (Table 2-1a, 2-1b). The qualitative scoring ranges of the CBI are still in development. These qualitative ranges are general interpretative guidelines only. To assess support of aquatic life uses, sample site IBI scores are compared against Biological Impairment Criteria (BIC) (Table 2-2), which more specifically reflect reference conditions defined by ecoregion, thermal class and habitat class.

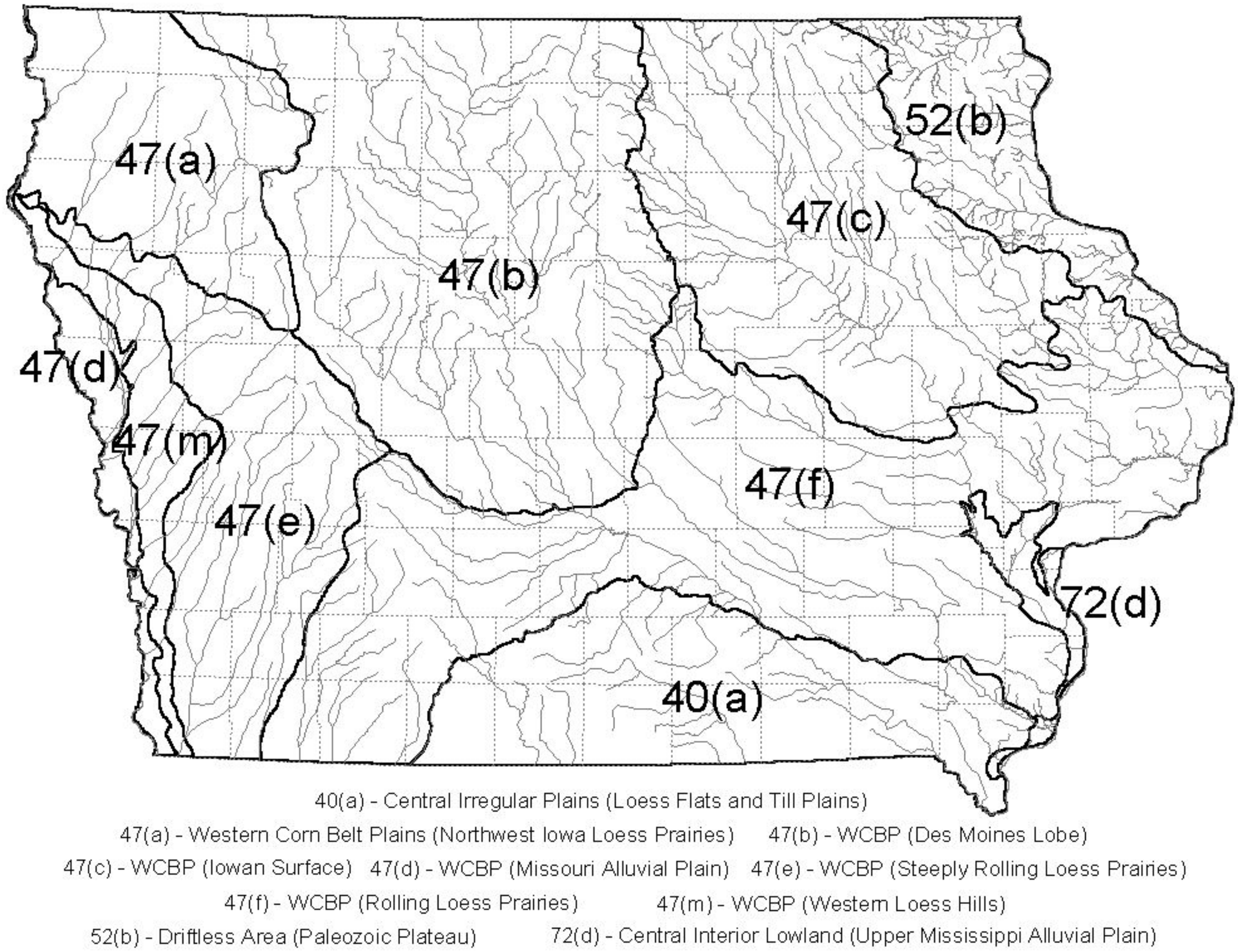


Figure 2-1. Ecological regions (ecoregions) of Iowa (after Chapman et al. 2002).

Determining Support of Aquatic Life Uses:

The primary types and sources of data are: a) benthic macroinvertebrate and fish assemblage data collected as part of the IDNR/SHL stream biocriteria project and b) fish assemblage data collected by staff of the IDNR Fisheries Bureau. Before making assessments, data completeness and quality are evaluated. "Comparable" data are considered as having completeness and quality that is comparable to biocriteria project data used to develop reference biotic indexes and impairment criteria. These data were collected using the proper sampling methodology and are used to make aquatic life use assessments. "Tentative" data are considered as having lesser or uncertain levels of completeness and quality documentation. These data are not used to make aquatic life use assessments but will continue to be used to develop follow-up sampling plans and for other internal uses.

To determine the level of aquatic life use support for a stream sampling site, the BMIBI, FIBI and/or CBI scores from that stream are compared against index levels measured at reference stream sites located in the same ecological region or thermal class. Warm water reference sites are also stratified by habitat class (FIBI) and benthic macroinvertebrate (BM) sampling gear (BMIBI) in certain ecoregions where statistically significant differences have been found between reference sites having abundant coarse (rock) substrates and riffle habitat versus those lacking these habitat characteristics. The 25th percentile values of the reference site BMIBI, FIBI and CBI scores within a given combination of ecoregion, thermal class, habitat class and BM sampling gear are used as the biological impairment criteria (BIC) for 305(b)/303(d) assessment purposes (Table 2-2). Use of the reference 25th percentile as an impairment threshold is consistent with biocriteria development guidance (U.S. EPA 1996), and has demonstrated efficacy in state bioassessment programs (Yoder and Rankin 1995). Biotic index performance evaluation in Iowa found little or no overlap of index interquartile ranges between reference sites and test (impacted) sites, which suggests that reference 25th percentile levels are appropriate for assessing biological impairment.

Generally, a stream is considered biologically impaired if one or both of its index scores are significantly lower than the BIC. An uncertainty adjustment value (UAV) equal to 8 BMIBI or CBI points or 7 FIBI points is applied in cases where single sample data are used to assess aquatic life use support status. The UAV reflects the typical year-to-year IBI scoring variation observed among least disturbed reference sites throughout Iowa. It is used to identify stream segments that are within a reasonable margin of error from the lower 25th percentile of reference site IBI scores. Stream segments assessed using the UAV may be considered a higher priority for follow-up sampling in order to better determine the status of aquatic life uses.

"Monitored" assessments are those for which comparable data are available to assess "calibrated" stream segments, which are defined by: a) Class B(CW1) aquatic life use designation or b) Class B(WW-1) or B(WW-2) and have a watershed drainage area $\leq$ 500 square miles. In both cases, at least two samples must be collected in multiple years in the most recent five year period to be considered "monitored". "Evaluated" assessments are generally of two kinds: 1) cases in which at least two samples have not been collected in multiple years and/or were not collected in the most recent five year period; 2) cases where biotic index data are used to assess "uncalibrated" segments (i.e., General Use, Class B(CW-2), Class B(WW-3) or non-wadeable river segments having watershed drainage area > 500 mi^2).

Aquatic Life Use Support Guidelines:

The following guidelines are used to make aquatic life use status recommendations on the basis of biological sampling data only. In many cases, water quality monitoring data are also available to evaluate aquatic life use status from the perspective of chemical and physical water quality standards attainment. In these cases, a weight of evidence approach is taken to make adjustments and assign the most appropriate aquatic life use status category.

Fully Supporting "Monitored"

- Assessments for calibrated warmwater or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples collected in multiple years during the most recent five year period and all scores (or simple majority of scores) equal or exceed the BIC(s).

Fully Supporting "Evaluated"

- Assessments for calibrated warmwater or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples not collected in multiple years and/or during the most recent five year period and all scores (or simple majority of scores) equal or exceed the BIC(s); *OR,*

- Assessments for calibrated warmwater or coldwater stream segments having comparable data consisting of only one valid BMIBI or CBI and/or FIBI score, and the single score(s) plus the applicable UAV equal or exceed the BIC; *OR,*
- Assessments for uncalibrated segments having comparable data consisting of at least one valid BMIBI score and/or FIBI score, and the score(s) or simple majority of the scores equal(s) or exceed(s) the BIC. In cases of single IBI scores, the applicable UAV will be applied.

Partially Supporting "Monitored"

- Assessments for calibrated warm water or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples collected in multiple years during the most recent five year period and all scores (or simple majority of scores) do not equal or exceed the BIC(s) and not all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b).

Partially Supporting "Evaluated"

- Assessments for calibrated warm water or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples not collected in multiple years and/or not during the most recent five year period and all scores (or simple majority of scores) do not equal or exceed the BIC(s) and not all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b); *OR,*
- Assessments for calibrated warmwater or coldwater stream segments having comparable data consisting of only one valid BMIBI or CBI and/or FIBI score, and the single score(s) plus the applicable UAV do not equal or exceed the BIC and not all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b) ; *OR,*
- Assessments for uncalibrated segments having comparable data consisting of at least one valid BMIBI score and/or FIBI score, and the score(s) or simple majority of the scores do not equal or exceed the BIC and all scores are not in the qualitative range

indicating "poor" biocondition (see Tables 2-1a and 2-1b). In cases of single IBI scores, the applicable UAV will be applied.

Not Supporting "Monitored"

- Assessments for calibrated warm water or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples collected in multiple years during the most recent five year period and all scores (or simple majority of scores) <u>do not</u> equal or exceed the BIC(s) and all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b).

Not Supporting "Evaluated"

- Assessments for calibrated warm water or coldwater stream segments having comparable data consisting of at least two valid BMIBI or CBI scores and/or at least two valid FIBI scores, with the samples <u>not</u> collected in multiple years and/or <u>not</u> during the most recent five year period and all scores (or simple majority of scores) <u>do not</u> equal or exceed the BIC(s) and all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b) ; <u>*OR,*</u>
- Assessments for calibrated warmwater or coldwater stream segments having comparable data consisting of only one valid BMIBI or CBI and/or FIBI score, and the single score(s) plus the applicable UAV <u>do not</u> equal or exceed the BIC and all score(s) are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b) ; <u>*OR,*</u>
- Assessments for uncalibrated segments having comparable data consisting of at least one valid BMIBI score and/or FIBI score, and the score(s) or simple majority of the scores <u>do not</u> equal or exceed the BIC and all scores are in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b). In cases of single IBI scores, the applicable UAV will be applied.

For a detailed flow chart on how the biological aquatic life use assessments are completed, see Figure 2-2.

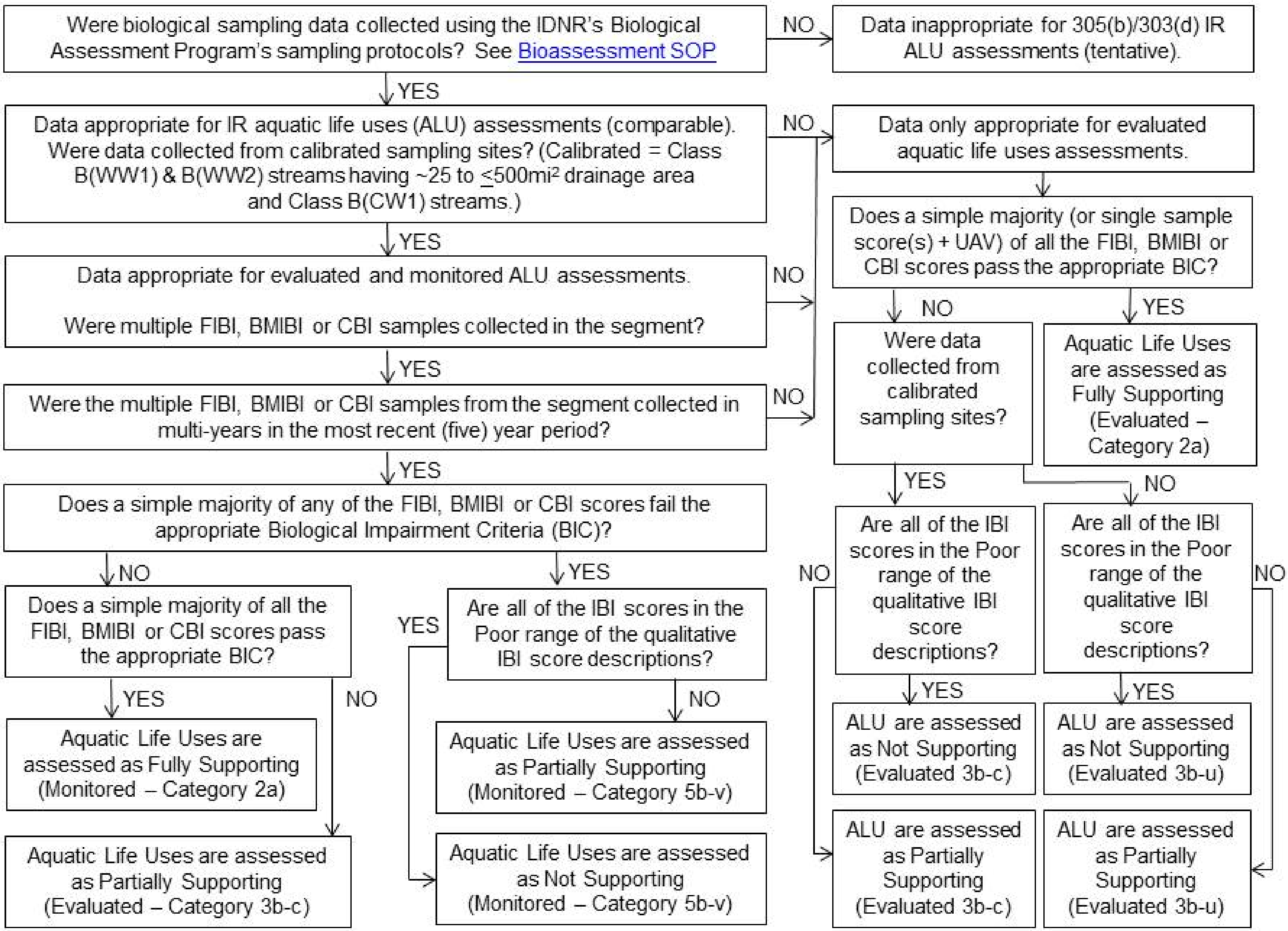


Figure 2-2. Aquatic life use biological assessment flowchart detailing how the IDNR biological assessment methodology is used when completing 305(b)/303(d) IR aquatic life use assessments.

Causes and Sources:

Historically, IDNR tried to assign causes and sources based on the limited water quality and habitat data collected at that same time as the biological data. This was a purely qualitative approach based on best professional judgment. However, that process was discontinued because of the complexity of the causes and sources of aquatic life use impairments. Presently, all aquatic life use impairments, based off of biological data, are assigned "unknown" cause and "unknown" source, with one exception: habitat. In 2015, the IDNR developed the Fish Habitat Indicators for the Assessment of Wadeable, Warmwater Streams document (http://publications.iowa.gov/21408/). This document contains a new quantitative habitat index, and comparison approach, that is used to determine if the physical habitat in the sampling reach is suppressing the fish community (FIBI score) enough that the segment is unable to pass the standard ecoregion BIC. IDNR first used this FIBI/habitat approach for the 2016 IR cycle.

Abbreviations and terms:

ALUS - Aquatic Life Use Support;
BIC - Biological Impairment Criteria/Criterion;
BMIBI - Benthic Macroinvertebrate Index of Biotic Integrity;
CBI - Coldwater Benthic Index;
FIBI - Fish Index of Biotic Integrity;
IDNR – Iowa Department of Natural Resources
UAV - Uncertainty Adjustment Value (8 pts. BMIBI, 8 pts. CBI, 7 pts. FIBI);
Calibrated – CW stream segments designated as B(CW-1) or WW stream segments designated as B(WW-1) or B(WW-2) and have a watershed drainage area $\leq$ 500 mi^2.
Uncalibrated – General Use, Class B(WW-3) or Class B(CW-2) segments or non-wadeable river segments having watershed drainage area > 500 mi^2.
Comparable - Data considered as having completeness and quality that is comparable to biocriteria project data used to develop reference biotic indexes and impairment criteria.
Tentative - Data considered as having lesser or uncertain levels of completeness and quality documentation.

Table 2-1(a). Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) qualitative scoring ranges.

Biological Condition Rating	**Characteristics of Benthic Macroinvertebrate Assemblage**
76-100 (Excellent)	High numbers of taxa are present, including many sensitive species. EPT taxa are very diverse and dominate the benthic macroinvertebrate assemblage in terms of abundance. Habitat and trophic specialists, such as scraper organisms, are present in good numbers. All major functional feeding groups (ffg) are represented, and no particular ffg is excessively dominant. The assemblage is diverse and reasonably balanced with respect to the abundance of each taxon.
56-75 (Good)	Taxa richness is slightly reduced from optimum levels; however, good numbers of taxa are present, including several sensitive species. EPT taxa are fairly diverse and numerically dominate the assemblage. The most-sensitive taxa and some habitat specialists may be reduced in abundance or absent. The assemblage is reasonably balanced, with no taxon excessively dominant. One ffg, often collector-filterers or collector-gatherers, may be somewhat dominant over other ffgs.
31-55 (Fair)	Levels of total taxa richness and EPT taxa richness are noticeably reduced from optimum levels; sensitive species and habitat specialists are rare; EPT taxa still may be dominant in abundance; however, the most-sensitive EPT taxa have been replaced by more-tolerant EPT taxa. The assemblage is not balanced; just a few taxa contribute to the majority of organisms. Collector-filterers or collector-gatherers often comprise more than 50% of the assemblage; representation among other ffgs is low or absent.
0-30 (Poor)	Total taxa richness and EPT taxa richness are low. Sensitive species and habitat specialists are rare or absent. EPT taxa are no longer numerically dominant. A few tolerant organisms typically dominate the assemblage. Trophic structure is unbalanced; collector-filterers or collector-gatherers are often excessively dominant; usually some ffgs are not represented. Abundance of organisms is often low.

Table 2-1(b). Fish Index of Biotic Integrity (FIBI) qualitative scoring guidelines.

71-100 (Excellent)	Fish (excluding tolerant species) are fairly abundant or abundant. A high number of native species are present, including many long-lived, habitat specialist, and sensitive species. Sensitive fish species and species of intermediate pollution tolerance are numerically-dominant. The three most abundant fish species typically comprise 50% or less of the total number of fish. Top carnivores are usually present in appropriate numbers and multiple life stages. Habitat specialists, such as benthic invertivore and simple lithophilous spawning fish are present at near optimal levels. Fish condition is good; typically less than 1% of the total number of fish exhibit external anomalies associated with disease or stress.
51-70 (Good)	Fish (excluding tolerant species) are fairly abundant to very abundant. If high numbers are present, intermediately tolerant species or tolerant species are usually dominant. A moderately high number of fish species belonging to several families are present. The three most abundant fish species typically comprise two-thirds or less of the total number of fish. Several long-lived species and benthic invertivore species are present. One to several sensitive species are usually present. Top carnivore species are usually present in low numbers and often one or more life stages is missing. Species that require silt-free, rock substrate for spawning or feeding are present in low proportion to the total number of fish. Fish condition is good; typically less than 1% of the total number of fish exhibit external anomalies associated with disease or stress.
26-50 (Fair)	Fish abundance ranges from lower than average to very abundant. If fish are abundant, tolerant species are usually dominant. Native fish species usually equal ten or more species. The three most abundant species typically comprise two-thirds or more of the total number of fish. One or more sensitive species, long-lived fish species or benthic habitat specialists such as Catostomids (suckers) are present. Top carnivore species are often, but not always present in low abundance. Species that are able to utilize a wide range of food items including plant, animal and detrital matter are usually more common than specialized feeders, such as benthic invertivore fish. Species that require silt-free, rock substrate for spawning or feeding are typically rare or absent. Fish condition is usually good; however, elevated levels of fish exhibiting external anomalies associated with disease or stress are not unusual.
0-25 (Poor)	Fish abundance is usually lower than normal or, if fish are abundant, the assemblage is dominated by a few or less tolerant species. The number of native fish species present is low. Sensitive species and habitat specialists are absent or extremely rare. The fish assemblage is dominated by just a few ubiquitous species that are tolerant of wide-ranging water quality and habitat conditions. Pioneering species, introduced species, and short-lived fish species are typically the most abundant types of fish. Elevated levels of fish with external physical anomalies are more likely to occur.

Table 2-2. Biological Impairment Criteria (BIC) used for the assessment of rivers and streams in Iowa's Section 305(b)/303(d) Integrated Report listing cycles.

Warm Water Streams and Rivers		
Ecoregion:	FIBI	BMIBI
40a – Central Irregular Plains	33	41
47 – Western Corn Belt Plains (WCBP) Subregions:		
47(a) – WCBP /Northwest Iowa Loess Prairies	43	54
47(b) – WCBP / Des Moines Lobe (Stable Riffle Habitat*) (No Stable Riffle Habitat)	 53 32	 62 62
47(c) – WCBP / Iowan Surface (Stable Riffle Habitat – FIBI, Natural Substrate Sampling - BMIBI) (No Stable Riffle Habitat – FIBI, Artificial Substrate Sampling - BMIBI)	 65 44 	 70 52
47(d) – WCBP / Missouri Alluvial Plain	-	-
47(e) – WCBP / Loess Hills and Rolling Loess Prairies	31	54
47(f) – WCBP / Southern Iowa Rolling Loess Prairies (Mississippi River Drainage System) (Missouri River Drainage System)	 36 31	 51 54
52b – Paleozoic Plateau (Driftless Area)	52	61
72d – Central Interior Lowland	36	51
Coldwater Streams	CBI	
Statewide CW streams (primarily located in 52b and 47c ecoregions).	60	
*Stable riffle habitat = ≥10% riffle macrohabitat, ≥10% cobble substrate and ≥30% total coarse substrate.		

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Attachment 3

THE USE OF THE TROPHIC STATE INDEX TO IDENTIFY WATER QUALITY IMPAIRMENTS IN IOWA LAKES FOR THE 2016 SECTION 305(b) REPORTING AND SECTION 303(d) LISTING CYCLES

Iowa DNR

Water Quality Monitoring & Assessment Section

Water Quality Bureau

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INTRODUCTION

Prior to 2000, relatively little water quality monitoring was conducted on Iowa lakes. Lake surveys in Iowa typically involved sampling in only summer seasons of one year at roughly ten-year intervals (see Bachmann 1965, Bachmann et al. 1980, and Bachmann et al. 1994). This amount of data, although providing a snapshot of lake water quality given the climatic conditions of the specific year of sampling, was not particularly useful for developing a more accurate characterization of lake-specific water quality over the long-term. In addition, due to the general lack of historical data, accurate identification of long-term trends in water quality parameters at most Iowa lakes was not possible. Diagnostic/feasibility studies at Iowa lakes (e.g., Bachmann et al. 1982, Downing et al. 2001), have included more intensive water quality monitoring, but such studies have been conducted on relatively few lakes and are of a relatively short duration (from one to two years). Due to this general lack of data, historical assessments of lake water quality in Iowa, such as those used for Section 305(b) reporting and Section 303(d) listing, had been based primarily on the best professional judgment of Iowa DNR fisheries biologists. The nearly total reliance on best professional judgment, while a valid assessment technique, resulted not only from the lack of routine ambient monitoring at Iowa lakes but also from the lack of state water quality criteria for the parameters that are most likely to indicate lake water quality impairments (e.g., nutrients (nitrogen and phosphorus), chlorophyll, turbidity, and impacts due to the accumulation of sediment in lake basins). Previous (pre-2000) Section 305(b) lake assessments that were based on best professional judgment were supplemented with lake monitoring data to the extent that this information was available (e.g., Bachmann et al. 1982, Bachmann et al. 1994).

Beginning in 2000, however, the first routine ambient monitoring program for Iowa lakes was initiated. This statewide lake survey of 131 publicly-owned Iowa lakes was funded by Iowa DNR and was conducted by ISU from 2000 through 2007 and from 2009 through 2010, and was conducted by the State Hygienic Laboratory at the University of Iowa (SHL) from 2005-2008. This study was designed to be a long-term study capable of providing multiple years of data that can be used to better characterize lake water quality than was possible with the limited data from previous surveys. This ambient lake monitoring program is ongoing.

Similar to Iowa's previous IR cycles, the lake assessment methodology for Iowa's 2016 integrated (305(b)/303(d)) report involves the use of data from the statewide lake surveys conducted by ISU and the SHL from 2010 through 2014 with Carlson's (1977) trophic state index (TSI) to identify lakes that do not fully meet the narrative criteria in Section 61.3(2) of the *Iowa Water Quality Standards*. This general approach has been used for all of Iowa's Integrated Reporting and Section 303(d) listing cycles since 2002. The existence of any lake impairments suggested by a TSI value will be reviewed and corroborated by IDNR field (Fisheries Bureau) staff. This approach is consistent with Iowa's credible data law and allows assessment of water quality impacts due to parameters that currently lack numeric criteria in the *Iowa Water Quality Standards*. The use of TSI values for chlorophyll and Secchi depth serves as an interim method of assessing lake water quality in Iowa until numeric criteria for nutrient parameters (phosphorus and nitrogen) and their response variables (chlorophyll-a and turbidity) are adopted into the *Iowa Water Quality Standards*.

ASSESSMENT RATIONALE

The concept of "trophic state" has long been used by limnologists to classify lakes and is based on the chemistry and biology of lakes. Although a number of approaches exist for classifying lakes according to trophic state, and although a number of variations exist regarding how "trophic state" is defined, the use of this framework has the advantages of historical usage, general acceptance of the trophic state concept (e.g., "eutrophic" indicates nutrient enrichment), and an improved ability to describe lake condition versus a description using a single variable or number (e.g., total phosphorus concentration). Table 3-1 describes the general framework of the lake trophic state concept. For a discussion on the development and variety of trophic state indices, see Chapter 2 (*The Basis for Lake and Reservoir Nutrient Criteria*) in U.S. EPA (2000) (see *http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/lakes/index.cfm*).

Carlson's (1977) trophic state index is a numeric indicator of the continuum of the biomass of suspended algae in lakes and thus reflects a lake's nutrient condition and water transparency. The level of plant biomass is estimated by calculating the TSI value for chlorophyll-a. TSI values for total phosphorus and Secchi depth serve as surrogate measures of the TSI value for chlorophyll. The focus on turbidity in general, and chlorophyll in particular, seems appropriate for assessing the degree to which Iowa lakes support their designated Class A1 (primary contact recreation) uses . Carlson's trophic state index provides a convenient and well-established method for identifying turbidity-related impacts to Iowa lakes. As described in a subsequent paper by Carlson (1991), turbidity, and especially turbidity related to large populations of suspended algae, is a key indicator of the degree to which a lake supports primary contact uses:

> *[plant] biomass is a proximate measure of the problems that plague lakes. Probably few citizens complain about the productivity of their lake and fewer yet lodge complaints about phosphorus concentrations. A biomass-related trophic state definition places the emphasis of the classification on the problem rather than on any potential cause.*

Because of this direct linkage between the perceived level of water quality and turbidity, TSI values for chlorophyll-a and Secchi depth will be used as guidelines to identify Iowa lakes that do not meet Iowa's narrative water quality standards protecting against "aesthetically objectionable conditions". Both chlorophyll-a and Secchi depth appear applicable to Iowa's narrative water quality criterion protecting against aesthetically objectionable conditions in Iowa surface waters (IAC 2014, 61.3(2)). IDNR field (Fisheries Bureau) staff will be contacted to corroborate that the aesthetically objectionable conditions suggested by the TSI values do, in fact, exist. Because aesthetics are more closely associated with recreational uses than to aquatic life uses of Iowa lakes, impairments based on violations of these narrative criteria are typically applied to Class A1 (primary contact recreation) uses for purposes of Section 305(b)/303(d) assessments and listings.

For two reasons, TSI values for total phosphorus are not used as the primary basis for assessing support of either primary contact recreation uses or aquatic life uses:

1. *TSI's for total phosphorus are poor predictors of impairment due to either Secchi depth or chlorophyll-a:* The typical use of the TSI for total phosphorus to

measure trophic state (and the level of water quality) presumes that the relationship between total phosphorus and chlorophyll-a will, more or less, hold for the lake being assessed. The production of chlorophyll in Iowa's natural lakes and impoundments, however, is sometimes limited by nutrients other than phosphorus (e.g., nitrogen) and/or high levels of non-algal turbidity in the water column. Other information suggests that phosphorus is seldom a limiting nutrient in Iowa's nutrient-rich lakes. The result is that lakes with very high levels of total phosphorus that suggest hypereutrophic conditions sometimes have levels of chlorophyll-*a* and Secchi depth that suggest relatively good water quality (i.e., in the middle to lower eutrophic range). As examples, the Iowa lakes in Table 3-2 are those that had TSI values for total phosphorus in the hypereutrophic range (i.e., greater than 70) but that had TSI values for chlorophyll-a and Secchi depth less than the impairment trigger of TSI=65. Examples of lakes in Iowa with historically high TSI values for total phosphorus but low values for chlorophyll-a and Secchi depth include West Lake Osceola (Clarke County), Saylorville Reservoir (Polk County), and Red Rock Reservoir (Marion County). Thus, while these lakes have very high levels of total phosphorus that might suggest impairment of designated uses, the levels of chlorophyll-a are relatively low and Secchi depths are relatively high and thus do not suggest impairment. Because of this lack of correlation between TSI values for total phosphorus and TSI values for the response variables that define the aesthetically objectionable conditions, TSI values for total phosphorus are not used as the primary basis for determining the level of use support or for identifying water quality impairments at Iowa lakes.

2. The Iowa Water Quality Standards lack water quality criteria—narrative or numeric—that are relevant to impacts of total phosphorus in surface waters. When developing this assessment procedure, careful consideration of Iowa's numeric and narrative criteria in the *Iowa Water Quality Standards* showed that none of these criteria are directly relevant to levels of phosphorus in the water column of a lake. That is, phosphorus is not a toxic substance at ambient levels seen in Iowa waters. In addition, high levels of phosphorus in Iowa lakes do not necessarily lead to either nuisance aquatic life or aesthetically objectionable conditions. For example, lakes with growths of aquatic macrophytes in littoral zone areas can have high levels of phosphorus but have low levels of chlorophyll-*a* <u>and</u> have good water transparency.

For lakes where assessment information from the IDNR Fisheries Bureau is available, TSI values were also used to supplement assessments of the designated Class B aquatic life uses based on best professional judgment of IDNR fisheries biologists. According to biologists in the IDNR Fisheries Bureau, algal blooms can also cause impairments to aquatic life uses of Iowa lakes through interference with some spawning activities of nest building species, e.g., Bluegill, Bullhead, crappie and Largemouth Bass) and lowered levels (sags) of dissolved oxygen that, in extreme cases, can cause fish mortality.

IDENTIFYING WATER QUALITY IMPAIRMENTS AT IOWA LAKES BASED ON TSI:

For purposes of developing water quality assessments for the 2016 Section 305(b) reporting cycle, Carlson's (1977, 1984, 1991) "trophic state index" (TSI) values were calculated using the data generated from approximately 130 Iowa lakes as part of ISU and SHL surveys from 2010 through 2014. Overall (five-year) median values were used to calculate TSI values for total phosphorus, chlorophyll-a, and Secchi depth for each lake. The identification of an impairment of the primary contact uses was based on TSI values for chlorophyll-a and/or Secchi depth. The TSI values for the indicator variable of total phosphorus are used primarily to interpret discrepancies between TSI values for chlorophyll-a and Secchi depth.

Relevant state water quality criteria:

The *Iowa Water Quality Standards* (IAC 2014) do not contain numeric criteria for nutrients (e.g., nitrogen or phosphorus), chlorophyll, or turbidity that apply to Class A1 uses. Thus, the assessments of the degree to which the these parameters might impair the Class A1 uses are based on a comparison of lake-specific TSI values to the following narrative criteria for general use waters as defined in Section 61.3(2) of the *Iowa Water Quality Standards*:

> *Such waters shall be free from materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions.*
>
> *Such waters shall be free from substances, attributable to wastewater discharges or agricultural practices, in quantities which would produce undesirable or nuisance aquatic* life;

Examples of *aesthetically objectionable conditions* include poor water transparency caused by blooms of algae or high levels of non-algal turbidity that make the lake less desirable (aesthetically unpleasing) for primary contact recreation. Cyanobacteria blooms can also cause *aesthetically objectionable conditions* due to their ability to create unpleasant floating scums on the water surface or unpleasant odors, both of which can limit the primary contact recreation uses at a lake. In addition, cyanobacteria can be considered a form of *nuisance aquatic life* due to their ability to produce toxins that can adversely affect aquatic life and the uses of the lake for watering by livestock and wildlife. In severe cases, levels of these toxins in lake water can affect human health.

IDNR is aware that some of the *aesthetically objectionable conditions* and/or *undesirable or nuisance aquatic life* at the lakes assessed as "impaired" may not be attributable to either wastewater discharges or agricultural practices. For example, a number of lakes assessed as "impaired" based on TSI values are very shallow (mean depth less than 2 meters) natural lakes of glacial origin with very low watershed-to-surface area ratios. The turbidity-related water quality problems at these lakes, whether caused by algae or suspended inorganic sediments, are due primarily to lack of sufficient water depth to prevent internal nutrient recycling and sediment re-suspension due to either bottom-feeding fish (e.g., Common Carp) and/or wind/wave action. Regardless, the levels of turbidity (whether of algal or non-algal origin) at these lakes constitute limitations to the use of these lakes for their designated beneficial uses. Thus, these lakes are appropriate for addition to the state list of impaired waters.

Data sources:

The primary data source for assessing the degree to which Iowa lakes support their designated primary contact uses is chlorophyll-a and Secchi depth values generated for approximately 130 Iowa lakes sampled as part of the ISU and SHL surveys from 2010 through 2014. Data for inorganic suspended solids and total phosphorus from these surveys were also used to interpret TSI values and to provide a more complete assessment of lake water quality. Information from the IDNR Fisheries Bureau on recent water quality conditions/problems, the status of fish populations, and on lake history was used where appropriate to supplement assessments based on TSI values for chlorophyll-a and/or Secchi depth and to verify the existence of any "aesthetically objectionable condition" suggested by TSI values. In addition, information on lake phytoplankton communities from the ISU and SHL surveys was used to determine the amount and proportion of cyanobacteria in the water column. The amount of cyanobacteria was used to determine potential impairments due to nuisance aquatic life.

Data requirements for listing:

Data quantity:

In 1990, in order to improve the accuracy and confidence level of Section 305(b) water quality assessments, IDNR developed "data completeness guidelines" for using results of routine water quality monitoring. With the advent of Section 303(d) listing in the late 1990s, these state guidelines were used to identify the numbers of samples needed for water quality assessments that could support Section 303(d) listings (i.e., *monitored* assessments). Assessments based on less than the recommended number of samples are considered "evaluated"; these assessments are of lower confidence than "monitored" assessments and are thus not appropriate for Section 303(d) impaired waters listing but are appropriate for Section 305(b) water quality reporting. In order to account for the year-to-year variability in lake water quality, state limnologists participating in the U.S. EPA Region 7 nutrient criteria regional technical assistance group (RTAG) (IA, KS, MO, NE) recommend in 2001 that the combined data from at least three years of monitoring conducted from three to five times per year should be used to characterize lake water quality and to identify water quality impairments. This recommendation has been incorporated into IDNR's data completeness guidelines. Thus, for purposes of Iowa's 2016 Integrated Report, overall median water quality values from the five-year period from 2010 through 2014 (approximately 15 samples) will be used to calculate TSI values to determine the existence of an impairment. As is typical in all monitoring networks, special circumstances occasionally prevent either sample collection (e.g., adverse weather conditions) or the reporting of data (e.g., laboratory accidents). For purposes of identifying candidate lakes for Iowa's impaired waters list, only those lakes with at least 10 samples each for chlorophyll-a and Secchi depth over the five-year period will be considered to meet IDNR's data completeness guidelines. Assessments for lakes with fewer than 10 samples for this period will be considered "evaluated" and thus will not be used to identify candidate lakes for impaired waters listing. Other lake water quality datasets appropriate for calculating TSI values will be reviewed to determine compliance with Iowa DNR's data completeness guidelines.

<u>Data quality:</u>

As specified in the 2001 Iowa Code, Section 455B.194, subsection 1, (Iowa's credible data law) the department shall use credible data when determining whether any water of the state is to be placed on or removed from any Section 303(d) list (Category 5 of the Integrated Report). In addition, Iowa's credible data law specifies that data more than five years before the end of the most current Section 305(b) period (for the 2016 IR, the end of calendar year 2014) are presumed under state law to be "not credible" unless IDNR identifies compelling reasons as to why the older data are credible. Data generated by the ISU lake survey and through the SHL lake monitoring network meet all requirements of Iowa's credible data law and can thus be used to add waters to Iowa's impaired waters list. Other datasets appropriate for calculating TSI values will be reviewed to determine compliance with Iowa's credible data law.

Threshold TSI values:

Similar to Iowa's five previous IR reporting/listing cycles, a TSI value of greater than or equal to 65 for either chlorophyll-a or Secchi depth will be used to identify candidate lakes for Category 5 of Iowa's 2016 Integrated Report (see Table 1 for a description of the "Integrated Report" categories). This threshold is similar to that used by the Minnesota Pollution Control Agency for lakes in the Western Corn Belt Plains ecoregion of southern Minnesota (MPCA 2005). Nearly the entire state of Iowa lies in this same ecoregion, the exceptions being (1) the portion of south-central and southeastern Iowa in the Central Irregular Plains ecoregion and (2) the portion of northeastern Iowa in the Driftless Area ecoregion. Lakes with TSI values greater than or equal to 65 are likely to have nutrient or sediment-related water quality problems that contribute to excessive turbidity (algal or non-algal) that impair the Class A1 uses and are thus potential candidates for Section 303(d) listing.

Assessment categories ("monitored" and "evaluated"):

Prior to recent revisions to guidance for state compliance with Sections 305(b) and 303(d) of the Clean Water Act (U.S. EPA 2003, 2005), U.S. EPA (1997) recommended that states identify water quality assessments as one of two types: evaluated or monitored. "Evaluated" assessments are those based on data older than five years or other than site-specific ambient monitoring data (e.g., questionnaire surveys of fish and game biologists [=best professional judgment] or predictive modeling using estimated input values) and thus are of relatively low confidence. In contrast, "monitored" assessments are based primarily on recent, site-specific ambient monitoring data and thus are of relatively high confidence. IDNR has historically not considered waterbodies identified as impaired based on evaluated (lower confidence) assessments as candidates for the state's Section 303(d) list. IDNR has, however, historically considered waterbodies identified as impaired based on monitored (higher confidence) assessments as candidates for the state's Section 303(d) list. In order to maintain continuity with past assessment procedures, and due to the usefulness of EPA's (1997) recommendation, IDNR continues to (1) identify each assessment of lake water quality as either evaluated or monitored and (2) consider only lakes with recent site-specific data ("monitored" assessments) as candidates for Section 303(d) listing. Similar to listings for other types of waterbodies, however, once a lake is added to the state's Section 303(d) list, the lake will remain on the list until new data or some other good cause suggests that the lake should be removed from Iowa's list. Age of data is not an acceptable reason for removing waters from the state's Section 303(d) list.

Use support categories:

The following are detailed descriptions of the use support categories used for Section 305(b) lake assessments. This approach is the same as that used for previous assessment/listing cycles in Iowa. The TSI values associated with each of these use support categories are summarized in Table 3-3. Any impairments (i.e., "aesthetically objectionable conditions") suggested by TSI values for chlorophyll-a and/or Secchi depth are verified by IDNR field (Fisheries) staff.

<u>Not Supporting and "monitored": candidate for Section 303(d) listing:</u>

> If the overall (2010-2014) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is greater than or equal to 70, then the lake should be assessed as "<u>not supporting</u>" designated uses, and the lake should considered as a candidate for Section 303(d) listing. These lakes are likely to have severe turbidity-related impacts, of either algal or non-algal origin that (1) interfere with designated uses for primary contact recreation and (2) constitute an aesthetically objectionable condition that violates narrative criteria for general use waters as defined in Section 61.3(2) of the *Iowa Water Quality Standards*. The TSI threshold value for chlorophyll-a and/or Secchi depth is the lower limit that identifies "hypereutrophic" lakes (Table 3-1). Thus, this threshold value provides strong evidence of a water quality impairment.

<u>Partially Supporting and "monitored": candidates for Section 303(d) listing:</u>

> If the overall (2010-2014) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is 65 to 69, then the lake should be assessed as "<u>partially supporting</u>" designated uses, and the lake should considered as a candidate for Section 303(d) listing. These lakes are likely to have moderate turbidity-related impacts of either algal or non-algal origin that interfere with designated uses for primary contact recreation. TSI values from 65 to 69 are in the middle to upper range between eutrophic and hypereutrophic lakes (Table 3-1). The chlorophyll-a and Secchi depth threshold values for this use support category (65 to 69) are those used by the Minnesota Pollution Control Agency to identify Section 303(d)-impaired lakes in southern Minnesota (MPCA 2005). As such, this threshold is appropriate for identifying impairments in Iowa lakes.

<u>Partially Supporting and "evaluated": not candidates for Section 303(d) listing:</u>

If the overall (2010-2014) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is 65 to 69, but the TSI value(s) is based on less than sufficient data (<10 samples), then the lake should be assessed as "partially supporting" designated uses but should not be considered a candidate for Section 303(d) listing. These lakes may have turbidity-related impacts, of either algal or non-algal origin, that may interfere with designated uses for primary contact recreation and/or aquatic life. Thus, while the TSI values for Iowa lakes in this category *may* be impaired for Class A1uses, insufficient data are available for developing Section 305(b) assessments having the high degree of confidence needed to justify Section 303(d) listing. These lakes will be placed into Integrated Report Category 3b and will thus be added to Iowa's list of waters in need of further investigation. Note: due to the existence of sufficient data for chlorophyll-a and Secchi depth from lakes in Iowa's ambient lake monitoring program, TSI-based "evaluated" (lower confidence) assessments are rare.

<u>Fully Supporting / Threatened and "monitored": candidates for Section 303(d) listing:</u>

EPA (2005) recommends that states consider as "threatened" those waters that are currently attaining water quality standards but which are expected to <u>not</u> meet water quality standards by the next listing cycle (i.e., with the next two years). For example, a water should be listed if an analysis demonstrates a declining trend in a specific water quality criterion, and the projected trend will result in a failure to meet a criterion by the date of the next list; or, segments should be listed if there are proposed activities that will result in violations of water quality standards.

Lakes with overall (2010-2014) summer median TSI values for chlorophyll-a and Secchi depth of less than 65, but that demonstrate adverse trends in either of these parameters such that impairment is likely for the next (2018) reporting/listing cycle, will be considered "fully supported/threatened (impaired)" and considered candidates for addition to IR Category 5 (Section 303(d) list).

Identifying water quality trends in "threatened" lakes: For the majority of Iowa lakes, sufficient data do not exist to determine the existence of water quality trends prior to 2000. This lack of historical data stems from the design of previous statewide surveys of Iowa lakes which involved sampling during only one summer season at approximately 10-year intervals (e.g., see Bachmann et al. 1980, Bachmann et al. 1994). The year-to-year variability in lake data—due largely to climatic factors—makes the existing historical (i.e., pre-2000) data of little use for trend determination. Due, however, to the continuity of the current lake monitoring program, sufficient data exist since 2000 to begin to identify trends in lake water quality over time. Although this approximately 15-year period provides barely enough data to determine trends, the lake-specific data will be examined to determine the existence of any potential changes in water quality over time. The IDNR/Iowa State University *Iowa Lakes Information System* (http://limnology.eeob.iastate.edu/lakereport/default.aspx) provides annual summaries of TSI values that can be used to quickly examine monitoring data for potential adverse trends in lake clarity.

Fully Supporting (not threatened); "evaluated" or "monitored": not candidates for Section 303(d) listing:

Lakes with overall (2010-2014) summer median TSI values for chlorophyll-a and Secchi depth less than 65 are assessed as "fully supporting" their designated uses for primary contact recreation. These lakes have moderately-good (TSI approaching 65) to sometimes exceptional (TSI < 55) water quality with only brief episodes of marginal water quality conditions. The TSI threshold values for both chlorophyll-a and Secchi depth in this category range from the middle range between eutrophic and hyper-eutrophic lakes to the upper range of mesotrophic lakes. Thus, the range of lake quality in this assessment category is considerable.

The narrative descriptions of these assessments in this database use qualitative characterizations of TSI values (e.g., "good"," poor", "high"; "low"); Table 3-4 summarizes these characterizations.

DE-LISTNG WATER QUALITY IMPAIRMENTS BASED ON TSI:

For lakes on Iowa's Section 303(d) list of impaired waters (IR Category 5), median-based trophic state index (TSI) values for both chlorophyll-a and Secchi depth must be 63 or less for two consecutive Section 305(b)/303(d) cycles before a lake can be removed from this list. A TSI value of 63 indicates a chlorophyll-a concentration of approximately 27 µg/L and a Secchi depth of approximately 0.8 meters. The requirement to have two consecutive 305(b)/303(d) cycles where a previously-impaired lake's TSI values are 63 or less is designed to ensure that a long-term and relatively stable improvement in lake water quality has occurred before de-listing the impairment.

MANAGEMENT AND ACCESSIBILITY OF ASSESSMENTS:

The Section 305(b) assessments of the degree of support of the primary contact recreation (Class A1) and aquatic life (Class B(LW) or B(WW)) uses for the 134 lakes sampled as part of the DNR's lake monitoring programs are entered into Iowa DNR's Section 305(b) assessment database (ADBNet).

Table 3-1. Changes in temperate lake attributes according to trophic state (modified from U.S. EPA 2000, Carlson and Simpson 1996, and Oglesby et al. 1987).

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	eutrophy: anoxic hypolimnia; macrophyte problems possible	[none]	warmwater fisheries only; percid fishery; bass may be dominant
60-70	bluegreen algae dominate; algal scums and macrophyte problems occur	weeds, algal scums, and low transparency discourage swimming and boating	Centrarchid fishery
70-80	hyper-eutrophy (light limited). Dense algae and macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	algal scums; few macrophytes	algal scums, and low transparency discourage swimming and boating	rough fish dominate; summer fish kills possible

Table 3-2. Iowa lakes with overall median TSI values for total phosphorus greater than 70 (=hypereutrophic) that have TSI values for chlorophyll-a and Secchi depth that do not suggest impairment of primary contact recreation (i.e., TSI values of less than 65). TSI values are based on data from the Iowa State University and the State Hygienic Laboratory surveys of 134 Iowa lakes from 2000 through 2010 (N approximately equal to 44); lakes are ranked by the TSI value for total phosphorus.

Lake Name	County	TSI for total phosphorus	TSI for chlorophyll-a	TSI for Secchi depth
Saylorville Reservoir	Polk	81	56	61
Red Rock Reservoir	Marion	78	50	64
West Lake (Osceola)	Clarke	71	60	62

Table 3-3. Summary of ranges of TSI values and measurements for chlorophyll-a and Secchi depth used to define Section 305(b) use support categories for Iowa lakes.

Level of Support	TSI value	Chlorophyll-a (µg/L)	Secchi Depth (m)
fully supported	≤55	*≤12*	*≥1.4*
fully supported / threatened *(candidate for Section 303(d) listing)*	55 → 65	*12 → 33*	*1.4 → 0.7*
partially supported (evaluated: in need of further investigation)	65 → 70	*33 → 55*	*0.7 → 0.5*
partially supported (monitored: candidates for Section 303(d) listing)	65→70	*33 → 55*	*0.7→ 0. 5*
not supported (monitored or evaluated: candidates for Section 303(d) listing)	≥70	*≥55*	*≤0.5*

Table 3-5. Narrative descriptions of TSI ranges for Secchi depth, phosphorus, and chlorophyll-a for Iowa lakes used for the Iowa's Section 305(b) reporting cycles. These characterizations were used in developing lake-specific assessments that are included in the Iowa DNR's Section 305(b) assessment database (ADBNet).

TSI value	Secchi description	Secchi depth (m)	Phosphorus & Chlorophyll-a description	Phosphorus levels (µg/L)	Chlorophyll-a levels (µg/L)
> 75	extremely poor	< 0.35	extremely high	> 136	> 92
70-75	very poor	0.5 – 0.35	very high	96 - 136	55 – 92
65-70	poor	0.71 – 0.5	high	68 – 96	33 – 55
60-65	moderately poor	1.0 – 0.71	moderately high	48 – 68	20 – 33
55-60	relatively good	1.41 – 1.0	relatively low	34 – 48	12 – 20
50-55	very good	2.0 – 1.41	low	24 – 34	7 – 12
< 50	exceptional	> 2.0	extremely low	< 24	< 7

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Attachment 4

METHODOLOGY FOR ASSESSING THE DEGREE TO WHICH IOWA'S SHALLOW NATURAL LAKES SUPPORT THEIR DESIGNATED AQUATIC LIFE USES FOR THE 2016 INTEGRATED REPORTING CYCLE

Iowa DNR
Waters Quality Monitoring & Assessment Section
Water Quality Bureau

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INTRODUCTION:

IDNR has historically relied on the professional judgment of IDNR biologists to assess Iowa's shallow lakes and wetlands due to the lack of (1) monitoring data, (2) appropriate water quality criteria and (3) an assessment protocol. Although assessed for purposes of Section 305(b) reporting, Iowa's wetlands and shallow lakes have typically not been identified as candidates for Section 303(d) impaired waters listing. That is, without water quality monitoring data, and without an assessment protocol to objectively identify the degree to which a shallow lake or wetland supported its designated aquatic life use, IDNR was unable to develop high-confidence assessments that would support a Section 303(d) listing.

In 2006, the IDNR Watershed Monitoring and Assessment Section initiated routine water quality monitoring on several shallow lakes and wetlands in north-central and northwest Iowa. This monitoring has continued through 2014. Thus, for the 2016 assessment/listing cycle, data generated from 2012-14 for total suspended solids and chlorophyll-a from 25 of Iowa's shallow natural lakes of glacial origin (Table 4-1) were again used with guidelines for wetland assessment from the Upper Mississippi River Conservation Committee's Water Quality Technical Section (UMRCC 2003) using total suspended solids and Carlson's (1977) trophic state index for chlorophyll-a to identify the degree to which these shallow lakes support their designated Class B(LW) aquatic life uses. Information from IDNR field staff on the status of aquatic macrophytes and aquatic macroinvertebrates at the shallow lakes monitored will be used to supplement the water quality assessments developed.

ASSESSMENT RATIONALE:

High levels of total suspended solids impact the ability of a shallow lake to support the growth of submersed aquatic vegetation (SAV). Because submersed aquatic vegetation is critical to the health of shallow lake ecosystems, the elimination of SAV can degrade habitat quality such that undesirable aquatic species such as cyanobacteria, Common Carp (*Cyprinus carpio*), and Fathead Minnows (*Pimephales promelas*) dominate the ecosystem.

The concept of "trophic state" has long been used by limnologists to classify lakes and is based on the chemistry and biology of lakes. Although a number of approaches exist for classifying lakes according to trophic state, and although a number of controversies exist regarding how "trophic state" is defined, the use of this framework has the advantages of historical usage, general acceptance of the trophic state concept (e.g., "eutrophic" indicates nutrient enrichment), and an improved ability to describe lake condition versus a description using a single variable or number (e.g., total phosphorus concentration). Table 4-2 describes the general framework of the lake trophic state concept. For a discussion on the development and variety of trophic state indices, see Chapter 2 (*The Basis for Lake and Reservoir Nutrient Criteria*) in U.S. EPA (2000) (see *http://www2.epa.gov/nutrient-policy-data/criteria-development-guidance-lakes-and-reservoirs).*

Carlson's (1977) trophic state index is a numeric indicator of the continuum of the biomass of suspended algae in lakes and thus reflects a lake's nutrient condition and water transparency. The level of plant biomass is estimated by calculating the TSI value for chlorophyll-a. TSI values for Secchi depth serves as surrogate measures of the TSI values for chlorophyll. Carlson's trophic state index provides a convenient and well-established method for identifying turbidity-related impacts to Iowa lakes and thus seems appropriate for assessing the degree to which Iowa's shallow lakes support their designated Class B(LW) aquatic life uses.

Because of the direct linkage between and turbidity and attainment of aquatic life goals, a TSI value for chlorophyll-a will be used to identify shallow lakes in Iowa that do not fully support their designated Class B(LW) aquatic life uses. For the following reason, the TSI value for Secchi depth will not be used to evaluate the attainment of aquatic life goals of shallow lakes. Due to the depth of these shallow lakes, TSI values for Secchi depth can be misleading. In some instances the Secchi disk remains visible at the bottom of the lake and the depth of the lake is recorded as the Secchi depth. In these instances, the water clarity may be sufficient to support the Class B(LW) uses, but the index value is limited by the depth of the lake. Thus, total suspended solids will be used as an indicator of water clarity to determine whether or not the Class B(LW) uses are impaired in these shallow systems.

IDNR field staff will provide available information from surveys for aquatic macrophytes, aquatic macroinvertebrates, and fish populations to supplement the assessment and to corroborate any impairment of aquatic life uses that is identified. IDNR field staff will be contacted to ensure that the TSI-based assessment is consistent with their knowledge of the particular shallow lake.

The connection of total suspended solids and chlorophyll-a (as interpreted by the trophic state index) at shallow lakes to the *Iowa Water Quality Standards* (IAC 2014) is the attainment of the designated Class B(LW) aquatic life use. This use is defined as follows:

> *Lakes and wetlands (Class "B(LW)"). These are artificial and natural impoundments with hydraulic retention times and other physical and chemical characteristics suitable to maintain a balanced community normally associated with lake-like conditions (IAC 2014).*

The goal of Iowa's shallow lakes management strategy is to use techniques such as lake draw-downs and biomanipulation to shift the lake from a turbid, algae-dominated system with little or no rooted aquatic vegetation and a poor-quality sport fishery to a clear-water, macrophyte-dominated state that supports a balanced warmwater aquatic community of fish, aquatic macroinvertebrates, and aquatic vegetation (macrophytes) (IDNR 2008). This total suspended solids and TSI-based assessment method, with its focus on water clarity to promote growth of submersed aquatic vegetation, provides an objective measure of the relative success of IDNR's management strategy.

This methodology applies only to shallow lakes and not to wetlands. For purposes of this assessment/listing cycle, shallow lakes are defined as lakes with maximum depths typically greater than seven feet but less than 15 feet. Shallow lakes typically do not stratify thermally in summer. Abundant rooted aquatic vegetation (macrophytes), including submergent and emergent vegetation, may cover much of a shallow lake. Shallow lakes can support a variety of beneficial uses including boating, fishing, waterfowl production, hunting, aesthetics, and limited swimming. Wetlands have maximum depths typically less than seven feet, often have minimal open water in summer, and are typically not managed as sport fisheries but for waterfowl and wildlife production, hunting, and aesthetics. Wetlands are not managed for swimming uses and lack swimming beaches. Due to limitations in Iowa DNR's Section 305(b) assessment database (*ADBNet*), Iowa's shallow lakes are placed in the "wetland" category.

IDENTIFYING WATER QUALITY IMPAIRMENTS AT SHALLOW LAKES

Overview:

For purposes of developing water quality assessments for the 2016 Section 305(b) reporting cycle, the total suspended solids concentration and Carlson's (1977) "trophic state index" (TSI) were used with the three years of data generated for 25 Iowa shallow lakes as part of Iowa DNR surveys from 2012 through 2014 (Table 4-1). Overall (three-year) summer-season median value for total suspended solids and the TSI value for chlorophyll-*a* were used for each lake. The identification of impairments of the Class B(LW) aquatic life uses was based on the resulting median total suspended solids concentration and median-based TSI value for chlorophyll-a.

Relevant state water quality criteria:

The *Iowa Water Quality Standards* (IAC 2014) do not contain numeric criteria for nutrients (e.g., nitrogen or phosphorus), chlorophyll, or turbidity that apply to Class B(LW) aquatic life uses. Thus, the assessments of the degree to which the Class B(LW) uses supported are based on a determination of whether this use is impaired by turbidity as interpreted through the trophic state index (Carlson 1977) and the UMRCC (2003) benchmarks to protect growth of submersed aquatic vegetation (SAV). The assessments of the degree to which turbidity might impair the Class B(LW) uses of shallow lakes are based on a comparison of lake-specific TSI values to the following narrative criteria for general use waters as defined in Section 61.3(2) of the *Iowa Water Quality Standards*:

> *Such waters shall be free from substances, attributable to wastewater discharges or agricultural practices, in quantities which would produce undesirable or nuisance aquatic* life;

Examples of *undesirable or nuisance aquatic life* include cyanobacteria blooms, blooms of sestonic algae, and dominance by populations of undesirable fish species (e.g., Common Carp). Cyanobacteria can be considered a form of *nuisance aquatic life* due to their ability to produce toxins that can adversely affect aquatic life and the uses of the lake for watering by livestock and wildlife. In severe cases, levels of these toxins in lake water can affect human health.

IDNR is aware that the presence of *undesirable or nuisance aquatic life* at the shallow lakes assessed as "impaired" may not be attributable to either wastewater discharges or agricultural practices. The turbidity-related water quality problems at these shallow lakes, whether caused by algae or suspended inorganic sediments, are due primarily to a dominance of nuisance aquatic life (e.g., Common Carp) that prevents the growth of rooted aquatic vegetation that is needed to stabilize shoreline sediments and improve water clarity. Without rooted aquatic vegetation, nutrient-rich sediments are easily resuspended into the water column by either bottom-feeding fish and/or wind/wave action. Regardless, high levels of turbidity (whether of algal or non-algal origin) at these lakes can limit the ability of the lake to support their designated aquatic life uses. Thus, these lakes are appropriate for addition to the state list of impaired waters.

Data Sources:

Data for total suspended solids and chlorophyll-*a* collected by IDNR staff from 2012 through 2014 will be used. IDNR field staff will also provide information on the status of aquatic macrophyte, macroinvertebrate, and fish communities at the shallow lakes assessed.

Data requirements for listing:

Data quantity:

In 1990, in order to improve the accuracy and confidence level of water quality assessments, IDNR developed "data completeness guidelines" for using results of routine water quality monitoring for Section 305(b) reporting. These state guidelines identify the numbers of samples needed for water quality assessments that can support Section 303(d) listings (i.e., a *monitored* assessment). Assessments based on less than the recommended number of samples are considered "evaluated"; these assessments are of relatively lower confidence than "monitored" assessments and are thus not appropriate for Section 303(d) impaired waters listing but are appropriate for Section 305(b) water quality reporting.

In order to account for the year-to-year variability in lake water quality, state limnologists participating in the U.S. EPA Region 7 nutrient criteria regional technical assistance group (RTAG) (IA, KS, MO, NE) recommend in 2001 that the combined data from at least three years of monitoring conducted from three to five times per year should be used to characterize lake water quality and to identify water quality impairments. This recommendation has been incorporated into IDNR's data completeness guidelines.

Thus, for purposes of Iowa's 2016 Integrated Report, overall summer-season median water quality values from the three-year period from 2012 through 2014 will be used to calculate overall median total suspended solids concentrations and chlorophyll TSI values to determine the existence of a turbidity-related impairment. Only those shallow lakes with at least nine samples for total suspended solids, chlorophyll-a and Secchi depth over the 2012-2014 period will be considered to meet IDNR's data completeness guidelines. Assessments for shallow lakes with fewer than nine samples for this period will be considered "evaluated" (i.e., of lower confidence) and thus will not be used to identify candidate lakes for Section 303(d) impaired waters listing.

Data quality:

As specified in the 2001 Iowa Code, Section 455B.194, subsection 1, (Iowa's credible data law) the department shall use credible data when determining whether any water of the state is to be placed on or removed from any Section 303(d) list (Category 5 of the Integrated Report). In addition, Iowa's credible data law specifies that data more than five years before the end of the most current Section 305(b) period (the end of calendar year 2014) are presumed under state law to be "not credible" unless IDNR identifies compelling reasons as to why the older data are credible. Data generated by the IDNR staff as part of the 2012-2014 shallow lakes surveys meet all requirements of Iowa's credible data law and can thus be used to add shallow lakes to Iowa's 2014 impaired waters list.

Threshold total suspended solids value:

Based on guidelines proposed by the Upper Mississippi River Conservation Committee's Water Quality Technical Section (UMRCC 2003), an overall growing season median concentration of total suspended solids equal to or greater than 30 mg/L will be used to identify candidate shallow lakes for Section 303(d) listing and addition to Category 5 of Iowa's 2016 Integrated Report (see Table 2 for a description of the "Integrated Report" categories). (Note: the original recommended TSS threshold for SAV was 25 mg/L; this threshold was subsequently revised to 30 mg/L (John Sullivan, Wisconsin DNR (retired), personal communication.) Shallow lakes with total suspended solids concentrations greater than or equal to 30 mg/L are likely to have impeded growth of submersed aquatic vegetation. A lack of submersed aquatic vegetation can degrade habitat quality such that undesirable aquatic species such as cyanobacteria, Common Carp, and Fathead Minnows dominate. The presence of nuisance/undesirable aquatic species constitutes an impairment of the Class B(LW) aquatic life uses and therefore makes lakes with a total suspended solids concentration equal to or greater than 30 mg/L candidates for Section 303(d) listing. Shallow lakes with total suspended solids concentrations approaching, but not exceeding, 30 mg/L will also be considered candidates for Section 303(d) listing if data suggest a worsening water quality trend that threatens full support.

Threshold TSI values for chlorophyll:

Similar to the approach for assessing lake water quality that Iowa has used since the 2004 reporting/listing cycle, a TSI value of equal to or greater than 65 for chlorophyll-a will be used to identify candidate shallow lakes for Section 303(d) listing and addition to Category 5 of Iowa's Integrated Report. Lakes with TSI values greater than or equal to 65 are likely to have nutrient water quality problems that contribute to excessive turbidity (algal) that impair the Class B(LW) aquatic life uses and are thus potential candidates for Section 303(d) listing. Shallow lakes with TSI values approaching, but not exceeding, 65 will also be considered candidates for Section 303(d) listing if data suggest a worsening water quality trend that threatens full support. This methodology is similar to that used by the Minnesota Pollution Control Agency for lakes in the Western Corn

Belt Plains ecoregion of southern Minnesota (MPCA 2005). All of Iowa's natural lakes of glacial origin lie within this ecoregion. As explained under *Assessment Rationale*, the TSI value for Secchi depth will not be used to evaluate the attainment of aquatic life goals. Due to the depth of these shallow lakes, TSI values for Secchi depth can be misleading. In some instances the Secchi disk remains visible at the bottom of the lake. In these instances the depth of the lake is recorded as the Secchi depth. The water clarity, therefore, may be sufficient to support the Class B(LW) uses, but the index value is limited by the depth of the lake. This makes the Secchi depth TSI value, an unreliable indicator of water clarity conditions. Total suspended solids will be used as an indicator of water clarity to determine whether or not the Class B(LW) uses are impaired in these shallow systems.

Assessment categories ("monitored" and "evaluated"):

Prior to recent revisions to guidance for state compliance with Sections 305(b) and 303(d) of the Clean Water Act (U.S. EPA 2003, 2005), U.S. EPA (1997) recommended that states identify water quality assessments as one of two types: evaluated or monitored. Evaluated assessments are those based on data older than five years or other than site-specific ambient monitoring data (e.g., questionnaire surveys of fish and game biologists [=best professional judgment] or predictive modeling using estimated input values) and thus are of relatively low confidence. In contrast, monitored assessments are based primarily on recent, site-specific ambient monitoring data and thus are of relatively high confidence. IDNR has historically not considered waterbodies identified as impaired based on evaluated (lower confidence) assessments as candidates for the state's Section 303(d) list. IDNR has, however, historically considered waterbodies identified as impaired based on monitored (higher confidence) assessments as candidates for the state's Section 303(d) list. In order to maintain continuity with past assessment procedures, and due to the usefulness of EPA's (1997) recommendation, IDNR continues to (1) identify each assessment of lake water quality as either evaluated or monitored and (2) only consider lakes with recent site-specific data ("monitored" assessments) as candidates for Section 303(d) listing.

Use support categories:

The following are detailed descriptions of the use support categories used for Section 305(b) shallow lake assessments. The total suspended solids concentrations associated with each of these support categories are summarized in Table 4-3. The chlorophyll-*a* TSI values associated with each of these use support categories are summarized in Table 4-4. This assessment methodology is summarized in Table 4-5. Any impairments suggested by total suspended solids concentrations or TSI values for chlorophyll-*a* are verified by IDNR field staff.

Not Supporting and "monitored": candidate for Section 303(d) listing:

If the overall (2012-2014) shallow lake-specific summer-season median total suspended solids concentration based on at least nine samples is greater than or equal to 50 mg/L, or the summer-season median TSI value for chlorophyll-a based on at least nine samples is greater than or equal to 70, then the lake should be assessed as "not supporting" its designated aquatic life uses, and the lake should considered as a candidate for Section 303(d) listing. These lakes are likely to have severe turbidity-related impacts, of either algal or non-algal origin that prevent the shallow lake from supporting its Class B(LW) aquatic life use. Based on research from Lake Pepin in Minnesota, an average TSS level of 50 mg/L would yield an SAV frequency of about 5%, thus representing a severe depletion but not elimination of SAV (John Sullivan, Wisconsin DNR, personal communication; Sullivan et al. 2009). The TSI threshold value of 70 for chlorophyll-a is the lower limit that identifies "hypereutrophic" lakes (Table 4-2). Thus, this threshold value provides strong evidence of a water quality impairment.

Partially Supporting and "monitored": candidate for Section 303(d) listing:

If the overall (2012-2014) shallow lake-specific median summer total suspended solids concentration based on at least nine samples is 30 to 49 mg/L, or the TSI value for chlorophyll-a based on at least nine samples is between 65 and 70, then the shallow lake should be assessed as "partially supporting" the designated aquatic life uses, and the lake should considered as a candidate for Section 303(d) listing. These shallow lakes are likely to have moderate turbidity-related impacts of algal origin that interfere with support of aquatic life uses. TSI values from 65 to 69 are in the middle to upper range between eutrophic and hypereutrophic lakes. The total suspended solids concentration for this use support category is utilized by the Upper Mississippi River Conservation Committee's Water Quality Technical Section as a threshold to sustain submersed aquatic vegetation in the Upper Mississippi River. The chlorophyll-a threshold values for this use support category (between 65 and 70) are those used by the Minnesota Pollution Control Agency to identify Section 303(d)-impaired lakes in southern Minnesota (MPCA 2005). As such, these thresholds are appropriate for identifying impairments in Iowa lakes.

Partially Supporting and "evaluated": not candidates for Section 303(d) listing:

If the overall (2012-2014) shallow lake-specific median total suspended solids concentration is 30 mg/L to 49 mg/L or the summer TSI value for chlorophyll-a is between 65 and 70, but the total suspended solids and TSI values are based on less than sufficient data (i.e., less than nine samples over the three-year period), then the shallow lake should be assessed as "partially supporting" designated uses but should not be considered a candidate for Section 303(d) listing. These shallow lakes possibly have turbidity-related impacts, of either algal or non-algal origin, that may interfere with support of designated uses for aquatic life. Thus, while the total suspended solids concentration and/or TSI value for Iowa lakes in this category *may* be impaired for Class B(LW) uses, insufficient data are available for developing Section 305(b) assessments having the high degree of confidence needed to justify Section 303(d) listing. These shallow lakes will be placed into Integrated Report categories 2b or 3b and will thus be added to Iowa's list of waters in need of further investigation.

Fully Supporting / Threatened and "monitored": candidates for Section 303(d) listing:

EPA (2005) recommends that states consider as "threatened" those waters that are currently attaining water quality standards but which are expected to not meet water quality standards by the next listing cycle (within the next two years). For example, a water should be listed if an analysis demonstrates a declining trend in a specific water quality criterion, and the projected trend will result in a failure to meet a criterion by the date of the next list (i.e., 2016 for purposes of the 2014 assessment cycle); or, segments should be listed if there are proposed activities that will result in violations of water quality standards.

Shallow lakes with overall (2012-2014) summer-season median total suspended solids concentrations based on at least nine samples of less than 30 mg/L or TSI values for chlorophyll-a based on at least nine sample of less than 65, but that demonstrate adverse trends in any of these parameters such that impairment is likely for the next (2016) reporting/listing cycle, will be considered "fully supported/threatened (impaired)" and considered candidates for addition to IR Category 5 (Section 303(d) list). Because, however, sufficient data do not currently exist to determine the existence of water quality trends at Iowa's shallow lakes, identification of adverse trends will likely not be possible for the 2016 assessment/listing cycle.

Fully Supporting (not threatened); "monitored": not candidates for Section 303(d) listing:

If the overall (2012-2014) shallow lake-specific summer-season median total suspended solids concentrations are less than 30 mg/L and TSI values for chlorophyll-a are less than 65 in the absence of any adverse water quality trend, and the overall median is based on based on at least nine samples, then the lake should be assessed as "fully supporting" its designated aquatic life uses. The assessment type should be considered "monitored" (i.e., of higher confidence), and the water should be placed into Categories 1 or 2a of the Integrated Report. The TSI threshold values for chlorophyll-a in this category range from the middle range between eutrophic and hyper-eutrophic lakes to the upper range of mesotrophic lakes.

Fully Supporting (not threatened); "evaluated": not candidates for Section 303(d) listing:

If the overall (2012-2014) lake-specific summer-season median total suspended solids concentration is less than 30 mg/L and TSI values for both chlorophyll-a or Secchi depth are less than 65 in the absence of any adverse water quality trend, and the overall medians are based on fewer than nine samples, then the lake should be assessed as "fully supporting" its designated aquatic life uses. The assessment type, however, should be indicated as "evaluated" (i.e., of lower confidence).

De-listing TSI and SAV water quality impairments at shallow lakes:

For shallow Iowa lakes assessed as Section 303(d) impaired to be de-listed and/or considered "fully supporting" its designated aquatic life uses, two conditions must be met:

1. The overall (three-year) median-based summer season trophic state index (TSI) values for chlorophyll-a must be 63 or less for two consecutive Section 305(b)/303(d) cycles before a shallow lake can be removed from the state's Section 303(d) list (IR Category 5). A TSI value of 63 indicates a chlorophyll-a concentration of approximately 27 µg/L and a Secchi depth of approximately 0.8 meters. The requirement to have two consecutive 305(b)/303(d) cycles where a previously-impaired lake's TSI values are 63 or less is designed to ensure that a long-term improvement in lake water quality has occurred before de-listing.

2. The overall (three-year) median-based summer season level of total suspended solids (TSS) must be less than 30 mg/L for two consecutive Section 305(b)/303(d) cycles before a shallow lake can be removed from the state's Section 303(d) list (IR Category 5). Median levels of TSS less than 30 mg/L have been shown to be protective of growth of submersed aquatic vegetation (SAV), and SAV is crucial to shallow lake water quality and ecosystem function (UMRCC 2003). The de-listing requirement to have median TSS levels below the impairment threshold of 30 mg/L for two consecutive 305(b)/303(d) cycles is designed to ensure that a long-term improvement in lake water quality has occurred before de-listing.

If either of these conditions is not met, the shallow lake will remain impaired or will be included in IR Category 5 (the state's Section 303(d) list).

MANAGEMENT AND ACCESSIBILITY OF ASSESSMENTS:

The Section 305(b) assessments of the degree of support of the Class B(LW) uses for the shallow lakes sampled as part of the IDNR survey are entered into Iowa DNR's Section 305(b) assessment database (ADBNet).

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Table 4-1. Shallow natural (glacial) lakes monitored by Iowa DNR from 2012 through 2014.

Name	Waterbody ID	Location	County	Designated Uses*	Size (acres)	Year(s) Monitored (2012-2014)
Barringer Slough	06-LSR-1631	S14, T96N, R35W	Clay	B(LW), HH	778	2014
Big Wall Lake	02-IOW-656	S14, T90N, R24W	Wright	B(LW), HH	935	2012-2014
Blue Wing Marsh	06-LSR-1775	S4, T96N, R34W	Palo Alto	B(LW), HH	130	2014
Cheever Lake	04-UDM-6384	S20, T99N, R34W	Emmet	[Not designated]	112	2012-2014
Dan Green Slough	06-LSR-1634	S20, T97N, R35W	Clay	B(LW), HH	311	2012-2014
Diamond Lake	06-LSR-1672	S15, T100N, R37W	Dickinson	B(LW), HH	166	2012, 2014
Eagle Lake	02-IOW-779	S18,T96N,R24W	Hancock	B(LW), HH	906	2012
Elk Lake	06-LSR-1629	S36, T96N, R35W	Clay	B(LW), HH	261	2012-2013
Elm Lake	02-IOW-657	S21, T92N, R24W	Wright	A1, B(WW2), HH	463	2012-2013
Fourmile Lake	04-UDM-1752	S19, T88N, R34W	Emmet	B(LW), HH	209	2012-2014
High Lake	04-UDM-1304	S14, T98N, R33W	Emmet	A1, B(LW), HH	467	2012-2013
Lizard Lake	04-UDM-1281	S22, T91N, R34W	Pocahontas	B(LW), HH	268	2014
Marble Lake	06-LSR-1656	S17, T100N, R36W	Dickinson	B(LW), HH	184	2012-2014
Morse Lake	02-IOW-658	S28, T93N, R24W	Wright	B(LW), HH	108	2012-2013
Pleasant Lake	06-LSR-1649	S7,T99N,R35W	Dickinson	B(LW), HH	77	2013-2014
Prairie Lake	06-LSR-1647	S23,T99N,R36W	Dickinson	B(LW), HH	100	2013
Rice Lake	02-WIN-832	S13,T99N,R23W	Winnebago	A1, B(LW), HH	702	2012
Silver Lake (Worth County)	02-SHL-796	S14,T100N,R22W	Worth	A1, B(LW), HH	316	2013-2014
South Twin Lake	04-RAC-1168	S1, T88N, R33W	Calhoun	B(LW),HH	600	2013
Trumbull Lake	06-LSR-1636	S27,T97N,R35W	Clay	A1, B(LW), HH	1,183	2012, 2014
Twelve-Mile Lake	04-UDM-1231	S21,T98N,R34W	Emmet	B(LW), HH	290	2012-2014
Ventura Marsh	02-WIN-844	S19, T96N, R22W	Cerro Gordo	B(LW),HH	225	2014
West Hottes Lake	06-LSR-1657	S18, T100N, R36W	Dickinson	B(LW),HH	378	2012-2014
West Swan Lake	04-UDM-1754	S31,T99N,R32W	Emmet	B(LW),HH	379	2013-2014
West Swan Lake (center)-Emmet-2	04-UDM-1754	S31,T99N,R32W	Emmet	B(LW),HH	379	2013-2014
West Twin Lake	02-IOW-778	S30,T94N,R24	Hancock	B(LW),HH	109	2013-2014

*Explanations of designated uses from the *Iowa Water Quality Standards*:

Class B(LW): artificial and natural impoundments with hydraulic retention times and other physical and chemical characteristics suitable to maintain a balanced community normally associated with lake-like conditions

Class HH: Waters in which fish are routinely harvested for human consumption

Class A1: Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Table 4-2. Changes in temperate lake attributes according to trophic state (modified from U.S. EPA 2000, Carlson and Simpson 1996, and Oglesby et al. 1987).

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	eutrophy: anoxic hypolimnia; macrophyte problems possible	[none]	warmwater fisheries only; percid fishery; bass may be dominant
60-70	bluegreen algae dominate; algal scums and macrophyte problems occur	weeds, algal scums, and low transparency discourage swimming and boating	Centrarchid fishery
70-80	hyper-eutrophy (light limited). Dense algae and macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	algal scums; few macrophytes	algal scums, and low transparency discourage swimming and boating	rough fish dominate; summer fish kills possible

Table 4-3. Assessment and impairment thresholds for aquatic life uses of shallow lakes in Iowa based on total suspended solids concentrations. Median, summer-season total suspended solids concentrations are calculated for each lake.

Total Suspended Solids Concentration	Rationale for threshold selection:	Assessment Decision:
< 30 mg/L	Water quality is sufficient to support growth of submerged aquatic vegetation (UMRCC 2003).	<u>Full support:</u> total suspended solids concentrations indicate full support of aquatic life uses and Clean Water Act goals.
25 – <30 mg/L	Water quality degrading over time. As total suspended solids concentrations approach 30 mg/L, the frequency of poor water clarity increases, causing the potential for limitation of the growth of submersed aquatic vegetation.	<u>Fully Supported/Threatened / Impaired:</u> Any adverse trends in apparent in data for total suspended solids, however, suggest that full support is "threatened" such that impairment is likely by the time of the next 303(d) listing cycle.
≥ 30 – <50 mg/L	A total suspended solids concentration of 30 mg/L or greater is used by the Upper Mississippi River Conservation Committee Water Quality Technical Section to indicate that submersed aquatic vegetation is inhibited. The inhibition of submersed aquatic vegetation leads to undesirable or nuisance aquatic life.	<u>Partially Supported / Impaired:</u> Water clarity is sufficiently poor that aquatic life uses can be considered moderately impaired.
≥50 mg/L	Total suspended solids concentrations greater than 50 mg/L indicate very poor water transparency and severe limitation of submersed aquatic vegetation.	<u>Not Supported / Impaired:</u> Very poor water transparency suggest that aquatic life uses are severely impaired.

Table 4-4. Assessment and impairment thresholds for aquatic life uses of shallow lakes in Iowa based on trophic state index (TSI) values. TSI values are calculated using an overall three-year summer-season median value for chlorophyll-a and Secchi depth.

TSI value	**Chlorophyll-a (median during growing season)**	**Rationale for threshold selection:**	**Assessment Decision:**
60- < 65	20 to 33 ppb	Water quality is sufficient to support growth of aquatic macrophytes (UMRCC 2003).	<u>Full support:</u> TSI values less than 65 indicate full support of aquatic life uses and Clean Water Act goals.
60- < 65	20 to 33 ppb	Water quality degrading over time. As TSI values approach 65, the frequency of nuisance algal blooms increases and water clarity declines.	<u>Fully Supported/Threatened / Impaired:</u> Any adverse trends in apparent in data for chlorophyll-a however, suggest that full support is "threatened" such that impairment is likely by the time of the next 303(d) listing cycle.
65- ≤ 70	33 to 55 ppb	A TSI value of 65 is used by state of Minnesota as an impairment threshold for chlorophyll-a and Secchi depth in shallow lakes in the southern part of the state (Heiskary and Wilson 2005). TSI values 65 or greater indicate generally poor water transparency such that growth of aquatic macrophytes is suppressed or eliminated.	<u>Partially Supported / Impaired:</u> Water clarity is sufficiently poor that aquatic life uses can be considered moderately impaired.
≥ 70	55 ppb	TSI values above 70 indicate heavy algal blooms in summer; light-limitation; hypereutrophic.	<u>Not Supported / Impaired:</u> Very poor water transparency suggests that aquatic life uses are severely impaired.

Table 4-5. Summary of methodology for assessing support of Class B(LW) aquatic life uses in Iowa's shallow lakes. Based on at least nine samples collected over a three-year monitoring period, the concentration of total suspended solids is the three-year growing season median. The Trophic State Index (TSI) value for chlorophyll-*a* is based on the overall three-year median concentration of chlorophyll-a during the growing season.

Parameter:	**Fully Supporting**	**Fully Supporting / Threatened**	**Partially Supporting**	**Not Supporting**
Total Suspended Solids:	< 30 mg/L	< 30 mg/L	> 30 but < 50 mg/L	> 50 mg/L
	And	*And*	*Or*	*Or*
Chlorophyll-a TSI:	TSI < 65	TSI < 65	TSI > 65 but < 70	TSI > 70
Candidate for 303(d) listing?	**No**	**Yes, if adverse WQ trend in progress**	**Yes**	**Yes**

Attachment 5

METHODOLOGY FOR IDENTIFYING RECOVERY OF IOWA STREAM FISH COMMUNITIES FROM POLLUTANT-CAUSED FISH KILLS

Water Quality Monitoring & Assessment Section and
Watershed Improvement Section,
Water Quality Bureau,
Iowa Department of Natural Resources

Introduction:

The following protocol is designed to provide the biological information needed to determine whether a fish community impacted by a pollutant-caused fish kill event has recovered from that event. This protocol defines thresholds for numbers of fish species (species richness) and fish abundance (catch per unit effort or fish density) that indicate a stream fish community is similar to non-fish kill impacted fish communities in a given ecoregion or watershed. Fish communities in fish kill-impaired stream segments that meet or exceed both these thresholds will be considered to have recovered from a fish kill event, and the associated stream segment will be moved from an impairment category of Iowa's Integrated Report (IR Categories 5 or 4) to a non-impairment category (IR Category 3a).

Background:

Iowa DNR began adding stream segments with pollutant-caused fish kills to the Iowa Section 303(d) lists during the 2002 reporting/listing cycle. Waterbody segments with fish kills where IDNR investigators identified or suspected a pollutant cause were added to the state's impaired waters list. The pollutant-caused fish kill was considered an impairment of the stream's designated (Class B) aquatic life uses. According to IDNR's methodology for the 2002 assessment/listing cycle, if no subsequent kills occurred in the affected waterbody segment for a three-year period following the kill, the fish community and other aquatic communities were assumed to have recovered from the fish kill event, and the impairment would be de-listed.

IDNR's 2002 methodology for de-listing fish kill-impaired assessment segments, however, was rejected by U.S. EPA for the 2008 reporting cycle. EPA informed IDNR that fish kill-impairments identified on wadeable streams could be de-listed only if more recent biological monitoring demonstrated recovery of the aquatic communities from the fish kill event. Unfortunately, the Iowa streams for which most of the fish kills impairments were identified were not (and have not been) targeted for monitoring as part of other IDNR biological assessment projects (e.g., biocriteria and REMAP projects). Given the lack of resources to expand IDNR's biological monitoring program to include fish kill-impaired waters, follow-up biological monitoring with the IDNR bioassessment protocol was not feasible. Based on the results an IDNR study of fish kill recovery (Wilton 2002) that showed some streams recover relatively quickly from a fish kill event (within a few months), IDNR's adoption of EPA's recommendation suggested that at least some fish kill-impaired stream segments would remain identified as Section 303(d) impaired (in IR Category 5) long after the full recovery of aquatic life in the affected waterbody had occurred.

Development of IDNR's fish kill follow-up protocol:

In late 2010, IDNR staff began discussions on a procedure for follow-up monitoring in fish kill-impaired stream segments. A fish kill follow-up biological sampling protocol was proposed for wadeable streams that, while based on IDNR's bioassessment protocol, could be performed by existing IDNR central office staff over a relatively short timeframe without contract employee support, thus reducing the staff resources, cost, and time needed to conduct this monitoring. Because this monitoring protocol does not include all aspects of IDNR's bioassessment protocol (IDNR 2001a)—and thus monitoring results cannot be used for comparison to ecoregion reference conditions—the decision was made to consider any stream showing recovery from a fish kill event as "not assessed" (IR Category 3a) as opposed to "fully supporting" aquatic life uses (IR Categories 1 or 2). Thus, if fish kill follow-up monitoring suggested recovery from a fish kill event, the impairment would be de-listed and moved to the non-impairment category of Iowa's Integrated Report (IR 3a) indicating that there are insufficient data exist to assess support of designated uses.

IDNR staff met with EPA Region 7 staff in July 2011 to discuss this proposal for fish kill follow-up monitoring and the de-listing of fish kill impairments. Region 7 staff were generally supportive of the IDNR proposal.

The following is an overview of the IDNR fish kill follow-up monitoring protocol:

- Fish kill waterbodies on wadeable streams in Categories 5 and 4 are targeted for follow-up monitoring to determine the composition and abundance of the fish community. Typically, fish kill-impaired waters are sampled as part of fish kill follow-up from two to five years following the kill.

- Field sampling is conducted during the July 15-October 15 biomonitoring timeframe as defined by the IDNR bioassessment protocol (IDNR 2001a).

- Sample locations are located within the stream assessment segment identified as affected by the fish kill.

- As recommended by the IDNR bioassessment protocol, the length of stream sampled is set at 30 times the estimated average stream width.

- Fish are sampled in one pass with backpack electrofishing equipment with the size of the sampling crew varying from 2 to 4 depending on stream width. In larger wadeable streams, a second backpack electrofisher is used.

- All fish collected are identified to species, counted, and returned to the stream. Unknown specimens are preserved for later identification.

- Field sheets from fish kill follow-up sampling sessions are scanned and stored on the department's network drive. All calculations and associated comparisons from each sampling event are also stored on the network drive as are the photographs taken to document the field work conducted.

Identifying recovery from the fish kill event:

Two components of the fish community are measured and compared to benchmark values to determine the degree to which the results of fish kill follow-up monitoring indicate recovery from a fish kill event: fish species richness and fish abundance.

1. Comparison of observed to expected fish species richness:

    De-listing threshold: If 50% or more of the regionally expected fish species are present at the fish kill follow-up site, the species richness of the fish community will be considered to have recovered from the fish kill event.

    Expectations for fish species richness in Iowa streams have previously been developed for purposes of Section 305(b) reporting (IDNR 2002; Tables 1 and 2). The 50% species richness threshold value has been used historically by IDNR for 305(b)/303(d) purposes for assessments and listings based on fish survey data (IDNR 2001b) and on freshwater mussel survey data (IDNR 2005). Given the large variability in species richness between watersheds and even between streams within a watershed or ecoregion, the 50% threshold is an appropriate threshold for expected species richness.

If less than 50% of the expected fish species are present, the fish community is considered to not meet regional expectations thus suggesting an ongoing impact from the fish kill event.

2. Comparison of fish abundance (i.e., catch per unit effort or fish density) to benchmark values established through other IDNR biological monitoring projects.

De-listing threshold: If the fish abundance at the fish kill follow-up site (reported as number of fish per 500 feet of stream) equals or exceeds the 25^{th} percentile of the Level IV ecoregion fish abundance estimates from the 2002-2006 Iowa REMAP project, the fish abundance of the stream segment will be considered to have recovered from the fish kill event. The selection of the 25^{th} percentile de-listing threshold is based on the common use of the 25^{th} percentile as an ecoregion reference benchmark. Use of the reference 25^{th} percentile as an impairment threshold is consistent with biocriteria development guidance (U.S. EPA 1996), and has demonstrated efficacy in state bioassessment programs (Yoder and Rankin 1995).

Fish kill impairment de-listing decisions:

If the fish community fails to meet either the species richness threshold or the fish abundance threshold, the stream segment will remain assessed as "impaired" and will remain in IR impairment categories 4 or 5. These stream segments will be considered for additional fish kill follow up sampling and or monitoring with the IDNR Bioassessment protocol to help determine the magnitude of potential aquatic life use impairment.

Fish communities that meet regional expectations for both species richness and abundance are considered to have recovered from the fish kill event. The associated impaired stream assessment segments will thus be removed from IR impairment categories (4 or 5). Because this fish kill follow-up monitoring protocol does not include all aspects of IDNR's biological assessment protocol (IDNR 2001a), recovery of the fish community from kill event does not necessarily indicate "full support" of aquatic life uses. Rather, this protocol is designed to determine whether the fish kill-impacted stream fish community is now similar to other non-fish kill-affected fish communities in a given ecoregion or watershed. Thus, assessment segments identified as recovered are most appropriate for placement in IR Category 3a (insufficient information is available to determine whether the designated use is supported).

References for Attachment 5

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Table 5-1. Expected non-game fish taxa and game fish species of wadeable warmwater streams in Iowa's ecoregions and subecoregions. Expected fish taxa for each region were based on distribution information in Harlan et al. (1987). Subregion 47f (Southern Iowa Rolling Loess Prairies) is split into Missouri River (47f-Mo) and Mississippi River (47f-Mi) sections due to zoogeographic differences; Subregion 72 (Interior River Lowlands) is split into groups of moderate gradient (72-m) and low-gradient (72-l) streams due to ecological differences. Ecoregions and subecoregions are defined according to Omernik 1993. See Table 2 for common and scientific names of Iowa fishes. Table modified from IDNR 2001b.

Ecoregion / Subecoregion->	**40**	**47a**	**47b**	**47c**	**47d**	**47e**	**47f-Mo**	**47f-Mi**	**52**	**72-m**	**72-l**
stoneroller (*Campostoma* spp.)	X	X	X	X					X	X	
Cyprinella spp. (red shiner or spotfin shiner)	X	X	X	X	X	X	X	X		X	
Common Shiner		X	X	X					X	X	
Hornyhead Chub										X	
Golden Shiner											X
Notropis spp. (esp., bigmouth shiner or sand shiner)	X	X	X	X	X	X	X	X	X	X	X
Southern Redbelly Dace									X		
Pimephales spp. (esp., fathead & bluntnose minnows)	X	X	X	X	X	X	X	X	X	X	X
Suckermouth Minnow	X						X	X			
Flathead Chub						X					
Rhinichthys spp.			X	X					X		
Creek Chub	X	X	X	X	X	X	X	X	X	X	
White Sucker / Northern Hog Sucker			X	X				X	X	X	
Ictaluridae spp., (e.g., Black Bullhead, Yellow Bullhead, or Channel Catfish)	X	X	X	X	X	X	X	X		X	X
Redfin Pickerel											X
Blackstripe Topminnow											X
Centrarchidae spp. (excluding lake species)	X	X	X	X	X	X	X	X		X	X
darter species, (esp., Johnny Darter or Fantail Darter)	X	X	X	X				X	X	X	
Expected Number of taxa:	**9**	**9**	**11**	**11**	**6**	**7**	**7**	**9**	**9**	**11**	**7**

Table 5-2. A list of the native and introduced (I) fishes of Iowa.

A list of the native and introduced [I] fishes of Iowa, with nomenclature of Page et al. (2013)*

Petromyzontidae - lampreys	
Ichthyomyzon castaneus	Chestnut Lamprey
Ichthyomyzon fossor	Northern Brook Lamprey
Ichthyomyzon unicuspis	Silver Lamprey
Lethenteron appendix	American Brook Lamprey
Acipenseridae - sturgeons	
Acipenser fulvescens	Lake Sturgeon
Scaphirhynchus albus	Pallid Sturgeon
Scaphirhynchus platorynchus	Shovelnose Sturgeon
Polyodontidae - paddlefishes	
Polyodon spathula	Paddlefish
Lepisosteidae - gars	
Lepisosteus oculatus	Spotted Gar
Lepisosteus osseus	Longnose Gar
Lepisosteus platostomus	Shortnose Gar
Amiidae - bowfins	
Amia calva	Bowfin
Hiodontidae - mooneyes	
Hiodon alosoides	Goldeye
Hiodon tergisus	Mooneye
Anguillidae - freshwater eels	
Anguilla rostrata	American Eel
Clupeidae - herrings	
Alosa chrysochloris	Skipjack Herring
Dorosoma cepedianum	Gizzard Shad
Dorosoma petenense	Threadfin Shad
Cyprinidae - carps and minnows	
Campostoma anomalum	Central Stoneroller
Campostoma oligolepis	Largescale Stoneroller
Carassius auratus	Goldfish [I]
Chrosomus erythrogaster	Southern Redbelly Dace
Clinostomus elongatus	Redside Dace
Couesius plumbeus	Lake Chub
Ctenopharyngodon idella	Grass Carp [I]
Cyprinella lutrensis	Red Shiner
Cyprinella spiloptera	Spotfin Shiner
Cyprinus carpio	Common Carp [I]
Erimystax x-punctata	Gravel Chub
Hybognathus argyritis	Western Silvery Minnow
Hybognathus hankinsoni	Brassy Minnow
Hybognathus nuchalis	Mississippi Silvery Minnow
Hybognathus placitus	Plains Minnow
Hybopsis amnis	Pallid Shiner
Hypophthalmichthys molitrix	Silver Carp [I]
Hypophthalmichthys nobilis	Bighead Carp [I]
Luxilus cornutus	Common Shiner
Lythrurus umbratilis	Redfin Shiner
Macrhybopsis gelida	Sturgeon Chub
Macrhybopsis hyostoma	Shoal Chub
Macrhybopsis meeki	Sicklefin Chub
Macrhybopsis storeriana	Silver Chub
Margariscus margarita	Pearl Dace
Nocomis biguttatus	Hornyhead Chub
Notemigonus crysoleucas	Golden Shiner
Notropis anogenus	Pugnose Shiner
Notropis atherinoides	Emerald Shiner
Notropis blennius	River Shiner
Notropis buchanani	Ghost Shiner
Notropis chalybaeus	Ironcolor Shiner
Notropis dorsalis	Bigmouth Shiner
Notropis heterodon	Blackchin Shiner
Notropis heterolepis	Blacknose Shiner
Notropis hudsonius	Spottail Shiner
Notropis nubilus	Ozark Minnow
Notropis percobromus	Carmine Shiner
Notropis shumardi	Silverband Shiner
Notropis stramineus	Sand Shiner
Notropis texanus	Weed Shiner
Notropis topeka	Topeka Shiner
Notropis volucellus	Mimic Shiner
Notropis wickliffi	Channel Shiner
Opsopoeodus emiliae	Pugnose Minnow
Phenacobius mirabilis	Suckermouth Minnow
Pimephales notatus	Bluntnose minnow
Pimephales promelas	Fathead Minnow
Pimephales vigilax	Bullhead Minnow
Platygobio gracilis	Flathead Chub
Rhinichthys obtusus	Western Blacknose Dace
Rhinichthys cataractae	Longnose Dace
Semotilus atromaculatus	Creek Chub
Catostomidae - suckers	
Carpiodes carpio	River Carpsucker
Carpiodes cyprinus	Quillback
Carpiodes velifer	Highfin Carpsucker
Catostomus commersonii	White Sucker
Cycleptus elongatus	Blue Sucker
Erimyzon sucetta	Lake Chubsucker
Hypentelium nigricans	Northern Hog Sucker
Ictiobus bubalus	Smallmouth Buffalo
Ictiobus cyprinellus	Bigmouth Buffalo
Ictiobus niger	Black Buffalo
Minytrema melanops	Spotted Sucker
Moxostoma anisurum	Silver Redhorse
Moxostoma carinatum	River Redhorse
Moxostoma duquesnei	Black Redhorse
Moxostoma erythrurum	Golden Redhorse
Moxostoma macrolepidotum	Shorthead Redhorse
Moxostoma valenciennesi	Greater Redhorse

Page 2 of 2.

A list of the native and introduced [I] fishes of Iowa, with nomenclature of Page et al. (2013)*

Ictaluridae - North American catfishes

Ameiurus melas	Black Bullhead
Ameiurus natalis	Yellow Bullhead
Ameiurus nebulosus	Brown Bullhead
Ictalurus furcatus	Blue Catfish
Ictalurus punctatus	Channel Catfish
Noturus exilis	Slender Madtom
Noturus flavus	Stonecat
Noturus gyrinus	Tadpole Madtom
Noturus nocturnus	Freckled Madtom
Pylodictis olivaris	Flathead Catfish

Esocidae - pikes

Esox americanus	Redfin Pickerel*
Esox lucius	Northern Pike
Esox masquinongy	Muskellunge
Umbra limi	Central Mudminnow

Osmeridae- smelts

Osmerus mordax	Rainbow Smelt [I]

Salmonidae - trouts and salmons

Oncorhynchus mykiss	Rainbow Trout [I]
Salmo trutta	Brown Trout [I]
Salvelinus fontinalis	Brook Trout

Percopsidae - trout-perches

Percopsis omiscomaycus	Trout-perch

Aphredoderidae - pirate perches

Aphredoderus sayanus	Pirate Perch

Gadidae - cods

Lota lota	Burbot

Atherinopsidae - New World silversides

Labidesthes sicculus	Brook Silverside

Fundulidae - topminnows

Fundulus diaphanus	Banded Killifish
Fundulus notatus	Blackstripe Topminnow
Fundulus sciadicus	Plains Topminnow

Poeciliidae - livebearers

Gambusia affinis	Western Mosquitofish

Gasterosteidae - sticklebacks

Culaea inconstans	Brook Stickleback

Cottidae - sculpins

Cottus bairdii	Mottled Sculpin
Cottus cognatus	Slimy Sculpin

Moronidae - temperate basses

Morone americana	White Perch [I]
Morone chrysops	White Bass
Morone mississippiensis	Yellow Bass
Morone saxatilis	Striped Bass [I]

Centrarchidae - sunfishes

Ambloplites rupestris	Rock Bass
Lepomis cyanellus	Green Sunfish
Lepomis gibbosus	Pumpkinseed
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted Sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear Sunfish
Lepomis microlophus	Redear Sunfish [I]
Lepomis peltastes	Northern Sunfish
Micropterus dolomieu	Smallmouth Bass
Micropterus punctulatus	Spotted Bass [I]
Micropterus salmoides	Largemouth Bass
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie

Percidae - perches

Ammocrypta clara	Western Sand Darter
Crystallaria asprella	Crystal Darter
Etheostoma asprigene	Mud Darter
Etheostoma caeruleum	Rainbow Darter
Etheostoma chlorosoma	Bluntnose Darter
Etheostoma exile	Iowa Darter
Etheostoma flabellare	Fantail Darter
Etheostoma microperca	Least Darter
Etheostoma nigrum	Johnny Darter
Etheostoma spectabile	Orangethroat Darter
Etheostoma zonale	Banded Darter
Perca flavescens	Yellow Perch
Percina caprodes	Logperch
Percina evides	Gilt Darter
Percina maculata	Blackside Darter
Percina phoxocephala	Slenderhead Darter
Percina shumardi	River Darter
Sander canadensis	Sauger
Sander vitreus	Walleye

Sciaenidae - drums and croakers

Aplodinotus grunniens	Freshwater Drum

*Page, L.M., H. Espinosa-Perez, LT. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak, R.L. Mayden, and J.S. Nelson. 2013. Common and scientific names of fishes from the United States, Canada, and Mexico, 7th Edition. American Fisheries Society, Special Publication 34, Bethesda, MD.

List prepared by John Olson, Iowa DNR

Attachment 6:

Methodology for identifying aquatic life impairments based on results of continuous monitoring for dissolved oxygen

2014

Water Quality Monitoring & Assessment Section and
Watershed Improvement Section,
Water Quality Bureau,
Iowa Department of Natural Resources

Background: Iowa DNR staff have historically used monthly grab sample data for dissolved oxygen (DO) generated by routine ambient monitoring networks for purposes of Section 305(b) water quality assessments and for Section 303(d) impaired waters listings. Impairments of designated aquatic life uses have been identified when monitoring results have shown that significantly greater than 10% of the grab-sample data collected over a three-year period for streams and rivers (approximately 36 samples) and a five-year period for lakes (approximately 15 samples) violated Iowa's quality criteria for dissolved oxygen. In recent years, an increasing amount of continuous monitoring for dissolved oxygen has occurred; this trend is expected to continue. This methodology describes the approach and procedures for using results of continuous monitoring for dissolved oxygen for both Iowa's Section 305(b) assessments and Section 303(d) listings. This methodology is consistent with the Iowa water quality standards (IAC 2014; Table 1) and with Iowa's existing assessment/listing methodology for dissolved oxygen based on results of grab sample monitoring and use of the 10% rule (see IDNR 2013).

Monitoring Rationale: Continuous dissolved oxygen monitoring will be targeted at critical conditions of low stream flow and high water temperatures that typically occur in mid to late summer (e.g., July and August) in Iowa streams. Results of previous grab-sample and continuous DO monitoring have shown mid to late summer to be the most likely times of year when levels of DO are likely to violate water quality criteria and adversely impact aquatic communities. Conversely, results of previous monitoring have not shown impairments due to low DO in Iowa streams and rivers during the higher flows and cooler water temperatures typical of other seasons of the year.

Data quality: All data used to identify Section 303(d) impairments in Iowa must meet requirements of Iowa's credible data law (http://www.iowadnr.gov/Environment/WaterQuality/WaterMonitoring/Data/CredibleDataLaw.aspx):

- "*Credible data*" means scientifically valid chemical, physical, or biological monitoring data collected under a scientifically accepted sampling and analysis plan, including quality control and quality assurance procedures.

- Data dated more than five years before the department's date of listing or other determination under section 455B.194, subsection 1 (Iowa's credible data law), shall be presumed not to be credible data unless the department identifies compelling reasons as to why the data is credible.

Data quantity: In order to use results of continuous DO monitoring for purposes of identifying Section 303(d) impairments, monitoring needs to have been conducted over at least one four-week (28-day) period during mid to late summer (e.g., July and August) in each of two different years within a five-year period. For any 28-day monitoring period, a minimum data interval of two consecutive weeks (14 days) is needed to adequately assess dissolved oxygen levels during critical (late summer) periods. IDNR staff will evaluate stream flow levels, air temperatures, and/or precipitation patterns that existed during deployment in order to determine whether monitoring equipment was deployed during the target conditions.

Table 6-1. Iowa's dissolved oxygen criteria for protecting designated aquatic life uses as specified in the *Iowa Water Quality Standards* (IAC 2014):

Classification:	**B(CW1)**	**B(CW2)**	**B(WW-1)**	**B(WW-2)**	**B(WW-3)**	**B(LW)**
Waterbody Type:	*Coldwater streams*		*Warmwater streams/rivers*			*Lake/wetland*
Minimum for 16 hours of a 24-hour period	7.0	7.0	5.0	5.0	5.0	5.0*
Minimum during a 24-hour period	5.0	5.0	5.0	4.0	4.0	5.0*

**applies only to the upper layer of stratification in lakes*

Identifying violations of Iowa's dissolved oxygen criteria using continuous data for dissolved oxygen: A violation of Iowa's dissolved oxygen criteria based on continuous monitoring data will be identified if results of continuous monitoring show that either of the following conditions has occurred:

- Levels of dissolved oxygen fail to meet the 16-hour criterion for more than 8 hours of a 24-hour period. In the context of continuous monitoring for dissolved oxygen, a violation would be a day where levels of dissolved oxygen failed to remain above the 16-hour criterion for at least 16 hours.

- Levels of dissolved oxygen fail to meet the 24-hour criterion. In the context of continuous monitoring for dissolved oxygen, a violation of this criterion would be a day (24-hour period) when the dissolved oxygen falls below the 24-hour criterion.

Identifying impairments of aquatic life uses based on continuous monitoring data for dissolved oxygen: Based on a 28-day deployment of continuous dissolved oxygen monitoring equipment, a Section 303(d) impairment of designated aquatic life uses will be identified if any of the following conditions occurs during each of two 28-day monitoring periods during different years within a five-year period:

- Significantly greater than 10% of the days monitored have levels of dissolved oxygen that fail to meet the 16-hour criterion for more than 8 hours of the 24-hour period.
    - Impairment based on this provision in the absence of impairment due to violations of the 24-hour criterion would suggest potential chronic impacts to the aquatic community.

- Significantly greater than 10% of the days monitored have levels of dissolved oxygen that fail to meet the 24-hour minimum DO criterion.
    - Impairments based on this provision would suggest relatively short-term and more severe impacts to the aquatic community from low dissolved oxygen.

As is done for other applications of the 10 percent rule for grab sample data in Iowa's assessment/listing methodology, guidelines developed by Lin at al. (2000) will be used to determine whether the number of days in violation of Iowa's dissolved oxygen criteria represent a significant exceedance of the 10% rule with a greater than 90 percent confidence. This approach is based on the binomial method for estimating the probability of committing Type I errors (incorrectly identifying an impairment were no impairment exists) and Type II errors (incorrectly assessing an impaired water as "fully supporting") (see Table 6-2). IDNR first used this binomial-based approach for identifying impairments based on violations of the 10% rule for the 2006 305(b)/303(d) assessment-listing cycle and has continued to use this approach.

Table 6-2. Sample size and number of exceedances required to determine an impaired beneficial use (10% exceedance) to maintain a greater than 90 percent confidence level as reported by Lin et al. (2000) (table excerpted from NDEQ 2006).

Minimum number of exceedances required to maintain a >90% confidence that a designated use is impaired (10% exceedance).					
Sample Size (n)	**Number of observations exceeding required to define an impaired use**	**Confidence Level**	**Sample Size (n)**	**Number of observations exceeding required to define an impaired use**	**Confidence Level**
10	3	0.930	56	10	0.951
11	3	0.910	57	10	0.945
12	4	0.974	58	10	0.940
13	4	0.966	59	10	0.933
14	4	0.956	60	10	0.927
15	4	0.944	61	10	0.920
16	4	0.932	62	10	0.913
17	4	0.917	63	10	0.905
18	4	0.911	64	11	0.948
19	5	0.965	65	11	0.943
20	5	0.957	66	11	0.938
21	5	0.948	67	11	0.932
22	5	0.938	68	11	0.926
23	5	0.927	69	11	0.920
24	5	0.915	70	11	0.913
25	5	0.902	71	11	0.906
26	6	0.960	72	12	0.947
27	6	0.953	73	12	0.942
28	6	0.945	74	12	0.937
29	6	0.936	75	12	0.931
30	6	0.927	76	12	0.926
31	6	0.917	77	12	0.920
32	6	0.906	78	12	0.913
33	7	0.958	79	12	0.907
34	7	0.952	80	13	0.946
35	7	0.945	81	13	0.942
36	7	0.937	82	13	0.937
37	7	0.929	83	13	0.931
38	7	0.920	84	13	0.926
39	7	0.911	85	13	0.920
40	7	0.900	86	13	0.914
41	8	0.952	87	13	0.908
42	8	0.946	88	13	0.901
43	8	0.939	89	14	0.941
44	8	0.932	90	14	0.937
45	8	0.924	91	14	0.932
46	8	0.916	92	14	0.927
47	8	0.907	93	14	0.921
48	9	0.954	94	14	0.915
49	9	0.948	95	14	0.910
50	9	0.942	96	14	0.903
51	9	0.936	97	15	0.941
52	9	0.929	98	15	0.937
53	9	0.922	99	15	0.932
54	9	0.914	100	15	0.927
55	9	0.906			

Identifying waters in need of further investigation: As provided for in Iowa's credible data law, Iowa's list of waters in need of further investigation (WINOFI) is not part of the Section 303(d) process in Iowa but includes waterbodies where limited information suggests, but does not credibly demonstrate, a water quality impairment. The state's WINOFI list is comprised of those waterbodies assessed (evaluated) as potentially "impaired"; that is, the assessment of a designated use in these waterbodies as "impaired" is based on less than complete information; thus, the assessment is of relatively low confidence and is not appropriate for addition to the list of Section 303(d) waterbodies. These potentially-impaired waters are thus placed in subcategories 2b and 3b of the Integrated Report which comprises the list of waters in need of further investigation. The following circumstances will result in waters with continuous DO-based violations of water quality criteria being placed on Iowa's list of waters in need of further investigation (WINOFI).

1. The frequency of DO violations during a 28-day monitoring period in one year, as interpreted for continuous monitoring data, suggests impairment of the designated aquatic life uses, but results from a second 28-day period in a subsequent year of a five-year period are not yet available.

2. Although the violation frequency of dissolved oxygen criteria is significantly greater than the 10% impairment threshold, too few data were available to meet Iowa's data quantity guidelines for identifying Section 303(d) impairments.

3. Although the violation frequency of dissolved oxygen criteria is significantly greater than 10% impairment threshold, the continuous data for dissolved oxygen were generated without an approved quality assurance/work plan in-place.

4. Due to insufficient data, there is less than 90% confidence that the 16-hour and/or 24-hour criteria are not violated significantly more than 10% of the time.

Waters on the WINOFI list require additional monitoring to determine whether addition to Iowa's Section 303(d) list of impaired waters is appropriate.

Overwhelming evidence of impairment: Situations exist where reliable information can accurately indicate a Section 303(d) impairment of designated beneficial uses even though this information does not meet IDNR's data quantity and/or data quality requirements for Section 303(d) listing. Such waterbodies would be considered for addition to Iowa's Section 303(d) list based on overwhelming evidence of impairment. If results of continuous monitoring for dissolved oxygen do not meet either IDNR's data quantity or data quality requirements, but these data suggest significant water quality degradation, these data can be used to consider a waterbody for Section 303(d) listing. For example, if a stream waterbody is monitored for less than the required number of days to support a Section 303(d) listing decision, but the violation frequencies are well into the impairment range (e.g., > 25% of days with violations of the 24-hour DO criterion), then this waterbody can be considered for addition to Iowa's Section 303(d) list. Another example is when the frequency of DO violations during a 28-day monitoring period in one year is > 25%, but results from a second 28-day period in a subsequent year of a five-year period are not yet available. Any decision to invoke overwhelming evidence of impairment based on continuous DO data will be supported by a detailed rationale in Iowa's water quality assessment database (ADBNet) that includes an evaluation of the quality and quality of data available. If data quality or data quantity are judged to be suspect, IDNR will either add the waterbody to the list of waters in need of further investigation or consider the waterbody to be "not assessed".

References

IAC. 2014. Chapter 567-61: water quality standards. Iowa Administrative Code [effective date 07/16/2014].

IDNR. 2013. Methodology for Iowa's 2012 Water Quality Assessment, Listing, and Reporting Pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act. Watershed Monitoring and Assessment Section, Iowa Dept. of Natural Resources. 155 p.

Lin, P., D. Meeter, and X. Niu. 2000. A nonparametric procedure for listing and delisting impaired waters based on criterion exceedances. Technical Report, prepared by Department of Statistics, Florida State University, submitted to the Florida Department of Environmental Protection. 21 p.

NDEQ. 2006. Methodologies for waterbody assessments and development of the 2006 integrated report for Nebraska. Nebraska Department of Environmental Quality, Water Quality Division. 21 p. plus appendix.

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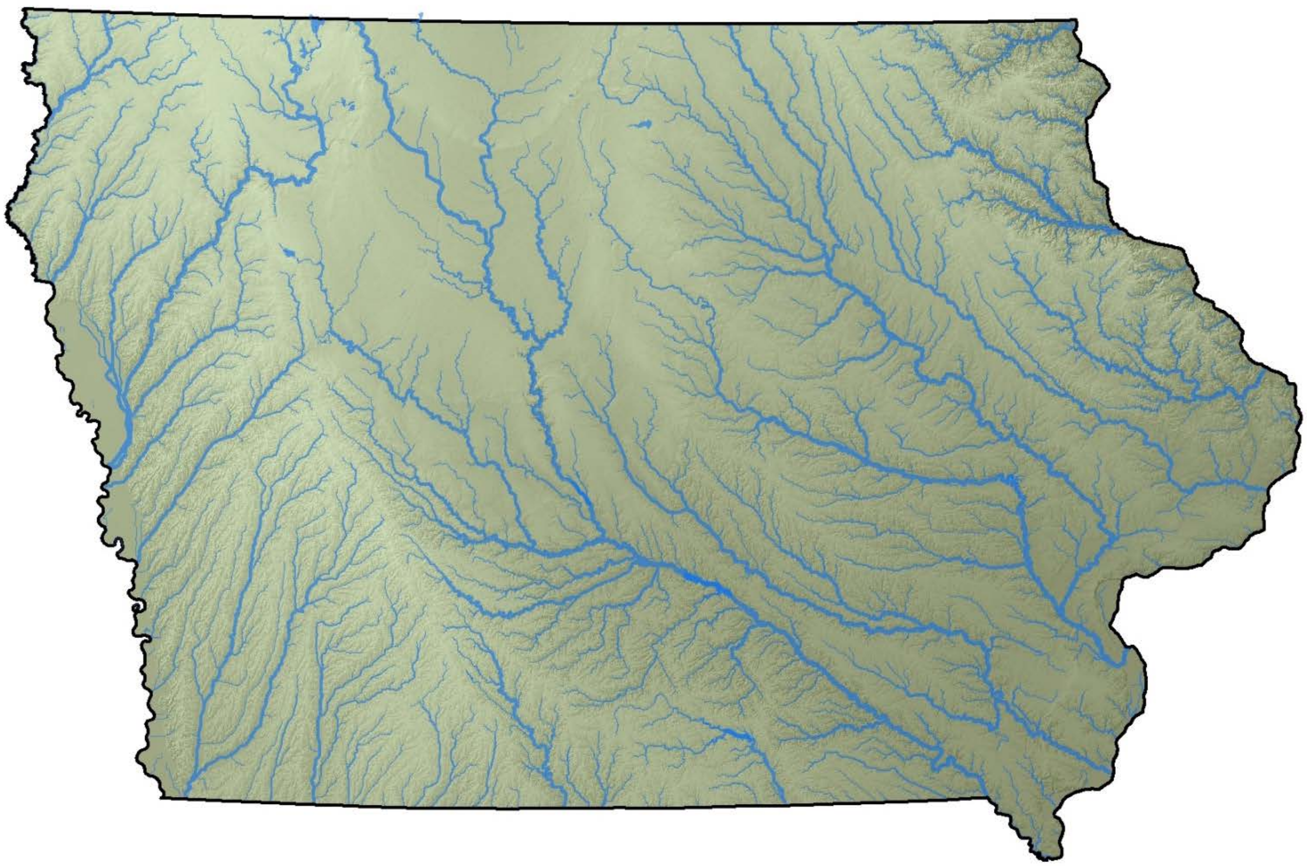
Attachment 7:

State of Iowa



Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program

Updated: March 2017

Introduction -

In August, 2011, the Environmental Protection Agency (EPA) and State program managers began the process of developing a new long-term vision for the Clean Water Act Section 303(d) program. Section 303(d) serves as the middle-man in the Clean Water Act by bridging the gap between Water Quality Standards and monitoring data on one side to implementation activities in the form of permits for point sources and valuable information for nonpoint source watershed projects on the other side. This section of the Clean Water Act is represented by two programs in the Iowa Department of Natural Resources. The first is the Integrated Reporting Program responsible for 305(b) reporting and 303(d) listing. The 303(d) list is commonly referred to as the Impaired Waters List. The Impaired Waters List is submitted to EPA every two years and incorporates water quality monitoring data analyzed against the State of Iowa Water Quality Standards. Inclusion on the Impaired Waters List triggers the need to develop a Total Maximum Daily Load (TMDL) for that water body. The TMDL Program constitutes the second half of Section 303(d) of the Clean Water Act. A TMDL document contains two distinct parts, known colloquially as the "math" and the "path." The "math" refers to the actual TMDL calculation, which sets the total maximum daily load (and usually a longer time step for implementation purposes). This daily load is parsed out between a margin of safety protective of the water body, a sum of Waste Load Allocations to all permitted point sources in the watershed, and the sum of Load Allocations to all nonpoint or non-permitted sources of pollution. The "path" refers to Iowa DNR's efforts at developing implementation and monitoring chapters in the document, which aim to provide a starting point for local planning efforts.

During the first decade of the TMDL Program, TMDL documents were developed as a response to a Consent Decree – a legal requirement to complete TMDLs for all waters listed on the 1998 Impaired Waters List. When Iowa's Consent Decree was officially closed, the State shifted to a new priority for developing TMDL documents. This priority focused on mostly small lake watersheds that held persistent local interest in water quality improvement. The documents were intended to serve as a useful bridge for the Section 319 Program to address nonpoint source pollution. This approach helped provide many potential projects for the Section 319 Program and launched various local watershed improvement projects.

The next iteration of the Section 303(d) programs look to combine successful elements learned throughout the past 15 years in Iowa and throughout the country while responding to new pressures. The Long-Term Vision does not stand as a static document as priorities, funding, personnel, etc. all play a role in how the programs most efficiently and effectively deliver a product that is both defensible and useful to aid in improving water quality. The Long-Term Vision identifies six pillars. Four of these pillars are "load bearing" in that they will play a lead role in all TMDL programs throughout the country: Prioritization, Assessment, Engagement, and Integration. The other two pillars, Protection and Alternatives, allow for creative approaches when a standard TMDL may not be the optimal choice. The ability to develop state specific priorities, engaging appropriate local stakeholders, integrating our work with other program priorities, and employing our creativity in addressing issues better and smarter as they present themselves truly gives rise to a tailored approach.

Prioritization – *For the 2016 integrated reporting cycle and beyond, States review, systematically prioritize, and report priority watersheds or waters for restoration and protection in their biennial integrated reports to facilitate State strategic planning for achieving water quality goals*

Summary:

Iowa DNR prioritizes TMDLs that are able to address impairments on waterbodies with a high potential for social impact. An overwhelming focus of the state of Iowa has been nutrients and nutrient related issues. Additionally, the State of Iowa and its citizens place great value on their lake systems for recreation. As a result, the Iowa DNR will focus first and foremost on lake systems impaired for eutrophic conditions (algae, turbidity, pH), which as of the 2016 Impaired Waters List includes a total of 51 impairments not yet addressed by a TMDL. The Iowa DNR will also pursue a state-wide TMDL for bacteria impaired lake beaches, which includes 33 impairments across the state currently. These swimming beaches are an important element in the recreational aspect of Iowa lakes. Finally, we had planned to prioritize the Skunk River Nitrate TMDL but the impairment was removed on the 2014 list and did not reappear on the 2016 list. That totals 84 priority group 1 TMDLs remaining in the current vision cycle.

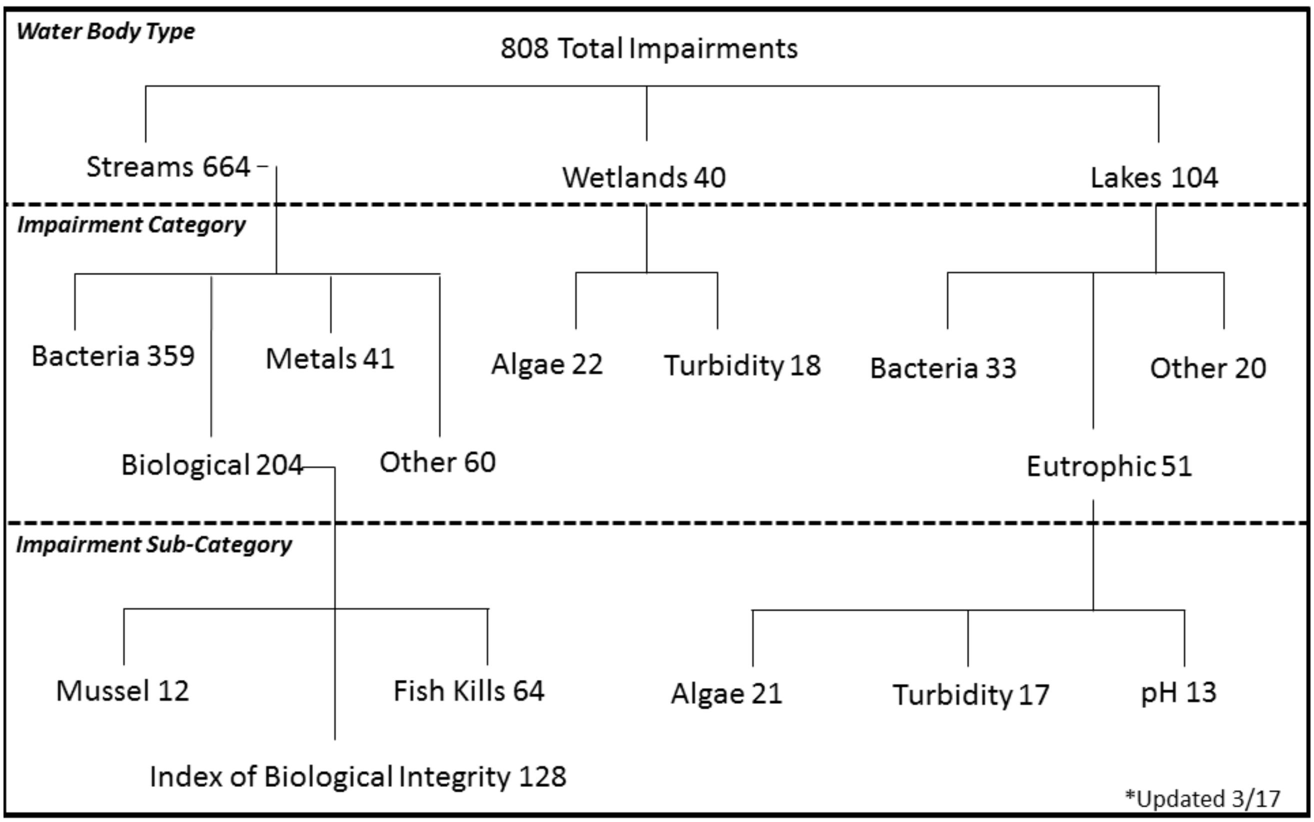


Figure 1 – Breakout of Impaired Waters List

To understand priorities, we must first look at the Impaired Waters List. The TMDL Program's candidate pool for development is restricted to impaired waters on Category 5 of the Integrated Report and, potentially, high quality waters for protection. The 2016 Impaired Waters List contains 808 total impairments (Figure 1). These impairments break out into 664 stream / river impairments, 40 wetland / oxbow impairments and 104 lake impairments.

Stream impairments by pollutant include 359 bacteria, 204 biological, 41 metals, and 60 other. Biological impairments can be further broken out as 128 impairments due to low scores on one or both of the indices of biotic integrity (IBI), 64 from fish kills, and 12 from mussel impairments. Biological impairments are listed in Category 5B of the Impaired Waters List, stated as "Cause Unknown." By definition, these impairments cannot have a TMDL written until a pollutant is identified as the cause of the impairment. Therefore, these impairments may or may not require a TMDL. Traditional methods of determining cause are prohibitively expensive for the TMDL Program. Ideally, these streams would be considered as "requires further investigation" rather than requires a TMDL. A statewide mussel survey is updating the existence of mussel impairments while a Fishkill Follow-up program is doing the same for fish kill impairments. A systematic verification sampling to confirm IBI impairments has been an ongoing effort for the past few years, but also carries a substantial cost. Going forward, impairments verified during these monitoring efforts will undergo a new investigative initiative led by the TMDL Program's staff biologist(s).

Wetland / oxbow systems include 22 algae and 18 turbidity impairments. Wetland impairments are relatively new to the Impaired Waters List and the DNR is currently investigating the usefulness of the TMDL process for impaired wetlands. Oxbow systems are essentially infant wetlands and are, geologically speaking, filling in as nature intended and therefore may not be a good fit for TMDL development. The 104 lake impairments include 33 bacteria, 51 eutrophic, and 20 other pollutant types. The eutrophic impairments can be further broken out to include 21 algae, 17 turbidity, and 13 pH impairments.

Each of these impairment types carries a level of complexity and cost in time and money for the DNR to develop a TMDL. For example, multiple stream bacteria TMDLs in the same river basin could efficiently be developed using a load duration curve approach with a minimal amount of data required. On the other hand, a large complex lake system using advanced modeling techniques would take more time and cost more in terms of data requirements. A river basin bacteria project may produce, say, 15 TMDLs, whereas the same amount of work effort may only produce 1 larger, more complex lake system TMDL.

Additionally, each type of system holds various levels of social impact. Multiple efforts reveal the importance of lake watersheds to the Iowa people, including Iowa State University's research on the local economic impact of lake systems (CARD, 2009 –http://www.card.iastate.edu/environment/nonmarket_valuation/iowa_lakes/). On the flip side, there is relatively little evidence in the potential social impact of reducing bacteria in streams.

Plotting each impairment type on a simple 2x2 plot reveals a path toward prioritization, depicted in Figure 2. The upper left quadrant of the chart includes projects that are relatively high in social impact and relatively low in complexity / cost for development. Projects that clearly fit that description include the smaller lake systems impaired for eutrophic conditions and the Skunk River Nitrate impairment.

The upper right quadrant contains projects that hold a relatively high social impact but are more complex and may have greater data needs for TMDL development. These projects include larger and more complex lake systems, protection TMDLs for some of our high quality resources, or a statewide TMDL for something like beach bacteria impairments. Staffing and funding limitations would limit the DNRs ability to complete a lot of these types of projects.

Quadrant 3 contains stream bacteria projects where there is a low social impact but the investment in development is relatively low. Finally, quadrant 4 includes projects with a relatively low social impact but high in complexity. These are projects that would represent low priorities at this time.

Using this approach, the TMDL Program can more easily decide what projects to select for development that will 1) have a greater potential to be of value to the local users of the resource, and 2) provide a tool that leads to measurable water quality improvement.

Complexity / Cost

Social Impact	Low	High
High	**Priority Group I** Impairments with relatively *high* social impact and a relatively *low* complexity & or cost for development. Example: • Smaller Eutrophic Lake Systems • River Nitrate	**Priority Group II** Impairments with relatively *high* social impact and a relatively *high* complexity & or cost for development. Example: • Larger / Complex Lake Systems • Protection TMDLs • Statewide TMDL
Low	**Priority Group III** Impairments with relatively *low* social impact and a relatively *low* complexity & or cost for development. Example: • Stream Bacteria	**Priority Group IV** Impairments with relatively *low* social impact and a relatively *high* complexity & or cost for development. Example: • Biological Impairments • Lake Mercury Impairments • Metals Impairments

Figure 2 – Prioritization chart

Rotating Basin Approach –

One popular approach for implementing TMDL programs across the country is commonly referred to as the rotating basin approach. While the specifics vary state to state, the essence is to focus on a river basin or group of river basins for a specific amount of time and then move to the next river basin. Employing this approach to TMDL development helps increase efficiency in working with similar resources and can optimize data collection efforts. Additionally, focusing on a specific geographic area could have the potential to influence local decision making with a steady presence of public outreach.

In Iowa, this approach has not been used in the past but is an approach that holds some appeal under the new vision. The state can be divided into 4 major basins as shown in Figure 3; Northeast (Wapsipinicon, Maquoketa, and Turkey Rivers, and Mississippi River Drainages); the Iowa-Cedar; the Des Moines-Skunk; and the Western-Southern.

Focusing on priorities, the TMDL Program can move from basin to basin when finished addressing these priorities. Much of previous TMDL work has been in the Iowa-Cedar River basin and since shifted into tackling projects in the Western - Southern basins. Work into the future will shift to the Des Moines-Skunk basin and finish up in the Northeast basin.

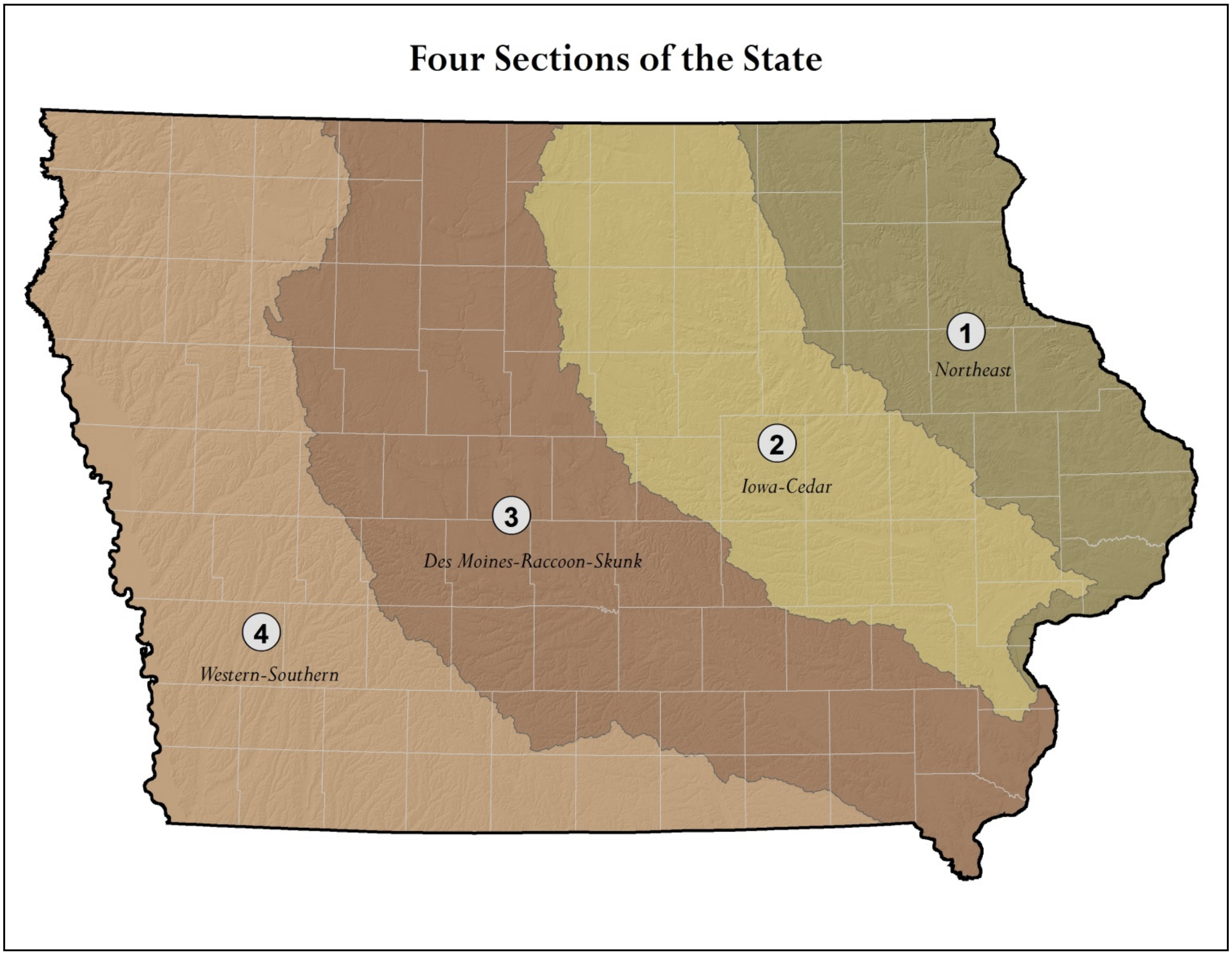


Figure 3 – Basin approach map

Next Level Priorities -

The Iowa DNR will investigate the feasibility of protection TMDLs for the state's Outstanding Iowa Waters. At this time, Iowa DNR is not ready to commit to developing a protection TMDL but will consider it in the future. The Iowa DNR will also potentially investigate wetland and oxbow lake impairments and determine the feasibility of a TMDL on such a system. The state will look into pursuing alternatives to TMDLs to address biological impairments. If there are resources available and the opportunity presents itself, the Iowa DNR will consider developing basin-wide bacteria TMDLs. The DNR is scheduled to complete a basin wide bacteria TMDL for the Iowa River basin.

Flexibility -

Given that a new Impaired Waters List is issued every two years, a certain amount of flexibility will be accounted for in the Vision. After each issuance of the Impaired Waters List, the TMDL program will evaluate any potential new projects that should be added into the priority schedule. For example, new eutrophic lake impairments (Figure 4) will be worked into the system as much as possible as time / money allows. If a new state priority manifests itself between now and the end of 2022, the TMDL Program will work with EPA in discussing a shift toward addressing that new priority. Additionally, some of the projects the Iowa DNR is committing to under the vision may be delisted or be of a lower priority than an impairment issued on a future Impaired Waters List. In that case, the Iowa DNR reserves the right to substitute projects, aiming for the agreed upon total catchment area by 2022 instead of a static list of priorities set in this document.

Maps and Lists of Priorities –

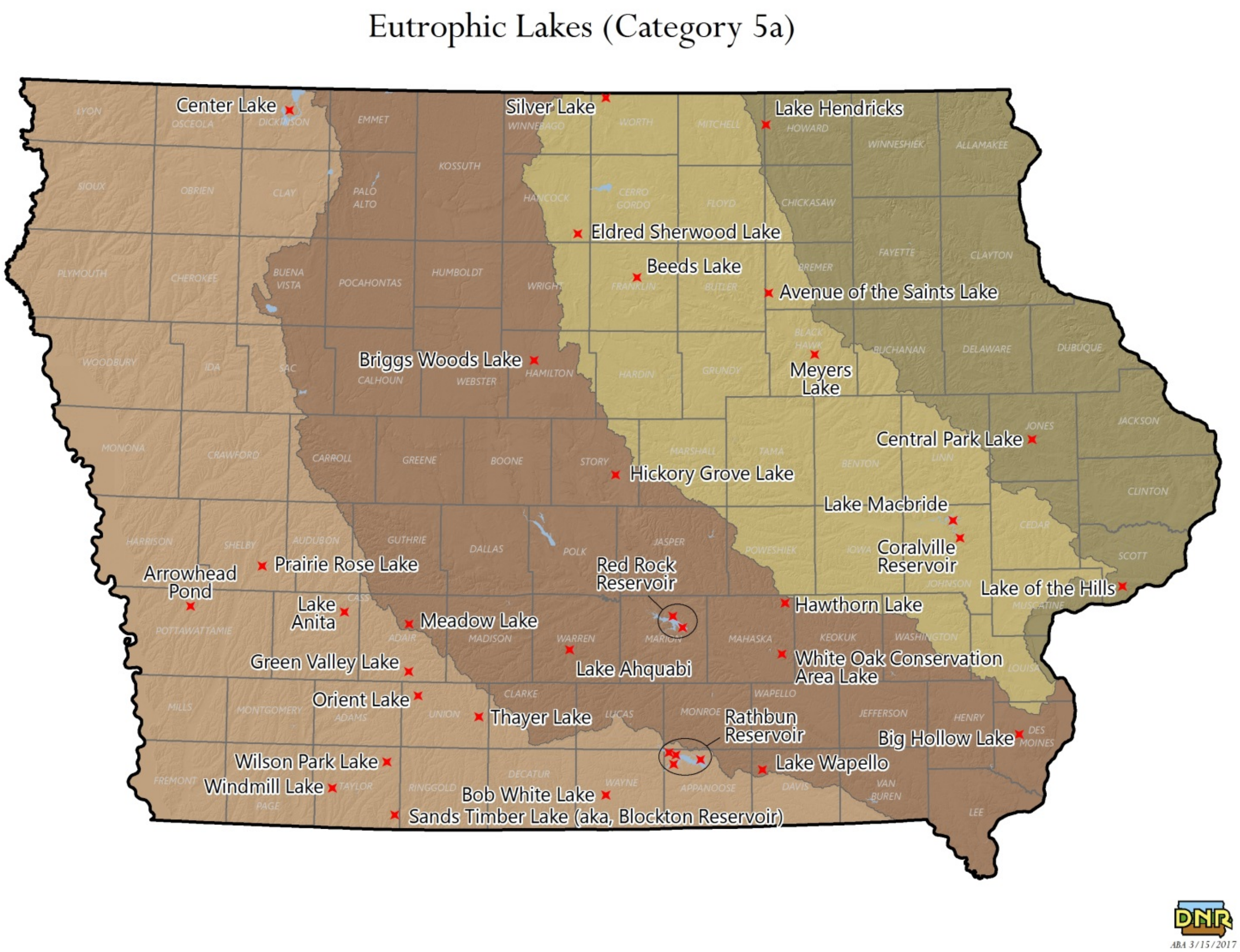


Figure 4 – Eutrophic Lakes on Category 5a

Eutrophic Lake Impairments

Year	NE Iowa Lakes	Impairment(s)		
2022	Lake Hendricks	Algae	pH (x2)	
2022	Central Park Lake	Algae		
2017	Lake Of The Hills	Algae		
Year	**Iowa / Cedar**	**Impairment(s)**		
2022	*Big Hollow Lake*	*Algae*	*pH (x2)*	
2022	*Silver Lake*	*pH (x2)*		
2019	Beeds Lake	Algae		
2017	Eldred Sherwood Lake	Algae		
2017	Avenue Of The Saints Lake	Algae	Turbidity	pH
2022	Coralville Reservoir	Turbidity		
2022	Lake Macbride	Algae		
2022	Meyers Lake	Algae		
Year	**DSM / Raccoon / Skunk**	**Impairment(s)**		
2022	*Hickory Grove Lake*	*Algae*		
2022	*Lake Wapello*	*Turbidity*		
2020	Hawthorn Lake	Algae	Turbidity	
2020	White Oak Conservation Area Lake	Algae		
2020	Red Rock Reservoir	Turbidity		
2021	Roberts Creek Lake	Algae	Turbidity	
2021	Meadow Lake	Algae		
2021	Lake Ahquabi	Algae		
Year	**Western / Southern Iowa**	**Impairment(s)**		
2022	*Center Lake*	*Algae*		
2017	Rathbun Reservoir	Turbidity		
2017	Bob White Lake	Algae	Turbidity	
2017	Windmill Lake	Algae	Turbidity	
2018	Thayer Lake	Algae	Turbidity	
2018	Briggs Woods Lake	pH (x2)		
2018	Green Valley Lake	Algae	Turbidity	
2019	Lake Anita	Algae		
2019	Orient Lake	Algae	pH (x2)	
2020	Prairie Rose Lake	Algae	Turbidity	
2020	Sands Timber Lake (aka, Blockton Reservoir)	Turbidity		
2020	Arrowhead Pond	Algae		
2020	Wilson Park Lake	Algae	pH (x2)	

**Green italics denote new additions to the impaired waters list as of the 2016 list. These projects will be worked into the schedule if time allows.*

Completed projects since issuance of 2012 Impaired waters list include Frog Hollow, Hannen Lake, Casey Lake, Otter Creek Lake, Upper Pine Lake, Kent Park Lake, Iowa Lake, Beaver Lake, Little River Lake and Lake Pahoja for a total of 16 impairments.

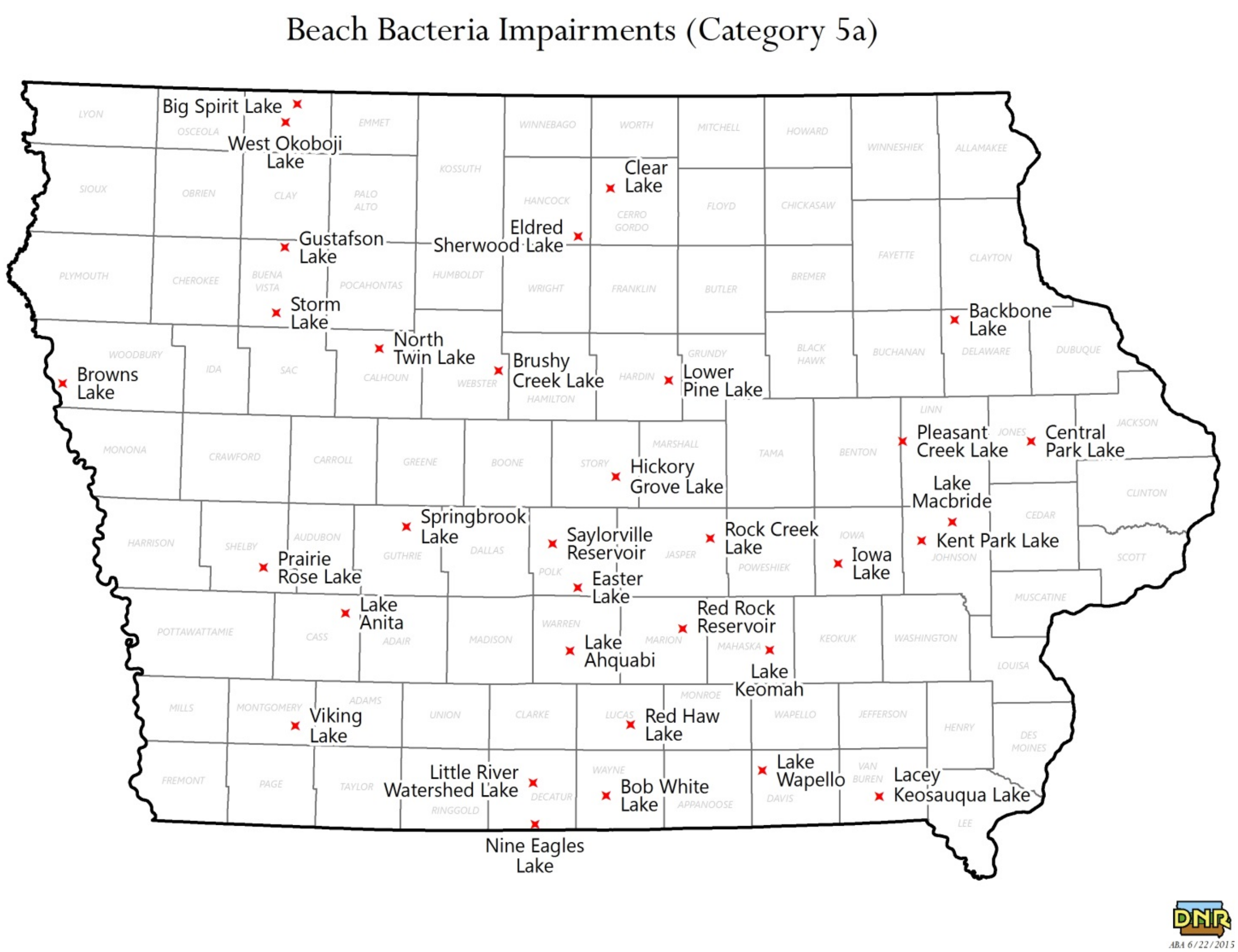


Figure 5 - State wide Beach Bacteria TMDL list – 2014 Impaired Waters List

Backbone Lake	Iowa Lake	North Twin Lake
Big Spirit Lake	Kent Park Lake	Pleasant Creek Lake
Bob White Lake	Lacey Keosauqua Lake	Prairie Rose Lake
Browns Lake	Lake Ahquabi	Red Haw Lake
Brushy Creek Lake	Lake Anita	Red rock Reservoir
Central Park Lake	Lake Keomah	Rock Creek Lake
Clear Lake	Lake Macbride	Saylorville Reservoir
Easter Lake	Lake Wapello	Springbrook Lake
Eldred Sherwood Lake	Little River Lake	Storm Lake
Gustafson Lake	Lower Pine Lake	Viking Lake
Hickory Grove Lake	Nine Eagles Lake	West Okoboji Lake

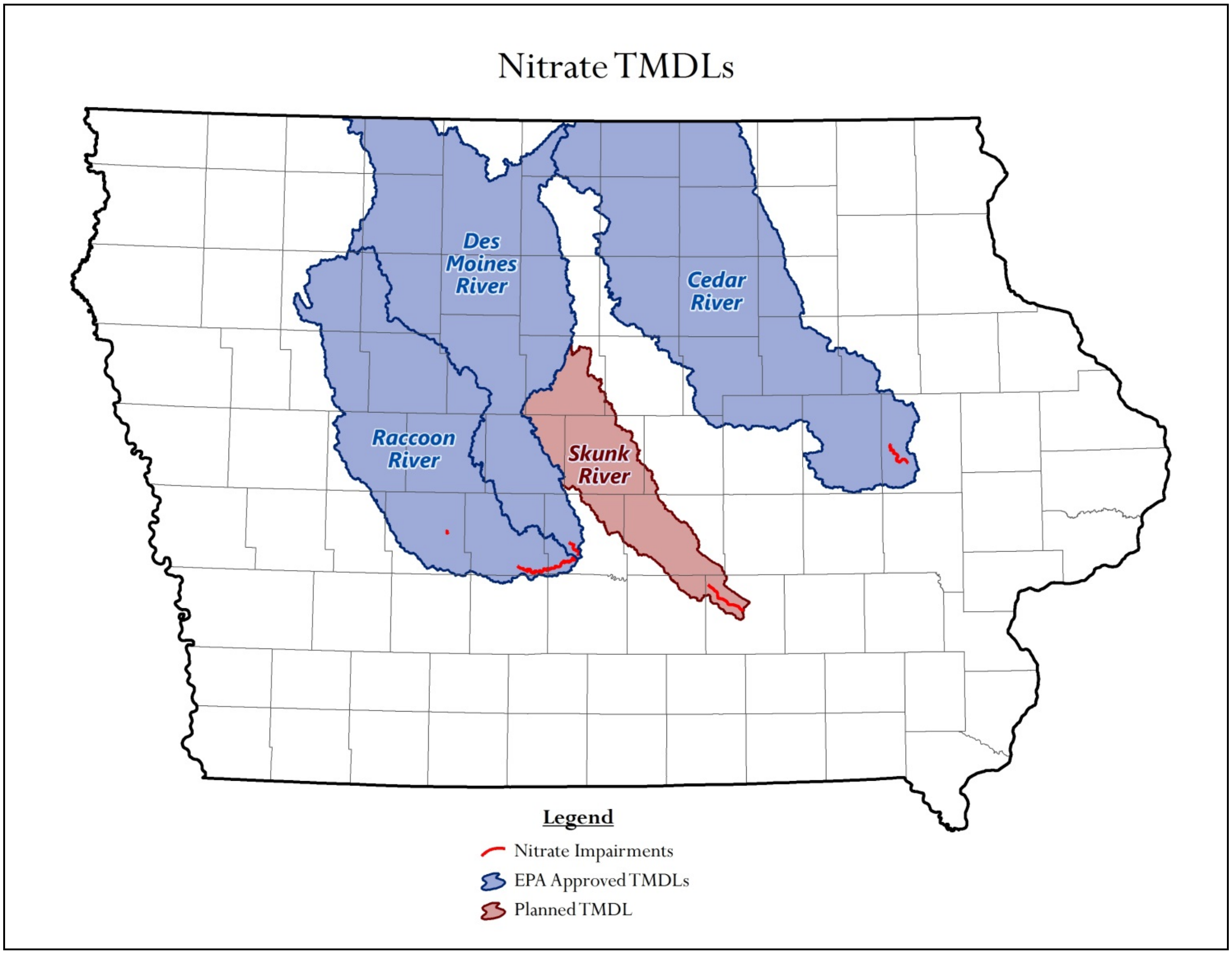


Figure 6 – Nitrate TMDLs map

The Iowa DNR has previously completed three Nitrate TMDLs and have one nitrate impairment was identified on Category 5a of the Impaired Waters List as late as 2012. The standard for nitrate is a drinking water standard and addresses an important human health risk. Therefore, the final Nitrate TMDL was an important priority in Iowa's TMDL Vision. However, the 2014 Impaired Waters List removed the Nitrate impairment on the Skunk River, thereby relieving the DNR of developing a TMDL at this time. However, if future Nitrate impairments for drinking water appear on the Impaired Waters List they would be placed in Priority Group I.

ATTACHMENT 8:

Addressing interstate inconsistencies in Section 303(d) lists:

The following is a summary of the Iowa DNR's review of 2016 impaired waters listings of states adjacent to Iowa.

From: Nebraska's 2016 IR (*http://deq.ne.gov/Publica.nsf/Pages/WAT234*):

MT1-10000: Missouri River [downriver from confluence with the Platte River]– *This waterbody was listed as Category 1 in the 2014 IR. Data gathered in 2010 determined this waterbody's recreational use is impaired for bacteria. This waterbody will be placed in category 5.*

- Potential change in Iowa DNR assessment.

  06-WEM-1708: Missouri River, from IA/MO state line to Platte River, 41 miles.

  Note: segment is assessed as IR Cat. 5 by NE and the downriver segment is considered impaired by MO. I changed the IA assessment to IR Cat. 5a. Note: Iowa segments WEM-1708 and WEM-1709 were assessed as IR 5a for the 2016 IR based on USGS data for E. coli.

NE1-10000: Missouri River [upriver from Platte River to Big Sioux River]:

- Impaired for bacteria (E. coli). TMDL approved in September 2007; IR 4a.
  - IA 06-WEM-0020_1: Missouri River, from Platte R. to Council Bluffs WS intake, 23.3 miles. *IR Category 5 based on IDNR 2016 assessment (USGS data).*
  - IA 06-WEM-0020_2: Missouri River, from Council Bluffs WS intake to Boyer R., 15.4 miles. *IR Category 5 based on IDNR 2016 assessment (USGS data).*
  - IA 06-WEM-0030_0: Missouri River, from Boyer R. to Little Sioux R., 33.3 miles.*
  - IA 06-WEM-0040_1: Missouri River, from Little Sioux River to Elm Creek, 20.8 miles.*
  - IA 06-WEM-0040_2: Missouri River, from Elm Creek to Omaha Creek Ditch, 25 miles.*
  - IA 06-WEM-0040_3: Missouri River, from Omaha Creek Ditch to Big Sioux R., 17.6 miles.*

    **Based on approach for Mississippi River, should probably consider these segments as IR Category 5. Since Iowa DNR was not involved with the TMDL, probably not appropriate to consider an IR 4a assessment.*

From South Dakota's 2016 IR (*http://denr.sd.gov/documents/16irfinal.pdf*):

- SD BS-R-Big-Sioux_17: mouth to Indian Creek: impaired for E. coli & TSS (IR 4a)
  - IA 06-BSR-0010_1: Big Sioux R., mouth to Broken Kettle Creek, Plymouth County, 16.9 miles

- IA 06-BSR-0010_2: Big Sioux R., Broken Kettle Creek to Brule Creek near Richland, SD., 18.4 miles.
- IA 06-BSR-0010_3: Big Sioux R., from Brule Cr. to Indian Cr., Plymouth Co. (1 mi S, Plymouth-Sioux Co. line)., 22.8 miles

- <u>SD BS-R-Big-Sioux_16:</u> Indian Creek to near Alcester: impaired for E. coli & TSS (IR 4a)
  - IA 06-BSR-0010_4: Big Sioux R., from Indian Cr. to Rock River, 23.7 miles

- <u>SD BS-R-Big-Sioux_15:</u> near Alcester to Fairview: impaired for E. coli & TSS (IR 4a)
  - IA 06-BSR-0020_1: Big Sioux R., from Rock R. to Beaver Cr. near Canton, SD., 22.2 miles

- <u>SD BS-R-Big-Sioux_14:</u> near Fairview to Ninemile Creek: impaired for E. coli & TSS (IR 5)
  - IA 06-BSR-0020_2: Big Sioux R., from Beaver Cr. to Ninemile Cr., 22.5 miles

- <u>SD BS-R-Big-Sioux_13:</u> Ninemile Creek to near Brandon (partial: to IA/MN state line) : impaired for E. coli & TSS (IR 4a)
  - IA 06-BSR-0020_3: Big Sioux R., from Ninemile Cr. to IA/MN line, 9.3 miles.
  - *Note: As shown in Appendix A of South Dakota's 2016 IR, all bacteria impairments are covered by an approved TMDL (IR 4a).*

From Minnesota's 2016 IR: (https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list):

Updated for IA 2016 IR?	*Relevant to IA's 2016 IR:*	**Water body name**	**Water body description**	**County in MN**	**HUC 8**	**Affected MN designated use**	**MN-identified pollutant or stressor**
No: state-specific thresholds	*N*	Mississippi River	Root R to MN/IA border	Houston	07060001	Aquatic Consumption	Mercury in fish tissue
No: state-specific thresholds	*N*	Mississippi River	Root R to MN/IA border	Houston	07060001	Aquatic Consumption	PCB in fish tissue
Y-exist Cat 5	*Y*	Cedar River	Woodbury Cr to MN/IA border	Mower	07080201	Aquatic Recreation	Indicator Bacteria: Escherichia coli
Y-exist Cat 5	*Y*	Cedar River	Woodbury Cr to MN/IA border	Mower	07080201	Aquatic Consumption	Mercury in fish tissue
No	*N*	Cedar River	Woodbury Cr to MN/IA border	Mower	07080201	Aquatic Life	Turbidity
Y-exist Cat 5	*Y*	Otter Creek	Headwaters to MN/IA border	Mower	07080201	Aquatic Recreation	Indicator Bacteria: Fecal Coliform
Y-new, Cat 3b	*Y*	Little Cedar River	Headwaters to MN/IA border	Mower	07080201	Aquatic Recreation	Indicator Bacteria: Escherichia coli
Y-new, Cat 3b	*Y*	Des Moines River	JD 66 to MN/IA border	Jackson	07100002	Aquatic Recreation	Indicator Bacteria: Fecal Coliform
Y-new, Cat 3b	*Y*	Des Moines River	JD 66 to MN/IA border	Jackson	07100002	Aquatic Consumption	Mercury in fish tissue
No: Iowa lacks WQS	*N*	Des Moines River	JD 66 to MN/IA border	Jackson	07100002	Aquatic Life	Turbidity
No: state-specific methods & thresholds	*N*	Rock River	Elk Cr to MN/IA border	Rock	10170204	Aquatic Life	Aquatic macroinvertebrat e bioassessments
No: state-specific methods & thresholds	*N*	Rock River	Elk Cr to MN/IA border	Rock	10170204	Aquatic Life	Fishes bioassessments
Y, exist Cat 5; letting it ride	*Y*	Rock River	Elk Cr to MN/IA border	Rock	10170204	Aquatic Recreation	Indicator Bacteria: Fecal Coliform
No: Iowa lacks WQS	N	Rock River	Elk Cr to MN/IA border	Rock	10170204	Aquatic Life	Turbidity
No: state-specific methods & thresholds	*N*	Little Rock River	Little Rock Cr to MN/IA border	Nobles	10170204	Aquatic Life	Aquatic macroinvertebrat e bioassessments
No: state-specific methods & thresholds	*N*	Little Rock River	Little Rock Cr to MN/IA border	Nobles	10170204	Aquatic Life	Fishes bioassessments
Yes, exist Cat 5	*Y*	Little Rock River	Little Rock Cr to MN/IA border	Nobles	10170204	Aquatic Recreation	Indicator Bacteria: Escherichia coli
No: Iowa lacks WQS	*N*	Little Rock River	Little Rock Cr to MN/IA border	Nobles	10170204	Aquatic Life	Turbidity
No: state-specific methods & thresholds	*N*	Kanaranzi Creek	Norwegian Cr to MN/IA border	Rock	10170204	Aquatic Life	Aquatic macroinvertebrat e bioassessments

Updated for IA 2016 IR?	*Relevant to IA's 2016 IR:*	**Water body name**	**Water body description**	**County in MN**	**HUC 8**	**Affected MN designated use**	**MN-identified pollutant or stressor**
No: state-specific methods & thresholds	*N*	Kanaranzi Creek	Norwegian Cr to MN/IA border	Rock	10170204	Aquatic Life	Fishes bioassessments
Y-new, Cat 3b	*Y*	Kanaranzi Creek	Norwegian Cr to MN/IA border	Rock	10170204	Aquatic Recreation	Indicator Bacteria: Escherichia coli
No: Iowa lacks WQS	*N*	Kanaranzi Creek	Norwegian Cr to MN/IA border	Rock	10170204	Aquatic Life	Turbidity
No: state-specific methods & thresholds	*N*	Mud Creek	Headwaters to MN/IA border	Rock	10170204	Aquatic Life	Aquatic macroinvertebrate bioassessments
No: state-specific methods & thresholds	*M*	Mud Creek	Headwaters to MN/IA border	Rock	10170204	Aquatic Life	Fishes bioassessments
Y- exist Cat 5	*Y*	Mud Creek	Headwaters to MN/IA border	Rock	10170204	Aquatic Recreation	Indicator Bacteria: Escherichia coli
No: Iowa lacks WQS	*N*	Mud Creek	Headwaters to MN/IA border	Rock	10170204	Aquatic Life	Turbidity
No: state-specific methods & thresholds	*N*	Ocheyedan River	Ocheda Lk to MN/IA border	Nobles	10230003	Aquatic Life	Aquatic macroinvertebrate bioassessments
No: state-specific methods & thresholds	*N*	Ocheyedan River	Ocheda Lk to MN/IA border	Nobles	10230003	Aquatic Life	Fishes bioassessments
Y-new, Cat 3b	*Y*	Little Sioux River, West Fork	JD 13 to MN/IA border	Jackson	10230003	Aquatic Recreation	Indicator Bacteria: Escherichia coli
No: state-specific methods & thresholds	*N*	Little Sioux River	Unnamed cr to MN/IA border	Jackson	10230003	Aquatic Life	Fishes bioassessments
Y-new, Cat 3b	*Y*	Little Sioux River	Unnamed cr to MN/IA border	Jackson	10230003	Aquatic Recreation	Indicator Bacteria: Escherichia coli
No: Iowa lacks WQS	*N*	Little Sioux River	Unnamed cr to MN/IA border	Jackson	10230003	Aquatic Life	Turbidity

Missouri: from Missouri's 2016 IR: *http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm*

Waterbodies of potential concern in Missouri counties of that border Iowa: Atchison, Clark, Harrison, Mercer, Nodaway, Putnam, Schulyer, Scotland, Worth.

Year Listed in Missouri	Waterbody	Imp Size (MI) in Missouri	Missouri-identified Pollutant	Missouri-identified Source	MO Use	U/D County in MO	Up X	Up Y	*Impairment to IA/MO line?*	*Updated for IA 2016 IR?*
2014	Nishnabotna R.	10.2	Escherichia coli (W)	Rural NPS	WBC B	Atchison	276742	4495889	*Y*	*Y: existing Cat 5*
2010	Missouri R.	184.5	Escherichia coli (W)	Municipal Point Source Discharges, Nonpoint Source	WBC B	Atchison/ Jackson	265899	4496416	*Y*	*Y: new Cat 3b*
2008	Fox R.	42.0	Escherichia coli (W)	Rural NPS	WBC B	Clark	591716	4495662	*Y*	*Y: new Cat 3b*
2008	Thompson R.	70.6	Escherichia coli (W)	Rural NPS	WBC B	Harrison	432172	4492124	*Y*	*Y: existing Cat 5*
2006	L. Medicine Cr.	39.8	Aquatic Macroinvertebrate Bioassessments/ Unknown	Source Unknown	AQL	Mercer/ Grundy	463960	4492230	*Y*	*N: state-specific methods & thresholds; only extreme headwaters in Iowa*
2006	L. Medicine Cr.	39.8	Escherichia coli (W)	Rural NPS	WBC B	Mercer/ Grundy	464025	4492224	*Y*	*Not in ADBNet; only extreme headwaters in Iowa*
2006	Weldon R.	43.4	Escherichia coli (W)	Rural NPS	WBC B	Mercer/ Grundy	448318	4492214	*Y*	*Y: new Cat 3b*
2010	Nodaway R.	59.3	Escherichia coli (W)	Rural NPS	WBC B	Nodaway/ Andrew	328881	4493666	*Y*	*Y: new Cat 3b*
2006	S. Blackbird Cr.	13.0	Ammonia, Total (W)	Source Unknown	AQL	Putnam	503682	4475363		*N?*

Year Listed in Missouri	Waterbody	Imp Size (MI) in Missouri	Missouri-identified Pollutant	Missouri-identified Source	MO Use	U/D County in MO	Up X	Up Y	*Impairment to IA/MO line?*	*Updated for IA 2016 IR?*
2006	Medicine Cr.	43.8	Escherichia coli (W)	Rural NPS	WBC B	Putnam/ Grundy	471740	4492250	*Y (E. Fk.)*	*Y: new Cat 3b*
2006	Locust Cr.	91.7	Escherichia coli (W)	Rural NPS	WBC B, SCR	Putnam/ Sullivan	488061	4492447	*Y*	*Y: new Cat 3b*
2006	E. Fk. Grand R.	28.7	Escherichia coli (W)	Rural NPS	WBC A	Worth/ Gentry	388817	4483394	*N*	
2006	Middle Fk. Grand R.	27.5	Escherichia coli (W)	Rural NPS	WBC A	Worth/ Gentry	385572	4488578	*N*	
2010	Platte R.	142.4	Escherichia coli (W)	Rural NPS	WBC B	Worth/ Platte	370620	4492569	*Y*	*Y: new Cat 3b*

Attachment 9

Iowa DNR interpretations of Section 305(b)/303(d) causes of impairment.

Information is also included on the historical use of the individual cause categories for water quality assessments in Iowa and on the existence of numeric criteria in the *Iowa Water Quality Standards*. NA = "not applicable. Information is taken from several published and on-line sources (see "References, Attachment 5") as well as from IDNR staff experience from identifying these causes of impairment for Iowa waters.

Cause Category	Historically Used?	Numeric Criteria?	Description
ammonia (un-ionized)	Yes	yes	Ammonia refers to the concentration of ionized (NH_4^+) and un-ionized ammonia (NH_3) in water. Ammonia is formed during bacterial decomposition of organic matter and is delivered to streams and rivers from wastewater discharges and from nonpoint sources. The primary source of ammonia dissolved in water comes from bacterial mineralization of dead plants and animals (Cole 1979). (Mineralization is the conversion of an element from an organic to an inorganic form as a result of microbial decomposition.) Impairments related to measured concentrations of ammonia in Iowa waters are rare. Most ammonia impairments are tied to fish kills caused by delivery of animal waste to streams; these impairments are based on the presumed presence of high levels of ammonia the high-strength animal waste generated by animal feeding operations to which fish kills are often attributed.
Arsenic	Yes	Yes	Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards. Inorganic arsenic is known human carcinogen (source: ATSDR (http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=19&tid=3). Arsenic impairments in Iowa waters are due to violations of Iowa's human health criterion designed to protect against adverse health impacts from consuming arsenic in water and fish. This criterion (0.18 parts per billion (ppb) is well below what is believed to be the natural background concentration of arsenic in Iowa surface waters and groundwaters (~1 to 2 ppb) and is far below the U.S. EPA's maximum contaminant level of no more than 10 parts per billion in drinking water.
atrazine	yes	yes	A common pesticide (corn herbicide) that is in the triazine family of herbicides. The only criterion for atrazine in the Iowa *Water Quality Standards* is the maximum contaminant level of 3 ppb to protect drinking water (Class C) uses.
cause unknown	yes	NA	Causes of impairment are identified as "unknown" where results of water quality monitoring suggest an impact, but no cause of the impact is apparent. Most often, this cause category is used when results of biological monitoring identify an impact to biotic integrity but do not suggest a specific cause of the impact. In such cases, follow-up monitoring is often needed to determine the specific cause or causes of the impairment.
chloride	no	yes	Chloride (Cl^-) is a naturally-occurring negatively-charged dissolved constituent of water and is one of several similar ions that combine to constitute "total dissolved solids." Chloride is a major ion commonly found in streams and wastewater. Chloride may get into surface water from several

Cause Category	Historically Used?	Numeric Criteria?	Description
			sources, including wastewater from certain industries, wastewater from communities that soften water, road salting, agricultural runoff, and produced water from oil and gas wells. Levels of chloride in Iowa surface waters are relatively low with a median concentration of 22 mg/L in the approximately 8,500 samples collected from 2000 through 2009 as part of Iowa DNR's ambient stream/river water quality monitoring network (IDNR 2010). Only 10% of these samples have had chloride levels greater than 39 mg/L; the maximum concentration in these samples was 170 mg/L. The *Iowa Water Quality Standards* (https://www.legis.iowa.gov/DOCS/ACO/IAC/LINC/Chapter.567.61.pdf) identifies a chloride criterion of 250 mg/L to protect surface waters used as a source of a municipal water supply (i.e., Class C waters). Results of water quality monitoring to date have not shown levels of chloride in surface waters that suggest impairment of Class C uses. Iowa's hardness-based aquatic life standards are (assuming a hardness of 200 mg/L) are a chronic criterion of 389 mg/L and an acute criterion of 629 mg/L. Chloride levels in Iowa waters are sufficiently low that violations of Iowa's aquatic life criteria for chloride are very rare.
chlorine	Yes	yes	Chlorine and chloramines are widely used in treatment of potable water supplies and wastewater treatment plant effluents and are used in a variety of industrial applications, including power generating facilities and paper mills. Although the *Iowa Water Quality Standards* contain numeric criteria to protect aquatic life uses from adverse impacts of total residual chlorine, analytical difficulties have precluded analysis for total residual chlorine as part of ambient surface water monitoring since 1999. Currently, the only scenario that would lead to identification of chlorine as the cause of an impairment is the accidental release of chlorine to surface waters such that a fish kill occurs (e.g., as would potentially occur following a water main break).
cyanide	No	yes	Cyanide enters air, water, and soil from both natural processes and industrial activities. Cyanide is usually found joined with other chemicals to form compounds. Examples include hydrogen cyanide, sodium cyanide and potassium cyanide. Certain bacteria, fungi, and algae can produce cyanide. Cyanide and hydrogen cyanide are used in electroplating, metallurgy, organic chemicals production, photographic developing, manufacture of plastics, fumigation of ships, and some mining processes. Most cyanide in surface water will form hydrogen cyanide and evaporate. Cyanide in water does not build up in the bodies of fish (source: http://www.atsdr.cdc.gov/tfacts8.pdf). Detectable levels of cyanide are extremely rare in Iowa waters; there are no water quality impairments, historical or current, attributed to cyanide.
dioxins	No	yes	Dioxins and dioxin-like compounds are by-products of various industrial processes, and are commonly regarded as highly toxic compounds that are environmental pollutants and persistent organic pollutants. Dioxins are not intentionally produced and have no known use. They are the by-products of various industrial processes (i.e., bleaching paper pulp, and chemical and pesticide manufacture) and combustion activities (i.e., burning household trash, forest fires, and waste incineration). The defoliant Agent Orange, used during the Vietnam War, contained dioxins. Dioxins are found at low levels throughout the world in air, soil, water, sediment, and in foods such as meats, dairy, fish, and shellfish. The highest levels of dioxins are usually found in soil, sediment, and in the fatty tissues of animals. Much lower levels are found in air and water. Sources: Wikipedia (http://en.wikipedia.org/wiki/Dioxins_and_dioxin-like_compounds) and ATSDR (http://www.atsdr.cdc.gov/substances/dioxin/policy/). In Iowa, dioxins have been detected in samples of fish tissue but occur at extremely low levels (in the low parts per trillion range) and pose no known

Cause Category	Historically Used?	Numeric Criteria?	Description
			risk to human health or the aquatic environment.
excessive algal growth / chlorophyll-a	yes	no	Chlorophyll is the pigment in plants that is essential for photosynthesis whereby carbon dioxide and water are converted to carbohydrates and oxygen; chlorophyll-a is a form of chlorophyll that is common to all types of freshwater algae (e.g., green algae, cyanobacteria, and diatoms). For purposes of water quality assessment, chlorophyll-a is used as a surrogate measure of growth of algae in the water column. "Excessive algal growth" refers to an unusually large concentration of algal organisms (planktonic or benthic) that can adversely affect either the aesthetic quality of the surface water for water-based recreation or the ability of the waterbody to support the expected types and numbers of aquatic biota (see explanation for "turbidity" below). Scenarios that can lead to impairments due to "excessive algal growth" include the following: (1) large populations of common carp that increase water column nutrient levels through feeding and spawning activities such that algal blooms occur, (2) populations of grass carp that, through removal of littoral zone vegetation and feeding activities, lead to increased water column nutrient levels such that algal blooms occur, and (3) excessive growth of attached algae (periphyton) or attached filamentous algae on coarse substrates in stream riffle areas.
exotic species	yes	no	For purposes of Section 305(b) water quality assessments in Iowa, "exotic species" refers to a form "introduced into an area or ecosystem outside its historic or native geographic range; this includes both foreign (i.e., exotic) and transplanted species, and is used synonymously with "alien," "nonnative," and "introduced." Examples of exotic species in Iowa include <u>common carp</u>, <u>grass carp</u>, and the plant <u>purple loosestrife</u>. Scenarios that can lead to impairments due to "exotic species" include the following: (1) re-suspension of sediment and nutrients in a shallow lake by a large population of common carp such that turbidity and/or algal populations are increased to nuisance levels; (2) elimination of aquatic macrophytes from the littoral zone of a lake by grass carp such that the lake shifts from a clear-water to a turbid, phytoplankton-dominated (green) lake; and (3) the replacement of native wetland vegetation (e.g., grasses, sedges, cattails) with the exotic invasive purple loosestrife, thus degrading the habitat quality of the wetland for waterfowl and nutritional value of the wetland for wildlife.
flow alterations	yes	no	"Flow alterations" refer to human-related deviations from natural seasonal flow regimes that can adversely affect native biota. Flow alterations can result from several activities including water withdrawal for irrigation or water supplies, regulation of stream flow at dams, and drainage projects that lead to localized lowering of water tables such that lake/wetland water levels are adversely affected.
habitat alterations (other than flow alterations)	yes	no	"Habitat alterations" refer to manmade changes in the physical habitats of surface waters such that native aquatic biota may be adversely affected. When assessing impairments to Iowa surface waters for Section 305(b) reporting, "habitat alterations" refers primarily to impacts from (1) stream channelization (i.e., channel straightening), (2) removal of riparian vegetation, (3) pasturing of the riparian zone, and/or (4) streambank destabilization. All of these alterations tend to decrease the value of streams and rivers as high quality habitats for use by aquatic life through removal of important naturally-occurring habitat types (e.g., pools, riffles, sand bars, and snags). In addition, the alteration of aquatic habitat tends to increase the severity of impacts from other sources of pollution on aquatic life, especially the effects of siltation during low-flow periods.
metals	Yes	yes	A general category that includes the following toxic metals: aluminum, antimony, arsenic, asbestos,

Cause Category	Historically Used?	Numeric Criteria?	Description
			beryllium, cadmium, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, thallium, zinc. All but aluminum are identified as "priority pollutants" under Section 307a of the Clean Water Act. Levels of toxic metals in Iowa waters are low. Impairments of Iowa waters for metals occur infrequently and tend to occur in rivers. Impairments are related to violations of chronic criteria to protect aquatic life uses from toxic metals. The occurrence of acutely toxic levels of toxic metals in Iowa surface waters is extremely rare.
nitrate	yes	yes	High levels of nitrate in drinking water can lead to infant methemoglobinemia (blue baby syndrome). This condition occurs as a result of ingestion of high levels of nitrate followed by the metabolism of nitrate to ammonia in the infant's digestive system. The conversion of nitrate to ammonia produces nitrite which can oxidize the iron atom in hemoglobin such that it cannot carry oxygen. The lack of oxygen can give blood and oxygen-deficient tissues a bluish color. To protect against this condition, the U.S. EPA recommends that nitrate levels in water delivered by a public water supply to consumers should not exceed a maximum contaminant level (MCL) of 10 mg/L as nitrogen. The *Iowa Water Quality Standards* identify this 10 mg/L MCL as the water quality criterion to protect surface waters used as a source of a municipal water supply. At concentrations seen in surface waters, nitrate is not believed to be toxic to aquatic life; thus, there are no water quality criteria in the *Iowa Water Quality Standards* that apply to aquatic life uses.
nitrogen	yes	no	Nitrogen is an essential nutrient, is very abundant in the earth's atmosphere, and—like phosphorus—is implicated in eutrophication of surface waters such than excessive production of plant biomass occurs. Being considerably more abundant that phosphorus, nitrogen is much less often identified as a limiting (critical) nutrient in the eutrophication process. In water, nitrogen occurs in several forms (oxidation states) including nitrate, nitrite, and ammonia. Total nitrogen is defined as the sum of ammonia, nitrate, nitrite, and total Kjeldahl nitrogen (a measure of organic forms of nitrogen; e.g., in proteins). Total nitrogen is the measure most often proposed as an indicator of nutrient enrichment in surface waters and is the form proposed for inclusion into state water quality standards as a nutrient criterion. In Iowa waters, nitrate usually accounts for the majority of total nitrogen. Levels of total nitrogen in Iowa waters and in waters of other Corn Belt states are high relative to those in other states and are high relative to nutrient benchmark values for total nitrogen that have developed by nutrient criteria workgroups over the last decade (approximately 1 part per million for both rivers and lakes). Assuming that nitrate+nitrite concentrations approximate levels of total nitrogen in Iowa surface waters, the median level of nitrate+nitrite in the approximately 9,500 samples collected from 2000 through 2009 as part of Iowa DNR's ambient stream/river water quality monitoring network is 5.8 parts per million (ppm). Seventy-five percent of the samples had nitrate levels greater than 3.0 ppm (IDNR 2010).
noxious aquatic plants**	yes	no	"Noxious aquatic plants" refers to excessive growths of aquatic macrophytes or algae (e.g., bluegreen algae) that are known to interfere with recreational uses and be potentially harmful to human health as well as to the health of aquatic biota. Scenarios that can lead to impairments due to "noxious aquatic plants" include the following: dominance of a lakes' phytoplankton community by bluegreen algae.
nutrients	Yes	no	High levels of plant nutrients (primarily, nitrogen and phosphorus) indicate the potential for water quality problems in surface waters that result from excessive production of plant biomass. In lakes, high levels of nutrients can lead to excessive growth of aquatic plants, especially algae, which can

Cause Category	Historically Used?	Numeric Criteria?	Description
			interfere with recreational uses of a lake (e.g., boating, swimming, and fishing). Excessive plant growth can also lead to oxygen depletion of lake water through respiration related to bacterial decomposition of plant material and other organic matter that accumulates on the lake bottom. Severe cases of oxygen depletion can lead to fish kills. High levels of plant nutrients are generally attributed to agricultural nonpoint source pollution, to background levels in soil, and to naturally-occurring conditions, especially the internal nutrient recycling that occurs in the shallow glacial lakes of northern Iowa. Urban point sources and urban runoff, however, also contribute excessive amounts of nutrients to Iowa lakes with urban watersheds. Both the origin of high levels of plant nutrients and the nutrient concentrations that can impair aquatic life uses of Iowa's surface waters are poorly understood. Due to the natural fertility of Iowa's soils, levels of plant nutrients were likely relatively high prior to settlement in the mid-19th century (Menzel 1983). Application of fertilizers, however, especially for row crop agriculture, has increased nutrient levels in the state's surface waters over that during pre-settlement times. The threshold levels at which plant nutrients cause problems in Iowa's surface waters have not yet been identified. Thus, the *Iowa Water Quality Standards* does not contain water quality criteria for either levels of phosphorus or nitrogen related to protection for primary contact recreation (Class A) or for aquatic life (Class B) beneficial uses. Since 2004, IDNR has used a trophic state index to identify nutrient-related water quality problems in lakes due to poor water clarity caused by large populations of algae that are aesthetically objectionable and that thus suggest impairment of recreational uses. Algal impairment based on the trophic state index is the most commonly identified impairment at Iowa lakes.
oil and grease	no	no	"Oil and grease" refers to adverse impacts to public water supplies or aquatic biota due to the presence of oils of petroleum or non-petroleum origin. Scenarios that can lead to impairments due to "oil and grease" include the following: (1) a fish kill caused by a spill of fuel oil and (2) adverse impacts to aquatic life resulting from contact of surface waters with coal tar waste.
organic enrichment / low dissolved oxygen	yes	yes	Impairments due to organic enrichment occur when the amount of organic material delivered to the waterbody exceeds the capacity of the stream to mineralize and assimilate this organic material with the result that levels of dissolved oxygen can fall below water quality criteria designed to protect aquatic life uses. In the absence of excessive inputs of oxygen-demanding organic material—as commonly measured through biochemical oxygen demand or "BOD"—streams, rivers, and lakes can process organic material without serious consequences to either chemical water quality or aquatic life. When inputs of organic materials exceed the stream or river's assimilative capacity, however, degradation of water quality will occur. The high rates of bacterial respiration resulting from the excessive amounts of organic material can lower the level of dissolved oxygen below that needed to support aquatic life. Most of the lakes with impacts due to organic enrichment are the relatively shallow natural lakes in north-central and northwest Iowa. Wind action at shallow lakes in summer tends to circulate lake water at all depths, thus resuspending sediments and nutrients that have settled to the bottom of the lake back into the water column. The increased levels of nutrients in the water column can increase plant production, usually in the form of algae. Continued resuspension of sediment and nutrients can lead to poor water transparency due to high levels of planktonic algae or due to high concentrations of suspended sediment. The relatively high levels of biological productivity in these lakes can lead to depletion of dissolved oxygen, and fish kills can occur. In temperate climates such as Iowa's, deeper lakes tend to thermally stratify during summer: a

Cause Category	Historically Used?	Numeric Criteria?	Description
			relatively cold and stagnant bottom layer of the lake (hypolimnion) becomes isolated from the relatively warm and wind-circulated surface layer (epilimnion) by a middle layer with a temperature gradient (metalimnion or thermocline). As summer progresses, bottom layers of stratified eutrophic lakes tend to become increasingly nutrient-rich and oxygen-poor. The isolation of this bottom layer, however, prevents movement of the poor-quality water to the surface layer of the lake. This isolation tends to improve the water quality of the surface layer of a lake that is used by aquatic life and is used for water-based recreation (e.g., swimming and water skiing). Water quality studies on Iowa lakes have shown that lakes with average depths greater than 13 feet tend to establish and maintain thermal stratification in summer and thus have better water quality than do shallower lakes (Bachmann et al. 1994).
other inorganics	No	yes	"Other inorganics" is a general cause category for inorganic substances that are not already included in a cause category.
pathogens (pathogen indicators)	yes	yes	"Pathogens," in the context of Section 305(b) reporting, actually refers to concentrations of typically non-pathogenic indicator bacteria (e.g., fecal coliforms or *E. coli*) in surface water samples. Iowa surface waters that support swimming, water skiing, and other primary body contact recreation that involves considerable risk of ingesting surface water are designated for one of several types of Class A (swimmable) use in the *Iowa Water Quality Standards*. Levels of fecal coliform bacteria and *E. coli* are monitored by DNR in rivers and lakes designated for Class A uses to *indicate* the health risks to persons using these waters for water-based recreation. Although typically not pathogenic, pathogen indicators such as fecal coliforms and *E. coli* are present in the intestines of warm-blooded animals and are commonly monitored by state environmental agencies to indicate the degree to which surface waters may contain waterborne pathogens (e.g., *Salmonella* and *Shigella*) that can cause disease in humans. "Pathogen indicators" (bacteria) is the most frequently identified impairment of Iowa streams and rivers. Despite the relatively high levels of indicator bacteria in Iowa streams and rivers, and despite the high numbers of impairments, reports of waterborne disease are extremely rare.
PCBs	Yes	yes	Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated organic compounds (congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils (excerpted from ATSCR ToxFAQ: http://www.atsdr.cdc.gov/tfacts17.pdf). Levels of PCBs in Iowa surface waters are too low to be detected in samples collected as part of ambient water quality monitoring. PCBs, however, like many chlorinated organic compounds, do accumulate (bioconcentrate) in animal tissue. In Iowa waters, the only Section 303(d) impairment caused by PCBs is their accumulation in fish tissue to levels that indicate the need to issue a fish consumption advisory (see http://www.iowadnr.gov/fish/news/consump.html). Levels of PCBs in Iowa fish and in fish nationwide, however, have declined greatly (by a factor of 100) since the banning PCB

Cause Category	Historically Used?	Numeric Criteria?	Description
			production in the United States in 1977.
pesticides	yes	yes	"Pesticides" refers to any substance, either currently or historically, used to kill plants, insects, algae, fungi, and other organisms; includes herbicides, insecticides, algalcides, fungicides, and other substances. For purposes of 305(b)/303(d) reporting in Iowa, this category includes priority pesticides* (as defined in Section 307a of the Clean Water Act) as well as non-priority pesticides (e.g., cyanazine, and metolachlor).
pH	yes	yes	"pH" indicates the hydrogen ion concentration a water sample and indicates the intensity of an acid. The pH of natural waters is a measure of acid-base equilibrium achieved by the various dissolved compounds, salts, and gases. A pH of 7 is considered neutral (neither acidic nor basic). As the pH of waters decreases below 7, the waters become increasingly acidic. For example, the pH of tomatoes is 4.5, that of vinegar is approximately 2 and of battery acid is roughly 1 pH unit. As the pH increases above 7, the waters become increasingly basic. For example, the pH of baking soda is 8.3, that of ammonia is 11, and lye has a pH of 13. The pH scale varies logarithmically such that water with a pH of 5 is ten times more acidic (i.e., has ten times the hydrogen ion concentration) than water with a pH of 6. The ability of surface waters to resist changes in pH is called buffering capacity and is measured by alkalinity. The alkalinity of a surface water reflects the nature of the rocks within a drainage basin and is measured as milligrams of calcium carbonate ($CaCO_3$) per liter (mg/L). Surface waters with high alkalinities resist lowering of pH values due, for example, to the addition of low-pH rainfall (acid precipitation). pH can have direct and indirect effects on aquatic life. Within a range of about pH 6.5 to 9, direct impact to aquatic life are minimal; outside of this range, adverse physiological impacts can occur and will increase as the pH deviates from this range. pH can also have indirect impacts on aquatic life as the toxicity of certain metals to aquatic life increases at lower pH and the toxicity of ammonia increases as pH levels increase. pH levels outside of the range of 6.5 to 9.0 can also impact swimmers by causing irritation to eyes (FWPCA 1968). Thus, because of the potential impacts to both aquatic life and primary contact recreation uses, the *Iowa Water Quality Standards* specify a range of pH values of 6.5 to 9.0 as protective of both aquatic life and primary contact recreation uses. Levels of pH in Iowa surface waters tends toward the basic side of neutral with lake pH values being somewhat higher than those found in rivers and streams. The median pH of over 9,000 stream/river samples collected from 2000-2009 was 8.2 units with over 90 percent of the samples greater than a pH of 7.8 units and with only 10 percent of the samples having a pH of greater than 8.6 (IDNR 2010). The median pH of almost 3,000 summer-season water samples collected from Iowa lakes from 2000-2007 was 8.6 units with over 90 percent of the samples having a pH of greater than 8.0 units; 17 percent of the samples had a pH greater than 9.0 units and thus are in violation of the Iowa water quality criterion. The tendency for lake pH values to be higher than rivers likely reflects the larger populations of algae in lakes versus rivers: the removal of carbon dioxide from the water column during algal photosynthesis results in an increase in pH levels.
phosphorus	yes	no	Phosphorus is an essential nutrient for all living cells and functions in the storage and transfer of energy in living organisms and in their genetic systems. Igneous rock was the original source of phosphorus on earth; biotic sources of phosphorus (e.g., guano from sea birds) also exist. Phosphorus is highly reactive and is not found as a free element in Nature. In water, phosphorus can occur in several forms including dissolved and particulate. In addition, phosphorus concentrations in water can be reported in a number of ways depending on the type of sample analyzed (i.e., filtered

Cause Category	Historically Used?	Numeric Criteria?	Description
			versus unfiltered) and the type analytical methods used. (Sources: Wikipedia (http://en.wikipedia.org/wiki/Phosphorus) and Cole (1979)). IDNR's ambient stream/river and lake monitoring networks measure and report phosphorus as "total phosphorus as P." Although an essential nutrient and although not toxic at levels found in the aquatic environment, high levels of phosphorus in water can stimulate excessive production of plant biomass (for example, algae) such that adverse water quality impacts can occur. These impacts range from reduced water clarity due to algae suspended in the water column, excessive oxygen demand from bacterial mineralization of decomposing plant material, and production of large populations of cyanobacteria (blue-green algae) that can be aesthetically objectionable as well as potentially harmful to human health. Levels of total phosphorus in Iowa surface waters tend to be high relative to levels considered to be of concern. The median level of total phosphorus in the approximately 9,500 samples collected from 2000 through 2009 as part of Iowa DNR's ambient stream/river water quality monitoring network is 200 parts per billion (ppb) (IDNR 2010). Twenty-five percent of the samples had phosphorus levels greater than 340 ppb. Of the 131 Iowa lakes monitored from 2001 through 2009, 99 lakes (75%) had median phosphorus levels greater than 50 ppb. The summary statistics suggest that the majority of Iowa's rivers, streams, and lakes have levels of phosphorus above the nutrient benchmark values for total phosphorus that have developed by nutrient criteria workgroups over the last decade (approximately 50 ppb for lakes and 100 ppb for rivers). The *Iowa Water Quality Standards* does not contain water quality criteria for either levels of phosphorus or nitrogen related to protection for primary contact recreation (Class A) or for aquatic life (Class B) beneficial uses. Thus, despite the quite high levels of phosphorus in Iowa waters, very few impairments of Iowa waters have been specifically attributed to "nutrients," "phosphorus," or "nitrogen." Given the lack of numeric nutrient criteria, IDNR has used a trophic state index to identify nutrient-related water quality impacts in lakes (e.g., poor water clarity due to large populations of algae) that are aesthetically objectionable and that thus suggest impairment of recreational uses. Algal impairment based on the trophic state index is the most commonly identified impairment at Iowa lakes.
priority organics	yes	yes	"Priority organics" are toxic organic pollutants listed in Section 307a of the federal Clean Water Act: "Priority organics" includes the following pollutant groups: chlorinated benzenes, chlorinated ethanes, chlorinated phenols, other chlorinated organics, haloethers, halomethanes, nitrosamines, non-chlorinated phenols, phthalate esters, polynuclear aromatic hydrocarbons (PAHs), pesticides and metabolites*, DDT and metabolites, polychlorinated biphenyls (PCBs), and other organics. For purposes of 305(b)/303(d) reporting in Iowa, this cause category does not include the following groups of priority organics: pesticides and metabolites, DDT and metabolites, or polychlorinated biphenyls (PCBs).
radiation (radium)	no	yes	Radiation is the energy emitted spontaneously in the process of decay of unstable atoms of radioisotopes. Sources of radiation include (1) the natural decay of primordial radioisotopes and their decay products and (2) manmade radioisotopes released into the environment beginning with testing and use of the atomic bomb in World War II. Radiation absorbed by plant and animal tissue may cause cellular and molecular damage that can adversely affect aquatic biota. Although routinely monitored for in Iowa groundwater monitoring networks, monitoring for radiation (radium) is not part of surface water monitoring networks in Iowa.
siltation	yes	no	Silt delivered to streams and rivers through nonpoint source runoff and/or through streambank

Cause Category	Historically Used?	Numeric Criteria?	Description
			erosion can degrade aquatic habitat through covering of coarse substrates, through deposition in pools, and through increasing the turbidity of the water. Siltation impacts in lakes refer to the erosion of soil particles by precipitation and movement of soil particles in runoff to lake basins where accumulation of silt occurs. The amount of silt delivered to Iowa's lakes relative to lake volume is an important factor in determining the quality of a lake for fishing, swimming and for use as a source of drinking water. Sedimentation is especially a problem for man-made lakes formed by dams placed across stream channels. Water quality impacts related to high rates of siltation/sedimentation include the delivery of excessive levels of plant nutrients (primarily phosphorus) to lakes, loss of lake volume, loss of surface area, a shortened useful life of the lake, interference with reproduction and growth of certain fish species, and impairments to recreational uses such as boating and fishing. While the delivery and accumulation of sediment is often the most serious problem in man-made lakes, it is generally less of a problem in the natural lakes of north-central and northwest Iowa. Natural lakes generally have much smaller watersheds relative to lake surface area, and their watersheds have less topographic relief and lower erosion rates than do lake watersheds in other regions of the state. Man-made lakes with low sedimentation rates tend to have clearer water and more productive fisheries than do lakes receiving large amounts of sediment. The man-made lakes in Iowa with the best water quality have relatively steep sides, small watersheds, and have well-controlled watersheds with a high percentage either in approved soil conservation practices or in non-crop land uses (e.g., pasture or forest) (see Hill 1981). Ideally, a man-made lake in Iowa would have a watershed-to-surface area ratio of from 20:1 up to 40:1. As watershed size increases relative to lake area, the more likely that the lake basin will be impacted (overloaded) with sediment delivered to the lake in rainfall runoff.
sulfates	No	no	Sulfate (SO_4^{-2}) is a naturally-occurring negatively-charged dissolved constituent of water and is one of several similar ions that combine to constitute "total dissolved solids." Sulfate may form salts with sodium, potassium, magnesium and other positively-charged ions. Sulfate is widely distributed in nature and may be present in natural waters at concentrations ranging from a few to several hundred milligrams per liter. At high levels (e.g., greater than 600 mg/L), sulfate in drinking water can have laxative effects on consumers. Levels of sulfate in Iowa surface waters are relatively low with a median concentration of 36 mg/L in the approximately 8,000 samples collected from 2000 through 2009 as part of Iowa DNR's ambient stream/river water quality monitoring network (IDNR 2010). Only 10% of these samples have had sulfate levels greater than 96 mg/L; the maximum concentration in these samples was 400 mg/L. The *Iowa Water Quality Standards* identify criteria to protect aquatic life from high levels of sulfate; the criteria depend on both hardness and the chloride concentrations (see https://www.legis.iowa.gov/DOCS/ACO/IAC/LINC/Chapter.567.61.pdf). Although sulfate criteria depend on hardness and the chloride concentration, levels below 500 mg/L likely to not violate these criteria.
suspended solids	yes	no	"Suspended solids" refers to the organic and inorganic particulate matter suspended in the water column. High levels of suspended solids in Iowa surface waters reduce water clarity and give a turbid or cloudy appearance to the water. Such material can originate from detritus carried by streams and rivers, atmospheric fallout, biological activity, chemical reactions, and re-suspension from bottom sediments as a result of current, wind/wave action, or movements of bottom-dwelling fish. The *Iowa Water Quality Standards* does not contain numeric aquatic life criteria for suspended

Cause Category	Historically Used?	Numeric Criteria?	Description
			solids. The Upper Mississippi River Conservation Committee's Water Quality Technical Section has identified a suspended solids threshold concentration of 30 mg/L above which turbidity in the water inhibits growth of types of submersed aquatic vegetation that are important to ecosystem function (see UMRCC 2003). IDNR has used this threshold to assess the degree to which Iowa's shallow lakes support their aquatic life uses.
taste and odor	no	no	"Taste and odor" refers to the acceptability of drinking water to the user. Most taste and odor problems are related to the presence of phenolic compounds or to the presence of odor-producing organic substances produced by microorganisms or by human and industrial wastes.
thermal modifica-tions	yes	yes	"Thermal modification" refers to a manmade deviation from natural seasonal water temperatures such that aquatic biota may be adversely affected. This deviation can include (1) addition of heat above physiological optimum levels of resident aquatic life, (2) the addition of heat such that state water quality standards are violated, or (3) the abrupt cessation of heated effluents during cooler seasons such that aquatic life cannot acclimate to the sudden change in ambient water temperature. Scenarios that can lead to impairments due to "thermal modifications" include the following: (1) discharge of heated effluent from power generating facilities such that ambient water temperatures violate water quality standards and (2) a fish kill caused by summer storm runoff with elevated water temperatures due to flow over super-heated impervious surfaces (streets, parking lots, etc) in urban areas. Criteria for water temperature are summarized in Table 7 of this document and can also be found in the *Iowa Water Quality Standards* (https://www.legis.iowa.gov/DOCS/ACO/IAC/LINC/Chapter.567.61.pdf).
total dissolved solids / salinity / chlorides / sulfates	no	no	"Total dissolved solids" (TDS) refers to the concentration of inorganic salts, small amounts of organic material, and other dissolved materials in the water column. The principal inorganic anions dissolved in water are carbonates, chlorides, sulfates, and nitrates; the principal cations are calcium, magnesium, sodium, and potassium. Previous version of the *Iowa Water Quality Standards* contained a numeric criterion for TDS of 750 mg/L as part of "general water quality criteria." Recent changes in the Standards, however, have included replacement of the TDS criterion with separate criteria for chloride and sulfate with the goal of improved protection of aquatic life (see http://www.iowadnr.gov/water/standards/files/ws_fact.pdf).
total toxics	no	no	"Total toxics" refers to the cumulative adverse impact of toxic parameters from multiple groupings on water quality and aquatic biota.
turbidity	yes	no	For purposes of Section 305(b) assessments and Section 303(d) listings, "turbidity" refers to non-algal materials suspended in the water column, especially soil particles (silt or clay), that give the water a brown, cloudy appearance. Turbidity-related impairments due to planktonic algae (i.e., "green" water) are considered to be caused by "excessive algal growth/chlorophyll-a." Regardless of the cause, high levels of turbidity may suggest a water quality impairment. High levels of turbidity in surface waters, whether due to suspended algae or non-algal materials, can interfere with the growth and reproduction of sight-feeding game fish (e.g., bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and walleye (*Sander vitreus*)), and excessive turbidity reduces the aesthetic appeal of surface waters for primary contact recreation such as swimming and water skiing. The primary sources of high turbidity in Iowa surface waters are (1) the resuspension of bottom sediments in shallow lakes through wind/wave action, (2) delivery of high amounts of silt and clay particles to the surface waters during precipitation runoff from agricultural areas, (3) contributions of silt and clay

Cause Category	Historically Used?	Numeric Criteria?	Description
			particles from erosion of stream banks or lake shorelines, or (4) bottom feeding fish (e.g., common carp (*Cyprinus carpio*) and bullheads (*Ameiurus* spp.) that increase turbidity through resuspension of sediment and nutrients during feeding and spawning activities. Surface waters that drain watersheds with certain types of clay-dominated soils may have chronic problems with turbidity regardless of the level of agricultural activity in the watershed. Historical evidence suggests that streams and rivers in the Missouri River drainage of southern and western Iowa had high levels of turbidity even during pre-settlement times. The presence of a turbidity tolerant fish fauna in these streams and rivers supports this assertion. Iowa surface waters with water quality problems due to high levels of turbidity are generally of three types: (1) man-made lakes in southern Iowa with relatively large watersheds having high rates of soil erosion (e.g., Bob White, Rock Creek, and Manteno lakes) and (2) shallow natural lakes of northern Iowa with high turbidities related to resuspension of silt and nutrients by bottom-feeding fish and/or wind/wave action (e.g., Ingham, Lower Gar, and North Twin lakes) and (3) streams and rivers with chronically high turbidities that may contribute to reduced aquatic diversity.
unknown toxicity	yes	NA	"Unknown toxicity" is identified as a cause of impairment when results of monitoring suggest some type of toxic impact but the identities of the substances causing toxicity are unknown. For example, results of a biological assessment that shows a complete lack of aquatic life in a stream strongly suggest the presence of toxic substances; the cause of impairment in such a case would be identified as "unknown toxicity."

* aldrin, dieldrin, chlordane, alpha-endosulfan, beta-endosulfan, endoslufan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, alpha BHC, beta BHC, gamma-BHC (lindane), delta-BHC, and toxaphene.

** Bluegreen algae (cyanobacteria) is considered a "noxious aquatic plant" by IDNR

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