Missouri Clean Water Commission Meeting
Department of Natural Resources
Lewis and Clark State Office Building
LaCharrette/Nightingale Creek Conference Rooms
1101 Riverside Drive
Jefferson City, Missouri

January 4, 2018

Proposed 2020 Listing Methodology Document

Issue: The Listing Methodology Document (LMD) is the document that describes how the Department will use water quality data to determine if waters of the state are impaired. Department staff meets with stakeholders and other interested members of the public approximately every two years to revise this document as needed.

Background: The Department has a public participation process for revision of the 303(d) LMD that runs concurrently with the public notice for the 303(d) List. The Draft 2020 LMD was placed on public notice July 3 through October 13, 2017. A summary of the public availability meetings held on August 24 and September 19, 2017, and the Biological Workgroup Meeting discussions on the Draft 2020 Listing Methodology Document held on January 4 and May 9, 2017, are all available in the Commission packet as well as on the Department's website: http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm.

The Draft 2020 Listing Methodology Document is an update to the 2018 Listing Methodology Document approved by the Commission in April 2016. The 2020 update includes revisions related to the addition of clarifying statements or information relating to biological assessment and minor corrections to tables.

Summary of Changes from the 2018 Listing Methodology

A majority of the revisions made to the 2018 Listing Methodology Document related to Table of Contents updates, page number updates, the addition of clarifying statements or information relating to biological assessment, references, and minor corrections to tables. Specifically, the most significant changes unrelated to document maintenance are:

1. Clarification language added to the Small Streams Assessment portion for aquatic macroinvertebrate monitoring.

2. Addition of Table 2 (on pg. 27) which describes the stream size classification for aquatic macroinvertebrate monitoring.

3. Addition of Toxicity test requirements for use in assessments.

4. Addition of information regarding sediment toxicity Probable Effects Concentrations and a relationship to Total Organic Carbon as a binding capacity for heavy metals.

5. Addition of sediment sample fraction size requirements and how new data that doesn't meet this criteria will be used going forward.

6. Addition of requirements and considerations for the use of Polycyclic Aromatic Hydrocarbons (PAHs) in assessments.

7. Additional of Table 3 (on pg. 37) which is a list of the 34 PAHs that are considered in the calculation of Total PAHs.

8. Addition of consideration of Equilibrium Partitioning Sediment Benchmark data also known as Acid Volatile Sulfides with Simultaneously Extracted Metals and Fractional Organic Carbon.

9. Addition of Appendix E which is a pictorial representation (flow chart) of how the Biological Weight of Evidence will be used in relation to sediment toxicity due to metals and PAHs.

Public Comment: All public comments and the Department's responses are part of the administrative record for the Listing Methodology Document and 303(d) List. Comments and responses are available on the Department's website. Comments were received from five different parties.

Summary of additional Department actions/changes to the draft 2020 Listing Methodology Document as a result of public comments

1. Amend 2020 Listing Methodology Document to include a statement indicating if a water has not been listed previously and <u>all</u> data indicating an impairment is older than 7 years, then the water shall be placed into Category 2B or 3B and prioritized for future sampling.

2. Amend 2020 Listing Methodology Document to include language that is flexible to future improvements to our data systems, but also include the ability of stakeholders to discuss the department's reasons for determining a change in the size of the assessment unit, until a better process has been vetted by the stakeholders.

3. Amend 2020 Listing Methodology Document to change the significance level for listing and delisting to be the same.

4. Amend 2020 Listing Methodology Document to add a minimum sample size of ten for water chemistry samples pertaining to dissolved oxygen, water temperature, pH, total dissolved gases, and oil and grease within the assessment

period outlined in the proposed 2020 Listing Methodology Document (i.e. within 7 years of available data).

5. Amend 2020 Listing Methodology Document to add language describing the Department's handling of data qualifiers such as less than, greater than, and estimated values.

6. Amend 2020 Listing Methodology Document to add language describing how dissolved oxygen readings taken either without associated flow data, or taken during non-flowing conditions, are handled.

7. Amend 2020 Listing Methodology Document to add language describing how the Department will assess pH based on what type of data is collected (i.e. continuous vs. grab samples).

Recommended Action: The Department recommends the Commission adopt the 2020 Missouri Listing Methodology Document as proposed.

The Department also requests the Commission to be open to future approval of an amended 2020 Listing Methodology Document if stakeholders feel additional changes are necessary and can be agreed upon.

Suggested Motion Language: The Department suggests the Commission adopt the 2020 Missouri Listing Methodology Document as proposed.

List of Attachments:

- Proposed 2020 303(d) Listing Methodology Document. Changes are shown in track changes and comment boxes
- Summaries of Public Availability Meeting discussions held on August 24 and September 19, 2017
- Summaries of Biological Workgroup Meeting discussions on the draft 2020 Listing Methodology Document held on January 4 and May 9, 2017
- Summaries of all public comments received as well as Department responses to those comments
- All public comments received

Methodology for the Development of the 2020 Section 303(d) List in Missouri

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Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program

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I. Citation and Requirements

A. Citation of Section of Clean Water Act

The Missouri Department of Natural Resources (MDNR) is responsible for the implementation and administration of the Federal Clean Water Act in Missouri. Pursuant to Section 40 CFR 130.7, States, Territories or authorized Tribes must submit biennially to the United States Environmental Protection Agency (EPA) a list of water quality limited (impaired) segments, pollutants causing impairment, and the priority ranking of waters targeted for Total Maximum Daily Load (TMDL) development. Federal regulation at 40 CFR 130.7 also requires States, Territories, and authorized Tribes to submit to EPA a written methodology document describing the State's approach in considering, and evaluating existing readily available data used to develop their 303(d) list of impaired water bodies. The listing methodology must be submitted to the EPA each year the Section 303(d) list is due. While EPA does not approve or disapprove the listing methodology, the agency considers the methodology during its review of the states 303(d) impaired waters list and the determination to list or not to list waters.

Following the Missouri Clean Water Commission approval, Section 303(d) is submitted to EPA. This fulfills Missouri's biennial submission requirements of an integrated report required under Sections 303(d), 305(b) and 314 of the Clean Water Act. In years when no integrated report is submitted, the department submits a copy of its statewide water quality assessment database to EPA.

B. U.S. EPA Guidance

In 2001 the Office of General Counsel and the Office of Wetlands, Oceans, and Watersheds developed a recommended framework to assist EPA regions in the preparation of their approval letters for the States' 2002 Section 303(d) list submissions. This was to provide consistency in making approval decisions along with guidance for integrating the development and submission of the 2002 Section 305(b) water quality reports and Section 303(d) list of impaired waters[1].

The following sections provide an overview of EPA Integrated Report guidance documents from calendar year 2002 through 2015.

The 2002 Integrated Water Quality Monitoring and Assessment Report Guidance was the first document EPA provided to the States, Territories, and authorized Tribes with directions on how to integrate the development and submission of the 2002 305(b) water quality reports and Section 303(d) list of impaired waters.

The guidance recommended that States, Territories and authorized Tribes submit a combined integrated report that would satisfy the Clean Water Act requirements for both Section 305(b) water quality reports and Section 303(d) list. The 2002 Integrated Report was to include:

[1] Additional information can be obtained from EPA's website: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/guidance.cfm).

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- Delineation of water quality assessment units based on the National Hydrography Dataset (NHD);
- Status of and progress toward achieving comprehensive assessments of all waters;
- Water quality standard attainment status for every assessment unit;
- Basis for the water quality standard attainment determinations for every assessment unit;
- Additional monitoring that may be needed to determine water quality standard attainment status and, if necessary, to support development of total maximum daily loads (TMDLs) for each pollutant/assessment unit combination;
- Schedules for additional monitoring planned for assessment units;
- Pollutant/assessment unit combinations still requiring TMDLs; and
- TMDL development schedules reflecting the priority ranking of each pollutant/ assessment unit combination.

The 2002 EPA guidance described the requirements under Section 303(d) of the Clean Water Act where states were required to describe the methodology used to develop their 303(d) list. EPA's guidance recommended the states provide: (1) a description of the methodology used to develop Section 303(d) list; (2) a description of the data and information used to identify impaired and threatened waters; (3) a rationale for not using any readily available data and information; and (4) information on how interstate or international disagreements concerning the list are resolved. Lastly (5), it is recommended that "prior to submission of its Integrated Report, each state should provide the public the opportunity to review and comment on the methodology." In accordance with EPA guidance, the department reviews and updates the Listing Methodology Document (LMD) every two years. The LMD is made available to the public for review and comment at the same time the state's 303(d) impaired waters list is published for public comment. Following the public comment period, the department responds to public comments and provides EPA with a document summarizing all comments received.

In July 2003, EPA issued new guidance entitled "Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act." This guidance gave further recommendations about listing of 303(d) and other waters.

In July 2005, EPA published an amended version entitled "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act" (see Appendix A for Excerpt).

In October 2006, EPA issued a memorandum entitled "Information Concerning 2008 Clean Water Act Sections 303(d), 305(b) and 314 Integrated Reporting and Listing Decisions." This memorandum serves as EPA's guidance for the 2008 reporting cycle and beyond. This guidance recommended the use of a five-part categorization scheme and that each state provides a comprehensive description of the water quality standards attainment status of all segments within a state (reference Table 1 below). The guidance also defined a "segment" as being used synonymous with the term "assessment unit" used in previous Integrated Report Guidance. Overall, the selected segmentation approach should be consistent with the state's water quality standards and be capable of providing a spatial scale that is adequate to characterize the water quality standards attainment status for the segment.

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It was in the 2006 guidance that EPA recommended all waters of the state be placed in one of five categories described below.

Table 1. Placement of Waters within the Five Categories in the 2006[2] EPA Assessment, Listing and Reporting Guidance

Category 1	All designated uses are fully maintained. Data or other information supporting full use attainment for all designated uses must be consistent with the state's Listing Methodology Document (LMD). The department will place a water in Category 1 if the following conditions are met: • The water has physical and chemical data (at a minimum, water temperature, pH, dissolved oxygen, ammonia, total cobalt, and total copper for streams, and total nitrogen, total phosphorus and secchi depth for lakes) and biological water quality data (at a minimum, *E. coli* or fecal coliform bacteria) that indicates attainment with water quality standards. • The level of mercury in fish fillets or plugs used for human consumption is 0.3 mg/kg (wet weight) or less. Only samples of higher trophic level species (largemouth, smallmouth and spotted bass, sauger, walleye, northern pike, trout (rainbow and trout), striped bass, white bass, flathead catfish and blue catfish) will be used. • The water is not rated as "threatened."
Category 2	One or more designated uses are fully attained but at least one designated use has inadequate data or information to make a use attainment decision consistent with the state's LMD. The department will place a water in Category 2 if at least one of the following conditions are met: • There is inadequate data for water temperature, pH, dissolved oxygen, ammonia, total cobalt or total copper in streams to assess attainment with water quality standards or inadequate data for total nitrogen, total phosphorus or secchi depth in lakes. • There is inadequate *E. coli* or fecal coliform bacteria data to assess attainment of the whole body contact recreational use. • There are insufficient fish fillet tissue, or plug data available for mercury to assess attainment of the fish consumption use. Category 2 waters will be placed in one of two sub-categories. Category 2A: Waters will be placed in this category if available data, using best professional judgement, suggests compliance with numerical water quality criteria of Tables A or B in Missouri's Water Quality Standards (10 CSR 20-7.031) or other quantitative thresholds for determining use attainment.

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[2] http://www.epa.gov/sites/production/files/2015-10/documents/2006irg-report.pdf

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	Category 2B: Waters will be placed in this category if the available data, using best professional judgment, suggests noncompliance with numeric water quality criteria of Tables A or B in Missouri's Water Quality Standards, or other quantitative thresholds for determining use attainment, and these data are insufficient to support a statistical test or to qualify as representative data. Category 2B waters will be given high priority for additional water quality monitoring.
Category 3	Water quality data are not adequate to assess any of the designated beneficial uses consistent with the LMD. The department will place a water in Category 3 if data are insufficient to support a statistical test or to qualify as representative data to assess any of the designated uses. Category 3 waters will be placed in one of two sub-categories. Category 3A. Waters will be placed in this category if available data, using best professional judgment, suggests compliance with numerical water quality criteria of Tables A or B in Missouri's Water Quality Standards (10 CSR 20-7.031) or other quantitative thresholds for determining use attainment. Category 3A waters will be tagged for additional water quality monitoring, but will be given lower priority than Category 3B waters. Category 3B. Waters will be placed in this category if the available data, using best professional judgment, suggest noncompliance with numerical water quality criteria of Tables A or B in Missouri's Water Quality Standards or other quantitative thresholds for determining use attainment. Category 3B waters will be given high priority for additional water quality monitoring.
Category 4	State water quality standards or other criteria, as per the requirements of Appendix B & C of this document, are not attained, but a Total Maximum Daily Load (TMDL) study is not required. Category 4 waters will be placed in one of three sub-categories. Category 4A. EPA has approved a TMDL study that addresses the impairment. The department will place a water in Category 4A if both the following conditions are met: • Any portion of the water is rated as being in non-attainment with state water quality standards or other criteria as explained in

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	Appendix B & C of this document due to one or more discrete pollutants or discrete properties of the water[3], and • EPA has approved a TMDL for all pollutants that are causing non-attainment. Category 4B. Water pollution controls required by a local, state or federal authority, are expected to correct the impairment in a reasonable period of time. The department will place a water in Category 4B if **both** of the following conditions are met: • Any portion of the water is rated as being in non-attainment with state water quality standards or other criteria as explained in Appendix B & C of this document due to one or more discrete pollutants or discrete properties of water[3], and • A water quality based permit that addresses the pollutant(s) causing the designated use, impairment has been issued, and compliance with the permit limits will eliminate the impairment; or other pollution control requirements have been made that are expected to adequately address the pollutant(s) causing the impairment. This may include implemented voluntary watershed control plans as noted in EPA's guidance document. Category 4C. Any portion of the water is rated as being in non-attainment with state water quality standards or other criteria as explained in Appendix B & C of this document, and a discrete pollutant(s) or other discrete property of the water[3] does not cause the impairment. Discrete pollutants may include specific chemical elements (e.g., lead, zinc), chemical compounds (e.g., ammonia, dieldrin, atrazine) or one of the following quantifiable physical, biological or bacteriological conditions: water temperature, percent of gas saturation, amount of dissolved oxygen, pH, deposited sediment, toxicity or counts of fecal coliform or *E. coli* bacteria.
Category 5	At least one discrete pollutant has caused non-attainment with state water quality standards or other criteria as explained in Appendix B & C of this document, and the water does not meet the qualifications for listing as either Categories 4A or 4B. Category 5 waters are those that are candidates for the state's 303(d) List[4]. If a designated use is not supported and the segment is impaired or threatened, the fact that a specific pollutant is not known does not provide a basis for excluding a segment from Category 5.

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[3] A discrete pollutant or a discrete property of water is defined here as a specific chemical or other attribute of the water (such as temperature, dissolved oxygen or pH) that causes beneficial use impairment and that can be measured quantitatively.
[4] The proposed state 303(d) List is determined by the Missouri Clean Water Commission and the final list is determined by the U.S. Environmental Protection Agency.

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	Category 5. These segments must be listed as Category 5 unless the state can demonstrate that no discrete pollutant(s) causes or contributes to the impairment. Pollutants causing the impairment will be identified through the 303(d) assessment and listing process before a TMDL study is written. The TMDL should be written within the time frame preferred in EPA guidance for TMDL development, when it fits within the state's TMDL prioritization scheme. Category 5-alt. A water body assigned to 5-alt is an impaired water without a completed TMDL but assigned a low priority for TMDL development because an alternative restoration approach is being pursued. This also provides transparency to the public that a state is pursuing restoration activities in those waters to achieve water quality standards. The addition of this sub-category will facilitate tracking alternative restoration approaches in 303(d) listed waters in priority areas.
Threatened Waters	When a water is currently attaining all designated uses, but the data shows an inverse (time) trend in quality for one or more discrete water quality pollutants indicating the water will not continue to meet these uses before the next listing cycle. Such water will be considered "threatened." A threatened water will be treated as an impaired water and placed in the appropriate Category (4A, 4B, or 5).

In subsequent years, EPA has provided additional guidance, but only limited new supplemental information has been provided since the 2008 cycle.

In August 2015, the EPA provided draft guidance that would include a Category 5-alternative (5-alt) (reference Table 1 above). Additional information can be found at EPA's website: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/guidance.cfm.

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II. The Methodology Document

A. Procedures and Methods Used to Collect Water Quality Data

- Department Monitoring

The major purposes of the department's water quality monitoring program are to:

- characterize background or reference water quality conditions;
- better understand daily, flow event and seasonal water quality variations and their underlying processes;
- characterize aquatic biological communities;
- assess trends in water quality;
- characterize local and regional effects of point and nonpoint sources pollutants on water quality;
- check for compliance with water quality standards and/or wastewater permit limits;
- support development of strategies, including Total Maximum Daily Loads, to return impaired waters to compliance with Water Quality Standards. All of these objectives are statewide in scope.

- Coordination with Other Monitoring Efforts in Missouri

To maximize efficiency, the department routinely coordinates its monitoring activities with other agencies to avoid overlap, and to give and receive feedback on monitoring design. Data from other sources are used for meeting the same objectives as department-sponsored monitoring. The data must fit the criteria described in the data quality considerations section of this document. The agencies most often involved are the U.S. Geological Survey, the U.S. Army Corps of Engineers, EPA, the Missouri Department of Conservation (MDC), and the Missouri Department of Health and Senior Services. The Department of Natural Resources also tracks the monitoring efforts of the National Park Service; the U.S. Forest Service; several of the state's larger cities; the states of Oklahoma, Arkansas, Kansas, Iowa, and Illinois; and graduate level research conducted at universities within Missouri. For those wastewater discharges where the department has required instream water quality monitoring, the department may also use monitoring data acquired by wastewater dischargers as a condition of discharge permits issued by the department. In 1995, the department also began using data collected by volunteers that have passed Volunteer Water Quality Monitoring Program Quality Assurance/Quality Control tests.

- Existing Monitoring Networks and Programs

The following is a list and a brief description of the kinds of water quality monitoring activities presently occurring in Missouri.

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1. Fixed Station Network

a) Objective: To better characterize background or reference water quality conditions, to better understand daily, flow events, and seasonal water quality variations and their underlying processes, to assess trends and to check for compliance with water quality standards.

b) Design Methodology: Sites are chosen based on one of the following criteria:
- Site is believed to have water quality representative of many neighboring streams of similar size due to similarity in watershed geology, hydrology and land use, and the absence of any impact from a significant point or discrete nonpoint water pollution source.
- Site is downstream of a significant point source or discrete nonpoint source area.

c) Number of Sites, Sampling Methods, Sampling Frequency, and Parameters:
- MDNR/U.S. Geological Survey cooperative network: approximately 70 sites statewide, horizontally and vertically integrated grab samples, four to twelve times per year. Samples are analyzed for major ions (e.g. calcium, magnesium, sulfate, and chloride), nutrients (e.g. phosphorus and nitrogen), temperature, pH, dissolved oxygen, specific conductance, bacteria (e.g. *Escherichia coli (E. coli)* and fecal coliform) and flow on all visits, two to four times annually for suspended solids and heavy metals, and for pesticides six times annually at four sites.
- MDNR/University of Missouri-Columbia's lake monitoring network. This program has monitored about 249 lakes since 1989. About 75 lakes are monitored each year. Each lake is usually sampled four times during the summer and about 12 are monitored spring through fall for nutrients, chlorophyll, turbidity and suspended solids.
- Department routine monitoring of finished public drinking water supplies for bacteria and trace contaminants.
- Routine bacterial monitoring for *E. coli* of swimming beaches at Missouri's state parks during the recreational season by the department's Missouri State Parks.
- Monitoring of sediment quality by the department at approximately 10-12 discretionary sites annually. Sites are monitored for several heavy metals (e.g. arsenic, cadmium, copper, lead, mercury, nickel, zinc, etc.) and/or organic contaminants (e.g. polycyclic aromatic hydrocarbons, etc.).

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2. Special Water Quality Studies

a) Objective: Special water quality studies are used to characterize water quality effects from a specific pollutant source area.

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b) Design Methodology: These studies are designed to verify and measure the contaminants of concern based on previous water quality studies, effluent sampling and/or Missouri State Operating Permit applications. These studies employ multiple sampling stations downstream and upstream (if appropriate). If contaminants of concern have significant seasonal or daily variation, the sampling design must account for such variation.

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c) Number of Sites, Sampling Methods, Sampling Frequency and Parameters: The department conducts or contracts up to 10 to 15 special studies annually, as funding allows. Each study has multiple sampling sites. The number of sites, sampling frequency and parameters all vary greatly depending on the study. Intensive studies would also require multiple samples per site over a relatively short time frame.

3. Toxics Monitoring Program

The fixed station network and many of the department's intensive studies monitor for acute and chronic toxic chemicals[5]. In addition, major municipal and industrial dischargers must monitor for acute and chronic toxicity in their effluents as a condition of their Missouri State Operating Permit.

4. Biological Monitoring Program

a) Objectives: The objectives of the Biological Monitoring programs are to develop numeric criteria describing "reference" aquatic macroinvertebrate and fish communities in Missouri's streams, to implement these criteria within state water quality standards and to maintain a statewide fish and aquatic macroinvertebrate monitoring program.

b) Design Methodology: Development of biocriteria for fish and aquatic marcoinvertebrates[6] involves identification of reference streams in each of Missouri's aquatic ecoregions and 17 ecological drainage units, respectively. It also includes intensive sampling of invertebrate and fish communities to quantify temporal and spatial variation in reference streams within ecoregions and variation among ecoregions, and the sampling of chemically and physically impaired streams to assess the aquatic community.

Deleted: to test sensitivity of various community metrics to differences in stream quality.

c) Number of Sites, Sampling Methods, Sampling Frequency and Parameters: The department has conducted biological sampling of aquatic macroinvertebrates for many years. Since 1991, the department's aquatic macroinvertebrate monitoring program has consisted of standardized monitoring of approximately 45 to 55 sites twice annually. In addition, the MDC presently has a statewide fish and aquatic macroinvertebrate monitoring program, the Resource Assessment and Monitoring (RAM) Program, designed monitor and assess the health of Missouri's stream resources on a rotating basis. This program samples a minimum of 450 random and 30 reference sites every five years.

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[5] As defined in 10 CSR 20-7.031(1)
[6] For additional information visit: http://dnr.mo.gov/env/esp/wqm/biologicalassessments.htm

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5. Fish Tissue Monitoring Program

a) Objective: Fish tissue monitoring addresses two objectives: (1) the assessment of ecological health or the health of aquatic biota (usually accomplished by monitoring whole fish samples); and (2) the assessment of human health risk based on the level of contamination of fish tissue plugs, or fillets.

b) Design Methodology: Fish tissue monitoring sites are chosen based on one of the following criteria:
- Site is believed to have water and sediment quality representative of many neighboring streams or lakes of similar size due to similarity in geology, hydrology and land use, and the absence of any known impact from a significant point source or discrete nonpoint water pollution source.
- Site is downstream of a significant point source or discrete nonpoint source area.
- Site has shown fish tissue contamination in the past.

c) Number of Sites, Sampling Methods, Sampling Frequency and Parameters:

The department plans to maintain a fish tissue monitoring program to collect whole fish composite samples[7] at approximately 13 fixed sites. In previous years, this was a cooperative effort between EPA and the department through EPAs Regional Ambient Fish Tissue (RAFT) Monitoring Program. Each site will be sampled once every two years. The preferred species for these sites are either Common Carp (*Cyprinus carpio*) or one of the Redhorse (a.k.a. sucker) species (*Moxostoma* sp.).

The department, EPA, and MDC also sample 40 to 50 discretionary sites annually for two fish fillet composite samples or fish tissue plug samples (mercury only) from fish of similar size and species. One sample is of a top carnivore such as Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieu*), Walleye (*Sander vitreus*), or Sauger (*Sander canadensis*). The other sample is for a species of a lower trophic level such as catfish, Common Carp or sucker species (Catostomidae). This program occasionally samples fish eggs for certain fish species at selected locations. Both of these monitoring programs analyze for several chlorinated hydrocarbon insecticides, PCBs, lead, cadmium, mercury, and fat content.

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6. Volunteer Monitoring Program

Two major volunteer monitoring programs generate water quality data in Missouri. The data generated from these programs are used for statewide 305(b) reporting on general water quality health, used as a screening level tool to determine where additional monitoring is needed, or used to supplement other water quality data for watershed planning purposes.
- Lakes of Missouri Volunteer Program[8]. This cooperative program consists of persons from the department, the University of Missouri-Columbia, and volunteers who monitor

[7] A composite sample is one in which several individual fish are combined to produce one sample.
[8] For additional program information visit: http://www.lmvp.org/

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approximately 137 sites on 66 lakes, including Lake Taneycomo, Table Rock Lake and several lakes in the Kansas City area. Lake volunteers are trained to collect samples for total phosphorus, total nitrogen, chlorophyll and inorganic suspended sediments. Data from this program is used by the university as part of a long-term study on the limnology of mid-western reservoirs.

- Volunteer Water Quality Monitoring Program. The Volunteer Water Quality Monitoring Program[9] is an activity of the Missouri Stream Team Program, which is a cooperative project sponsored by the department, the Missouri Department of Conservation, and the Conservation Federation of Missouri. The program involves volunteers who monitor water quality of streams throughout Missouri. There are currently over 5,000 Stream Teams and more than 3,600 trained water quality monitors. Approximately 80,000 citizens are served each year through the program. Since the beginning of the Stream Team program, 494,232 volunteers have donated about 2 million hours valued at more than $38 million to the State of Missouri.

  After the Introductory class, many attend at least one more class of higher level training: Levels 1, 2, 3 and 4. Each level of training is a prerequisite for the next higher level, as is appropriate data submission. Data generated by Levels 2, 3, and 4 and the Cooperative Stream Investigation (CSI) Program volunteers represent increasingly higher quality assurance. For CSI projects, the volunteers have completed a quality assurance/quality control workshop, completed field evaluation, and/or have been trained to collect samples following department protocols. Upon completing Introductory and Level 1 and 2 training, volunteers will have received the basic level training to conduct visual stream surveys, stream discharge measurements, biological monitoring, and collect physical and chemical measurements for pH, conductivity, dissolved oxygen, nitrate, and turbidity.

  Of those completing an Introductory course, about 35 percent proceed to Levels 1 and 2. The CSI Program uses trained volunteers to collect samples and transport them to laboratories approved by the department. Volunteers and department staff work together to develop a monitoring plan. All Level 2, 3, and 4 volunteers, as well as all CSI trained volunteers, are required to attend a validation session every 3 years to ensure equipment, reagents and methods meet program standards.

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- Identification of All Existing and Readily Available Water Quality Data Sources

Data Solicitation Request

In the calendar year 2 years prior to the current listing cycle, the department sends out a request for all available water quality data (chemical and biological). The data solicitation requests water quality data for approximately a two year timeframe prior to and including the current calendar year (up to October 31st of the current year). The data solicitation request is sent to multiple agencies, neighboring states, and organizations. In addition, and

[9] For additional program information visit: http://dnr.mo.gov/env/wpp/VWQM.htm

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as part of the data solicitation process, the department queries available water quality data from national databases such as EPA's Storage and Retrieval (STORET)/Water Quality Exchange (WQX) data warehouse[10], and the USGS Water Quality Portal[11].

The data must be spatially and temporally representative of the actual annual ambient conditions of the water body. Sample locations should be characteristic and representative of the main water mass or distinct hydrologic areas. With the exception of the data collected for those designated uses that require seasonally based data (e.g., whole body contact recreation, biological community data, and critical season dissolved oxygen), data should be distributed over at least three seasons, over two years, and should not be biased toward specific conditions (such as runoff, season, or hydrologic conditions).

Data meeting the following criteria will be accepted.

- Samples must be collected and analyzed under a Quality Assurance/Quality Control (QA/QC) protocol that follows the EPA requirements for quality assurance project plans.
- Samples must be analyzed following protocols that are consistent with the EPA or Standard Method procedures.
- All data submitted must be accompanied by a copy of the organization's QA/QC protocol and standard operating procedures.
- All data must be reported in standard units as recommended in the relevant approved methods.
- All data must be accompanied by precise sample location(s), preferably in either decimal degrees or Universal Transverse Mercator (UTM).
- All data must be received in a Microsoft Excel or compatible format.
- All data must have been collected within the requested period of record.

All readily available and acceptable data are uploaded into the department's Water Quality Assessment Database[12], where the data undergoes quality control checks prior to 303(d) or 305(b) assessment processes.

- Laboratory Analytical Support

Laboratories used:

- Department/U.S. Geological Survey Cooperative Fixed Station Network: U.S. Geological Survey Lab, Denver, Colorado
- Intensive Surveys: Varies, many are done by the department's Environmental Services Program
- Toxicity Testing of Effluents: Many commercial laboratories

[10] http://www.epa.gov/storet/dw_home.html
[11] http://www.waterqualitydata.us/
[12] http://dnr.mo.gov/mocwis_public/wqa/water bodySearch.do

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- Biological Criteria for Aquatic Macroinvertebrates: department's Environmental Services Program and Missouri Department of Conservation
- Fish Tissue: EPA Region VII Laboratory, Kansas City, Kansas, and miscellaneous contract laboratories (Missouri Department of Conservation or U.S. Geological Survey's Columbia Environmental Research Center)
- Missouri State Operating Permit: Self-monitoring or commercial laboratories
- Department's Public Drinking Water Monitoring: department's Environmental Services Program and commercial laboratories[13]
- Other water quality studies: Many commercial laboratories

B. Sources of Water Quality Data

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The following data sources are used by the department to aid in the compilation of the state's integrated report (previously the 305(b) report). Where quality assurance programs are deemed acceptable, additional sources would also be used to develop the state's Section 303(d) list. These sources presently include, but are not limited to:

1. Fixed station water quality and sediment data collected and analyzed by the department's Environmental Services Program personnel.
2. Fixed station water quality data collected by the U.S. Geological Survey under contractual agreements with the department.
3. Fixed station water quality data collected by the U.S. Geological Survey under contractual agreements to agencies or organizations other than the department.
4. Fixed station water quality, sediment quality, and aquatic biological information collected by the U.S. Geological Survey under their National Stream Quality Accounting Network and the National Water Quality Assessment Monitoring Programs.
5. Fixed station raw water quality data collected by the Kansas City Water Services Department, the St. Louis City Water Company, the Missouri American Water Company (formerly St. Louis County Water Company), Springfield City Utilities, and Springfield's Department of Public Works.
6. Fixed station water quality data collected by the U.S. Army Corps of Engineers. The Kansas City, St. Louis, and Little Rock Corps Districts have monitoring programs for Corps-operated reservoirs in Missouri.
7. Fixed station water quality data collected by the Arkansas Department of Environmental Quality, the Kansas Department of Health and Environment, the Iowa Department of Natural Resources, and the Illinois Environmental Protection Agency.
8. Fixed station water quality monitoring by corporations.
9. Annual fish tissue monitoring programs by EPA/Department RAFT Monitoring Program and MDC.

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10. Special water quality surveys conducted by the department. Most of these surveys are

[13] For additional information visit: http://dnr.mo.gov/env/wpp/labs/

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focused on the water quality impacts of specific point source wastewater discharges. Some surveys are of well-delimited nonpoint sources such as abandoned mined lands. These surveys often include physical habitat evaluation and monitoring of aquatic macroinvertebrates as well as water chemistry monitoring.

11. Special water quality surveys conducted by U.S. Geological Survey, including but not limited to:
    a) Geology, hydrology and water quality of various hazardous waste sites,
    b) Geology, hydrology and water quality of various abandoned mining areas,
    c) Hydrology and water quality of urban nonpoint source runoff in metropolitan areas of Missouri (e.g. St. Louis, Kansas City, and Springfield), and
    d) Bacterial and nutrient contamination of streams in southern Missouri.
12. Special water quality studies by other agencies such as MDC, the U.S. Public Health Service, and the Missouri Department of Health and Senior Services.
13. Monitoring of fish occurrence and distribution by MDC.
14. Fish Kill and Water Pollution Investigations Reports published by MDC.
15. Selected graduate research projects pertaining to water quality and/or aquatic biology.
16. Water quality, sediment, and aquatic biological data collected by the department, EPA or their contractors at hazardous waste sites in Missouri.
17. Self-monitoring of receiving streams by cities, sewer districts and industries, or contractors on their behalf, for those discharges that require this kind of monitoring. This monitoring includes chemical and sometimes toxicity monitoring of some of the larger wastewater discharges, particularly those that discharge to smaller streams and have the greatest potential to affect instream water quality.
18. Compliance monitoring of receiving waters by the department and EPA. This can include chemical and toxicity monitoring.
19. Bacterial monitoring of streams and lakes by county health departments, community lake associations, and other organizations using acceptable analytical methods.
20. Other monitoring activities done under a quality assurance project plan approved by the department.
21. Fixed station water quality and aquatic macroinvertebrate monitoring by volunteers who have successfully completed the Volunteer Water Quality Monitoring Program Level 2 workshop. Data collected by volunteers who have successfully completed a training Level 2 workshop is considered to be Data Code One. Data generated from Volunteer Training Levels 2, 3 and 4 are considered "screening" level data and can be useful in providing an indication of a water quality problem. For this reason, the data are eligible for use in distinguishing between waters in Categories 2A and 2B or Categories 3A and 3B. Most of this data are not used to place waters in main Categories (1, 2, 3, 4, and 5) because analytical procedures do not use EPA or Standard Methods or other department approved methods. Data from volunteers who have not yet completed a Level 2 training

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workshop do not have sufficient quality assurance to be used for assessment. Data generated by volunteers while participating in the department's Cooperative Site Investigation Program (Section II C1) or other volunteer data that otherwise meets the quality assurance outlined in Section II C2 may be used in Section 303(d) assessment.

The following data sources (22-23) **cannot** be used to rate a water as impaired (Categories 4A, 4B, 4C or 5); however, these data sources may be used to direct additional monitoring that would allow a water quality assessment for Section 303(d) listing.

22. Fish Management Basin Plans published by MDC.
23. Fish Consumption Advisories published annually by the Missouri Department of Health and Senior Services. Note: the department may use data from data source listed as Number 9 above, to list individual waters as impaired due to contaminated fish tissue.

As previously stated, the department will review all data of acceptable quality that are submitted to the department prior to the first public notice of the draft 303(d) list. However, the department will reserve the right to review and use data of acceptable quality submitted after this date if the data results in a change to the assessment outcome of the water.

C. Data Quality Considerations

- DNR Quality Assurance/Quality Control Program

The department and EPA Region VII have completed a Quality Management Plan. All environmental data generated directly by the department, or through contracts funded by the department, or EPA require a Quality Assurance Project Plan[14]. The agency or organization responsible for collecting and/or analyzing environmental data must write and adhere to a Quality Assurance Project Plan approved through the department's Quality Management Plan. Any environmental data generated via a monitoring plan with a department approved Quality Assurance Project Plan are considered suitable for use in water quality assessment and the 303(d) listing. This includes data generated by volunteers participating in the department's CSI Program. Under this program, the department's Environmental Services Program will audit select laboratories. Laboratories that pass this audit will be approved for the CSI Program. Individual volunteers who collect field samples and deliver them to an approved laboratory must first successfully complete department training on how to properly collect and handle environmental samples. The types of information that will allow the department to make a judgment on the acceptability of a quality assurance program are: (1) a description of the training, and work experience of the persons involved in the program, (2) a description of the field meters and maintenance and calibration procedures, (3) a description of sample collection and handling procedures, and (4) a description of all analytical methods used in the laboratory for analysis.

[14] For additional information visit: http://www.epa.gov/quality/qapps.html

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- Other Quality Assurance/Quality Control Programs

  Data generated in the absence of a department-approved Quality Assurance Project Plan may be used to assess a water body if the department determines that the data are adequate after reviewing and accepting the quality assurance procedures plan used by the data generator. This review would include: (1) names of all persons involved in the monitoring program, their duties, and a description of their training and work related experience, (2) all written procedures, Standard Operating Procedures, or Quality Assurance Project Plans pertaining to this monitoring effort, (3) a description of all field methods used, brand names and model numbers of any equipment, and a description of calibration and maintenance procedures, and (4) a description of laboratory analytical methods. This review may also include an audit by the department's Environmental Services Program.

- Data Qualifiers

  Data qualifiers will be handled in different ways depending upon the qualifier, the analytical detection limit, and the numeric WQS.

  - Less Than Qualifier "<" – For this qualifier the department will use half of the reported less than value. Unless circumstances cause issues with assessment. Examples of this include but are not limited to:
    - Less than values for bacteria. Since we calculate a geometric mean any value less than 1.0 could cause the data to be skewed if using the geometric mean calculation method of multiplying the values then dividing by the nth root.
    - Less than values below the criterion but still close to the criterion, less than values that are above the criterion. In these cases the department will not use the data for assessments.
  - Non-detection Qualifier "ND" – The department treats these same as less than ("<") qualifiers, with the exception that a value is not reported. For these cases the department will use the method detection limit as the reported less than value.
  - Greater Than Qualifier " >" – The department will only consider data with these qualifiers for assessments when it pertains to bacteria. In the cases of bacteria data the reported greater than (" >") value is doubled then used in the assessment calculation. In circumstances where this practice is the sole reason for impairment then the greater than value(s) will be used at the reported value (i.e. not doubled) in the assessment calculation.
  - Estimated Values "E" – These values are usually characterized as being above the laboratory quantification limit but below the laboratory reporting limit and are thus reported as estimated ("E"). Sometimes bacteria values are reported as estimated ("E") at the high end and due to the particular method used for analysis this usually means a dilution of the sample was used because the true bacteria count is higher than the method reporting maximum. The department will not use estimated ("E") values if the value reported is near the criterion. If the value is well above or well below the criterion then it will be used in assessments.

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- Data Age

For assessing present conditions, more recent data are preferable; however, older data may be used to assess present conditions if the data remains representative of present conditions.

  - If the department uses data older than seven years to make a Section 303(d) list decision a written justification for the use of such data will be provided.

  - If a water that has not previously been listed, has data all of which is older than 7 years, then the department will add the water to either Category 2B or 3B and prioritize it for future sampling.

  - A second consideration is the age of the data relative to significant events that may have an effect on water quality. Data collected prior to the initiation, closure, or significant change in a wastewater discharge, or prior to a large spill event or the reclamation of a mining or hazardous waste site, for example, may not be representative of present conditions. Such data would not be used to assess present conditions even if it was less than seven years old. Such "pre-event" data can be used to determine changes in water quality before and after the event or to show water quality trends.

- Data Type, Amount and Information Content

EPA recommends establishing a series of data codes, and rating data quality by the kind and amount of data present at a particular location (EPA 1997[15]). The codes are single-digit numbers from one to four, indicating the relative degree of assurance the user has in the value of a particular environmental data set. Data Code One indicates the least assurance or the least number of samples or analytes and Data Code Four the greatest. Based on EPA's guidance, the department uses the following rules to assign code numbers to data.

  - Data Code[16] One: All data not meeting the requirements of the other data codes.

  - Data Code Two: Chemical data collected quarterly to bimonthly for at least three years, or intensive studies that monitor several nearby sites repeatedly over short periods of time, or at least three composite or plug fish tissue samples per water body, or at least five bacterial samples collected during the recreational season of one calendar year.

[15] *Guidelines for the Preparation of the Comprehensive State Water Quality Assessments (305b) and Electronic Updates*, 1997. (http://water.epa.gov/type/watersheds/monitoring/repguid.cfm)
[16] Data Code One is equivalent to data water quality assurance Level One in 10 CSR 20-7.050 General Methodology for Development of Impaired Waters List, subsection (2)(C), Data Code Two is equivalent to Level 2, etc.

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- Data Code Three: Chemical data collected at least monthly for more than three years on a variety of water quality constituents including heavy metals and pesticides; or a minimum of one quantitative biological monitoring study of at least one aquatic assemblage (fish, macroinvertebrates, or algae) at multiple sites, multiple seasons (spring and fall), or multiple samples at a single site when data from that site is supported by biological monitoring at an appropriate control site.

- Data Code Four: Chemical data collected at least monthly for more than three years that provides data on a variety of water quality constituents including heavy metals and pesticides, and including chemical sampling of sediments and fish tissue; or a minimum of one quantitative biological monitoring study of at least two aquatic assemblages (fish, macroinvertebrates, or algae) at multiple sites.

In Missouri, the primary purpose of Data Code One data is to provide a rapid and inexpensive method of screening large numbers of waters for obvious water quality problems and to determine where more intensive monitoring is needed. In the preparation of the state's Integrated Report, data from all four data quality levels are used. Most of the data is of Data Code One quality, and without Data Code One data, the department would not be able to assess a majority of the state's waters.

In general, when selecting water bodies for the Missouri 303(d) List, only Data Code Two or higher are used, unless the problem can be accurately characterized by Data Code One data.[17] The reason is that Data Code Two data provides a higher level of assurance that a Water Quality Standard is not actually being attained and that a TMDL study is necessary. All water bodies placed in Categories 2 or 3 receive high priority for additional monitoring so that data quality is upgraded to at least Data Code Two. Category 2B and 3B waters will be given higher priority than Categories 2A and 3A.

- Dissolved Oxygen and Flow

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Dissolved oxygen in streams is highly dependent on flow. For the assessment of streams dissolved oxygen measurements must be accompanied by a flow measurement taken on the same day as the dissolved oxygen measurement. The dissolved oxygen measurements must also be collected from the flowing portion of the stream and must not be influenced by flooding or backwater conditions.

- pH Data Considerations

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The criterion for pH will be clarified at some point in the Missouri WQS as a chronic criterion. Assessment will be handled in the following ways:

- Continuous Sampling (i.e. time series or sonde data collection)

[17] When a listing, amendment or delisting of a 303(d) water is made with only Data Code One data, a document will be prepared that includes a display of all data and a presentation of all statistical tests or other evaluative techniques that documents the scientific defensibility of the data. This requirement applies to all Data Code One data identified in Appendix B of this document.

- Data collected in a time series fashion will be looked at on a 4 day period. If an entire 4 day period is outside of the 6.5 – 9.0 criterion range that will count as a chronic toxicity event. More than one of these events will constitute an impairment listing of the stream.

- Grab Samples
  - Data collected as grab samples will be treated as is and the binomial probability calculation will be used for assessment. See Appendix D for further information.

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D. How Water Quality Data is Evaluated to Determine Whether or Not Waters are Impaired for 303(d) Listing Purposes

I. Physical, Chemical, Biological and Toxicity Data

During each reporting cycle, the department and stakeholders review and revise the guidelines for determining water quality impairment. The guidelines shown in Appendix B & C provides the general rules of data use and assessment and Appendix D provides details about the specific analytical procedure used. In addition, if trend analysis indicates that presently unimpaired waters will become impaired prior to the next listing cycle, these "threatened waters" will be judged as impaired. Where antidegradation provisions in Missouri's Water Quality Standards apply, those provisions shall be upheld. The numerical criteria included in Appendix B have been adopted into the state water quality standards, 10 CSR 20-7.031, and are used, as described in Appendix B to make use attainment decisions.

II. Weight of Evidence Approach

When evaluating narrative criteria described in the state water quality standards, 10 CSR 20-7.031, the department will use a weight of evidence analysis for assessing numerical translators that have not been adopted into state water quality standards (see Appendix C). Under the weight of evidence approach, all available information is examined and the greatest weight is given to data providing the "best supporting evidence" for an attainment decision. Determination of "best supporting evidence" will be made using best professional judgment, considering factors such as data quality, and site-specific environmental conditions. For those analytes with numeric thresholds, the threshold values given in Appendix C will trigger a weight of evidence analysis to determine the existence or likelihood of a use impairment and the appropriateness of proposing a 303(d) listing based on narrative criteria. This weight of evidence analysis will include the use of other types of environmental data when it is available or collection of additional data to make the most informed use attainment decision. Examples of other relevant environmental data might include physical or chemical data, biological data on fish [Fish Index of Biotic Integrity (fIBI)] or aquatic macroinvertebrate [Macroinvertebrate Stream Condition Index (MSCI)] scores, fish tissue, or toxicity testing of water or sediments.

Biological data will be given greater weight in a weight of evidence analysis for making attainment decisions for aquatic life use and subsequent Section 303(d) listings. Whether or not numeric translators of biological criteria are met is a strong indicator for the

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attainment of aquatic life use. Moreover, the department retains a high degree of confidence in an attainment decision based on biological data that is representative of water quality condition.

When the weight of evidence analysis suggests, but does not provide strong scientifically valid evidence of impairment, the department will place the water body in question in Categories 2B or 3B. The department will produce a document showing all relevant data and the rationale for the attainment decision. All such documents will be available to the public at the time of the first public notice of the proposed 303(d) list. A final recommendation on the listing of a water body based on narrative criteria will only be made after full consideration of all comments on the proposed list.

III. Biological Data

Methods for assessing biological data typically receive considerable attention during the public comment period of development of the Listing Methodology Document. Currently, a defined set of biocriteria are used to evaluate biological data for assessing compliance with water quality standards. These biological criteria contain numeric thresholds, that when exceeded relative to prescribed assessment methods, serve as a basis for identifying candidate waters for Section 303(d) listing. Biocriteria are based on three types of biological data, including: (1) aquatic macroinvertebrate community data; (2) fish community data; and, (3) a catch-all class referred to as "other biological data."

In general, for interpretation of macroinvertebrate data where Stream Habitat Assessment Project Procedure (SHAPP) (MDNR 2016b) assessment scores indicate habitat is less than 75 percent of reference or appropriate control stream scores, and in the absence of other data indicating impairment by a discrete pollutant, a water body judged to be impaired will be placed in Category 4C. When interpreting fish community data, a provisional multi-metric habitat index called the QCPH1 index is used to identify stream habitat in poor condition. The QCPH1 index separates adequate habitat from poor habitat using a 0.39 threshold value; whereby, QCPH1 scores < 0.39 indicate stream habitat is of poor quality, and scores greater than 0.39 indicate available stream habitat is adequate. In the absence of other data indicating impairment by a discrete pollutant, impaired fish communities with poor habitat will be placed in Category 4C. Additional information about QCPH1 is provided in the *Considerations for the Influence of Habitat Quality and Sample Representativeness* section.

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The sections below describe the methods used to evaluate the three types of biological data (macroinvertebrate community, fish community, and other biological data), along with background information on the development and scoring of biological criteria, procedures for assessing biological data, methods used to ensure sample representativeness, and additional information used to aid in assessing biological data such as the weight of evidence approach.

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Aquatic Macroinvertebrate Community Data

The department conducts aquatic macroinvertebrate assessments to determine macroinvertebrate community health as a function of water quality and habitat. The health of a macroinvertebrate community is directly related to water quality and habitat. Almost all macroinvertebrate evaluation consists of comparing the health of the community of the "target" to healthy macroinvertebrate communities from reference streams of the same general size and usually in the same Ecological Drainage Unit (EDU).

The department's approach to monitoring and evaluating aquatic macroinvertebrates is largely based on *Biological Criteria for Wadeable/Perennial Streams of Missouri* (MDNR 2002). This document provides the framework for numerical biological criteria (biocriteria) relevant to the protection of aquatic life use for wadeable streams in the state. Biocriteria were developed using wadeable reference streams that occur in specific EDUs as mapped by the Missouri Resource Assessment Partnership (reference Figure 1 below). For macroinvertebrates, the numerical biocriterion translator is expressed as a multiple metric index referred to as the MSCI. The MSCI includes four metrics: Taxa Richness (TR); Ephemeroptera, Plecoptera, and Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Diversity Index (SDI). These metrics are considered indicators of stream health, and change predictably in response to the environmental condition of a stream.

Metric values are determined directly from macroinvertebrate sampling. To calculate the MSCI, each metric is normalized to unitless values of 5, 3, or 1, which are then added together for a total possible score of 20. MSCI scores are divided into three levels of stream condition:

- Fully Biologically Supporting (16-20),
- Partially Biologically Supporting (10-14), and
- Non-Biologically Supporting (4-8).

Partially and Non-Biologically Supporting streams may be considered impaired and are candidates for Section 303(d) listing.

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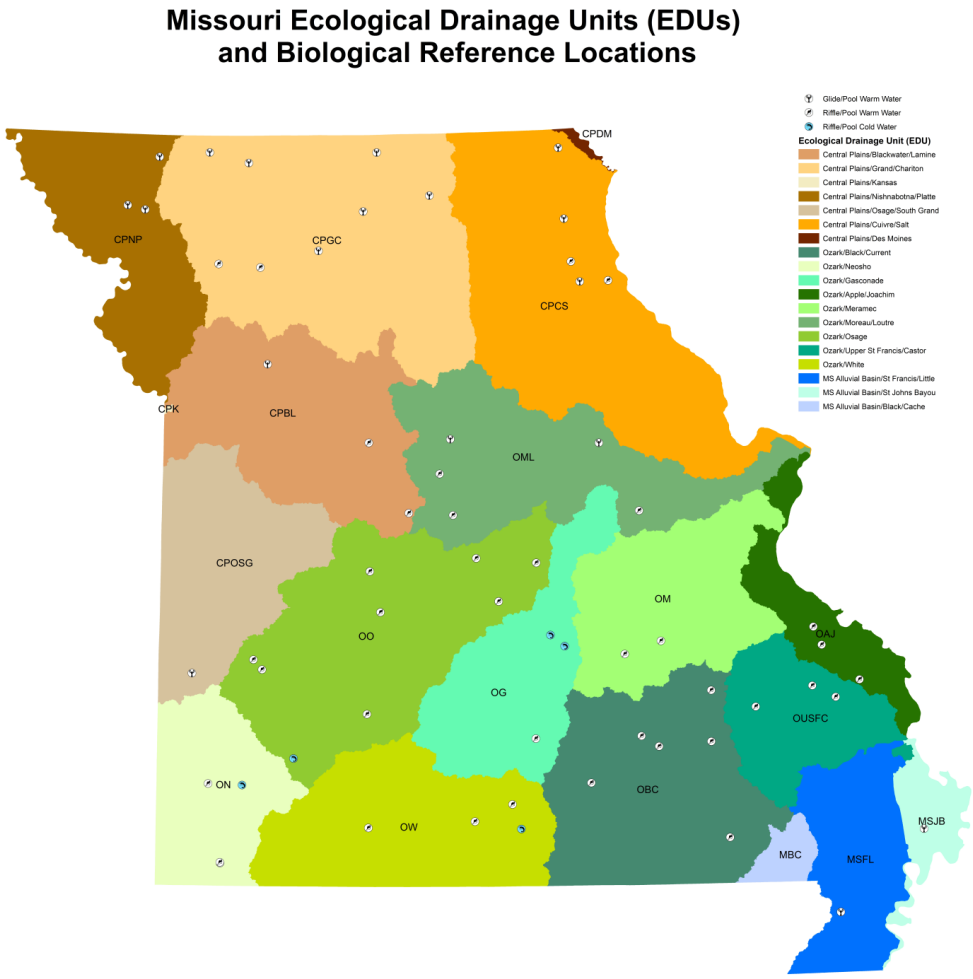

Figure 1: Missouri Ecological Drainage Units (EDUs) and Biological Reference Locations

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Unitless metric values (5, 3, or 1) were developed from the lower quartile of the distribution of each metric as calculated from reference streams for each EDU. The lower quartile (25th percentile) of each metric equates to the minimum value still representative of unimpaired conditions. In operational assessments, metric values below the lower quartile of reference conditions are typically judged as impaired (United States Environmental Protection Agency 1996, Ohio Environmental Protection Agency 1990, Barbour *et al.* 1996). Moreover, using the 25th percentile of reference conditions for each metric as a standard for impairment allows natural variability to be filtered out. For metrics with values that decrease with increasing impairment (TR, EPTT, SDI), any value above the lower quartile of the reference distribution receives a score of five. For

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the BI, whose value increases with increasing impairment, any value below the upper quartile (75th percentile) of the reference distribution receives a score of five. The remainder of each metric's potential quartile range below the lower quartile is bisected, and scored either a three or a one. If the metric value is less than or equal to the quartile value and greater than the bisection value it is scored a three. If the metric value is less than or equal to the bisection value it is scored a one.

MSCI scores meeting data quality considerations may be assessed for the protection of aquatic life using the following procedures.

Determining Full Attainment of Aquatic Life Use:

- For seven or fewer samples, 75% of the MSCI scores must be 16 or greater. Fauna achieving these scores are considered to be very similar to biocriteria reference streams.
- For eight or more samples, results must be statistically similar to representative reference or control streams.

Determining Non-Attainment of Aquatic Life Use:

- For seven or fewer samples, 75% of the MSCI scores must be 14 or lower. Fauna achieving these scores are considered to be substantially different from biocriteria reference streams**.**
- For eight or more samples, results must be statistically dissimilar to representative reference or control streams.

Data will be judged inconclusive when outcomes do not meet requirements for decisions of full or non-attainment.

As noted, when eight or more samples are available, results must be statistically similar or dissimilar to reference or control conditions in order to make an attainment decision. To accomplish this, a binomial probability with an appropriate level of significance (α=alpha), is calculated based on the null hypothesis that the test stream would have a similar percentage of MSCI scores that are 16 or greater as reference streams. The significance level is set at α=0.1, meaning if the p-value of the hypothesis test is less than α, the hypothesis is considered statistically significant. The significance level of α is in fact the probability of making a wrong decision and committing a Type I error (rejecting a true null hypothesis). When the Type I error rate is less than α=0.1, the null hypothesis is rejected. Inversely, when the Type I error rate is greater than α=0.1, the null hypothesis is accepted. For comparing samples from a test stream to samples collected from reference streams in the same EDU, the percentage of samples from reference streams scoring 16 or greater is used to determine the probability of "success" and "failure" in the binomial probability equation. For example, if 84% of the reference stream MSCI scores in a particular EDU are 16 or greater, then 0.84 would be used as the probability of success and 0.16 would be used as the probability of failure. Note that Appendix D states to "rate a stream as impaired if biological criteria reference

stream frequency of fully biologically supporting scores is greater than five percent more than the test stream," thus, a value of 0.79 (0.84 - 0.05) would actually be used as the probability of success in the binomial distribution equation.

Binomial Probability Example:
Reference streams from the Ozark/Gasconade EDU classified as riffle/pool stream types with warm water temperature regimes produce fully biologically supporting streams 85.7% of the time. In the test stream of interest, six out of ten samples resulted in MSCI scores of 16 or more. Calculate the Type I error rate for the probability of getting six or fewer fully biologically supporting scores in ten samples.

The binomial probability formula may be summarized as:

$$p^n + (n!/ X!(n-X)!*p^n q^{n-x}) = 1$$

Where,
Sample Size (n) = 10
Number of Successes (X) = 6
Probability of Success (p) = 0.857 - 0.05 = 0.807
Probability of Failure (q) = 0.193

Excel has the BINOM.DIST function that will perform this calculation.

=BINOM.DIST(number_s,trials,probability_s,cumulative)
=BINOM.DIST(6,10,0.807,TRUE)

Using Excel's Binomial Function	
Probability of Success	0.807
Sample Size	10
# of Successes	6
Type 1 Error Rate	0.109

Since 0.109 is greater than the test significance level (minimum allowable Type I error rate) of α= 0.1, we accept the null hypothesis that the test stream has the same percent of fully biologically supporting scores as the same type of reference streams from the Ozark/Gasconade EDU. Thus, this test stream would be judged as unimpaired.

If under the same scenario, there were only 5 samples from the test stream with MSCI scores of 16 or greater, the Type I error rate would change to 0.028, and since this value is less than the significance level of α=0.1, the stream would be judged as impaired.

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Deleted: The equation may then be written as:¶
¶
= 1 - ((0.807^10) + ((10*(0.807^9)*(0.193))) + ((45*(0.807^8)*(0.193^2)) +¶
((120*(0.807^7) * (0.193^3))) ¶
¶
= 0.109
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Within each EDU, MSCI scores are categorized by sampling regime (Glide/Pool vs. Riffle/Pool) and temperature regime (warm water vs. cold water). The percentage of fully biologically supporting scores for the Mississippi River Alluvial Basin/Black/Cache EDU is not available due to the lack of reference sites in this region. Percentages of fully biologically supporting samples per EDU is not included here, but can be made available upon request. The percentage of reference streams per EDU that are fully biologically supporting may change periodically as additional macroinvertebrate samples are collected and processed from reference samples within an EDU.

Sample Representativeness

The departments field and laboratory methods used to collect and process macroinvertebrate samples are contained in the document *Semi-Quantitative Macroinvertebrate Stream Bioassessment* (MDNR 2015). Macroinvertebrates are identified to levels following standard operating procedures contained in *Taxonomic Levels for Macroinvertebrate Identifications* (MDNR 2016b). Macroinvertebrate monitoring is accompanied by physical habitat evaluations as described in the document *Stream Habitat Assessment* (MDNR 2016a). For the assessment of macroinvertebrate samples, available information must meet data code levels three and four as described in Section II.C of this LMD. Data coded as levels three and four represent environmental data providing the greatest degree of assurance. Thus, at a minimum, macroinvertebrate assessments include multiple samples from a single site, or samples from multiple sites within a single reach.

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It is important to avoid situations where poor or inadequate habitat prohibits macroinvertebrate communities from being assessed as fully biologically supporting. Therefore, when assessing macroinvertebrate samples, the quality of available habitat must be similar to that of reference streams within the appropriate EDU. The department's policy for addressing this concern has been to exclude MSCI scores from an assessment when accompanying habitat scores are less than 75 percent of the mean habitat scores from reference streams of the appropriate EDU. The following procedures outline the department's method for assessing macroinvertebrate communities from sites with poor or inadequate habitat.

Assessing Macroinvertebrate Communities from Poor/Inadequate Habitat:

- If less than half the macroinvertebrate samples in an assessed stream segment have habitat scores less than 75 percent of the mean score for reference streams in that EDU, any sample that scores less than 16 and has a habitat score less than 75 percent of the mean reference stream score for that EDU, is excluded from the assessment process.

- If at least half the macroinvertebrate samples in an assessed stream segment have habitat scores less than 75 percent of the mean score for reference streams in that EDU and the assessment results in a judgment that the macroinvertebrate community is impaired, the assessed segment will be placed in Category 4C impairment due to poor aquatic habitat.

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- If one portion of the assessment reach contains two or more samples with habitat scores less than 75 percent of reference streams from that EDU while the remaining portion does not, the portion of the stream with poor habitat scores could be separately assessed as a category 4C stream permitting low MSCI scores.

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Macroinvertebrate sampling methods vary by stream type. One method is used in riffle/pool predominant streams, and the other method is for glide/pool predominant streams. For each stream type, macroinvertebrate sampling targets three habitats.

- For riffle/pool streams, the three habitats sampled are flowing water over coarse substrate, non-flowing water over depositional substrate, and rootmat substrate.
- For glide/pool streams, the three habitats sampled are non-flowing water over depositional substrate, large woody debris substrate, and rootmat substrate.

In some instances, one or more of the habitats sampled can be limited or missing from a stream reach, which may affect an MSCI score. Macroinvertebrate samples based on only two habitats may have an MSCI score equal to or greater than 16, but it is also possible that a missing habitat may lead to a decreased MSCI score. Although MDNR stream habitat assessment procedures take into account a number of physical habitat parameters from the sample reach (for example, riparian vegetation width, channel alteration, bank stability, bank vegetation protection, etc.), they do not exclusively measure the quality or quantity of the three predominant habitats from each stream. When evaluating potentially impaired macroinvertebrate communities, the number of habitats sampled, in addition to the stream habitat assessment score, will be considered to ensure MSCI scores less than 16 are properly attributed to poor water quality or poor/inadequate habitat condition.

Biologists responsible for conducting biological assessments will determine the extent to which habitat availability is responsible for a non-supporting (<16) MSCI score. If it is apparent that a non-supporting MSCI score was due to limited habitat, these effects will be stated in the biological assessment report. This limitation will then be considered when deciding which Listing Methodology category is most appropriate for an individual stream. This procedure, as part of an MDNR biological assessment, will aid in determining whether impaired macroinvertebrate samples have MSCI scores based on poor water quality conditions versus habitat limitations.

To ensure assessments are based on representative macroinverterbrate samples, samples collected during or shortly after prolonged drought, shortly after major flood events, or any other conditions that fall outside the range of environmental conditions under which reference streams in the EDU were sampled, will not be used to make an attainment decision for a Section 303(d) listing or any other water quality assessment purposes. Sample “representativeness” is judged by Water Protection Program (WPP) staff after reading the biomonitoring report for that stream, and if needed, consultation with biologists from the department’s Environmental Services Program. Regarding smaller deviations

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from "normal" conditions, roughly 20 percent of reference samples failing to meet a fully biologically supporting MSCI score were collected following weather/climate extremes; as a result, biological criteria for a given EDU are inclusive of samples collected during not only ideal macroinvertebrate-rearing conditions, but also during the weather extremes that Missouri experiences.

Assessing Small Streams

Occasionally, macroinvertebrate monitoring is needed to assess streams smaller than the typical wadeable/perennial reference streams listed in Table I of Missouri's Water Quality Standards. Smaller streams may include Class C streams (streams that may cease flow in dry periods but maintain permanent pools which support aquatic life) or those that are unclassified. Assessing small streams involves comparing test stream and candidate reference stream MSCI scores first, to Wadeable/Perennial Reference Stream (WPRS) criteria, and second to each other.

In MDNR's Biological Criteria Database, there are 16 candidate reference streams labeled as Class P, 23 labeled as Class C, and 24 labeled as Class U. In previous work by MDNR, when the MSCI was calculated according to WPRS criteria, the failure rate for such candidate reference streams was 31% for Class P, 39% for Class C, and 70% for Class U. The data trend showed a higher failure rate for increasingly smaller high quality streams when scored using WPRS biological criteria. This trend demonstrates the need to include the utilization of candidate reference streams in biological stream assessments.

Prior to the 2014 revision of the Missouri Water Quality Standards there was no size classification for streams. The 2014 revision codified size classification for rivers and streams based on five size categories for Warm Water, Cool Water and Cold Water Habitats. The size classifications are defined as Headwater, Creek, Small River, Large River and Great River. Water permanence continues to be classified as Class P (streams that maintain permanent flow even in drought periods); Class C (streams that cease flow in dry periods but maintain permanent pools which support aquatic life); and the newly adopted Class E (streams that do not maintain permanent surface flow or pools, but have surface flow or pools in response to precipitation events).

Table I of Missouri's Water Quality Standards lists 62 wadeable/perennial reference streams that provide the current basis for numeric biological criteria. Wadeable/perennial reference streams are a composite of Creek and Small River size classes. Interpretation of Creek (Size Code 2) and Small River (Size Code 3) is based on the Missouri Resource Assessment Partnership Shreve Link number found in Table 2. These wadeable/perennial reference streams were selected previous to the 2014 revision of the Missouri Water Quality Standards and were based on the former Table H (Stream Classifications and Use Designations). All, or a portion, of seven wadeable/perennial reference streams are Class C; and all, or a portion, of 57 wadeable/perennial reference streams are Class P.

As part of the 2014 revision of the Missouri Water Quality Standards, classified streams were changed from Table H to a modified version of the 1:100,000 National Hydrography

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Dataset. This dataset provides a geospatial framework for classified streams and is referred to as the Missouri Use Designation Dataset (MUDD). The streams and rivers now listed in MUDD contain approximately 100,000 miles of newly classified streams, many of which are the Headwater size class. Interpretation of Headwater size (Size Code 1) is based on the Missouri Resource Assessment Partnership Shreve Link number found in Table 2

Table 2.
Missouri Resource Assessment Partnership Shreve Link Number for Stream Size Code

Stream Size	Size Code	Plains Shreve Link Number	Ozark Shreve Link Number
Headwater	1	1-2	1-4
Creek	2	3-30	5-50
Small river	3	31-700	51-450
Large River	4	701-maximum	451- maximum
Great River	5	Missouri & Mississippi	Missouri & Mississippi
Unknown	0		

In natural channels, biological assessments will be based on criteria established from comparable stream size and permanence. The need for alternate criteria is supported by the higher failure rate (70%) for small size streams when scored using wadeable/perennial reference stream biological criteria (MDNR, unpublished data). Since headwater stream biological criteria have not been established, the utilization of candidate headwater reference streams and draft criteria will be necessary to perform biological stream assessments of headwater size streams.

For test streams that are smaller than wadeable perennial reference streams, MDNR also samples five candidate reference streams (small control streams) of same or similar size and Valley Segment Type (VST) in the same EDU twice during the same year the test stream is sampled (additional information about the selection small control streams is provided below). Although in most cases the MDNR samples small candidate reference streams concurrently with test streams, existing data may be used if a robust candidate reference stream data set exists for the EDU.

If the ten small candidate reference stream scores are similar to wadeable perennial reference stream criteria, then they and the test stream are considered to have a Class C or Class P general warm water beneficial use, and the MSCI scoring system in the LMD should be used. If the small candidate reference streams have scores lower than the wadeable perennial reference streams, the assumption is that the small candidate reference streams, and the test stream, represent designated uses related to stream size that are not yet

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approved by EPA in the state's water quality standards. The current assessment method for test streams that are smaller than reference streams is stated below.

- If the ten candidate reference stream (small control stream) scores are similar to WPRSs and meet LMD criteria for an unimpaired macroinvertebrate community, then the test stream will be assessed using MSCI based procedures in the LMD.

- If the ten candidate reference stream scores are lower than those of WPRSs and do not meet the LMD criteria for an unimpaired macroinvertebrate community, then:

  a) The test stream will be assessed as having an unimpaired macroinvertebrate community if the test stream scores meet the LMD criteria for an unimpaired community;
  b) The test stream data will be judged inconclusive if test stream scores are similar to candidate reference stream scores;
  c) The test stream will be assessed as having a "suspect" macroinvertebrate community if its scores are found to be low but statistically close to candidate reference streams; or,
  d) The test stream will be assessed as having an "impaired" macroinvertebrate community if its scores are found to be statistically lower than the candidate reference streams.

This method of assessing small streams will be used only until such time as the aquatic habitat protection use categories based on watershed size classifications of Headwater, Creek, Small River, Large River and Great River are ~~is~~ promulgated into Missouri Water Quality Standards and appropriate biological metrics are established for stream size and permanence.

The approach for determining a "suspect" or "impaired" macroinvertebrate community will be made using a direct comparison between all streams being evaluated, which may include the use of percent and/or mean calculations as determined on a case by case basis. All work will be documented on the macroinvertebrate assessment worksheet and be made available during the public notice period.

Selecting Small Candidate Reference Streams

Accurately assessing streams that are smaller than reference streams begins with properly selecting small candidate reference streams. Candidate reference streams are smaller than WPRS streams and have been identified as "best available" reference stream segments in the same EDU as the test stream according to watershed, riparian, and in-channel conditions. The selection of candidate reference streams is consistent with framework provided by Hughes *et al.* (1986) with added requirements that candidate reference streams must be from the same EDU and have the same or similar values for VST parameters. If candidate reference streams perform well when compared to WPRS, then test streams of similar size and VST are expected to do so as well. VST parameters important for

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selection are based on temperature, stream size, flow, geology, and relative gradient, with emphasis placed on the first three parameters.

The stepwise process for candidate reference stream selection is listed below.

1. Determine test stream reaches to be assessed.
2. Identify appropriate EDU.
3. Determine five variable VST of test stream segments (1st digit = temperature; 2nd digit = size; 3rd digit = flow; 4th digit = geology; and 5th digit = relative gradient). The GIS shapefile should have columns corresponding to these variables and can be concatenated to create the five variable VST.
4. Filter all stream segments within the same EDU for the relevant five variable VSTs (1st and 2nd digits especially critical for small streams).
5. Filter all potential VST stream segments for stressors against available GIS layers (e.g. point source, landfills, CAFOs, lakes, reservoirs, mining, etc.).
6. Filter all potential VST stream segments against historical reports and databases.
7. Develop candidate stream list with coordinates for field verification.
8. Field verify candidate list for actual use (e.g. animal grazing, in-stream habitat, riparian habitat, migration barriers (e.g. culverts, low water bridge crossings) representativeness, gravel mining, and other obvious human stressors).
9. Rank order candidate sites, eliminate obvious stressed sites, and select at least top five sites.
10. Calculate land use-land cover and compare to EDU.
11. Collect chemical, biological, habitat, and possibly sediment field data.
12. After multiple sampling events evaluate field data, land use, and historical data in biological assessment report.
13. If field data are satisfactory, retain candidate reference stream label in database.

Fish Community Data

The department utilizes fish community data to determine if aquatic life use is supported in certain types of Missouri streams. When properly evaluated, fish communities serve as important indicators of stream health. In Missouri, fish communities are surveyed by the MDC. MDC selects an aquatic subregion to sample each year, and therein, surveys randomly selected streams of 2nd to 5th order in size. Fish sampling follows procedures described in the document *Resource Assessment and Monitoring Program: Standard Operational Procedures--Fish Sampling* (Combes 2011). Numeric biocriteria for fish are represented by the fish Index of Biotic Integrity (fIBI). Development of the fIBI is described in the document *Biological Criteria for Stream Fish Communities of Missouri* (Doisy *et al.* 2008).

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The fIBI is a multi-metric index made up of nine individual metrics, which include:

- number (#) of native individuals;
- # of native darter species;
- # of native benthic species;
- # of native water column species;
- # of native minnow species;
- # of all native lithophilic species;
- percentage (%) of native insectivore cyprinid individuals;
- % of native sunfish individuals; and,
- % of the three top dominant species.

Values for each metric, as directly calculated from the fish community sample, are converted to unitless scores of 1, 3, or 5 according to criteria in Doisy *et al.* (2008). The fIBI is then calculated by adding these unitless values together for a total possible score of 45. Doisy *et al.* (2008) established an impairment threshold of 36 (where the 25th percentile of reference sites represented a score of 37), with values equal to or greater than 36 representing unimpaired communities, and values less than 36 representing impaired communities. For more information regarding fIBI scoring, please see Doisy *et al.* (2008).

Based on consultation between the department and MDC, the fIBI impairment threshold value of 36 was used as the numeric biocriterion translator for making an attainment decision for aquatic life (Appendix C). Work by Doisy *et al.* (2008) focused on streams 3rd to 5th order in size, and the fIBI was only validated for streams in the Ozark ecoregion, not for streams in the Central Plains and Mississippi Alluvial Basin. Therefore, when assessing streams with the fIBI, the index may only be applied to streams 3rd to 5th order in size from the Ozark ecoregion. Assessment procedures are outlined below.

Full Attainment

- For seven or fewer samples and following MDC RAM fish community protocols, 75% of fIBI scores must be 36 or greater. Fauna achieving these scores are considered to be very similar to Ozark reference streams.

- For eight or more samples, the percent of samples scoring 36 or greater must be statistically similar to representative reference or control streams. To determine statistical similarity, a binomial probability Type I error rate (0.1) is calculated based on the null hypothesis that the test stream would have the same percentage (75%) of fIBI scores greater than 36 as reference streams. If the Type I error rate is more than the significance level α=0.1, the fish community would be rated as unimpaired.

Non-Attainment

- For seven or fewer samples and following MDC RAM fish community protocols, 75% of the fIBI scores must be lower than 36. Fauna achieving

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these scores are considered to be substantially different than regional reference streams.

- For eight or more samples, the percent of samples scoring 36 or less must be statistically dissimilar to representative reference or control streams. To determine statistical dissimilarity, a binomial probability Type I error rate is calculated based on the null hypothesis that the test stream would have the same percentage (75%) of fIBI scores greater than 36 as reference streams. If the Type I error rate is less than 0.1, the null hypothesis is rejected and the fish community would be rated as impaired.

Data will be judged inconclusive when outcomes do not meet requirements for decisions of full or non-attainment.

With the exception of two subtle differences, use of the binomial probability for fish community samples will follow the example provided for macroinvertebrate samples in the previous section. First, instead of test stream samples being compared to reference streams of the same EDU, they will be compared to reference streams from the Ozark ecoregion. Secondly, the probability of success used in the binomial distribution equation will always be set to 0.70 since Appendix D states to "rate a stream as impaired if biological criteria reference stream frequency of fully biologically supporting scores is greater than five percent more than the test stream."

Although 1st and 2nd order stream data will not be used to judge a stream as impaired for Section 303(d) purposes, the department may use the above assessment procedures to judge 1st and 2nd order streams as unimpaired. Moreover, should samples contain fIBI scores less than 29, the department may judge the stream as "suspected of impairment" using the above procedures.

Considerations for the Influence of Habitat Quality and Sample Representativeness
Low fIBI scores that are substantially different than reference streams could be the result of water quality problems, habitat problems, or both. When low fIBI scores are established, it is necessary to review additional information to differentiate between an impairment caused by water quality and one that is caused by habitat. The collection of a fish community sample is also accompanied by a survey of physical habitat from the sampled reach. MDC sampling protocol for stream habitat follows procedures provided by Peck *et al.* (2006). With MDC guidance, the department utilizes this habitat data and other available information to assure that an assessment of aquatic life attainment based on fish data is only the result of water quality, and that an impairment resulting from habitat is categorized as such. This section describes the procedures used to assure low fIBI scores are the result of water quality problems and not habitat degradation. The information below outlines the department's provisional method to identify unrepresentative samples and low fIBI scores with questionable habitat condition, and ensure corresponding fish IBI scores are not used for Section 303(d) listing.

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a) Following recommendations from the biocriteria workgroup, the department will consult MDC about the habitat condition of particular streams when assessing low fIBI scores.

b) Samples may be considered for Section 303(d) listing ONLY if they were collected in the Ozark ecoregion, and the samples were collected during normal representative conditions, based upon best professional judgment from MDC staff,. Samples collected from the Central Plains and Mississippi Alluvial Basin are excluded from Section 303(d) listing.

c) Only samples from streams 3rd to 5th order in size may be considered for Section 303(d) listing. Samples from 1st or 2nd order stream sizes are excluded from Section 303(d) consideration; however, they may be placed into Categories 2B and 3B if impairment is suspected, or into Categories 1, 2A, or 3A if sample scores indicate a stream is unimpaired. Samples from lower stream orders are surveyed under a different RAM Program protocol than 3rd to 5th order streams.

d) Samples that are ineligible for Section 303(d) listing include those collected from losing streams, as defined by the Department of Geology and Land Survey, or collected in close proximity to losing streams. Additionally, ineligible samples may include those collected on streams that were considered to have natural flow issues (such as streams reduced predominately to subsurface flow) preventing good fish IBI scores from being obtained, as determined through best professional judgment of MDC staff.

e) Fish IBI scores must be accompanied by habitat samples with a QCPH1 habitat index score. MDC was asked to analyze meaningful habitat metrics and identify samples where habitat metrics seemed to indicate potential habitat concerns. As a result, a provisional index named QCPH1 was developed. QCPH1 values less than 0.39 indicate poor habitat, and values greater than 0.39 suggest adequate habitat is available. The QCPH1 comprises six sub-metrics indicative of substrate quality, channel disturbance, channel volume, channel spatial complexity, fish cover, and tractive force and velocity.

The QCPH1 index is calculated as follows:

$$QCPH1 = ((\text{Substrate Quality} * \text{Channel Disturbance} * \text{Channel Volume} * \text{Channel Spatial Complexity} * \text{Fish Cover} * \text{Tractive Force \& Velocity})^{1/6})$$

Where sub-metrics are determined by:

Substrate Quality = [(embeddedness + small particles)/2] * [(filamentous algae + aquatic macrophyte)/2] * bedrock and hardpan

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Channel Disturbance = concrete * riprap * inlet/outlet pipes * relative bed stability * residual pool observed to expected ratio

Channel Volume = [(dry substrate+width depth product + residual pool + wetted width)/4]

Channel Spatial Complexity = (coefficient of variation of mean depth + coefficient of variation of mean wetted width + fish cover variety)/3

Fish Cover = [(all natural fish cover + ((brush and overhanging vegetation + boulders + undercut bank + large woody debris)/4) + large types of fish cover)/3]

Tractive Force & Velocity = [(mean slope + depth * slope)/2]

Unimpaired fish IBI samples (fIBI ≥36) with QCPH1 index scores below the 0.39 threshold value, or samples without a QCPH1 score altogether, are eliminated from consideration for Category 5 and instead placed into Categories 2B or 3B should an impairment be suspected. Impaired fish communities (fIBI <36) with QCPH1 scores <0.39 can be placed into Category 4C (non-discrete pollutant/habitat impairment). Impaired fish communities (fIBI <36) with adequate habitat scores (QCPH1 >0.39) can be placed into Category 5. Appropriate streams with unimpaired fish communities and adequate habitat (QCPH1 >0.39) may be used to judge a stream as unimpaired.

Similar to macroinvertebrates, assessment of fish community information must be based on data coded level three or four as described in Section II.C of this document. Data coded as levels three and four represent environmental data with the greatest degree of assurance, and thus, assessments will include multiple samples from a single site, or samples from multiple sites within a single reach.

Following the department's provisional methodology, fish community samples available for assessment (using procedures in Appendix C & D include only those from 3rd to 5th order Ozark Plateau streams, collected under normal, representative conditions, where habitat seemed to be good, and where there were no issues with inadequate flow or water volume.

IV. Other Biological Data

On a case by case basis, the department may use biological data other than MSCI or fIBI scores for assessing attainment of aquatic life. Other biological data may include information on single indicator aquatic species that are ecologically or recreationally important, or individual measures of community health that respond predictably to environmental stress. Measures of community health could be represented by aspects of structure, composition, individual health, and processes of the aquatic biota. Examples

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could include measures of density or diversity of aquatic organisms, replacement of pollution intolerant taxa, or even the presence of biochemical markers.

Acute or Chronic Toxicity Tests
If toxicity tests are to be used as part of the weight of evidence then accompanying media (water or sediment) analysis must accompany the toxicity test results. (e.g. Metals concentrations in the sediment sample used for an acute toxicity test must accompany the toxicity test results.) The organism, its developmental stage used for the toxicity test, and the duration of the test must also accompany the results.

Other biological data should be collected under a well vetted study that is documented in a scientific report, a weight of evidence approach should be established, and the report should be referenced in the 303(d) listing worksheet. If other biological data is a critical component of the community and has been adversely affected by the presence of a pollutant or stressor, then such data would indicate a water body is impaired. The department's use of other biological data is consistent with EPA's policy on independent applicability for making attainment decisions, which is intended to protect against dismissing valuable information when diagnosing an impairment of aquatic life.

The use of other biological data in water body assessments occurs infrequently, but when available, it is usually assessed in combination with other information collected within the water body of interest. The department will avoid using other biological data as the sole justification for a Section 303(d) listing; however, other biological data will be used as part of a weight of evidence analysis for making the most informed assessment decision.

V. Toxic Chemicals

Water
For the interpretation of toxicity test data, standard acute or chronic bioassay procedures using freshwater aquatic fauna such as, but not limited to, *Ceriodaphnia dubia*, Fathead Minnows (*Pimephales promelas*), *Hyalella azteca*, or Rainbow Trout (*Oncorhynchus mykiss)*[18] will provide adequate evidence of toxicity for 303(d) listing purposes. Microtox®toxicity tests may be used to list a water as affected by "toxicity" only if there are data of another kind (freshwater toxicity tests, sediment chemistry, water chemistry, or biological sampling) that indicate water quality impairment.

For any given water, available data may occur throughout the system and/or be concentrated in certain areas. When the location of pollution sources are known, the department reserves the right to assess data representative of impacted conditions separately from data representative of unimpacted conditions. Pollution sources include those that may occur at discrete points along a water body, or those that are more diffuse.

[18] Reference 10 CSR 20-7.015(9)(L) for additional information

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Sediment

For toxic chemicals occurring in benthic sediments, data interpretation will include calculation of a geometric mean for specific toxins from an adequate number of samples, and comparing that value to a corresponding Probable Effect Concentration (PEC) given by MacDonald *et al.* (2000). The PEC is the level of a pollutant above which harmful effects on the aquatic community are likely to be observed. MacDonald (2000) gave an estimate of accuracy for the ability of individual PECs to predict toxicity. For all metals except arsenic, pollutant geometric means will be compared to 150% of the recommended PEC values. These comparisons should meet confidence requirements applied elsewhere in this document When multiple metal contaminants occur in sediment, toxicity may occur even though the level of each individual pollutant does not reach toxic levels. The method of estimating the synergistic effects of multiple metals in sediments is described below.

The sediment PECs given by MacDonald *et. al.* (2000) are based on some additional data assumptions. Those assumptions include a 1% Total Organic Carbon (TOC) content and that the sample has been sieved to less than 2mm.

For the TOC assumption the department completed an analysis of sediment TOC concentrations in their database and found that the TOC concentrations were too variable for the department to be confident in TOC normalization. Since the department uses 150% of the PEC values there is some variability accounted for in our assessment of sediment toxicity.

For the sample sieving assumption, the department will only use non-sieved (bulk) sediment concentrations for screening level data (Data Code One). Current impairments that have used bulk sediment data as evidence for impairment will remain on the list of impaired streams until sieved data can be collected to show either that it should remain on the list or that the sieved concentrations are below the 150% PEC values. Data that has been sieved to less than 2mm or smaller will be used for comparison to the 150% PEC values.

The Meaning of the Sediment Quotient and How to Calculate It

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Although sediment criteria in the form of a PEC are given for several individual contaminants, it is recognized that when multiple contaminants occur in sediment, toxicity may occur even though the level of each individual pollutant does not reach toxic levels. The method of estimating the synergistic effects of multiple pollutants in sediments given in MacDonald *et al.* (2000) includes the calculation of a PECQ. PECQs greater than 0.75 will be judged as toxic.

This calculation is made by dividing the pollutant concentration in the sample by the PEC value for that pollutant. For single samples, the quotients are summed, and then normalized by dividing that sum by the number of pollutants in the formula. When multiple samples

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are available, the geometric mean (as calculated for specific pollutants) will be placed in the numerator position for each pollutant included in the equation.

Example: A sediment sample contains the following results in mg/kg:

Arsenic 2.5, Cadmium 4.5, Copper 17, Lead 100, and Zinc 260.

The PEC values for these five pollutants in respective order are:

33, 4.98, 149, 128, and 459 mg/kg.

PECQ =

$$[(2.5/33) + (4.5/4.98) + (17/149) + (100/128) + (260/459)]/5 = 0.488$$

Using PECQ to Judge Toxicity

Based on research by MacDonald *et al.* (2000) 83% of sediment samples with a PECQ less than 0.5 were non-toxic while 85% of sediment samples with a PECQ greater than 0.5 were toxic. Therefore, to accurately assess the synergistic effects of sediment contaminants on aquatic life, the department will judge PECQ greater than 0.75 as toxic**.**

Using Total PAHs to Judge Toxicity

Based on research by MacDonald *et.al* (2000) 81.5% of sediment samples with a PEC value less than 22.8 mg/kg (ppm) were non-toxic while 100% of sediment samples with a PEC value greater than 22.8 mg/kg (ppm) were toxic. Therefore, to accurately assess the toxicity to aquatic life of total PAHs in sediment, the department will judge total PAH values greater than 150% of the PEC value (34.2 mg/kg) as toxic. For polycyclic aromatic hydrocarbons (PAHs) the sum of the geometric means for all PAH compounds will be compared to 150% of the recommended PEC value for total PAHs. Mount *et al.* (2003) indicates that individual PAH guidelines (PECs) are based on the samples also having elevated presence of additional PAHs, potentially overestimating the actual toxicity of an individual PAH value. The use of a total PAH guideline (PEC) reduces variability and provides a better representation of toxicity than the use of individual PAH PECs.

What compounds are considered in calculating Total PAHs and how will they be compared to the 150% PEC value?

To calculate total PAHs for a sample, Mount *et.al.* (2003) recommends following United States Environmental Protection Agency, Environmental Monitoring Assessment Program's definition of total PAHs. This definition includes 34 PAH compounds; 18 parent PAHs and 16 alkylated PAHs. (See Table 3 below for a list of these compounds.) Mount *et.al.* (2003) shows that using less than the 34 PAH compounds can underestimate the toxicity of PAHs

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in sediment. Commonly only 14 to 18 of the 34 PAH compounds are requested for analysis. Therefore the process to judge toxicity due to total PAHs is as follows:

- If samples are analyzed for less than the 34 PAH compounds then
  - If the sum (sum of the geometric means for more than one sample) of those compounds is greater than the 150% PEC then the sample(s) will be judged as toxic.
  - If the sum (sum of the geometric means for more than one sample) of those compounds is greater than the 100% PEC but less than 150% of the PEC then the sample(s) will be judged as inconclusive.
  - If the sum (sum of the geometric means for more than one sample) of those compounds is less than the 100% PEC then the values will be judged as non-toxic.
- If samples are analyzed for the 34 PAH compounds then
  - If the sum (sum of the geometric means for more than one sample) of those compounds is greater than the 150% PEC then the sample(s) will be judged as toxic.
  - If the sum (sum of the geometric means for more than one sample) of those compounds is less than the 150% PEC then the values will be judged as non-toxic.

Table 3. List of 34 polycyclic aromatic hydrocarbon (PAH) compounds that are considered for the calculation of total PAHs.

Parent PAHs	Alkylated PAHs
Acenaphthene	C1-Benzanthracene/chrysenes
Acenphthylene	C1-Fluorenes
Anthracene*	C1-Naphthalenes
Benz(a)anthracene*	C1-Phenanthrene/anthracenes
Benzo(a)pyrene*	C1-Pyrene/fluoranthenes
Benzo(b)fluoranthene	C2-Benzanthracene/chrysenes
Benzo(e)pyrene	C2-Fluorenes
Benzo(g,h,i)perylene	C2-Naphthalenes
Benzo(k)fluoranthene	C2-Phenanthrene/anthracenes
Chrysene*	C3-Benzanthracene/chrysenes
Dibenz(a,h)anthracene	C3-Fluorenes
Fluoranthene*	C3-Naphthalenes

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Fluorene*	C3-Phenanthrene/anthracenes
Indeno(1,2,3-cd)pyrene	C4-Benzanthracene/chrysenes
Naphthalene*	C4-Naphthalenes
Perylene	C4-Phenanthracene/anthracenes
Phenanthrene*	
Pyrene*	
**Listed in Table 3 of MacDonald et.al (2000)*	

Equilibrium Partitioning Sediment Benchmark (ESB) Data

Another type of analysis of the toxicity of metals in sediment is based on the EPA (2006) paper that discusses ESBs and their use. The department will not be collecting this type of data but will consider the data under the weight of evidence approach. To be considered the data must be accompanied by the name of the laboratory that completed the analysis and a copy of their laboratory procedures and QC documentation. Sieved sediment samples will be judged as toxic for metals in sediment if the sum of the simultaneously extracted metals minus acid volatile sulfides then divided by the fractional organic carbon [(ΣSEM-AVS)/FOC] is greater than 3000. If additional sieved sediment samples also show toxicity for a particular metal(s) then that particular metal(s) will be identified as the cause for toxicity.

Pictorial Representations (flow charts) for how these different sediment toxicity procedures could be used in the weight of evidence procedure are displayed in Appendix E.

VI. Duration of Assessment Period.

Except where the assessment period is specifically noted in Appendix B, the time period during which data will be used in making the assessments will be determined by data age and data code considerations, as well as representativeness considerations such as those described in footnote 14.

VII. Assessment of Tier Three Waters

Waters given Tier Three protection by the antidegradation rule at 10 CSR 20-7.031(2) shall be considered impaired if data indicate water quality has been reduced in comparison to its historical quality. Historical quality is determined from past data that best describes a water body's water quality following promulgation of the antidegradation rule and at the time the water was given Tier Three protection.

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Historical data gathered at the time waters were given Tier Three protection will be used if available. Because historical data may be limited, the historical quality of the waters may be determined by comparing data from the assessed segment with data from a "representative" segment. A representative segment is a body or stretch of water that best reflects the conditions that probably existed at the time the antidegradation rule first applied to the waters being assessed. Examples of possible representative data include 1) data from stream segments upstream of assessed segments that receive discharges, and 2) data from other water bodies in the same ecoregion having similar watershed and landscape characters. These representative stream segments also would be characterized by receiving discharges similar to the quality and quantity of historic discharges of the assessed segment. The assessment may also use data from the assessed segment gathered between the time of the initiation of Tier Three protection and the last known time in which upstream discharges, runoff, and watershed conditions remained the same, provided that the data do not show any significant trends of declining water quality during that period.

The data used in the comparisons will be tested for normality and an appropriate statistical test will be applied. The null hypothesis for statistical analysis will be that water quality at the test segment and representative segment is the same. This will be a one-tailed test (the test will consider only the possibility that the assessed segment has poorer water quality) with the alpha level of 0.1, meaning that the test must show greater than a 90 percent probability that the assessed segment has poorer water quality than the representative segment before the assessed segment can be listed as impaired.

VIII. Other Types of Information

1. Observation and evaluation of waters for noncompliance with state narrative water quality criteria. Missouri's narrative water quality criteria, as described in 10 CSR 20-7.031 Section (3), may be used to evaluate waters when a quantitative (narrative) value can be applied to the pollutant. These narrative criteria apply to both classified and unclassified waters and prohibit the following in waters of the state:

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   a. Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly, or harmful bottom deposits or prevent full maintenance of beneficial uses;

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   b. Waters shall be free from oil, scum, and floating debris in sufficient amounts to be unsightly or prevent full maintenance of beneficial uses;

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   c. Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor, or prevent full maintenance of beneficial uses;

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   d. Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal, or aquatic life;

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   e. There shall be no significant human health hazard from incidental contact with the water;

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   f. There shall be no acute toxicity to livestock or wildlife watering;

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g. Waters shall be free from physical, chemical, or hydrologic changes that would impair the natural biological community;

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h. Waters shall be free from used tires, car bodies, appliances, demolition debris, used vehicles or equipment, and solid waste as defined in Missouri's Solid Waste Law, section 260.200, RSMo, except as the use of such materials is specifically permitted pursuant to sections 260.200–260.247, RSMo;

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2. Habitat assessment protocols for wadeable streams have been established and are conducted in conjunction with sampling aquatic macroinvertebrates and fish. Methods for evaluating aquatic macroinvertebrate and fish community data include assessment procedures that account for the presence or absence of representative habitat quality. The department will not use habitat data alone for assessment purposes.

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E. Other 303(d) Listing Considerations

- Adding to the Existing List or Expanding the Scope of Impairment to a Previously Listed Water.

  The listed portion of impaired water bodies may be increased based on recent monitoring data following the guidelines in this document. One or more new pollutants may be added to the listing for a water body already on the list based on recent monitoring data following these same guidelines. Waters not previously listed may be added to the list following the guidelines in this document.

- Deleting from the Existing List or Decreasing the Scope of Impairment to a Previously Listed Water

  The listed portion of an impaired water body may be decreased based on recent monitoring data following the guidelines in this document. One or more pollutants may be deleted from the listing for a water body already on the list based on recent monitoring data following guidelines in Appendix D. Waters may be completely removed from the list for several reasons[19], the most common being (1) water has returned to compliance with water quality standards, or (2) the water has an approved TMDL study or Permit in Lieu of a TMDL.

- Listing Length of Impaired Segments

  The length of a 303(d) listing is currently based on the WBID length from the Missouri WQS. The department is using the WBID as the assessment unit to report to USEPA. When the department gains the database capability to further refine assessment units into segments smaller than WBIDs while maintain a transparent link to the WBID and Missouri's WQS, then the department will do so and will provide justification for

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[19] See, "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act". USEPA, Office of Water, Washington DC.

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splitting the WBID up into smaller assessment units in the assessment worksheets and can be discussed during the public notice process.

F. Prioritization of Waters for TMDL Development

Section 303(d) of the Clean Water Act and federal regulation 40 CFR 130.7(b)(4) require states to submit a priority ranking of waters requiring TMDLs. The department will prioritize development of TMDLs based on several variables including:

- social impact/public interest and risk to public health
- complexity and cost (including consideration of budget constraints), availability of data of sufficient quality and quantity for TMDL modeling
- court orders, consent decrees, or other formal agreements
- source of impairments
- existence of appropriate numeric quality criteria
- implementation potential and amenability of the problem to treatment, and
- Integrated Planning efforts by municipalities and other entities

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The department's TMDL schedule will represent its prioritization. The TMDL Program develops the TMDL schedule and maintains it at the following website: http://www.dnr.mo.gov/env/wpp/tmdl/.

G. Resolution of Interstate/International Disagreements

The department will review the draft 303(d) Lists of all other states with which it shares a border (Missouri River, Mississippi River, Des Moines River and the St. Francis River) or other interstate waters. Where the listing for the same water body in another state is different than the one in Missouri, the department will request the data and the listing justification. These data will be reviewed following the evaluation guidelines in this document. The Missouri Section 303(d) list may be changed pending the evaluation of this additional data.

H. Statistical Considerations

The most recent EPA guidance on the use of statistics in the 303(d) listing methodology document is given in Appendix A. Within this guidance there are three major recommendations regarding statistics:

- Provide a description of analytical tools the state uses under various circumstances
- When conducting hypothesis testing, explain the various circumstances under which the burden of proof is placed on proving the water is impaired and when it is placed on proving the water is unimpaired, and
- Explain the level of statistical significance (α) used under various circumstances.

- Description of Analytical Tools

  Appendix D, describes the analytical tools the department will use to determine whether a water body is impaired and whether or when a listed water body is no longer impaired.

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- Rationale for the Burden-of-Proof

Hypothesis testing is a common statistical practice. The procedure involves first stating a hypothesis you want to test, such as "the most frequently seen color on clothing at a St. Louis Cardinals game is red" and then the opposite or null hypothesis "red is not the most frequently seen color on clothing at a Cardinals game." Then a statistical test is applied to the data (a sample of the predominant color of clothing worn by 200 fans at a Cardinals game on July 12) and based on an analysis of that data, one of the two hypotheses is chosen as correct.

In hypothesis testing, the burden-of-proof is always on the alternate hypothesis. In other words, there must be very convincing data to make us conclude that the null hypothesis is not true and that we must accept the alternate hypothesis. How convincing the data must be is stated as the "significance level" of the test. A significance level of α=0.10 means that there must be at least a 90 percent probability that the alternate hypothesis is true before we can accept it and reject the null hypothesis.

For analysis of a specific kind of data, either the test significance level or the statement of null and alternative hypotheses, or both, can be varied to achieve the desired degree of statistical rigor. The department has chosen to maintain a consistent set of null and alternate hypotheses for all our statistical procedures. The null hypothesis will be that the water body in question is unimpaired and the alternate hypothesis will be that it is impaired. Varying the level of statistical rigor will be accomplished by varying the test significance level. For determining impairment (Appendix D) test significance levels are set at either α=0.1 or α=0.4, meaning the data must show at minimum 90% or 60% probability, respectively that the water body is impaired. However, if the department retained these same test significance levels in determining when an impaired water body had been restored to an unimpaired status (Appendix D) some undesirable results can occur.

For example, using a 0.1 significance level for determining both impairment and non-impairment, if the sample data indicate the stream had a 92 percent probability of being impaired, it would be rated as impaired. If subsequent data were collected and added to the database, and the data now showed the water had an 88 percent chance of being impaired, it would be rated as unimpaired. Judging as unimpaired a water body with only a 12 percent probability of being unimpaired is clearly a poor decision. To correct this problem, the department will use a test significance level of 0.4 for some analytes and 0.6 for others. This will increase our confidence in determining compliance with criteria to 40 percent and 60 percent, respectively under the worst case conditions, and for most databases will provide an even higher level of confidence.

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- Level of Significance Used in Tests

The choice of significance levels is largely related to two concerns. The first concern is with matching error rates with the severity of the consequences of making a decision error. The second addresses the need to balance, to the degree practicable, Type I and Type II error rates. For relatively small number of samples, the disparity between Type I and Type II errors can be large. The tables 4 and 5 below shows error rates calculated using the binomial distribution for two very similar situations. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard, and Type II error rates are based on a stream with a 15 percent exceedence rate of a standard. Note that when sample size remains the same, Type II error rates increase as Type I error rates decrease (Table 4). Also note that for a given Type I error rate, the Type II error rate declines as sample size increases (Table 5).

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Table 4,
Effects of Type I error rates on Type II error rates. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard and Type II error rates for a stream with a 15 percent exceedance rate of a standard.

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Total No. of Samples	No. Samples Meeting Std.	Type I Error Rate	Type II Error Rate
18	17	0.850	0.479
18	16	0.550	0.719
18	15	0.266	0.897
18	14	0.098	0.958
18	13	0.028	0.988

Table 5,
Effects of Type I error rates and sample size on Type II error rates. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard and Type II error rates for a stream with a 15 percent exceedance rate of a standard.

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Total No. of Samples	No. Samples Meeting Std.	Type I Error Rate	Type II Error Rate
6	5	0.469	0.953
11	9	0.303	0.930
18	15	0.266	0.897
25	21	0.236	0.836

- Use of the Binomial Probability Distribution for Interpretation of the 10 Percent Rule

There are two options for assessing data for compliance with the 10 percent rule. One is to simply calculate the percent of time the criterion value is not met, and to judge the water to be impaired if this value is greater than 10 percent. The second method is to use some evaluative

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procedure that can review the data and provide a probability statement regarding compliance with the 10 percent rule. Since the latter option allows assessment decisions relative to specific test significance levels and the first option does not, the latter option is preferred. The procedure chosen is the binomial probability distribution and calculation of the Type I error rate.

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- Other Statistical Considerations

Prior to calculation of confidence limits, the normality of the data set will be evaluated. If normality is improved by a data transformation, the confidence limits will be calculated on the transformed data.

Time of sample collection may be biased and interfere with an accurate measurement of frequency of exceedance of a criterion. Data sets composed mainly or entirely of storm water data or data collected only during a season when water quality problems are expected could result in a biased estimate of the true exceedance frequency. In these cases, the department may use methods to estimate the true annual frequency and display these calculations whenever they result in a change in the impairment status of a water body.

For waters judged to be impaired based on biological data where data evaluation procedures are not specifically noted in Table 1, the statistical procedure used, test assumptions, and results will be reported.

- Examples of Statistical Procedures

Two Sample "t" Test for Color

Null Hypothesis: Amount of color is no greater in a test stream than in a control stream. As stated, this is a one-sided test, meaning that we are only interested in determining whether or not the color level in the test stream is greater than in a control stream. If the null hypothesis had been "amount of color is different in the test and control streams," we would have been interested in determining if the amount of color was either less than or greater than the control stream, a two-sided test.

Significance Level: α=0.10

Data Set: Platinum-Cobalt color units data for the test stream and a control stream samples collected at each stream on same date.

Test Stream	70	45	35	45	60	60	80
Control Stream	50	40	20	40	30	40	75
Difference (T-C)	20	5	15	5	30	20	5

Statistics for the Difference: Mean = 14.28, standard deviation = 9.76, n = 7
Calculated "t" value = (square root of n)(mean)/standard deviation = 3.86

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Tabular "t" value is taken from a table of the "t" distribution for 2 alpha (0.20) and n-1 degrees of freedom. Tabular "t" = 1.44.

Since calculated "t" value is greater than tabular t value, reject the null hypothesis and conclude that the test stream is impaired by color.

Statistical Procedure for Mercury in Fish Tissue

Data Set: data in µg/Kg 130, 230, 450. Mean = 270, Standard Deviation = 163.7
The 60% Lower Confidence Limit Interval = the sample mean minus the quantity:
((0.253)(163.7)/square root 3) = 23.9. Thus the 60% LCL Confidence Interval is 246.1 µg/Kg.

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The criterion value is 300 µg/Kg. Therefore, since the 60% LCL Confidence Interval is less than the criterion value, the water is judged to be unimpaired by mercury in fish tissue, and the water body is placed in either Category 2B or 3B.

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Appendix A

Excerpt from *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act.* July 29, 2005. USEPA pp. 39-41.

The document can be read in its entirety from the US. EPA web site:
http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/2006irg-report.pdf

G. How should statistical approaches be used in attainment determinations?

The state's methodology should provide a rationale for any statistical interpretation of data for the purpose of making an assessment determination.

- *Description of statistical methods to be employed in various circumstances*

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The methodology should provide a clear explanation of which analytic tools the state uses and under which circumstances. EPA recommends that the methodology explain issues such as the selection of key sample statistics (arithmetic mean concentration, median concentration, or a percentile), null and alternative hypotheses, confidence intervals, and Type I and Type II error thresholds. The choice of a statistic tool should be based on the known or expected distribution of the concentration of the pollutant in the segment (e.g., normal or log normal) in both time and space.

Past EPA guidance (1997 305(b) and 2000 CALM) recommended making non-attainment decisions, for "conventional pollutants[20]" — TSS, pH, BOD, fecal coliform bacteria, and oil and grease — when more than "10% of measurements exceed the water quality criterion." (However, EPA guidance has not encouraged use of the "10% rule" with other pollutants, including toxics.) Use of this rule when addressing conventional pollutants, is appropriate if its application is consistent with the manner in which applicable WQC are expressed. An example of a WQC for which an assessment based on the ten percent rule would be appropriate is the EPA acute WQC for fecal coliform bacteria, applicable to protection of water contact recreational use. This 1976-issued WQC was expressed as, "...no more than ten percent of the samples exceeding 400 CFU per 100 ml, during a 30-day period." Here, the assessment methodology is clearly reflective of the WQC.

On the other hand, use of the ten percent rule for interpreting water quality data is usually not consistent with WQC expressed either as: 1) instantaneous maxima not to be surpassed at any time, or 2) average concentrations over specified times. In the case of "instantaneous maxima (or minima) never to occur" criteria use of the ten percent rule typically leads to the belief that segment conditions are equal or better than specified by the WQC, when they in fact are considerably worse. (That is,

[20] There are a variety of definitions for the term "conventional pollutants." Wherever this term is referred to in this guidance, it means "a pollutant other than a toxic pollutant."

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pollutant concentrations are above the criterion-concentration a far greater proportion of the time than specified by the WQC.) Conversely, use of this decision rule in concert with WQC expressed as average concentrations over specific times can lead to concluding that segment conditions are worse than WQC, when in fact they are not.

If the state applies different decision rules for different types of pollutants (e.g., toxic, conventional, and non-conventional pollutants) and types of standards (e.g., acute vs. chronic criteria for aquatic life or human health), the state should provide a reasonable rationale supporting the choice of a particular statistical approach to each of its different sets of pollutants and types of standards.

1. *Elucidation of policy choices embedded in selection of particular statistical approaches and use of certain assumptions EPA strongly encourages states to highlight policy decisions implicit in the statistical analysis that they have chosen to employ in various circumstances. For example, if hypothesis testing is used, the state should make its decision-making rules transparent by explaining why it chose either "meeting WQS" or "not meeting WQS" as the null hypothesis (rebuttable presumption) as a general rule for all waters, a category of waters, or an individual segment. Starting with the assumption that a water is "healthy" when employing hypothesis testing means that a segment will be identified as impaired, and placed in Category 4 or 5, only if substantial amounts of credible evidence exist to refute that presumption. By contrast, making the null hypothesis "WQS not being met" shifts the burden of proof to those who believe the segment is, in fact, meeting WQS.*

Which "null hypothesis" a state selects could likely create contrasting incentives regarding support for additional ambient monitoring among different stakeholders. If the null hypothesis is "meeting standards," there were no previous data on the segment, and no additional existing and readily available data and information are collected, then the "null hypothesis" cannot be rejected, and the segment would not be placed in Category 4 or 5. In this situation, those concerned about possible adverse consequences of having a segment declared "impaired" might have little interest in collection of additional ambient data. Meanwhile, users of the segment would likely want to have the segment monitored, so they can be ensured that it is indeed capable of supporting the uses of concern. On the other hand, if the null hypothesis is changed to "segment not meeting WQS," then those that would prefer that a particular segment not be labeled "impaired" would probably want more data collected, in hopes of proving that the null hypothesis is not true.

Another key policy issue in hypothesis testing is what significance level to use in deciding whether to reject the null hypothesis. Picking a high level of significance for rejecting the null hypothesis means that great emphasis is being placed on avoiding a Type I error (rejecting the null hypothesis, when in fact, the null hypothesis is true). This means that if a 0.10 significance level is chosen, the state wants to keep the chance of making a Type I error at or below ten percent. Hence, if the chosen null hypothesis 2006 IR Guidance

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July 2005 41 is "segment meeting WQS," the state is trying to keep the chance of saying a segment is impaired – when in reality it is not – under ten percent.

An additional policy issue is the Type II errors (not rejecting the null hypothesis, when it should have been). The probability of Type II errors depends on several factors. One key factor is the number of samples available. With a fixed number of samples, as the probability of Type I error decreases, the probability of a Type II error increases. States would ideally collect enough samples so the chances of making Type I and Type II errors are simultaneously small. Unfortunately, resources needed to collect such numbers of samples are quite often not available.

The final example of a policy issue that a state should describe is the rationale for concentrating limited resources to support data collection and statistical analysis in segments where there are documented water quality problems or where the combination of nonpoint source loadings and point source discharges would indicate a strong potential for a water quality problem to exist.

EPA recommends that, when picking the decision rules and statistical methods to be utilized when interpreting data and information, states attempt to minimize the chances of making either of the two following errors:

- *Concluding the segment is impaired, when in fact it is not, and*
- *Deciding not to declare a segment impaired, when it is in fact impaired.*

States should specify in their methodology what significance level they have chosen to use, in various circumstances. The methodology would best describe in "plain English" the likelihood of deciding to list a segment that in reality is not impaired (Type I error if the null hypothesis is "segment not impaired"). Also, EPA encourages states to estimate, in their assessment databases, the probability of making a Type II error (not putting on the 303(d) list a segment that in fact fails to meet WQS), when: 1) commonly-available numbers of grab samples are available, and 2) the degree of variance in pollutant concentrations are at commonly encountered levels. For example, if an assessment is being performed with a WQC expressed as a 30-day average concentration of a certain pollutant, it would be useful to estimate the probability of a Type II error when the number of available samples over a 30 day period is equal to the average number of samples for that pollutant in segments state-wide, or in a given group of segments, assuming a degree of variance in levels of the pollutant often observed over typical 30 day periods.

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Appendix B

METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(d) LISTING PURPOSES: NUMERIC CRITERIA THAT ARE INCLUDED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[i]	Notes
Overall use protection (all designated uses)	No data. Evaluated based on similar land use/ geology as stream with water quality data.	Not applicable	Given same rating as monitored stream with same land use and geology.	**Data Type Note:** This data type is used only for wide-scale assessments of aquatic biota and aquatic habitat for 305(b) Report purposes. This data type is not used in the development of the 303(d) List.
Any designated uses	No data available or where only effluent data is available. Results of dilution calculations or water quality modeling	Not applicable	Where models or other dilution calculations indicate noncompliance with allowable pollutant levels and frequencies noted in this table, waters may be added to Category 3B and considered high priority for water quality monitoring.	
Protection of Aquatic Life	Dissolved oxygen, water temperature, pH, total dissolved gases, oil and grease.	1-4	Full: No more than 10% of all samples exceed criterion. Non-Attainment: Requirements for full attainment not met. Requirments: A minimum sample size of 10 samples during the assessment period (see Section VI above).	**Compliance with Water Quality Standards Note:** Some sampling periods are wholly or predominantly during the critical period of the year when criteria violations occur. Where the monitoring program presents good evidence of a demarcation between seasons where criteria exceedences occur and seasons when they do not, the 10% exceedence rate will be based on an annual estimate of the frequency of exceedence. Continuous (e.g. sonde) data with a quality rating of excellent or good will be used for assessments. Chronic pH will be used in the 2018 LMD only if these criteria appear in the Code of State Regulations, and approved by the U.S. Environmental Protection Agency.

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DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[i]	Notes
Losing Streams	*E. coli* bacteria	1-4	Full: No more than 10% of all samples exceed criterion. Non-Attainment: Requirements for full attainment not met. The criterion for *E. coli* is 126 counts/100ml. 10 CSR 20-7.031 (4)(C)	
Protection of Aquatic Life	Toxic chemicals	1-4	Full: No more than one acute toxic event in three years that results in a documented die-off of aquatic life such as fish, mussels, and crayfish (does not include die-offs due to natural origin). No more than one exceedence of acute or chronic criterion in the last three years for which data is available. Non-Attainment: Requirements for full attainment not met.	**Compliance with Water Quality Standards Note:** For hardness based metals with eight or fewer samples, the hardness value associated with the sample will be used to calculate the acute or chronic thresholds. For hardness based metals with more than eight samples, the hardness definition provided in state water quality standards will be used to calculate the acute and chronic thresholds.
Protection of Aquatic Life	Nutrients in Lakes (total phosphorus, total nitrogen, plus chlorophyll)	1-4	Full: Nutrient levels do not exceed water quality standards following procedures stated in Appendix D. Non-Attainment: Requirements for full attainment not met.	**Compliance with Water Quality Standards Note:** Nutrient criteria will be used in the 2018 LMD only if these criteria appear in the Code of State Regulations, and approved by the U.S. Environmental Protection Agency.
Human Health - Fish Consumption	Chemicals (water)	1-4	Full: Water quality does not exceed water quality standards following procedures stated in Appendix D. Non-Attainment: Requirements for full attainment not met.	

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METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(d) LISTING PURPOSES: NUMERIC CRITERIA THAT ARE INCLUDED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[i]	Notes
Drinking Water Supply -Raw Water.	Chemical (toxics)	1-4	Full: Water Quality Standards not exceeded following procedures stated in Appendix D. Non-Attainment: Requirements for full attainment not met.	**Designated Use Note:** Raw water is water from a stream, lake or groundwater prior to treatment in a drinking water treatment plant.
Drinking Water Supply- Raw Water	Chemical (sulfate, chloride, fluoride)	1-4	Full: Water quality standards not exceeded following procedures stated in Appendix D. Non-Attainment: Requirements for full attainment not met.	
Drinking Water Supply-Finished Water	Chemical (toxics)	1-4	Full: No Maximum Contaminant Level (MCL) violations based on Safe Drinking Water Act data evaluation procedures. Non-Attainment: Requirements for full attainment not met.	**Compliance with Water Quality Standards Note:** Finished water data will not be used for analytes where water quality problems may be caused by the drinking water treatment process such as the formation of Trihalomethanes (THMs) or problems that may be caused by the distribution system (bacteria, lead, copper).
Whole-Body-Contact Recreation and Secondary Contact Recreation	Fecal coliform or *E. coli* count	2-4	Where there are at least five samples per year taken during the recreational season: Full: Water quality standards not exceeded as a geometric mean, in any of the last three years for which data is available, for samples collected during seasons for which bacteria criteria apply. Non-Attainment: Requirements for full attainment not met.	**Compliance with Water Quality Standards Note:** A geometric mean of 206 cfu/100 ml for *E. coli* will be used as a criterion value for Category B Recreational Waters. Because Missouri's Fecal Coliform Standard ended December 31, 2008, any waters appearing on the 2008 303(d) List as a result of the Fecal Coliform Standard will be retained on the list with the pollutant listed as "bacteria" until sufficient *E. coli* sampling has determined the status of the water.
Irrigation, Livestock and	Chemical	1-4	Full: Water quality standards not exceeded following procedures stated in Appendix D.	

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DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[i]	Notes
Wildlife Water			Non-Attainment: Requirements for full attainment not met.	

[i] See section on Statistical Considerations, Appendix C & D.

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Appendix C

METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(d) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[ii]	Notes
Overall use protection (all beneficial uses)	Narrative criteria for which quantifiable measurements can be made.	1-4	Full: Stream condition typical of reference or appropriate control streams in this region of the state. Non-Attainment: The weight of evidence, based on the narrative criteria in 10 CSR 20-7.031(3), demonstrates the observed condition exceeds a numeric threshold necessary for the attainment of a beneficial use. For example: Color: Color as measured by the Platinum-Cobalt visual method (SM 2120 B) in a water body is statistically significantly higher than a control water. Objectionable Bottom Deposits: The bottom that is covered by sewage sludge, trash, or other materials reaching the water due to anthropogenic sources exceeds the amount in reference or control streams by more than 20 percent. Note: Waters in mixing zones and unclassified waters that support aquatic life on an intermittent basis shall be subject to acute toxicity criteria for protection of aquatic life. Waters in the initial Zone of Dilution shall not be subject to acute toxicity criteria.	
Protection of	Toxic	1-4	Full: No more than one acute toxic event	**Compliance with Water Quality Standards Note**: The test

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BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[ii]	Notes
Aquatic Life	Chemicals		in three years (does not include die-offs of aquatic life due to natural origin). No more than one exceedence of acute or chronic criterion in three years for all toxics. Non-Attainment: Requirements for full attainment not met.	result must be representative of water quality for the entire time period for which acute or chronic criteria apply. For ammonia the chronic exposure period is 30 days, for all other toxics 96 hours. The acute exposure period for all toxics is 24 hours, except for ammonia which has a one hour exposure period. The department will review all appropriate data, including hydrographic data, to ensure only representative data are used. Except on large rivers where storm water flows may persist at relatively unvarying levels for several days, grab samples collected during storm water flows will not be used for assessing chronic toxicity criteria. **Compliance with Water Quality Standards Note:** In the case of toxic chemicals occurring in benthic sediment rather than in water, the numeric thresholds used to determine the need for further evaluation will be the Probable Effect Concentrations proposed in "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" by MacDonald, D.D. *et al.* Arch. Environ. Contam. Toxicol. 39,20-31 (2000). These Probable Effect Concentrations are as follows: 33 mg/kg As; 4.98 mg/kg Cd; 111 mg/kg Cr; 149 mg/kg Cu; 48.6 mg/kg Ni; 128 mg/kg Pb; 459 mg/kg Zn; 561 µg/kg naphthalene; 1170 µg/kg phenanthrene; 1520 µg/kg pyrene; 1050 µg/kg benzo(a)anthracene, 1290 µg/kg chrysene; 1450 µg/kg benzo(a)pyrene; 22,800 µg/kg total polyaromatic hydrocarbons; 676 µg/kg total PCBs; chlordane 17.6 ug/kg; Sum DDE 31.3 ug/kg; lindane (gamma-BHC) 4.99 ug/kg. Where multiple sediment contaminants exist, the Probable Effect Concentrations Quotient shall not exceed 0.75. See Appendix D and Section II. D for more information on the Probable Effect Concentrations Quotient.

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METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(d) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[ii]	Notes
Protection of Aquatic Life	Biological: Aquatic Macro-invertebrates sampled using DNR Protocol.	3-4	Full: For seven or fewer samples and following DNR wadeable streams macroinvertebrate sampling and evaluation protocols, 75% of the stream condition index scores must be 16 or greater. Fauna achieving these scores are considered to be very similar to regional reference streams. For greater than seven samples or for other sampling and evaluation protocols, results must be statistically similar to representative reference or control stream. Non-Attainment: For seven or fewer samples and following DNR wadeable streams macroinvertebrate sampling and evaluation protocols, 75% of the stream condition index scores must be 14 or lower. Fauna achieving these scores are considered to be substantially different from regional reference streams. For more than seven samples or for other sampling and evaluation protocols, results must be statistically dissimilar to control or representative reference streams.	**Data Type Note:** DNR invert protocol will not be used for assessment in the Mississippi Alluvial Basin (bootheel area) due to lack of reference streams for comparison. **Data Type Note:** See Section II.D. for additional criteria used to assess biological data. **Compliance with Water Quality Standards Note:** See Appendix D. For test streams that are significantly smaller than bioreference streams where both bioreference streams and small candidate reference streams are used to assess the biological integrity of the test stream, the assessment of the data should display and take into account both biocriteria reference streams and candidate reference streams.
Protection of Aquatic Life	Biological: MDC Fish Community (RAM) Protocol (Ozark Plateau only)	3-4	Full: For seven or fewer samples and following MDC RAM fish community protocols, 75% of the fIBI scores must be 36 or greater. Fauna achieving these scores are considered to be very similar to regional reference streams. For greater than seven samples or for other sampling	**Data Type Note:** See Section II.D. for additional criteria used to assess biological data. **Compliance with Water Quality Standards Note:** MDC fIBI scores are from "Biological Criteria for Streams and Fish Communities in Missouri" by Doisy et al. (2008). If habitat limitations (as measured by either the QCPH1 index or other appropriate methods) are judged to contribute to low fish

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BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[ii]	Notes
			and evaluation protocols, results must be statistically similar to representative reference or control streams. Suspected of Impairment: Data not conclusive (Category 2B or 3B). For first and second order streams fIBI score < 29. Non-Attainment: First and second order streams will not be assessed for non-attainment. When assessing third to fifth order streams with data sets of seven or fewer samples collected by following MDC RAM fish community protocols, 75% of the fIBI scores must be lower than 36. Fauna achieving these scores are considered to be substantially different from regional reference streams. For more than seven samples or for other sampling and evaluation protocols, results must be statistically dissimilar to control or representative reference streams.	community scores and this is the only type of data available, the water body will be included in Category 4C, 2B, or 3B. If other types of data exist, the weight of evidence approach will be used as described in this document. **Compliance with Water Quality Standards Note:** For determining influence of poor habitat on those samples that are deemed as impaired, consultation with MDC RAM staff will be utilized. If, through this consultation, habitat is determined to be a significant possible cause for impairment, the water body will not be rated as impaired, but rather as suspect of impairment (categories 2B or 3B). **Compliance with Water Quality Standards Note:** See Appendix D. For test streams that are significantly smaller than bioreference streams where both bioreference streams and small candidate reference streams are used to assess the biological integrity of the test stream, the assessment of the data should display and take into account both biocriteria reference streams and candidate reference streams.
Protection of Aquatic Life	Other Biological Data	3-4	Full: Results must be statistically similar to representative reference or control streams. Non-Attainment: Results must be statistically dissimilar to control or representative reference streams.	**Data Type Note:** See Section II.D. for additional criteria used to assess biological data

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BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[ii]	Notes
Protection of Aquatic Life	Toxicity testing of streams or lakes using aquatic organisms	2	Full: No more than one test result of statistically significant deviation from controls in acute or chronic test in a three-year period. Non-Attainment: Requirements for full attainment not met.	
Human Health - Fish Consumption	Chemicals (tissue)	1-2	Full: Contaminant levels in fish tissue levels in fillets, tissue plugs, and eggs do not exceed guidelines. Non-Attainment: Requirements for full attainment not met.	**Compliance with Water Quality Standards Note**: Fish tissue threshold levels are; chlordane 0.1 mg/kg (Crellin, J.R. 1989, *"New Trigger Levels for Chlordane in Fish-Revised Memo"* Mo. Dept. of Health inter-office memorandum. June 16, 1989); mercury 0.3 mg/kg based on "Water Quality Criterion for Protection of Human Health: Methylmercury" EPA-823-R-01-001. Jan. 2001. http://www.epa.gov/waterscience/criteria/methylmercury/merctitl.pdf; PCBs 0.75 mg/kg, MDHSS Memorandum August 30, 2006 *"Development of PCB Risk-based Fish Consumption Limit Tables*;" and lead 0.3- mg/kg (World Health Organization 1972. *"Evaluation of Certain Food Additives and the Contaminants Mercury, Lead and Cadmium."* WHO Technical Report Series No. 505, Sixteenth Report on the Joint FAO/WHO Expert Committee on Food Additives. Geneva 33 pp. Assessment of Mercury will be based on samples solely from the following higher trophic level fish species: Walleye, Sauger, Trout, Black Bass, White Bass, Striped Bass, Northern Pike, Flathead Catfish and Blue Catfish. In a 2012 DHSS memorandum (not yet approved, but are being considered for future LMD revisions) threshold values are proposed to change as follows: chlordane 0.2 mg/kg ; mercury 0.27 mg/kg ; and PCBs = 0.540 ; lead has not changed, but they do add atrazine and PDBEs **(Fish Fillet Advisory Concentrations (FFACs) in Missouri).**

[ii] **See section on Statistical Considerations and Appendix D.**

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Appendix D

DESCRIPTION OF ANALYTICAL TOOLS USED FOR DETERMINING THE STATUS OF MISSOURI WATERS (11" X 14" FOLD OUT)

			Determining when waters are impaired			Determining when waters are no longer impaired			
Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
Narrative Criteria	Color	Hypothesis Test: Two Sample, one tailed t-Test	Null Hypothesis: There is no difference in color between test stream and control stream.	Reject Null Hypothesis if calculated "t" value exceeds tabular "t" value for test alpha	0.1	Same Hypothesis	Same Criterion	Same Significance Level	
	Bottom deposits	Hypothesis Test, Two Sample, one tailed "t "Test	Null Hypothesis: Solids of anthropogenic origin cover less than 20% of stream bottom where velocity is less than 0.5 feet/second.	Reject Null Hypothesis if 60% Lower Confidence Limit (LCL) of mean percent fine sediment deposition (pfsd) in stream is greater than the sum of the pfsd in the control and 20 % more of the stream bottom. i.e., where the pfsd is expressed as a decimal, test stream pfsd > (control stream pfsd)+(0.20)	0.4	Same Hypothesis	Same Criterion	Same Significance Level	**Criterion Note:** If data is non-normal a nonparametric test will be used as a comparison of medians. The same 20% difference still applies. With current software the Mann-Whitney test is used.

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Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
Aquatic Life	Biological monitoring (Narrative)	For DNR Invert protocol: Sample sizes of 7 or less, 75% of samples must score 14 or lower.	Using DNR Invert. Protocol: Null Hypothesis: Frequency of full sustaining scores for test stream is the same as for biological criteria reference streams.	Reject Null Hypothesis if frequency of fully sustaining scores on test stream is significantly less than for biological criteria reference streams.	Not Applicable	Same Hypothesis	Same Criterion	Same Significance Level	
		For RAM Fish IBI protocol: Sample sizes of 7 or less, 75% of samples must score less than 36.							
		For DNR Invert protocol and sample size of 8 or more: Binomial Probability	A direct comparison of frequencies between test and biological criteria reference streams will be made.	Rate as impaired if biological criteria reference stream frequency of fully biologically supporting scores is greater than five percent more than test stream.	0.1	Same Hypothesis	Same Criterion	Same Significance Level	**Criterion Note:** For inverts, the reference number will change depending on which EDU the stream is in (X%-5%), for RAM samples the reference number will always be 70 (75%-5%).
		For RAM Fish IBI protocol and sample size of 8 or more: Binomial Probability.							
		For other biological data an appropriate parametric or	Null Hypothesis, Community metric(s) in	Reject Null Hypothesis if metric scores for test stream are	0.1	Same Hypothesis	Same Criterion	Same Significance Level	

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			Determining when waters are impaired			Determining when waters are no longer impaired			
Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
Aquatic Life (cont.)		nonparametric test will be used.	test stream is the same as for a reference stream or control streams.	significantly less than reference or control streams.					
			Other biological monitoring to be determined by type of data.	Dependent upon available information.	Dependent upon available information.	Same Hypothesis	Same Criterion	Same Significance Level	
	Toxic chemicals in water: (Numeric)	Not applicable	No more than one toxic event, toxicity test failure or exceedence of acute or chronic criterion in 3 years.	Not applicable	Not applicable	Same Hypothesis	Same Criterion	Same Significance Level	
	Toxic chemicals in sediments: (Narrative)	Comparison of geometric mean to PEC value, or calculation of a PECQ value.	Waters are judged to be impaired if parameter geomean exceeds PEC, or site PECQ is exceeded.	For metals use 150% PEC threshold. The PECQ threshold value is 0.75.	Not applicable	Water is judged to be unimpaired if parameter geomean is equal to or less than PEC, or site PECQ equaled or not exceeded.	For metals use 150% of PEC threshold. The PECQ threshold value is 0.75.	Not applicable	**Compliance with Water Quality Standards Note:** In the case of toxic chemicals occurring in benthic sediment rather than in water, the numeric thresholds used to determine the need for further evaluation will be the Probable Effect Concentrations proposed in "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" by MacDonald, D.D. *et al.* Arch. Environ. Contam. Toxicol. 39,20-31 (2000). These Probable Effect Concentrations are as follows:

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			Determining when waters are impaired			Determining when waters are no longer impaired			
Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
Aquatic Life (cont.)									33 mg/kg As; 4.98 mg/kg Cd; 111 mg/kg Cr; 149 mg/kg Cu; 48.6 mg/kg Ni; 128 mg/kg Pb; 459 mg/kg Zn; 561 µg/kg naphthalene; 1170 µg/kg phenanthrene; 1520 µg/kg pyrene; 1050 µg/kg benzo(a)anthracene, 1290 µg/kg chrysene; 1450 µg/kg benzo(a)pyrene; 22,800 µg/kg total polycyclic aromatic hydrocarbons; 676 µg/kg total PCBs; chlordane 17.6 ug/kg; Sum DDE 31.3 ug/kg; lindane (gamma-BHC) 4.99 ug/kg. Where multiple sediment contaminants exist, the Probable Effect Concentrations Quotient shall not exceed 0.75. See Appendix D and Section II. D for more information on the Probable Effect Concentrations Quotient.
	Temperature, pH, total diss. gases, oil and grease, diss. oxygen (Numeric)	Binomial probability	Null Hypothesis: No more than 10% of samples exceed the water quality criterion.	Reject Null Hypothesis if the Type I error rate is less than 0.1.	Not applicable	Same Hypothesis	Same Criterion	Same Significance Level	Continuous Sampling (i.e. time series or sonde data collection): Data collected in a time series fashion will be looked at on a 4 day period. If an entire 4 day period is outside of the 6.5 – 9.0 criterion range that will count as a chronic toxicity event. More than one of these events will constitute an impairment listing of the stream. Grab Samples: Data collected as grab samples will be treated as is and the binomial probability calculation will be used for assessment.

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			Determining when waters are impaired			Determining when waters are no longer impaired			
Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
Losing Streams	*E.coli*	Binomial probability	Null Hypothesis: No more than 10% of samples exceed the water quality criterion.	Reject Null Hypothesis if the Type I error rate is less than 0.1.	0.1	Same Hypothesis	Same Criterion	Same Significance Level	
Human Health – Fish Consumption	Toxic chemicals in water (Numeric)	Hypothesis test: 1-sided confidence limit	Null Hypothesis: Levels of contaminants in water do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.4	Same Hypothesis	Reject Null Hypothesis if the 60% UCL is greater than the criterion value.	Same Significance Level	
	Toxic chemicals in tissue (Narrative)	Four or more samples: Hypothesis test 1-sided confidence limit	Null Hypothesis: Levels in fillet samples or fish eggs do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.4	Same Hypothesis	Reject null hypothesis if the 60% UCL is greater than the criterion value.	Same Significance Level	
Drinking Water Supply (Raw)	Toxic chemicals (Numeric)	Hypothesis test: 1-sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.4	Same Hypothesis	Reject null hypothesis if the 60% UCL is greater than the criterion value.	Same Significance Level	

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			Determining when waters are impaired			Determining when waters are no longer impaired			
Designated Use	**Analytes**	**Analytical Tool**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule[iii]**	**Significance Level (α)**	**Decision Rule/ Hypothesis**	**Criterion Used with the Decision Rule**	**Significance Level (α)**	**Notes**
	Non-toxic chemicals (Numeric)	Hypothesis test: 1-sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis: if the 60% LCL is greater than the criterion value.	0.4	Same Hypothesis	Reject null hypothesis if the 60% UCL is greater than the criterion value.	Same Significance Level	
Drinking Water Supply (Finished)	Toxic chemicals	Methods stipulated by Safe Drinking Water Act.	Methods stipulated by Safe Drinking Water Act.	Methods stipulated by Safe Drinking Water Act.	Methods stipulated by Safe Drinking Water Act.	Same Hypothesis	Same Criterion	Same Significance Level	
Whole Body Contact and Secondary	Bacteria (Numeric)	Geometric mean	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis: if the geometric mean is greater than the criterion value.	Not Applicable	Same Hypothesis	Same Criterion	Not applicable	
Irrigation & Livestock Water	Toxic chemicals (Numeric)	Hypothesis test 1-Sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.4	Same Hypothesis	Reject null hypothesis if the 60% UCL is greater than the criterion value.	Same Significance Level	
Protection of Aquatic Life	Nutrients in lakes (Numeric)	Hypothesis test	Null hypothesis: Criteria are not exceeded.	Reject Null Hypothesis if 60% LCL value is greater than criterion value.	0.4	Same Hypothesis	Same Criterion	Same Significance Level	**Hypothesis Test Note:** State nutrient criteria require at least four samples per year taken near the outflow point of the lake (or reservoir) between May 1 and August 31 for at least four different, not necessarily consecutive, years.

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[iii] Where hypothesis testing is used for media other than fish tissue, for data sets with five samples or fewer, a 75 percent confidence interval around the appropriate central tendencies will be used to determine use attainment status. Use attainment will be determined as follows: (1) If the criterion value is above this interval (all values within the interval are in conformance with the criterion), rate as unimpaired; (2) If the criterion value falls within this interval, rate as unimpaired and place in Category 2B or 3B; (3) If the criterion value is below this interval (all values within the interval are not in conformance with the criterion), rate as impaired. For fish tissue, this procedure will be used with the following changes: (1) it will apply only to sample sizes of less than four and, (2) a 50% confidence interval will be used in place of the 75% confidence interval.

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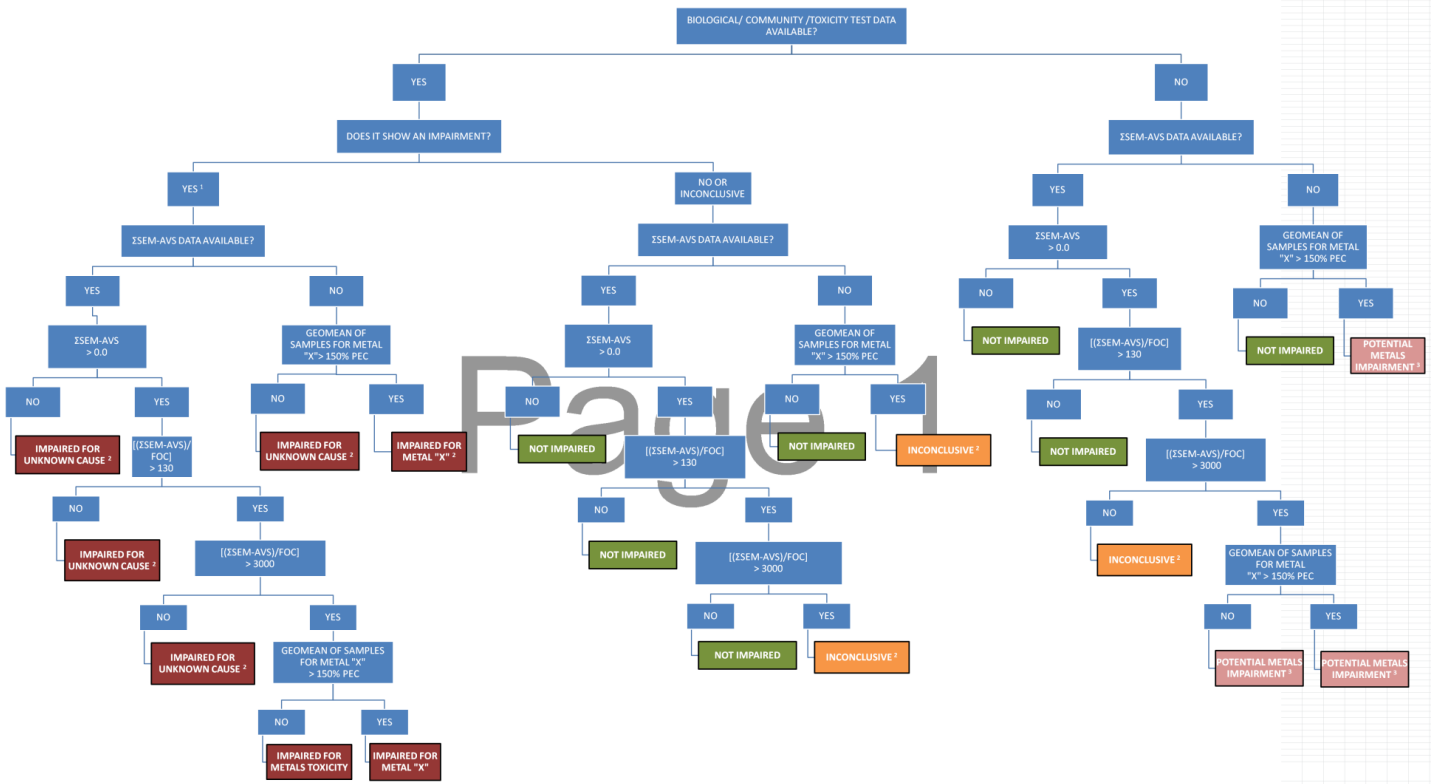
Appendix E

PICTORIAL REPRESENTATIONS OF THE WEIGHT OF EVIDENCE PROCEDURE FOR JUDGING TOXICITY OF SEDIMENT DUE TO METALS AND PAHS

Biological Weight of Evidence Decision Chart - Sediment Toxicity (Metals)



Notes:

1 - If there are Numeric WQS violations (unrelated to sediment) then follow LMD Procedure in LMD Appendix B. **Do Not Continue.**

2 - Note waterbody for further investigation related to metals or habitat issues.

3 - Note waterbody for Biological Sampling.

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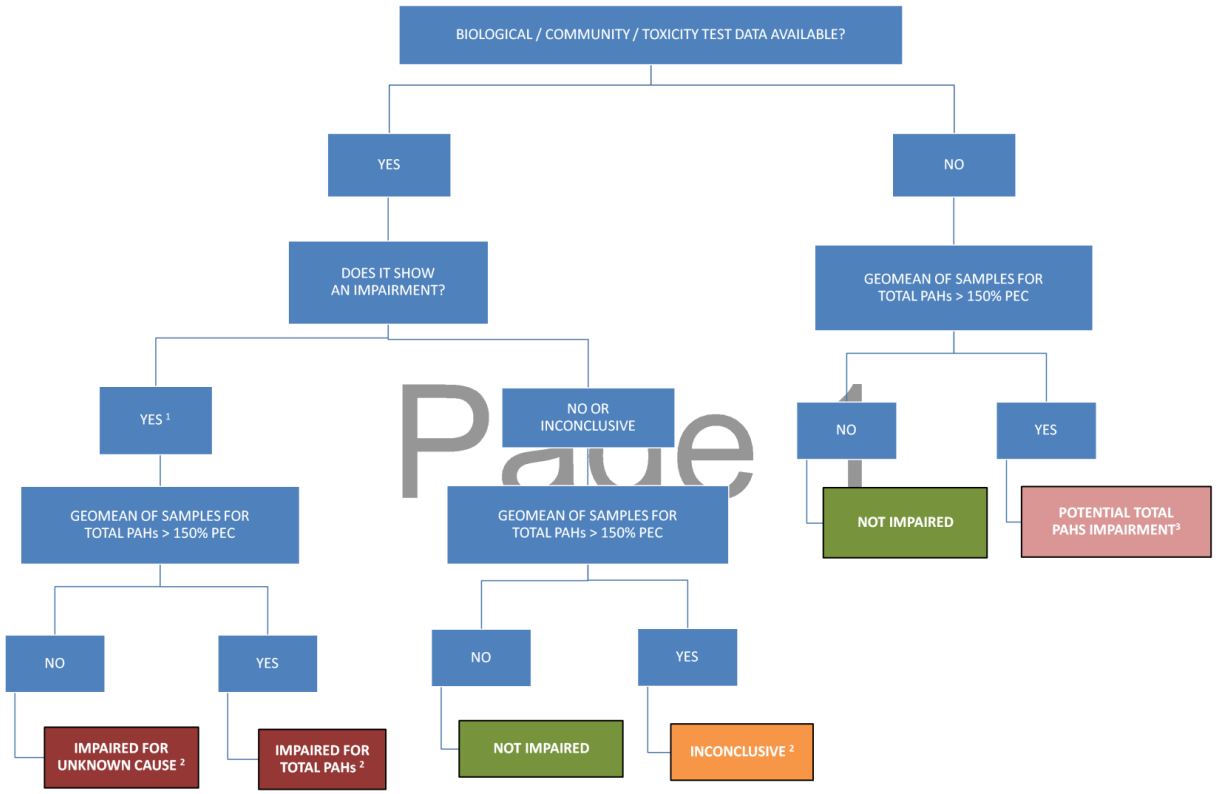
Biological Weight of Evidence Decision Chart - Sediment Toxicity (PAHs)



Notes:

1 - If there are Numeric WQS violations (unrelated to sediment) then follow LMD Procedure in LMD Appendix B. Do Not Continue.

2 - Note waterbody for further investigation.

3 - Note waterbody for Biological Sampling.

2018 303(d) List & 2020 303(d) Listing Methodology Document
Public Availability Meeting #1
Department of Natural Resources
1101 Riverside Drive
Jefferson City, MO
August 24, 2017

Meeting Purpose:
An open forum for comments, questions and discussion on proposed 2018 303(d) impaired waters listings and the data used for assessments. The meeting was also an open forum for comments, questions, and discussion on the proposed 2020 303(d) Listing Methodology Document

Summary of the Topics Discussed:

303(d) List

- The department provided an overview of the 2018 303(d) List format and organization; staff highlightednew links in the table for finding assessment data and a map viewer for locating proposed impairments and sampling locations. A table at end of the 303(d) List summarizes the list in several ways.
- Bee Fork was discussed in relation to the Doe Run outfall that was removed
    - The department provided information and requirements for collecting additional data for consideration in the assessment
- Addressing potential errors that are identified – The department welcomes information on errors and notification through digital or written communication.
- Age of bacteria data on Wilsons Creek – The department clarified that only the latest 3 years of data is used for assessment, the rest of the data is for informational/trend purposes.
- Bacteria TMDLs – The department provided information on the status and rationale for bacteria TMDLs in the state
- The addition of bolded new listings was helpful, also noted that new (2018) listings may be filtered or sorted using Excel functions.
- Black Creek and E. Fk. Locust Creek were discussed in relation to bacteria and the source identified.
- Trib. to Gravois Creek, and Trib. to River des Peres were discussed in relation to bacteria as well as CSI data. QAPPs for the CSI data were requested.

- Straight Fork was discussed in relation to the age of data and that the identified source has been upgraded after the latest data in the assessment.
- Discussed requirements for Wilsons creek to be put in category 5-alt.
- Discussed Laboratory QC codes
- Discussed data handling of greater than “>” values for bacteria assessments and the process of doubling the values. Discussed situations where not doubling the greater than values results in a geometric mean below the standard
- Discussed situations where flooding and backwater may have affected dissolved oxygen measurements

Listing Methodology Document

- Changes are in red
- Total pages in the header is wrong, but page numbers are correct
- TOC normalization was removed because of variability concerns
    - TOC spreadsheet from May 9th meeting will be posted on the website under that meeting header
- Added language to require only sieved sediment for assessments, bulk data will be used for screening.
- Use of facility Discharge Monitoring Report (DMR) data in assessments. Only instream data following the data requirements in the Listing Methodology Document can be used
- Additional wording added to the macroinvertebrate section clarifying the process and size definitions

2018 303(d) List & 2020 303(d) Listing Methodology Document
Public Availability Meeting #2
Department of Natural Resources
1101 Riverside Drive
Jefferson City, MO
September 19, 2017

Meeting Purpose:
An open forum for comments, questions and discussion on proposed 2018 303(d) impaired waters listings and the data used for assessments. The meeting was also an open forum for comments, questions, and discussion on the proposed 2020 303(d) Listing Methodology Document.

Summary of the Topics Discussed:

General Discussion:

1. General discussion on future pollutant trends and challenges related to drinking water, permits, etc.
2. Timeline for listing impaired waters, Clean Water Commission hearing, and submitting the list to EPA was discussed.
3. Timeline and schedule for writing TMDLs was discussed.

303(d) List

4. The question was asked if there was still time to submit data that could potentially change the listing of a stream. The department's response was that data will be taken until the end of the public comment period (Oct. 13, 2017).
5. Discussion regarding data age, number of samples taken, and new listings; stakeholders are concerned that the age of some data does not represent the current state of waters and that they would like to see more recent data specifically regarding Brushy Creek. Staff discussed that new data will only be collected if there is reason to believe there has been a significant change in the watershed.
    a. MoDNR after meeting follow-up: There was a TMDL written for Brushy Creek in 2002. Facility upgrades were completed shortly thereafter. Only 2003 and newer data should be considered for assessment. MoDNR re-assessment after the meeting shows that the water is meeting standards. Thus MoDNR will be removing Brushy Creek from the Proposed 2018 303(d) List.

6. There was discussion regarding why the entire segment of Muddy Creek was listed as impaired when data exists for only 2 locations. Staff explained that the two sampling locations were representative for the entire segment. Staff also discussed the possibility of specific areas of a stream being listed in the future instead of entire lengths.
7. Petite Saline Creek was discussed regarding data age and number of exceedances.
8. River Des Peres tributary data and sampling locations were discussed.
9. Martigney Creek data was discussed.

Listing Methodology Document

10. Discussion of the use of duplicate samples in assessments. It was also brought to the department's attention that duplicate samples might be used as a quality control measure for analytical testing only.
    a. Concern over two duplicate samples taken by the department that are not within the relative percent difference thresholds. It was suggested that these samples be removed if they were not in conformance with protocol.
11. The department's methodology was discussed on the use of a sample that has high bacterial levels due to a precipitation event with higher runoff influencing the results.
    a. The department responded that single samples should not skew the data when using geometric means, but there are occasions that extremely high results can potentially impact the listing of a stream, if only one sample is driving the listing, then more data should be collected. Care should be taken to make sure all samples are not taken during high-flow events, thus biasing the dataset.
    b. A request was made to add more clarity in the Listing Methodology Document on how the department handles high-flow bacterial samples when determining impairments, as well as how the department handles qualifiers such as >,<, and E.
12. Discussion of the use of USGS hydrography data being used in relation to flow conditions and data collection.
13. Suggestions were made pertaining to bacterial data reporting and clarifying how final results are calculated.
14. Sample sizes used to list impaired waters were discussed. Concern was expressed over low sampling sizes and sampling time period, specifically pertaining to Gailey Branch.
15. Statistical methods were discussed with explanations on how sample sizes and amounts of data are used to determine impaired status.

2020 Listing Methodology Meeting
Department of Natural Resources
1101 Riverside Drive
Jefferson City, Mo
January 4, 2017

Meeting Attendees:

- Robert Brundage, Newman, Comley & Ruth P.C.
- Jim Bureks, City of Springfield
- Lynne Hopper, Boone County
- Nick Muenks, Geosyntec Consultants
- Randy Sarver, Missouri Department of Natural Resources, Environmental Services Program
- Mohsen Dkhili, Missouri Department of Natural Resources, Water Protection Program
- John Hoke, Missouri Department of Natural Resources, Water Protection Program
- Tim Rielly, Missouri Department of Natural Resources, Division of Environmental Quality
- Leslie Holloway, Missouri Farm Bureau
- Colleen Meredith, Missouri Department of Natural Resources, Soil and Water Program
- David Carani, HDR, Inc
- Trent Stober, HDR, Inc
- Dave Michaelson, Missouri Department of Natural Resources, Environmental Services Program
- John Besser, U.S. Geological Survey
- Lynn Milberg, Missouri Department of Natural Resources, Environmental Services Program
- Sam McCord, Missouri Department of Natural Resources, Water Protection Program
- Trish Rielly, Missouri Department of Natural Resources, Water Protection Program

Meeting Purpose:
A technical group meeting to discuss a revised assessment process of sediments for metals and polycyclic aromatic hydrocarbons (PAHs).

Summary of the Meeting Discussions:

A general overview of the meeting was provided regarding the assessment of sediments for metals and PAHs, and the consideration of other parameters to include as part of the weight of evidence approach.

The meeting started with an overview of a few of the documents reviewed to determine how the weight of evidence approach could be used with or without available biological data [aquatic community (fish and macroinvertebrates) and toxicity]. The biological data itself would be given the greatest weight of evidence of an aquatic life impairment. Sediment data would be assessed the same as in the past, however, if additional chemical data is available (such as, total/fractional organic carbon (TOC) or acid volatile sulfides (AVS)), the flow chart would be used to show how the information would be incorporated into the assessment determination. The US Environmental Protection Agency (EPA) guidance and other reference documents were used to develop the proposed flow charts for metals and PAH assessments. EPA provided guidelines for PECs, fractional organic, AVS, and SEM in metals. The flow charts are broken up into two categories. Referencing the flow chart: No aquatic life impairment, acid volatile sulfides (AVS) and simultaneously extracted metals (SEM) available. If the AVS minus the

SEM is less than zero, then metals are bound to organic content and assumed not available for toxicity to occur. In this case, the data would be assessed as no impairment. If greater than zero and TOC is available, then you would need to continue down the flow chart. According to the EPA document; if TOC is less than 130, then there is no toxicity; if TOC is between 130 and 3000, there is potential toxicity (but unknown); if TOC is over 3000, then there is toxicity occurring. The main take away, is the department is not changing the assessment procedures, still using the biological data as the strongest weight of evidence. Will still need to have biological data along with the PEC data to show an impairment. In the absence of biological data, and sediment data exceeding the PEC threshold, the assessment would be considered inconclusive and flagged for additional monitoring. Again, the biological data would be given the same weight as previous assessment cycles.

The biological data has to be available and has to show an impairment before a stream would be listed as impaired. All other determinations would indicate no impairment, inconclusive, or potentially impaired. If inconclusive or potentially impaired, additional data would be needed.

The PAH flow chart follows the same procedure (with supporting biological community, PEC >150%): If TOC data is available, the PEC values normalized based on the percent of TOC present, does that change the assessment conclusion? For example, if the PECs are greater than 150%, the data is then normalized by TOC; does this bring the PEC value below the 150% threshold or does it not change the assessment decision. If below the 150% threshold, it would be considered inconclusive.

If TOC data is not available, the department would follow the same assessment process as in the past.

John Besser, with USGS provided an overview of the AVS and SEM process. The reason to look at TOC, AVS and SEM is to reduce the uncertainty of the PEC value. The data used to generate the PECs had on average a 1% TOC. Therefore, if the sediment deviated from that substantially one direction or the other, the PEC may be over or under protective. A sediment sample with high TOC has a greater metals binding capacity, and therefore, have lower toxicity potential. While a sediment sample with low TOC has a low metals binding capacity, therefore, a higher toxicity potential. The AVS is a strong binding phase for metals, it (equally) immobilizes each concentration of metal for each molar concentration of AVS. Overall, AVS subtracts that fraction of metal and assuming it is unavailable. You would still divide by the TOC to determine any additional control of bioavailability above and beyond the AVS calculation.

Further discussions occurred related to how TOC would be used. If between the %TOC is calculated between 1%-5%, then the actual %TOC calculation would be used; If below %TOC is calculated below 1%, 1% TOC would be used; if the % TOC is calculated greater than 5% TOC, than 5% TOC would be used. Seasonality not as much of a factor for TOC as it is for AVS.

For PAH assessment, the department is looking at assessing against the Total PAH PEC threshold instead of the individual PAH PECs. The EPA document references 34 PAHs, assuming this will allow one to recover the high percentage of total PAHs. If a lower number of PAHs are used (e.g. 50%), you are not really measuring total PAHs and, therefore, may be underestimating the risk. The McDonald paper provides PEC for a subset of PAHs and total PAHs.

For assessments with less than 34 PAHs and the total is over the PEC threshold, it would be assumed any additional PAH data would increase the total PAH value. However, if a dataset has results for 16 PAHs and the total PAH is below the PEC threshold, then the data would likely be considered inconclusive. Inconclusive because you don't know if the addition of the other PAHs would cause the total PAH value to exceed the PEC threshold.

This is how the department would assess PAH data if available.

An overview of information presented in a PAH study completed by Ozarks Environmental and Water Resources Institute (OEWRI) in 2012 was discussed along with types of sediment studies completed by USGS nationally and within the state.

Regarding toxicity testing, the department stated reviewing traditional toxicity tests looking at both acute and chronic effects (standard 10-day midge, and 28-day amphipod).

The numeric criteria assessment would be the primary assessment for causing a biological impairment, but sediment could also be contributing.

The department would still be assessing for the quotient. In addition, metals would also be assessed against the individual metals as well.

The department would not be analyzing sediments for AVS. If the data is available, it will be considered for assessments. The department sediment collection efforts will include sieving sediment samples to less than 2 mm and requesting TOC analysis on each sediment sample.

The department would like feedback on other major topics to discuss regarding the 2020 Listing Methodology. Feel free to send those topics to Trish Rielly at trish.rielly@dnr.mo.gov.

2020 Listing Methodology Document Meeting
Department of Natural Resources
1101 Riverside Drive
Jefferson City, MO
May 9, 2017

Meeting Attendees:

- Robert Brundage, Newman, Comley & Ruth P.C.
- Lynne Hopper, Boone County
- Nick Muenks, Geosyntec Consultants
- Kevin Perry, Regform
- Randy Sarver, Missouri Department of Natural Resources, Environmental Services Program
- John Hoke, Missouri Department of Natural Resources, Water Protection Program
- Tim Rielly, Missouri Department of Natural Resources, Division of Environmental Quality
- Leslie Holloway, Missouri Farm Bureau
- Matt Combes, Missouri Department of Conservation
- Brett Landwer, Missouri Department of Conservation
- Trish Rielly, Missouri Department of Natural Resources, Soil and Water Program
- David Carani, HDR Inc
- Dave Michaelson, Missouri Department of Natural Resources, Environmental Services Program
- Sam McCord, Missouri Department of Natural Resources, Water Protection Program
- Robert Voss, Missouri Department of Natural Resources, Water Protection Program
- Collin Mackey, Missouri Department of Natural Resources, Water Protection Program

Meeting Purpose:
A technical discussion of a revised assessment process of sediments for metals and polycyclic aromatic hydrocarbons (PAHs), biological assessment data, and other stakeholder concerns.

Summary of the Meeting Discussions:

- The meeting started with introductions of attendees. Then, John Hoke provided a brief update on the status of the vacant MAU Unit Chief position. The upcoming Public Notice Period schedule for the 2018 303(d) List and 2020 Listing Methodology Document was referenced, highlighting that it will be starting approximately three months earlier than in the past.
- The availability of biological data and the corresponding impairment thresholds were discussed. The DNR webpages where this information could be found were displayed. ***The department will look into developing a guide for users and the public to more quickly find these data.***
- The development status of small candidate reference stream criteria, and the stakeholders' availability to comment on that and the completed project to outline the selection process were discussed. ***The department is currently in the process of field verification of small headwater candidate reference streams. When those studies are complete, the department will provide an update and additional details to stakeholders.***
- A question was raised about the VST processes outlined in the Listing Methodology Document in regards to macroinvertebrate sampling. Clarification of which columns in the GIS data are used

needs to be added to the 2020 Listing Methodology Document. ***– 2020 Listing Methodology Document will be updated to reflect this.***

- Total Organic Carbon (TOC) in sediment was discussed. DNR pulled data from WQA and looked at the averages and standard deviations for TOC. Both showed that TOC is quite variable within what would be considered a site on a stream. DNR recommended the removal of TOC normalization from the proposed assessment process (flow charts) except in the case of using ΣSEM-AVS/FOC. No objections were voiced. ***– 2020 Listing Methodology Document will be updated to reflect this.***
- A department proposal to assess hydrocarbon pollutants in sediment as Total PAHs (proposed) rather than individual PAHs (current methodology) was discussed. DNR stated that previous research indicated that individual PAH PECs are based on the samples also having elevated presence of additional PAHs, potentially overestimating the actual toxicity of an individual PAH. DNR believes that the proposed change to using Total PAHs would provide a better representation of toxicity than the use of individual PAHs.
    - There were no objections at this point, but a better textual representation of how this would be handled was requested. ***– 2020 Listing Methodology Document will be updated to reflect this.***
- DNR stated that it wants to move to assessing only sediment samples sieved to less than 2mm in the future. Past unsieved data that was used for impairment listings will still be valid for those listings, but greater weight will be given to new sieved data. New unsieved data will be used only as screening level data. ***– 2020 Listing Methodology Document will be updated to reflect this.***
- Toxicity Test requirements (e.g., acceptability of acute vs. chronic tests, appropriateness of various test organisms) were discussed. ***– Some draft language will be provided in the 2020 Listing Methodology Document during the Public Notice Period.***

Draft 2020 Listing Methodology Document
Responses to Public Comments

Public Notice
July 1, 2017 – October 13, 2017

Missouri Department of Natural Resources
Water Protection Program
PO Box 176
Jefferson City, MO 65102-0176
800-361-4827 / 573-751-1300

Introduction

Pursuant to 40 CFR 130.7, States, Territories and authorized Tribes must submit biennially to the U.S. Environmental Protection Agency (EPA) a list of water-quality limited (impaired) segments, pollutants causing impairment, and the priority ranking of waters targeted for Total Maximum Daily Load (TMDL) development. Federal regulation at 40 CFR 130.7 also requires States, Territories, and authorized Tribes to submit to EPA a written methodology describing the state's approach in considering and evaluating existing and readily available data used to develop its 303(d) List of impaired waters. The listing methodology must be submitted to EPA each year the Section 303(d) List is due. While EPA does not approve or disapprove the listing methodology, the agency considers the methodology during its review of the state's 303(d) impaired waters list and the determination to list or not to list waters.

The Missouri Department of Natural Resources (department) placed the draft 2020 Listing Methodology Document (Listing Methodology Document) on public notice from July 1, 2017 to October 13, 2017. All original comments received during this public notice period are available online on the department's website at http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm. Comments were received from the following groups or individuals:

I. Missouri Farm Bureau
II. City of Springfield
III. Newman, Comley and Ruth, P.C. Law Firm
IV. Association of Missouri Cleanwater Agencies
V. Metropolitan St. Louis Sewer District (Listing Methodology Document)

This document summarizes and paraphrases the comments received, provides the department's responses to those comments, and notes any changes made to the final draft 2020 Listing Methodology Document resulting from these comments.

Summary of department actions as a result of public comments

1. Amend 2020 Listing Methodology Document to include a statement indicating if a water has not been listed previously and all data indicating an impairment is older than 7 years, then the water shall be placed into Category 2B or 3B and prioritized for future sampling.

2. Amend 2020 Listing Methodology Document to include language that is flexible to future improvements to our data systems, but also include the ability of stakeholders to discuss the department's reasons for determining a change in the size of the assessment unit, until a better process has been vetted by the stakeholders.

3. Amend 2020 Listing Methodology Document to change the significance level for listing and delisting to be the same.

4. Amend 2020 Listing Methodology Document to add a minimum sample size of ten for water chemistry samples pertaining to dissolved oxygen, water temperature, pH, total dissolved gases, and oil and grease within the assessment period outlined in the proposed 2020 Listing Methodology Document (i.e. within 7 years of available data).

5. Amend 2020 Listing Methodology Document to add language describing the department's handling of data qualifiers such as less than, greater than, and estimated values.

6. Amend 2020 Listing Methodology Document to add language describing how dissolved oxygen readings taken either without associated flow data, or taken during non-flowing conditions, are handled.

7. Amend 2020 Listing Methodology Document to add language describing how the department will assess pH based on what type of data is collected (i.e. continuous vs grab samples).

I. Missouri Farm Bureau comments

1. Data Age

Missouri Farm Bureau provided comments during the October 4, 2017 Clean Water Commission Hearing regarding the age of data and how it is used. The Missouri Farm Bureau requested clarification in the Listing Methodology Document.

Department Response

The department agrees that the age of data used to list a water can be a concern. The department will update the proposed 2020 Listing Methodology Document to state that if a water has not been listed previously and all data indicating an impairment is older than 7 years, then the water shall be placed into Category 2B or 3B and prioritized for future sampling.

2. Timing of Sampling

Missouri Farm Bureau provided comments during the October 4, 2017 Clean Water Commission Hearing regarding the timing of sampling and the representativeness of short duration intensive sampling.

Department Response

The department uses short duration, intensive studies to identify waters that are not meeting water quality standards during critical time(s) of the year. An example of this are the 24-48 hour waste load allocation studies conducted during the summer months when stream flows are lower and assimilative capacity may be reduced. Studies conducted during these critical low flow conditions ensure that effluent limitations and conditions of a discharge are protective of water quality. When the water chemistry of discharge from a waste water treatment facility, or from nonpoint source run-off, mixes with water chemistry and temperatures typically observed during summer months, conditions that cause stress to aquatic life can exist. The department believes that the conditions observed during these short duration studies are prevalent throughout the summer months, but are likely not causing the same amount of stress the rest of the year. Since these are season specific issues, the department collects data and assesses those data based on the season using the Listing Methodology Document. Another example of seasonal analyses are recreational uses and *Escherichia coli* which only apply during the recreational season (April 1 until October 31). Outside of this time period water could be meeting WQS, but the critical time for the use is during the established recreation season. Therefore, the department only samples and assesses based on conditions observed during the recreational season.

3. Listing Length

Missouri Farm Bureau provided comments during the October 4, 2017 Clean Water Commission Hearing asking the department and USEPA to allow states to list only the impaired portion.

Department Response

The department agrees that impaired segments should be more narrowly defined when data reasonably shows justification to do so. In the past, the department has been limited by technology and has lacked the ability to split Water Body Identification numbers (WBIDs) for assessment purposes. The extent and associated uses determined by the Water Quality Standards (WQS) form the baseline for waters to be assessed. The inability of the department to assess and track sub-segments of the WBID resulted in the department listing the entire length of the WBID as impaired. When the 303(d) list is submitted to EPA for approval, the entire WBID, the assessment unit in this case, is approved as impaired. When the department gains the technological ability to geospatially track individual assessment units, while maintaining a link to the WBIDs defined by WQS, the listing process will be revised to allow for such refinement.

The department believes it is necessary for interested stakeholders to be involved in the process of determining the criteria for splitting of a stream into multiple assessment units. The department will add language to the 2020 Listing Methodology Document that is flexible enough to incorporate future improvements to our data systems, but also include the ability of stakeholders to discuss the department's reasons for determining a change in the size of the assessment unit, until a better process has been vetted through the stakeholder process.

II. <u>City of Springfield comments</u>

1. Carbon-normalization should be allowed in the Listing Methodology Document

The City of Springfield provided comments to allow the normalization of sediment contaminants (metals or Polycyclic Aromatic Hydrocarbons, PAHs) to the percent total organic carbon (TOC). Additionally the City provided comments that the department takes issue with using a default assumption regarding TOC. The City requested that the department use site specific TOC data to normalize the contaminants. The City also requested that the department clarify that the 1% TOC assumption shall be used for carbon-normalizing the PAH Probable Effects Concentration (PEC) values.

Department Response

The department takes issue with blanket normalization to total organic carbon (TOC) content without citing the true relationship of TOC to contaminants. The Probable Effects

Concentrations (PECs) referenced by the department in the Listing Methodology Document are levels at which it is assumed that the sediment contains 1% TOC (default assumption of 1% TOC content). TOC can be important for consideration since organic carbon provides a binding capacity for contaminants making them essentially non-bioavailable. In talking to the authors of the article referenced in the Listing Methodology Document (McDonald et.al 2000), the authors looked at the data used for developing the PECs and found the data on average had 1% TOC. There is potential for streams in Missouri to have more or less than 1% TOC. It has been suggested that one way to account for this difference is to normalize the data to the amount of TOC in the sediment. Normalizing is the mathematical process of dividing the concentration of contaminant in the sediment by the fraction or percent of TOC. For example, consider the two separate sediment samples below:

Sample 1 – 50 mg/kg of lead and 0.25% TOC
Sample 2 – 50 mg/kg of lead and 4% TOC

To normalize the lead concentrations to the amount of TOC, one must now divide 50 by 0.25 for Sample 1 and divide 50 by 4 for Sample 2. This results in the normalized concentrations below:

Sample 1 – 200 mg/kg of lead
Sample 2 – 12.5 mg/kg of lead

Sample 1 normalized for TOC exceeds the 150% PEC for lead, but sample 2 does not. As the hypothetic example above illustrates, the amount of TOC in a sample can greatly change the normalized concentration of the contaminant. While this change can seem mathematically sound, it extrapolates the concentration without knowing the true relationship.
Additionally Table 5 of the *McDonald et. al. 2000* article, referenced in the 2020 Listing Methodology Document, shows the accuracy of the PECs in regard to their ability to predict toxicity. With the exception of arsenic and lead, the PECs correctly identified toxicity in greater than 90% of the samples predicted to be toxic. The department has agreed with stakeholders in past Listing Methodology Document meetings to use 150% of the PEC values which provides some additional room for uncertainty. In a general sense, using 150% of the PEC value could be considered as the equivalent of normalizing the PECs to 1.5% TOC (defaulting to 1.5% TOC content).

The department is not aware of any recent research documenting the normalization relationship with metals or PAHs and it is not clear if there is a strict linear relationship. If the relationship is not linear, the range of binding capacity is unknown and adds additional uncertainly to the analysis. Additionally, the spatial and seasonal variability of TOC is not known and adds further uncertainty. The department addressed some of these concerns in the Biological Workgroup meeting held May 9th, 2017. During that meeting the department provided data showing that TOC data is quite variable within the state,

among individual waters, as well as among sampling sites. This variability was high enough to add uncertainty, not reduce it. The department is open to further discussions on this topic, but in order for the department to use carbon normalization in assessments many variables will need to be accounted for.

At this time the department does not propose changes to the proposed 2020 Listing Methodology Document to allow for carbon normalization.

2. **The assessment methods used to delist a water should be the same as those used to list the same water.**

The City of Springfield provided comments regarding the use of different significance levels for certain data types in regards to listing and de-listing waters.

Department Response

The department agrees with the City's comment and will make the associated changes in the proposed 2020 Listing Methodology Document.

III. Newman, Comley, and Ruth, P.C. Law Firm comments

1. **Assessing Small Streams**

Newman, Comley, and Ruth, P.C. provided comments asking the department to add additional language to the bottom of page 28. Language to be added:

> *"Stream Size including watershed size should be similar to test streams. Similarly, small candidate reference stream flow should be similar to a test stream's flow under natural conditions (not augmented by effluent). Additionally, small candidate reference streams should have the same or similar land use as the test stream."*

A proposed deletion from the 2018 Listing Methodology Document was also requested to be maintained.

Department Response

The department appreciates the suggested language provided in the comment. The department believes the current process outlined in the draft 2020 Listing Methodology Document (pages 26-29) is the best process for conducting assessments until robust criteria for small streams is developed. Watershed size is one of a number of considerations under the current process for selecting candidate reference streams. Because flow conditions may be heterogeneous in certain watersheds, e.g., those with well-developed karst, stream flow is another factor considered in the evaluation. Land use

is also a consideration in candidate reference stream selection under the current process to ensure the best candidate reference is selected for the assessment.

In regards to comment on a proposed deletion, the department will maintain the discussion of the MSCI failure rates in some form in the 2020 Listing Methodology Document.

2. Stream Segment Size

Newman, Comley, and Ruth, P.C. Law Firm provided comments asking the department to add a description of how impaired segments can be more narrowly defined.

Department Response

The department agrees that impaired segments should be more narrowly defined when data reasonably shows justification to do so. In the past, the department has been limited by technology and has lacked the ability to split Water Body Identification numbers (WBIDs) for assessment purposes. The extent and associated uses were determined by the Water Quality Standards (WQS) form the baseline for waters to be assessed. The inability of the department to assess and track sub-segments of the WBID resulted in the department listing the entire length of the WBID as impaired. When the 303(d) list is submitted to EPA for approval, the entire WBID, the assessment unit in this case, is approved as impaired. When the department gains the technological ability to geospatially track individual assessment units, while maintaining a link to the WBIDs defined by WQS, the listing process will be revised to allow for such refinement.

The department believes it is necessary for interested stakeholders to be involved in the process of determining the criteria for splitting of a stream into multiple assessment units. The department will add language to the 2020 Listing Methodology Document that is flexible enough to incorporate future improvements to our data systems, but also include the ability of stakeholders to question the department's reasons for determining a change in the size of the assessment unit, until a better process has been vetted through the stakeholder process.

3. Burden of Proof to List and De-List

Newman, Comley, and Ruth, P.C. Law Firm provided comments regarding the use of different significance levels for certain data types in regards to listing and de-listing waters.

Department Response

The department agrees with the comment and will make the associated changes in the proposed 2020 Listing Methodology Document.

IV. Association of Missouri Cleanwater Agencies comments

1. The ">1-in-3" Methodology is Not Required, is Inaccurate and Should Not Be Used; Explanation of Binomial Distribution Method and Comparison to the >1-in-3 Method and the Raw Score Method; A minimum Sample Size of Ten is Both Warranted and Appropriate; Alternatively, DNR Should Use the Raw Score Method Rather Than EPA's >1-in-3 Method

The Association of Cleanwater Agencies (AMCA) provided comments regarding the methodology of impairing a stream when an acute or chronic criterion is exceeded more than once in the last three years of available data. AMCA also provided comments suggesting a minimum sample size of ten be added to the Listing Methodology Document. AMCA provided comments on data quality and the use of binomial probability for toxics and non-conventional pollutants.

Department Response

The one-in-three year assessment method is consistent with EPA IR Guidance and state implementation of water quality standards. As stated in the guidance, "For toxic (priority pollutants) and protection of freshwater aquatic life, EPA IR guidance recommends use of a one-in-three year maximum allowable excursion recurrence frequency." The guidance also recommends making non-attainment decisions for "conventional pollutants" and has not encouraged the use of the 10 percent rule with other pollutants, including toxics. Development and implementation of acute and chronic water quality criteria are based on the concept that toxicity criteria contain components of magnitude, duration and frequency protective of aquatic life. The not to exceed more than "once every three years" frequency can be found in both criteria development guidelines (e.g., *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses, (p.34, PB85-227049)* and *Water Quality Standards Handbook*, (Chapter 3, p.4, EPA 823-B-94-005a) as well as criteria implementation guidance (e.g., *Technical Support Document for Water Quality-based Toxics Control*, p. 36, EPA 505-2-90-001). Water quality assessments using the once every three year return interval frequency ensures consistency with toxicity criteria development and water quality standards implementation. It also ensures that aquatic communities impacted by pollutants are identified and provide opportunity for ecological recovery from toxic stressors in an expeditious manner. The department is open to discussion of this topic in regards to chronic criteria at the January 18, 2018 meeting. However the department will maintain the current policy. The department will, however, add a minimum sample size of ten water chemistry samples within the time range outlined in the proposed 2020 Listing Methodology Document (i.e. within the most recent 7 years of available data) in response to the comment.

V. Metropolitan St. Louis Sewer District (MSD) comments

1. MSD Supports comments submitted by the AMCA

The Metropolitan St. Louis Sewer District submitted comments in support of the comments submitted by the Association of Missouri Cleanwater Agencies.

Department Response

Please see the department's response to Association of Missouri Cleanwater Agencies' comments in section IV above.

2. MDNR should clarify how they use data collected when streamflow is zero or when stream flow is not reported with chemistry data.

The Metropolitan St. Louis Sewer District submitted comments regarding the use of data collected during non-flowing conditions or when streamflow is not reported.

Department Response

The department will add language to the 2020 Listing Methodology Document describing how dissolved oxygen readings taken either without associated flow data, or taken during non-flowing conditions are handled.

3. MDNR should clarify how they assign, track, and apply data quality codes.

The Metropolitan St. Louis Sewer District submitted comments asking the department to clarify how data quality codes are used.

Department Response

The 2020 Listing Methodology Document currently addresses data quality codes on pages 16 and 17. All data used for assessments falls into one of these categories. If there are questions or comments as to the quality or validity of the data for an individual water body, these can be discussed during the public availability meetings. The department is open to further discussions on this topic at the January 18, 2018 meeting.

4. MDNR should clarify their intended approach for evaluating pH as a chronic water quality criterion.

The Metropolitan St. Louis Sewer District submitted comments asking the department to clarify how it will assess evaluating pH as a chronic criterion.

Department Response

The department will add language to the 2020 Listing Methodology Document to address pH assessments based on what type of data is collected (i.e., continuous vs grab samples).

5. **The assessment methods used to delist a water should be the same as those used to list the same water.**

   The Metropolitan St. Louis Sewer District submitted comments asking the department to have the same methods for listing and delisting waters.

   Department Response

   The department agrees with the comment and will make the associated changes in the proposed 2020 Listing Methodology Document.

6. **MDNR should clarify the role that changing regulations, alternative restoration approaches, and waterbody assessment categorization have in the TMDL prioritization and development process.**

   The Metropolitan St. Louis Sewer District submitted comments that the department should clarify how changing regulations and future water quality standards will play into TMDL priorities and development.

   Department Response

   The department agrees that developing TMDL priorities is an important part of the 303(d) List development process. The department will hold a meeting on January 18, 2018 to discuss TMDL prioritization as well as 2020 Listing Methodology Document topics. The department invites stakeholders to be a part of this important process.

7. **Data age, quality, and minimum sample sizes should be addressed when making impairment decisions**

   The Metropolitan St. Louis Sewer District submitted comments regarding data age, quality, and minimum sample size.

   Department Response

   In regards to data age, the department will update the proposed 2020 Listing Methodology Document to state that if a water has not been listed previously, and <u>all</u> data indicating an impairment is older than 7 years, then the water shall be placed into Category 2B or 3B and prioritized for future sampling. In regards to minimum sample size, the department will add a minimum sample size of ten within the time range outlined in the proposed 2020 Listing Methodology Document (i.e. within 7 years of

available data). In regards to data quality, this comment is already addressed in the 2020 Listing Methodology Document on pages 11, 12, and 15-17.

8. Biological data should have a greater weight than specific pollutant data.

The Metropolitan St. Louis Sewer District submitted comments stating that biological data should have greater weight than specific pollutant data.

Department Response

The 2020 Listing Methodology Document currently addresses this comment with regard to narrative criteria as well as numeric translators for narrative criteria. However, numeric criteria do not fall under the biological weight of evidence outlined in the Listing Methodology Document. Numeric criteria are based on biological responses and developed to be protective of designated uses (i.e., toxicity-based endpoints) and do not need associated biological data. Numeric criteria are set to be protective of sensitive species and designated uses. Indices of biological integrity are indicators of overall community health. Indices are based on the taxonomic groups found rather than species found. Many species can make up a taxonomic group, but the species have individual sensitivities. Numeric water quality criteria must be protective of the more sensitive species as well as the more tolerant.

9. The use of qualified data in water quality data sets should be clearly explained.

The Metropolitan St. Louis Sewer District submitted comments asking the department to clarify how data qualifiers are handled during assessments.

Department Response

The department will add language to the proposed 2020 Listing Methodology Document that addresses data qualifiers.

Draft 2020 Listing Methodology Document
Public Comments

Public Notice
July 1, 2017 – October 13, 2017

Missouri Department of Natural Resources
Water Protection Program
PO Box 176
Jefferson City, MO 65102-0176
800-361-4827 / 573-751-1300

Introduction

The Missouri Department of Natural Resources (department) placed the draft 2020 Listing Methodology Document on public notice from July 1, 2017 to October 13, 2017. All original comments received during this public notice period are below.

October 12, 2017

Mr. Robert Voss
Water Protection Program
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Subject: Public Comments Regarding the Draft Methodology for the Development of the 2020 Section 303(d) List in Missouri

Mr. Voss:

The City of Springfield (City) appreciates this opportunity to provide comments on Missouri's draft Methodology for the Development of the 2020 Section 303(d) List (i.e., Listing Methodology Document or LMD). The City's comments are provided below.

Comment #1: Carbon-normalization should be allowed in the LMD.

The City supports allowing for the normalization of nonpolar organic compounds (e.g., PAHs, PCBs, and chlorinated pesticides) to Total Organic Carbon (TOC) within the LMD. The organic content of sediment is an important factor in the movement and bioavailability of such compounds. Where TOC data are available, it should be used to estimate site-specific toxicity of PAH and other nonionic organic compounds. However, page 35 of the draft LMD appears to suggest that TOC normalization will not be considered by the Department. Specifically, the LMD states the following:

> "The sediment PECs given in MacDonald *et al*. (2002) are based on some additional data assumptions. Those assumptions include a 1% Total Organic Carbon (TOC) content and that the sample has been sieved to less than 2mm. For the TOC assumption the department completed an analysis of sediment TOC concentrations in their database and found that the TOC concentrations were too variable for the department to be confident in TOC normalization. Since the department uses 150% of the PEC values there is some variability accounted for in our assessment of sediment toxicity."

To clarify, it appears the Department takes issue with applying a default assumption regarding TOC content for carbon-normalizing field data. Presumably, the Department does not take issue with expressing the PAH PECs on an organic carbon-normalized basis using the 1% TOC assumption. The City concurs that it would be inappropriate to carbon-normalize field data using a default TOC value. However, where contemporaneous and site-specific TOC field data exists, its use should be allowed. Therefore, the City recommends the Department clarify that where contemporaneous and site-specific TOC data exists, it may be used to carbon-normalize sediment PAH data. The City also requests the Department clarify that the 1% TOC assumption shall be used for carbon-normalizing the PAH PEC values.

Office of the Director
Busch Municipal Building • 840 Boonville Avenue
Springfield, Missouri 65802 • 417-864-1919 • springfieldmo.gov/recycling

CITY OF Springfield
ENVIRONMENTAL SERVICES

Comment #2: The assessment methods used to delist a water should be the same as those used to list the same water.

It is not clear why the Department requires a greater burden of proof to delist waters than to list them for biological monitoring or color data. The City notes that the LMD includes a higher significance level for delisting (0.4) than for listing (0.1) (see Appendix D in the LMD) for these parameters. Increasing the burden of proof for delisting decisions will lead to waters being listed for longer periods of time (potentially perpetually) than is otherwise necessary. MDNR explains their rationale for this approach on page 42 of the LMD by stating that some undesirable effects can occur from maintaining consistent significance levels. However, the apparent undesirable environmental effects are not clear, as waterbodies that are very close to the water quality standard (slightly above or below) are not likely to represent a fundamentally different biological or chemical condition. The issue is further complicated by the fact that for all of the remaining data types listed in Appendix D, MDNR does maintain the same burden of proof for listing and delisting. Therefore, the City requests that MDNR treat all data types consistently and use the same significance levels for listing and delisting decisions.

Thank you for considering our comments on the draft 2020 LMD. In addition to these comments, Springfield is a member of the Association of Missouri Clean Water Agencies and fully supports their public comment on this topic. Please contact Errin Kemper at (417) 864-1910 or ekemper@springfieldmo.gov if you have any questions or would like to discuss these issues further.

Sincerely,

Errin Kemper, P.E.
Assistant Director – Environmental Services
Springfield Missouri

CC:
Steve Meyer, P.E. – Director
Jan Y. Millington – Assistant City Attorney
Paul Calamita – Aqualaw
Trent Stober, P.E. - HDR

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CATHLEEN A. MARTIN
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JOHN A. RUTH
ALICIA EMBLEY TURNER

October 13, 2017

Via Email Only

Missouri Department of Natural Resources
Water Protection Program
Attention Robert Voss
P.O. Box 176
Jefferson City, MO 65102-0176
robert.voss@dnr.mo.gov

Re: Public Notice – 2020 Listing Methodology

Dear Mr. Voss:

I offer the following comments on the proposed 2020 Listing Methodology Document.

Assessing Small Streams

According to the current Listing Methodology, when evaluating narrative criteria, the Missouri Department of Natural Resources (MDNR) "will use a weight of evidence analysis for assessing numerical translators that have not been adopted in the state water quality standards." Pg. 18. This weight of evidence analysis may include the use of other types of environmental data to make the most informed use attainment decision. An example of other relevant environmental data includes aquatic macroinvertebrate scores.

When assessing aquatic macroinvertebrate communities, the MDNR uses the *Biological Criteria for Wadeable/Perennial Streams of Missouri (MDNR 2012)*. As inferred in its title, this method for assessing biological criteria only applies to wadeable and perennial flowing streams. However, on occasion the MDNR is tasked with assessing small streams that are neither wadeable nor perennial. The MDNR has determined that the wadeable/perennial method results in a 70% failure rate for Class U (unclassified) streams. The Listing Methodology contemplates comparing small streams to other "small candidate reference streams." The 2020 Listing Methodology suggests that small candidate reference streams should be of "comparable stream size and permanence", and should be "of same or similar size and Valley Segment Type (VST)." I agree. When selecting the small candidate reference streams the MDNR choses streams with same or similar values for VST parameters include selection based upon "stream size, flow, geology, and relative gradient."

The Listing Methodology includes a "stepwise process for candidate reference stream selection." Factor 4 says that the MDNR should "filter all stream segments within the same EDU

for the relevant five variable VSTs." It is unclear what is meant by "filter." The filtering process is not described. I suggest that this filtering process should require that streams have a similar VST including similar watershed size and similar flow under natural conditions (not augmented by effluent).

The stepwise process for selecting candidate reference streams is found on pages 28-29. Factor 10 says the MDNR must "calculate land use-land cover and compare to EDU." However, there is no discussion on how land use and land cover should be compared to the EDU of the stream in questions. I suggest that a test stream be compared to small candidate reference streams with similar land use characteristics. It would be unfair and scientifically flawed to compare a forested site to a grass land site, or a forested site to a mixed agricultural setting. The best available streams in a similar land use should be compared to the stream in question.

I suggest the methodology be revised to further clarify the role of watershed size, flow and land use play in selecting small candidate reference streams. The bottom of page 28 could be revised as follows:

> . . . VST parameters important for selection are based on temperature, stream size, flow, geology, and relative gradient, with emphasis placed on the first three parameters. **Stream size including watershed size should be similar to test streams. Similarly, small candidate reference stream flow should be similar to a test stream's flow under natural conditions (not augmented by effluent). Additionally, small candidate reference streams should have the same or similar land use as the test stream.**

New language on pages 26 and 27 refers to Missouri Resource Assessment Partnership Shreve Link Number for Stream Size Code. It says that the interpretation of the "headwater size" classification, size code one, is based upon the MoRAP Shreve Link Number found in Table 2. It is unclear what the definition of a Planes Shreve Link Number is or an Ozark Shreve Link Number is and how that differentiates between a test stream and its relative water shed size, natural flow and land use. This should be further defined and explored before this new language is included in the Listing Methodology.

On page 26, the draft proposes to delete a paragraph discussing MSCI failure rates for Class P, C and U streams. This is valuable information that helps add perspective to why there should be a separate assessment method for small streams. Please keep this paragraph.

Stream Segment Size

At the October 4, 2017 Clean Water Commission meeting, Robert Voss informed the Commission that EPA now allows states to refine the description of impaired segments in lieu of using an entire length of a Water Body ID segment. If data shows an impairment only affects a portion of a WBID segment, the Listing Methodology should include a description how impaired segments can be more narrowly defined (e.g., GPS coordinates, mapped segments using the MUDD mapping system).

Burden of Proof to List and De-List

I have noted Appendix D applies differing standards to list or de-list waterbody segments. Regarding biological monitoring, different significance levels are assigned depending if waters are being assess as impaired, or no longer impaired. The methodology should not make it harder to de-list a stream than to list a stream with biological monitoring data.

I appreciate the opportunity to comment on the 2020 Listing Methodology.

Sincerely,

NEWMAN, COMLEY & RUTH P.C.

By: Robert J. Brundage

Robert J. Brundage
rbrundage@ncrpc.com

ASSOCIATION OF MISSOURI CLEANWATER AGENCIES

October 11, 2017

By email: Robert.voss@dnr.mo.gov

Missouri Department of Natural Resources
ATTN: Robert Voss
Water Protection Program
P.O. Box 176
Jefferson City, MO 65102-0176

RE: Draft 2020 Listing Methodology

Dear Mr. Voss:

I am writing on behalf of the Association of Missouri Cleanwater Agencies ("AMCA") to urge the Department to clarify its "1-in-3" listing methodology for the State's toxics criteria. As detailed in the attached comments, this methodology is not required by federal or Missouri law, and it is neither the best nor a desirable approach to federal Clean Water Act Section 303(d) listing decisions. The clarification we propose is warranted if DNR intends to retain this provision in the listing methodology.

AMCA is a statewide association in Missouri comprised of owners and operators of public water, sewer, and stormwater utilities. Our members strive every day to provide affordable and cost-effective services protective of public health and the environment.

As our preferred option, AMCA recommends that DNR simply delete the sentence of the listing protocol referring to exceedances of the aquatic life numeric criteria. That provision is inconsistent with the basis of the Missouri criteria themselves.

As a second option AMCA strongly encourages the Department to utilize the binomial distribution method instead. The binomial distribution method is a proven approach to accurate listing decisions, and allows the explicit management of error rates.

As a final alternative, rather than the faulty >1-in-3 listing methodology, we recommend that DNR use the raw score approach, in which no more than 10 percent of the ambient data can exceed the established numeric criteria.

Thank you in advance for your consideration of AMCA's comments. Please let me know if you have any questions.

Sincerely,

F. Paul Calamita
General Counsel

Attachment

C: AMCA Members
Mr. Ed Galbraith
Mr. Chris Wieberg

ASSOCIATION OF MISSOURI CLEANWATER AGENCIES
Comments on Draft 2020 Listing Methodology
October 11, 2017

In its draft 2020 Section 303(d) Listing Methodology, the Missouri Department of Natural Resources ("DNR") provided (App. B to Listing Methodology, Protection of Aquatic Life – Toxic Chemicals) that impaired waters listings are to be based on the following protocol.

> No more than one acute toxic event in three years that results in a documented die-off of aquatic life such as fish, mussels, and crayfish (does not include die-offs due to natural origin). No more than one exceedance of acute or chronic criteria in the last three years for which data are available.

The first sentence of the protocol is appropriate because the current DNR aquatic life criteria for toxics are based on protection against such acutely toxic events. However, those criteria are not based on or designed to be protective against more general acute toxicity or against chronic toxicity, nor are they designed to reflect a one-in-three-year exceedance frequency. For these reasons the second sentence of the protocol does not accurately reflect the current criteria. Accordingly, AMCA urges the Department to delete the second sentence of the listing protocol.

Further, if DNR does include in its listing protocol provisions addressing exceedances of the numeric aquatic life criteria, AMCA objects to the use of the ">1-in-3" methodology for toxic chemicals. Under this part of the methodology, waters will be listed as impaired if there is: "*more than one exceedance of acute or chronic criterion in the last three years for which data are available*."

As explained below, AMCA objects to DNR's use of the ">1-in-3" methodology on practical and legal grounds. The ">1-in-3" methodology ignores critical factors such as the size of the data set, confidence levels, and the management of false positives. Instead, the Department, if it elects to consider frequency of numeric criteria exceedances, should utilize the binomial distribution method - a statistical approach requiring sufficient quality data to provide a 90 percent confidence level that at least 10 percent of instream samples exceed the water quality standard in question, with a minimum sample size of ten. The binomial distribution method is advantageous in a number of ways that we address below and fully protective of aquatic life.

As a final alternative, if DNR decides against the binomial distribution method, DNR should utilize the "raw score" approach, in which case no more than 10 percent of the data can exceed the established criteria.

I. The ">1-in-3" Methodology is Not Required, is Inaccurate and Should Not Be Used

EPA's >1-in-3 methodology is problematic because it does not account for the importance of sample size or data quality. While the binomial distribution method at least considers the proportion of samples that exceed the water quality standard, the >1-in-3 methodology requires a finding of impairment without accounting for other

critical factors. For example, say there were two exceedances in a three-year period. Using the >1-in-3 methodology, it makes no difference if the two values were from a data set of two or 200 total samples, even though the latter would be much less likely to indicate truly impaired ambient conditions. Larger datasets are more likely to include samples collected during brief extremes, such as the "first-flush" of stormwater, which are too short-lived to impact the biological community. In determining whether a stream is impaired, it is essential to take sample size into account in order to address such issues (a point addressed in detail below). However, this essential consideration is ignored by the >1-in-3 methodology.

The method is also extraordinarily overly-conservative given that the field studies upon which the recommendation was based primarily focused on recovery time from severe biological degradation caused by extreme events.[1] Reliance on those unrepresentative studies has resulted in an overestimation of necessary recovery time from routine non-compliance under real world conditions. The studies cited by EPA do not support the need for a three-year recovery period for typical exceedances of water quality standards, which are much more likely to be marginal than large excursions.[2] The first sentence of the listing approach – which we are okay with leaving in the methodology – would address any real toxic event. However, the second sentence is directed at events that likely have no toxicity whatsoever. We know this from the water effects ratio procedures which have been implemented across the country to develop site-specific water quality criteria. Many of those WERs result in site-specific metals criteria which are 2-10 times the default criteria. Thus, assigning significance to two isolated exceedances of those criteria is illogical.

Finally, as a legal matter, the >1-in-3 methodology is not mandated by the federal Clean Water Act, and EPA has not promulgated the method as a regulation. Accordingly, it is not a binding legal requirement on Missouri. For these reasons, Missouri should either (1) delete the second sentence of the listing methodology, (2) utilize the binomial distribution method rather than the >1-in-3 methodology, or (3) adopt a raw score approach.

II. Explanation of Binomial Distribution Method and Comparison to the >1-in-3 Method and the Raw Score Method

A "binomial distribution" assessment methodology (or "binomial hypothesis test") explicitly manages error rates, reduces false-positive errors, accounts for sample size, establishes the confidence level associated with the assessment, and addresses sampling and analytical errors as well as non-representative sampling bias. EPA has

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[1] *See, e.g.*, North Carolina Dep't of Envtl. Quality, MODERNIZING WATER QUALITY ASSESSMENT METHODS FOR TOXICS at 2-6 (Apr. 2016) ("MODERNIZING WATER QUALITY ASSESSMENT METHODS"), available at: https://files.nc.gov/ncdeq/Water%20Quality/Planning/TMDL/303d/2016/Assessment%20Method%20for%20Toxics-April-1-2016.pdf.

[2] *See* U.S. EPA, Technical Support Document for Water Quality-Based Toxics Control, Responsiveness Summary at 10 (1991) ("EPA recognizes that the chemical and ecological field data summarized in Chapter 1 suggest that successive excursions well above the criteria would be needed to cause severe impacts. EPA also recognizes that the probability of large excursions can be calculated to be extremely small compared to the probability of marginal excursions").

accepted this nonparametric hypothesis approach for listing purposes in the case of conventional pollutants.[3] Moreover, the National Research Council has recommended that EPA endorse statistical approaches such as the binomial hypothesis test, "that can more effectively make use of the data collected to determine water quality impairment than does the raw score approach."[4] In other words, this methodology represents an accepted procedure to account for data reliability.

A. Statistical Methodology

In conducting water quality assessments, hypothesis testing is used to compare the water's true exceedance probability for the pollutant (p) with the probability value for allowable exceedances ($p_0 = 0.10$).[5] The null hypothesis (H_0) is that the water is not impaired for the pollutant at issue, while the alternative hypothesis (H_1) is that the water is impaired. The null and alternative hypotheses are respectively expressed as:

H_0: $p \leq p_o$ or $p \leq 0.10$

H_1: $p > p_o$ or $p > 0.10$

A water will be designated as impaired if H_1: $p > 0.10$ at the 90% confidence level.

Water quality data can be expressed in terms of a binomial distribution, in which pollutant concentration samples are assigned *yes/no* dichotomous responses.[6] Each sample for a specific pollutant is expressed as one of two possible alternatives: either "*yes*, the measurement exceeds the numeric criterion," or "*no*, the measurement does not exceed the numeric criterion."[7] The binomial distribution depends on sample size (n) and the true exceedance probability (p). The total number of *yes* responses is represented by a binomial random variable (x).

The exceedance probability cannot be known with 100% certainty because it depends on the unknown pollutant distribution. Therefore, it must be estimated. The sample proportion of *yes* ($\hat{p} = X/n$) is considered the best point estimator of the true

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[3] See, e.g., U.S. EPA, Region 4, Water Protection Division, Decision Document for the Partial Approval of the North Carolina Department of Environmental Quality 2016 Section 303(d) List § III.A.4.b–c, at 16–17 (Dec. 8, 2016), *available at*: https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/nc2016_303ddecisionpackage20161208_reduced.pdf ("NC Decision Document"); U.S. EPA, Determination Upon Review of Amended Florida Administrative Code Chapter 62-3-3, Identification of Impaired Waters, App. A, at 1 (2008), available at: https://archive.epa.gov/pesticides/region4/water/wqs/web/pdf/epa_iwr_decdoc_2-19-08.pdf ("Florida Determination").

[4] National Research Council, ASSESSING THE TMDL APPROACH TO WATER QUALITY MANAGEMENT at 61 (2001), available at http://www.nap.edu/openbook.php?isbn=0309075793.

[5] Eric P. Smith, et al., *Statistical Assessment of Violations of Water Quality Standards under Section 303(d) of the Clean Water Act*, 35 ENVTL. SCI. & TECH. 606, 607 (2001).

[6] Pi-Erh Lin, et al., *A Nonparametric Procedure for Listing and Delisting Impaired Waters Based on Criterion Exceedances* at 3 (Oct. 2000), *available at* https://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303d_policydocs/227.pdf.

[7] *See id.*

exceedance probability because it is the unbiased estimator with the lowest variance. However, because $\hat{p}$ is a random variable that differs among samples, "[m]odern statistics strongly recommends the use of a confidence interval estimation approach that takes into account the variability of the estimator."[8] This approach "allows us to incorporate our uncertainty in the true parameters of the distribution into our comparison to the regulatory standard."[9] The confidence interval approach yields identical results to the hypothesis testing approach.[10]

Nonparametric confidence limits on the 90th percentile of a distribution may be defined by calculating the cumulative binomial distribution (*Bin*(x, *n*, *p*)) for the dataset.[11] The cumulative binomial distribution is represented by the following formula:

$$Bin(x; n, p) = \sum_{i=0}^{x} \binom{n}{i} p^{i} (1-p)^{n-1}$$

where $\binom{n}{i}$ denotes the number of combinations of *n* samples taken *i* at a time, and $\binom{n}{i} = \frac{n!}{i!(n-i!)}$.[12]

This equation yields the cumulative binomial probability that a population with a given exceedance probability (here, *p* = 10%) will have x violations out of a sample size of *n*.[13] Binomial probability can be calculated using the Microsoft Excel BINOMDIST or BINOM.DIST functions.[14]

The binomial method is applied to determine the number (critical value) of exceedances of water quality standards necessary to reject the null hypothesis and list the waterbody as impaired for a given sample size. In applying the binomial method for water quality assessment, the cumulative binomial probability is compared to the desired confidence level (here, 90%). For a given sample size, the number of exceedances (x), corresponding to the lowest cumulative binomial probability greater than or equal to the confidence level, is the critical value.[15] Where x values are greater than or equal to the critical value, the water is deemed impaired. For the closest cumulative binomial probability value below the 90% confidence level, the corresponding x value is the maximum number of exceedances for the sample size for which the waterbody will not be listed as impaired.

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[8] *Id.* at 4.
[9] Robert D. Gibbons, *A Statistical Approach for Performing Water Quality Impairment Assessments under the TMDL Program*, 39 J. AM. WATER RES. ASS'N 841–49 (Aug. 2003), *available at* http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.387.5522.
[10] Lin, et al., *supra* note 6, at 6–7.
[11] *See* Gibbons, *supra* note 9.
[12] *Id.*
[13] *Id.*
[14] *See* Microsoft Office, BINOM.DIST Function, http://office.microsoft.com/en-us/excel-help/binom-dist-function-HP010335671.aspx; Microsoft Office, BINOMDIST, https://support.microsoft.com/en-us/help/827459/excel-statistical-functions-binomdist.
[15] *See* Gibbons, *supra* note 9.

In comparison to the raw score method (discussed below), the binomial method requires a slightly higher percentage of samples to exceed the water quality standard for a water to be listed as impaired. The difference in required percent exceedances between the binomial and raw score methods decreases with increased sample size. It is reasonable and a good management practice to require a stronger showing of impairment by way of a slightly higher percentage of exceedances where fewer data points are available, to ensure that exceedances in a small data set truly reflect impaired conditions in the water body.

Beyond the statistics, several practical factors support this approach. First, states are required to make impaired waters determinations every two years; typically, at each new assessment point, newer and/or additional data are available to add to the database for a segment and bolster the power of the statistical determination of standards attainment or non-attainment. Second, the exercise of this biannual reevaluation of standards attainment itself subjects segments to repeated evaluations and opportunities for 303(d) listings, and the practicalities are that, once listed, a segment will be difficult to remove, and it will eventually receive more intense data review by virtue of the TMDL process.

The binomial method is particularly applicable to ambient water quality data because it does not involve an assumption regarding the distribution of the water quality parameter.[16] Unlike other data which may frequently be characterized by a typical statistical distribution, the multiple and varying causes contributing to ambient pollutant concentrations lead to no such predictable distributions. Because it is non-parametric, this method may be employed for all water quality parameters without an estimate of variance or other understanding of distribution. The nonparametric hypothesis testing approach based on the binomial distribution is appropriate for assessing water quality data because such nonparametric tests are applicable to data that may not be normally, etc. distributed. It is also appropriate for data sets that may include data points below the level of detection, which commonly occurs in the water quality context. This is because,[17] by definition, it is not possible to define the distribution parameters of such data.

B. Error Rates Support Use of the Binomial Method

Due to limited samples sizes and potential for human error, 303(d) assessments always involve some risk for Type I (false positive) and Type II (false negative) errors.[18] A Type I error occurs where an unimpaired water is incorrectly listed as impaired; this type of error may result in substantial public and private costs from developing and implementing an unwarranted Total Maximum Daily Load and complying with

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[16] *See* Gibbons, *supra* note 9.

[17] *See, e.g.,* U.S. EPA, Determination Upon Review of Amended Florida Administrative Code Chapter 62-3-3, Identification of Impaired Waters, App. A, at 1 (2008), *supra* fn. 3 ("Florida Determination").

[18] ASSESSING THE TMDL APPROACH, *supra* note 4, at 57; Smith et al., *supra* note 5, at 607.

unnecessary water quality based effluent limitations.[19] Conversely, a Type II error occurs where an impaired water is incorrectly listed as being unimpaired, which may result in environmental and/or public health issues.[20] At any given sample size, there is an inverse relationship between Type I and II error rates.[21] Given that neither type of error can be completely eliminated, "water quality managers must choose (directly or indirectly) the tolerable amount of error."[22] The binomial hypothesis test allows the state to "*explicitly* control and make trade-offs between error rates."[23]

This approach is consistent with the Clean Water Act, which specifically makes impaired waters listings a state responsibility, subject to the state identifying impaired (and unimpaired) waters based on good cause, accurate data, and sound modeling.[24] The policy and public interest judgments between Type I and Type II error rates are a matter for the state, as long as those judgments are made reasonably.[25]

Error rates decrease with increasing sample sizes.[26] One of the advantages of the binomial method is that it takes sample sizes into account, while the raw score approach does not allow for any consideration of sample size.[27] In this regard, the binomial method is preferable to the raw score approach because, as the National Research Council explains, "[c]learly, 1 out of 6 measurements above the criterion is a weaker case for impairment than is 6 out of 36."[28]

The binomial approach has been shown to yield substantially fewer Type I errors than the raw score approach at all sample sizes.[29] While the binomial approach has higher Type II error rates than the raw score approach at low sample sizes, the error rates converge to zero as sample sizes increase.[30] Thus, concerns about false negative errors may be alleviated by increasing minimum sample sizes. Error rates are also mitigated by the every-two-year assessment requirement. Overall, statistical methods, including the binomial approach, "have controllable error rates that may be made reasonably small while the raw score method has a large error rate."[31] Statistical studies have concluded that "the Binomial method can be easily applied to address the

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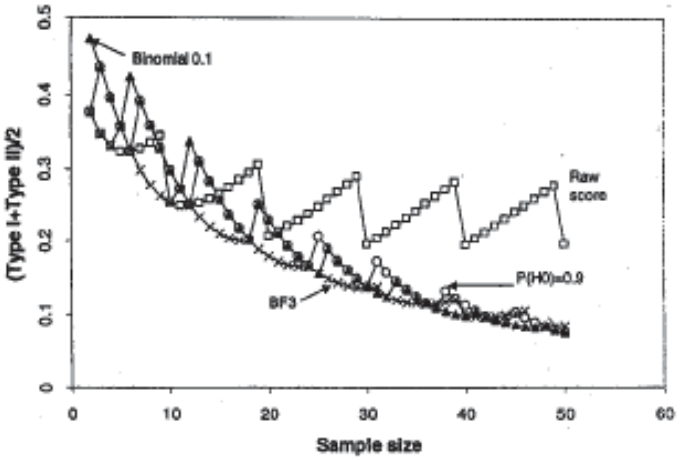
[19] Smith et al., *supra* note 5, at 606.
[20] *Id.*
[21] ASSESSING THE TMDL APPROACH, *supra* note 4, at 57 n.12.
[22] Smith et al., *supra* note 5, at 607.
[23] ASSESSING THE TMDL APPROACH, *supra* note 4, at 57.
[24] CWA § 303(d), 33 U.S.C. § 1313(d); 40 C.F.R. § 130.10(d)(7).
[25] The Clean Water Act explicitly recognizes "the primary responsibilities and rights of States to prevent, reduce, and eliminate pollution, to plan the development and use (including restoration, preservation, and enhancement) of land and water resources, and to consult with the Administrator in the exercise of his authority under [the CWA]." CWA § 101(b), 33 U.S.C. § 1251(b).
[26] ASSESSING THE TMDL APPROACH, *supra* note 4, at 57.
[27] *Id.*
[28] *Id.*
[29] Smith et al., *supra* note 5, at 609.
[30] *Id.* at 610.
[31] *Id.*

balancing of error rates, using the same data . . . used to apply the raw score approach."[32]

Figure 1 below, developed by Eric P. Smith et al., shows the difference in average error rates for the binomial method and other statistical approaches in comparison to the raw score method. This graph demonstrates the superiority of the binomial method over the raw score method in terms of controlling error rates, particularly at higher sample sizes. The spikes in the trend lines are associated with changes in the critical value of exceedances necessary to support an impairment listing.[33]

Figure 1: Average Error Rates for the Binomial Method and other Statistical Approaches and the Raw Score Method[34]



While there are trade-offs between Type I and Type II error rates, the advantages of the binomial method outweigh the disadvantages of EPA's >1-in-3 methodology. In addition, Type I errors can be extremely costly for public and private entities, including AMCA members. Incorrectly listing a stream as impaired, when it is in fact unimpaired, triggers a requirement for DNR to develop a TMDL — an arduous and expensive planning process ultimately financed by the state's taxpayers. These misdirected plans trigger in turn unwarranted compliance costs (e.g. complying with unnecessarily stringent water quality based effluent limitations or other steps) to improve water quality that actually already satisfies applicable water quality standards. Again, such compliance costs are passed on to the public. Moreover, Type I errors can have their own environmental consequences because misdirected TMDLs divert resources away from streams with actual impairments.[35] Any relatively small increase in Type II error rates is mitigated by the biannual process of 303(d) listing determinations; every two years, the data for a stream segment are reviewed again, providing a continual process of identifying impaired waters.

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[32] *Id.* at 612.
[33] *Id.* at 608–09.
[34] This graph is reproduced from Eric P. Smith et al., *supra* note 5, at 610.
[35] Smith et al., *supra* note 5, at 611.

C. The 10% Probability Value is Both Necessary and Appropriate for Assessing Numeric Water Quality Criteria for Toxics and Non-Conventional Pollutants

The 10% probability value for criterion excursion establishes the signal strength from the data necessary to determine that the ambient water actually exceeds water quality standards.[36] It is equivalent to the 90th percentile of the sample distribution.[37] The 10% probability value functions as a practical adjustment to compensate for uncertainty due to sampling and analytical errors, extreme conditions, and variability. It reasonably represents the proportion of erroneously high values in the overall set of water quality data, regardless of sample size. Further, the 10% probability value is conservative and protective of the state's waters.

The choice of the 10% probability value is specifically a state responsibility. We reiterate that EPA may not override a state's policy judgment under the Clean Water Act when it is reasonably and rationally adopted. We encourage Missouri to utilize the 10% probability value for assessing numeric water quality criteria for toxics and non-conventional pollutants.

D. The 10% Probability Values Addresses Uncertainty in Data Quality

The reliability and accuracy of all the data relied upon cannot be guaranteed. Such data comes from numerous sources, including DNR itself; the United States Geological Survey; local governments; environmental groups; and industry, municipal, and university coalitions. During every listing cycle, DNR likely must process hundreds of thousands of data points. According to EPA, the uncertain quality of collected data from these various sources weighed in favor of EPA's decision to approve the use of the nonparametric statistical test for listing decisions in Florida.[38] It is well understood that erroneously high data may result from errors during sample collection, handling, reporting, blank contamination, transcription reversals, and laboratory matrix interference.[39] Therefore, it is essential that the assessment methodology account for data reliability so that erroneous listing decisions do not impose unwarranted, increased compliance costs on the community.

Toxics are particularly susceptible to sampling and analytical errors in part due to the very low pollutant concentrations commonly at issue.[40] Measuring low-concentration pollutants is challenging because "various operations performed on the sample during its preparation for the stage of final determinations can be a source of

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[36] NC Decision Document, *supra* note 3, App. E, at 2 (citing Florida Determination).
[37] *See* Gibbons, *supra* note 9.
[38] NC Decision Document, *supra* note 3, at pt. III.A.4.e, at 21 ("A large proportion of FDEP's sizable data set is from third party sources, including volunteer groups, and its validity is uncertain. These factors weighed heavily in the EPA's evaluation of the use of the nonparametric statistical test for use support determinations for that State.").
[39] Florida Determination, *supra* note 3, at 9.
[40] *See, e.g.*, 40 C.F.R. Pt. 136 app. D (methods for metals, coefficient of variation uniformly increasing as sample concentration decreases); *see also* 40 C.F.R. Pt. 136 app. D (2011 & prior) (additional analytical methods—same conclusion).

many errors crucially affecting the final result of the analysis."[41] Even low levels of contamination can dramatically affect results when sampling for low-concentration constituents. Where clean sampling and analytical methods are not properly used for measuring toxic pollutants, the resulting data are unsuitable for 303(d) listing purposes.

Scientific literature also demonstrates that conventional sample handling methods used in measuring levels of freshwater metals often result in significant rates of erroneously high data due to contamination artifacts.[42] For example, the sample composition may be distorted by "[t]he contact of analytes present in both gas and liquid mixtures with the walls of vessels, tubing and appliances [which] crucially affects the concentration levels of trace . . . components."[43] Due to the ubiquitous presence of metals and other inorganic analytes in laboratories and analytical reagents, errors in toxics measurements tend to be skewed toward values higher than actual concentration levels, increasing the risk of incorrectly including unimpaired waters on the state's 303(d) list.[44]

Another reason for high error rates in toxics data is the fact that numeric criteria for many toxic substances are below current detection limits (e.g. 10 CSR 20-7, Table A & B). There is significant uncertainty in data values close to detection or quantitation limits, so the risk of erroneously high data points increases where the criteria are near these limits. Additionally, the method for determining detection or quantitation limits may lead to false positives due to bias and variability in methodological noise and sensitivity, and errors may result from incorrect reporting of values below detection limits.[45]

For these reasons, it is essential that the assessment methodology account for uncertainty regarding data reliability to minimize the impact of sampling and analytical errors on listing decisions. The 10% probability value is an accepted procedure for addressing uncertainty in data quality and Missouri's adoption of this procedure would be a reasonable exercise of its judgment under the Clean Water Act.

F. The 10% Probability Value Also Addresses Exceedances from Extreme Conditions and Variability

In addition to accounting for sampling and analytical errors, the 10% probability value also accounts for occasional exceedances due to extreme conditions and natural variability. Where no more than 10% of samples exceed water quality standards, it is reasonable not to include a waterbody on the state's 303(d) list because (1) as described above, such samples are likely unrepresentative of actual water quality, and

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[41] Jacek Namieśnik, *Trace Analysis—Challenges and Problems*, 32 CRITICAL REVIEWS IN ANALYTICAL CHEMISTRY 271, 274 (2002).
[42] *See* Gaboury Benoit et al., *Sources of Trace Metal Contamination Artifacts during Collection, Handling, and Analysis of Freshwater*, 69 ANALYTICAL CHEMISTRY 1006–11 (1997); *see also* Herbert L. Windom et al., *Inadequacy of NASQAN Data for Assessing Metal Trends in the Nation's Rivers*, 25 ENVTL. SCI. & TECH. 1137 (1991).
[43] Namieśnik, *supra* note 41, at 274.
[44] *E.g.*, Benoit et al., *supra* note 42.
[45] NC Decision Document, *supra* note 3, App. E, at 2 (citing Florida Determination).

(2) even if valid, a small percentage of samples may exceed numeric water quality standards without causing the water's designated uses to be impaired.

In fact, EPA has agreed with the latter point:

> EPA does not disagree with the general point, as evidenced by EPA's own criteria recommendation published pursuant to Clean Water Act section 304(a), which are the basis for the magnitude value in Florida's underlying water quality criteria for metals, and for which EPA has recommended associated duration and frequency components whereby the magnitude may be exceeded for short periods of time at infrequent intervals and still be fully protective of aquatic life uses.[46]

Impairment listings and resulting TMDL requirements should not be based on samples collected during unusual or extreme conditions that result in outlier data points. For example, during the "first flush" of stormwater, pollutant levels are likely to vary significantly from normal (e.g. event mean) levels, and any samples taken during such events are likely to be unrepresentative of normal water quality conditions.[47] Concentrations of pollutants tend to peak near the beginning of a storm event prior to peak stormwater flows, resulting in "a disproportionately greater discharge of mass relative to the proportion of volume discharged during a storm event."[48]

Like other parameters, the levels of toxic substances can vary dramatically during the "first flush" of stormwater.[49] Exceedances of water quality criteria due to "first flush" events are unlikely to impact the biological community due to the short term nature of the increase in toxics levels.[50] Additionally, the concentrations of many toxic substances have also been observed to fluctuate diurnally.[51] For example, one study measured diurnal increases in zinc concentrations of 70-500% and diurnal increase in manganese of 17-152%, primarily due to in-stream geochemical processes. That study concluded that "[d]iel cycles of dissolved metal concentrations should be assumed to occur at any time of year in any stream with dissolved metals and neutral to alkaline

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[46] Florida Determination, *supra* note 3, at 10.
[47] NC Decision Document, *supra* note 3, App. E (citing Florida Determination).
[48] Liesl L. Tiefenthaler & Kenneth C. Schiff, *Effects of Rainfall Intensity and Duration on First Flush of Stormwater Pollutants*, 2001-2002 Southern California Coastal Water Research Project Annual Report at 209 (2002), *available at* http://ftp.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2001_02AnnualReport/21_ar40-liesl.pdf.
[49] For example, a strong "first-flush" phenomenon has been observed for cadmium, zinc, and copper. *See* John J. Sansalone & Steven G. Buchberger, *Partitioning and First Flush of Metals in Urban Roadway Storm Water*, 123 J. ENVTL. ENGINEERING 134 (1997).
[50] NC Decision Document, *supra* note 3, App. E (citing Florida Determination)...
[51] *See* David A. Nimick et al., *Seasonality of Diel Cycles of Dissolved Trace-Metal Concentrations in a Rocky Mountain Stream*, 47 ENVTL. GEOLOGY 603 (2005); *see also* Christopher L. Shope et al., *The Influence of Hydrous Mn-Zn Oxides on Diel Cycling of Zn in an Alkaline Stream Draining Abandoned Mine Lands*, 21 APPLIED GEOCHEMISTRY 476 (2006).

pH."[52] The 10% probability value helps to weed out such occasional exceedances attributable to "first flush" and diurnal variability and reduces the influence of unrepresentative outlier data points. Moreover, EPA has recognized that "all numeric water quality criteria have three elements: magnitude (e.g., how much), duration (e.g., how long at the specified magnitude), and frequency of exceedance (e.g., how often for the specified duration period), regardless of whether they are explicitly described in state water quality standards."[53]

III. A Minimum Sample Size of Ten is Both Warranted and Appropriate

AMCA urges DNR to specify a minimum sample size of ten for listing decisions. This minimum sample size requirement is necessary to improve the statistical strength of DNR's listing methodology by reducing error rates.

This sample size requirement is supported by scientific literature. A technical report by Pi-Erh Lin, et al., concluded that a minimum of ten samples should be required in order to list a water as impaired on a state's 303(d) list.[54] Likewise, a study by Robert D. Gibbons found that "statistical power computations . . . revealed that the nonparametric approach should never be used when fewer than ten samples are available."[55] Smaller sample sizes lead to greater uncertainty in estimating the true probability of a pollutant exceeding the state's water quality standards.[56] A sample size less than ten is less likely to be representative of conditions in the water body as a whole. Requiring impairment decisions to be based on an increased number of samples decreases the risk of error in the 303(d) listing process. Although it would be preferable for sample sizes to be at least twenty in applying the binomial method,[57] a sample size of ten is sufficient in light of the fact that "[c]ost realities, given the need for statewide monitoring and the fact that most monitoring is for enforcement of point source discharge permits, results in a limited number of stations and samples for each station."[58]

Figure 1 (Part II.B above) provides a graphic demonstration of the significant decrease in error rates with increased sample sizes for the binomial method and other approaches. The clear trend therein strongly supports a DNR decision to require a minimum sample size greater than nine for listing decisions.

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[52] *Id.*
[53] U.S. EPA, Amended Decision Document Regarding Florida Department of Environmental Protection's Section 303(d) List Amendments for Basin Groups 1, 2, and 5 app. F, at 1 (Sept. 2, 2009).
[54] Lin et al., *supra* note 6, at 16.
[55] Gibbons, *supra* note 9, at 841–49.
[56] Lin et al., *supra* note 6, at 15.
[57] *See* Smith et al., *supra* note 5, at 612 ("When sample sizes are around 20–25, the assessment process can confidently rely on statistical procedures to manage and measure type I and type II errors.").
[58] *Id.* at 606.

IV. Alternatively, DNR Should Use the Raw Score Method Rather Than EPA's <1-in-3 Method

While the AMCA strongly encourages DNR to (1) delete the second sentence in the existing methodology or (2) use the binomial distribution method, AMCA would accept DNR's use of the raw score method (where no more than 10 percent of the data can exceed the established criteria) as an alternative to the first two approaches. The raw score method is simple and easy to implement. While not as comprehensive as the binomial distribution method, it considers sample size and not simply exceedance frequency. For these reasons, it is technically superior to the >1-in-3 approach.

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October 12, 2017

Mr. Robert Voss
Water Protection Program
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Subject: Public Comments Regarding the Proposed 2020 Listing Methodology Document

Mr. Voss,

The Metropolitan St. Louis Sewer District (MSD) would like to submit the following comments on the proposed Methodology for the Development of the 2020 Section 303(d) List in Missouri (LMD), which Missouri Department of Natural Resources (MDNR or Department) placed on public notice on July 3, 2017.

MSD acknowledges the time and resources MDNR staff have invested in developing the proposed LMD. The Department's efforts to update and improve the document are appreciated and will make the LMD more transparent and easier to implement. However, there are still several issues in the proposed LMD that were not addressed in prior revisions. MSD believes the document should be modified to improve the consistency and defensibility. Our specific comments are outlined below.

Comment #1. MSD supports comments submitted by the Association of Missouri Cleanwater Agencies (AMCA).

MSD supports the comments prepared and submitted by AMCA. We believe that addressing the issues raised by AMCA will be necessary for improving the LMD and its implementation.

Comment #2. MDNR should clarify how they use data collected when streamflow is zero or when streamflow is not reported with chemistry data.

MDNR has indicated in the past that Environmental Service Program (ESP) staff generally does not collect water quality samples when stream flows are zero because these data are not representative of normal stream conditions. MDNR has also indicated that they do not use samples collected under zero flow conditions for listing or assessment purposes. However, we note that there are a number of sample results with a reported flow of zero (or no flow reported at all) in the LMD assessment sheets.

We agree that zero flow conditions do not reflect normal stream conditions in Class P and Class C streams and request that the MDNR clarify their intended data collection and data use procedures when classified streams have flows of zero or when flow data are not available.

Comment #3. MDNR should clarify how they assign, track, and apply data quality codes.

On page 16, the LMD says that the MDNR assigns Data Codes 1 through 4 to data. The data codes have very specific requirements as to number of samples, seasons, and quality assurance protocols.

The LMD also states (page 17) that only Data Code Two or above are generally used for making listing decisions; however, data quality or codes are rarely discussed or apparent in the 303(d) listing worksheets or in MDNR's Water Quality Assessment System. We note that data age and quality are

critical components that must be considered to make a fully informed listing decision. Therefore, MSD requests that the MDNR provide data codes in 303(d) listing worksheets. If data quality information is not available or suggests the data are not representative, the MDNR should consider waters with suspected impairments as Category 2 or 3 until sufficient data are collected.

Comment #4. MDNR should clarify their intended approach for evaluating pH as a chronic water quality criterion.

On page 51, the LMD states that "Chronic pH will be used in the 2020 LMD only if these criteria appear in the Code of State Regulations, and, [are] approved by the US Environmental Protection Agency." We understand that current state regulation may require some modification on this issue. However, it is clear from EPA's 1986 criteria development report[1] and supporting documentation that the pH criterion was intended to be a chronic value. Therefore, we request that MDNR strike the aforementioned language and instead outline methods that will be used to evaluate pH data for compliance as a chronic value. We recommend that MDNR adopt the following procedure:

1. **Calculate the "calendar day" average value.** If multiple measurements are collected in a day, calculate the appropriate statistical average of each calendar day.

2. **Calculate 4-day rolling average of calendar day values.** Calculate the appropriate statistical 4-day rolling average of sequentially-ordered (by date) calendar day data. As data are considered, preference should be given to data collected over consecutive calendar days, as these data likely best represent existing conditions. If consecutive day data are not available, waterbodies will be assigned to Categories 2 or 3, as appropriate, until representative data are available.

3. **Evaluate compliance**. Using the 4-day rolling average data, determine whether or not more than 10% of data are below 6.5 SU or above 9.0 SU using the binomial probability approach outlined in the LMD.

Comment #5. The assessment methods used to delist a water should be the same as those used to list the same water.

As we have noted in previous comments, it is not clear why the Department requires a greater burden of proof to delist waters than to list them for biological monitoring or color data. MSD notes that the LMD includes a higher significance level for delisting (0.4) than for listing (0.1) (see Appendix D in the LMD) for these parameters. Increasing the burden of proof for delisting decisions will lead to waters being listed for longer periods of time (potentially perpetually) than is otherwise necessary. MDNR explains their rationale for this approach on page 42 of the LMD by stating that some undesirable effects can occur from maintaining consistent significance levels. However, the apparent undesirable environmental effects are not clear, as waterbodies that are very close to the water quality standard (slightly above or below) are not likely to represent a fundamentally different biological or chemical condition. The issue is further complicated by the fact that for all of the remaining data types listed in Appendix D, MDNR does maintain the same burden of proof for listing and delisting. Therefore, the MSD requests that MDNR treat all data types consistently and use the same significance levels for listing and delisting decisions.

We continue to request that methods and decision criteria used to delist a waterbody be consistent with methods and criteria to list a waterbody. We recognize that some may believe that this request constrains

[1] 1986. Quality Criteria for Water. Office of Water. Washington, DC. EPA 440/5-86-001

MDNR's ability to exercise best professional judgment in some situations, however additional data can always be collected for streams where attainment status is unclear.

Comment #6. MDNR should clarify the role that changing regulations, alternative restoration approaches, and waterbody assessment categorization have in the TMDL prioritization and development process.

MSD is concerned that new and changing regulations introduce significant uncertainty into the assessment process and prevent MDNR from concentrating resources on waters where impairment thresholds are more certain. MSD believes that MDNR should consider impairments based on water quality standards that are likely to change in the near future as low priorities for TMDL development. MSD notes that on page 37 of the 2016 integrated report[2], they are considering a three-step method for addressing TMDL prioritization in the future and will encourage public involvement in that process. We commend MDNR for actively planning to address this issue and request that MDNR initiate a Clean Water Forum stakeholder group to discuss it in the near future.

As part of those prioritization discussions, stakeholders should also discuss the role that alternative restoration approaches such as watershed plans or integrated plans have in the overall 303(d) process. The US Environmental Protection Agency has acknowledged that under certain circumstances, alternative restoration approaches may be more beneficial or practicable in achieving water quality standards than a total maximum daily load (TMDL)[3]. In 2016, the Department also recognized the importance of alternative approaches and included Category 5-Alt in their listing and reporting guidance[4]. MSD looks forward to discussing these issues with MDNR in more detail during future Clean Water Forum meetings.

Comment #7. Data age, quality, and minimum sample sizes should be addressed when making impairment decisions.

The LMD states (page 16) that when data older than seven years are used to make a listing decision, MDNR will provide a written justification for using those data. It is likely listing decisions incorporating older data have not fully explored if those data remain representative of present conditions. Listings based on data older than seven years should be carefully assessed or have additional data gathered to assess present conditions. It is incumbent upon MDNR to provide rationale for the use of older data as stated in the LMD. If recent data are not available, MSD recommends placing waterbodies with data older than seven years in Category 2 or 3 until contemporaneous data can be collected to adequately assess present conditions.

Another concern is related to the minimum number of samples required to make a listing determination. Other than the five minimum samples required for assessing compliance with recreational uses, this issue is not addressed in the LMD. As MDNR is aware, environmental data can be highly variable and may introduce significant uncertainty into conclusions regarding impairment status. For example, on page 51 of the LMD, MDNR notes; "Some sampling periods are wholly or predominantly during the critical period of the year when criteria violations occur. Where the monitoring program presents good evidence of a demarcation between season where criteria exceedances occur and seasons when they do not, the 10%

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[2] Missouri Department of Natural Resources (MDNR). 2016. Missouri Integrated Water Quality Report and Section 303(d) List, 2016: Clean Water Act Sections 303(d), 305(b), and 314. Water Protection Program. Jefferson City, MO. April 7, 2016.

[3] Best-Wong, B. 2015. Information Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions. Office of Wetlands, Oceans, and Watersheds. Washington, DC. August 13, 2015.

[4] Missouri Department of Natural Resources (MDNR). 2016. Methodology for the Development of the 2018 Section 303(d) List in Missouri. Water Protection Program. Jefferson City, MO. April 6, 2016.

exceedance rate will be based on an annual estimate of the frequency of exceedance." MSD requests that MDNR set appropriate minimum sample sizes and identify clear distribution requirements for all data types that will be used to make listing decisions. These modifications will provide the Department greater confidence when making 303(d) decisions.

Comment #8. Biological data should have a greater weight than specific pollutant data.

MSD commends MDNR for including the draft flowcharts in Appendix E which clarify the role of using biological data in weight of evidence evaluations for parameters that do not have approved water quality criteria. For aquatic life uses, biological data represent the most direct measurement of use attainment and should be given greater weight in listing and de-listing decisions. Therefore, we suggest that MDNR consider implementing an approach similar to that presented in Appendix E when evaluating other chemical criteria.

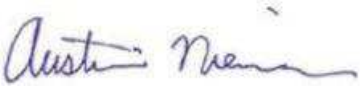
Comment #9. The use of qualified data in water quality data sets should be clearly explained.

There are several bacteria analytical methods that have maximum quantification limits. MDNR has provided no guidance on the consistent handling of samples qualified as greater than the maximum quantification limit in the LMD. MSD recommends MDNR handle data qualified as greater than by setting the value equal to the maximum quantification level of the analytical method rather than doubling it, as MDNR has done in the past. For example, if the maximum quantification level of the analytical method is 24,196 #/100 mL and the sample result was >24,196 #/100 mL, the value used for calculations should be 24,196 #/100 mL. This would provide the greatest level of certainty and defensibility of the data. In addition, we request the MDNR clearly define the handling of data qualified as less than the minimum level in LMD. We understand that MDNR generally uses half of the minimum detection limit when making permitting decisions and recommend that MDNR use the same approach in the LMD.

Thank you for the opportunity to comment on the proposed methodology. We look forward to working with MDNR to develop an LMD document that is transparent, objective, and repeatable.

If you have any questions or comments, please feel free to contact me at (314) 436-8700 or John Lodderhose at (314) 436-8714.

Sincerely,



Austin Nieman
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cc: John Lodderhose
Jay Hoskins
Austin Nieman