Missouri
Department of
Natural Resources

Water Protection Program
Water Pollution Control Branch

Water Quality Monitoring in Support of Missouri's Antidegradation Rule

The following guidance addresses water quality monitoring and Missouri's Antidegradation Rule, Section II, the Antidegradation Implementation Plan. Water quality monitoring and modeling may be necessary to support the development of permit limits under the requirements of the *Missouri Antidegradation Rule & Implementation Procedure* (AIP). Additionally, Section A. 1.b of the AIP describes procedures that must be followed to determine existing water quality.

The preferred approach for assessing existing water quality (EWQ) is to use previously collected data where available. Any previously collected data used to determine EWQ must meet the data quality requirements noted below. Where adequate data are not available, water quality monitoring must occur. Sometimes more than one approach may be needed to characterize EWQ for all pollutants of concern (POCs). For some waters requiring additional water quality monitoring, a year or more may be needed to conduct this monitoring. Thus, contact the department well in advance of any planned activities or permit application submittals.

I. Development of a Quality Assurance Project Plan

Prior to initiating any water quality sampling, a Quality Assurance Project Plan (QAPP) must be submitted to and approved by the department (see QAPP template available on the DNR website). The department recommends that this QAPP follow the US Environmental Protection Agency (EPA) guidance found in *EPA Requirements of Quality Assurance Project Plans, EPA QA/R-5* (EPA/240/B-01/003, March, 2001 or subsequent editions of this document). If this guidance is not followed, the following, provided in a single, bound document, is the minimum amount of information that must be supplied to the department describing the quality assurance of the monitoring project:

1. Names of all personnel involved in sample collection and handling and a description of all academic and on-the-job training each has received that relates to collection and handling of water quality samples. Include the name, phone number and email address of at least one person that can act as a contact.
2. Copies of all Standard Operating Procedures (SOPs), instruction sheets or any other written documents that pertain to the procedures involved in collection and handling of samples.
3. The brand name and model number (if applicable) of all meters used to make water quality measurements in the field (water temperature, pH, dissolved oxygen and specific conductance). Include a description of how and when these meters are calibrated.
4. A detailed sampling plan that gives the location of all sampling points, a complete list of all water quality analytes, how frequently each will be monitored and any other considerations regarding when and how samples will be collected. The number and location of the monitoring points needs to be adequate to delineate the segment(s) of the water body for which the tier determination applies.

5. The name of the laboratory doing the analytical work, a contact name, phone number and email address. For each analyte, the laboratory must provide the method number, and the minimum detection level and practical quantitation limit for that method. All methods must be either a EPA approved method, a method published in the APHA/AWWA *Standard Methods for the Examination of Water and Wastewater*, 20th edition or a subsequent addition, or a method specifically approved for this monitoring project by the department.

II. Determination of Existing Water Quality

Recommended process to follow when a permittee requests assistance with establishing EWQ of the receiving water body for the purpose of either documenting Tier 1 status of the POCs, or establishing that the selected treatment alternative will only result in minimal degradation (less than 10% of the assimilative capacity of the water body).

1. Permits Section informs Water Quality Monitoring and Assessment Section/Monitoring and Assessment Unit (MAU) of the receiving stream location for which they want to establish EWQ.
2. MAU will review water quality data files to see whether EWQ can be determined for the receiving stream in question from existing data. The review will be based on all acceptable data from the stream in question wherever possible, but may be based on a nearby stream with similar geology and land use if there are no potential localized water pollution sources that would confound using another stream as a surrogate. Acceptable data are data which have been collected using a monitoring program whose quality assurance has been accepted by the department and which, in the department's opinion, is representative of current conditions[1].
3. The permittee would have the option of instituting a water quality monitoring program to collect the data and making the EWQ assessment, or have the department make the EWQ assessment. The first step would be the development of a Quality Assurance Project Plan by the permittee and review of the plan by the MAU. Once this data is collected, the department would make the EWQ assessment using all available data of acceptable quality assurance.
4. The monitoring program should be structured as follows:
    - Unless the primary or only discharge is from storm water, all sampling should be during non-storm water influenced flows, preferably during low flow periods and at times when wastewater discharge volume is at or near maximum volume for the weather conditions at the time of sampling.
    - If dissolved oxygen is measured, the measurements should be taken within one hour of sunrise.
    - Unless specifically requested by the department to do otherwise and noted in the sampling plan, all sampling events should be evenly spaced in time throughout the life of the sampling program.
    - If ammonia is measured, pH and water temperature will be measured at the same time.

[1] For additional information on what constitutes an acceptable quality assurance plan, contact John Ford at john.ford@dnr.mo.gov or 573/751-7024.

- A minimum of 24 samples should be analyzed.
- The monitoring program should be at least 12 months in length. If the monitoring period is atypically wet, the department may require additional monitoring under more typical flow conditions.

5. MAU will review data from the monitoring program and provide Permit Section or the permittee with a document showing all data collected, delineation of the segments(s) analyzed, an analysis of the data and tier determination for each of the POCs analyzed. The review shall also assist in determining whether additional sampling is needed to account for possibly seasonal fluctuations.
6. A POC will be assessed as Tier One if the calculated 90th percentile value: (1) exceeds[2] the water quality standard, or (2) does not exceed the water quality standard but is at least 95% of the water quality standard.[3]

III. Wasteload Allocation Studies

Wasteload allocation (WLA) studies may be conducted to develop water quality-based permit limits to protect water quality to the appropriate anti-degradation tier. It is assumed that most permittees will first use a simple Streeter-Phelps model without supporting water quality data to predict instream DO and BOD values (see *DO Modeling & BOD Effluent Limit Development Administrative Guidance)*. The department will review the input values for this model to insure they are representative for the receiving stream in question. If the result of the Streeter-Phelps model, as approved by the department, indicates that technology-based alternatives to treatment were not attainable, the permittee may elect to conduct more detailed water quality modeling to support the development of a Qual 2K model.

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1. WLA studies should collect data for the following:
    - At least five representative (ripple, run, pool) stream cross-sections shall be measured for each mile of stream included in the WLA study. At each cross-section the width of the wetted channel, average depth, and side slope shall be measured. These measurements should allow calculation of the volume of water in the modeled section of the stream, and with flow measurement, should allow the calculation of average stream velocity.
    - At each sampling location measure flow, water temperature, pH, dissolved oxygen, specific conductance, ammonia-N, Kjeldahl-N, nitrite plus nitrate-N, total phosphorus, and five-day CBOD. Ultimate CBOD should be collected once for each study at three locations: upstream of the outfall, at the outfall, and at the first site downstream from the outfall. Generally, any other analytes for which permit limits or "monitoring only" provisions apply should also be monitored. The department on a case-by-case basis may choose to amend the monitoring plan analyte list by adding other analytes believed to be necessary, or to delete any analytes believed to be unnecessary.

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[2] For dissolved oxygen, an "exceedence" is a value less than the water quality standard. For pH, an "exceedence" is a value outside the range stipulated by the water quality standard.
[3] For pH, any 90th percentile value less than 6.6 or greater than 8.9 will be considered Tier 1.

2. At a minimum, two WLA studies, each 48 hours in duration, should be conducted during the summer at times of relatively low stream flow and when the facility is discharging at least an average volume of effluent for the prevailing weather conditions (dry weather). These two studies can be done during the same summer, but should be separated in time by at least four weeks. Ideally, there would be at least five sampling locations, one just upstream and uninfluenced by the wastewater discharge, the effluent itself, and at least three locations downstream of the effluent discharge beginning between 0.5 and 1.0 miles below the outfall and spaced about 1.0 to 1.5 miles apart (total length may depend on the Streeter Phelps modeling results). The number and exact location of sampling sites may be modified based upon availability of access to the stream and the location of confluence with other streams.
3. Field measurements and sample collection will occur twice daily at all sites with the exception that flow measurement is required only once during the 48-hour study. Morning samples will be collected during the period of one hour before sunrise to one hour after sunrise. Afternoon measurements should be made during the period 12:30 pm to 4:00 pm. An automatic sampler set to collect a 12-hour composite sample may be substituted for the effluent grab sample. Field measurements of the effluent (water temperature, pH, dissolved oxygen, specific conductance) must be made on the effluent stream and not from the composite sample.

IV. Development of Water Quality Models

Non-conservative water quality variables such as water temperature, the various forms of nitrogen, total phosphorus, five-day CBOD, and dissolved oxygen should be modeled with the Qual 2K or another model specifically approved by the department. Conservative water quality variables such as chloride, sulfate, metals and toxic organic compounds that degrade slowly in the environment can be modeled by a steady-state mass balance analysis.

1. For non-conservative variables, the data from the first WLA study should be used to calibrate the model and the data from the second and any subsequent WLAs should be used to adjust the model to obtain the best overall solution fit of model predictions to all of the actual data collected. The verified (final) version of the model, at a minimum, shall model water temperature, dissolved oxygen, five day carbonaceous BOD and the various forms of nitrogen (organic, ammonia, nitrite and nitrate). The model will be used to predict effluent concentrations necessary to meet the appropriate tier designation at the 7Q10 low flow of the receiving stream.
2. Once the modeling is completed, the permittee or the permittee's contractor must provide the department with the following: 1) all the data collected by the WLA studies, 2) input and output files for the calibrated model based on the data from the first WLA study, 3) the input and output files for the model for the verified (final) version of the model based upon all the data from all the WLA studies, 4) input and output files for the recommended effluent limits.

3. The Modeling and Standards Unit will review all WLA data and modeling files and provide comments to the permittee or the permittee's contractor on the acceptability of the model. This review may require adjustment to and or additional simulation runs of the model.
4. For conservative water quality variables, the steady-state mass balance calculations as defined in the EPA's *Technical Support Document for Water Quality-based Toxics Control* must include four variables:
    - One, the 7Q10 low flow of the stream immediately upstream of the discharge. This value has been calculated for several stream locations in Missouri. This data is published in *Missouri Stream and Springflow Characteristics: Low Flow Frequency and Flow Duration*, U.S. Geological Survey Water Resources Report No. 32, J. Skelton, 1976. This publication also includes a procedure for estimating the 7Q10 low flow where this data is not available from actual stream flow measurements. This procedure should be used to estimate the 7Q10 low flow if it cannot be reasonably estimated from the published 7Q10 values at selected sites.
    - Two, the mean, range, 90th percentile concentration of the water quality variable immediately upstream of the effluent discharged, as determined by data obtained during the WLA studies. These data may be supplemented by credible data from other sources that are believed to be representative of water quality in this portion of the stream during dry weather, with the department's approval.
    - Three, the dry weather design flow of the facility that will be allowed in the new permit.
    - Four, the applicable chronic water quality standard for the receiving stream.
5. The Modeling and Standards Unit will review these steady-state mass balance calculations and provide comments to the permittee or the permittee's contractor.