2020 Total Ammonia Nitrogen Criteria Implementation Guidance

Intent

The intent of the 2020 Total Ammonia Nitrogen Criteria Implementation Guidance (guidance) is to establish a procedure for developing ammonia WQBELs for use in renewal operating permits and applicable dischargers. The intent of this guidance is to establish procedures for developing ammonia Water Quality-based Effluent Limits (WQBELs) in Missouri State Operating Permits. The establishment of these procedures does not preclude the Department from implementing alternative derivation approaches on a site-specific basis.

Background

Missouri's Water Quality Standards, amended November 30, 2005, incorporate the U.S. Environmental Protection Agency criteria document "1999 Update of Ambient Water Quality Criteria for Ammonia (EPA/505/2-90-001)" (1999 update). On August 9, 2007, the Missouri Department of Natural Resources implemented its guidance "Total Ammonia Nitrogen Criteria Implementation Guidance (2007 Ammonia Guidance)," which established a procedure for developing water quality based effluent limitations (WQBELs) for ammonia.

This guidance replaces the 2007 Ammonia Guidance. Additionally, this guidance does not implement the US Environmental Protection Agency (EPA) 2013 Aquatic Life Criteria for ammonia (i.e., mollusk ammonia). In the event that the Department amends Missouri's Water Quality Standards to include mollusk ammonia, this guidance will be revised to include the updated ammonia standards.

Rationale for Effluent Limit Calculations

Water quality criteria are developed by EPA under Section 304(a) of the federal Clean Water Act and are designed to be protective of designated uses. Aquatic life protection criteria, such as total ammonia nitrogen, are designated to protect aquatic organisms from acute and chronic toxicity and are based on toxicity testing that measures the pollutant's effect on aquatic organisms. Toxicity test results are then converted into water quality criteria with components of magnitude, duration, and frequency. The magnitude of a criteria is the maximum amount of the pollutant that can be in the aquatic environment before toxicity, either acute or chronic, occurs. The duration of a criteria is the time period that aquatic organisms can be exposed to the pollutant at a given magnitude before toxicity occurs. Acute toxicity criteria are protective of short duration exposure, such as 1-hour or 1-day, while chronic toxicity criteria are protective of longer durations, such as 4 or 30 day periods. The frequency of a criteria is how often the aquatic organisms can be exposed to the magnitude and duration of concern before toxicity occurs. Most toxicity criteria are set at a frequency to not exceed more than once every three years, which is protective of the aquatic life designated use.

Reasonable potential analysis and effluent limit calculations translate acute and chronic toxicity criteria into limitations for discharge that maintain and protect the applicable designated use. EPA documents, such as the "Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001)" (TSD), provide mathematical and statistical calculations to ensure

reasonable potential analyses and effluent limitations protect designated uses. Additionally, the TSD provides a number of options to convert aquatic life protection criteria into effluent limitations. Commonly used approaches for acute and chronic criteria use effluent variability to establish maximum daily limits (MDL) and average monthly limits (AML) for toxics of concern. The underlying premise of these calculations, however, is that the criteria duration (1-day, 4-day, or 30-day) is properly aligned with the criteria development in order to ensure the effluent limitation is protective.

As noted in the 1999 update, the duration of the total ammonia nitrogen acute and chronic criteria are 1-day and 30-days, respectively. This guidance establishes that permit writers apply the acute criteria (1-day duration) as a MDL and the chronic criteria (30-day duration) as an AML. This application is also aligned with the ammonia criteria development document and the duration of the chronic criterion.

Designated Uses:
The effluent limit calculations contained in this guidance are to be administered appropriately to applicable designated uses as established in 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031, Tables B1, B2 and B3.

Ecoregion Default Values for pH and Temperature
Temperature and pH impact the toxicity of ammonia ultimately affecting reasonable potential and limit derivation. Prior to this guidance, the Department utilized statewide default pH and temperature values. This guidance now established default pH and temperature values based on ecoregions. Additionally, pH values are based on the 50^{th} percentile due to the lack of variability in pH data. However, temperature data is based on the 75^{th} percentile due to temperature variability during any given quarter, month, and day. The use of the 50^{th} and 75^{th} percentile reduces compounding conservative assumptions, are protective of Missouri's Water Quality Standards, and are used by other states (e.g., Illinois, Ohio). The ecoregional default values for pH and Temperature are included in the Supplemental Information of this guidance.

Site-Specific Data Usage
Permittees may opt for the use of site-specific pH and temperature data for reasonable potential and effluent limit calculations. In the event that the permittee seeks to use site-specific data, it is the responsibility of the permittee to inform the Department. However, permit writers are encouraged to propose the use of site-specific data, if available.

For the parameter of pH, the 50^{th} percentile will be used to determine either monthly or quarterly values depending on their ammonia monitoring and reporting frequency. For the parameter of temperature, the 75^{th} percentile will be used to determine either monthly or quarterly values depending on their ammonia monitoring and reporting frequency.

If the receiving water body does not provide mixing considerations, then the effluent of the permittee is to be used to determine the site-specific data. If mixing considerations are applicable, then the edge of the Zone of Initial Dilution (ZID) will be used for acute criteria site-specific data and the edge of the mixing zone will be used for chronic criteria site-specific data. All other applicable mixing considerations are to be implemented per regulations.

Reasonable Potential

Federal regulation 40 CFR 122.44(d)(1)(i) requires limitations for all pollutants or pollutant parameters that the Department determines are or may be discharged at a level which will cause, have reasonable potential to cause, or contribute to an excursion above state water quality standards.

The Operating Permit Section will continue to use the two-season approach (summer and winter) for determining reasonable potential. The two-season approach provides protection to receiving waters as it assumes the most protective month as the not-to-exceed value when determining reasonable potential. This approach also allows the maximum number of data points per season reducing the multiplying factor and compounding conservative assumptions. However, upon request by the permittee, permit writers can conduct quarterly or monthly reasonable potential. The monthly and quarterly distribution by seasons is shown below:

Two-Season Distribution

Summer Season		**Winter Season**	
Month	**Quarter**	**Month**	**Quarter**
April	2nd	January	1st
May	2nd	February	1st
June	2nd	March	1st
July	3rd	October	4th
August	3rd	November	4th
September	3rd	December	4th

When conducting reasonable potential, permit writers will account for the affect of pH and temperature on ammonia's criterion maximum concentration (CMC) and criterion continuous concentration (CCC) per the receiving water's protected designated uses as established in 10 CSR 20-7.031 Tables B1, B2, and B3.

Two-Season Reasonable Potential Approach – Quarterly Monitoring

Permittees with quarterly sampling and reporting (i.e., permittees required to sample once per quarter), will have their quarterly Discharge Monitoring Reports (DMR) data distributed into the proper seasons. Permit writers will separate DMR quarterly data into the appropriate season. Permit writers will then conduct reasonable potential for each season based on the most protective monthly ammonia criteria per season, which includes the impact of pH and temperature data. If DMR data shows reasonable potential for a season, then the permit will contain final effluent limits for both quarters in the season. If DMR data does not result in reasonable potential for a season, then the permit will contain monitoring only for both quarters in the season.

Two-Season Reasonable Potential Approach – Monthly Monitoring

Permittees with monthly sampling and reporting (i.e., permittees required to sample once per month), will have their monthly DMR data distributed into the proper seasons. Permit writers will separate DMR monthly data into the appropriate seasons. Permit writers will then conduct reasonable potential for each season based on the most protective monthly ammonia criteria per season, which includes the impact of pH and temperature data. If DMR data shows reasonable

potential for a season, then the permit will contain final effluent limits for all months in the season. If DMR data does not result in reasonable potential for a season, then the permit will contain monitoring only for all months in the season.

Monthly Reasonable Potential

As noted previously, permittees may opt to have monthly reasonable potential conducted in place of the two-season approach. For monthly reasonable potential, permit writers will distribute monthly DMR data based into the applicable calendar month. Permit writers will then conduct reasonable potential for each month based on the individual month's criteria, which includes the impact of pH and temperature data. If DMR data results in reasonable potential for the specific month, then effluent limits will be established for the individual month. If DMR data does not result in reasonable potential for the specific month, then the permit will contain monitoring only for the month.

Quarterly Reasonable Potential

As noted previously, permittees may opt to have quarterly reasonable potential conducted in place of the two-season approach. For quarterly reasonable potential, permit writers will distribute quarterly DMR data based into the applicable quarters. Permit writers will then conduct reasonable potential for each quarter based on the most protective month's criteria in the quarter, which includes the impact of pH and temperature data. If DMR data results in reasonable potential, then effluent limits will be established for the individual quarter. If DMR data does not result in reasonable potential for the quarter, then the permit will contain monitoring only for the quarter.

Effluent Limits Alignment

This guidance establishes that effluent limits for ammonia for MDL and AML are to align with the development of ammonia's CMC and CCC. This approach allows for the direct application of both the CMC (i.e., acute criteria) and CCC (i.e., chronic criteria) as acute and chronic wasteload allocations (WLA), which are subsequently established as permit limits. The CMC or acute WLA is established as the MDL and the CCC or chronic WLA is established as the AML, as shown below:

$CMC = WLA_{acute} = MDL$
$CCC = WLA_{chronic} = AML$

Additionally, because the CMC and CCC are aligned with the development of the criteria (i.e., 1-day and 30-day), variability of the DMR data does not impact effluent derivation. However, variability still impacts reasonable potential. Example effluent limit derivations based on the direct application approach are contained in the Supplemental Information of this guidance.

If permittees may request to have Weekly Average Limits in place of Daily Maximum Limits, which is appropriate. However, the Weekly Average Limits may differ (i.e., more stringent) than the Daily Maximum Limit.

Mixing Considerations

Missouri's Water Quality Standards, 10 CSR 20-7.031(5)(A)4., provide applicability and requirements for Mixing Zones and Zone of Initial Dilution. The direct application of both acute and chronic criteria as WLA is also applicable for facilities that discharge into receiving waterbodies with mixing considerations. The CCC and CMC will need to be calculated into WLA with mixing considerations using the mass-balance equation:

$$Ce = \frac{(Qe + Qs)C - (Qs \times Cs)}{(Qe)}$$

Where C = downstream concentration Ce = effluent concentration
Cs = upstream concentration Qe = effluent flow
Qs = upstream flow

After the WLA for both acute and chronic have been calculated, permit writers will take each acute and chronic WLA and directly apply the values as MDL and AML. This removes the additional effluent limit determinations of calculating acute and chronic Long Term Averages (LTA) and uses the most protective LTA to establish the MDL and AML.

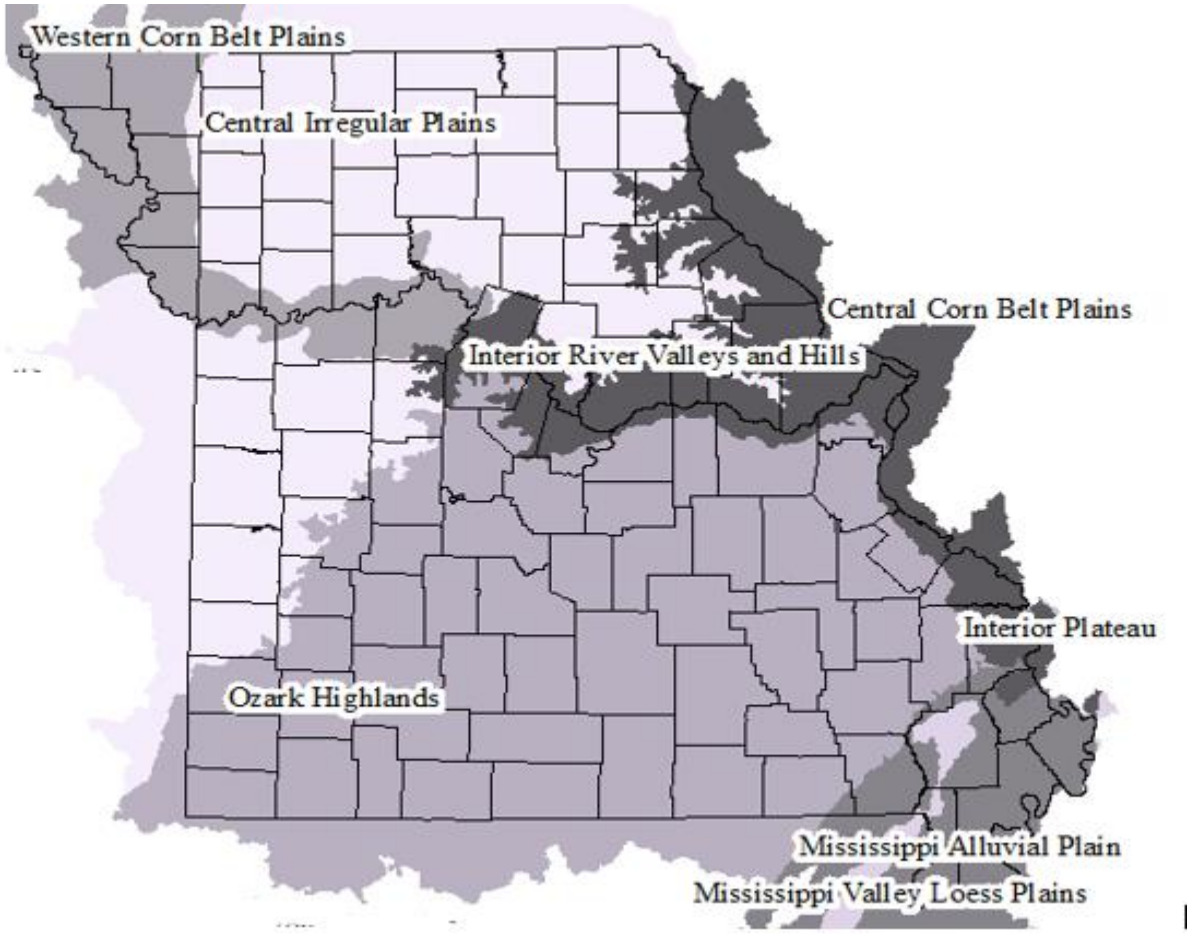
In certain circumstances, utilizing the direct application approach with mixing considerations, the AML calculations can result in a value greater than the MDL. When this circumstance is observed by the permit writer, the permit writer will establish the AML value to equal the MDL value. Example effluent limit derivations based on the direct application approach and mixing considerations are contained in the Supplemental Information of this guidance.

Controlled Discharges

Effluent limits for ammonia as a direct application for permitted facilities utilizing controlled discharges is appropriate. Federal regulation 40 CFR 122.45 defines non-continuous discharges and establishes factors to take into consideration when determining applicability. Using the direct application approach for ammonia effluent limits for controlled discharging facilities, the permit will only contain MDL ammonia effluent limits or monitoring conditions, depending on reasonable potential results. Additionally, facilities utilizing controlled discharges are also subject to mixing considerations based on the receiving waterbody in accordance with 10 CSR 20-7.031(5)(A)4. The assessment regarding the impact of pH and the receiving water's protected designated use also affect the effluent derivation or the determination of limits or monitoring.

SUPPLEMENTAL INFORMATION

Missouri's Ecoregions



Default Monthly Values for pH and Temperature by Ecoregion

Ecoregion Category Description	Calendar Month	Median pH	75th Percentile Temp °C
Central Irregular Plains	January	7.80	2.8
	February	7.90	4.0
	March	7.90	10.6
	April	7.90	17.0
	May	7.80	22.0
	June	7.80	26.0
	July	7.90	28.9
	August	7.80	28.0
	September	7.80	24.1
	October	7.80	17.5
	November	7.80	11.6
	December	7.90	4.9
Ecoregion Category Description	**Calendar Month**	**Median pH**	**75th Percentile Temp °C**
Interior River Valleys and Hills	January	7.80	2.8
	February	7.80	4.4
	March	7.90	9.4
	April	8.00	16.1
	May	7.80	21.0
	June	7.90	26.0
	July	8.00	29.4
	August	8.00	29.3
	September	8.00	25.6
	October	8.00	19.0
	November	8.00	12.0
	December	7.90	6.9
Ecoregion Category Description	**Calendar Month**	**Median pH**	**75th Percentile Temp °C**
Mississippi Alluvial Plain	January	7.6	7.2
	February	7.6	7.0
	March	7.6	12.5
	April	7.7	17.95
	May	7.4	22.0
	June	7.7	26.4
	July	7.7	29.3
	August	7.8	29.2
	September	7.7	26.08
	October	7.9	19.1
	November	7.6	14.0
	December	7.7	8.0

Default Monthly Values for pH and Temperature by Ecoregion (continued)

Ecoregion Category Description	Calendar Month	Median pH	75th Percentile Temp °C
Ozark Highlands	January	7.8	8.1
	February	7.9	9.3
	March	7.8	13.0
	April	7.8	16.7
	May	7.8	20.0
	June	7.8	24.0
	July	7.8	26.6
	August	7.8	26.5
	September	7.8	23.5
	October	7.8	18.0
	November	7.8	14.0
	December	7.8	10.0
Ecoregion Category Description	**Calendar Month**	**Median pH**	**75th Percentile Temp °C**
Western Corn Belt Plains	January	8.0	2.25
	February	8.0	2.7
	March	8.0	9.05
	April	8.1	15.8
	May	8.0	20.3
	June	8.1	26.0
	July	8.1	28.8
	August	8.0	28.1
	September	8.1	23.58
	October	8.1	16.1
	November	8.0	10.28
	December	8.0	4.0

Default Quarterly Values for pH and Temperature by Ecoregion

Ecoregion Category Description	Calendar Qtr	Median pH	75th Percentile Temp °C
Central Irregular Plains	1	7.90	6.9
	2	7.80	23.5
	3	7.80	27.8
	4	7.80	14.0
Ecoregion Category Description	**Calendar Qtr**	**Median pH**	**75th Percentile Temp °C**
Interior River Valleys and Hills	1	7.80	7.4
	2	7.90	24.0
	3	8.00	28.6
	4	8.00	15.9

Default Quarterly Values for pH and Temperature by Ecoregion (continued)

Ecoregion Category Description	Calendar Qtr	Median pH	75th Percentile Temp °C
Mississippi Alluvial Plain	1	7.6	10.0
	2	7.6	23.4
	3	7.7	28.5
	4	7.7	15.0
Ecoregion Category Description	**Calendar Qtr**	**Median pH**	**75th Percentile Temp °C**
Ozark Highlands	1	7.8	11.0
	2	7.8	21.2
	3	7.8	26.0
	4	7.8	15.5
Ecoregion Category Description	**Calendar Qtr**	**Median pH**	**75th Percentile Temp °C**
Western Corn Belt Plains	1	8.0	6.6
	2	8.0	22.5
	3	8.1	27.7
	4	8.0	13.4

Examples Effluent Limits

Example 1:
POTW with quarterly monitoring/reporting, reasonable potential for both seasons, located in the Mississippi Alluvial Plain Ecoregion, warm-water receiving stream with early life stages present, and no mixing considerations.

Quarter	pH	Temp. °C	MDL mg/L	AML mg/L
1	7.6	10.0	17.0	3.9
2	7.6	23.4	17.0	2.2
3	7.7	28.5	14.4	1.4
4	7.7	15.0	14.4	3.5

MDL per 10 CSR 20-7.031, Table B1, and AML per 10 CSR 20-7.031, Table B3
For controlled discharging facilities, only MDL limits would apply.

Example 2:
Same POTW and factors except for reasonable potential. This example shows the POTW only has reasonable potential during the summer seasons, and no mixing considerations.

Quarter	pH	Temp. °C	MDL mg/L	AML mg/L
1	7.6	10.0	17.0	3.9
2	7.6	23.4	17.0	*
3	7.7	28.5	14.4	*
4	7.7	15.0	14.4	3.5

MDL per 10 CSR 20-7.031, Table B1, and AML per 10 CSR 20-7.031, Table B3
For controlled discharging facilities, only MDL limits would apply.
* - Monitoring only

Example 3:
POTW with monthly monitoring/reporting, reasonable potential for both seasons, located in the Ozark Highlands Ecoregion, warm-water receiving stream with early life stages present, and no mixing considerations.

Month	pH	Temp. °C	MDL mg/L	AML mg/L
January	7.8	8.1	12.1	3.1
February	7.9	9.3	10.1	2.7
March	7.8	13.0	12.1	3.1
April	7.8	16.7	12.1	2.7
May	7.8	20.0	12.1	2.2
June	7.8	24.0	12.1	1.7
July	7.8	26.6	12.1	1.5
August	7.8	26.5	12.1	1.3
September	7.8	23.5	12.1	1.8
October	7.8	18.0	12.1	2.5
November	7.8	14.0	12.1	3.1
December	7.8	10.0	12.1	3.1

MDL per 10 CSR 20-7.031, Table B1, and AML per 10 CSR 20-7.031, Table B3
For controlled discharging facilities, only MDL limits would apply.

Example 4:
POTW with monthly monitoring/reporting, reasonable potential for both seasons, located in the Mississippi Alluvial Plain Ecoregion, warm-water receiving stream with early life stages present, mixing considerations applicable (default), and Design flow = 0.5 cfs, Default Mixing used for example.

Permit writers will need to first determine the monthly CMC and CCC prior to determining limits subject to mixing considerations.

Month	pH	Temp. °C	CMC mg/L	CCC mg/L
January	7.6	7.2	17.0	3.1
February	7.6	7.0	17.0	2.7
March	7.6	12.5	17.0	3.1
April	7.7	17.95	14.4	2.8
May	7.4	22.0	23.0	1.9
June	7.7	26.4	14.4	1.5
July	7.7	29.3	14.4	1.2
August	7.8	29.2	12.1	1.2
September	7.7	26.08	14.4	1.7
October	7.9	19.1	10.1	2.3
November	7.6	14.0	17.0	3.1
December	7.7	8.0	14.4	3.1

CMC per 10 CSR 20-7.031, Table B1, and CCC per 10 CSR 20-7.031, Table B3
For controlled discharging facilities, only CMC values would apply.

Example 4 (continued)

After determining the CMC and CCC, permit writers will then subject the monthly values to the mass-balance equation.

Receiving Stream Low-Flow Values

Receiving Stream	Low-Flow Values (CFS)*	
	1Q10	30Q10
Stream Name	0.1	1.0

* - 7Q10 is not used for ammonia derivation

Mixing Consideration

Mixing Zone (CFS)		Zone of Initial Dilution (CFS)	
1Q10	30Q10	1Q10	30Q10
0.025	0.25	0.0025	NA

$$Ce = \frac{(Qe + Qs)C - (Qs \times Cs)}{(Qe)}$$

Where C = downstream concentration Ce = effluent concentration
Cs = upstream concentration Qe = effluent flow
Qs = upstream flow

January
Chronic WLA: $C_e = ((0.5 + 0.25)3.1 – (0.25 * 0.01)) / 0.5$
$C_e = 4.6$ mg/L

Acute WLA: $C_e = ((0.5 + 0.0025)17.0 – (0.0025 * 0.01)) / 0.5$
$C_e = 17.1$ mg/L

Acute WLA = 17.1 mg/L = MDL
Chronic WLA = 4.6 mg/L = AML

Using the example for January, permit writers will use the process of using applicable monthly CMC and CCC criterion for acute WLA and chronic WLA for all months corresponding to MDL and AMLs respectively.

Example 4 (continued)

Month	MDL mg/L	AML mg/L
January	17.1	4.6
February	17.1	4.0
March	17.1	4.6
April	14.4	3.7
May	23.1	2.8
June	14.1	2.2
July	14.4	1.8
August	12.1	1.8
September	14.4	2.5
October	10.1	3.4
November	17.1	4.6
December	14.4	4.6

For controlled discharging facilities, only MDL limits would apply.