Missouri
Department of
Natural Resources

7.031 (5) Specific Criteria

(N) Nutrients and Chlorophyll.
1. Definitions.
A. For the purposes of this rule, *[—*
(I) A] **a**ll lakes and reservoirs shall be referred to as "lakes".*[; and*
(II) Only total phosphorus (TP) criteria are derived from lake characteristics. Total nitrogen (TN) and chlorophyll (Chl) criteria are determined as a function of TP criteria.]
B. Lake ecoregions—Due to differences in **watershed** topography, soils, and geology, nutrient criteria f or lakes and reservoirs will be determined by the use of four (4) major ecoregions **based upon dominant watershed ecoregion.** These regions were delineated by grouping the ecological subsections described in Nigh and Schroeder, 2002, *Atlas of Missouri Ecoregions*, *[Missouri Department of Conservation]* as follows:
(I) Plains: **OP1 – Scarped Osage Plains: OP2 – Cherokee Plains;** TP2—Deep Loess Hills; TP3—Loess Hills; TP4—Grand River Hills; TP5—Chariton River Hills; TP6—Claypan Till Plains; TP7—Wyaconda River Dissected Till Plai ns; TP8—Mississippi River Hills;
(II) Ozark Border: MB2a—Crowley's Ridge Loess Woodl and/Forest Hills; OZ11—Prairie Ozark Border; OZ12—O uter Ozark Border; OZ13—Inner Ozark Border;
(III) Ozark Highland: OZ1—Springfield Plain; OZ2—Sp ringfield Plateau; OZ3—Elk River Hills; OZ4—White R iver Hills; OZ5—Central Plateau; OZ6—Osage River Hills; OZ7—Gas conade River Hills; OZ8—Meramec River Hills; OZ9—Cu rrent River Hills; OZ10—St. Francois Knobs and Basins; OZ 14—Black River Ozark Border; and
(IV) Big River Floodplain: MB1—Black River Alluvial Plain; MB2b—Crowley's Ridge Footslopes and Alluvia l Plains; MB3—St. Francis River Alluvial Plain; MB4, OZ16, TP9—Mi ssissippi River Alluvial Plain; OZ15, TP1—Missouri River Alluvial Plain.
C. Nutrient Criteria—**The following nutrient criteria represent the desi red condition for a water body necessary to protect the designated uses assigned in rule:**
[(I) Prediction value—A TP concentration that is de rived from the characteristics of a lake including dam height in feet, hydraulic residence time in years, and percentage of the watershed that was historically covered by prairie grasses. Prediction values for total phosphorus are calculated directly from these characteristics.
(II) Reference value—A TP concentration that is rep resentative of lakes within an ecoregion having the following characteristics:
(a) Less than twenty percent (20%) of the watershed is in crop land and urban land combined;
(b) There are no point source wastewater discharges and no concentrated animal feeding operations within the watershed;
(c) In the Plains region, more than fifty percent (50%) of the watershed is in grass land; and
(d) In the Ozark Highlands region, more than fifty percent (50%) of the watershed is in woodland.]
(I) Lake Ecoregion Criteria – Maximum Ambient Concentration of Chlorophyll-a (Chl-a) that is based on the geometric mean of a minimum of three (3) years of data for lakes within a lake ecoregion that have not been assigned site-specific criteria.
[(III) Site-specific value—A TP concentration for a lake that has been identified as having trophic characteristics for which the reference of the ecoregion and the prediction values for that water body are not adequate to prevent deterioration of water quality. Site-specific criteria are applicable to lakes having a geometric mean TP concentration equal to or less than the 10th percentile value of the range of geometric mean TP concentrations measured in reference lakes within a lake ecoregion. Site-specific criteria are also applicable to lakes with actual TP geometric mean concentrations that are at or below the reference value where the prediction value is at or below the 10th percentile for TP geometric mean concentrations within a lake ecoregion. The 10th percentile values for each ecoregion are listed in Table L and lakes with site-specific criteria are listed in Tables M and N.]
(II) Lake Site-Specific Criteria – Maximum Ambient Concentrations of total phosphorus (TP), total nitrogen (TN), or Chl-a that are based on the geometric mean of a minimum of three (3) years of data and the unique characteristics of the waterbody.
D. Nutrient Screening Values—The following nutrien t screening values represent nutrient concentrations that, over time, set the potential to threaten the designated uses assigned in rule:
(I) Long-Term Screening Value – Maximum Ambient Concentrations of TP, TN, and Chl-a that are based on the geometric mean of a minimum of three (3) years of nutrient data.
(II) Short-Term Screening Value – Maximum Ambient Concentrations of TP, TN, and Chl-a that are based on the geometric mean of one (1) year of nutrient data.

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(III) Long-Term Lake Site-Specific Screening Values – Maximum Ambient Concentrations of TP, TN, or Chl-a that are based on the geometric mean of a minimum of three (3) years of data and the unique characteristics of the waterbody.
(IV) Short-Term Lake Site-Specific Screening Values – Maximum Ambient Concentrations of TP, TN, or Chl-a that are based on the geometric mean of one (1) year of nutrient data and the unique characteristics of the waterbody.

E. Tributary arm—A substantial segment of a *[n]* **Class** L2 lake that is primarily recharged by a source or sources other than the main channel of the lake.

2. This rule applies to all lakes *[and reservoirs]* that are waters of the state and *[that are outside the Big River Floodplain ecoregion and]* have an area of at least ten (10) acres during norm al pool **condition**. **Big River Floodplain lakes shall not be subject to these criteria.**

3. **Lake Ecoregion Criteria and Long-Term and Short-Ter m Screening Values for TP, TN, and Chl-a are listed in Table L. Lake Site-Specific Criteria for TP, TN, a nd Chl-a are listed in Table M. Additional lake si te-specific criteria and screening values may be developed in accordance with subsection (5)(S) to account for the unique c haracteristics of the waterbody that affect trophic status, such as l ake morphology, hydraulic residence time, temperatu re, internal nutrient cycling, or watershed contribution from multiple ecoregions. TP criteria for tributary arms of Class L2 lakes are listed in Table N .** *[Nutrient criteria for lakes and reservoirs with si te-specific criteria are listed in Tables M and N. Nutrient criteria for other lakes are as follows:*

A. Total phosphorus (TP)—

(I) For lakes in which the TP prediction value or the actual TP concentration does not exceed the reference value listed in Table L, the TP criterion shall be the reference value, except as described below;

(II) For lakes in which the TP prediction value does not exceed the reference value, and the actual TP value does not exceed the prediction value, the TP criterion shall be the prediction value;

(III) For lakes in which the TP prediction value and the actual TP concentration exceed the reference value listed in Table L, the TP criterion shall be limited to the prediction value; and

(IV) Site-specific TP criteria for the tributary arms of L2 lakes are listed in Table N;

B. Total nitrogen (TN)—

(I) For lakes in which the TP prediction value does not exceed the reference value listed in Table L, TN concentration shall be limited to twenty (20) times the TP reference value;

(II) For lakes in which the TP prediction value does not exceed the reference value, and the actual TP value does not exceed the prediction value, TN concentration shall be limited to twenty (20) times the TP prediction value;

(III) For lakes in which the TP prediction value exceeds the TP reference value listed in Table L, TN concentration shall be limited to twenty (20) times the TP prediction value; and

(IV) This portion of the rule does not apply to lakes that are held to site-specific criteria for TP, TN, and Chl, as listed in Tables M and N; and

C. Chlorophyll (Chl)—Chl criteria shall be calculat ed from TP criteria as follows:

(I) Plains: Chl:TP = 0.44;

(II) Ozark Border and Ozark Highlands: Chl:TP = 0.42; and

(III) This portion of the rule does not apply to lakes that are held to site-specific criteria for TP, TN, and Chl, as listed in Tables M and N.]

4. All TP, TN, and **Chl-a** concentrations must be calculated as the geometric mean of a minimum of four (4) representative samples per year for **three (3) years for purposes of comparison to criteria and long-ter m screening values.** ***[four (4) years that are not necessarily consecutive]*. All TP, TN, and Chl-a concentrations must be calc ulated as the geometric mean of a minimum of four (4) representative samples per year for one (1) year for purposes of comparison to sho rt-term screening values.** All samples must be collected from the **lake** surface, near the outflow end of the lake, and dur ing the period May 1– **September 30** *[August 31]*.

5. Lakes with water quality that exceed Nutrient Criteria identified in Tables L and M are to be deemed impaired for excess nutrients.

6. Lakes with water quality that exceed long-term or short-term screening values for Chl-a, TN, or TP will be assessed for impairment using a weight of evidence evaluation. Weight of evidence factors for aquatic life uses include: a) occurrence of eutrophication related fish mortality or morbidity events, b) epilimnetic excursions from dissolved oxygen or pH criteria, and c) excessive levels of mineral turbidity that consistently limit algal productivity during the period May 1 – September 30. Weight of evidence factors for drinking water supply uses include: a) impacts on water treatment operations due to eutrophication including excessive disinfection byproduct formation or unacceptable aesthetics, and b) reoccurring algal toxins in excess of guideline values found in the 4th edition of the World Health Organization's Guidelines for Drinking-water Quality.

7. Lakes with water quality that exceed long-term or short-term Screening values for Chl-a, TN, or TP for which the weight of evidence as described in paragraph 6 of this rule does not clearly indicate impairment or lack of impairment will receive continued observation and monitoring until such time as a determination can be made concerning their impairment status.

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[Table L: Total Phosphorus (TP) Criteria for Classified Lakes

Lake Ecoregion TP	*Reference Value (µg/L)*	*TP Prediction Value (µg/L) (1)*	*TP 10th Percentile Reference Value for Site Specific Criteria (µg/L)*
Plains	*58*	*a/4 + 16/b + 570/c*	*20*
Ozark Border	*41*	*15 + 740/c*	*16*
Ozark Highland	*26*	*5 + 740/c*	*9*

(1) Coefficients: a = percentage of watershed originally in prairie (0 to 100); b = hydraulic residence time in years; c = dam height in feet]

Table L: Lake Ecoregion Nutrient Criteria and Long-Term and Short-Term Screening Values (µg/L)

Lake Ecoregion	**Chl-a Criterion**	**Short-Term Screening Value**			**Long-Term Screening Value**		
		TP	**TN**	**Chl-a**	**TP**	**TN**	**Chl-a**
Plains (DWS)	**26**	**65**	**1,000**	**26**	**26**	**560**	**10**
Plains (AQL)	**40**	**100**	**1,300**	**40**	**50**	**850**	**20**
Ozark Border (DWS)	**26**	**70**	**1,000**	**26**	**29**	**600**	**10**
Ozark Border (AQL)	**22**	**60**	**960**	**22**	**26**	**580**	**9.0**
Ozark Highland (DWS)	**26**	**52**	**1,000**	**26**	**24**	**550**	**10**
Ozark Highland (AQL)	**15**	**34**	**700**	**15**	**18**	**430**	**7.0**

Table M: *[Lakes with]*Site-Specific **Nutrient** Criteria

Lake Ecoregion	Lake	County	Site-Specific Criteria (µg/L)		
			TP	TN	Chl-**a**
Plains	Bowling Green Lake	Pike	21	502	6.5
	Bowling Green Lake (old)	Pike	31	506	5.0
	Forest Lake	Adair	21	412	4.3
	Fox Valley Lake	Clark	17	581	6.3
	Hazel Creek Lake	Adair	27	616	6.9
	Lincoln Lake – Cuivre River State Park	Lincoln	16	413	4.3
	Marie, Lake	Mercer	14	444	3.6
	Nehai Tonkaia Lake	Chariton	15	418	2.7
	Viking, Lake	Daviess	25	509	7.8
	Waukomis Lake	Platte	25	553	11.0
	Weatherby Lake	Platte	16	363	5.1
Ozark Border	Goose Creek Lake	St Francois	12	383	3.2
	Wauwanoka, Lake	Jefferson	12	384	6.1
Ozark Highlands	Clearwater Lake	Wayne-Reynolds	13	220	2.6
	Council Bluff Lake	Iron	7	229	2.1
	Crane Lake	Iron	9	240	2.6
	Fourche Lake	Ripley	9	236	2.1
	Loggers Lake	Shannon	9	200	2.6
	Lower Taum Sauk Lake	Reynolds	9	203	2.6

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	Noblett Lake	Douglas	9	211	2.0
	St. Joe State Park Lakes	St Francois	9	253	2.0
	Sunnen Lake	Washington	9	274	2.6
	Table Rock Lake	Stone	9	253	2.6
	Terre du Lac Lakes	St Francois	9	284	1.7
	Timberline Lakes	St Francois	8	276	1.5

Table N: Total Phosphorus Criteria in Tributary Arms of Major *[Reservoirs]* **Lakes**

Reservoir	Tributary Arm	Sample Site (dec. deg.)		TP (µg/L)
		Latitude	Longitude	
Ozarks, Lake of the	Grand Glaize	38.11	-92.664	26
	Gravois	38.245	-92.745	26
	Niangua	38.071	-92.822	26
Table Rock Lake	James River	*[36.678]* **36.6775**	*[-93.535]* **-93.5353**	*[16]* **22**
	Kings River	*[36.576]* **36.5647**	*[-93.596]* **-93.5972**	18
	Long Creek	*[36.557]* **36.5256**	*[-93.294]* **-93.3021**	*[12]* **14**

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