Version 5.9

Montana Department of
ENVIRONMENTAL QUALITY

DEPARTMENT CIRCULAR

DEQ-12, PARTS A and B

Montana Base Numeric Nutrient Standards and Nutrient Standards Variances

GENERAL INTRODUCTION

This circular contains information pertaining to the base numeric nutrients standards (§75-5-103[2], MCA) and their implementation. It is divided into **Parts A** and **B**. **Part A** contains the water quality standards including concentration limits, where they apply, and their period of application. **Part A** is adopted by the Board of Environmental Review under its rulemaking authority in §75-5-301(2), MCA.

Part B contains information about variances from the base numeric nutrient standards. This includes effluent treatment requirements associated with general nutrient standards variances, as well as effluent treatment requirements for individual nutrient standards variances and to whom these apply. **Part B** also contains the Department's definition of the total nitrogen (TN) and total phosphorus (TP) concentrations achievable at the limits of technology. Unlike **Part A**, **Part B** is not adopted by the Board of Environmental Review; **Part B** is adopted by the Department following its formal rule making process, pursuant to §75-5-313, MCA.

The Department has reviewed a considerable amount of scientific literature and has carried out scientific research on its own in order to derive the base numeric nutrient standards (see **References** in **Part A**). Because many of the base numeric nutrient standards are stringent and may be difficult for MPDES permit holders to meet in the short term, Montana's legislature adopted laws (e.g., §75-5-313, MCA) allowing for the achievement of the standards over time. This approach should allow time for nitrogen and phosphorus removal technologies to improve and become less costly, and to allow time for nonpoint sources of nitrogen and phosphorus pollution to be better addressed.

Circular DEQ-12, PART A

OCTOBER 2011 EDITION

1.0 Introduction

Elements comprising Circular DEQ-12, **Part A** are found below. These elements are adopted by the Montana Board of Environmental Review. The nitrogen and phosphorus concentrations provided here have been set at levels that should prevent instream exceedences of other surface water quality standards. The nitrogen and phosphorus concentrations also reflect the intent of the narrative standard at ARM 17.30.637(1)(e), and will preclude the need for case-by-case interpretations of the narrative standard.

1.1 Definitions

1. **Ecoregion** means mapped regions of relative homogeneity in ecological systems, derived from perceived patterns of a combination of causal and integrative factors including land use, land surface form, potential natural vegetation, soils, and geology. See also, endnote 1.

2. **Large river** means a perennial waterbody which has, during summer and fall baseflow (August 1 to October 31 each year), a wadeability index (product of river depth [in feet] and mean velocity [in ft/sec]) of 7.24 ft^2/sec or greater, a depth of 3.15 ft or greater, or a baseflow annual discharge of 1,500 ft^3/sec or greater. See also, endnote 4.

3. **Total nitrogen** means the sum of all nitrate, nitrite, ammonia, and organic nitrogen, as N, in an unfiltered water sample. Total nitrogen in a sample may also be determined via persulfate digestion, or as the sum of total kjeldahl nitrogen plus nitrate plus nitrite.

4. **Total phosphorus** means the sum of orthophosphates, polyphosphates, and organically bound phosphates, as P, in an unfiltered water sample. Total phosphorus may also be determined directly by persulfate digestion.

5. **Wadeable stream** means a perennial or intermittent stream in which most of the wetted channel is safely wadeable by a person during baseflow conditions.

2.0 Base Numeric Nutrient Standards

Table 12A-1 below shows the base numeric nutrient standards for Montana's wadeable streams and large rivers. Details on how these standards were derived can be found mainly in Addendum 1 of Suplee et al. (2008). Standards for wadeable streams are sub-grouped by ecoregion, either by level III (coarse scale) or level IV (fine scale). There is also a list of wadeable streams with reach-specific standards; these waterbodies have characteristics disimilar from those of the ecoregions in which they reside and have therefore been provided more specifically-applicable standards. **For the wadeable streams, the standards should be applied in this order: reach specific (if applicable) then level IV ecoregion (if applicable) then level III ecoregion.**

Table 12A-2 shows the base numeric nutrient standards for Montana's lakes and reservoirs. For lakes, these are sub-grouped by ecoregion, either by level III (coarse scale) or level IV (fine scale). Also listed are lakes with specific standards; these waterbodies have characteristics disimilar from those of the ecoregions in which they reside and have therefore been provided more specifically-applicable standards. Reservoir standards are developed case-by-case and are therefore all individually listed. **For the lakes, the standards should be applied in this order: lake specific (if applicable) then level IV ecoregion (if applicable) then level III ecoregion.**

Table 12A-1. Draft numeric nutrient standards for wadeable stream and large rivers. **This table is not yet complete and values will change.**

Waterbodies Criteria Apply to	Level III Ecoregion[1] (number)	Level IV Ecoregion[1] (number)	Period of Application	Numeric Nutrient Standard[2]		Related Assessment Information[3]
				Total P (μg/L)	Total N (μg/L)	
Wadable Streams-Reach Specific:						
Flint Creek (Georgetown Lake outlet to Clark Fork River	n/a	n/a	July 1-Sept 30	[]	[]	120 mg Chla/m^2 or 35 g AFDM/m^2
Clark Fork River from below the Warm Springs Creek confluence (46.1881, -112.7680) to the Bitterroot River confluence	n/a	n/a	July 1-Sept 30	20	300	100 mg Chl*a* /m^2 (summer mean); 150 mg Chl*a* /m^2 (summer maximum)
Wadeable Streams-by ecoregion:						
	Northern Rockies (15)		July 1-Sept 30	25	300	120 mg Chla/m^2 or 35 g AFDM/m^2
	Canadian Rockies (41)		July 1-Sept 30	25	300	120 mg Chla/m^2 or 35 g AFDM/m^2
	Middle Rockies (17)		July 1-Sept 30	30	300	120 mg Chla/m^2 or 35 g AFDM/m^2
		Absaroka -Gallatin Volcanic Mountains (17i)	July 1-Sept 30	130	250	120 mg Chla/m^2 or 35 g AFDM/m^2
	Idaho Batholith (16)		July 1-Sept 30	30	300	120 mg Chla/m^2 or 35 g AFDM/m^2
	Northwestern Glaciated Plains (42)		June 16-Sept 30	120	1100	
	Northwestern Great Plains (43)		July 1-Sept 30	120	1000	
		Non-calcareous Foothill Grassland (43s)	July 1-Sept 30	30	300	120 mg Chla/m^2 or 35 g AFDM/m^2
		Limy Foothill Grassland (43u)	July 1-Sept 30	35	350	120 mg Chla/m^2 or 35 g AFDM/m^2
Large Rivers [4]***:***						
Yellowstone River (Unit 3; Bighorn River confluence to Powder River confluence)	n/a	n/a	Aug 1 -Oct 31	90	700	
Yellowstone River (Unit 4; Powder River confluence to stateline)	n/a	n/a	Aug 1 -Oct 31	140	1000	
Clark Fork River from the Bitterroot River confluence to the Flathead River confluence	n/a	n/a	July 1-Sept 30	20	300	100 mg Chl*a* /m^2 (summer mean); 150 mg Chl*a* /m^2 (summer maximum)

[1] See endnote 1
[2] See endnote 2
[3] See endnote 3
[4] See endnote 4

12A-2. Numeric nutrient standards for lakes and reservoirs. **This table is not yet complete.**

Waterbodies Criteria Apply to	Level III Ecoregion[1] (number)	Level IV Ecoregion[1] (number)	Period of Application	Numeric Nutrient Standard[5]: Total P (µg/L)	Numeric Nutrient Standard[5]: Total N (µg/L)	Related Assessment Information[6]
Lakes-specific lakes:						
Flathead Lake	n/a	n/a	Year-round	[]	[]	Phytoplankton [] µg/l
Lakes-by ecoregion:						
	Middle Rockies (17)		Year-round	[]	[]	Phytoplankton [] µg/l
	Northern Rockies (15)		Year-round	[]	[]	Phytoplankton [] µg/l
	Canadian Rockies (41)		Year-round	[]	[]	Phytoplankton [] µg/l
	Idaho Batholith (16)		Year-round	[]	[]	Phytoplankton [] µg/l
Reservoirs						

[1] See endnote 1
[5] See endnote 5
[6] See endnote 6

2.1 Required Reporting Values for Base Numeric Nutrient Standards

Table 12A-3 presents the required reporting values for total phosphorus and total nitrogen measurements used to conform with the base numeric nutrient standards in this circular.

Table 12A-3. Required reporting values[a] for total nitrogen and phosphorus measurements. **RRVs for these compounds are currently under review and will change.**

Nutrient		Method of Measurement	Required Reporting Value
Total phosphorus		Persulfate digestion	3 µg/L
Total nitrogen		Persulfate digestion	40 µg/L
Total nitrogen	Sum of:	(a) total kjeldahl nitrogen	150 µg/L
		(b) nitrate + nitrite	See RRVs below
Nitrate- as N			20 µg/L
Nitrite- as N			10 µg/L
Nitrate + Nitrite-as N			20 µg/L

[a] See definition for required reporting values found in footnote 19 of Department Circular DEQ-7.

2.2 Developing Permit Limits for Base Numeric Nutrient Standards

For total nitrogen and total phosphorus, the critical low-flow for the design of disposal systems shall be based on the seasonal 14Q10 of the receiving water (see ARM 17.30.635[4]). When developing permit limits for base numeric nutrient standards, the Department will use an average monthly limit (AML) only, using methods appropriate for criterion continuous concentrations (i.e., chronic concentrations). Permit limits will be established using a value corresponding to the 95th percentile probability distribution of the effluent. The Department shall use methods that are appropriate for criterion continuous concentrations which are found in the document "*Technical Support Document for Water Quality-based Toxics Control*", Document No. EPA/505/2-90-001, United States Environmental Protection Agency, 1991.

3.0 Endnotes

(1) Ecoregions are based on the 2009 version (version 2) of the U.S. Environmental Protection Agency maps. These can be found at: http://www.epa.gov/wed/pages/ecoregions/mt_eco.htm . For Geographic Information System (GIS) use within DEQ, the GIS layers may be found at: L:\DEQ\Layers\Ecoregions.lyr

(2) No wadeable stream or large river referenced in **Table12A-1** shall have an average concentration that exceeds the values shown based upon a monthly (30-day) period.

(3) Algae density values refer to bottom-attached (benthic) algal chlorophyll *a* (Chl*a*) or ash free dry mass (AFDM) per square meter of stream bottom. These values are the arithmetic mean of between 10 and 20 replicates of benthic algae collected from a site during a sampling event. A site is a stream reach ≥ 100 m length or, for large rivers, may be a transect perpendicular to flow. For wadeable streams and large rivers, algae replicates must be collected in wadeable zones (depth ≤ 1 m) using a randomized approach or other, unbiased systematic approaches. Chl*a* and AFDM are used to assess the biomass of algae accumulated on the stream bottom; algae is stimulated by excess nitrogen and phosphorus levels and has been associated with impacts to recreational uses and impacts to stream dissolved oxygen levels, for example.

In the case of the Clark Fork River, the maximum summer algae value is the single greatest of any of the monthly means of the Chl*a* values at a given site. Therefore, there is only one month each summer representing the maximum. The summer mean is the arithmetic mean of the set of all replicates collected at a site during a given summer.

(4) **Table F-4** below shows the beginning and ending locations for large rivers in Montana.

Table F-4. Large river segments within the state of Montana.

River Name	Segment Description
Big Horn River	Yellowtail Dam to mouth
Clark Fork River	Bitterroot River to state-line
Flathead River	Origin to mouth
Kootenai River	Libby Dam to state-line
Madison River	Ennis Lake to mouth
Missouri River	Origin to state-line
South Fork Flathead River	Hungry Horse Dam to mouth
Yellowstone River	State-line to state-line

(5)) No lake or reservoir referenced in **Table12A-2** shall have an average concentration that exceeds the values shown based upon a monthly (30-day) period. The Department will determine on a case-by-case basis whether or not a permitted discharge to a stream or river is likely to be impacting a lake or reservoir. If yes, the permittee would be expected to meet its average monthly limit year round.

(6) Lake algae concentrations are expressed as micrograms chlorophyll *a* per L.

4.0 References

The following are citations for key scientific and technical literature used to derive the base numeric nutrient standards. This is not a complete list; rather, it contains the most pertinent citations. Many other articles and reports were reviewed during the development of the standards.

Biggs, B.J.F., 2000. New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment in Streams. Prepared for the New Zealand Ministry of the Environment, Christchurch, 122 p.

Dodds, W.K., V.H. Smith, and B. Zander, 1997. Developing Nutrient Targets to Control Benthic Chlorophyll Levels in Streams: A Case Study of the Clark Fork River. Water Research 31: 1738-1750.

Dodds, W.K., V.H. Smith, and K. Lohman, 2002. Nitrogen and Phosphorus Relationships to Benthic Algal Biomass in Temperate Streams. Canadian Journal of Fisheries and Aquatic Sciences 59: 865-874.

Dodds, W.K, V.H. Smith, and K. Lohman, 2006. Erratum: Nitrogen and Phosphorus Relationships to Benthic Algal Biomass in Temperate Streams. Canadian Journal of Fisheries and Aquatic Sciences 63: 1190-1191.

Elser, J.J., M.E.S. Bracken, E.E. Cleland, D.S. Gruner, W.S. Harpole, H. Hillebrand, J.T. Ngai, E.W. Seabloom, J.B. Shurin, and J.E. Smith, 2007. Global Analysis of Nitrogen and Phosphorus Limitation of Primary Producers in Freshwater, Marine and Terrestrial Ecosystems. Ecology Letters 10: 1135-1142.

Flynn, K., and M.W. Suplee, 2010. Defining Large Rivers in Montana using a Wadeability Index. Helena, MT: Montana Department of Environmental Quality, 14 p.

Flynn, K., and M.W. Suplee, 2011. *Draft*. Using a Computer Water Quality Model to Derive Numeric Nutrient Criteria. Lower Yellowstone River, MT. WQPBMSTECH-22. Helena, MT: Montana Department of Environmental Quality, 274 p plus appendices.

McCarthy, P.M., 2005. Statistical Summaries of Streamflow in Montana and Adjacent Areas, Water years 1900 through 2002. U.S. Geological Survey Scientific Investigations Report 2004-5266, 317 p.

Omernik, J.M., 1987. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers 77: 118-125.

Smith, R.A., R.B. Alexander, and G.E. Schwarz, 2003. Natural Background Concentrations of Nutrients in Streams and Rivers of the Conterminous United States. Environmental Science and Technology 37: 3039-3047.

Sosiak, A., 2002. Long-term Response of Periphyton and Macrophytes to Reduced Municipal Nutrient Loading to the Bow River (Alberta, Canada). Canadian Journal of Fisheries and Aquatic Sciences 59: 987-1001.

Stevenson, R.J, S.T. Rier, C.M. Riseng, R.E. Schultz, and M.J. Wiley, 2006. Comparing Effects of Nutrients on Algal Biomass in Streams in Two Regions with Different Disturbance Regimes and with Applications for Developing Nutrient Criteria. Hydrobiologia 561: 149-165.

Suplee, M., R. Sada de Suplee, D. Feldman, and T. Laidlaw, 2005. Identification and Assessment of Montana Reference Streams: A Follow-up and Expansion of the 1992 Benchmark Biology Study. Helena, MT: Montana Department of Environmental Quality, 41 p.

Suplee, M.W., A. Varghese, and J. Cleland, 2007. Developing Nutrient Criteria for Streams: An Evaluation of the Frequency Distribution Method. Journal of the American Water Resources Association 43: 453-472.

Suplee, M.W., V. Watson, A. Varghese, and J. Cleland, 2008. Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers, ***and Addendums***. Helena, MT: Montana Department of Environmental Quality, 86 p.

Suplee, M.W., V. Watson, M. Teply, and H. McKee, 2009. How Green is too Green? Public Opinion of what Constitutes Undesirable Algae Levels in Streams. Journal of the American Water Resources Association 45: 123-140.

Suplee, M.W., and R. Sada de Suplee, 2011. Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels. Helena, MT: Montana Department of Environmental Quality

Suplee, M.W., V. Watson, W.K, Dodds, and C. Shirley, 2012. Response of Algal Biomass to Large Scale Nutrient Controls on the Clark Fork River, Montana, U.S.A. Journal of the American Water Resources Association- IN PRESS.

U.S. Environmental Protection Agency, 2000a. Nutrient Criteria Technical Guidance Manual, Rivers and Streams. United States Environmental Protection Agency, EPA-822-B00-002. Washington, D.C.

U.S. Environmental Protection Agency, 2000b. Nutrient Criteria Technical Guidance Manual, Lakes and Reservoirs. United States Environmental Protection Agency, EPA-822-B00-001. Washington, D.C.

Varghese, A., and J. Cleland, 2005. Seasonally Stratified Water Quality Analysis for Montana Rivers and Streams-Final Report. Prepared by ICF International for the Montana Department of Environmental Quality, 44 p plus appendices.

Varghese, A., J. Cleland, and B. Dederick, 2008. Updated Statistical Analyses of Water Quality Data, Compliance Tools, and Changepoint Assessment for Montana Rivers and Streams. Prepared by ICF International for the Montana Department of Environmental Quality under agreement No. 205031, task order 5.

Woods, A.J., J.M. Omernik, J.A. Nesser, J. Shelden, J.A. Comstock, and S. J. Azevedo, 2002. Ecoregions of Montana, 2nd edition. (Color Poster with Map, Descriptive Text, Summary Tables, and Photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Circular DEQ-12, PART B

OCTOBER 2011 EDITION

1.0 Introduction

Elements comprising Circular DEQ-12**, Part B** are found below. These elements are adopted by the Department following the Department's formal rule making process. Montana state law (§75-5-103 [22], MCA and 75-5-313, MCA) allows for variances from the base numeric nutrient standards (found in **Part A** of this circular) based on a determination that base numeric nutrient standards cannot be achieved because of economic impacts or because of the limits of technology.

1.1 Definitions

1. **Limits of technology** means wastewater treatment processes for the removal of nitrogen and phosphorus compounds from wastewater that can achieve a concentration of 70 µg TP/L and 4,000 µg TN/L.

2. **Long-term average** means a description of effluent data from a treatment system using standard descriptive statistics and an assumption that the data follow a lognormal distribution. See also, "*Technical Support Document for Water Quality-based Toxics Control*", Document No. EPA/505/2-90-001, United States Environmental Protection Agency, 1991.

2.0 General Nutrient Standards Variances

Because the treatment of wastewater to base numeric nutrient standards in 2011 would have resulted in substantial and widespread economic impacts on a statewide basis (§75-5 -313 [5][a], MCA), a permittee who meets the end-of-pipe treatment requirements provided below in **Table 12B-1** may apply for and will receive a general nutrient standards variance ("general variance")(§75-5 -313 [5][b], MCA). A person may apply for a general variance for either total phosphorus or total nitrogen, or both. The general variance may be established for a period not to exceed 20 years. A compliance schedule to meet the treatment requirements shown in the table will be established on a case-by-case basis.

Cases will arise in which a permittee is or will be discharging effluent with N and/or P concentrations lower than (i.e., superior to) the minimum requirements of a general variance. And yet, the resulting concentrations outside of the mixing zone still exceed the base numeric nutrient standards. Such discharges are still within the scope of the general variance, because statute indicates that a general variance is allowable if the permittee treats the discharge to, **at a minimum**, the concentrations indicated by §75-5-313(5)(b)(i)and (ii), MCA. Thus, permitted discharges better than those at §75-5-313(5)(b)(i)and (ii), MCA are not precluded from falling under a general variance.

Table 12B-1. General variance end-of-pipe treatment requirements per §MCA 75-5 -313(5)(b), through May 2016.

	Long-term Average	
Discharger Category[1]	**Total P (µg/L)**	**Total N (µg/L)**
≥ 1.0 million gallons per day	1,000	10,000
< 1.0 million gallons per day	2,000	15,000
Lagoons not designed to actively remove nutrients	Maintain current performance	Maintain current performance

[1] See endnote 1

The Department must review the general variance treatment requirements every 3 years to assure that the justification for their adoption remains valid. If a low-cost technological innovation for lowering nitrogen and phosphorus concentrations in effluent were to be developed in the near future, for example, the Department could (after May 2016) make more stringent the concentrations shown in the table. If the Department were to adopt general variance treatment requirements more stringent than those provided in **Table 12B-1**, the permittee will be expected to meet the updated concentration(s) during the next permit cycle in order to continue to hold the general variance.

Only after changes in specified factors had occurred would the general variance treatment requirements be made more stringent. The review will occur triennially and would generally be carried out at a fairly coarse level (i.e., statewide). The Department and the Nutrient Work Group may consider whether or not:

1. Wastewater treatment technologies and costs for nutrient removal have improved
2. A substantial number of TMDLs had been developed and implemented
3. Nonpoint source BMPs had been widely applied
4. Montana's economic status had changed sufficiently to make treatment more affordable
5. Base numeric nutrient standards should be revised to reflect N- or P-compound speciation and bioavailability
6. Nutrient trading options had been implemented where feasible

2.1 Wastewater Facility Optimization Study

Permitees receiving a general variance are required to evaluate current facility operations to optimize nutrient reduction with existing infrastructure and shall analyze cost-effective methods of reducing nutrient loading, including but not limited to nutrient trading without substantial investment in new infrastructure (§75-5-313[9][a], MCA). The Department may request the results of the optimization/nutrient reduction analysis within two years of granting a general variance to a permittee.

Changes to facility operations resulting from the analysis carried out per the above paragraph are only intended to be refinements to the system already in place. Therefore, optimizations should:

1. Address only changes to facility operation and maintenance and not structural changes
2. Not result in rate increases
3. Must include exploration of the feasibility of nutrient trading within the basin

Who and how the analysis is carried out is to be decided by the permittee. The Department encourages the use of a third-party firm with expertise in this subject.

3.0 Individual Nutrient Standards Variances

Montana law allows for the granting of nutrient standards variances based on the particular economic and financial conditions of a permittee (§75-5-313 [1], MCA). Individual nutrient standards variances ("individual variances") may be granted on a case-by-case basis because the attainment of the base numeric nutrient standards is precluded due to economic impacts, limits of technology, or both. In general, individual variances are intended for permittees who would have financial difficulties meeting even the general variance concentrations, and are seeking individual N and P permit limits tailored to their specific economic situation.

Unlike the general variances presented in **Section 2.0** above, individual variances may only be granted to a permittee after the permittee has made a demonstration to the Department of economic impacts, the limits of technology, or both. The Department, in conjunction with the Nutrient Work Group, has developed as assessment process that must be completed. The assessment process is found in the Department guidance document "*Carrying out a Substantial and Widespread Economic Analysis for Individual Nutrient Standards Variances*".

A permittee, using the assessment process referred to above, must also demonstrate to the Department that there are no reasonable alternatives (including but not limited to trading, compliance schedules, reuse, recharge, and land application) that would allow compliance with the base numeric nutrient standards. If no reasonable alternatives exist, then an individual variance is justifiable and becomes effective and may be incorporated into a permit following the Department's formal rule making process.

Individual variances the Department may adopt in the future will be documented in **Table 12B-2** below.

Table 12B-2. Table for individual variances that may be adopted.

MPDES Number	Facility Name	Discharge Latitude	Discharge Longitude	Receiving Waterbody	Receiving Waterbody Classification	Long-term Average Total P (µg/L)	Long-term Average Total N (µg/L)	Start Date	Sunset Date (maximum)	Review Schedule (year)	Review Outcome

4.0 Endnotes

(1) Based on facility design flow.