Disclaimer:
This initial draft circular is being provided for consultation purposes with the Nutrient Work Group. This is a preliminary document for review and may undergo substantial changes based upon Nutrient Work Group input or other considerations prior to proposal through formal rulemaking procedures.

The formal rulemaking process under Title 2, Chapter 4, Part 3, MCA, which includes a notice of proposed rulemaking, hearing, and formal comment period has not yet commenced. Prior to final rule adoption, the public will be afforded the opportunity to submit data, views, or arguments orally or in writing and DEQ must fully consider all public comments on the proposed rule.

Circular DEQ-15: Draft 2

Implementation of Narrative Nutrient Standards under the Adaptive Management Program

September 2022 Edition

Prepared by:
Montana Department of Environmental Quality
1520 E. Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901

Document Number

Table of Contents

ACRONYMS

AMP	Adaptive Management Plan
ARM	Administrative Rules of Montana
DSS	Decision Support System
EBT	Exact Binomial Test
EPA	United States Environmental Protection Agency
HUC	Hydrological Unit Code
LA	Load Allocation
MCA	Montana Code Annotated
MPDES	Montana Pollutant Discharge Elimination System
TDG	Total Dissolved Gas
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
WLA	Wasteload Allocation

1.0 INTRODUCTION

In 2021 the 67th Montana Legislature adopted Senate Bill 358, which described a new process for implementing narrative standards for nutrients in permits. Nutrients, in this context, refer to total phosphorus (TP) and total nitrogen (TN) concentrations in state surface waters. The Montana Legislature also directed the department to eliminate the numeric criteria that had been adopted for these parameters in Circular DEQ-12A. The numeric criteria in Circular DEQ-12A applied to wadeable streams across Montana as well as portions of the Yellowstone River. Circular DEQ-12A criteria were not applicable to Montana's remaining large rivers.

The narrative standards at ARM 17.30.637(1) — "State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant, or aquatic life; and (e) create conditions which produce undesirable aquatic life" — are the primary narrative standards the department uses to regulate the impacts of excess phosphorus and nitrogen in state waters. These narrative nutrient standards apply to wadeable streams and medium rivers, as well as large river segments previously under Circular DEQ-12A, and continue to apply to other large rivers of the state.

While the narrative nutrient standards remain unchanged, 75-5-321, MCA, now requires the department to adopt rules allowing for the use of an adaptive management program when implementing the narrative standards; this circular is part of those rules. The adaptive management program is an incremental, watershed-based approach for protecting and maintaining water quality affected by excess nutrients. An important element of the adaptive management program is that it allows different types of nutrients (phosphorus vs. nitrogen) and nutrient sources to be addressed separately and incrementally over time by incorporating flexible decision-making which can be adjusted as management actions and other factors become better understood in each watershed.

The general structure of the process for an existing publicly-owned treatment works is provided in **Figure 1-1**. The department will evaluate each point source with nutrients as a pollutant of concern for the discharge's reasonable potential to cause or contribute to an exceedance of the narrative nutrient standards. For point sources with reasonable potential, adaptive management allows for permittees to prioritize phosphorus reduction, where appropriate. Reduction of phosphorus is the initial phase of adaptive management and will be implemented if appropriate (see boxes 3 and 4, **Figure 1-1**). If phosphorus control is successful in protecting receiving water body beneficial uses and downstream uses, ongoing monitoring is required but additional nutrient controls are not (box 2). If phosphorus-focused control is not successful in protecting water quality and beneficial uses, then phosphorus *and* nitrogen controls are implemented (box 5). Nitrogen sources in watersheds are often dispersed among different sources and the adaptive management process at this stage allows permittees to examine the potential for wider reduction of nutrients in their watershed. The entire process is adaptive in that it allows for an incremental approach (phosphorus focus first, then nitrogen) and incorporates flexible decision-making which can be adjusted as management actions and other factors become better understood in each watershed.

An adaptive management plan (AMP) is watershed-specific plan developed under the broader adaptive management program. Note that adaptive management is a complex, iterative process with the potential for feedbacks which may not all be presented in **Figure 1-1**.

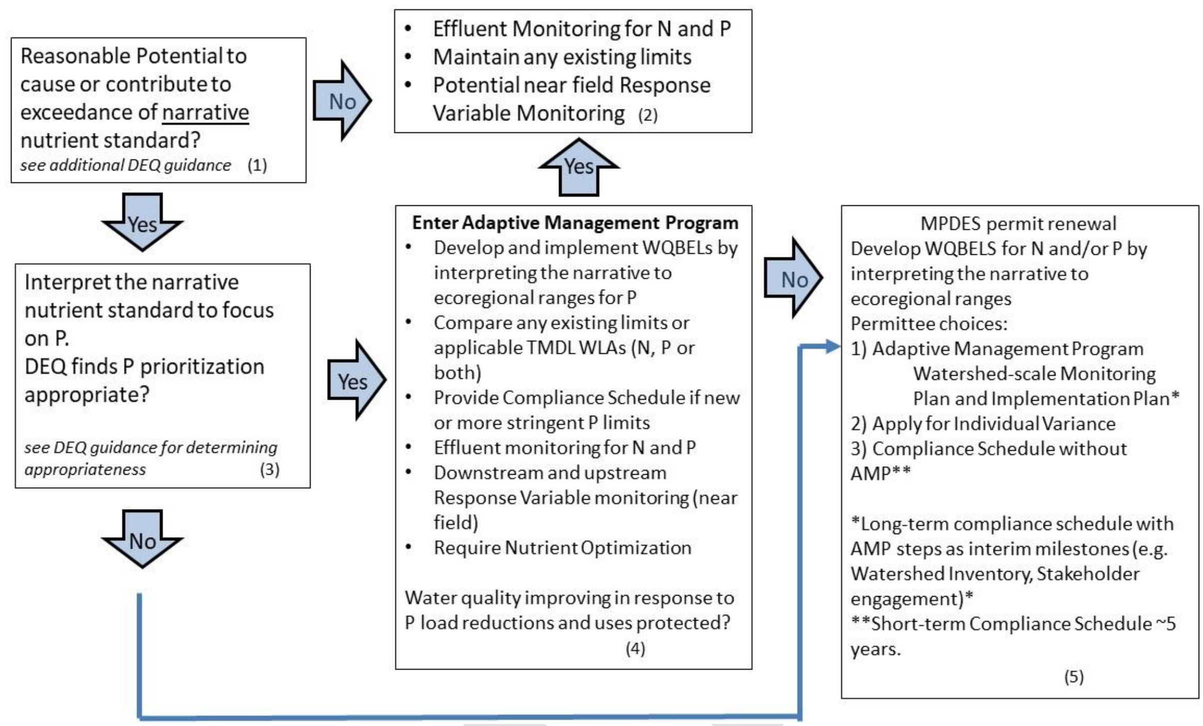

Figure 1-1. Flowchart Outlining Implementation of Narrative Nutrient Standards and Steps Leading to the Adaptive Management Program for an Existing Publicly Owned Treatment Works on a Wadeable Stream or Medium River. The adaptive management program begins upon entering box 4.

Figure1-1 also addresses permittees who need or chose to select other regulatory tools instead of adaptive management to achieve the narrative nutrient standards. These additional tools include water quality standard variances and compliance schedules. These options have separate and distinct rules and regulations that are not included in this circular.

The department adopted this circular in conformance with the statutory requirements found in 75-5-321, MCA. This circular contains adaptive management implementation requirements for Montana's narrative nutrient standards found at ARM 17.30.637(1)(d)-(e) for point sources whose discharges contains total phosphorus and/or total nitrogen that may cause or contribute to an exceedance of the narrative nutrient standards. This circular is applicable only to the implementation of these narrative nutrient standards. The methods, implementation process, and department approach described in this circular are not applicable to any other Department Circular DEQ-7 water quality standards including but not limited to nitrate + nitrite and ammonia.

1.1 DEFINITIONS

Adaptive Management Plan (AMP) means a watershed-specific plan developed under the adaptive management program to achieve the narrative nutrient standards and address nutrients in a specific watershed. An adaptive management plan includes a watershed monitoring plan and, if required, an implementation plan.

Adaptive Management Program means a watershed-scale program that protects water quality from the impacts of nutrient sources by: (a) prioritizing phosphorus reduction, as appropriate, while accounting for site specific conditions; (b) allowing for nutrient sources to be addressed incrementally over time by incorporating flexible decision-making which can be adjusted as management actions and other factors become better understood; (c) reasonably balancing all factors impacting a waterbody while considering the relative cost of treatment options, their feasibility, and their expected water quality improvement; (d) identifying specific nutrient reduction requirements, and (e) setting as its goal the protection and achievement of beneficial uses of the waterbody.

Far Field Sites means, for purposes of an adaptive management plan, instream sampling locations placed throughout the adaptive management plan watershed for the primary purpose of characterizing nutrient loads entering and exiting the watershed.

Large River means a perennial waterbody that is unwadeable by a person during baseflow conditions.

Medium River means a perennial waterbody in which much of the wetted channel is unwadeable by a person during baseflow conditions.

Near Field Sites means, for purposes of an adaptive management plan, instream sampling locations near a point source discharge that (a) downstream of the point source represent segments of the stream directly under the influence of the point source's effluent and (b) upstream of the point source represent segments of the stream uninfluenced by the point source but having similar physical characteristic to the downstream location(s) in terms of gradient, flow, base flow water depth, substrate, and stream shading.

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 Identify Waterbody Size

For purposes of developing an adaptive management plan (AMP), each point source receiving waterbody must be identified as a wadeable stream, medium river, or large river (see **Section 4.1** if discharging to or affecting a lake or reservoir). **Figure 2-1** is a guide to different sections of this document, depending on water body size; the indicated sections provide detail on each subject.

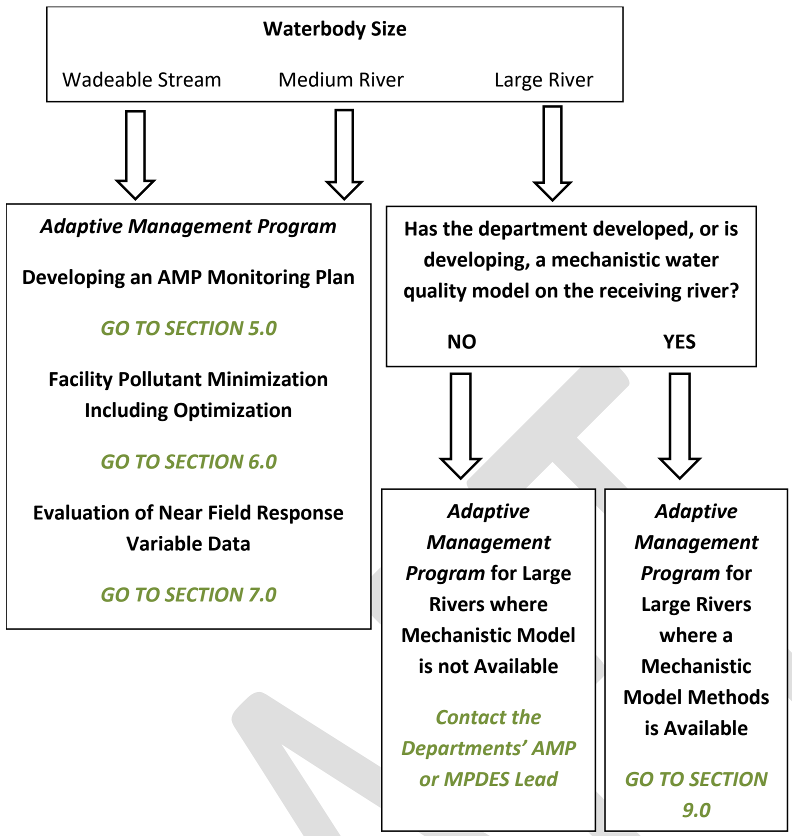

Figure 2-1. Guide to Sections in this Document Applicable to Different Adaptive Management Program Topics as Appropriate for Different Sized Waterbodies

Permittees should refer to definitions in **Section 1.1**, the list of large rivers in **Table 2-1** below, and any other current department guidance when determining the size of their receiving water body.

Permittees on a large river should consult with the department as to the status of mechanistic modeling on the river segment they discharge to and then go to **Section 9.0**, per **Figure 2-1**. **Table 2-1** below provides a list of large rivers in the state. Where models are developed or being developed, modeling shall be used to examine the effects simulated point and nonpoint management activities will have on a waterbody's beneficial uses and water quality (**Section 9.0**). **Please note that permittees on medium rivers and wadeable streams are not precluded from developing and using a mechanistic water quality model for their AMP.** However, developing water quality models is resource intensive and therefore simpler, more direct methods for developing and applying an AMP are provided for medium rivers and wadeable streams in this document. If an MPDES permittee or permittees on a wadeable stream or medium river chooses to develop a water quality model for their receiving waterbody, refer to **Section 9.0.**

For large rivers where a mechanistic model has not been developed and a model is not currently under development, the adaptive management program may follow a process similar to that for wadeable streams and medium rivers (phosphorus control first), however the response variables measured and considerations about where to place monitoring sites will be different from those for the smaller waterbodies. Permittees on large rivers where models are not developed nor or currently under development should consult with the department on developing an AMP and are advised to consider any current department guidance.

In circumstances where the receiving waterbody size or characteristics are not appropriately addressed by the sections in this circular, permittees must contact the department for guidance on developing an appropriate site-specific AMP.

Table 2-1. 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

3.0. DETERMINING IF PHOSPHORUS PRIORITIZATION IS APPROPRIATE FOR THE POINT SOURCE AND THE WATER BODY

Sections in the rule may be addressed further here.

3.1 Techniques for Identifying the Limiting Nutrient in a Waterbody

75-5-321, MCA, requires the department to prioritize the minimization of phosphorus in a watershed where appropriate, accounting for site-specific conditions. In areas of the state where nitrogen is the primary limiting nutrient (e.g., in the Absaroka-Gallatin Volcanic Mountains level IV ecoregion in **Table 4-1**, where natural background phosphorus is at saturating concentrations), nitrogen control will likely be required in addition to phosphorus control.

Nutrient diffusing substrates provide a mechanism to determine if phosphorus, nitrogen, or both control algae growth and primary productivity in a location of a stream or river. Nutrient diffusing substrates may be deployed in flowing waterbodies for the purpose of determining the limiting nutrient(s). The ratio of TN to TP (i.e., the Redfield Ratio) of water samples from the waterbody may also be used to inform this analysis, but water TN:TP ratios must be used in conjunction with (not as an alternative to) nutrient diffusing substrates.

Results from nutrient diffusing substrates deployed downstream of a point source should be considered together with the status of phosphorus and nitrogen treatment and effluent concentrations from the facility. A receiving waterbody (via diffusing substrate data) could show nitrogen limitation but, rather than reducing nitrogen concentrations in the effluent, it might be effective (from a cost and engineering perspective) to first lower facility effluent phosphorus concentrations and—as a result—render the waterbody P limited and reduce nuisance algae growth, etc. Permittees are advised to consider any current department guidance on this subject.

Some MPDES permits regulate activities where total nitrogen is present in the effluent, however total phosphorus is absent. For these circumstances, the department will limit total nitrogen rather than total phosphorus, when necessary.

4.0 WADEABLE STREAMS AND MEDIUM RIVERS: RANGES OF NUTRIENT CONCENTRATIONS PROTECTIVE OF BENEFICIAL USES IN DIFFERENT ECOLOGICAL REGIONS, AND TIMEFRAMES FOR THEIR APPLICATION

The department uses ecological regions, or ecoregions, to describe geographic regions which have relatively uniform ambient stream nutrient concentrations, macroinvertebrate populations, and diatom algae populations. Ecoregions must be based on the 2002 version (version 2) of the U.S. Environmental Protection Agency map which is found at: https://www.epa.gov/eco-research/ecoregion-download-files-state-region-8#pane-24 . Ecoregions are hierarchical; level III ecoregions cover large geographic areas which transcend Montana's state borders. Level III ecoregions are comprised of multiple level IV (small) ecoregions.

The department reviewed and compiled scientific literature and department studies[1,2,3] which demonstrated that total phosphorus (TP) and total nitrogen (TN) concentrations protective of aquatic life and recreation beneficial uses vary across the state (ecoregion by ecoregion). The ranges of TP and TN concentrations that protect sensitive uses are outlined in **Table 4-1** and are organized by Montana's different ecoregions. Similarly, the department used stream hydrograph and biological patterns to identify appropriate index periods applicable to wadeable streams and medium rivers for each ecoregion[1,2]. Montana streams and rivers are generally most vulnerable to excess nutrient impacts during the summer baseflow months, therefore values derived from the ranges in **Table 4-1** shall be applied seasonally, at a minimum, per the applicable time periods in **Table 4-1.**

The department shall use these ranges and time periods to translate the narrative nutrient standards and derive TP limits for MPDES permits, and they shall be used to derive TN limits, when necessary. To identify the ecoregion applicable to a point source, start at the smallest geographic scale (column three from the left) and determine if the point source is located in one of the listed level IV ecoregions. If it is not, then the nutrient range applicable to the broader level III ecoregion applies.

Table 4-1. TP and TN Concentration Ranges for Specific Ecoregions that Protect Aquatic Life and Recreation Beneficial Uses. Also shown are the time periods when values derived from the ranges should be applied, at a minimum.

			Maximum Recommended Range		Applicable Time Period	
Ecoregional Zone	**Ecoregion (Level III)**	**Ecoregion (Level IV)**	**Total Phosphorus (µg/L)**	**Total Nitrogen (µg/L)**	**Start of Growing Season**	**End of Growing Season**
Western	Northern Rockies (15)	all	20 - 40	210 - 1,210	July 1	Sept. 30
Western	Canadian Rockies (41)	all	23 - 62	325 - 821	July 1	Sept. 30
Western	Idaho Batholith (16)	all	20 - 62	210 - 718	July 1	Sept. 30
Western	Middle Rockies (17)	all except 17i	20 - 40	210 - 1,210	July 1	Sept. 30
Western	Middle Rockies (17)	Absaroka-Gallatin Volcanic Mountains (17i)	61 - 105[b]	Use values from the lower end of the range for the Middle Rockies (17)	July 1	Sept. 30
Western (transitional)	Northwestern Glaciated Plains (42)	Sweetgrass Upland (42l), Milk River Pothole Upland (42n), Rocky Mountain Front Foothill Potholes (42q), and Foothill Grassland (42r)	23 - 80[c]	445 - 775	July 1	Sept. 30
Western (transitional)	Northwestern Great Plains (43)	Non-calcareous Foothill Grassland (43s), Shields-Smith Valleys (43t), Limy Foothill Grassland (43u), Pryor-Bighorn Foothills (43v), and Unglaciated Montana High Plains (43o)[a]	20 - 41[d]	439 - 1,125	July 1	Sept. 30
Eastern	Northwestern Glaciated Plains (42)	all except those listed above for 42	70 - 150	540 - 1,830	June 16	Sept. 30
Eastern	Northwestern Great Plains (43) and Wyoming Basin (18)	all except for those listed above for 43, and 43c below	70 - 150	540 - 1,830	July 1	Sept. 30
Eastern	Northwestern Great Plains (43)	River Breaks (43c)	None recommended	None recommended	None recommended	None recommended

[a]For the Unglaciated High Plains ecoregion (43o), the range applies only to the polygon located just south of Great Falls, MT.
[b]Based on the 25th and 75th percentiles of the natural background concentrations in this level IV ecoregion.
[c]Lower end based on streams' origins in the Canadian Rockies; upper end based on 75th percentile of natural background for these ecoregions.
[d]Lower end based on similarity to Middle Rockies, upper end based on Elk Creek reference site.

4.1 MPDES Discharges that May Affect a Lake, Reservoir, or a Downstream Beneficial Use

Loading of nutrients to lakes and reservoirs occurs year-round and, in northern temperate regions like Montana, spring runoff normally constitutes the bulk of the annual loading. Although the bulk of nutrient loading to lakes and reservoirs occurs in spring, undesirable aquatic life (e.g., phytoplankton algae blooms) may occur in lakes and reservoirs later, in summer and fall, if the annual nutrient load is excessive.

4.1.1 Discharges Directly to a Lake or Reservoir

Permittees who discharge nutrients directly to a lake or reservoir will be required to have year-round monitoring for TP and/or TN. Where MPDES effluent limits are required for direct discharges of nutrients to a lake or reservoir, the department shall apply these effluent limits apply year-round. In addition, and in consultation with the department under their AMP monitoring plan, permittees must determine the proportion of their TP and/or TN load relative to the total annual load to the lentic waterbody. This data must be collected over at least two calendar years. Depending upon the permittee's proportion of the annual load, the permittee may be required to undertake in-lake response variable monitoring (e.g., phytoplankton chlorophyll *a*), to be determined in consultation with the department. AMP actions to protect, maintain, and potentially improve the lake condition shall be determined on a case-by-case basis. In determining their contribution to the annual load, permittees are advised to consider any current department guidance.

4.1.2 Discharges to a Flowing Waterbody that May Affect a Downstream Lake or Reservoir

Permittees whose discharge is likely to affect a downstream lake or reservoir will be informed by the department. The department may determine year-round TP and/or TN permit limits are necessary, to be determined on a case-by-case basis.

4.1.3 Discharges to a Flowing Waterbody that May Affect Beneficial Uses in a Downstream Reach

The department must ensure that beneficial uses downstream of point source discharges are protected. A reach of a wadeable stream or medium river considerably downstream from an MPDES discharge may have beneficial uses sensitive to phosphorus and/or nitrogen concentrations from the upstream point source. In these cases, the department shall evaluate each applicable MPDES permit case-by-case and the department may require MPDES nutrient limits for both TP and TN (per **Table 4-1)** and may require them to apply year-round.

5.0 The AMP Monitoring Plan: Data Collection Requirements for Watershed Monitoring in Wadeable Streams and Medium Rivers

Permittees operating under the phosphorus-focused phase of the adaptive management program (box 4, **Figure 1-1**) are required to collect instream nutrients and response variables data. This section addresses methods, timeframes, and approaches for data collection. These requirements must be incorporated into individual AMP monitoring plans.

5.1 Collection of Nutrient Concentration data

Total phosphorus and TN must be monitored by the permittee in the effluent, and at all near field and far field department-approved sites. (Site types and locations are discussed below in **Section 5.4**.) When TN and TP data are collected along with response variables, they must be collected at least at the same frequency and during the same monitoring events as the response variables (**Section 5.3**). Nutrient data will be used to characterize nutrient concentrations and loads in the near field area upstream and downstream of the point-source discharge point. At a minimum, TP and TN must be measured, however soluble forms (e.g., nitrate, SRP) can provide important information about sources and the department encourages permittees to collect samples for soluble nutrient forms during monitoring events for TN and TP.

Table 5-1 provides the required reporting values (RRVs) for TP and TN, the RRVs for nitrogen fractions that can be used to compute total nitrogen, and the RRV for dissolved phosphorus. Permittees are also advised to consider any current department guidance.

Table 5-1. Required Reporting Values[a,b,c] for Phosphorus and Nitrogen Measurements

Nutrient		Method of Measurement	Required Reporting Value
Total phosphorus		Persulfate digestion	3 µg/L
Total nitrogen		Persulfate digestion	70 µg/L
Total nitrogen	Sum of:	(a) total kjeldahl nitrogen	225 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
Dissolved orthophosphate		Sampled filtered, 0.45 µm	1 µg/L

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

[b] Concentrations in Table 4-1 must be achieved unless otherwise specified in a permit, approval, or authorization issued by the Department (DEQ-7; ARM 17.30.702).

[c]The total nitrogen persulfate method is for instream measurements only and cannot be used for effluent. Persulfate digestion is not a 40 CFR Part 136 approved method.

5.2 Sample Collection Index Period

The index periods below in **Table 5-2** (which match those in **Table 4-1**) largely correspond to the summer baseflow period (aka growing season). Instream nutrients (**Section 5.1**) and instream response variable data (**Section 5.3**) should be collected during the time periods applicable to each ecoregion.

To identify the ecoregion index period applicable to a point source, start at the smallest geographic scale, which is the level IV ecoregions (e.g., 17i). Determine if the point source is located in one of the listed level IV ecoregions. If it is, use the indicated date range; if it is not, then use the index period applicable to the larger-scale level III ecoregion listed just the level IV (e.g., 17).

If appropriate for the waterbody, the index period may be expanded to include earlier or later dates on a case-by-case basis, subject to department review and approval. Permittees are advised to consider any current department guidance on this subject.

Table 5-2. Annual Timeframes for Nutrient and Response Variable Data Collection Based on Ecoregion

Ecoregion (level III or IV) and Number, or Large River Reach Description	Time Period to Collect Data
Northern Rockies (15)	July 1 to September 30
Canadian Rockies (41)	July 1 to September 30
Idaho Batholith (16)	July 1 to September 30
Middle Rockies (17)	July 1 to September 30
Absaroka-Gallatin Volcanic Mountains (17i)	July 1 to September 30
Northwestern Glaciated Plains (42)	June 16 to September 30
Sweetgrass Upland (42l), Milk River Pothole Upland (42n), Rocky Mountain Front Foothill Potholes (42q), and Foothill Grassland (42r)	July 1 to September 30
Northwestern Great Plains (43) and Wyoming Basin (18)	July 1 to September 30
*Non-calcareous Foothill Grassland (43s), Shields-Smith Valleys (43t), Limy Foothill Grassland (43u), Pryor-Bighorn Foothills (43v), and Unglaciated Montana High Plains (43o)**	July 1 to September 30
River Breaks (43c)	NONE RECOMMENDED

*For the Unglaciated High Plains ecoregion (43o), limits only apply to the polygon located just south of Great Falls, MT.

5.3 Collection of Response Variable Data

As noted in **Section 4.0**, the department used ecoregions to describe regions of relative uniformity for macroinvertebrate populations, diatom algae populations, and ambient stream nutrient concentrations. Ecoregions must be based on the 2002 version (version 2) of the U.S. Environmental Protection Agency map which is found at: https://www.epa.gov/eco-research/ecoregion-download-files-state-region-8#pane-24 .

For purposes of this circular, two broad ecoregional zones are identified (**Figure 5-1**)[4]. In **Figure 5-1,** the western and transitional ecoregions (green and dark gray areas) comprise a single "western" ecoregional zone, while an eastern ecoregional zone (in orange) comprises the second. Different response variable data collection requirements apply to each of these two zones. Wadeable streams and medium rivers in each zone typically display the following general characteristics:

Western Ecoregional Zone streams are those that are usually perennial and generally clear during summer/fall base flow, have moderate gradient, are mostly gravel- to cobble-bottomed, comprise a pool-riffle-run series longitudinally, have limited macrophyte populations, and generally support a salmonid fish population. This zone has a high degree of geographic overlap with Montana's A-1 and B-1 waterbody classifications (see ARM 17.30.607 through 613).

Eastern Ecoregional Zone streams are those that are low-gradient and which may become intermittent during summer/fall baseflow, often haves deep pools even when intermittent, commonly have a mud bottom, may be quite turbid, are often very sinuous, frequently have substantial macrophyte populations including near-bank emergent macrophytes, often have filamentous algae but sometimes only phytoplankton algae (i.e., a green color to the stream water), and generally support warm-water fish species (e.g., green sunfish, black bullheads, silvery minnows, etc.). This zone has a high degree of geographic overlap with Montana's B-2, B-3, and C-1 waterbody classifications (see ARM 17.30.607 through 613).

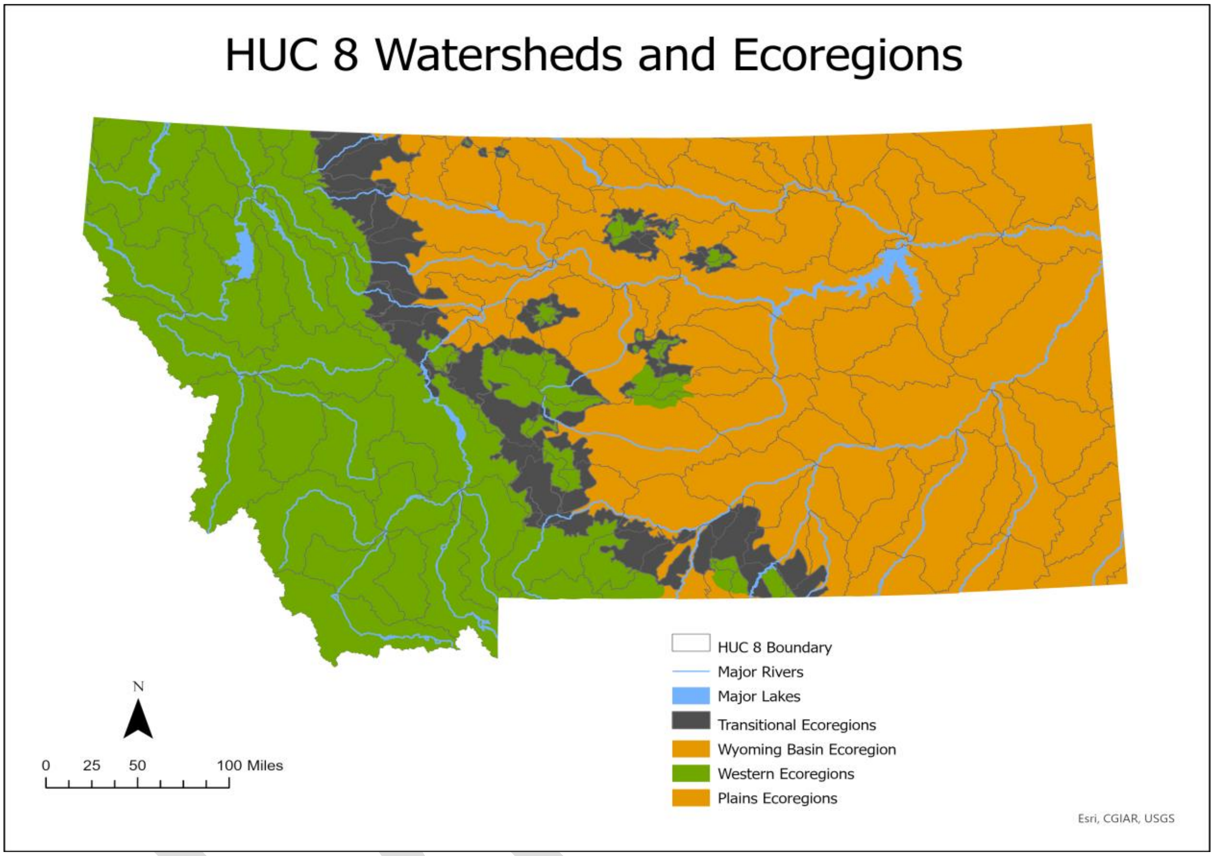

Figure 5-1. Ecoregional Zones in Montana, along with 8-digit Hydrologic Unit Codes (HUC) Boundaries. For purposes of this circular, the green and dark gray areas comprise a western ecoregional zone, the dark orange area an eastern ecoregional zone.

Permittees should refer to ARM 17.30.607 through 613 and identify their receiving waterbody's use classification, and then review the associated beneficial uses provided in ARM 17.30.621 through 631. A proposed AMP monitoring plan must describe the applicable use class of the waterbody, which ecoregion zone (western or eastern) best applies to them, and which response variables will be measured, along with a justification; this is subject to department review and approval.

AMP monitoring plans are based on watershed boundaries. Different ecoregions may exist within a single watershed because ecoregions boundaries are not watershed-based (see **Figure 5-1**). This could result in permittees identifying both western and eastern ecoregion response variables for their watershed. Permittees are advised to consider any current department guidance to address such situations, and to select the response variables most appropriate for their near field sites.

The department acknowledges that there may be streams within the main body of each ecoregional zone that do not fit the typical regional patterns. For streams that do not fit the typical expectations of the ecoregion, please refer to **Section 5.3.3.** When determining which response variables are most appropriate for such waterbodies, permittees are advised to consult the department early in monitoring plan development and to consider any current department guidance.

5.3.1 Response Variable Monitoring Data for the Western Ecoregional Zone

Table 5-3 shows minimum data collection requirements for wadeable streams and medium rivers in the western Montana ecoregional zone along with response variables and any associated threshold. Nutrient collection requirements (**per Section 5.1**) are also included in **Table 5-3**. When developing and implementing sampling methods for purposes of meeting the requirements in **Table 5-3**, permittees are advised to consider any current department guidance.

Section 7.0 will discuss the use of responsible variables and associated thresholds in decision making.

Table 5-3. Data Collection Requirements for Different Types of AMP Monitoring Sites in the Western Ecoregional Zone. Associated response variable thresholds are shown, if applicable.

Parameter	Site Type	Annual Index Period	Minimum Annual Sampling Requirements	Threshold
1. Response Variables				
Reach average benthic chlorophyll *a* (Chl*a*)	All Near Field Sites, All Downstream Far Field Sites	July 1 to September 30	Twice during the index period, with a minimum of 6 weeks between sampling events	125 mg Chl*a*/m^2
Reach average benthic ash free dry weight (AFDW)				35 g AFDW/m^2
% Bottom cover by filamentous algae, reach average			Monthly during the index period; two of the events must pair with the Chl*a* /AFDW sampling	30% bottom coverage
Macroinvertebrates (reach composite)			Once per annual index period, corresponding to one of the other sampling events	No threshold specified. Examine relative upstream/downstream change of Hilsenhoff Biotic Index (HBI)
2. Nutrient Concentrations				
Total P, Total N	Near Field	July 1 to September 30	Twice during the index period, with a minimum of 6 weeks between sampling events	No threshold specified. Examine relative upstream/downstream change.
Total P, Total N	Far Field		(1) Upstream Far Field Sites: As established in the AMP. (2) Downstream Far Field Sites: Twice during the index period, with a minimum of 6 weeks between sampling events.	No threshold specified
Total P, Total N	Tributaries		At a sufficient frequency to characterize tributary loads as established in the AMP.	No threshold specified

Laboratory analysis of benthic Chlorophyll *a* (Chl*a*) samples is required as part of the response variable data collection (**Table 5-3**). Extraction of Chl*a* from samples, and the subsequent determination of Chl*a* concentration, must be performed in an analytical laboratory by a qualified laboratory technician or chemist. Benthic Chl*a* must be reported as milligrams chlorophyll *a* per square meter of stream bottom (mg Chl*a*/m^2). Chlorophyll *a* may be analyzed spectrophotometrically or by the use of high-performance liquid chromatography (HPLC). If using spectrophotometric methods, use of the monochromatic equation for phaeopigment-corrected Chl*a* is required. For both spectrophotometric and HPLC methods, Chl*a* extraction must be undertaken using warmed ethanol.

Analysis of benthic algae ash free dry weight (AFDW) and collection of macroinvertebrates must be undertaken using standard methods. Benthic algal AFDW must be reported as grams ash free dry weight per square meter of stream bottom (g AFDW/m^2). Percent bottom cover of the stream bottom may be assessed by eye or via the use of aerial drone technology (subject to review and approval by the department).

5.3.2 Response Variable Monitoring Data for the Eastern Ecoregional Zone

Table 5-4 below shows the minimum data collection requirements for medium rivers and wadeable streams in the eastern Montana ecoregional zone along with response variable and any associated thresholds. Nutrient collection requirements (per **Section 5.1**) are also included in **Table 5-4**. When developing and implementing sampling methods to meet the requirements in **Table 5-4**, permittees are advised to consider any current department guidance.

Section 7.0 will discuss the use of responsible variables and associated thresholds in decision making.

Table 5-4. Data Collection Requirements for Different Types of AMP Monitoring Sites in the Eastern Ecoregional Zone. Associated response variable thresholds are shown, if applicable.

Parameter	Site Type	Annual Index Period	Minimum Annual Sampling Requirements	Threshold
1. Response Variables				
Dissolved Oxygen* Delta (daily maximum minus daily minimum)	All Near Field Sites, All Downstream Far Field Sites	See Applicable Ecoregion in **Table 5-2**	Instruments must be deployed for a minimum of 30 continous days with at least 21 days collected during August. Instruments must log a record at least every 15 minutes.	5.3 mg DO/L, computed as a weekly average
5-day Biochemical Oxygen Demand (BOD_5)			Once annually, collected in September or October (note: October is outside the Index Period)	No threshold specified. Examine relative upstream/downstream change
2. Nutrient Concentrations				
Total P, Total N	Near Field	See Applicable Ecoregion in **Table 5-2**	Twice during the index period, with a minimum of 30 days between sampling events	No threshold specified. Examine relative upstream/downstream change
Total P, Total N	Far Field		(1) Upstream Far Field Sites: As established in the AMP. (2) Downstream Far Field Sites: Twice during the index period, with a minimum of 30 days between sampling events.	No threshold specified
Total P, Total N	Tributaries		At a sufficient frequency to characterize tributary loads as established in the AMP.	No threshold specified

*Dissolved oxygen concentration standards in Circular DEQ-7 also apply, and must be examined using the instrument datasets.

Dissolved oxygen must be measured using instream deployed logging instruments that have been properly calibrated according to the manufacturer's instructions. All BOD_5 samples must be analyzed in an analytical laboratory by a qualified laboratory technician or chemist using standard methods. When selecting instruments and evaluating different instrument deployment options, permittees are advised to consider any current guidance developed by the department.

5.3.3 Identifying Response Variables for Waterbodies which are Atypical of the Ecoregional Zone

It is possible that a very small fraction of permittees may find that although they are located within the main geographic area of an ecoregional zone (**Figure 5-1**), their receiving waterbody does not appear to fit the general stream characteristics outlined at the start of **Section 5.3**. Permittees in this situation are advised to contact the department early in the process of developing their AMP monitoring plan so that the department can assist with identifying appropriate response variables and thresholds. Permittees are also advised to consider any current department guidance.

In some cases, it may be concluded that some type of modeling is more appropriate for the waterbody, including conceptual water quality modeling. If, after consultation with the department, it is concluded that modeling is the most appropriate approach, please refer to **Section 9.0**.

5.4 TYPES OF SITES IN AN AMP MONITORING PLAN

Sampling site locations in a submitted AMP monitoring plan are subject to department review and approval. At a minimum, an AMP monitoring plan must comprise one near field site upstream and one near field site downstream of each point source discharge (**Figure 5-2**). The department expects the permittee to establish the sampling sites in an approved AMP monitoring plan as long-term monitoring locations. The permittee may request to modify the monitoring locations.

Data collection at the near field sites under the AMP monitoring plan shall be used by the department to determine if phosphorus prioritization has been successful in protecting beneficial uses and achieving the narrative nutrient standards along with other credible data. Other credible data includes chemical and biological information, it must be collected in the watershed, and it must be from locations useful for evaluating point source P-control effectiveness. Such data might, for example, be collected by a Conservation District, Watershed Protection District, or similar entity.

Figure 5-2. For permittees in the initial phases of the Adaptive Management Program (Box 4, **Figure 1-1**), the two near field sites may be all that is necessary. However, downstream far field sites may be required by the department to ensure attainment of water quality standards of downstream waterbodies (far field sites are further discussed in **Section 8.0**).

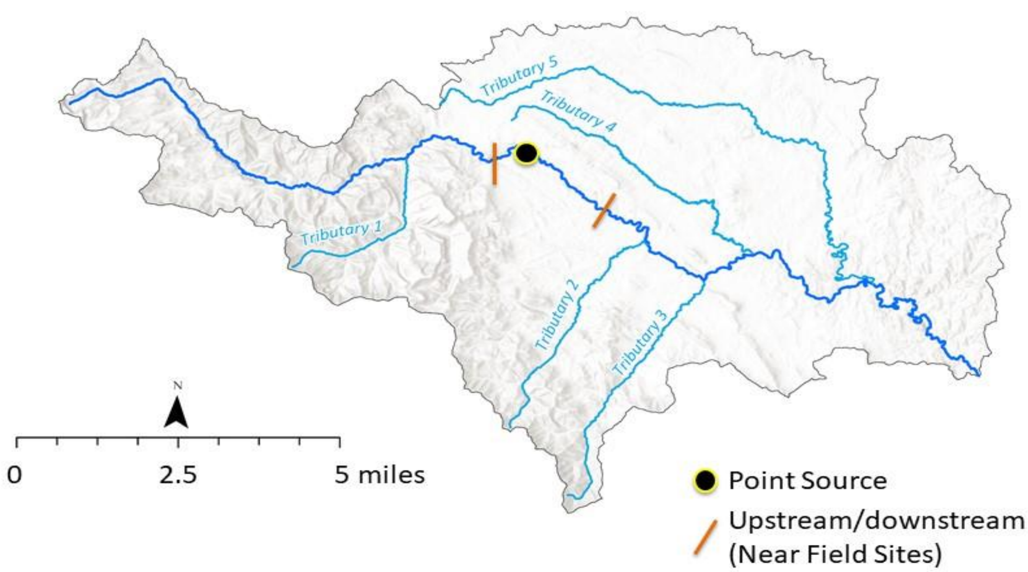

Figure 5-2. Example of an AMP Watershed with Near Field Sites Bracketing the Single Point Source

5.5 Collecting Monitoring Data: Department Field Audits

This circular requires the implementation of complex field data-collection methods. To ensure high quality data are collected the department shall carry out field audits to ensure all data collection protocols are being properly adhered to. The department shall audit a minimum of **10%** of permittees under the Adaptive Management Program per year. Audits will be performed by department staff with expertise in the applicable data collection methods accompanying the data collection entity (permittee, their consultant, or other responsible agent) in the field and observing a field data collection event as it proceeds. The department shall prepare an annual report on their findings and permittees not properly adhering to protocols established in their AMP watershed monitoring plan will be informed in writing and requested to correct the issue prior to the next field sampling event.

6.0 Pollutant Minimization Activities for Point Sources, including Optimization

Permittees entering the phase of the adaptive management program which allows for a focus on phosphorus reduction are required to examine all possible pollutant minimization activities which may reduce nutrient concentrations in the effluent. This section provides requirements and resources for undertaking this work.

A strong optimization effort should begin with monitoring of the influent, effluent and internal points within the system such as between cells, tanks, or zones. The permittee should monitor ammonia, nitrate, nitrite, dissolved oxygen, alkalinity, and pH at all of these locations to assess the wastewater chemistry at each treatment phase. This chemistry can inform decision making regarding nitrification or denitrification (modify oxygen levels) in the system. The department recommends consultation with our technical assistance staff or qualified third-party wastewater optimization experts.

For lagoons, the department recommends regular sludge depth recording and sludge removal when needed to ensure proper health and function of the lagoon. Proper sludge maintenance increases retention time.

MORE TO COME IN THIS SECTION …….

7.0 Evaluation of Near Field Response Variable Data to Determine if Beneficial Uses are Protected and Narrative Nutrient Standards are Achieved

A permittee under the adaptive management program is required to collect response variable data at sites upstream and downstream of their facility (box 2, box 4, box 5, **Figure 1-1**). Under adaptive management and per NEW RULE I(2)(d), the department may use these data, along with other credible data, to determine if phosphorus control alone has resulted in the protection of beneficial uses in the water body and whether narrative nutrient standards are achieved.

Permittees on wadeable streams and medium rivers may select the method used to assess response variables on their receiving water body (Simple, Combined Data, or Permittee-Proposed; **Figure 7-1**). Each method is described in detail in subsections below to assist in the selection process. Permittees discharging to large rivers and/or using a mechanistic water quality model should refer to **Sections 9.0**.

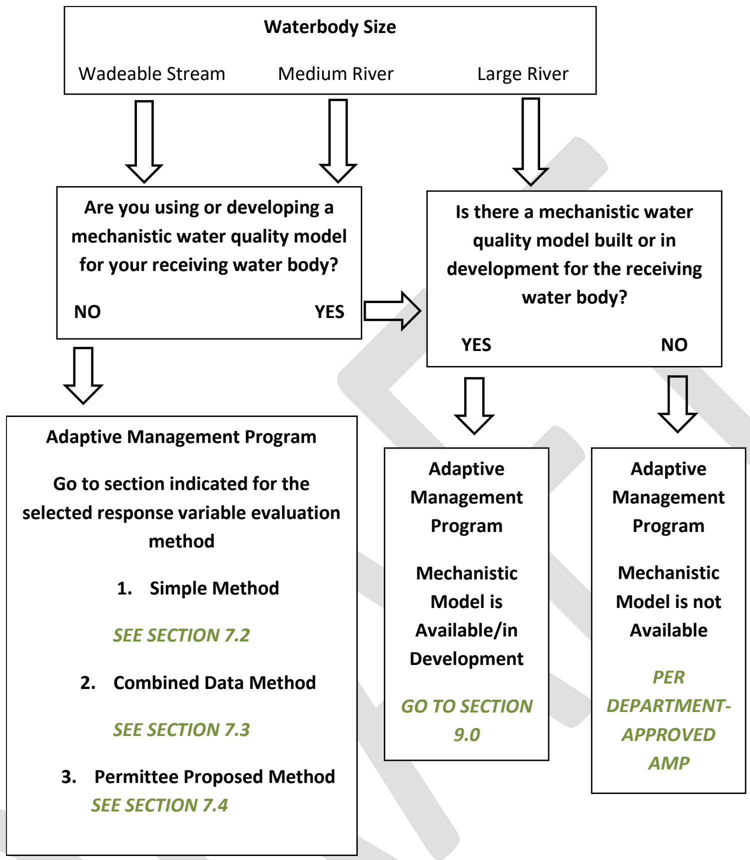

Figure 7-1. Guide to Subsections in this Document Detailing a Response Variable Evaluation Method. Pathways to other document sections or actions are also provided.

If the department finds that phosphorus-focused control at the point source is not protecting beneficial uses nor achieving the narrative nutrient standards based on credible data including the response variable data collected from near field monitoring sites, and the permittee would like to continue under Adaptive Management Program, the department will require the permittee to develop and execute an AMP implementation plan.

7.1 Response Variables and Thresholds

The department will evaluate data collected at near field sites (and potentially at downstream far field sites, depending on the AMP). Response variables come in two basic forms; those with a specified impact thresholds, and those without. Response variables with thresholds and response variables without thresholds are both necessary because, when evaluated together, they inform the extent of eutrophication (excess nutrient) impacts in an AMP watershed. Response variables and thresholds were presented in **Table 5-3** and **Table 5-4** along with details about sampling frequency, etc.; this information is summarized below in **Table 7-1**. Benthic Chl*a* and AFDW, % bottom cover by filamentous algae, and dissolved oxygen delta are all response variables with associated thresholds; macroinvertebrate Hilsenhoff Biotic Index (HBI) and 5-day BOD do not have specified thresholds per this circular.

Table 7-1. Summary of Response Variables and Associated Thresholds (Where Applicable), for Wadeable Streams and Medium Rivers in the Western and Eastern Montana Ecoregional Zones

Applicable Ecoregional Zone	Parameter	Threshold	Minimum Locations where Data are Collected
Western	Reach average benthic chlorophyll *a* (Chl*a*)	125 mg Chla/m^2	At upstream near field site(s), at downstream near field site(s)
Western	Reach average benthic ash free dry weight (AFDW)	35 g AFDW/m^2	
Western	% Bottom cover by filamentous algae, reach average	30% bottom coverage	
Western	Macroinvertebrates	No threshold specified. Examine relative upstream/downstream change.	
Eastern	Dissolved Oxygen Delta (daily maximum minus daily minimum)	5.3 mg DO/L, computed as a weekly average	
Eastern	5-day Biochemical Oxygen Demand (BOD_5)	No threshold specified. Examine relative upstream/downstream change of Hilsenhoff Biotic Index (HBI)	

7.2. Simple Method

Permittees must monitor each applicable response variable at the department-approved near field upstream and downstream sites. Sampling events for a specific parameter must be within the defined index period, at the minimum frequency described in the permit, and may not exceed 24 hours between upstream and downstream sample collection. Sampling events at near field sites located upstream and downstream of a point source are paired (i.e., they occur on the same day or within a day of one another). If, during any one of these paired sampling events, the concentration, density, or biological metric (HBI) at the downstream near field site(s) exceeds that of the upstream near field site(s) then the conclusion would be that beneficial uses are not supported and narrative nutrient standards are not achieved. Similarly, if a response variable with a specified threshold is exceeded at the downstream near field site(s), then the conclusion would be that beneficial uses are not supported and narrative nutrient standards are not achieved. However, final department conclusions about use protection and achievement of narrative nutrient standards under this method must also consider other credible data.

7.3. Combined Data Method: Combining Response Variable Data which have Thresholds with Response Variable Data which do not have Thresholds

For this method, a statistical evaluation is carried out using the exact binomial test (EBT) on response variable data which have thresholds; the results are then combined with the results from response variable data which do not have thresholds. Together, the combined results are used to determine if uses are supported/narrative standards are achieved at near-field monitoring sites.

The EBT will output either a "pass" (the specified threshold has not been exceeded) or "fail" (the specified threshold has been exceeded) as a function of the test conditions. Threshold-based response variable data are allowed to have a defined exceedance rate; that is, a certain percentage of sampling events may exceed the threshold without concluding that the dataset as a whole has exceeded (failed) the threshold. The EBT must be used to evaluate all response variable data with thresholds. The allowable exceedance rate is established at 10%, with an effect size (gray zone) of 15%. In the EBT, the gray zone represents the range of exceedance rates where the consequence of decision errors are considered relatively minor. Based on the EBT and the aforementioned test conditions, **Table 7-2** shows the allowable number of threshold exceedances for different ranges of sample sizes.

An important characteristic of the EBT is that permittees who opt to collect more data than the minimum are held to the same allowable exceedance rate as those who collect the minimum requirement (that is, there is no discouragement to collecting additional data).

It will take a number of years of data collection to achieve the number of samples shown in **Table 7-2** and to, in turn, provide reasonably robust conclusions**. Five years is the minimum per this circular**. At the minimum annual level of data collection for benthic Chl*a* (two events per year, **Table 7-2**), it will take five years to accumulate 10 samples (the minimum) at a downstream near field site.

In carrying out any of the methods described in this subsection, permittees are advised to consider any current guidance developed by the department.

Table 7-2. Allowable Number of Threshold Exceedances For a Single Data Type (e.g., Benthic Chlorophyll *a*)

Sample Size Range	Number of Threshold Exceedences Allowed While Still Passing[a] the Exact Binomial Test
2-10	1
11-18	2
19-26	3
27-35	4

[a]Failing the Exact Binomial Test indicates that the allowable exceedence rate has been exceeded.

7.3.1 Evaluation of Downstream Near Field Site(s)

Exact Binomial Test results for downstream near field sites are combined with the relative changes (upstream *vs*. downstream) in the arithmetic averages of the non-threshold response variable data, as shown in **Table 7-3** (western ecoregional zone) and **Table 7-4** (eastern ecoregional zone).

The department shall evaluate beneficial use support and achievement of the narrative nutrient standards in the fifth year of AMP monitoring in accordance with the near field dataset that has been collected, tables in this subsection, other credible data, and the conditions of the MPDES permit. This evaluation will result in a conclusion of "achieving" or "not achieving" beneficial use support/achievement of narrative nutrient standards. Evaluations made subsequent to the fifth year of data collection must be made using the entire applicable period of record until the time that the dataset time period is reset (dataset reset will be addressed in **Section 7.5** below).

Table 7-3. Evaluation at the 5-year Permit Cycle (n ≥ 10 Samples) for the Downstream Near Field Results in the Western Ecoregional Zone

Scenario	**EBT Result: Benthic Algae Levels** <125 mg Chla/m^2 AND <35 g AFDW/m^2 AND <30% FA cover?	**Macroinvertebrates** On average, D/S HBI > or ≤ U/S (note: higher HBIs are worse)	**Interpretation/Action**
A	PASS	D/S HBI ≤ U/S	Uses supported/narrative nutrient standards achieved
B	PASS	D/S HBI > U/S	Uses may be supported, narrative nutrient standards may be achieved. Consider HBI scores, investigate cause of higher (worse) downstream HBI scores; department will make final decision
C	FAIL	D/S HBI ≤ U/S	Uses may not be supported, narrative nutrient standards may not be achieved. HBI scores should be carefully reviewed and the department will make final decision
D	FAIL	D/S HBI > U/S	Uses not supported/narrative nutrient standards not achieved

Table 7-4. Evaluation at the 5-year Permit Cycle (n ≥ 20 Samples) for the Downstream Near Field Results in the Eastern Ecoregional Zone

Scenario	**EBT Result: DO Delta** <5.3 mg/L?	**BOD_5** On average, D/S BOD > or ≤ U/S (note: higher BOD is worse)	**Interpretation/Action**
A	PASS	D/S BOD ≤ U/S	Uses supported/narrative nutrient standards achieved
B	PASS	D/S BOD > U/S	Uses supported/narrative nutrient standards achieved: investigate cause of higher (worse) downstream BOD
C	FAIL	D/S BOD ≤ U/S	Uses not supported/narrative nutrient standards not achieved: minimal BOD sampling probably missed high-BOD events
D	FAIL	D/S BOD > U/S	Uses not supported/narrative nutrient standards not achieved

7.3.2 Evaluation of Upstream Near Field Site(s)

Similar to **Section 7.3.1**, dataset evaluations are undertaken at the *upstream* near field sites, which provide information about what is occurring in the watershed upstream of a point source facility. These are shown in **Table 7-5** and **Table 7-6**.

The department shall evaluate beneficial use support and achievement of the narrative nutrient standards in the fifth year of AMP monitoring in accordance with the near field dataset that has been collected, the tables in this subsection, other credible data, and the conditions of the MPDES permit. This evaluation will result in a conclusion of “achieving” or “not achieving” beneficial use support/achievement of narrative nutrient standards. Evaluations made subsequent to the fifth year of data collection will be made using the entire applicable period of record until the time that the dataset time period is reset (dataset reset will be addressed in **Section 7.5** below).

Table 7-5. Evaluation at the 5-year Permit Cycle (n ≥ 10 Samples) for the Upstream Near Field Results in the Western Ecoregional Zone

Scenario	**EBT Result: Benthic Algae Levels** <125 mg Chla/m^2 AND <35 g AFDW/m^2 AND <30% FA cover?	**Macroinvertebrates** On average, U/S HBI > or ≤ D/S (note: higher HBIs are worse)	**Interpretation/Action**
A	PASS	U/S HBI ≤ D/S HBI	Upstream area uses are supported/achieiving narrative nutrient standards
B	PASS	U/S HBI > D/S HBI	Apparently achieving: Consider HBI scores, investigate cause of higher (worse) upstream HBI scores; achievement of narrative standards will be evaluated by department
C	FAIL	U/S HBI ≤ D/S HBI	Apparently not achieving, however, HBI scores should be reviewed and final decision made by the department
D	FAIL	U/S HBI > D/S HBI	Upstream area uses not supported/not achieiving narrative nutrient standards

Table 7-6. Evaluation at the 5-year Permit Cycle (n ≥ 20 Samples) for the Upstream Near Field Results in the Eastern Ecoregional Zone

Scenario	**EBT Result: DO Delta** <5.3 mg/L?	**BOD_5** On average, U/S BOD > or ≤ D/S (note: higher BOD is worse)	**Interpretation/Action**
A	PASS	U/S BOD ≤ D/S BOD	Upstream area uses are supported/achieiving narrative nutrient standards
B	PASS	U/S BOD > D/S BOD	Upstream area achieving: Investigate cause of higher (worse) upstream BOD
C	FAIL	U/S BOD ≤ D/S BOD	Upstream area not achieving: minimal BOD sampling probably missed high-BOD events
D	FAIL	U/S BOD > D/S BOD	Upstream area uses not supported/not achieiving narrative nutrient standards

7.4. Permittee-Proposed Method

A permittee may propose an alternative method to evaluate beneficial use protection and achievement of the narrative nutrient standards. The department will review and approve or deny all alternate method proposals.

7.5 Dataset Reset

Nutrient reduction activities undertaken in the AMP watershed may justify a reset of the response variable dataset used to evaluate nutrient control effectiveness. The response variable datasets must properly represent current conditions. A dataset reset means establishing a new period of record for evaluating response variable data which begins after nutrient reduction activities have been implemented and these changes have the potential to affect response variables at the monitoring sites. Changes could come from improvement in the facility discharge, nonpoint source controls, or both. Permittees may request that a dataset be reset. The department will determine if and when a dataset reset is appropriate, in accordance with the AMP and the conditions of the MPDES permit.

7.6 Information Provided by Changes Upstream and Downstream of a Point Source

Near field site datasets collected upstream and downstream of a point source provide important information about relative changes in the response variables and the effectiveness of phosphorus-focused point source control. These data (and other relevant information) will be used (1) to inform the determination as to whether beneficial uses are supported and narrative nutrient standards are achieved, and (2) to inform next steps in adaptive management. Based on the outcomes of the upstream- and downstream- near field sites, different scenarios will be encountered; these are outlined in **Table 7-7**. The implications/actions in the table's right column should be used to guide next steps.

Table 7-7. Scenarios Resulting from the Outcome of Analyses Undertaken Per Subsections 7.2 through 7.4 above. Achieving/not achieving refers to whether beneficial uses are protected/the narrative nutrient standards are achieved at the near field monitoring location indicated.

Scenario	Upstream Site(s)	Downstream Site(s)	Implication/Action
A	Achieving	Achieving	Uses are supported/the narrative nutrient standards are achieved; continue to monitor
B	Achieving	Not Achieving	Uses are not supported/the narrative nutrient standards are not achieved; proceed to AMP implementation plan with nitrogen control considerations for the point source
C	Not Achieving	Achieving	Uses are not supported/the narrative nutrient standards are not achieved; any watershed nutrient reduction work undertaken should focus on the upstream watershed
D	Not Achieving	Not Achieving	Uses are not supported/the narrative nutrient standards are not acheived; proceed to AMP implementation plan with nitrogen control considerations which may begin upstream of the point source, at the point source, or both

8.0 AMP Implementation Plan Elements

All elements in this section must be incorporated into an AMP implementation plan. If the department finds that (1) phosphorus-focused control at the point source was unsuccessful in supporting beneficial uses and achieving the narrative nutrient standards (per **Section 7.0**), or (2) that phosphorus prioritization was not appropriate for the point source or receiving water body (per box 3, **Figure 1-1**), the permittee must develop and execute and AMP Implementation Plan. The Implementation Plan must, at a minimum, include the sections outlined in Chapter 8.

8.1 Identification, Quantification, and Characterization of All Sources of Nutrient Contributions in the AMP Watershed

The permittee(s) must identify, quantify, and characterize all nutrient sources in the watershed. The AMP must list all identified sources of nutrients in the watershed with specific locations.

Robust monitoring within the watershed will be necessary for a successful AMP implementation plan. Existing scientific information concerning algal growth dynamics, applicable scientific data specific to the region, locally collected data from the waterbody, and features of the point source effluent(s) and the nonpoint sources may all be used by the permittee to quantify and characterize the nutrient sources and loads in the watershed. Consideration should be given to the magnitude and extent of nonpoint source nutrients already in the receiving waterbody and the degree to which the point source(s) alone can reduce nutrient concentrations below algal growth saturation concentrations. Nutrient control projects downstream of a point source can be undertaken and may be credited to the point source's permitted load so long as hot spots (localized areas of water quality exceedences) are not occurring downstream of the facility.

For small, simple watersheds with a single point source (**Figure 8-1**), the two near field sites plus a downstream far field site and strategically selected tributary sites may be all that are necessary to adequately characterize nutrient loads in the watershed. A downstream far field site should normally be placed near the terminus of the AMP watershed (i.e., the point where the waterbody flows into the next watershed). Tributary sites are used to track tributary nutrient loading and, as illustrated in **Figure 8-1**, they may be used to monitor the effect of nonpoint source nutrient reduction projects (see Tributary 4 in the figure).

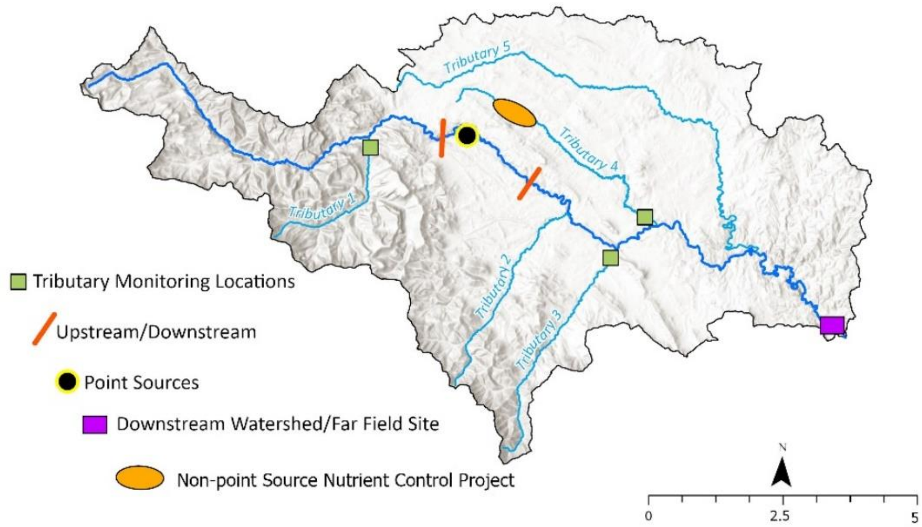

Figure 8-1. Example of a Simple AMP Watershed. Monitoring sites include near field sites, a downstream far field site, tributary sites, and a tributary site placed on Tributary 4 so that effects of an upstream nonpoint source nutrient control project on that tributary can be tracked.

In complex watersheds, such as those with multiple dischargers, there will need to be multiple sampling sites. These include near field sites bracketing the point source(s), far field sites, tributary sites, and mainstem monitoring sites (**Figure 8-2**). Tributary sites may be used to characterize nutrient concentrations and loads from principal tributaries, while far field sites characterize nutrient concentrations and loads at the far up- and downstream extent of an AMP watershed (**Figure 8-2**) as well as response variables, where applicable. One downstream far field site is required, at a minimum. When locating sites for an AMP watershed, permittees are advised to consider any current department guidance.

A downstream far field site should normally be placed at the terminus of the AMP watershed (i.e., at the point where the waterbody flows into the next watershed; see the downstream far field site in **Figure 8-2**), although there may be exceptions subject to department review and approval. Far field sites may be used to help assess achievement of the narrative nutrient standards at a larger waterbody or watershed (multiple waterbody) scale, if the permittee identifies this as an objective in the AMP monitoring plan and coordinates with the department to select sites for this objective. Upstream far field sites provide data on nutrient concentrations and loads entering the AMP watershed, and inform AMP loading calculations, TMDLs, etc. These do not necessarily have to be placed at the upper-most boundary of the HUC; they may be placed within the HUC if appropriate.

Site locations should be strategically located to monitor the effect of any nonpoint source control activities. For illustration, there are two nonpoint source nutrient control projects in the watershed in

Figure 8-2. The effects of the nonpoint source project on Tributary 2 are tracked at the monitoring site at the mouth of that tributary. Similarly, changes resulting from the nonpoint source project on the mainstem are tracked using a mainstem location placed downstream of it (red square, **Figure 8-2**).

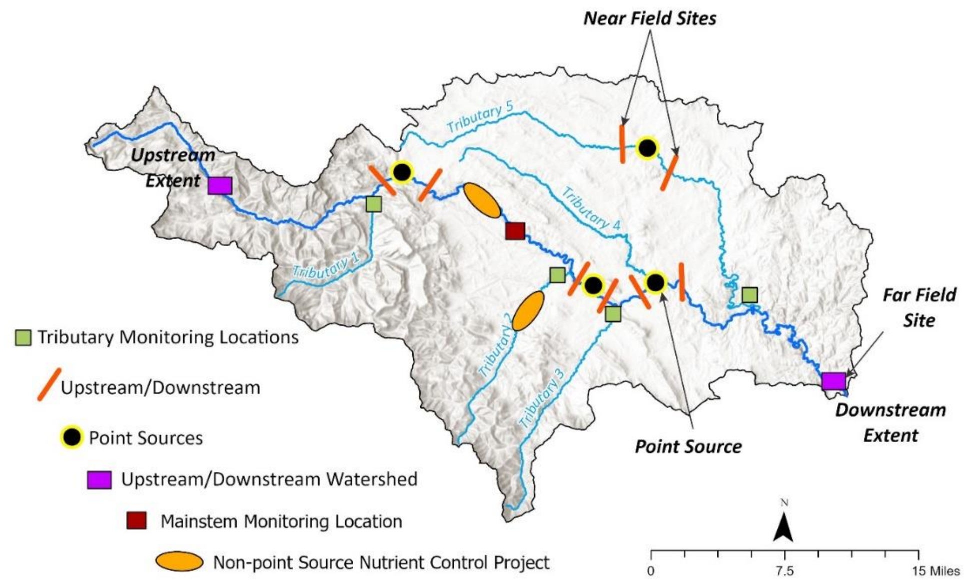

Figure 8-2. Example of a Complex AMP Watershed, Showing Different Types of Monitoring Sites

8.2 Identifying All Partners that will Assist in Implementing Nutrient Reductions

Permittees must identify partners to work with, including landowners, conservation districts, watershed groups, water quality districts, municipalities, counties, and others to target point and nonpoint sources of nutrients to minimize their overall fiscal outlays while achieving compliance with narrative water quality standards and improving water quality.

8.3 Develop and Document Action Items for the Reduction of Nutrients in the Watershed

Permittees must develop action items and goals to achieve nutrient reductions. Evaluation of information from the near field upstream and downstream monitoring sites (**Table 7-7**) should be used to inform these decisions. The permittee may choose to improve their individual facility and/or proceed with a broader nitrogen-focused watershed approach, possibly including additional phosphorus control or offsetting point and nonpoint sources in order to meet necessary nutrient reductions and achieve compliance.

8.3.1 Implementing Facility Improvements

A permittee may achieve nutrient reductions through conventional capital improvements or through additional work via Montana's optimization program. Montana offers technical support and training to municipal wastewater treatment plant operators to achieve nutrient reductions through operational optimization.

8.3.2 Implementing Nonpoint Source Projects

A permittee may achieve nutrient reductions in the watershed through nonpoint source project implementation. A TMDL WLA (more on TMDLs in **Section 10**) requires reasonable assurance that the load reduction expected will in fact be achieved. All significant pollutant sources, including natural background, permitted point sources, and nonpoint sources, need to be quantified at the watershed scale so that the relative pollutant contributions and reductions can be determined. Because the effects of pollutants on water quality can vary throughout the year, assessing pollutant sources must include an evaluation of the seasonal variability of the pollutant loading in relation to the time period nutrient controls are in place (most commonly, the growing season). This loading and reduction analysis may be done using a DEQ approved watershed-loading model and, in all cases, must be based on sound scientific an engineering practices.

Once necessary reductions have been calculated and allocated to nutrient sources, the permittee must select nonpoint source projects that will reduce nutrients to a level which will achieve the narrative nutrient standards in the waterbody. Further, the permittee must demonstrate reasonable assurance by having secured funding and landowner/partner agreements to implement nonpoint source projects in the watershed either individually, or in conjunction with other permittees and nonpoint sources, or other partners, including municipal and county governments. AMP implementation plans must include any contracts/landowner agreements reflecting commitments by partners to implement applicable actions.

8.3.3 Nutrient Trading

A permittee may achieve nutrient reductions through nutrient trading. *See* Circular DEQ-13. Trading is a market-based approach to achieving water quality standards in which a point source purchases pollutant reduction credits from another point source or a nonpoint source in the applicable trading region; these credits are then used to meet the source's pollutant discharge obligations.

8.4. Demonstrate the Ability to Fund and Implement the AMP Implementation Plan

Permittees who choose to invest in nonpoint source projects in the watershed to reduce nutrient loading must provide funding documentation in the AMP implementation plan. This documentation may include memorandums of agreement, contracts, or other written agreements that document a commitment to fund, implement, and complete projects with stakeholders. The documentation must identify all stakeholders participating, include cost estimates, assign specific contribution amounts to each stakeholder, and identify timelines for project completion that include responsibilities for each project implementation step. The contract or agreement must also specify the period non-point source controls will be maintained.

8.5 Continued Data Collection for Response Variables as Performance Indicators

Ongoing and potentially expanded collection and monitoring of response variables and thresholds, as well as nutrient concentrations, are the principal means by which the department will conclude if an AMP watershed is achieving the narrative nutrient standards. Data collection locations, frequency, and types must be linked to the action items and on-the-ground activities planned for a permittee's AMP implementation plan; these actions in turn must inform any updates to the AMP watershed monitoring plan, subject to department review and approval.

Data collection at the near field sites must be on-going and remain relatively consistent. However, data collection that best supports an AMP implementation plan needs to be adaptive. For example, potential nutrient sources identified during a watershed inventory may prompt the selection of new or additional monitoring sites to quantify nutrient loads or isolate potential nutrient reduction projects. Initial characterization at tributary sites may clarify which tributaries contribute greater or lesser nutrient loads to the receiving waterbody and therefore may lead to tributary sites being added or discontinued. Additional or different monitoring sites—particularly far field sites—may be required in order to demonstrate effectiveness of nonpoint source reduction projects or to affirm achievement of the narrative nutrient standards. Far field sites may be required in order demonstrate protection of downstream beneficial uses and to monitor changes over time.

8.6 Timeframes for Completing and Submitting Items in Sections 8.1 through 8.5; Annual Reports

Permittees or multiple permittees must identify the timeframe for completing and submitting to the department each of the components in **Sections 8.1** through **8.5** as part of their AMP implementation plan (or updated plan). Annual progress reports must be submitted to the department and must address all of the relevant actions taken under the AMP implementation plan in the year prior to the report.

9.0 Water Quality Models: Data Collection, Calibration and Validation, Assessment of Beneficial Use/Water Quality Impacts, Simulating the Effect of Potential Management Activities

The department may develop mechanistic water quality models for the state's large rivers where feasible. Once calibrated and validated, the models must be used to derive phosphorus limits for MPDES permits that protect beneficial uses and achieve water quality standards along the modeled reach.

A permittee may opt to pursue a mechanistic model for their adaptive management plan. In so doing, permittees must conform to the requirements in this section.

Field data to support model development serve multiple purposes. The data inform and constrain the model. The data must be collected at a sufficient number of strategically selected sites to ensure that the built model can properly simulate the effect of different management options and their resulting effects on water quality. The data are also used to determine if the narrative nutrient standards (and other water quality standards) have been achieved, per NEW RULE I (3)(c); more on this in **Section 9.2**.

Figure 9-1 (reproduced from Chapra 2003)[5] shows the overall methodology for developing and using a mechanistic model in an AMP watershed. Once developed, the model becomes a decision support system (DSS) which involves the integration of science and data for waterbody and water quality management. AMPs for nutrient management that are model-based must follow the water-quality modeling process identified in **Figure 9-1**, including each step starting with the problem specification (i.e., nutrient management), the water-quality modeling process (model selection, data collection for modeling, calibration and confirmation procedures, uncertainty analysis, and decision support, as detailed in the right side of the figure), and finally use of the model-based DSS to evaluate beneficial uses and achievement of water quality standards. Since the DSS can directly simulate (1) management activity impacts on surface water and (2) hypothetical load reduction(s) necessary to achieve the narrative nutrient standards and other water applicable water quality standards (dissolved oxygen, pH), and, the department shall use the modeling results to inform MPDES permit limits. Simulation of potential management activities within the DSS must reasonably balance all factors impacting a waterbody while considering the feasibility of treatment options and the expected water quality improvements.

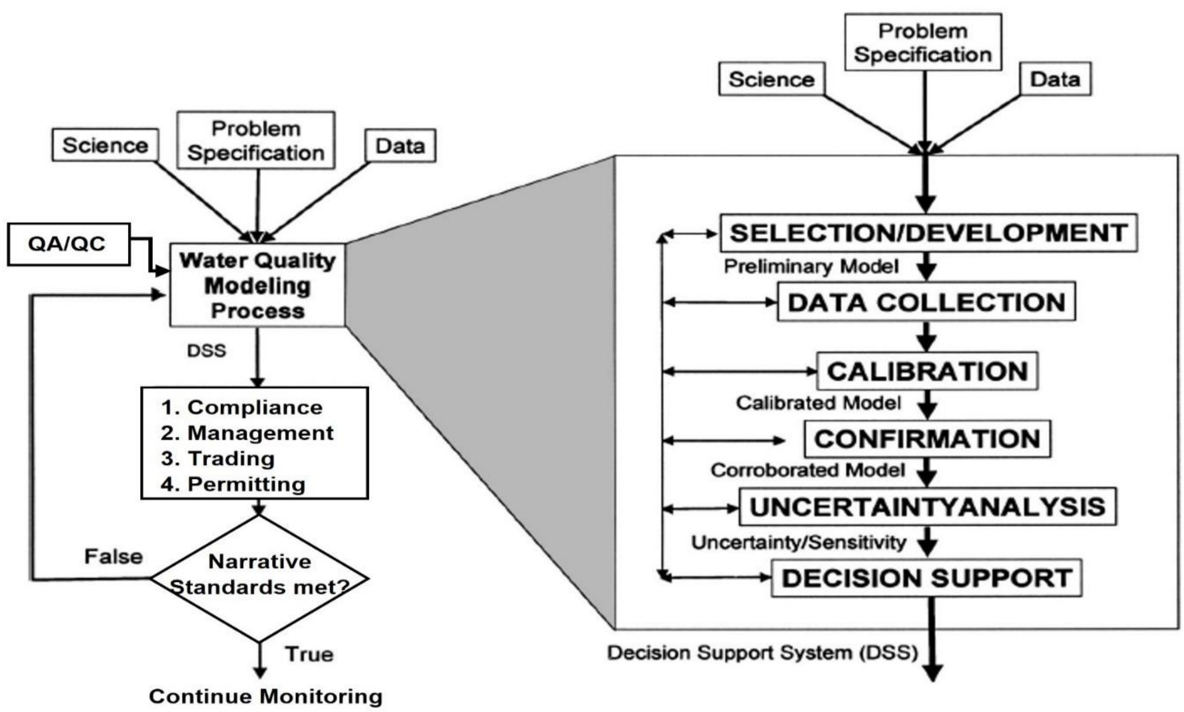

Figure 9-1. Process for Applying Water Quality Modeling an AMP Watershed. The principal components for developing, calibrating, and confirming a model are contained in the break-out box shown on the right-hand side of the figure. The developed model then becomes a decision support system for evaluating the effect of different management options, determining potential compliance pathways, and establishing permit limits.

9.1. TYPES OF MODELS, REPORT REQUIREMENTS

The department and permittees shall use non-proprietary modeling tools for AMPs. This means using only standardized modeling applications that are readily available to the public, are widely supported by federal agencies, and are also well known through both the professional and academic literature. In selecting a non-propriety modeling tool, permittees are advised to consider any current department guidance.

Once modeling activities are completed the modeling process must be documented in a report; it must describe the application of the model and report on outcomes and AMP planning decisions. Although reporting requirements will be project specific, minimum requirements for AMP defensibility must include the following: (1) an executive summary, (2) numeric table of contents, (3) project information and background, (4) model overview, (5) model construction overview, (6) model parameterization section, (7) model calibration, (8) model confirmation, and (9) the final modeling results. The report must have sufficient detail to document all phases of the modeling project in order that the process could be completed by an experienced user to generate similar modeling results. In developing models and the associated report, permittees are advised to consider any current department guidance.

9.2. DETERMINING IF NARRATIVE NUTRIENT STANDARDS ARE ACHIEVED

Field data collected to support model development may be used to assess if the narrative nutrient standards are achieved. Such an assessment could be completed even before a model is completed.

Protection of beneficial uses and achievement of water quality standard in large rivers—as well as for other flowing waterbodies which are being modeled—must be evaluated using all of the following response variables: (1) dissolved oxygen concentrations, (2) pH, (3) chlorophyll *a* (as bottom-attached [benthic] biomass), (4) turbidity (as a function of increased phytoplankton biomass), and (5) total dissolved gas (TDG). Water quality standards and thresholds associated with these response variables are found in: (1) for dissolved oxygen, Circular DEQ-7; (2) for pH, within specific water-use classifications found in ARM Title 17, chapter 30, subchapter 6; (3) for benthic biomass as chlorophyll *a*, in Suplee et al., 2009[6] at a density of ≤150 mg chlorophyll a/m^2; (4) for turbidity (as a function of increased phytoplankton biomass), within specific water-use classifications found in ARM Title 17, chapter 30, subchapter 6; and (5) for TDG, in Department Circular DEQ-7, but accounting for the fact the dissolved oxygen is only a fraction of TDG.

9.3. CONCEPTUAL WATER QUALITY MODEL

An alternative modeling approach to the mechanistic modeling methods described above is the development of a conceptual water quality model. Conceptual water quality models are a formal and rigorous process to identify stressors causing biological impairments in aquatic ecosystems (i.e., impacts to aquatic life beneficial uses), and a structure for organizing the scientific evidence supporting the conclusions. However, they do not provide for carrying out "what if" scenarios (e.g., "what will be the effect on diel pH fluctuations if the phosphorus load from source X is reduced by 25%?"), which is a distinct advantage of mechanistic models. The department must review and approve the use of a conceptual water quality model.

Permittees may develop conceptual water quality models to assess the array of factors which may be affecting their AMP watershed. This can include analysis of physicochemical factors which enhance or mute the effects of nutrients, analysis of conditions that may impact the macroinvertebrate community, etc. In developing conceptual models and the associated report, permittees are advised to consider any current department guidance.

10.0 Integration of the Adaptive Management Program with the Total Maximum Daily Load Program

When a waterbody is not achieving the narrative nutrient standards for TP and/or TN, it is considered impaired, and a total maximum daily load (TMDL) must be developed. To calculate the TMDL load allocations and wasteload allocations, the department will directly translate the narrative nutrient water quality standard to TP and TN values using a range of TN and TP concentrations derived from numerous relevant studies (see concentration ranges in **Table 4-1** in **Section 4.0**). Once the TMDL is determined, reductions are allocated to the source(s) of the pollutant in order to meet the TMDL.

Pollutant sources are characterized as either point sources, which receive a wasteload allocation (WLA), or as nonpoint sources, which receive a load allocation (LA). For purposes of assigning WLAs, point sources include all sources subject to regulation under the MPDES program. Where appropriate, wasteload allocations in a TMDL may incorporate strategies from the AMP implementation plan, designed to achieve water quality standards. When possible, the department will develop or revise TMDLs in conjunction with the AMP implementation plan to promote data collection and analysis, source assessment, and implementation efficiency and consistency.

10.1. Integrating an AMP Implementation Plan and the TMDL Wasteload Allocation

Effluent limits developed in MPDES permits will be consistent with the assumptions and requirements of any available TMDL wasteload allocation. Wasteload allocations may consider strategies outlined in the AMP implementation plan.

After implementing approved action items in the adaptive management plan, the department may find, based on the continued AMP watershed monitoring plan or other department assessment, that the facility is not in compliance; in this case, the department may require the permittee to evaluate AMP implementation to find additional ways to reduce nutrients in the watershed or require TN and TP limits at the end of pipe. AMP review and adaptation may prompt modifications to existing TMDL documents. Any substantive modifications to the TMDL require public comment and U.S. Environmental Protection Agency (EPA) approval.

11.0 ENDNOTES

(1) 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.

(2) 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. Helena, MT: Montana Dept. of Environmental Quality. For more specificity, refer to scientific citations within the document.

(3) Suplee, M.W., and V. Watson, 2013. Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers—Update 1. Helena, MT: Montana Dept. of Environmental Quality. For more specificity, refer to scientific citations within the document.

(4) Please refer to **Figure 5-1**. The most western zone (in green) comprises Montana sections of the ecoregions Canadian Rockies (41), Northern Rockies (15), Middle Rockies (17), and the Idaho Batholith (16). The transitional zone (dark gray) comprises Montana sections of the level IV ecoregions Sweetgrass Upland (42l), Milk River Pothole Upland (42n), Rocky Mountain Front Foothill Potholes (42q), and Foothill Grassland (42r) Non-calcareous Foothill Grassland (43s), Shields-Smith Valleys (43t), Limy Foothill Grassland (43u), Pryor-Bighorn Foothills (43v), and Unglaciated Montana High Plains (43o). The transitional zone has water quality and biological characteristics more in common with the far western zone than the eastern zone. The eastern zone (in dark orange) comprises Montana sections of the ecoregions Northwestern Glaciated Plains (42) and Northwestern Great Plains (43) which are not part of the aforementioned transitional zone.

(5) Chapra, S.C., 2003. Engineering Water Quality Models and TMDLs. *Journal of Water Resources Planning and Management* 129(4): 247-256.

(6) 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(1): 123-140.