EXHIBIT N

CRITICAL EVALUATION OF EPA'S DRAFT EMPIRICAL APPROACHES FOR NUTRIENT CRITERIA DERIVATION

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INTRODUCTION

The EPA Science Advisory Board (SAB) will meet on September 9 – 11, 2009 to consider the charge questions posed by the EPA Office of Water, Office of Science and Technology to review EPA's draft guidance on *Empirical Approaches For Nutrient Criteria Derivation* (hereafter "EPA Criteria Derivation Report"). The basic purpose of Section 303(c) criteria is to establish the level of water quality that is required to protect designated uses from specific adverse impacts associated with a pollutant. This document was released for public review on August 17, 2009 and it presents six statistical methods for analyzing nutrient data to relate the effect of nutrients to indicators of invertebrate use impairment. The guidance also presents a chapter on evaluating candidate stressor-response criteria from a consideration of the various statistical methods (See Guidance, Chapter 5 at 46). Together, these statistical approaches and the evaluation method are intended to serve as the primary basis for deriving Clean Water Act Section 303(c) numeric nutrient criteria. Where uncertainty exists in the regression analyses, EPA recommends that the lower confidence bound of the regression analysis be used to select the numeric nutrient criteria applicable to all similarly classified waters. EPA further indicates that even if an impairment threshold cannot be identified for a water body type, statistical "change point analyses" are sufficient to identify the necessary level of water quality that must be achieved. These criteria will serve as the basis for identifying waters as nutrient impaired and for preparing TMDLs to restore designated uses to nutrient-impaired waters.

The methods discussed in the draft EPA Criteria Derivation Report have already been used by EPA, as part of a "weight of evidence" analysis to derive numeric nutrient endpoints for several TMDL applications. (Attachment 1 (Piedmont End Point Report), Attachment 2 (Allegheny Plateau and Ridge and Valley Ecoregions of Pennsylvania: TMDL Application)). This "weight of evidence" analysis also considers distributional statistics and "literature" recommendations, in addition to stressor-response data, as the basis for selecting numeric nutrient endpoints for TMDL application. See EPA Criteria Derivation Report at 18. Objections raised on these TMDLs initiated an appeal of these methods and a request, supported by the Pennsylvania delegation, that the entire procedure undergo SAB review. (Attachment 3 (Request for SAB review) and Attachment 4 (support letter from Senators Specter/Casey)). In response, EPA agreed to conduct a SAB review of the new statistical methods being employed to derive nutrient criteria. EPA confirmed that SAB approval would allow nationwide implementation of the new approach (Attachment 5). In advance of this review, a detailed history of the misapplication of these various statistical concepts in nutrient TMDL development was prepared by Hall & Associates and published in BNA. (Attachment 6). This analysis, which demonstrated that specific application of simplified methods misdirected resources and failed to identify appropriate solutions for invertebrate impairments, provides insight to the Board on why EPA is seeking SAB approval of these new methodologies.

It is axiomatic that the Section 303(c) water quality criteria be based on clearly demonstrated cause and effect relationships. "*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*", USEPA 1985. The draft EPA Criteria Derivation Report and the charge to the SAB seeks SAB confirmation that the stressor-response data and framework provide this demonstration. We believe that the statistical methods presented by EPA for evaluating the stressor-response data are wholly inadequate for deriving water quality criteria, will misdirect state and local resources on a nationwide basis and more comprehensive methods in a mechanistic framework are necessary to properly address nutrient impairment issues. Moreover, statistical methods do not demonstrate that a scientifically defensible cause-and-effect relationship exists between stressors and recognized use impairment metrics (e.g., distributional statistics). The analyses fail to address a host of well understood plant growth mechanisms as well as the other ecological factors that influence invertebrate population dynamics. What is presented is merely a correlation analysis and correlations do not prove causation. Moreover, the alleged correlations presented are demonstrably flawed. Therefore, these methods cannot serve as the basis for deriving either necessary or protective numeric water quality criteria.

CRITERIA DEVELOPMENT REQUIREMENTS

By statute, criteria must be based on the latest available science and set at the level necessary to protect aquatic life and human health uses (CWA Section 304(a)). To achieve this requirement it is essential that criteria possess two attributes: (1) the criteria must be based on data that confirm the pollutant is causing use impairment at ambient concentrations, and (2) the level at which the numeric criteria is set is both <u>sufficient</u> and <u>necessary</u> to protect designated uses. See, 40 CFR 131.2 (Purpose) and 131.3 (Definitions – "Criteria", "Section 304(a) Criteria"). Thus, criteria are, in general, set at the <u>threshold</u> level where the pollutant exposure is demonstrated not to pose a significant threat to aquatic life (Section 304(a); 40 CFR 131.2 131.3 (b), (c)).

Since 1985, EPA has had a well-defined procedure for developing scientifically defensible water quality criteria when it published the "*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*", USEPA 1985 (hereafter "*Guidelines*"). The *Guidelines* establish a number of very specific scientific screening procedures that must be met to establish criteria that meet Section 304(a) mandates, as follows:

- Water quality criteria must ensure use protection "with a small probability of considerable overprotection or under-protection." (*Guidelines* p. 5).

- It is not enough that the criterion is the best estimate given the available data. Criteria should be derived "only if adequate appropriate data are available to provide reasonable confidence that it is a good estimate." (*Guidelines* p. 5).

- Criteria must be based upon studies showing a clear close/response relationship to determine effect concentration. Data from confounded studies (i.e., results that are influenced by factors other than the pollutant of concern) should not be used. (*Guidelines* p. 15, 16, 21).

- All decisions should be based on a thorough knowledge of aquatic toxicology and criteria decisions must be altered if there is a substantial probability of over or under protection of aquatic organisms and their uses. (*Guidelines* p. 18).

- Based on "all available laboratory and field information", it must be determined that proposed criteria are "consistent with sound scientific evidence." If not, another criterion should be derived. (The concluding recommendation of the *Guidelines* p. 57).

The new approach recommended for nutrient criteria development, however, fails to reflect these long established principles. While the focus of the *Guidelines* requirements was on parameters that cause direct toxicity, the scientific principles summarized above apply to all criteria development, including to nutrient criteria. A demonstrated cause-effect relationship is a requirement of all criteria. The EPA Criteria Derivation Report nowhere makes such a demonstration with regard to invertebrate impacts. The regressions and statistical methods simply <u>assume</u> the nutrient plotted is the cause of the changed condition, even under circumstances where the nutrient levels could not rationally be expected to be causing increased plant growth. Regardless of the method of derivation, nutrient criteria must ensure use protection with a small probability of considerable overprotection or under-protection. If there is a substantial probability that the criteria derived using the proposed method are over or under-protective, such criteria must be rejected. It is apparent, however, that large uncertainties are associated with the suggested methods, as the nutrient concentration alleged to be causing the metric response may vary by a factor of 50. (See EPA Report Figures 13, 14, 16, 25). If the available data are insufficient to ensure that the resultant criteria are reasonable, those data need to be augmented or discarded in favor of more appropriate data. Finally, if field data confirm the approach is misplaced, it should not be utilized. Unfortunately, the recommended approach makes no allowance for consideration of actual conditions and will result in regulating nutrients even where it is apparent that the metric level is already achieved. (See, Figure 33).

Expert Opinion Surveys are Inadequate to Derive Criteria

The draft EPA Criteria Derivation Report addresses the development of numeric criteria in Section 3.1. In the first case, it notes that states may already have designated use criteria (e.g., biological criteria) that can be related to numeric nutrient levels. If such relationships can be developed that ensure the designated use criteria are achieved with a small probability of considerable overprotection or under-protection, the resulting numeric nutrient criteria would be appropriate. The draft EPA Criteria Derivation Report also provides an alternative case:

Also, expert opinion regarding protective levels of variables can be methodically collected (Reckhow et al. 2005), and surveys can identify conditions that support user expectations for different waterbodies (Heiskary and Walker 1988). (EPA Criteria Derivation Report at 18).

Such an approach is not supported by Federal or State law and must be rejected as inappropriate for criteria development. Expert opinion surveys cannot replace specific requirements in federal and state law for deriving appropriate water quality criteria. The draft EPA Criteria Derivation Report is full of examples that derive candidate numeric nutrient criteria from metrics that are not recognized as a priori use impairments, particularly with regard to streams. These metrics include total taxa richness, number of EPT taxa, chlorophyll-a concentration, and diatom trophic state index. Such response metrics cannot be used as the basis for establishing numeric nutrient criteria unless those metrics are first designated as use impairment thresholds (i.e., criteria).

Failure to Consider Relevant Factors Influencing Plant Growth and Invertebrate Metrics

The EPA Criteria Derivation Report recognizes that biological metrics, in particular, may change dramatically in streams due to a host of conditions, natural and man-induced. (Report @ 14,17, 24, 25, 30, 34, etc.) Therefore, selection of a single metric is not scientifically defensible. The metric must be related to specific physical conditions that support the metric and its threshold. When criteria are met, water quality will generally protect the designated use. (See the definition of "criteria" in the draft EPA Criteria Derivation Report, at 76). If the methods contained in the draft EPA Criteria Derivation Report are appropriate, then compliance with the candidate numeric nutrient criterion will ensure that the biological metric is achieved. If the metric is not a use-impairment threshold (i.e., a criterion), then use restoration cannot be demonstrated and the *Guidelines* requirement is not met. However, it is not apparent that any of the examples presented in the draft EPA Criteria Derivation Report demonstrate an appropriate linkage between nutrients and the response variables. First, there is no linkage presented between plant growth and invertebrate impairment. Without this linkage, all other relationships are simply speculative.

In several cases presented, the stressor is identified as a nutrient concentration derived from a grab sample measurement (e.g., a measure of the instantaneous concentration at one point in time). (See, Figure 14). The response variable (e.g., total taxa richness) represents an instream condition that develops over an extended period of time unrelated to the time frame associated with the grab sample. In the case of stream macroinvertebrates, the community develops over time in response to antecedent conditions and the measure of total taxa richness reflects an averaging period consistent with the life cycle of the individual organisms, with some organisms living a year or more. Unless the grab sample measurement reflects the average condition over a period of time relevant to the biological response metric and other factors are <u>not</u> influencing the response metric (e.g., habitat), there is no reason to believe that the stressor measurement bears any relationship to the response. Since no evidence is presented in the EPA Criteria Derivation Report to suggest that stressor grab sample concentrations are representative of average conditions relevant to the response metric, the evaluation methods presented in the draft EPA Criteria Derivation Report are not consistent with sound scientific evidence and cannot be used to derive criteria.

Finally, the draft EPA Criteria Derivation Report advocates the development of numeric nutrient criteria for nitrogen and phosphorus regardless of need. (See, Figure 33). The EPA Criteria Derivation Report ignores plant growth mechanics and suggests that reducing nutrient levels that are far above saturation growth levels will somehow limit plant growth and thereby improve the invertebrate metrics. This is not scientifically defensible. Moreover, while nitrogen and phosphorus are both needed to sustain growth if either one is sufficiently limited growth will be limited. This scientifically validated concept has served as the basis for nutrient control for decades and establishing criteria for both parameters where control on only one parameter is needed to restore designated uses guarantees that such an approach provides significant overprotection in violation of the *Guidelines*.

PROBLEM DEFINITION

The draft EPA Criteria Derivation Report provides a reasonable problem definition with regard to nutrients and water quality criteria. It notes:

> Nutrients are essential for plant and microbial growth and at natural concentrations are generally considered beneficial. Over-enrichment by nitrogen and phosphorus stimulates excessive rates of plant and microbial growth and can produce biological and physical responses in surface water that adversely affect water quality and aquatic life. (EPA, 2009 at 1).

Simply stated, nutrients are not toxic to aquatic life at the concentrations typically encountered in receiving waters. However, depending upon the physical setting, they can stimulate excessive plant growth which, under certain conditions, can cause designated use impairments with regard to aquatic life, drinking water supply, or recreation. Use impairment is <u>not</u> caused by an "excessive" nutrient concentration. Rather, use impairment (e.g., recreation, fishery) is attributed to the presence of excessive levels of plant growth. In addition, elevated levels of plant growth may cause aquatic life impairments (e.g., low dissolved oxygen, pH out of range, habitat impairment). However, the linkage between nutrients and the impairments associated with them is highly complex and affected by a multitude of factors as suggested in Figure 10 from the draft EPA Criteria Derivation Report (at 16; presented below).

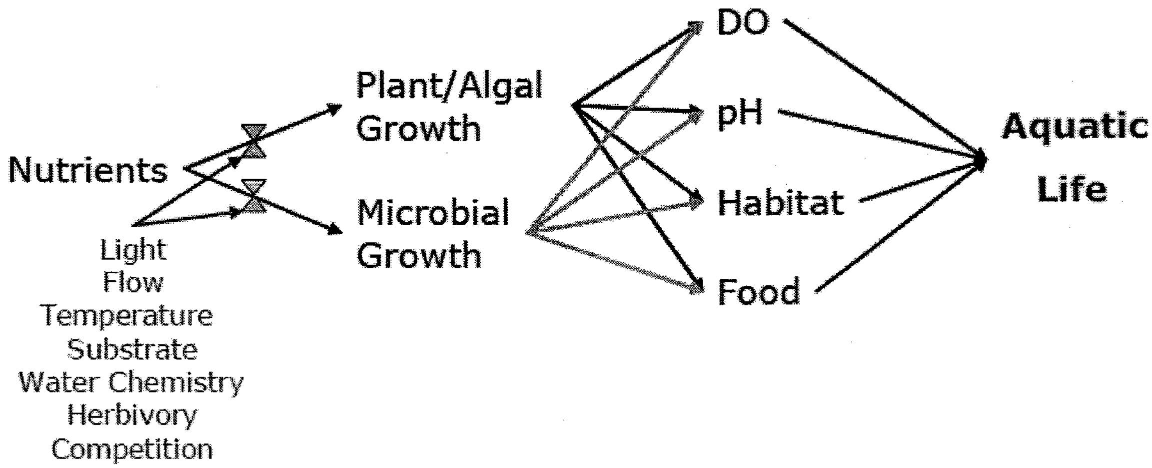


Figure 10. Simplified diagram illustrating the causal pathway between nutrients and aquatic life use impacts. Nutrients enrich both plant/algal as well as microbial assemblages, which lead to changes in the physical/chemical habitat and food quality of streams. These effects directly impact the insect and fish assemblages. The effects of nutrients are influenced by a number of other confounding factors as well, such as light, flow, and temperature.

Thus, two steps are required to link nutrient to invertebrate impairments: (l) demonstrate that nutrients are causing the excessive plant growth, and (2) demonstrate the level of excessive plant growth that will cause invertebrate population impairment. The degree of understanding of this complex linkage depends upon the type of receiving water being considered and the site-specific habitat. In the case of lakes and other receiving waters with extended residence times, this understanding is more advanced (relatively speaking with respect to plant growth) and numerous mechanistic models exist that reasonably predict the level of phytoplankton growth in response to nutrient loading. The degree of variability (a key *Guidelines* criteria development issue) associated with phytoplankton chlorophyll-a levels and nutrients is about a factor of 4, as illustrated in Figure 12 from the draft EPA Criteria Derivation Report. This figure shows that the target chlorophyll-a level of 15 μg/L spans TP concentrations ranging from approximately 16 – 64 g/L . Mechanistic considerations of lake processes are required on a site-specific basis to reduce this variability and set appropriate TP targets for use restoration, because a given TP level (e.g., 35 ug/L) could easily produce both unimpaired (< 15u/L chl "a") or impaired (>15 ug/L chl "a") results. Thus, even for lakes, simply knowing the nutrient concentration present is not sufficient information to determine what, if anything, needs to be done though the range of uncertainty is relatively small.

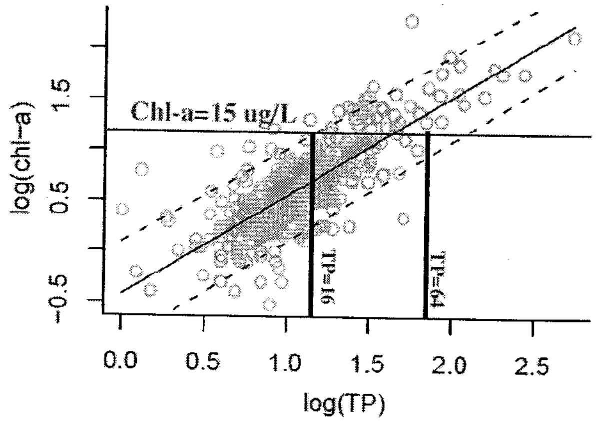
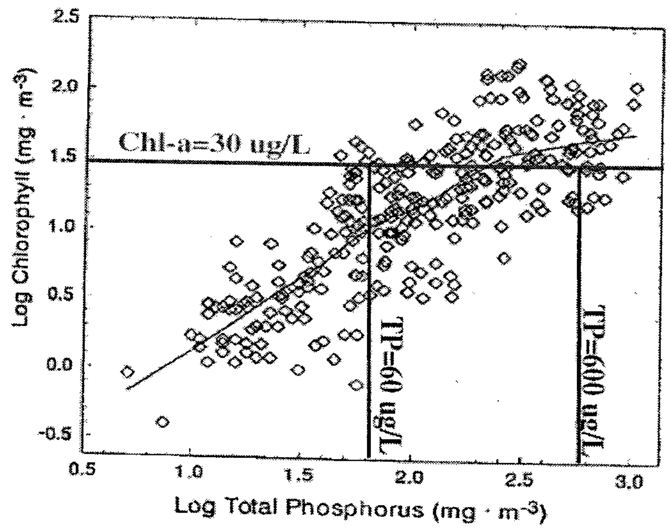


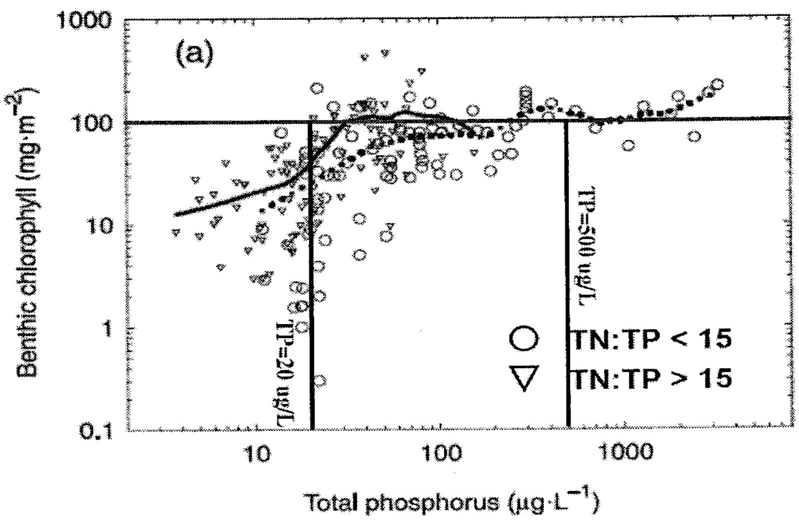
Figure 15. Log(TP) vs. log(chl *a*) for EMAP Northeast Lakes Survey. Dashed lines are the 5th and 95th percentile estimated by quantile regression. Solid line is the 50th percentile. Red line indicates where chlorophyll *a* = 15 μg/L. Units are μg/L.

In the case of rivers and streams, the ability to predict plant growth responses is significantly reduced and the uncertainty in nutrient effects increases markedly. For large rivers with phytoplankton growth issues, compared to lakes, increases to about a factor of 10.



Total Phosphorus Vs. Benthic Chlorophyll-a
(From Dodds. W. K., Smith, V. H., and Lohman, K., 2006)

The work of Dodds regarding periphyton growth regressions was referenced in several places in the document, though the actual data and results were not presented. Dodds' work demonstrates that the uncertainty in periphyton growth for streams is far greater than phytoplantkton growth in rivers. The graph below indicates that periphyton responses vary by a factor of 25 with regard to nutrient level. While not presented in this report, EPA has extensively assessed the relationship between periphyton growth and nutrient levels. The results generally confirm there is no demonstrable "regression" relationship between nutrient levels and periphyton response.



Total Phosphorus Vs. Benthic Chlorophyll-a
(From Dodds. W. K., Smith, V. H., and Lohman, K., 2006)

In fact, it was analyses such as these that led EPA to abandon its earlier recommendations that Dodd's simple regression equations be used to predict periphyton growth. Mechanistic models to predict the level of periphyton growth (i.e., benthic algae) are available and many factors that are unimportant in lakes and large rivers significantly affect such growth in streams (e.g., canopy, scour, substrate) are addressed in those model frameworks. This information confirms that there is no reasonable confidence in setting a river or stream nutrient objective, given the lack of cause and effect relationship presented by the periphyton data and wide range in phytoplankton responses. Thus, the following is apparent with regard to plant growth responses to elevated nutrient levels:

(1) simplified approaches used for lakes do not apply to rivers and streams, as the variability in response increases greatly for these waters; and,

(2) a scientifically defensible approach to rivers and streams must account for the factors influencing plant growth dynamics.

Regarding the "relationship" between nutrient levels and invertebrate populations, the uncertainty increases even further. This is evidenced by the extremely poor r^2 that results from the attempted correlation analyses (See, Figures 14, 16). In most instances, EPA does not even provide this basic statistical information for the SAB review. The poor correlation coefficient is indicative of a very weak relationship. For example, Figure 13 from the draft EPA Criteria Derivation Report illustrates total taxa richness in West Xeric region streams as a function of nutrient concentration. This figure shows that the target richness level of 40 spans TN concentrations ranging over two to three orders of magnitude (based on the 90% prediction interval). Even at quite high nutrient levels (TN> 2 mg/l) taxa richness response ranges from less than 10 (very poor) to 70 (excellent). Such information confirms that some other factors, unrelated to nutrient level are responsible for these widely varying results. Similar results are found for phosphorus and EPT richness. See EPA Report Figure 14. This type of data scatter prevent the reasonable selection of a nutrient target level that is necessary to ensure use protection.

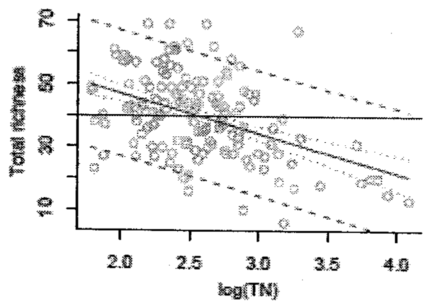


Figure 13. Log(TN) versus total species richness in EMAP-West Xeric region streams. Solid line: mean regression relationship, dashed lines: 90% prediction intervals. Red horizontal line indicates total richness = 40. Units are µg/L for log(TN). Regression equation: Total Richness = 72 – 13[Log(TN)], R^2=0.19, p<0.001.

EPA'S REPORT IS MISSING CRITICAL FOUNDATION ANALYSES

The draft EPA Criteria Derivation Report does not provide any analysis showing the most critical relationship needed to establish an invertebrate-based nutrient criteria– the relationships between algal growth and invertebrate metrics. Moreover, the EPA Report is devoid of information showing a reliable connection between nutrient level and benthic plant growth for streams or rivers. The Report does cite on several occasions to the work of Dodds (relating periphyton growth to nutrient concentrations), though as shown above, such relationships are simply misplaced. (See also Attachment 6 confirming Dodds' equations fail to reliably predict periphyton growth in the PA TMDL action). This is rather dramatic oversight considering that nutrient criteria development is primarily targeted at excessive plant growth. If such a relationship was presented, it would likely show variability exceeding two orders of magnitude. This extreme level of variability is due to the fact that other factors tend to control plant growth in streams and invertebrate responses are more influenced by factors other than nutrients.

Tetra Tech (2008) (EPA's contractor on the EPA Criteria Derivation Report) conducted a literature review of nutrient – algal growth relationships for EPA in conjunction with the development of five nutrient TMDLs in Pennsylvania, and concluded the following:

> "Study results summarized as part of this literature review support the assertion that while a relationship may exist between periphyton growth and nutrients, the dynamics change as a function of multiple factors. These factors include antecedent conditions, water temperature, pH, light availability, flow regime, and grazing, among others. *Nutrient levels may be secondary to other determinants of biomass and growth such as light, disturbance, and grazing."* (Tetra Tech (2008a) at 18).

The linkage between nutrients and aquatic life is more indirect than that for plant growth. As depicted in Figure 10, algal growth and microbial growth are more directly affected by nutrients. These effects filter through the receiving water ecology and influence macroinvertebrate and fish communities. However, this linkage is more subtle because of the intervening steps that separate the animal communities from nutrients and the numerous other factors influencing the presence of these higher order organisms. For this reason, prior EPA nutrient criteria development guidelines have recommended that nutrient criteria development focus on the relationship between nutrients and plant growth (EPA, 2000). Once that relationship is defined, the more indirect impacts on macroinvertebrates and fish can be explored if necessary.

> "fish and macroinvertebrates do not directly respond to nutrients, and therefore may not be as sensitive to changes in nutrient concentrations as algal assemblages. 6It is recommended that relations between biotic integrity of algal assemblages and nutrients be defined and then related to biotic integrity of macroinvertebrate and fish assemblages in a stepwise, mechanistic fashion." *Nutrient Criteria Technical Guidance Manual – Rivers and Streams, USEPA July 2000* @ 85.

Contrary to the *Technical Guidance Manual,* the draft EPA Criteria Derivation Report provides multiple examples attempting to relate macroinvertebrate metric response directly to nutrient concentrations even though the response is far removed from the stressor and none of the necessary intervening plant growth responses were documented. Clearly, the candidate numeric nutrient criteria that result from this approach will be either too restrictive or not restrictive enough, and, with EPA's recommended approach, there will be no way of knowing which error has been made until the numeric criteria are achieved and the response is re-evaluated. Thus, it is apparent that the new recommended approach is guaranteed to misallocate resources on a large scale if applied to the regulatory process. Such an approach fails to meet *National Guidelines* prerequisites.

ESTABLISHMENT OF FIXED NUTRIENT CONCENTRATIONS AS CRITERIA IS INAPPROPRIATE

The expressed purpose of the draft EPA Criteria Derivation Report is to facilitate the development of nutrient criteria. Criteria are defined as constituent concentrations, levels, or narrative statements representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use. With respect to Figure 10, the quality of water that supports a particular use is defined by the algal growth in the receiving water, constituent concentrations that may impair uses, affected by algal growth (i.e., DO, pH, clarity), and the aquatic life present. These measures are a direct indication of whether a designated use is impaired or not. The nutrient level is not the parameter that describes use impairment.

This situation is analogous to the relationship between dissolved oxygen and biochemical oxygen demand. Low dissolved oxygen level directly causes toxicity to aquatic life and water quality criteria are established to protect aquatic life by setting numeric DO requirements. Although BOD affects DO, there are no BOD water quality criteria because BOD, itself, is not toxic and multiple factors affect how BOD is expressed in the water column. These factors are reasonably well known and site-specific, mechanistic models are used to account for them in setting appropriate effluent limitations. This well known approach should serve as a model for addressing nutrient-related impairments.

Consequently, nutrient criteria should be expressed as a level of algal growth or an aquatic life metric that reflects the designated use, impacted by algal growth (e.g., secchi depth in lakes, periphyton growth level that impairs invertebrate populations). Then, based on a mechanistic understanding of the waterbody, the concentrations of nitrogen and/or phosphorus necessary to achieve the target water quality may be ascertained because there are no uniform system responses to this pollutant. Mechanistic models that relate the significant determinants of criteria response must be applied to ensure the correct cause of impairment and solution are related. Then, the controls necessary to eliminate use impairment, as evidenced by the numeric criteria, can be implemented on a site-specific basis.

CONCLUSIONS AND RECOMMENDATIONS

The statistical procedures presented in the EPA Report are not a scientifically defensible substitute for developing a clear, reproducible relationship between a pollutant and the stressor of concern. Such information must exist to develop scientifically defensible Section 303(c) criteria. Moreover, it is apparent that extreme uncertainty exists under EPA's suggested approach such that there is no reasonable basis to believe that nutrients are either (1) the cause of a macroinvertebrate impairment or (2) that reducing nutrients to the levels described in the report would remedy such impairment. Where regression analyses are completed, the r^2 values all appear to be 0.1 or less. Thus, more than 90% of the "impairment" is NOT explained by the nutrient level. Using alternative statistical tools does not "improve" the lack of relationship contained in the dataset. The scientific community generally recognizes that such weak relationships are not a basis for concluding that a cause and effect relationship has been established. Such weak relationships cannot be used to develop necessary, sufficient and scientifically defensible water quality criteria.

Perhaps the greatest flaw in the suggested approach is that it assumes that nutrients are the cause of the impacts being assessed, ignoring (1) other factors that influence the metric being measured (e.g., habitat and other common stressors) and (2) known plant growth kinetics that confirm the measured impacts at high nutrient levels cannot be the cause of reduced invertebrate populations. In particular, where the saturation growth rate concentration is exceeded (generally above 50 ug/l TP or 300 ug/l TN), increased nutrient concentrations are not expected to cause additional plant growth. For these high nutrient levels, the sometimes measured dramatic decrease in invertebrate metrics must be caused by a co-occurring phenomena – such as excessive sedimentation or habitat alteration, not nutrients. Ignoring these well established factors that may control the type and richness of invertebrate populations is not scientifically defensible. Conversely, the analysis entirely failed to assess how the invertebrate metrics change in the range where nutrients may be the primary factor controlling plant growth – assuming excessive plant growth is occurring. Such analyses, as discussed herein, indicate that there is no demonstrable nutrient: invertebrate population relationship in this range of nutrient concentration.

Lastly, it is apparent from the extensive stream and river databases that attempts to select a single nutrient value to be applicable in all such waters is not rational. Plant growth responses, the primary concern of nutrient control, are not uniform, and are primarily controlled by the physical setting. Even in lakes where light is not generally limited and sufficient detention time is not an issue, selection of a single target value will allow the actual plant growth level to vary by a factor of 4. Selecting the target nutrient level from the lower end of the uncertainty range, as suggested by EPA, will ensure that a very substantial number of situations are over regulated. For streams, the range of plant growth responses increases to a factor of 20 or greater. Invertebrate responses that are even more remotely related to nutrient levels have a *2 order of magnitude range.* A more rational approach would be to identify appropriate plant and biological response levels that represent impaired and unimpaired conditions over a range of habitat types. Such indices could be used to appropriately identify waters that need remediation. Based upon the factors influencing the impairment, as appropriately assessed with site-specific information, the proper remedial measures would be identified. Where "excessive" plant growth is occurring, particularly with streams, the solution may not be nutrient reduction. Rather, various forms of canopy or stream bank restoration or flow/depth modification may be the more effective and possibly the only solution to address the condition. Again, this would be determined on a case-specific basis, not through a one-size-fits-all nutrient criteria that is certain to misallocate and misidentify impairments and appropriate solutions.