**Comments on**
**US EPA "Empirical Approaches for Nutrient Criteria Derivation"**
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Comments submitted
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The US EPA Office of Water is attempting to gain support for the development of nutrient criteria based on a statistical approach that is supposed to relate nutrient concentrations to a water quality impact. The US EPA Science Advisory Board's (SAB) draft executive summary for its discussion of "Empirical Approaches for Nutrient Criteria Derivation" states:

> "*Step 1 reviews techniques for selecting the variables that appropriately quantify the stressor (i.e., excess nutrients) and the response (e.g., chlorophyll a (chl a), dissolved oxygen, or a biological index). Selecting response variables that relate directly to measures of designated use are most appropriate since criteria must ensure protection of the designated uses. This step then describes data exploration, visualization, and summary. Exploratory techniques include histograms, box and whisker plots, Quantile-Quantile plots, cumulative distribution plots, scatter diagrams, and spatial mapping. The visualization step helps the analyst understand how variables change across space and time, general relationships among variables and how one or more variables co-vary. Conditional probability analysis, a more quantitative statistical approach for summarizing the data can also be used for data exploration.*"

Lee and Jones-Lee commented on the unreliability of the US EPA's conditional probability approach for establishing phosphorus nutrient criteria in the report:

> Lee, G. F., and Jones-Lee, A., "Comments on US EPA's Conditional Probability Approach for Developing Phosphorus Nutrient Criteria," Report of G. Fred Lee & Associates, El Macero, CA, September 26 (2008).
> http://www.gfredlee.com/Nutrients/PCriterionCondProb.pdf

As Lee and Jones-Lee discussed in that report, "conditional probability" as being advanced by the US EPA is not a technically valid approach for establishing phosphorus nutrient criteria for use in establishing and regulating allowable phosphorus discharges to a waterbody. Because those Lee and Jones-Lee (2008) comments on technical aspects of the unreliability of the conditional probability approach have considerable applicability to this review of the US EPA proposed statistical approach for developing nutrient criteria, they are appended to these comments as a source of additional information on the problems with the proposed statistical approach, and should become part of the record of the SAB review of the statistical approach for establishing nutrient criteria.

Dr. G. Fred Lee has had more than 40 years of experience in developing water quality criteria and using such criteria in water quality management, as well as in the aqueous environmental chemistry of nutrients, including their behavior, fate, and water quality impacts. In the early 1970s Dr. Lee was a National Academies of Sciences and Engineering-invited peer reviewer of Academies' Bluebook of Water Quality Criteria-1972. In the early 1980s Dr. Lee served as a US EPA-invited peer reviewer of the then-proposed water quality criteria development approach and of several criteria documents. The approach that was developed is still being used today. Additional information on the authors' qualifications to submit these comments is provided on their website, www.gfredlee.com. Based on this experience, it is clear that statistical approaches of the type proposed are not reliable for the development of nutrient criteria. Criteria developed through that approach cannot be relied upon to provide technically valid assessments of potential water quality impacts of nutrient inputs or to provide appropriate regulation of nutrient discharges.

*"Step 1"* of the proposed approach, quoted above, states that a "*biological index"* can be used as a "*stressor response."* That claim is without technical merit. The factors that influence the various "biological indexes" are poorly understood; relationships between "biological indexes" and water quality are coincidental. Nutrient loads/concentrations do not even necessarily influence, much less control, such "indexes." Biological indexes are not reliable stressor responses to nutrient enrichment.

While it is of interest to examine the relationships between nutrient loads/concentrations to/within a waterbody and nutrient-related water quality characteristics of the waterbody, great caution must be exercised in using statistical relationships developed from such exercises to establish regulatory requirements enacted for the purpose of achieving desired nutrient-related water quality characteristics. Employment of technically inappropriate statistical relationships can readily lead to arbitrary nutrient discharge restrictions that can trigger large expenditures for "nutrient control" from domestic wastewaters, urban and agricultural runoff/discharges, and others without the expectation or achievement of the desired water quality.

The SAB's draft Executive Summary stated,

> "*Step 2 is assessing the strength of the cause-effect relationship represented in the stressor-response linkage. When stressor-response relationships are used to establish nutrient criteria, it is important to assess the degree to which changes in nutrient concentration are likely to cause changes in the chosen response variable. This can be accomplished using conceptual models, existing literature, and empirical models."*

Beginning in the 1960s G. F. Lee became highly involved in examining the relationships between nutrient loads to waterbodies and the associated resultant nutrient concentrations and nutrient-related water quality characteristics/responses within those waterbodies. Beginning in the 1970s, with support from the US EPA nutrient management water quality program, he held contracts to examine and quantify relationships between nutrient loads to waterbodies and associated fertilization water quality responses. In the 1970s he, Dr. Anne Jones-Lee, and several colleagues, especially Dr. Walter Rast, became involved in the US and the international OECD Eutrophication Study program. They developed a series of reports on nutrient load–

fertilization response relationships for several hundred waterbodies located throughout the US, in Western Europe, North America, Japan and Australia. That work included investigation of predictive capabilities of empirical models based comparison of predicted and measured changes in water quality response resulting from nutrient load alterations. Many of their papers and reports on that past and ongoing effort are located on the Lee/Jones-Lee website, www.gfredlee.com in the Excessive Fertilization Section http://www.gfredlee.com/pexfert2.htm.

The work by Drs. Lee and Jones-Lee on these issues continues today including on issues of the excessive fertilization of the Sacramento San Joaquin Delta. They continue to closely follow work on these issues in other areas including the California State Water Resources Control Board's work to develop nutrient criteria for enclosed bay and estuaries, and the Mississippi River watershed. They also periodically discuss emergent and recurring nutrient-related water quality issues in their Stormwater Runoff Water Quality Newsletter, an email-based newsletter distributed at no cost to more than 10,400 professionals and other interested individuals. Past issues are available online at http://www.gfredlee.com/newsindex.htm. The most recent issue (Volume 12, Number 5) is devoted to nutrient water quality issues. Newsletters 1-2, 1-3, 1-5, 4-3/4, 5-1, 6-1, 6-2, 7-6/7, 9-1/2, 9-7, 9-8, 9-10, 10-4, 10-5, 10-6, 10-7, 10-13, 11-2, 11-5, 11-9, 12-3, 12-5, 11-7/8, 11-9, 11-10, and 12-3 have discussed nutrient-related water quality issues. Many of the topics discussed in those issues need to be considered in developing water quality criteria for nutrients, but were not reliably considered in the draft approach outlined by the US EPA.

Over the past four decades that Dr. G. Fred Lee has been active in examining nutrient load – response relationships, he has repeated observed the unreliability of statistical correlations developed between nutrient concentrations and assumed responses. It has been his experience that the current "Empirical Approach" can readily lead to unreliable approaches for developing nutrient criteria for the management of excessive fertilization of waterbodies. It is not a matter of the approaches' yielding overly protective, or under-protective regulation and management. The problem is that they are not technically sound; a technically unsound approach cannot be expected to render reliable criteria/standards, or conclusions regarding the necessity for or water quality impacts of nutrient loads or management steps that could be required to achieve arbitrary criteria/standards.

*Steps 3 though 5 (Step 3 – Analyzing Data, Step 4 – Evaluating estimated stressor response relationships, Step 5 – Evaluating candidate stressor response criteria).* Basically these steps direct the use of the statistical relationships to develop nutrient criteria. One of the fundamental flaws in the US EPA's empirical approach is that statistical "relationships" can be developed without there being a mechanistic (cause-effect) foundation that relates how nutrients impact water quality. An example is seen in the situation that occurred when a national US university professor conducted a multi-variant analysis of data that were available on nutrient concentrations and algal biomass without including information on the hydrologic and morphologic characteristics of the waterbodies in the statistical analysis. As was demonstrated in the authors'(Lee and Jones-Lee) evaluation and quantification of nutrient load–response relationships based on data from more than 750 waterbodies world-wide noted above, waterbody mean depth and hydraulic residence time are key parameters controlling the nutrient concentrations and nutrient-related water quality characteristics that result from nutrient input to waterbodies.

There are many other "statistical approach" relationships reported in the literature that are not valid for relating nutrient loads/concentrations to fertilization response. Statistical "relationships" can be developed that have little or no capability to reliably predict changes in nutrient-related water quality characteristics that would result from changes in nutrient loads. Such a demonstration is of paramount importance for the development of nutrient criteria developed for the purpose of controlling nutrient-related water quality. Any statistical relationship between nutrient load and waterbody response must be solidly grounded in fundamental mechanisms (cause-effect) that influence how a nutrient could impact a fertilization response. Without such a foundation, the statistical relationship is simply game playing.

The draft proposed approach contains a number of log-log plots of total nutrient concentrations vs some "indicator response." Critical examination of those plots shows that there is no defensible relationship between the concentrations and the "indicator." Such plots cannot be used to develop a meaningful criterion or defend a management practice for the control of nutrient-related water quality characteristics of a waterbody.

Overall, the US EPA should abandon it present efforts to develop nutrient criteria based on "statistical approaches" and focus on supporting research to reliably define the adverse and beneficial impacts caused by addition of nutrients to waterbodies.

Appendix

Lee, G. F., and Jones-Lee, A., "Comments on US EPA's Conditional Probability Approach for Developing Phosphorus Nutrient Criteria," Report of G. Fred Lee & Associates, El Macero, CA, September 26 (2008).
This report is available as a downloadable file from,
http://www.gfredlee.com/Nutrients/PCriterionCondProb.pdf, and should be incorporated as part of these comments.

**Comments on US EPA's Conditional Probability Approach for Developing Phosphorus Nutrient Criteria**

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The US EPA Region 3 (Mid-Atlantic Region) has adopted a "conditional probability" approach for developing phosphorus nutrient criteria/standards, which are being used in implementation of TMDLs to limit the discharge of phosphorus to streams in part of that Region. The approach is based on an assumption that total phosphorus is a primary and incremental cause of alterations in selected invertebrate populations in streams, and that those alterations diminish the water quality/beneficial uses of those streams. It also assumes that the statistical association between those two variables in one location can be reliably transferred to another.

The conditional probability approach for developing phosphorus criteria for streams evolved from the US EPA headquarters' promotion and representation of the conditional probability approach as scientifically defensible for stream nutrient standard development, through its N-Steps program. The US EPA's summary of the N-Steps' conditional probability approach is presented at,
http://n-steps.tetratech-ffx.com/PDF&otherFiles/stat_anal_tools/conditional%20prob_final.pdf.
That approach presumes a cause-and-effect relationship between total phosphorus in a stream and the "EPT taxa richness" (abundance of organisms in the orders *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies)) based on the co-occurrence of measured total P concentrations and EPT populations for a small group of selected streams. In those streams, higher total phosphorus concentrations were said to co-occur with lower invertebrate populations.

The US EPA Region 3 applied this "conditional probability" approach to implement TMDLs for nutrient control for several Pennsylvania streams. Despite the US EPA headquarter's advocacy and Region 3's use of this approach, the technical foundations of and assumptions inherent in that approach, the applicability of the "conditional probability" statistical manipulation, itself, for this purpose, as well as the reliability of the outcomes of such assessments for management purposes, have all been the subject of considerable and justified criticism.

Further, there are significant procedural problems with the approach that the US EPA has followed in adopting the "conditional probability" approach for developing water quality criteria. Section 304(a) of the Clean Water Act requires that the US EPA first publish proposed changes in water quality criteria development guidance in the *Federal Register* before using the proposed changes. A *Federal Register* notice would have informed the regulated community and others of the proposed new criteria development approach and provided a formal opportunity for interested and knowledgeable parties to comment on the scientific basis for US EPA's proposal.

Following that required approach would have triggered a formal peer review of the new proposed approach for developing water quality criteria. The conditional probability criteria development approach has not been formally peer-reviewed.

Presented below are comments on the conditional probability approach for establishing water quality criteria/standards; they focus on aspects of its technical foundations and assumptions. The deficiencies discussed underscore the inappropriateness and unreliability of the approach for use in developing instream, phosphorus water quality criteria/standards used to limit the discharge of phosphorus from point and non-point sources, as well as in developing water quality criteria/standards for other parameters.

**Background of Authors**

Dr. Lee has been involved in research, teaching, public service, and private consulting in the evaluation and management of water quality impacts of phosphorus for the past nearly five decades. He earned a PhD degree in environmental engineering/water chemistry from Harvard University in 1960. For the following 30 years he held university graduate-level faculty positions at several US universities, focusing on aquatic chemistry, aquatic toxicology, and water quality evaluation and management. During that time he also conducted more than $5-million in research and published more than 500 papers and reports on his work. A large portion of that research was devoted to aquatic plant nutrients, especially phosphorus – nutrient sources, availability, monitoring, quantification, load–response relationships/modeling, and management. During his university faculty career he frequently served as a consultant to governmental agencies in the US and in other countries on the causes, evaluation, and management of excessive fertilization of waterbodies. In 1989 Dr. Lee retired from his position as Distinguished Professor of Environmental Engineering at the New Jersey Institute of Technology to shift his professional focus to full-time, independent consulting on water quality issues through his firm, G. Fred Lee & Associates.

Dr. Anne Jones-Lee earned her Bachelor of Science degree in biology from Southern Methodist University and her PhD degree environmental sciences from the University of Texas at Dallas. Her PhD dissertation was devoted to the aquatic chemistry of phosphorus associated with aquatic sediments. From 1978 through 1989 she held professional positions in environmental engineering and environmental sciences at several US universities. Having teamed with Dr. Lee since the mid-1970s, she joined him in full-time consulting in 1989.

Over the past two decades, Drs. Lee and Jones-Lee have had several major research projects devoted to nutrient water quality issues, and have developed more than 600 additional papers and reports on their research and consulting activities. They have established a website, www.gfredlee.com, on which they post their papers and reports. One of the major sections of that website [http://www.gfredlee.com/pexfert2.htm] is devoted to their investigations into aquatic plant nutrients and the excessive fertilization of waterbodies. In addition, many of the papers and reports they developed during their university careers have been scanned and posted on their website. Additional information on Drs. Lee and Jones-Lee's professional experience in investigating nutrient-related water quality issues is available at, http://www.gfredlee.com/exfert.htm.

Over the past ten years Drs. Lee and Jones-Lee have been involved in the investigation of excessive fertilization – its causes, impacts, and control – in the Sacramento and San Joaquin Rivers and Delta. Several of the papers and reports they have developed on those studies are posted on their website at http://www.gfredlee.com/psjriv2.htm. On behalf of the California Water and Environmental Modeling Forum they organized the "Delta Nutrient Modeling Workshop" that was held in Sacramento in March 2008 (Lee and Jones-Lee, 2008). They have also been involved in reviewing nutrient control issues for the Upper Mississippi River as nutrients from that area impact the anoxic conditions that develop in the northern Gulf of Mexico.

Dr. Lee has been involved in the development of water quality criteria and their use as water quality standards since the mid-1960s. He served as an invited peer-reviewer for the National Academies of Science and Engineering "Blue Book," "Water Quality Criteria – 1972" (NAS/NAE, 1973). He led the professional review and critique of the US EPA "Red Book" water quality criteria for phosphorus on behalf of the Water Quality Section of the American Fisheries Society (Lee et al., 1979), and served as a US EPA-invited peer-reviewer for the water quality criteria development approach incorporated in the US EPA "Yellow Book" of water quality criteria (US EPA, 1987). That criteria development approach is still in use today. A summary of Drs. Lee and Jones-Lee's work in the development, evaluation, and use of water quality criteria and standards is available on their website at,
http://www.gfredlee.com/exp/wqexp.htm.

**Unreliability of Conditional Probability**

The foundation for the new US EPA instream phosphorus criteria is a conditional probability approach developed by J. Paul and McDonald (2005) to try to relate, through statistical manipulation, what they called "sedimentation" (actually, percent fines in the bedded sediments) in streams to "EPT taxa richness" (organisms considered by some to be present in numbers lower than expected in streams whose nonspecific "quality" may be considered "degraded."). M. Paul and Zheng (2007, 2008) presented a conditional probability association between "EPT taxa" and total P upon which the US EPA Region 3 instream phosphorus criterion was based. Aside from the issue of whether or not the statistical manipulations executed in those works were made correctly and reliably describe the associations, much of the underlying science and a number of the critical technical assumptions incorporated into the analysis were faulty. The unreliability of the science and assumption components of the statistical analysis renders the results of that analysis unreliable and misleading.

As described by its developers, the "conditional probability" approach seeks to use a statistical manipulation to quantify an association between one measurable condition or characteristic of a water (a "pollution metric") and another, undesirable, characteristic ("impact"), with a goal of establishing a "threshold" of the former that renders the latter unacceptable. There is however, no requirement that the "metric" be determined to actually be the cause of the "impact;" such a determination is imperative if the "metric" is to serve as a criterion used in regulations to influence the "impact." In the case of the instream phosphorus criterion, the conditional probability "metric" is total phosphorus concentration and the "impact" is "EPT taxa richness."

The overriding, fundamental, and fatal flaw of the "conditional probability" approach for the instream phosphorus criterion is that it is not based on a cause-and-effect relationship between the total P concentration and the "EPT taxa richness." First, the mathematically described association between the two sets of measurements considered is tenuous, at best. The plot of data used to define the association revealed a wide scattering of data, which would be expected based on an understanding of the chemistry/biology/toxicology of total P. Further, the fact that a level of responsibility for the statistical association so-defined can be mathematically derived for, and assigned to, total P is meaningless in terms of reliably and responsibly addressing water quality problems, when the aquatic chemistry/biology/toxicology science is not properly represented in those statistics.

Hall (2008) of Hall & Associates expanded the database used by Paul and Zheng (2007) for developing their conditional probability association between EPT taxa and total P, to include USGS data (Rief, 1999, 2000, 2002) for the same streams considered by Paul and Zheng (2007), as well as others in the region. The complete, combined data set is shown in Figure 1. As would be expected based on the aquatic chemistry and toxicology of phosphorus, Figure 1 shows there is no sustainable relationship between total P and EPT taxa even for those streams.

Nevertheless, even if the statistical association between total P and "EPT taxa richness" were strong, it would not provide evidence or support for a presumption that the total P is the cause of EPT taxa richness decline, or that a decrease in the total P would effect an improvement in the EPT taxa richness. The limited-basis relationship could also not be presumed to be widely applicable to other streams. The definition of a causal relationship with well-defined and evaluated ranges of applicability is paramount to the creation of reliable water quality criteria.

The conditional probability approach presumes that the total phosphorus in stream water is, by some undefined mechanism, "toxic" to the invertebrate organisms. Not only is the presumption of a causal relationship unjustified, it also does not reflect an understanding of the behavior of aquatic systems. There is no justification for the presumption that total phosphorus is "toxic" or otherwise specifically adverse to invertebrate populations. Even if total P were demonstrated to cause decline in "EPT taxa richness," that "impact" parameter is a highly questionable basis for establishing a water quality criterion. There is little evidence of that "impact" parameter's being causally related to beneficial uses of streams that the criteria are intended to protect. Finally, for criteria/standards to be reliable and meaningful, the "threshold" for regulatory action must relate in a meaningful way to adverse impact on beneficial use of the water, not on some arbitrary statistical point.

In the late 1970s Dr. Lee served as the coordinator of an American Fisheries Society Water Quality Section review (Lee et al., 1979) of the US EPA 1976 "Red Book" of water quality criteria (US EPA, 1976). The US EPA (1976) discussion of water quality criteria for phosphorus had been based largely on the National Academies of Science and Engineering "Blue Book" – Water Quality Criteria of 1972 (NAS/NAE, 1973). The NAS/NAE (1973) phosphorus criteria discussed the water quality impacts of orthophosphate and elemental phosphorus. Orthophosphate is of concern to water quality owing to its action as an aquatic plant nutrient; it is not toxic to aquatic life. Indeed, generally, the greater the orthophosphate, the greater the aquatic plant production, and the greater the abundance of fish. Elemental phosphorus, on the other hand, is known to be toxic to some forms of aquatic life. However, while elemental phosphorus was, at one time, present in some wastewaters typically associated with some industrial discharges, it is rarely found in aquatic systems today. The US EPA (1987) "Yellow Book" of water quality criteria lists 0.01 µg P/L as the water quality criterion for elemental phosphorus in marine and estuarine waters, citing the fish and shellfish kills in nearshore marine waters associated with an elemental phosphorus plant discharge in Newfoundland, Canada.

The impacts of soluble orthophosphate on water quality have been well-studied for decades and are well-recognized. Technically sound, quantitative, causal relationships between loading of soluble orthophosphate and aquatic plant growths that adversely affect a variety of aspects of water quality/beneficial uses of lakes, reservoirs, and some other types of waterbodies have been well-documented in the technical literature. Overall, it is understood that generally, greater inputs of soluble orthophosphate supports greater aquatic plant growth, which in turn supports a more productive food web of secondary producers, including invertebrate populations, and higher levels of fish production.

The adverse impact of phosphorus on aquatic life is indirect. Basically, the bacteria that decompose dead aquatic plants require oxygen. The greater the amount of aquatic plant material, the greater the amount of oxygen used, in bacterial respiration, for its decomposition. It is only when the dissolved oxygen (DO) supply (through reaeration and/or photosynthesis) is inadequate to meet that demand, that DO concentrations may be decreased to levels that adversely affect fish and other aquatic life. While these relationships in lotic systems are more complex, the fundamental causal relationships between nutrient (soluble orthophosphate) input and algal growth remain.

From the information available, the lower populations of invertebrate species ("EPT taxa") exhibited in US EPA Region 3 streams considered in the statistical analysis are not likely to be caused by low-DO related to phosphorus stimulation of aquatic plant growth. In streams, the DO conditions can be highly influenced by a number of other, more likely, factors such as the degree of canopy cover of the stream. The low-DO problems arising from excessive fertilization are readily identified by monitoring DO conditions in the streams of concern.

The potential for total phosphorus in streams to be toxic to invertebrates can be more reliably evaluated through conventional toxicity testing procedures of the type that the US EPA adopted in the mid-1980s. Before any TMDL goals based on "conditional probability" are imposed, appropriate, detailed studies should be conducted to evaluate whether or not the total phosphorus is responsible for changes in invertebrate populations in the selected streams where Region 3 claims that total phosphorus is the cause of such changes. This situation can readily be investigated through field studies that involve the addition of phosphorus to selected streams and observing whether the invertebrate populations are adversely impacted. Based on our professional experience, the addition of available forms of phosphorus will, in some streams, stimulate the development of invertebrate populations.

Further, it is important to note that the demonstrated causal relationships between aquatic plant-related water quality characteristics and phosphorus consider the available phosphorus, not "total phosphorus." It has been well-established through myriad studies around the world that particulate forms of phosphorus, especially inorganic phosphate associated with erosion from agricultural lands and urban areas, are largely unavailable for support of algal growth. It is also US EPA policy to regulate toxics based on dissolved/available forms rather than concentrations of total forms. These issues are discussed in several papers and reports by Lee et al. (1980), Lee and Jones-Lee (2002, 2004), and Lee (2006a, b). Contrary to the US EPA's present position, phosphorus management should be based on available P.

Another of the significant deficiencies in the "conditional probability" approach for instream P criteria is its use of "EPT taxa richness" as an "impact" parameter. Not only is the connection between that measure and water quality/beneficial-use impact nonspecific and indeterminate, but also that measure itself is influenced by a vast array of conditions. Various sublevels (e.g., families, genera, and species) of each of those orders have different food preferences and susceptibilities to other influences such as low dissolved oxygen. Even the relationship between available phosphorus and the abundance of these aquatic invertebrates is multifaceted. As noted above, available phosphorus is a required nutrient for aquatic plants that serve as a direct or indirect food source for many of these organisms. Hence, within a range, an increase in available P can result in an increase in the abundance of these aquatic invertebrates. On the other hand, if aquatic plant growth is sufficient, bacterial respiration of the dead plants/algae can cause depletion of dissolved oxygen to levels below those needed or desirable for these aquatic invertebrates and/or higher-level organisms. The "EPT taxa" tend to be sensitive to low-DO conditions. However, the DO concentrations in a water can be controlled or influenced by a variety of factors other than aquatic plant growth stimulated by available P input. Thus, in situations in which low-DO conditions affect the abundance of these organisms, the role of available P may not be controlling or even dominant. Overall, "EPT taxa richness" is not a suitable indicator for impacts of available P on water quality/beneficial uses.

If the water quality/beneficial-use concern itself were the presence and abundance of mayflies, stoneflies, and caddisflies in a particular stream, then the conditions present and factors affecting the abundance of those organisms should be the focus of evaluation. Assessments should be made of the ability to regulate important controlling factors; the expected effects of instituting control measures on the abundance of those organisms should be quantified.

Hall & Associates (2008) discussed the need for peer-review of the US EPA Region 3 instream nutrient criteria/standards based in "conditional probability," including evaluating the appropriateness of trying to develop phosphorus discharge limits for municipal, industrial, and non-point sources such as agriculture, based on those standards. Hall & Associates' summary of that discussion is appended to these comments.

**Overall**

Years of experience has taught that relying on statistical manipulations in environmental quality evaluation and regulation is a dicey business. "Statistical significance" is not the equivalent of "environmental quality significance," just as "environmental significance" may not be able to be described with "statistical significance." While statistical evaluation may point to associations that may be of interest to explore, environmental quality assessment and management must be based soundly in the sciences of aquatic chemistry, toxicology, and biology.

Conditional probability is not a technically valid approach for establishing water quality criteria/standards destined to be used as a basis for limitations on phosphorus or any other chemical in point-source discharges (e.g., domestic wastewater discharges) or non-point-source discharges/runoff (e.g., urban and agricultural runoff).

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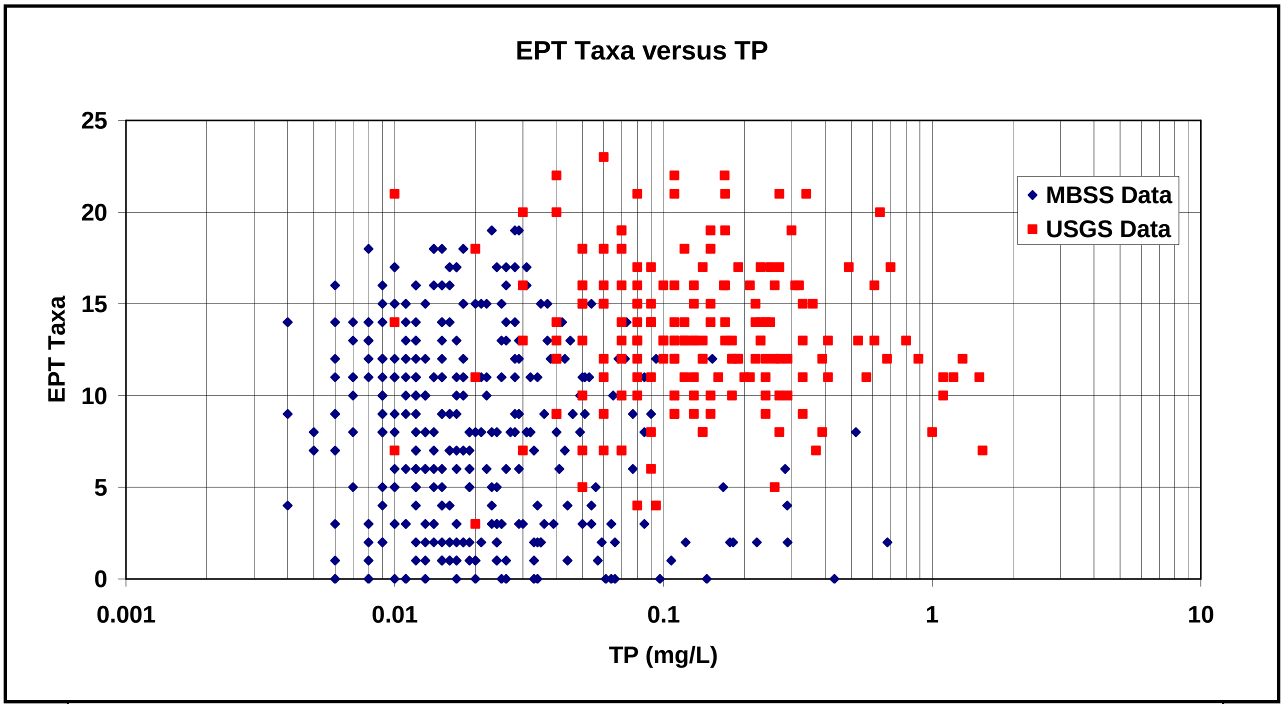
Figure 1




The original MBSS data used in the Paul and Zheng (2007) TP endpoint analysis was augmented with USGS data for the following 12 streams: Stony Run near Spring City; Ridley Creek at Goshenville, and at Dutton Mill near West Chester; East Branch Chester Creek at Westtown, and below Goose Creek near West Chester; Middle Branch White Clay Creek at Wickerton; East Branch Big Elk Creek at Elkview; West Branch Big Elk Creek near Oxford; Valley Creek near Atglen; West Branch Brandywine Creek, and East Branch Brandywine Creek at Wawaset; and, Brandywine Creek near Chadds Ford.

from: Hall (2008)

**Briefing Sheet**
**EPA's New Methodology for Developing Stream Nutrient Standards and Need for Peer Review**
**Prepared by Hall & Associates**
**Washington DC**
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## Background

As part of five recently issued Pennsylvania TMDLs (June 30, 2008), EPA Region III imposed very stringent nutrient reduction requirements on all non-point source (NPS), MS4s, and wastewater discharges in the affected watersheds. These requirements were based on a **radical new numeric standard derivation methodology that assumed impairments exist regardless of the actual data or stream impairment designation.** This new methodology for imposing stringent nutrient reduction requirements:

1) Ignored whether or not excessive plant growth existed in the watershed;
2) Assumed that total **phosphorus directly impairs aquatic macroinvertebrate (insect) communities;** and
3) Ignored the available site-specific data confirming insect populations do not respond to TP levels.

The new criteria derivation method **never underwent federal peer review or public notice** that is required for changing water quality standards or Section 3 04(a) criteria derivation methods.

The resulting numeric standard for total phosphorus (TP) ranged from 25 – 40 µg/L. EPA's contractor, who developed the TP endpoints, acknowledged that improvements to the macroinvertebrate communities are not assured and plant growth will not be limited if the stringent standards are achieved.

These TP standards are generally at or below background water quality levels in most waters. Consequently, these TMDLs establish extremely restrictive load reduction requirements for TP from **all point and non-point sources in the watersheds.** Municipal WWTPs affected by these TMDLs must reduce TP by 90% - 99%. MS4 communities and NPS loads must be reduced by 54% - 90%. It is highly unlikely that the MS4 and NPS reduction requirements are achievable.

## Consequences for Regulated Community

- State-of-the-art phosphorus removal for all municipal WWTPs regardless of whether impairments actually exist;
- Construction of massive retention basins throughout the watershed will likely be required to address mandated load reductions for phosphorus;
- The inability of MS4 communities to comply will result in a moratorium on growth until load limits are achieved throughout the watershed; and
- Agricultural operations will require extensive BMP implementation.

## National Impact of New EPA Approach

The new approach radically deviates from all prior EPA guidance on nutrient criteria development. Existing guidance was premised on demonstrating that nutrients are causing excessive plant growth and TMDLs are only developed where site-specific information confirms that a problem exists. This new approach, **approved by EPA Headquarters,** presumes nutrients directly impair invertebrate communities. No site-specific data are considered. Other factors which might be responsible for the observed differences or mitigate the influence of nutrients on the macroinvertebrate community were ignored. The use of this unprecedented scientific approach has nationwide implications and the potential to misdirect resources on an enormous level because:

- Headquarters has conducted workshops in all Regions to teach use of this new method for developing nutrient standards and is encouraging its use; Once deemed "scientifically defensible" this approach may be applied to other water quality parameters (e.g., endocrine disruptors, pesticides, personal care products);
- The new approach violates CWA Section 303(d) requirements to document stream impairments with site-specific data and allow public comment on such determinations;
- The procedure violates numerous National Guidelines principles on criteria development and, in particular, ignores site-specific data showing invertebrate communities are not impaired at higher TP levels;
- No objective, independent scientific review has been conducted on any aspect of the new methodology or the chosen impairment metrics, in violation of the Agency's and OMB's peer review policies; and,
- Based on the results of the Pennsylvania TMDLs, the nationwide cost impacts will easily exceed $100 billion dollars.

## Need for Peer Review

This new approach to nutrient criteria development must undergo peer review before it is instituted. The following summarize the basis for such a review:

- Other similar water quality standard development procedures have first undergone Science Advisory Board or National Academy of Sciences review (e.g., Sediment criteria);
- The development approach advocated by EPA is highly controversial – disputed by nationally recognized experts and contrary to EPA's current procedures;
- OMB requires peer review before this approach can be implemented; and
- EPA guidance requires peer review.