Final Report

Oklahoma Scenic Rivers Phosphorus Criteria Review – Majority Report

March 30th, 2012

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Executive Summary

As required in the 2003 Statement of Joint Principles and Actions agreement, in concert with an EPA grant, as well as Oklahoma's continual review of the Oklahoma Water Quality Standards (OWQS), staff of the Oklahoma Water Resources Board (OWRB) convened an interstate/tribal/EPA technical advisory group (TAG). The objective of this TAG was to re-evaluate, by 2012, the 0.037 mg/L total phosphorus (TP) criterion assigned to all of Oklahoma's Scenic Rivers. This review process involved state agency staff from both Oklahoma and Arkansas representing WQS staff, point and nonpoint source control staff, US EPA Region 6 staff, and the Cherokee Nation. During 2011, all submitted information and over 100 specific technical publications were reviewed (Appendix A), and 10 of those were determined to constitute "best scientific information available" by the TAG for purposes of the criterion review effort. After several face to face meetings and conference calls of this group, no consensus was reached on the recommendations. The majority of the TAG concluded that the best scientific information currently available supports the current criterion; therefore, no change in the criterion is necessary. It further recommends that an additional study documenting chemical, physical and biological integrity should occur to guide future water quality management of these waters. The Arkansas members of the TAG have prepared a separate report titled "Arkansas TAG Members' Minority Report to OWRB," which is being submitted as a separate document.

Introduction

The Oklahoma Legislature resolved to protect a handful of treasured streams when, in 1970, it passed the "Scenic Rivers Act" (82 O.S. 1451-1471) as a means to identify and preserve the unique characteristics and uses of the state's most scenic streams. This same legislation identified four streams to be designated as "Scenic River Areas": Flint Creek, Illinois River, Barren Fork Creek, and Upper Mountain Fork River. In 1975, the Legislature added Lee Creek and Little Lee Creek (Figure 1). The primary purpose of the Scenic Rivers Act, and the subsequent Water Quality Standards (WQS) regulations promulgated pursuant thereto, is to preserve the high quality and unique characteristics of these outstanding resource waters.

> *"The Oklahoma Legislature finds that some of the free-flowing streams and rivers of Oklahoma possess such unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values of present and future benefit to the people of the state that it is the policy of the Legislature to preserve these areas for the benefit of the people of Oklahoma. For this purpose there are hereby designated certain "scenic river areas" to be preserved as a part of Oklahoma's diminishing resource of free-flowing rivers and streams."*

A body of statu te and rule has been subsequently established to protect Oklahoma's six Scenic Rivers. Rules are now in place limiting loading from point sources, placement of septic tanks, placement of poultry houses, disposal of poultry waste, and disposal of biosolids. Substantial resources have been dedicated to limiting nutrients in the watersheds with Best Management Practices (BMP) demonstrations, incentives and education. Antidegradation protection for scenic rivers, in place since 1973, adds basis to implement the statutory policy to preserve the Scenic Rivers as a part of Oklahoma's diminishing resource of free-flowing rivers and streams.

In 2001, it was recognized that both empirical and anecdotal evidence over the preceding two decades indicated that, Illinois River status as a "Scenic River" pursuant to Title 82 Chapter 21 of Oklahoma Statute, was seriously threatened by excess nutrients. These nutrients – primarily phosphorus – were seen to be causing accelerated primary productivity in the Illinois River and

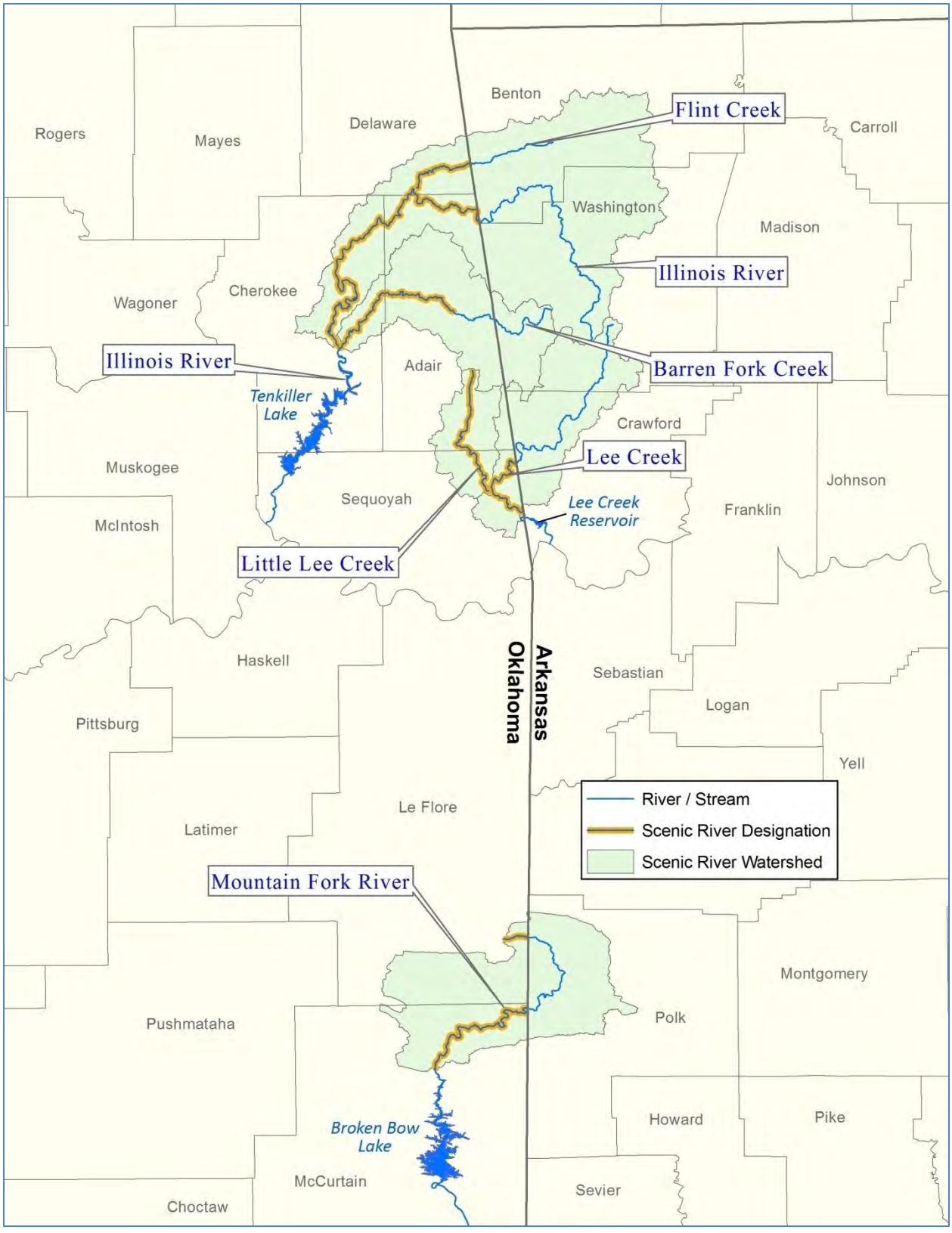


Figure 1. Map of the six Oklahoma Scenic Rivers and their watersheds.

Lake Tenkiller, resulting in significant growths of both attached algae (periphyton) and suspended algae (phytoplankton). As a consequence, historical river clarity and substrate quality were being adversely affected to such an extent that, without intervention, the Illinois River's exceptional ecological and recreational significance were in jeopardy. Further reviews of the data identified that similar problems with ecological and recreational integrity were also present in the other five Scenic Rivers. Although less pronounced and obvious to the public, the Barren Fork River, Flint Creek, Lee Creek, Little Lee Creek and the Upper Mountain Fork River above Broken Bow Reservoir were all showing signs of adverse impacts from excess nutrients.

To holistically address these problems and protect Oklahoma's six Scenic Rivers, it was proposed that a numerical criterion be incorporated into Oklahoma's WQS applicable to total phosphorus (TP) for all six Scenic Rivers. While water quality management programs were already in place to protect designated beneficial uses, this numerical value should assure that water quality greater than that necessary to support beneficial uses is achieved. Based upon input received through personal communications and at informal water quality standards meetings in late 2001, the general consensus was that Oklahoma's six Scenic Rivers should be "better than average."

OWRB staff investigated statistical techniques appropriate for historical data (Figure 2). EPA's July *2000 Nutrient Criteria Technical Guidance Manual for Rivers and Streams* (EPA-822-B-00-002) based a substantial portion of their recommended nutrient criteria on the premise that the 25th percentile of nutrient concentrations on all streams in a given region is roughly equivalent to the 75th percentile of

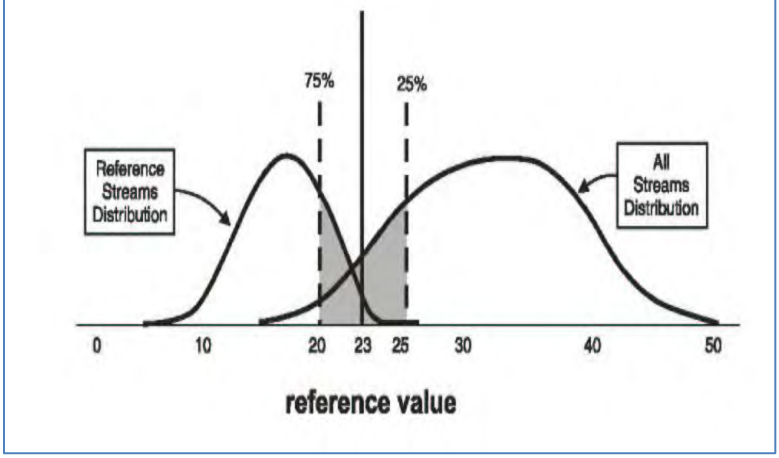
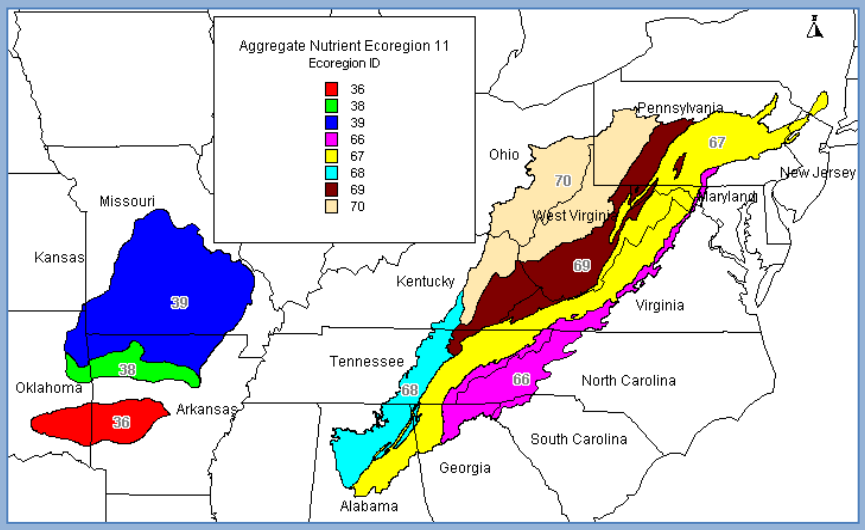


Figure 2. EPA statistical technique for using historical data. From *Nutrient Criteria Technical Guidance Manual for Rivers and Streams* (EPA-822-B-00-002)

concentrations in least impacted or reference quality streams (Figure 3). An analysis of nutrient values in relatively un-impacted basins is found in *Nutrient Concentrations and Yield in Undeveloped Stream Basins of the United States* (*Gregory M Clark, David K. Mueller and M. Alisa Mast; Journal of the American Water Resources Association Volume 36, No. 4 August 2000*). This research was the basis for this comparison as it evaluates TP data on least impacted/reference sites. In this report, 75% of the streams assessed in least impacted areas had a flow weighted TP concentration of 0.037 mg/L or less. This value was similar to the median TP concentration seen in the Barren Fork River and the relatively un-impacted Mountain Fork River from Oklahoma's Beneficial Use Monitoring Program (BUMP) (0.045 mg/L and 0.028 mg/L,



Ecoregion	Reference Condition based on 25th Percentiles
Ozark Highlands (39)	0.006625 mg/L
Boston Mountains (38)	0.005625 mg/L
Ouachita Mountains (36)	0.010469 mg/L
Aggregate Level III Ecoregion – The Central and Eastern Forested Uplands	0.01 mg/L

Figure 3. EPA ecoregions and recommended criteria. From *Nutrient Criteria Technical Guidance Manual for Rivers and Streams* (EPA-822-B-00-002)

respectively). It is also consistent with USGS monitoring of the Barren Fork River which resulted in a median phosphorus concentration of 0.03 mg/L. The OWRB staff therefore, recommended

that 0.037 mg/L of TP be promulgated as a numerical criterion to protect our Scenic Rivers. The specific rule states:

> *"**785:45-5-19(c)(2) Nutrients; numerical criterion applicable to waters designated Scenic Rivers.** The thirty (30) day geometric mean total phosphorus concentration in waters designated "Scenic River" in Appendix A of this Chapter shall not exceed 0.037 mg/L. The criterion stated in this subparagraph applies in addition to, and shall be construed so as to be consistent with, any other provision of this Chapter which may be applicable to such waters. Such criterion became effective July 1, 2002 and shall be implemented as authorized by state law through Water Quality Standards Implementation Plans and other rules, permits, settlement agreements, consent orders, compliance orders, compliance schedules or voluntary measures designed to achieve full compliance with the criterion in the stream by June 30, 2012".*

Revisions of the Oklahoma Water Quality Standards (OWQS) must follow the process required by the Oklahoma Administrative Procedures Act. Prior to adoption, a Notice of Rule Making Intent was published in the Oklahoma Register that initiated a 45 day comment period. A Rule Impact Statement was filed and the formal rule revisions were available for public review. After the 45 day comment period, a formal hearing was held. In the process, over 600 comments were received supporting the criterion or asking for a more stringent criterion. Sixty Five (65) comments were received opposed to the criterion. Subsequent to the public review process, OWRB staff recommended that the Board adopt a not-to-be-exceeded 30 day geometric mean total phosphorus criterion of 0.037 mg/L for the Scenic Rivers in both the Antidegradation section and the Aesthetics beneficial use section of the OWQS.

Recognizing the impacts and the revolutionary nature of the criterion, the nine-member Oklahoma Water Resources Board added the caveat: "*such criterion shall be fully implemented within ten (10) years as provided in a separate rule promulgated by the Board*". The OWRB then followed through with its requirement of an additional rule and promulgated an emergency rule and a final rule in February 2003.

A consequence of the criterion is that the discharge of phosphorus to Oklahoma's Scenic Rivers must be strictly controlled. The point and nonpoint source phosphorus dischargers of northwest Arkansas, in particular, have steadfastly maintained that the 0.037 mg/L for TP is neither attainable nor appropriate, and was based upon faulty science. EPA negotiated the December 2003, "Statement of Joint Principles and Actions" signed by Oklahoma and Arkansas, stating that "Oklahoma periodically re-evaluates all of its water quality standards. In particular, Oklahoma will re-evaluate Oklahoma's 0.037 mg/L criterion for total phosphorus in Oklahoma's Scenic Rivers by 2012, based on the best scientific information available at that time, and with the full, timely inclusion of officials from the State of Arkansas representing both point and nonpoint source dischargers." Following this agreement EPA approved the Oklahoma criterion on December 29, 2003.

Prior to its approval, EPA reviewed the TP criterion in light of the USGS study previously referenced (Clark et. al.), EPA's national nutrient criteria recommendations, and Ozark Highlands ecoregion stream data for TP presented in another USGS report entitled *Percentile Distributions of Median Nitrite Plus Nitrate as Nitrogen, Total Nitrogen, and Total Phosphorus Concentrations in Oklahoma Streams, 1973-2001 (Report 03-4084)*. Based upon this analysis and the record before it, EPA determined that Oklahoma's TP criterion of 0.037 mg/L for its Scenic Rivers was "sufficient to protect the designated uses of the affected rivers" (including Fish and Wildlife Propagation, Recreation, and Aesthetic beneficial uses).

Objectives

The objective of this project was to re-evaluate the Oklahoma Scenic Rivers phosphorus criterion to reaffirm its appropriateness or to recommend if a revised phosphorous criterion might better serve to restore and protect the integrity of Oklahoma's Scenic Rivers. Because the current criterion has three components, including a magnitude (0.037 mg/L), duration (30-day geometric mean), and frequency (shall not exceed), all three of these components were considered as part of the criterion re-evaluation. The process, embodied in the Quality

Assurance Project Plan (QAPP), facilitated the review of the "best scientific information available" utilizing a technical advisory group (TAG) which included appropriate technical staff designated by officials from EPA, Cherokee Nation and the States of Oklahoma and Arkansas representing both point and nonpoint source dischargers.

Process and Method of the Re-evaluation

The Technical Advisory Group (TAG) was assembled to review the relevant "best scientific information available" regarding the phosphorus criterion and develop final recommendations to OWRB staff regarding whether additional action should be taken to revise the phosphorus criterion (See Table 1 for a schedule of TAG meetings).

The TAG was comprised of:

Derek Smithee, Chief of the Water Quality Programs Division of the Oklahoma Water Resources Board (Facilitator),

Shanon Phillips, Director of the Water Quality Division of the Oklahoma Conservation Commission,

Shellie Chard-McClary, Director of the Water Quality Division of the Oklahoma Department of Environmental Quality,

Quang Pham of the Oklahoma Department of Agriculture, Food and Forestry,

Cara Cowan Watts of the Cherokee Nation,

Melinda McCoy with Region 6 of the U.S. Environmental Protection Agency,

Ed Swaim, Chief of the Water Resources of the Arkansas Natural Resources Commission,

Steve Drown, Chief of the Water Division of the Arkansas Department of Environmental Quality.

A Secondary Data Quality Assurance Project Plan (QAPP) was prepared, reviewed by the TAG, and approved by EPA. The process established in this QAPP addressed: acquisition of scientific information relevant to the Oklahoma Scenic Rivers criterion, the process for determining which of this information represents the "best scientific information available" for purposes of the criterion review effort, and then review of the best scientific information to recommend action regarding the criterion.

"Best Scientific Information Available" was solicited from the public by way of public announcements on June 10th, 2011 utilizing e-mail lists and newspaper publications throughout the Oklahoma Scenic River's watersheds. A public meeting was also held on August 11th, 2011 to allow the general public an opportunity to submit additional scientific information. Information was compiled and reviewed by the TAG. Staff of the OWRB compiled summaries of the information reviewed and recommendations made by the TAG to advise the OWRB. Based on the information from the scientific literature review, the phosphorus criterion was re-evaluated.

Table 1. Timeline of meetings regarding the criteria re-evaluation.

January 2011	TAG meeting	Oklahoma City, OK
April 2011	TAG Conference Call	
May 2011	TAG Meeting	Rogers, AR
August 2011	Public Meeting	Tahlequah, OK
October 2011	TAG Conference Call	
November 2011	TAG Meeting	Sallisaw, OK
February 2012	TAG Conference Call	

Studies Summary

The following summaries are of relevant scientific studies that were reviewed as part of the re-evaluation of the Oklahoma Scenic Rivers Phosphorus Criteria.

Current Total Phosphorus (TP) Values and Trends

The following three summaries provide a view of the current phosphorus values and trends in some of Oklahoma's Scenic Rivers. These research articles show that the TP values in the Illinois River watershed have decreased since the implementation of point source controls. This research also indicates that while TP values and loading have been reduced, high TP values still remain.

Haggard, B., J. Masoner and C. Becker. 2003. Percentile Distributions of Median Nitrite Plus Nitrate as Nitrogen, Total Nitrogen, and Total Phosphorus Concentrations in Oklahoma Streams, 1973–2001. USGS Water-Resources Investigations Report 03-4084.

> Percentile distributions of median nitrite plus nitrate as nitrogen, total nitrogen, and total phosphorous concentrations were calculated from 563 sites in Oklahoma and 4 sites in Arkansas near the Oklahoma and Arkansas border to facilitate development of nutrient criteria for Oklahoma streams. The 50th percentiles of median nitrite plus nitrate as nitrogen, total nitrogen, and total phosphorus concentrations were greater in the Ozark Highland ecoregion and were less in the Ouachita Mountains ecoregion when compared to other geographic areas used to group sites. Nitrate as nitrogen and total phosphorus concentrations currently (2002) used in the Use Support Assessment Protocols for Oklahoma were greater than the 75th percentiles of median nitrite plus nitrate as nitrogen and total phosphorus concentrations calculated for this report.

Haggard, B. 2010. Phosphorus Concentrations, Loads, and Sources within the Illinois River Drainage Area, Northwest Arkansas, 1997–2008. J. Environ. Qual. 39: pp. 2113-2120.

> This study evaluated (i) annual phosphorus (P) loads at the Illinois River at Arkansas Highway 59 from calendar year 1997 through 2008, (ii) the relative contribution of effluent P sources to annual riverine P transport, (iii) longitudinal gradients in water column P concentrations downstream from several wastewater treatment plant effluent discharges, and (iv) changes in monthly P loads over the last decade. The relative contribution of P inputs from municipal facilities has decreased from 40% of the annual P load at the Illinois River at Arkansas Highway 59 to <15% in recent years. Flow adjusted monthly P loads showed two distinct trends over time. Flow-adjusted loads significantly increased from 1997 through 2002 and significantly decreased from 2002 through 2008. The concentrations and transport of P within the Illinois River drainage area are significantly decreasing from all the watershed management changes that have occurred.

Haggard, B. 2005. Proceedings Report – 3rd Annual Total Maximum Daily Load Conference. Effect of Reduced Effluent Phosphorus Concentrations at the Illinois River, Northwest Arkansas, 1997-2004.

Spatial distribution of dissolved P concentrations was evaluated using multiple water quality monitoring sites from the Illinois River, South of Siloam Springs upstream to the effluent discharges in Mud/Clear Creeks, Osage Creek and Spring Creeks. Dissolved P concentrations as great as 10 mg SRP L^{-1} were observed on one sampling in March 2002 at Spring Creek, and dissolved P concentrations throughout the IRDA were generally several orders of magnitude greater than concentrations which typically limit Periphyton growth in streams or that are observed in relatively undeveloped basins. Dissolved P concentrations at the Illinois River, South of Siloam Springs, Arkansas, were less than the Oklahoma Scenic Rivers TP criterion on one sampling date in Feb 2004, and dissolved P concentrations were close to the criterion in April 2004. The results observed in summer 2003 and 2004 show some mechanism of internal P loading exists in streams draining the IRDA because ambient P concentrations often increase downstream through selected stream reaches. Dissolved P concentrations at the Illinois River, South of Siloam Springs, Arkansas, were generally around 0.10 SRP L-1 and still almost three times greater than the Oklahoma Scenic Rivers TP Criterion.

Nutrient Thresholds & Distributions

Nutrient thresholds are one of EPA's recommended ways of developing nutrient criteria. The following research summaries relate to nutrient thresholds and distributions from various watersheds of various sizes. It is of particular interest to note that while many of these streams are geographically different, the distributions and thresholds appear to follow very similar patterns.

Stevenson, et al. 2006. Comparing Effects of Nutrients on Algal Biomass in Streams in Two Regions with Different Disturbance Regimes and with Applications for Developing Nutrient Criteria. Hydrobiologia 561: pp. 149-165.

Responses of stream algal biomass to nutrient enrichment were studied in two regions where differences in hydrologic variability cause great differences in herbivory (Kentucky and Michigan). Many measures of algal biomass and nutrient availability were positively correlated in both regions, however the amount of variation explained varied with measures of biomass and nutrient concentration and with region. Most observed responses in benthic algal biomass occurred in nutrient concentrations between 10 and 30 µg TP /L and between 400 and 1000 µg TN /L.[1] High algal biomasses were rare (less than 10% of streams) in both regions, if TP was less than 30 µg l^{-1} and TN was less than 1000 µg l^{-1}. The 30 µg l^{-1} target was also recognized by Dodds et al. (1998) as a concentration that constrained chlorophyll *a (chl a)* to less than 15 µg chl *a* cm^{-2} in a *Cladophora* dominated stream. Higher probabilities of more extensive *Cladophora* growths were observed with increasing nutrient levels. Thus, 30 µg TP l^{-1} and 1000 ug TN l^{-1} could be considered as targets to prevent a high probability of nuisance accrual of *Cladophora*.

Stevenson, et al. 2008. Algae–P Relationships, Thresholds, and Frequency Distributions Guide Nutrient Criterion Development. J. N. Am. Benthol. Soc., 27(3): pp. 783-799.

This study used complementary information collected using different conceptual approaches to develop recommendations for a stream nutrient criterion based on responses of algal assemblages to anthropogenic P enrichment. Benthic algal attributes, water chemistry, physical habitat, and human activities in watersheds were measured in streams of the Mid-Atlantic Highlands region. Regression models showed that TP concentrations were ~10 µg/L in streams with low levels of human activities in watersheds and that TP increased with % agriculture and urban land uses in watersheds.

[1] Total Phosphorus concentration units in the summaries are written as reported in the original research articles.

The 75th percentile at reference sites was 12 µg TP/L. Thresholds in these responses occurred between 10 and 20 µg/L. Multiple lines of evidence indicate that a nutrient criterion of 10 to 12 µg/L can be justified for Mid-Atlantic Highlands wadeable streams based on reference conditions and benthic algal responses to nutrients. Increases in TP from 10 to 30 µg/L were associated with responses of benthic diatom assemblages that indicated release from nutrient limitation. Extensive, long-lasting nuisance growths of the filamentous green alga, *Cladophora* that are unaesthetic and a problem for fishing and recreational use can be prevented by maintaining an average of 30 µg TP/L (Dodds et al. 1997, Stevenson et al. 2006). On the other hand, higher stressor criteria, such as between 30 and 60 µg TP/L, could be interpreted as protective of ‘‘fish, shellfish, and wildlife’’ that would correspond to the lower, interim goal of the US Clean Water Act.

Justus, B.G., et al. 2009. A Comparison of Algal, Macroinvertebrate, and Fish Assemblage Indices for Assessing Low-level Nutrient Enrichment in Wadeable Ozark Streams. Ecol. Indicat.

Seventy-three algal metrics, 62 macroinvertebrate metrics, and 60 fish metrics were evaluated for each of the three biotic indices. Biotic metric scores were inversely related to nutrients and were generally highest when TN and TP concentrations were less than about 0.40 mg/L and about 0.018 mg/L (respectively), but were generally lowest when concentrations were higher. These TN and TP concentrations are comparable to background concentrations from sites across the United States (Clark et al., 2000; Smith et al., 2003; Herlihy and Sifneos, 2008). Other studies have indicated that substantial changes in macroinvertebrate assemblage structure (Smith et al., 2007) and algal biomass (Stevenson et al., 2006) may occur near these concentrations. The algal index had a much stronger relation to low- to moderate-level nutrient enrichment than did the macroinvertebrate or fish index but all three indices were negatively correlated to nutrient enrichment.

Smith, A.J. and C.P. Tran. 2010. A Weight-of-Evidence Approach to Define Nutrient Criteria Protective of Aquatic Life in Large Rivers. J. N. Am. Benthol. Soc., 29(3): pp. 875-891 (2010)

> Based on percentile analysis (median value of the 75th percentile of the reference sites and the 25th percentile of the test sites), numeric nutrient criteria would be: 0.023 mg TP/L. Cumulative probability distributions suggested that threshold responses of biological community metrics occurred between 0.009 and 0.07 mg TP/L. For site clusters based on macroinvertebrate data these values were 0.037 mg TP/L. For clusters based on diatom data these were 0.037 mg TP/L. The multiple lines of evidence used were percentiles, metrics that yielded significant change points, and cluster analyses. Results from metrics established specifically for or directly related to nutrients in the water were weighted more heavily than those associated with general pollution or, in the case of percentile analysis, had no connection with biological responses. Based on the weight-of-evidence approach and results from all 3 methods, the proposed guidance values for nutrients in large rivers are 0.03 mg TP/L. These values are similar to those derived by others and provide meaningful nutrient endpoints that would be protective of aquatic life in large rivers.

Stressor-Response Studies

There has been much discussion of the need for stressor-response studies to provide information to truly evaluate the current phosphorus criterion. The following summaries include a study looking at small rivers and streams in Ohio, wadeable streams in the Cross Timbers region of Texas, and a stressor-response study conducted on the Illinois River Watershed. It is very important to note that while the King (2009) paper researched streams in Texas; these streams share many similarities to Oklahoma's Scenic Rivers. These Texas streams have limestone substrates comprised of gravel, cobble, boulder, and bedrock. The Stevenson research paper was very worthy of note since it was a stressor-response study that was conducted on one of Oklahoma's Scenic Rivers (ie, Illinois River). This study especially looks at threshold responses in cover of stream bottoms by filamentous green algae. This particular

focus of research directly relates to the assigned Aesthetics beneficial use of the Scenic Rivers. It is also very interesting to note that these studies correspond well to what Dodds et al. (1997) found; that accrual of benthic algae from streams throughout the world, measured as chlorophyll a, was saturated at approximately 30 µg TP/L.

Miltner, R.J., A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio. Environmental Management, January 2010.

> This study describes relationships among primary nutrients (phosphorus and nitrogen), benthic chlorophyll a concentrations, daily dissolved oxygen (DO) concentrations, and the condition of macroinvertebrate and fish communities in small rivers and streams in Ohio, USA. Clear associations between nutrients, secondary response indicators (i.e., benthic chlorophyll and DO), and biological condition were found, and change points between the various indicators were identified for use in water quality criteria for nutrients in small rivers and streams (<1300 km2). A change point in benthic chlorophyll a density was detected at an inorganic nitrogen concentration of 0.435 mg/l (±0.599 SD), and a total phosphorus **(TP) concentration of 0.038 mg/l** (±0.085 SD). 0.078 mg/l (i.e., the 90th percentile) approximates an upper limit for the change point.

King, R.S., et al. 2009. Final Report: Linking Observational and Experimental Approaches for the Development of Regional Nutrient Criteria for Wadeable Streams.

> Shifts from periphyton communities comprised of sensitive diatoms, calcareous cyanobacteria, and other non-chlorophyll bearing microbes to communities with higher chlorophyll content and more filamentous algae was repeatedly demonstrated at concentrations of surface-water TP above **20 µg/L**. Streams with TP > 200-1000 µg/L likely represent a second tier of degradation, and appear at greater risk for nuisance algal growth. However, results from the P dosing experiment suggest that concentrations as low as 20 µg/L (PO4-P) can lead to high levels of *Cladophora* biomass in as little as 28 days. Aquatic macrophyte cover consistently declined in streams with

TP > 25-50 µg/L. These submersed plants serve as important refugia for juvenile fishes and macroinvertebrates, and provide a source of dissolved oxygen during low flows. Their decline likely represents a key structural and functional change in these streams ecosystems. Minimum dissolved oxygen levels are highly dependent upon an interaction between flow and nutrient enrichment. This study suggests that TP levels >20-30 µg/L, coupled with low flows, will cause detrimental declines in minimum dissolved oxygen levels. Based on the weight of evidence from the coupling of the field stream study and the experimental stream study suggests that there is a very high probability that streams exposed to surface-water TP levels exceeding 20 µg/L, and possibly 15 µg/L, will experience a sharp decline in biological integrity, including loss of characteristic structure (periphyton and macrophytes), loss of numerous species (algae and macroinvertebrates), minimum dissolved oxygen levels unsuitable for supporting native fauna during low flows, and increase likelihood of nuisance algal growth that limits recreational use of streams.

Stevenson, R.J., et al., Phosphorus Regulates Stream Injury by Filamentous Green Algae, Thresholds, DO, and pH. (manuscript in press – Hydrobiologia 2011)

Nutrient concentrations, benthic algal biomass, dissolved oxygen, and pH were measured in 70 or more streams during spring and summer in the Illinois River Watershed (IRW) to determine injury to streams that was related to spreading poultry waste on fields. Molar N:P ratios were high and indicated that phosphorus was the most likely limiting nutrient. A threshold response in cover of stream bottoms by filamentous green algae (FGA): *Cladophora*, *Rhizoclonium*, and *Oedogonium*, during spring was observed at **27 µg** TP/L, with increases from averages of 4 to 36 percent cover in streams with TP less than and greater than the TP threshold. Thresholds in algal biomass response to nutrients have often been observed close to this TP concentration. Filamentous green algae (FGA) cover in minimally disturbed, low P streams usually had less than 10 percent FGA cover. When TP was greater than 27 µg/L, FGA cover averaged 36% cover.

Table 2. Summary of literature values found to be relevant for this review.

Literature Reviewed	Study Area	Concentration (mg/L)
Haggard, Masoner & Becker (2005)	Oklahoma Streams	Statistical analysis shows that the 75th percentile of TP concentrations were greater than the criterion.
Haggard (2005)	Illinois River Drainage Area	Dissolved P in the Illinois River (South of Siloam Springs) was generally around 3 times greater than the TP criterion
Stevenson et al (2006)	Kentucky and Michigan	0.010 – 0.030 (responses in benthic algal biomass)
Stevenson et al (2008)	Mid-Atlantic Highlands	0.010 – 0.020 (threshold responses occurred)
		0.010 – 0.012 (recommended P criterion)
		0.030 (to prevent Caldophora)
Justus, et al (2009)	Wadeable Ozark Streams	<0.018 (biotic metric scores were highest)
King (2009)	Brazos River Watershed, Texas	0.020 (shifts in periphyton communities)
		>0.025 – 0.050 (aquatic macrophyte cover declines)
		>0.020 – 0.030 (coupled with low flows will cause DO declines)
Haggard (2010)	Illinois River Drainage	The concentrations and transport of P within the Illinois River drainage area are significantly decreasing
Smith and Tran (2010)	Large Rivers	0.023 (numeric criteria based on percentile analysis)
		0.009 – 0.07 (threshold responses occurred)
		0.037 (based on macroinvertebrate data)
		0.030 (recommended nutrient criteria based on a weight-of-evidence approach)
Miltner (2010)	Ohio	0.038 (a change point in benthic chlorophyll a)
Stevenson, et al (2011)	Illinois River Watershed	0.027 (a threshold response in cover of stream bottoms by filamentous green algae)

A spreadsheet was compiled of recommended criteria and ecological change points from the literature reviewed by the TAG (Appendix B – Phosphorus Values Assembled from Literature Review). The median value of all of these recommendations was 0.036 mg/L and the mode was 0.020 mg/L.

The current "best scientific information available" signified that the Oklahoma Scenic River Total Phosphorus criterion of 0.037 mg/L is within the range of the current and relevant scientific literature. The majority of the new scientific information reviewed indicated 0.037 mg/L phosphorus is appropriate as a criterion protective of the Aesthetics beneficial use.

The TAG members from the Oklahoma Water Resources Board, Oklahoma Conservation Commission, Oklahoma Department of Environmental Quality, Oklahoma Department of Agriculture Food and Forestry, EPA Region 6, and The Cherokee Nation support the following findings. A separate body of findings has been provided by the TAG members from the Arkansas Department of Environmental Quality and the Arkansas Natural Resources Commission which can be found in the report titled "*Arkansas TAG Members' Minority Report to OWRB.*"

Findings of the TAG Majority based upon "Best Scientific Information Available"

1) After reviewing the "best scientific information available" as of the date of this report, no information was found that refuted the criterion. The TAG did not find information that the 0.037 mg/L total phosphorus (TP) criterion is outside of the acceptable range of the TP concentrations necessary to inhibit or limit algae growth to protect the Aesthetics beneficial use of Oklahoma's Scenic Rivers. Limited scientific information suggests TP concentration could be up to 0.040 mg/L and still limit algae growth sufficiently. Other scientific information suggests that TP concentration should be closer to 0.010 mg/L to sufficiently inhibit algae growth to protect the aesthetics of the free flowing streams.

   The majority of the Oklahoma Scenic Rivers Total Phosphorus Criterion TAG concludes that no change in the criterion is necessary due to the fact that the best scientific information currently available supports the current criterion.

2) The TAG finds that the results of monitoring of TP concentration in the water for most Scenic Rivers in Oklahoma shows results of greater than 0.037 mg/L. However, the TAG also finds that TP concentrations in the water for most Scenic Rivers in Oklahoma has decreased by varying degrees after the efforts and progress made by Arkansas and Oklahoma environmental agencies and interests to limit TP concentrations in point source discharges and with Best Management Practices (BMPs) for nonpoint pollution sources in the watersheds of Oklahoma's Scenic Rivers.

3) The TAG finds that continuing the efforts and progress made by Arkansas and Oklahoma environmental agencies and interests to limit TP concentrations in point and nonpoint source discharges in the watersheds of Oklahoma's Scenic Rivers, should result in continued reduction in TP concentrations in Oklahoma's Scenic Rivers.

4) The TAG further suggests that a comprehensive monitoring program be implemented to further evaluate the efforts and progress made by Arkansas and Oklahoma environmental agencies and interests to limit the TP concentrations in point and nonpoint source discharges in the watersheds of Oklahoma's Scenic Rivers.

5) Finally, the TAG concludes that as new scientific information is acquired through the suggested comprehensive monitoring program and other monitoring and research programs, such information should be considered by Oklahoma and Arkansas in the review of their respective Water Quality Standards.

Further Findings Concerning Duration and Frequency

The OWRB selected a 30 day geometric mean as the appropriate measure for implementing the Scenic Rivers phosphorus criterion despite the fact that the specific criterion reference used in part as justification for the criteria was based upon a flow weighted annual mean. After the 30 day criterion was adopted, the need for an assessment protocol became evident because the promise of data suitable for calculation of 30 day geometric means faded with inadequate funds for monitoring. In 2004, through an Oklahoma environmental agency working group with participation by EPA Region 6 and ADEQ, Oklahoma developed and adopted an assessment rule that used data collected over 90 days as a proxy for data collected over 30 days, to better represent the uptake of nutrients by algae. This assessment rule required a minimum number of storm events to be included in the data set and allowed a 25% excursion rate for geometric means calculated on a monthly basis. The assessment rule essentially was established to

balance the adopted criterion, technical information and the practical constraints of data collection into a single rule.

A common complaint against the currently promulgated duration and frequency is the data intensive nature of a 30 day geometric mean. EPA assessment staff, based upon settlement of the Florida impaired waters rule lawsuits, now requires assessment in strict accord with the WQS.

The latest effort by EPA to promulgate criteria for the State of Florida provides a good starting place for this discussion. The stream criteria that EPA promulgated are implemented as an annual geometric mean with an allowed excursion of once every 3 years. EPA expressed in their justification that:

> *"Appropriate duration and frequency components of criteria should be based on how the data used to derive the criteria were analyzed and the implications for protecting designated uses given the effects of exposure at the specified criterion concentration for different periods and recurrence patterns."*

The annual geometric mean and 1 in 3 years allowable excursion rate ostensibly is appropriate for protecting the "*longer term shifts in biological conditions*" in Florida streams. The special status of Oklahoma Scenic Rivers dictates that not only "*longer term shifts in biological conditions*" must be prevented , but also, short term events of excessive algae growth and perturbations of the biota at the algal community level must be prevented as well. The Oklahoma criterion with a 30 day averaging period is more appropriate to help prevent these short term impacts.

Oklahoma's 30 day Averaging Period.

In considering the effects of nutrients, the factors that influence growth of algae must be considered. Scouring events from storm flow essentially resets a stream and then the recovery rate is partially controlled by the availability of nutrients. Turbidity and canopy cover have strong influence on the recovery and the final standing crop. The seasonal presence or absence of canopy cover has also been demonstrated to effect algal growth. The accrual time after a

scouring event can also affect the standing crop. Streams with stable substrate and very stable flows can experience substantial growth of filamentous algae even at low nutrient concentrations. The presence of macrophytic grazers greatly affects algae re-growth and the standing crop in exclusion studies. When protected from grazing fishes and invertebrates, cyanobacterial felts are overgrown by turfs of benthic diatoms within 4-10 days (Power et al 1988).

It is generally accepted that after a scouring event, maximum standing crop of periphyton is reached in around 6-8 weeks. To prevent aesthetic problems, the growth of algae and thus the nutrient concentrations in that time period are critical to control. To protect from effects on benthic invertebrates, the concentrations of nutrients should be evaluated over a time frame that would sustain elevated algal biomass over a full life cycle of the benthic invertebrates. For only protecting the invertebrates, assessment with a full year's averaging would be appropriate. For protecting fish, the assessment should look for concentrations that sustain elevated algal biomass over several years. Longer term averaging periods protective of fish and macro-invertebrates would fail to prevent episodic algal growth.

Acute effects from elevated algae biomass must also be prevented. Nutrients should be evaluated over time frames which would allow accrual of algae to the point where dissolved oxygen diurnal swings stress or kill the aquatic community.

Lavoie, et al. (2008) showed that in mesotrophic rivers, the diatom indices show a response after only 2 weeks, and that in eutrophic rivers, the diatoms respond within 5 weeks. Their research stated:

> *"….3. Along a large phosphorus gradient, the IDEC* [Indice Diatomees de l'Est du Canada (a diatom-based index of integrity)] *was highly correlated with averaged water chemistry data. Along with in-stream phosphorus gradients, the IDEC integrated phosphorus over various periods of time, depending on the trophic status of the site studied (Boyer, Nicolet or Ste. Anne river) and variability in nutrient concentration.*
>
> *4. In the Ste. Anne River, where nutrient concentrations were low and generally stable, an input of phosphorus induced a rapid change in diatom community structure and IDEC*

value within the following week. In the mesotrophic Nicolet River, the observed integration period was approximately 2 weeks. Diatom communities in the eutrophic Boyer River appeared to be adapted to frequent and significant fluctuations in nutrient concentrations. In this system, the IDEC therefore showed a slower response to short term fluctuations and integrated nutrient concentrations over a period of 5 weeks."

In a study where tiles from a degraded river and a relatively pristine river were switched to examine the response to higher nutrients and recovery from the same, Lacoursie`, et al. 2011 found:

"…the present study provides strong evidence for an accelerated response of diatoms to a degradation (within a week in certain cases) and a slower path to recovery (up to 4 weeks for the Nicolet Sud-Ouest River)."

The 30 day averaging period presupposes the availability of daily or weekly data which represents the full range of concentrations the algae are exposed to and that the daily concentrations are related to the growth rate. No studies have been found determining whether the maximum, simple average, geometric mean or median is the best descriptor for nutrient data in relation to algae growth. Literature evaluating algal growth generally uses arithmetic means or single nutrient values compared to single algal chlorophyll a or AFDM values. In establishing the original criterion, a simple 30 day average was proposed. It was pointed out by the Oklahoma Dept. of Environmental Quality (ODEQ) that since nutrient data is rarely normally distributed, the arithmetic average was inappropriate. OWRB concurred and revised the proposed criterion to use a 30 day geometric mean.

Substantial comment from TAG members has stemmed from the 30 day assessment period. Much of this comment is caused from discomfort between the assessment protocol that recognizes the paucity of data and the promulgated 30 day geometric mean. While extended averaging periods could be justified for protecting macoinvertebrates and fisheries, the bulk of the literature shows that maximum biomass of the periphyton accrue in time periods of less

than 30 days. And it is clear that the 30 day time period would be protective of the Scenic Rivers. A strategy to address inadequate data will be discussed in subsequent paragraphs.

Frequency

The Oklahoma Scenic Rivers criterion, as promulgated, does not allow *any* exceedance. For the Florida nutrient criteria, however, EPA promulgated a one in three year allowable excursion frequency for the annual geometric mean similar to the EPA Guidelines for Controlling Toxic Discharges.

> *"A no more than one in three year frequency of excursions avoids unacceptable effects on aquatic life as it will allow the stream ecosystem enough time to recover from the occasionally elevated year of nutrient loadings (Chung et al. 1993; Huchens et al. 1998; Minshall 2003; Stephan et al. 1985; Tikkanen et al. 1994; Vieira et al. 2004; Wallace 1990; Wallace et al. 1986, 1991)."*

These events from which EPA justifies the recovery period are toxic pesticide spills and stream reconstruction. The nature of the impact from toxic events by far eclipses the nature and extent of the impact from excessive algae. In examining the appropriate allowable excursion frequency, the biological effect of an excursion must be considered. The one in three year frequency allowed excursion of an annual geometric mean could, in essence, allow unchecked algal growth and sustained major impacts to the stream 33% of the time. In the Oklahoma Scenic Rivers, this frequency would be unacceptable and would not be protective of the scenic rivers special status.

For criteria in the range that controls algae growth, the effect of a single excursion (one day) should be imperceptible. That single excursion would allow luxury uptake of the nutrient that would drive a slight elevation of biomass and a slight change in the community metrics. Lacoursie` re (2011) showed that the recovery of the diatom community after a stone or tile is moved from high nutrient waters to low nutrient waters was a few weeks. The consequence of a single excursion in the short term is minimal. Cumulative effects of multiple short term excursions, however, should be prevented. Frequent short term excursion and luxury uptake

can result in a prolonged increase in algal standing crop followed by shifts in grazer communities and ultimately the fish community. Preventing the cumulative impacts makes it imperative that the 30 day geometric mean should not be exceeded. It should be noted, however; a geometric mean in itself does allow a frequency of exceedance because it renders single values as a descriptor of the data set. Furthermore, a geometric mean reduces the influence of extremely high values.

Oklahoma has implemented an assessment protocol that allows monthly geometric means to exceed no more that 25% of the time. This implementation, however, is not promulgated as part of the OWQS, and contrary to the promulgated criterion which says that "*The thirty (30) day geometric mean total phosphorus concentration in waters designated "Scenic River" in Appendix A of this Chapter shall not exceed 0.037 mg/L."* The assessment protocol was developed by a working group made up of Oklahoma agencies with EPA Region 6 and Arkansas DEQ participating via telephone. The allowed 25% excursions frequency of monthly geometric means was adopted to reduce the likelihood of false positives in light of the limited data sets available to calculate 30 day geometric means. The assessment reality is that current technology and funding cannot practically provide data that represents the full range of conditions available to drive algae growth. As a side note, the working group favored extending the data sets to 3 months and included a requirement for storm flow data to bolster the data sets for the monthly calculation of the geometric mean. The allowed 25% exceedance was adopted to offset potential error introduced by limited data and compounded influence of the 90 day data set reassessed every 30 days.

In this review effort, the Arkansas TAG members recommend that an "appropriate allowable exceedance frequency should be included in the TP criterion" because of the variability in phosphorus concentrations. EPA has also recommended that OWRB reconcile the assessment protocol and the approved criterion. EPA suggested that reconciliation could be achieved through modification of either the assessment protocol or the approved criterion such that the same averaging period and frequency are reflected in both places. (EPA noted that doing so would entail further OWRB analysis.) EPA also suggested that OWRB consider adding a

statement or footnote in the water quality standards at OAC 785:45-5-19(c)(2) to clarify that applicability or implementation of the averaging period and frequency in light of the data representativeness issues described by OWRB. To resolve these issues, the 30 day geometric mean could be preserved in the Scenic River's criterion language. Modification of the standards language could be considered to add a provision that would allow the calculated 30 day geometric mean to exceed the numerical criterion when the available data is not representative of full range of conditions in the preceding 30 days.

Consideration of the Protectiveness of the Scenic River Criterion for Downstream Waters

Tenkiller and Broken Bow Reservoirs in Oklahoma and Lee Creek Reservoir in Arkansas are each downstream of an Oklahoma Scenic River(s). EPA requires that criteria must be protective not only of in-stream uses but of downstream uses as well. This principle is established in 40 CFR 131.10(6). OWRB solicited information regarding this issue. There was no information submitted regarding the protectiveness of the criterion regarding these particular downstream waters. The ongoing Total Maximum Daily Load (TMDL) development schedule for the Illinois River is planned to include modeling for Tenkiller Reservoir. This modeling effort is not complete and any results have yet to be made available. Therefore, there is no data to consider at this time.

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Appendix A

Bibliography of Reviewed Literature

Scientific Literature Reviewed

Over the past 10 years, OWRB staff have continually reviewed the major scientific literature and guidance related to nutrient criteria. Staff has continually reviewed all new editions of: Hydobiolgia, Journal of North American Benthological Society, Journal of American Water Resources Association, Limnology and Oceanography, Canadian Journal of Fisheries and Aquatic Sciences, as well as any other relevant literature and state or EPA documents that relate to nutrient criteria development.

The Technical Advisory Group reviewed information and reports that were submitted in response to the "Best Scientific Information" request. Included in the information submitted was a report completed by Wright Water Engineers, Inc. on behalf of the Northwest Arkansas Council. Also included in this information was a technical memorandum from GBMc & Associates on behalf of the City of Siloam Springs, Arkansas. The University of Arkansas as well as the United States Geological Survey (USGS) submitted information and research to be included in the TAG's review. In addition to these technical reports, there were also several comment letters from cities in northwest Arkansas. Reports and information from the Oklahoma Attorney General's files were also reviewed by the TAG. (All information reviewed is available at www.owrb.ok.gov/quality/standards/scenicrivers.php)

In addition to the submitted information, the TAG also reviewed the results from an EPA "N-steps" review. This review included abstracts from over 900 research articles related to nutrients and nutrient criteria development.

The following are journal articles that were found to be relevant and were reviewed by the OWRB and the TAG:

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Appendix B

Phosphorus Values Assembled from Literature Review

	Reference	TP (mg/L)	Statistical Measure	Benthic Chl a (mg/m^2)	Area Studied	Citation	Additional Comments
1	Baker, M.A., and R.S. King 2010		Threshold Indicator Taxa Analysis (TITAN)			Methods in Ecology and Evolution. 2010. 1(1):25-37	
2	Biggs 2000	-	-	9.1 - 396	25 Temperate New Zealand streams and rivers		
3	Biggs 2000	-	-	0.73 - 81	25 Temperate New Zealand streams and rivers		
4	Bourassa and Cattaneo 1998	0.005 - 0.054	Average of 3 Replicates for 2 Sampling Days for Actual Conditions	4.8 - 54.6	12 Snowmelt Fed Streams in the Lower Laurentian Mountains of Quebec		
5	Caskey, Brian J., Jeffrey W. Frey, and Shivi Selvaratnam 2010	0.042			Ohio	Biological Breakpoints of the Stressor Variables and Implications for Developing Nutrient CriteriaScientific Investigations Report 2010–5026	These findings indicate that a TP concentration target of 0.042 mg/L based upon striped shiner biomass might be an appropriate concentration for showing changes from eutrophic or mesotrophic stream classification
6	Chetelat et al. 1999	0.006 - 0.130	Mean Concentration Range for Actual Conditions for 30 Samples	9.0 - 470	13 Temperate Lowland Rivers in Southern Ontario & Western Quebec		
7	Chetelat et al. 1999	0.56	Mean Concentration for Actual Conditions for 30 Samples	-	13 Temperate Lowland Rivers in Southern Ontario & Western Quebec		
8	Chetelat et al. 1999	0.02	-	-	13 Temperate Lowland Rivers in Southern Ontario & Western Quebec		
9	Chetelat, J., F.R. Pick, and P.B. Hamilton 2006	-	-	-	Canada	Limnology and Oceanography 51(1, part 2), 2006, 681-689	Potamoplankton size structure and taxonomic composition: Influence of river size and nutrient concentrations.
10	Chin 2006	< 0.02	-	-	Unknown		
11	Clark Fork River Tri-State Council, MT	0.02	Nuisance growth is defined as 150 mg/m2 Periphyton Maximum	-	Streams		
12	Clark, Mueller and Mast 2000	0.022	Relative undeveloped, flow-weighted median	-	U.S.		
13	Dodds 2006	-	-	> 100	Rivers and streams	Limnol. Oceanogr., 51(1, part 2), 2006, 671-680	

14	Dodds 2007	-	-	-		TRENDS in Ecology and Evolution Vol. 22 No. 12	Trophic State, Eutrophication and Nutrient Criteria in Streams
15	Dodds and Oakes 2004	0.059	Intercept of Multiple Linear Regression Models Based on Actual Land Use	-	Ecoregion IV		
16	Dodds and Oakes 2004	0.031	Intercept of Multiple Linear Regression Models Based on Actual Land Use	-	Ecoregion IX		
17	Dodds and Oakes 2004	0.043	Intercept of Multiple Linear Regression Models Based on Actual Land Use	-	Ecoregion XI		
18	Dodds and Oakes 2004	0.06	Maximum for Streams and Rivers	-	Overall recommendation		
19	Dodds and Oakes 2004	0.059	Forested Streams in Lesser Developed Basins	-	Nutrient Ecoregion IV		
20	Dodds and Oakes 2004	0.031	Forested Streams in Lesser Developed Basins	-	Nutrient Ecoregion IX		
21	Dodds and Oakes 2004	0.043	Forested Streams in Lesser Developed Basins	-	Nutrient Ecoregion XI	Limnol. Oceanogr.: Methods 2, 2004, 333-341.	
22	Dodda and Oakes 2006	-	-	-	Flint Hills of Kansas	Environmental Management Vol. 37, No. 5, pp. 634-646.	This research suggests that nutrient criteria may not be met only by managing permanently flowing streams.
23	Dodds and Welch 2000	0.06	Benthic Chl a < 100 mg/m^2 'most of the time'	Most of the Time' < 100	Literature review findings	J. N. Am. Benthol. Soc., 2000, 19(1):186–196	Establishing nutrient criteria in streams
24	Dodds and Welch 2000	0.02	Tri-State Implementation Council, Clark Fork Voluntary Nutrient Reduction Program	-	Clark Fork River, Montana		
25	Dodds and Welch 2000	literature comipation excellent background reading			Literature review findings	J. N. Am. Benthol. Soc., 2000, 19(1):186–196	http://www.k-state.edu/doddslab/journalarts/dodds%20and%20welch%20jnabs%202000.pdf
26	Dodds et al. (2006)	0.08			Data from North American, Australian, New Zealand and European temperate streams		
27	Dodds et al. 1998	0.075	Eutrophy is defined as 200 mg/m2 Periphyton Maximum	-	Streams		
28	Dodds et al. 2008	0.087	Current Median Concentration for 65 River Stations during Summer Months with 100% Exceeding EPA Reference Median	-	Ecoregion IV		
29	Dodds et al. 2008	0.08	Current Median Concentration for 274 River Stations during Summer Months with 99% Exceeding EPA Reference Median	-	Ecoregion IX		

30	Dodds et al. 2008	0.022	Current Median Concentration for 290 River Stations during Summer Months with 94% Exceeding EPA Reference Median	-	Ecoregion XI		
31	Dodds, Smith and Zander 1997	0.038 - 0.09	Nuisance growth is defined as 100-200 mg/m^2 Periphyton Max	100 - 200 Maximum	Clark Fork River, Montana		
32	Dodds, Smith and Zander 1997	0.03	Mean Reference Level & Suggested Target Level to Control Algae	< 150	Clark Fork River, Montana		
33	Dodds, Smith and Zander 1997	0.035	Global Data Regression Analysis for Max 100 mg/m^2 Chl a	< 100	Clark Fork River, Montana		
34	Dodds, Smith and Zander 1997	0.02	Breakpoint in Algal Response - No Risk of 150 mg/m^2 Chl a	<< 150	Clark Fork River, Montana		
35	Dodds, Smith and Zander 1997	0.055	Mean Benthic Chl a < 50 mg/m^2	Mean < 50	-		
36	Dodds, W. K., V. H. Smith, and K. Lohman. 2002	0.03	breakpoint on periphyton biomass			Dodds, W. K., V. H. Smith, and K. Lohman. 2002. Nitrogen and phosphorus relationships to benthic algal biomass in temperate streams. Can. J. Fish. Aquat. Sci. 59: 865-874	
37	Dodds, W.K., V.H. Smith, B. Zander.1997	0.03			Clark Fork River, Montana	W.K. Dodds, V.H. Smith, B. Zander. Developing nutrient targets to control benthic chlorophyll levels in streams: A case study of the Clark Fork River. Water Research, Volume 31, Issue 7, July 1997	
38	Dodds, et al (2008)				Kansas River	Dodds, W. K., et al. (2008), Nitrogen cycling and metabolism in the thalweg of a prairie river, J. Geophys. Res., 113,G04029, doi:10.1029/2008JG000696.	
39	Dojlido and Best 1993	< 0.01	-	-	Surface waters		
40	Dojlido and Best 1993	#####	-	-	Surface waters		
41	Dojlido and Best 1993	> 0.035	-	-	Surface waters		
42	EPA	0.02			Agg Ecor IX	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
43	EPA 2000	0.008			Agg Ecor VIII	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	

44	EPA 2000	0.008			Agg Ecor XI	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
45	EPA 2000	0.008			Agg Ecor XIV	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
46	EPA 2000	0.00875			Agg Ecor II	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
47	EPA 2000	0.01			Agg Ecor XII	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
48	EPA 2000	0.01475			Agg Ecor VII	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
49	EPA 2000	0.017			Agg Ecor III	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
50	EPA 2000	0.0175			Agg Ecor XIII	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
51	EPA 2000	0.02			Agg Ecor IV	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	

52	EPA 2000	0.033			Agg Ecor V	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
53	EPA 2000	0.0375			Agg Ecor VI	Ambient Water Quality Criteria Recommendations Information Supporting the Development of State and Tribal Nutrient Criteria Rivers and Streams in Nutrient Ecoregion XI (Dec 2000)	
54	EPA 2006c	-	Human Health	-	Any water		
55	EPA 2006c	0.1	Criteria Continuous Concentration (CCC)	-	Sea water		
56	EPA 2010	0.01			Clear lakes, Acidic	Has been proposed by EPA for the State of Florida. January 2010	
57	EPA 2010	0.03			Clear lakes, Alkaline	Has been proposed by EPA for the State of Florida. January 2010	
58	EPA 2010	0.042			Canals	Has been proposed by EPA for the State of Florida. January 2010	
59	EPA 2010	0.043			Panhandle Region	Has been proposed by EPA for the State of Florida. January 2010	
60	EPA 2010	0.05			Colored lakes	Has been proposed by EPA for the State of Florida. January 2010	
61	EPA 2010	0.107			Peninsula	Has been proposed by EPA for the State of Florida. January 2010	
62	EPA 2010	0.359			North Central	Has been proposed by EPA for the State of Florida. January 2010	
63	EPA 2010	0.739			Bone Valley	Has been proposed by EPA for the State of Florida. January 2010	
64	EPA Region 7 & 8 November 2008	0.03 - 0.050			Big Souix [South Dakota] Periphyton and Nutrient Study	Info from a presentation given at an EPA Region 7 & 8 meeting in Denver in November 2008	
65	Evans-White, M.A., W.K. Dodds, D.G. Huggins, D.S. Baker				Central Plains streams	J. N. Am. Benthol. Soc., 2009, 28(4):855-868	results suggest that changes in resource quality could contribute to large-scale losses in biodiversity in nutrient-enriched lotic ecosystems. Within shredder and collector-gatherer macroinvertebrate feeding groups, P-rich food might allow faster growing taxa with high body P demands to out-compete slower growing taxa adapted to lower quality food resources. This pattern suggests that biotic integrity is directly linked to nutrients in streams and that toxicity, low dissolved O_2, and increased turbidity might not be the only mechanisms leading to reductions in diversity as nutrient concentrations increase.
66	Fifield and Haines 1995	2.2	Nitrate, Nitrite, Ammonia & Kejldahl Nitrogen Summed	-	1989 UK Standards		
67	Godwin, C.M., M.A. Arthur, and H.J. Carrick	-	-	-	Pennsylvania streams	Hydrobiologia (2009) 623:141-152	Periphyton communities were analyzed for nutrient status and elemental composition.

68	Haggard 2005	no recommendation			Illinois River and tribs		effect of reduced efluent phosphorus concentrations at the illinois river mw arkansas 1997-2004 Proceedings report TMDL conference ASAE Atlanta, GA - March, 2005
69	Haggard, Masoner and Becker 2003	0.003 - 0.103	25th Percentile of Median Concentrations for All Data	-	Ozark Highland Ecoregion 39 Oklahoma, only		
70	Haggard, Masoner and Becker 2003	0.0 - 0.770	Actual Median Concentrations (Min./Max.) for All Data	-	Ozark Highland Ecoregion 39 Oklahoma, only		
71	Haggard, Masoner and Becker 2003	0.01 - 0.069	25th Percentile of Median Concentrations for All Data	-	All Oklahoma and Part of Arkansas		
72	Haggard, Masoner and Becker 2003	0.0 - 1.315	Actual Median Concentrations (Min./Max.) for All Data	-	All Oklahoma and Part of Arkansas		
73	Haggard 2010	-	Trends	-	NW Arkansas	J. Environ. Qual. 39:2113-2120 (2010)	
74	Herlihy, A.T. and J.C. Sifneos	-	-	-	Wadeable streams in the lower 48 state.	Journal of the North American Benthological Society: Vol. 27, No. 4, pp. 932-948.	Our analysis and the literature strongly suggest that 14 national nutrient ecoregions are too coarse to account for natural variation in stream nutrient concentrations. Setting appropriate national nutrient criteria will require finer-scale typology or classification of sites that better controls for natural variation.
75	Hill, W.R., and S.E. Fanta (2008)	0.022 threshold	-	-	Experimental Streams	Freshwater Biology (2008) 53, 215-225	Phosphorus and light colimit periphyton growth at subsaturating irradiances
76	Hill, W.R., S.E. Fanta, and B. J. Roberts (2009)	0.025 threshold	-	-	Experimental streams	Limnol. Oceanogr., 54(1), 2009, 368-380	Quanitifying phosphorus and light effects in stream algae.
77	Hill, W.R. et al (2011)	-	-	-	Experimental streams	Journal of Ecology 2011, 99, 454-463	Resource synergy in stream periphyton communities
78	Justus, B.G. et al. 2009	0.015 (median)	Comparison of indices across a nutrient gradient		Ozark streams	B.G. Justus et al. Ecological Indicators 10 (2010) 627-638.	
79	King, R.S. and C. J. Richardson. 2003	0.012 - 0.015 will cause degradtaiotn to macro inverts			Everglades canals	King, R.S. and C. J. Richardson. 2003. Integrating bioassessment and ecological risk assessment: an approach to developing numerical water-quality criteria. Environmental Management 31: 795 – 809.	

80	King, R.S., et al. 2009	0.015 - 0.020	maximum, threshold	"sharp decline in biolgical integrety"	Texas/Cross Timbers Ecoregion	R.S. King et al. 2009 (Baylor University) 104(b)(3) report to EPA region 6	
81	Maidment 1993	0.02 – 6.0	“Range and Typical Concentrations for Water Quality Parameters in Streams and Rivers”	-	1963 Data		
82	Maidment 1993	0.02 – 6.0	Tables 11.1.3 “Range and Typical Concentrations for Water Quality Parameters in Streams and Rivers”	-	Data sites are unknown but appear to exclude heavily polluted rivers.		
83	Maidment 1993	0.01 - 3.0	Tables 11.1.3 “Range and Typical Concentrations for Water Quality Parameters in Streams and Rivers”	-	Data sites are unknown but appear to exclude heavily polluted rivers.		
84	Miltner & Rankin (1998)	0.06			Ohio	Miltner & Rankin (1998)	
85	Miltner 2010	0.04	protective cap?	.04 mg/ l TP for protection based upon the change point in periphyton	Small rivers and streams in Ohio	environmental managemt publishd on line january 28 2010	
86	Montana Department of Environmental Quality	0.006			Canadian Rockies	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana’s Wadeable Streams and Rivers,	
87	Montana Department of Environmental Quality 20008	0.048			Middle Rockies	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana’s Wadeable Streams and Rivers, Montana Department of Environmental Quality	
88	Montana Department of Environmental Quality 20008	0.123			Northwestern Glaciated Plains	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana’s Wadeable Streams and Rivers, Montana Department of Environmental Quality	

89	Montana Department of Environmental Quality 20008	0.124			Northwestern Great Plains, Wyoming Basin	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers, Montana Department of Environmental Quality	
90	Montana Department of Environmental Quality 2008	0.011			Idaho Batholith	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers, Montana Department of Environmental Quality	
91	Montana Department of Environmental Quality 2008	0.012			Northern Rockies	(November 2008) Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers, Montana Department of Environmental Quality	
92	Morgan. A.M., T.V. Royer, M.B. David, and L.E. Gentry (2006)				Agricultural streams in Illinois	Journal of Environmental Quality, Vol. 35, July - August 2006	Relationships among Nutrients, Chlorophyll-a, and Dissovled Oxygen in Agricultural Streams in Illinois
93	Mueller and Spahr 2006	~ 0.01	Flow-Weighted 25th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped /Reference Watersheds)	-	Ecoregion IV		
94	Mueller and Spahr 2006	~ 0.150	Flow-Weighted 75th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped /Reference Watersheds)	-	Ecoregion IV		
95	Mueller and Spahr 2006	~ 0.03	Flow-Weighted 25th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped/ Reference Watersheds)	-	Ecoregion IX		
96	Mueller and Spahr 2006	~ 0.08	Flow-Weighted 75th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped /Reference Watersheds)	-	Ecoregion IX		
97	Mueller and Spahr 2006	~ 0.022	Flow-Weighted 25th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped /Reference Watersheds)	-	Ecoregion XI		
98	Mueller and Spahr 2006	~ 0.05	Flow-Weighted 75th Percentile Concentrations Regression Models Based on Actual NAWQA Data (Undeveloped /Reference Watersheds)	-	Ecoregion XI		

99	Mueller and Spahr 2006	~ 0.075	Undeveloped Land Use 75th Percentile	-	All data for undeveloped watersheds		
100	Murdock et al (2004)	-	-	-	Urban streams	Ecological Engineering 22 (2004) 197-207	
101	Murdock Et al (2011)				Northeastern Kansas mesocosms	J. N. Am. Benthol. Soc., 2011, 30(2):331–345	Dynamic influences of nutrients and grazing fish on periphyton during recovery from a flood
102	Needham, Riley (2002)	0.02	none		Literatrue review		
103	OWRB	0.037			Oklahoma Scenic Rivers		Became effective July 1, 2002
104	Rier, S.T. and R.J. Stevenson				Kentucky	Hydrobiologia (2006) 561: 131-147	Response of periphytic algae to gradients in nitrogen and phosphorus in streamside mesocosms
105	Robertson, Saad and Wieben 2001	0.01 - 2.16	Actual Mid Monthly Median Concentrations (Min./Max.) for All Data Reported	-	Data from 234 sites across 14 Nutrient Ecoregions in upper Midwest U.S. temperate streams for watersheds ranging from 1.5 to 11,628.9 square miles		
106	Robertson, Saad and Wieben 2001	0.02 - 0.11	25th Percentile Range for General Population	-	Data from 234 sites across 14 Nutrient Ecoregions in upper Midwest U.S. temperate streams for watersheds ranging from 1.5 to 11,628.9 square miles		
107	Robertson, Saad and Wieben 2001	0.17	Mean for General Population	-	Data from 234 sites across 14 Nutrient Ecoregions in upper Midwest U.S. temperate streams for watersheds ranging from 1.5 to 11,628.9 square miles		
108	Robertson, Saad and Wieben 2001	0.11	Median for General Population	-	Data from 234 sites across 14 Nutrient Ecoregions in upper Midwest U.S. temperate streams for watersheds ranging from 1.5 to 11,628.9 square miles		
109	Rohm et al. 2002	0.082	Median for General Population	-	Nutrient Ecoregion IV over 52 sample sites		
110	Rohm et al. 2002	0.04	Median for General Population	-	Nutrient Ecoregion IX over 227 sample sites		
111	Rohm et al. 2002	0.022	Median for General Population	-	Nutrient Ecoregion XI over 164 sample sites		

112	Schneider, Susanne C. and Eli-Anne Lindstrøm 2011	0.01			Norway	hydrobiolgia Volume 665, Number 1, 143-155	>500 samples from >350 sites from the Norwegian mainland and can be used to describe trophic status at a river site.
113	Sheeder, S.A., and B.M. Evans 2004	0.07	Midpoint between impaired and unimpaired watersheds	-	Pennsylvania	Journal of the American Water Resources Association, August 2004, pp 881-888.	Estimating Nutrient and Sediment Threshold Criteria for Biological Impairment in Pennsylvania Watersheds
114	Smith and Christopher P. Tran 2010	clusters based on macroinvertebrate data 0.037 mg TP/L clusters based on diatom data 0.037 mg TP/L			40 large river sites throughout New York State	J. N. Am. Benthol. Soc., 2010, 29(3):875–891	A weight-of-evidence approach to define nutrient criteria protective of aquatic life in large rivers
115	Smith et al. 2003	0.06	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion IV		
116	Smith et al. 2003	0.048	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion IX		
117	Smith et al. 2003	0.02	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion XI		
118	Smith et al. 2003	0.06	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion IV		
119	Smith et al. 2003	0.048	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion IX		
120	Smith et al. 2003	0.02	Fully Forested Streams in Undeveloped Basins	-	Nutrient Ecoregion XI		
121	Soranno, P.A., et al. 2008	0.008 - 0.018	predictive model of biological thresholds, alogrithm		374 Michigan lakes	Limnol. Oceanogr., 53(2), 2008, 773-787	
122	Stevenson et al 2006	0.03	Maximum nutrient to avoid nuisance algae risks.	> 20% avg. & > 40% max.	104 streams over 2 month period for 1st through 4th order streams in North Central U.S. and northwest Kentucky and Michigan		
123	Stevenson et al 2006	0.01 - 0.03	Observed Nutrient Inputs Creating an Algal Response	-	104 streams over 2 month period for 1st through 4th order streams in North Central U.S. and northwest Kentucky and Michigan	Hydrobiologia (2006) 561:149-165	Comparing effects of nutrients on algal biomass in streams in two regions with different disturbance regimes and with applications for developing nutrient criteria.
124	Stevenson et al 2006	≤ 0.011	Oligotrophic Reference Value for Streams and Rivers	10.0 - 20.0	104 streams over 2 month period for 1st through 4th order streams in North Central U.S. and northwest Kentucky and Michigan		

125	Stevenson unpublished data (EPA 2000d)	0.01 - 0.02	Cladophora Nuisance Growth	-	Streams		
126	Stevenson, R. Jan , Brian H. Hill, Alan T. Herlihy, Lester L. Yuan, and Susan B. Norton. (2008)	0.01 - 0.012	Thresholds and responces	-	High-quality biological conditions in streams of the Mid-Atlantic Highlands	R. Jan Stevenson, Brian H. Hill, Alan T. Herlihy, Lester L. Yuan, and Susan B. Norton. (2008) Algae–P relationships, thresholds, and frequency distributions guide nutrient criterion development. Journal of the North American Benthological Society 27:3, 783-799	
127	Stevenson, R. Jan, et al. (2006)	.010 - .030				R. Jan Stevenson et al., Hydrobiologia (2006) 561:149-165. Comparing effects of nutrients on algal biomass in streams in two regions with different disturbance regimes and with applications for developing nutrient criteria	
128	Stevenson, R. Jan, et al. (2008)	.010 - .020			Mid-Atlantic Highlands	R. Jan Stevenson et al. (2008) Journal of the North American Benthological Society. Algae–P relationships, thresholds, and frequency distributions guide nutrient criterion development	
129	STEVENSON, R.J., ET AL. 2008	P criterion between **0.01 and 0.012** TP/L to protect highquality biological conditions in streams of the Mid-Atlantic Highlands	median and average?		Mid-Atlantic Highlands.	J. N. Am. Benthol. Soc., 2008, 27(3):783–799	Algae-P relationships, thresholds, and frequency distributions guide nutrient citerion development.
130	Suplee, M.W., A. Varghese, J. Cleland 2007	-	-	-	Montana streams	Suplee, Michael W., Arun Varghese, and Joshua Cleland, 2007. Developing Nutrient Criteria for Streams: An Evaluation of the Frequency Distribution Method. Journal of the American Water Resources Association (JAWRA) 43(2):453-472. DOI: 10.1111/j.l752-1688.2007.00036.x	Developing Nutrient Criteria for Streams: an Evaluation of the Frequency Distribution Method
131	Stevenson et al 2010	0.027	Threshold Response with filamentous algae		Illinoir River Watershed	Manuscript is in press - Hydrobiologia	

132	Van Nieuwenhuyse and Jones 1996	0.048	Calculated summer (May-September) arithmetic mean 25th percentile	-	116 temperate streams from across the world but primarily from North America for phytoplankton response		
133	Wang et al. (2007)	0.073			Wisconsin		
134	Welch et al. 1988	0.016 - 1.38		< 100	22 Northwestern U.S. and Swedish Streams	Hydrobiologia 157:161-168 (1988)	
135	Zimmerman and Campo 2007	0.019	25th Percentile of Median Concentrations for All Data	6.0 Closed Canopy; 7.2 Open Canopy	65 Massachusetts USGS 1st through 4th order River and Stream Locations with Varied Anthropogenic Impacts		
136	Zimmerman and Campo 2007	0.017 - 0.037	25th Percentile of Median Concentrations Range for All Data	4.325 - 8.25 Closed Canopy; 4.725 - 8.75 Open Canopy	65 Massachusetts USGS 1st through 4th order River and Stream Locations with Varied Anthropogenic Impacts		

Appendix C

TAG Member's Comment Letters Regarding Draft Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

MAR 2 0 2012

Mr. Derek Smithee, Chief
Water Quality Programs Division
Oklahoma Water Resources Board
3800 North Classen Blvd.
Oklahoma City, OK 73118

Dear Mr. Smithee:

I appreciate the opportunity to have participated in the Technical Advisory Group (TAG) assembled by the Oklahoma Water Resources Board (OWRB) in January 2011 to advise OWRB in its review of the Oklahoma Scenic Rivers total phosphorus criterion. This letter provides the U.S. Environmental Protection Agency (EPA) Region 6's general input on key aspects of the review, while the enclosure to this letter provides additional, more specific comments on OWRB staff's document titled *Draft Final Report: Oklahoma Scenic Rivers Phosphorus Criteria Review* which was provided to TAG members for review on March 12, 2012.

In light of EPA's role under Clean Water Act (CWA) Section 303(c) to review and approve or disapprove new and revised State water quality standards (WQS), EPA would like to separate its TAG member input from the overarching TAG recommendations included in OWRB staff's draft final report. Accordingly, I request that OWRB include this EPA letter as a separate appendix within OWRB staff's final version of the report (as has been done for the Arkansas TAG members' minority report). In addition to incorporating this letter in an appendix to the final OWRB staff report, I request that OWRB incorporate the revisions identified in the enclosure to this letter prior to finalizing the report.

Oklahoma's Scenic Rivers total phosphorus criterion is established in the *Oklahoma Administrative Code* (OAC) at OAC 785:45-5-19(c)(2) and provides that, "The thirty (30) day geometric mean total phosphorus concentration in waters designated 'Scenic River' in Appendix A of this Chapter shall not exceed 0.037 [milligrams per liter] mg/L" (brackets added). Because the objective of the TAG's effort was to review all three components of the Oklahoma Scenic Rivers total phosphorus criterion (including magnitude, duration, and frequency), EPA's input below focuses on each of these criterion components.

Magnitude

In adopting the Scenic Rivers total phosphorus criterion in 2002, OWRB used a 2000 United States Geological Survey (USGS) report titled *Nutrient Concentrations and Yields in Undeveloped Basins of the United States* as part of the scientific basis for the criterion. In the report, summary statistics were calculated for percentile values (10%, 25%, 50%, 75%, and 90%) of the flow-weighted mean stream values for several nutrient descriptors, including total

phosphorus. OWRB adopted a total phosphorus concentration of 0.037 mg/L, based on the values included in the report as Table 1, representing the 75th percentile value of undeveloped streams.

In reviewing Oklahoma's submittal of the Scenic Rivers total phosphorus criterion, EPA reviewed not only Oklahoma's scientific basis, but independently considered several other sources of data and information to address whether the outcome of Oklahoma's analysis is representative, scientifically defensible, and protective. EPA reviewed its national nutrient criteria recommendations for the Level III ecoregions occupied by the Scenic Rivers, as well Ozark Highlands ecoregion stream data for total phosphorus presented in another USGS report titled *Percentile Distributions of Median Nitrite Plus Nitrate as Nitrogen, Total Nitrogen, and Total Phosphorus Concentrations in Oklahoma Streams, 1973-2001*. Based upon the record before it, EPA determined that Oklahoma's total phosphorus criterion is sufficient to protect the designated uses of the Scenic Rivers and approved the criterion on December 29, 2003.

Limited scientific information, additional to that available in 2003, has been gathered as a result of the 2011-2012 TAG criterion review effort and is described in OWRB's final report. The additional information does not indicate that a revision to the 0.037 mg/L magnitude component of the current criterion is necessary to ensure the criterion is sufficient to protect the designated uses of the Scenic Rivers.

Additionally, the Quality Assurance Project Plan (QAPP) developed by OWRB to guide the TAG's review effort explains that a "no change" recommendation should result from the review effort if there is either a "lack of adequate information" or if the "best scientific information supports the criterion." Arkansas TAG members' input stresses the lack of adequate information (e.g., need for a quantitative ecological endpoint; need for a stressor-response study on the Illinois River), while Oklahoma TAG members' input emphasizes that the "best scientific information supports the criterion." OWRB's QAPP provides that either of these conclusions should result in a "no change" recommendation to OWRB's nine-member Board. Therefore, OWRB's recommendation to retain the current 0.037 mg/L criterion appears consistent with the QAPP.

Duration and Frequency

EPA believes that a consistent phosphorus criterion and assessment protocol is necessary to manage the Scenic River watersheds. In previous EPA TAG member comments, EPA suggested that reconciliation of the phosphorus criterion and assessment protocol could be achieved through modification of either the assessment protocol or the approved criterion such that the same averaging period and frequency are reflected in both places. EPA also suggested that OWRB consider adding a statement or footnote in the Oklahoma WQS at OAC 785:45-5-19(c)(2) to clarify the applicability or implementation of the averaging period and frequency in light of the data representativeness issues described by OWRB. Either approach is likely to require additional data analysis and review of scientific information. EPA recommends that future work be completed to reconcile the differing durations and frequencies found in the phosphorus criterion and assessment protocol.

In summary, I would like to commend OWRB staff for their commitment, hard work, and transparency in completing this task of reviewing the Oklahoma Scenic Rivers total phosphorus

criterion, as well as each of the TAG members for their time, attention, and contributions throughout the review. EPA recognizes how important the shared watersheds of the Scenic Rivers are to both the States of Oklahoma and Arkansas. Ultimately, EPA believes that successful management of nutrients in these interstate watersheds will result from the availability of scientifically defensible and protective numeric nutrient criteria, supported by robust and carefully considered implementation, in both the States of Oklahoma and Arkansas. If you have any questions or concerns, please contact me at (214) 665-8055.

Sincerely,

Melinda N. McCoy

Melinda N. McCoy
Environmental Scientist
Watershed Management Section

Enclosure

cc: Shellie Chard-McClary, Oklahoma Department of Environmental Quality
Shannon Phillips, Oklahoma Conservation Commission
Quang Pham, Oklahoma Department of Agriculture, Food and Forestry
Steve Drown, Arkansas Department of Environmental Quality
Ed Swaim, Arkansas Natural Resources Commission
Cara Cowan Watts, Cherokee Nation

Additional EPA Comments on OWRB Staff's Document Titled *Draft Final Report: Oklahoma Scenic Rivers Phosphorus Criteria Review*
(Provided to TAG members for review on March 12, 2012)

1. (Page 2.) Given Arkansas' minority report and EPA's comment #5 below, we request the following revision to the second to last sentence in the "Executive Summary" on page 2:

   After several face to face meetings and conference calls of this group, the majority of the TAG concluded that the best scientific information currently available supports the current criterion; therefore, no change in the criterion is necessary.

2. (Page 2.) The last sentence in the "Executive Summary" on page 2 states that the TAG "recommends that a ***holistic study*** documenting chemical, physical and biological integrity should occur to guide future water quality management of these waters" (emphasis added). However, the 4th and 5th "Findings of the TAG" found at the top of page 20 "suggest that a **comprehensive *monitoring program*** be implemented." In light of the Arkansas TAG members' recommendation for "completion of stressor-response studies on the Illinois River...," OWRB should clarify its reference to "holistic study" in the Executive Summary. Is the "holistic study" referring to OWRB's original suggestion for a "comprehensive monitoring program" or to Arkansas TAG members' recommendation for a "stressor-response study"?

3. (Page 8.) In the last sentence in the "Introduction" on page 8, an opening quotation mark should be inserted before the word "sufficient."

4. (Page 10.) The TAG Conference Call held in February 2012 (the 17th) should be added to Table 1 on page 10.

5. (Page 19.) EPA requests the following revisions to the second paragraph of the 1st finding within the "Findings of the TAG" section on page 19:

   The majority of the Oklahoma Scenic Rivers Total Phosphorus Criterion Technical Advisory Group concludes that no change in the criterion is necessary due to the fact that the best scientific information currently available supports the current criterion. ~~However, t~~The Arkansas members of the TAG have provided separate, contrary, recommendations which are included as Appendix C. EPA TAG member input is provided separately from the overarching TAG recommendation and is included in Appendix D of this report.

6. (Page 25.) Within the section titled "Further Findings Concerning Duration and Frequency," we would like to request that the last two sentences under the subsection titled "Frequency" (near bottom of page 25) be replaced with new language.

   These statements:

   EPA also has called for a review of alternative assessment periods or to adopt rules that eliminate the inconsistency between the assessment protocol and the approved criterion.

EPA recommends modification of the Scenic Rivers criterion with a proviso that would allow some exceedance when limited data are available.

should be replaced with the following statements:

EPA has also recommended that OWRB reconcile the assessment protocol and the approved criterion. EPA suggested that reconciliation could be achieved through modification of either the assessment protocol or the approved criterion such that the same averaging period and frequency are reflected in both places. (EPA noted that doing so would entail further OWRB analysis.) EPA also suggested that OWRB consider adding a statement or footnote in the water quality standards at OAC 785:45-5-19(c)(2) to clarify the applicability or implementation of the averaging period and frequency in light of the data representativeness issues described by OWRB.

7. (Page 25.) Within the section titled "Further Findings Concerning Duration and Frequency," we would like to request that the subsection heading titled "Recommendation" (near bottom of page 25) be revised to "OWRB Recommendation" or "OWRB Recommendation in Light of Arkansas and EPA TAG Member Comments." We request this revision, since the recommendation is an OWRB recommendation that has not been discussed or agreed to by the full TAG. Additionally, EPA would need to review and take action on any WQS revisions that could be adopted as a result of OWRB's recommendation.

STEVEN A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

MARY FALLIN
Governor

March 20, 2012

Mr. Derek Smithee, Chief
Water Quality Programs Division
Oklahoma Water Resources Board
3800 N. Classen Blvd.
Oklahoma City OK 73118

RE: Draft Final Report - Oklahoma Scenic Rivers Phosphorus Criteria Review

Dear Mr. Smithee:

The Oklahoma Department of Environmental Quality (DEQ) would once again like to thank you and all of the members of the Technical Advisory Group (TAG) for the extensive effort put forth in the review of the Oklahoma Scenic Rivers phosphorus criterion. The Oklahoma DEQ concurs with the conclusions set forth in the Oklahoma Scenic Rivers Phosphorus Criteria Review Draft Final Report. We would, however, like to offer comments on the Minority Report submitted by the Arkansas TAG members (Appendix C).

The focus of the Arkansas TAG members' Minority Report is that the 0.037 mg/L TP criterion is not substantiated by the available information and the implementation of the standard should be delayed for a minimum of 10 years. The 0.037 mg/L criterion is not only appropriate, but is on the high end of the range supported by the studies reviewed during the re-evaluation process. The Arkansas TAG members' report states their belief that "there is a significant lack of data specific to the Oklahoma Scenic Rivers and the Oklahoma portion of the Illinois River in particular." Based on the review of the available scientific literature, the studies indicate that algal growth response to total phosphorus concentrations is relatively constant across the globe. The opinions expressed in the Minority Report seem to be unfounded.

The Arkansas TAG members' recommend a 10 year delay in implementation of the current standard to complete stressor-response studies on the Illinois River, allow for completion of the EPA's Illinois River Watershed Model, provide time for "legacy phosphorus" to work through the system, and include an allowable exceedance frequency to the TP criterion. The "completion of stressor-response studies on the Illinois River to provide a scientific basis to determine the appropriate numeric standard for the river" as recommended in the Minority Report is not necessary in this case. Although fish and invertebrate evaluation is important in determination of the overall biological integrity of the stream, the designated use protected by the phosphorus

criterion is "Aesthetics" which is not dependent on the status of fish and invertebrate communities. Additionally, completion of the EPA's Illinois River Watershed Model and allowing time to allow the effects of "legacy pollutants" to work through the system are not relevant to the task of establishing a total phosphorus criterion.

The Arkansas TAG members raised the inconsistency between the total phosphorus criterion in Chapter 45 of Oklahoma's Water Quality Standards and the assessment methodology established in Chapter 46. The assessment methodology is not in question during the re-evaluation of the total phosphorus criterion. The total phosphorus criterion established in Chapter 45 is the criterion approved by EPA.

Three additional recommendations proposed by the Minority Report are requiring implementation of Nutrient Management Plans, delaying controls specified for point source dischargers until 2022, and continuing to encourage implementation of voluntary programs to reduce in-stream concentrations of total phosphorus in the shared Scenic Rivers. This appears to simply delay until 2022 the point source controls without regard to the EPA approved Scenic Rivers Phosphorus criterion.

The Minority Report suggests that "both states should continue to encourage implementation of voluntary programs to reduce in-stream concentrations of total phosphorus in the Shared Scenic Rivers." While DEQ agrees with encouraging voluntary programs, these voluntary programs should be implemented in concert with regulatory restrictions on dischargers and poultry litter applications in order to achieve the clean water goals we all share.

Once again, DEQ supports the decision of the Technical Advisory Group to retain the current Total Phosphorus criterion of 0.037 mg/L for Scenic Rivers in Oklahoma and appreciates the significant effort and hard work invested in this review by the OWRB and the other members of the TAG in the review of this criterion.

If you need any additional information on this issue, please contact me at 405-702-8174 or have your staff contact Mark Derichsweiler at 405-702-8188.

Sincerely,

Shellie Chard-McClary

Shellie Chard-McClary, Director
Water Quality Division
Oklahoma Department of Environmental Quality

State of Oklahoma
Secretary of Agriculture

Mary Fallin
Governor

Jim Reese
Secretary of Agriculture

March 26, 2012

Mr. Derek Smithee, Chief
Water Quality Program Division
Oklahoma Water Resources Board
3800 N. Classen Blvd
Oklahoma City, OK 73118

Dear Mr. Smithee:

I appreciate the opportunity of participating in the Technical Advisory Group (TAG) for the re-evaluation of the total Phosphorus criterion of 0.037 mg/l established to protect Scenic Rivers of our State. Your staff has provided the TAG with more than hundred technical documents and studies regarding the effect of Phosphorus on stream water quality. These documents and studies were reviewed and evaluated; the relevant scientific information indicated that the above criterion is within the range of values protective of outstanding resources waters or scenic rivers.

We support the OWRB's recommendation to maintain the current total Phosphorus criterion of 0.037 mg/l for Scenic Rivers. The time and effort that you and your staff dedicated to this task are highly commendable. We are looking forward to working with you and other members of TAG in the protection and improvement of water quality of Oklahoma's streams and lakes.

Sincerely;

Quang Pham

Quang Pham, P.E.
Environmental Programs Manager
Agricultural Environmental Management Services Division

2800 N. Lincoln Blvd., Oklahoma City, OK 73105 (405) 522-5719
jim.reese@oda.state.ok.us

OKLAHOMA
CONSERVATION
COMMISSION

Responsible Care For Oklahoma's Natural Resources

Feb. 8, 12

Phil Moershel
Water Quality Standards Section
Oklahoma Water Resources Board
3800 N Classen Blvd.
Oklahoma City, OK 73118

Dear Phil,

The Oklahoma Conservation Commission has greatly appreciated the opportunity to participate with the Interstate/Tribal/EPA Technical Advisory Group charged with re-evaluation of the 0.037 mg/L total phosphorus criterion for Oklahoma's Scenic Rivers. We must commend the OWRB staff including Jason Childress, yourself,Derek Smithee, and others for the efforts made in coordinating the review and offering opportunity for review and input from the TAG as well as the tremendous efforts made to collect, evaluate, and summarize current and otherwise relevant scientific studies pertinent to the review.

Certainly, if given unlimited resources, any scientist would envision a strategy for such a review that would involve a literature review and then specific field sampling program that studied the relationship between the biotic response and instream nutrient concentrations and cycling in the Scenic River watersheds. However, what that scientist would probably assume was that they already knew where the literature review would lead them and that literature review would not necessarily deter their path toward additional field work. Perhaps the most rewarding and educational experience of this exercise from my perspective was that the literature review reaffirmed that we had been following the most appropriate policy all along, even though we had limited in-situ data from Scenic Rivers when the state set the policy back in 2002. The literature review reaffirmed that whether you are in Texas, Kansas, Oklahoma, Canada, or New Zealand, the algal response to nutrient concentrations, especially phosphorus, was within the same range and that the Oklahoma Scenic River Criterion was conservatively within that range. So, the literature review confirmed that, although additional field investigations within the site specific conditions of the Scenic Rivers would certainly be valuable given

the need for repeatability in science, there was no reason to suspect that such an investigation would lead us toward a significantly different number to protect this resource from eutrophication.

The second topic of consideration was whether the current review based on a 30-day geometric mean of the data was appropriate. The geometric mean and averaging period were both topics of consideration and discussion, as was the case when they were originally developed. When Oklahoma first began to develop the standard in the early 2000s, OCC "ran the numbers" using our available data from the scenic river watersheds to consider what impact varying averaging periods would have on evaluation of the criterion. Based on that review, we concurred with OWRB's recommendation for a 30 day averaging period because the longer 90 day or annual averaging period greatly reduced the impact of large, primarily NPS-driven loading events on the ability to meet the criteria. We felt that a longer averaging period placed the burden of meeting the criterion squarely on the shoulders of point sources while giving nonpoint source a pass or waiver.

Additional concerns about the appropriateness of the 30 day averaging period relate toward the misconception that sampling schedules generally mean that only one sample is collected in each reach per month so there really isn't anything to average. In fact, our network of various agency sampling in the watershedplus additional targeted storm event sampling results in multiple samples from each reach being collected during the 30 day period.

The literature review related to the 30-day averaging period considered many different factors that affect algal biomass growth and accumulation other than or in concert with nutrient concentrations. Although longer averaging periods may be more appropriate to consider in terms of pollutant impacts on different aspects of the biological community, with respect to the impact of nutrient concentrations on algal biomass accumulation, the 30 day window is more closely tied to the time period for algae to respond to a loading and/or scouring event.

Finally, as natural resources agencies, our mission cannot be to merely maintain the status quo, it must be to protect and improve the quality of natural resources. The State recognized the value of these scenic river unique resources in 1970 and since that time, water quality, in terms of algal biomass accumulations has continued to degrade. To protect that resource, we must adopt a criterion that will

not enable the status quo, but will push toward protection against anti-degradation and work toward improved water quality.

In closing, we respect our partners in Arkansas who are working to protect their natural resources and suggest that we are all working toward the same goal. Arkansas has focused substantial efforts toward protecting water quality in Beaver Lake and the White River where USGS reports (Analysis of Ambient Conditions and Simulation of Hydrodynamics and Water-Quality Characteristics in Beaver Lake, Arkansas, 2001 through 2003,*by Joel M. Galloway and W. Reed Green*) median in-stream phosphorus concentrations of 0.02 – 0.04 mg/L for multiple sites between 2001 and 2003 and in-lake concentrations near or below detection forsurface and metalimnion sites. Compare these numbers to the 2003 Oklahoma Beneficial Use Monitoring Program summary where the Illinois River geometric mean was 0.119 mg/L at Tahlequah and 0.225 mg/L at Watts. Lakewide average total phosphorus in Lake Tenkiller was reported in the OWRB 2003 BUMP report at 0.063 mg/L at the surface and ranged from 0.006 -0.156 mg/L. Concentrations in the White River watershed have increased over time, although median values for the last two years of record are approximately 0.047 and seem to be fairly constant at that level since 2009. We applaud Arkansas for their efforts to protect this valuable resource, and value their partnership in our efforts to protect our Scenic Rivers.

In summary, we support the OWRB recommendations that the current Oklahoma Scenic River total phosphorus criterion of 0.037 mg/L is a scientifically defensible number and conservatively within the range of what should be an appropriate goal for the river. We also agree that the 30 day geometric mean is the appropriate means by which to assess this criterion.You and your staff are to be commended for your efforts in this review process and we look forward to working with all partners involved in the TAG toward the continued improvement of water quality in these important resources.

Sincerely,

Shanon Phillips

Water Quality Division Director

Cherokee Nation Tribal Councilwoman
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Claremore, OK 74018
Email: cara@caracowan.com

Cherokee Nation
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Tahlequah, OK 74465
www.cherokee.org
(918) 453-5000

March 26, 2012

Re: Comments on OWRB's Draft Report for Scenic Rivers TP Criterion Review

Dear Oklahoma Scenic Rivers Technical Advisory Group Members:

I am honored to be an active member of the Interstate/Tribal/EPA Technical Advisory Group (TAG) to review the Oklahoma Scenic Rivers Standard (OSRS) for Total Phosphorus (TP) of 0.037 mg/L TP. The work is required as stated in the 2004 Joint Principles and Actions agreement between the State of Oklahoma and the State of Arkansas. I appreciate the EPA for funding the work of this group and the dedication of the Oklahoma Water Resources Board (OWRB) staff for making the work happen.

Overall, I found the report is excellent. Work on the OSRS is an on-going effort where I am sure all governments involved will strive to protect our water ways for future generations. Based on the work of the TAG, I find no reason to lower the standard by increasing the allowable TP levels within our Scenic Rivers. No one on the TAG offered either relevant literature, existing studies or new data which would cause the standard to be less stringent. The literature suggests to me our standard should be stronger and lower than 0.037 mg/L TP.

With respect to the objective of the TAG to re-evaluate the 0.037 mg/L total phosphorus (TP) Oklahoma Water Quality Standard (WQS) criterion assigned to all six Oklahoma Scenic Rivers, I offer the following comments on the OWRB's Draft Report for Scenic Rivers TP Criterion Review.

1. There are six Scenic Rivers and little to no work by the TAG was done to consider the other Scenic Rivers. Most of the focus was on the Illinois River and consideration of the TP standard for the one river body.
2. On page 3, Oklahoma's Scenic Rivers should be more than "better than average," Oklahoma's Scenic Rivers should be or should strive to be pristine and remarkable.
3. The EPA's Numerical Nutrient Criteria recommendations from 2000 should be included in a table within the report for comparison. As an example, I have included a table from my dissertation work as an attachment.
4. Since this is a TAG, we should include the technical qualifications of each participant on page 6 for transparency to both the public and the technical and academic communities who need to better understand the outcomes of the TAG reports.
5. I am concerned the TAG never reached consensus on the acceptable level of risk before moving forward with actual data and plans for future work together to protect our waters of national significance. Without a numerical threshold of risk, I believe it is difficult to determine the feasibility or effectiveness of any WQS.
6. A visual needs to be included on the actual implementation of the OSRS, so duration and frequency of sampling as applied to the OSRS is clear.
7. The information at the top of page 19 concerning toxic pesticide spills needs to be framed more within the context of our report.

8. More work could be included involving luxury uptake, nutrient response thresholds and such but there seemed to be little interest amongst many of the TAG participants to really delve into the science of nutrient uptake mechanisms involved with understanding nutrient response thresholds and more which impact the determination of numerical nutrient criteria.

Please acknowledge the contribution from my literature review as I have not, yet, defended my dissertation and do not want any confusion about the source of the work completed.

Please note the Choctaw and Chickasaw Nations were not included in the TAG and possibly have jurisdiction and interests concerning the (Upper) Mountain Fork River. The Cherokee Nation does not speak for the Choctaw Nation or Chickasaw Nation.

The Cherokee Nation is participating in this TAG in an effort to reach a science based consensus regarding whether 0.037 mg/L TP is sufficiently protective of water quality for our Scenic Rivers. In no way does the Cherokee Nation acknowledge the right of the State of Oklahoma to set water quality standards for waters located within the traditional treaty boundaries of the Cherokee Nation, nor does the Cherokee Nation acknowledge the regulatory role or any other claims the State of Oklahoma may assert over such waters.

Wado (Thank you) to everyone who has contributed to this report and the OWRB staff who did an excellent job in compiling our work and providing additional scientific depth from the literature.

Sincerely,

Cara Cowan Watts
Deputy Speaker
Cherokee Nation Tribal Council

STEVEN A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

MARY FALLIN
Governor

February 1, 2012

Mr. Derek Smithee, Chief
Water Quality Programs Division
Oklahoma Water Resources Board
3800 N. Classen Blvd.
Oklahoma City OK 73118

Dear Mr. Smithee:

The Oklahoma Department of Environmental Quality would like to thank you and all of the members of the Technical Advisory Group (TAG) for the extensive effort put forth in the review of the Oklahoma Scenic Rivers phosphorus criterion. The Oklahoma DEQ believes that the phosphorus criterion is critically important to protect the water quality of our Scenic Rivers. The considerable effort put forth by the Oklahoma and Arkansas state agencies, EPA Region 6, and the Cherokee Nation demonstrates the importance of protecting these waters.

OWRB staff compiled over 150 documents pertaining to the review of the phosphorus criterion. These documents included numerous scientific studies, water quality data, and other documents submitted by concerned parties. DEQ staff conducted an extensive review of the identified relevant scientific literature provided by the OWRB. Our review of the data and scientific studies led us to the conclusion that the current 0.037 mg/L Total Phosphorus criterion is within the range of values consistently demonstrated as protective of the concerned waters. Although we believe the 0.037 mg/L criterion occurs at the upper portion of the protective range, the literature reviewed does not indicate that the 0.037 mg/L Total Phosphorus criterion for Scenic Rivers should be modified. DEQ's opinion is that the studies confirm that the current Scenic Rivers criterion is scientifically supported.

Based on the available scientific studies, DEQ supports the decision of the TAG to retain the current Total Phosphorus criterion of 0.037 mg/L for Scenic Rivers in Oklahoma. We appreciate the significant effort and hard work invested in this review by the OWRB and the other members of the TAG in the review of this criterion.

Sincerely,

Shellie Chard-McClary, Director
Water Quality Division
Oklahoma Department of Environmental Quality

ADEQ

A R K A N S A S
Department of Environmental Quality

March 16, 2012

Mr. Derek Smithee, Chief
Water Quality Programs Division
Oklahoma Water Resources Board
3800 N. Classen Boulevard
Oklahoma City, Oklahoma 73118

Re: Draft Final Report, "Oklahoma Scenic Rivers Phosphorus Criteria Review," March 30th, 2012

Dear Mr. Smithee,

We are in receipt of the Oklahoma Water Resources Board (OWRB) Draft Final Report entitled, "Oklahoma Scenic Rivers Phosphorus Criteria Review," and dated March 30, 2012. We are writing to document the Arkansas TAG members' objections to this final draft.

There is no consensus on the recommendations contained in the final draft. The members of the TAG representing Arkansas do not agree with the recommendations contained in the final draft. This fact is not discussed until page 19 (of a 27 page report). On page 19, the Arkansas TAG members' position is summarized as having "provided separate, contrary, recommendations...." It appears to the Arkansas TAG members that no good reason exists for characterizing our separate recommendations as "contrary" and for not clearly identifying throughout the final draft whose opinions and recommendations are reflected in the report.

As discussed during the TAG's first meeting, it was your stated goal that you hoped a consensus could be reached at the conclusion of this process. However, if a consensus could not be reached, the Arkansas TAG members understood that a "Majority Report" and a "Minority Report" would be prepared and would be submitted as companion documents to the OWRB Board. There was no consensus reached on the total phosphorus criterion review. Accordingly, the Arkansas TAG members prepared a Minority Report, which clearly identifies the authors, their separate recommendations, and the fact that the report is a minority report. Our report is entitled, "***Arkansas TAG Members' Minority Report to OWRB.***" Further, the first paragraph of the report states:

> The following report is prepared by the Arkansas TAG members as a Minority Report in response to OWRB staff's report to OWRB. The Arkansas TAG members appreciate the opportunity to participate in the process to develop a recommendation to the OWRB on Oklahoma's total phosphorus criterion. However, because the Arkansas TAG members cannot agree with the OWRB staff's report recommendations to maintain the total phosphorus standard for Oklahoma's Scenic Rivers as adopted without modification, we have prepared this Minority Report to OWRB.

(Page 3 of Minority Report.) The Arkansas TAG members also clearly asked in the first section of the document that the Minority Report be submitted to the OWRB as a separate stand-alone document (see page 5). Nonetheless, the Minority Report is attached as the last appendix of the 87-page final draft document.

For purposes of clarification, the Arkansas TAG members insist on the following changes to the final draft:

- The Final Report must clearly be identified as a Majority Report and titled as such;
- The Final Report must clearly articulate at the beginning that no consensus was reached on the recommendations to the OWRB, and a Majority Report and a Minority Report were drafted and submitted to OWRB as separate documents;
- The TAG members who support the recommendations contained in the Majority Report must be clearly identified throughout the Final Report to eliminate any confusion about who supports the recommendations and who does not;
- The last sentence in paragraph 2, on page 19, which states, "However, the Arkansas members of the TAG have provided separate, contrary, recommendations which are included as Appendix C" should be deleted; and
- Appendix C should be deleted so the Arkansas TAG Members' Minority Report is not attached to the Majority Report.

The Arkansas TAG members ask OWRB staff to submit the Majority Report and the Minority Report as separate documents to the OWRB.

If these requests cannot be accommodated, then the Arkansas TAG Members ask you to delete from the Final Report any reference to the Arkansas TAG members' participation in this process.

Finally, the Arkansas TAG members note that the final draft contains revisions, including new information. Without adequate time to conduct a substantive review, the Arkansas TAG members are not commenting on the revisions or new information.

Sincerely,

Steven L. Drown

Steven L. Drown
Chief, Water Division
ADEQ

cc: Teresa Marks, Director ADEQ
Randy Young, Director, ANRC
Ryan Benefield, PE, Deputy Director, ADEQ
Melinda McCoy, U.S. EPA, Region 6