State of Arkansas

Nutrient Criteria Development Plan

2012

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Water Division – Planning Branch

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Executive Summary

In 2001 the US EPA published recommended water quality criteria for nutrients under section 304(a) of the Clean Water Act (66 FR 1671) with the intention that this document would serve as a starting point for states, tribes, interstate commissions, and others to develop refined nutrient criteria (US EPA 2001). According to the EPA, Nutrient criteria are needed due to impairment of designated uses per the listing in Dobbs and Welch 2000: 1) adverse effects on humans and domestic animals; 2) aesthetic impairment; 3) interference with human use; 4) negative impacts on aquatic life; and 5) excessive nutrient input into downstream systems. Arkansas proposes to use a combination of EPA's first and third approaches.

1. Whenever possible, develop nutrient criteria that fully recognize localized conditions and protect specific designated uses, using the process outlined in the technical guidance manuals.
2. Use other scientifically defensible methods and appropriate water quality data to develop criteria protective of designated uses.

The Upper Saline watershed was used as a pilot study to test the methods for developing and utilizing a three level approach for nutrient criteria development for Arkansas's river/streams,. The Level I Assessment was performed to screen sites for potential nutrient impairment. The Level II and Level III Assessment was performed at sites where potential nutrient impairment exists. It was meant after completion of the pilot study and verification of assessment methodology, that the approach derived from the Upper Saline Watershed pilot project transfer to other rivers/streams in Arkansas.

Completion of the Upper Saline River Pilot Study brought forth the intrinsic study design flaws, which was the purpose of the study. During the pilot study, water quality was comparable between 25th and 75th percentile, and other regional studies. This was due to the original modification of Approach 1 and the calculation of 25th and 75th percentiles of all data and because the lack of severely nutrient impacted reaches, or in other words gradient. Because of this, macroinvertebrate assemblages exhibited little spatial or temporal differences, while fish assemblages among groups were highly variable. The final issue addressed by the Upper Saline Pilot Study was the need for a copious dataset. The small sample size of the Upper Saline Pilot Study prevented identification of nutrient concentration thresholds among biotic assemblages through the use of regression modeling.

Beaver Reservoir, a large drinking water source for Northwest Arkansas, was a pilot study area for development of nutrient criteria for Arkansas's lakes/reservoirs.
It was meant that after completion of the pilot study and verification of assessment methodology, tools and processes derived for the Beaver Reservoir pilot project would be transferable to other lakes/reservoirs in the State. Completed in 2008 and based on weight-of-evidence approach, findings from the study recommend effects-based numeric water criteria for Hickory Creek on Beaver Lake for growing season geometric mean

chlorophyll a concentration of 8 µg/L, annual average Secchi depth of 1.1m, and nutrient targets for total phosphorus and total nitrogen of 0.04mg/L and 0.4mg/L, respectively.

Assessments continue with priority being assigned to lakes/reservoirs based on screening flags obtained from monitoring data, such as Chl a, water clarity (secchi depth), turbidity, total phosphorus (TP), and total nitrogen (TN).

Introduction

History of Nutrients in AR

Currently, Arkansas maintains the following narrative nutrient standard, Reg. 2.509 in Regulation No. 2, “Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas.”

> Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients is dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, streams will be assessed by a combination of factors such as water clarity (secchi depth), periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in impairment, based upon Department assessment methodology, by any established, numeric water quality standard, the waterbody will be determined to be impaired by nutrients.
>
> All point source discharges into the watershed of waters officially listed on Arkansas’s impaired waterbody list (303d) with phosphorus as the major cause shall have monthly average discharge permit limits no greater than those listed below. Additionally, waters in nutrient surplus watersheds as determined by Act 1061 of 2003 Regular Session of the Arkansas 84th General Assembly and subsequently designated nutrient surplus watersheds may be included under this Reg. if point source discharges are shown to provide a significant phosphorus contribution to waters within the listed nutrient surplus watersheds.
>
> TABLE 1. Total Phosphate as Phosphorus Discharge Limit (mg/l) for Facility Design Flow (mgd).

Facility Design Flow – mgd	Total phosphate as phosphorus discharge
= or > 15	Case by case
3.0 to <15	1.0
1.0 to <3.0	2.0
0.5 to <1.0	5.0
<0.5	Case by Case

> For discharges from point sources which are greater than 15 mgd, reduction of phosphorus below 1 mg/l may be required based on the magnitude of the phosphorus load (mass) and the type of downstream waterbodies (e.g., reservoirs, Extraordinary Resource Waters). Additionally, any discharge limits listed above

> may be further reduced if it is determined that these values are causing impairments to special waters such as domestic water supplies, lakes or reservoirs, or Extraordinary Resource Waters. (ADEQ 2004)

The US EPA published the National strategy for the development of regional nutrient criteria in June of 1998. Portions of Arkansas are contained within three EPA aggregate nutrient ecoregions, IX – South Eastern Temperate Forested Plains and Hills, X – Texas Louisiana Coastal and Mississippi Alluvial Plains, and XI – Central and Eastern Forested Uplands.

TABLE 2. Recommended EPA criteria for Aggregate Ecoregions IX, X, and XI.

	Rivers and Streams			Lakes and Reservoirs	
	Agg Ecor IX	Agg Ecor X	Agg Ecor XI	Agg Ecor IX	Agg Ecor XI
TP ug/l	36.56	128.00	10.00	20.00	8.00
TN mg/l	0.69	0.76	0.31	0.36	0.46
Chl a ug/l	0.93	2.1	1.61	4.93	2.79
Turbidity FTU/NTU	5.7	17.5	2.3	N/A	N/A
Secchi / m	N/A	N/A	N/A	1.53	2.86

Adapted from http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/sumtable.pdf

The difficulties associated with EPA's National Strategy for the Development of Regional Nutrient Criteria are the fact that the strategy is a "one number fits all" approach. The Regional Nutrient Criteria does not take into account the dynamic characteristics of streams and rivers and their ability to assimilate nutrient impacts. These characteristics include but are not limited to: flow, gradient, canopy cover, substrate type, water clarity, pH, DO, channel stability, temperature, season, trophic status, and other factors. In addition, large, generalize data sets, such as EPA's Nutrient Ecoregions Approach, do not account for the natural state of streams and rivers, nor do they determine levels for predicting excessive levels of benthic algae. Finally, generalized nutrient criteria do not have a mechanism for predicting or differentiating in-stream total nitrogen and total phosphorus concentrations attributed to non-point source and point source of nutrients.

Problem Statement

According to the US EPA, 40% of streams are listed as impaired because of nutrients, primarily nitrogen (N) and phosphorus (P) (US EPA 1998). Sources and factors influencing nutrient enrichment and productivity include fertilizers, sewage treatment plants, detergents, septic systems, combined sewer overflows, sediment mobilization, animal manure, atmospheric deposition, internal nutrient recycling from sediments, light attenuation, land-use practices, and imbalances between primary and secondary producers (US EPA 1998).

Elevated nutrient concentrations above background levels can result in a range of negative effects on stream and lake ecosystems. These negative effects could include the following:

I. Ecosystem structure and function
   a. Loss of support for designated uses
   b. Overabundance of primary producers
   c. Shift to macroinvertebrate community dominated by tolerant species, change in community structure and function (loss of biodiversity)
   d. Higher magnitude shifts in diurnal dissolved oxygen
   e. Greater biomass and algal blooms
   f. Reduction of habitat

II. Adverse effects on humans and domestic animals
   a. Loss of support for designated uses
   b. Taste and odor problems in drinking water supplies
   c. Cyanobacteria and microbes producing toxins which can affect human and animal health

1. Listing of Parameters for Which Criteria Will Be Set

The 2004 revision of Regulation No.2, Reg. 2.509 Nutrients, states that impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure, and possibly others.

<u>Rivers/Streams</u>

The Upper Saline watershed was used as a pilot study area to test the methods for developing appropriate nutrient criteria for Arkansas's river/streams, utilizing a three level approach. At the completion of ADEQ's three level assessment, specifically Level III, an assessment site was determined to be "potentially impacted due to nutrients" if three or more of the following indicators are present:

- 72-hour diurnal dissolved oxygen:
  - D.O. % saturation >125%
  - D.O. concentration (mg/L) falls below ecoregional standard
- pH < 6 su or > 9 su
- Nitrite + nitrate-nitrogen (NO_2 +NO_3 – N) is above the 75^{th} percentile
- Total phosphorus (TP) is above the 75^{th} percentile
- Ortho-phosphate as phosphorus is above the 75^{th} percentile
- Algal cover > 50%
- Periphyton thickness > 0.5 – 1.0 mm
- Algal filament length > 4 in
- Macroinvertebrate Biotic Metrics
- Fish Biotic Metrics within ecoregional metrics
- Turbidity > ecoregional standard (Reg. 2.503)

Future nutrient studies will continue assessment of all listed paramenters above as well as:

- Ash-Free Dry Mass
- Chlorophyll a

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<u>Lakes/Reservoirs</u>

Beaver Reservoir, a large drinking water source for Northwest Arkansas, was a pilot study area for development of nutrient criteria for Arkansas's lakes/reservoirs. ADEQ has recommended numeric criteria for Chl a, water clarity (secchi depth), nitrogen, and phosphorus for Beaver Reservoir.

ADEQ is considering these parameters, but will not make a final decision until after the completion of the study.

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined any specific parameters for the development of water quality criteria, including nutrient criteria, for wetlands; nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

2. Rationale for Key Parameters That Will Not be Included in the Plan.

Rivers/Streams

The water quality laboratory at ADEQ does not analyze for total nitrogen (TN). Therefore, nitrite + nitrate-nitrogen (NO_2+NO_3-N) and total Kjeldahl nitrogen (TKN) are being used to assess nitrogen. These parameters are sufficient to provide information needed to assess nutrients.

Lakes/Reservoirs

EPA's listed key parameters, nitrogen, phosphorus, chl a, and TSS for lakes/reservoirs will be included in this plan, therefore, rational for not including key parameters is not necessary.

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined which parameters will not be included for the development of water quality criteria, including nutrient criteria, for wetlands, nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

3. Type of Criteria

Rivers/Streams

ADEQ intends to set narrative criteria or quantitative translators for rivers/streams on an ecoregional, watershed, or site specific basis. Therefore, qualitative criteria with numeric translators for parameters such as dissolved oxygen, dissolved oxygen percent saturation, pH, nitrite + nitrate-nitrogen (NO_2 +NO_3 – N), total phosphorus (TP), ortho-phosphate as phosphorus, turbidity, and biological community composition will be developed.

Lakes/Reservoirs

The Beaver Reservoir Scientific Work Group developed effects-based, site specific water quality criteria to protect the Beaver Reservoir for all its designated uses. ADEQ petitioned the Commission (Arkansas Pollution Control and Ecology Commission) to adopt these criteria as site specific water quality standards for Beaver Reservoir, however they have yet to be adopted. ADEQ will still consider setting criteria for Chl a, water clarity (secchi depth), phosphorus, and nitrogen. ADEQ will then use this approach for future development of appropriate criteria on other lakes and reservoirs.

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined what type of water quality criteria, including nutrient criteria, will be developed for wetlands, nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

4. Approach Being Used

In 2001 the US EPA published recommended water quality criteria for nutrients under section 304(a) of the Clean Water Act (66 FR 1671) with the intention that this document would serve as a starting point for states, tribes, interstate commissions, and others to develop refined nutrient criteria (US EPA 2001). The US EPA recommended the following approaches:

1. Whenever possible, develop nutrient criteria that fully recognize localized conditions and protect specific designated uses, using the process outlined in the technical guidance manuals.
2. Adopt EPA's recommended section 304(a) criteria for nutrients, either as numeric criteria or as a translator for a state or tribal narrative criterion.
3. Use other scientifically defensible methods and appropriate water quality data to develop criteria protective of designated uses.

ADEQ proposes to use a combination of EPA's first and third approaches, and intends to implement nutrient criteria that adopt methods and procedures which translate narrative criteria to protect designated uses on an ecoregional (or another to be determined grouping) basis for streams/reservoirs and criteria related to nutrients (such as Chl a and turbidity) for lakes. This process will begin with a pilot study for both rivers/streams and lakes/reservoirs. The goal is to implement nutrient criteria to protect the designated uses of the waterbodies of the state.

<u>Rivers/Streams</u>

ADEQ has selected a combination of two of the approaches suggested by the EPA for development and adoption of nutrient criteria into water quality standards (EPA 2001). A combination of all three approaches may be used as follows and modified to fit the State of Arkansas's approach.

Approach 1. Develop nutrient criteria that fully recognize localized conditions and protect specific designated uses using EPA's Technical Manual.

Approach 2 Use of predictive relationships

a. Research the development of a Nutrient Biotic Index

Approach 3. Develop a unique, scientifically defensible method utilizing:

a. Cause and effect based studies or relationships
b. Empirical approaches
c. Appropriate models
d. Other

Currently, a three level assessment approach will be used to develop an appropriate nutrient criteria development plan for Arkansas's rivers and streams.

Sampling Design for Potential Sites

Level I

The Level I assessment involves gathering data from the past ten years from ADEQ's Water Quality database for roving and ambient water quality monitoring sites, sorting the data based on specific screening criteria, and determining percentile rankings of the data. A minimum of six samples is required for analysis. Data collected when water temperatures were less than $22^{o}C$ will not be incorporated into the data set as per critical season determination by ADEQ Regulation No. 2.

From those samples with water temperature $>22^{o}C$, the following parameters will be sorted according to these limitations:

- dissolved oxygen less than ecoregional standards (Reg. 2.505)
- the 25^{th} percentiles of the following parameters measured will be reviewed:
    - total Kjeldahl nitrogen (TKN)
    - nitrite + nitrate-nitrogen (NO_2+NO_3-N)
    - ammonia as nitrogen (NH_4-N)
    - total phosphate as phosphorus (TP)
    - ortho-phosphate as phosphorus
    - total organic carbon (TOC)
    - turbidity
    - total dissolved solids (TDS)
    - total suspended solids (TSS)

The results will characterize trends for each ecoregion as well as develop a summarization of potential sites which require field assessments. All sorted data will be evaluated further to identify monitoring stations which may require field assessment. Any station with exceedances in three of the above parameters will then be included as a candidate for a Level II assessment.

Level II

Level II assessment will consist of a site visit with the following data collected and field observations made:

- Photo documentation will be made at each sample location
- 72 hour diurnal dissolved oxygen
- pH
- temperature
- nitrite + nitrate-nitrogen (NO_2+NO_3 – N)
- ammonia as nitrogen (NH-$_4$-N)
- total Kjeldahl nitrogen (TKN)
- total phosphate as phosphorus (TP)
- ortho-phosphate as phosphorus
- total organic carbon (TOC)
- total suspended solids (TSS)
- total dissolved solids (TDS)
- turbidity
- % canopy

- potential nutrient sources
- bank stability
- riparian habitat
- vegetative protection
- percentage of algal cover
- algal filament length
- periphyton thickness
- Ash Free Dry Mass
- Chlorophyll a

All water quality data, including diurnal data, will be collected during the months of June through early October when water temperatures are 22^{o}C or greater.

Level III

The level III assessment includes, but is not limited to, the water quality measurements listed in Level II, including 72-hour diurnal D.O., pH, and temperature (using Data Sondes). All water quality data, including diurnal data, will be collected during the months of June through early October when water temperatures are 22^{o}C or greater.

As indicated by the Level II assessment, sampling of benthic macroinvertebrates and peripyhton assemblages, including coinciding habitat and water quality samples for field and routine parameters, will be conducted during the spring and fall.

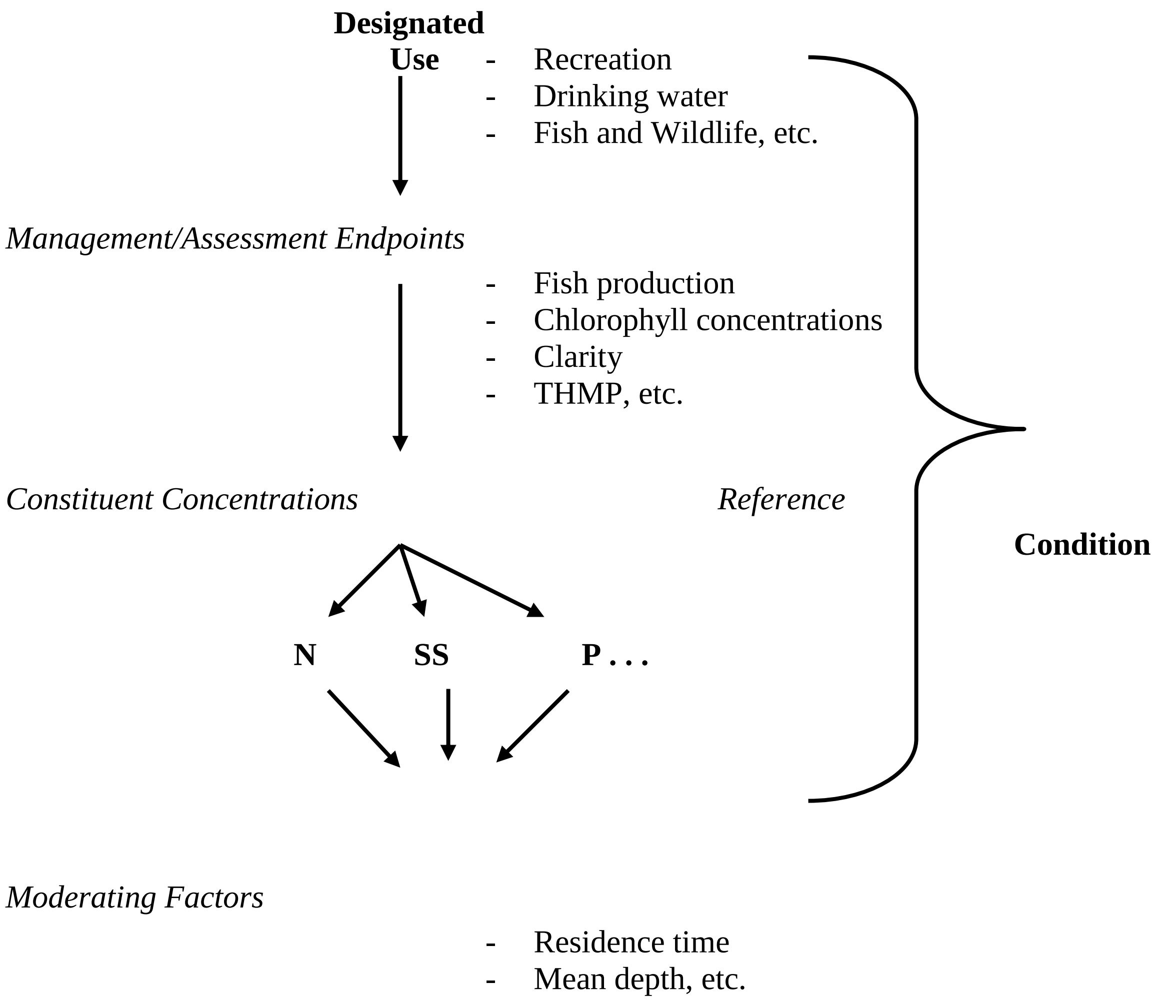
In addition, fish community samples will be collected during the months of June through September from those sites with adequate water quantity. The fish data will be compared for similarity to ADEQ's Ecoregional Fish Community Biocriteria.

ADEQ is considering these parameters, but will not make a finial decision until after the completion of the study.

Lakes/Reservoirs

Nutrient criteria and clarity translators were developed in cooperation with the BLSWG (Beaver Lake Scientific Work Group) created in March 2005. These work groups included members of local, state, and federal government agencies, academia, and individuals who are knowledgeable in this area. The work group initially focused on Beaver Reservoir in Northwest Arkansas as a pilot study. The BLSWG jointly developed sound, scientifically based water quality criteria to protect the reservoir for all its current designated uses. ADEQ proposed these criteria for adoption into state regulations as site specific water quality criteria for Beaver Reservoir in 2012. ADEQ still intends to consider setting numeric criteria for Chl a, water clarity (secchi depth), phosphorus, and nitrogen. ADEQ will then use this approach to consider development of appropriate criteria on other lakes and reservoirs.

The Beaver Lake Scientific Work Group used an effects-based water quality criteria conceptual approach, illustrated below.



a. Review and refine, if needed, the designated uses for Beaver Reservoir, including project purposes.

b. Identify appropriate assessment/management endpoints for these designated uses that reflect those attributes of interest and concern to the public (e.g., drinking water, recreation, fishing, flood control, hydroelectric power generation, …).

c. Use or develop the relationships between water quality constituents and the management/assessment endpoints and how these relate to the designated uses. Relationships among some of the assessment endpoints and stressors (e.g., chlorophyll concentrations based on total phosphorus, total suspended solids, and Secchi disk transparency) have been developed for Beaver Reservoir or similar reservoirs within the South and Southeast. These empirical relationships should be compiled and tested. There is a rich literature on these relationships that should be used.

d. Consider the factors that affect the relationships among water quality constituents and endpoints, such as residence time, mean depth, or similar factors.

e. Evaluate where Beaver Reservoir is right now with respect to these water quality constituents, assessment/management endpoints, and attainment of designated uses by comparing it against some reference.

f. Establish the water quality criteria for the appropriate constituents, based on this reference and modifying factors that will protect the designated uses.

g. This approach will be used to guide discussions and analyses, and can be used to communicate with the public and other groups. This conceptual model, with refinements, has been used to facilitate Nutrient Task Force meetings in Mississippi.

Issues that need to be addressed as part of the process, include:

1. **Precedence** - Even though the water quality criteria for Beaver Reservoir are to be site-specific, there will be a precedent for other lakes and reservoirs throughout Arkansas based on establishing and implementing these criteria in Beaver Reservoir. Therefore, it is important the water quality criteria for Beaver Reservoir be compatible with stream water quality criteria and lake water quality criteria in place or to be developed for other water bodies.

2. **Dynamic system** - The model is static, but Beaver Reservoir is a dynamic system. It will be necessary to determine where and when these criteria are applicable. For example, seasonal criteria are common for many water quality constituents.

3. **Location** – Beaver Reservoir does not have homogeneous water quality from its headwater to the dam. Spatial gradients exist that need be considered when establishing water quality criteria.

4. **Reference** – A reference condition approach for establishing water quality criteria will be used. Appropriate reference(s) for Beaver Reservoir have been determined. Regional information on water quality criteria for Missouri and Oklahoma, as well as EPA ecoregional data, are available and could be complied for perspective and reference to Beaver Reservoir. Extensive water quality data from Lakes DeGray, Ouachita, and Greeson were used to establish background conditions for Beaver Reservoir. These reservoirs have primarily forested watersheds with little development compared to many other reservoirs throughout Arkansas. The water quality gradients observed in these systems should provide reasonable estimates of background conditions expected for Beaver Reservoir. It is recognized that Beaver Reservoir has karst geology that is not present in these other reservoirs, but these effects can likely be accounted through analysis.

5. **Expectations** - It is also important that the expectations of various community sectors be determined as the process of developing water quality criteria proceeds. Heiskery and Walker (1998) compiled survey information from lake users and compared user perceptions of water quality with water constituent concentrations

to assess what was considered poor, adequate, and excellent water quality for the public. Similar information on Beaver Reservoir water quality would be valuable for both public education programs as well as for assessing public expectations and whether these expectations can be attained.

The Beaver Lake Scientific Workgroup (BLSWG) has outlined four main elements for the nutrient study.

Element 1. The BLSWG described the ambient hydrologic and water-quality conditions in Beaver Reservoir and its inflows. Factors that were investigated include, but are not limited to hydrologic and water-quality conditions in Beaver Reservoir for stream flow, lake water-surface elevation, and selected water-quality characteristics (temperature, DO, nutrient concentrations, organic carbon concentrations, secchi depth and chlorophyll *a*).

Element 2. The BLSWG utilized a two-dimensional model of hydrodynamics and water-quality, developed by USGS, of Beaver Reservoir for the period of 2001 to 2003.

Element 3. The BLSWG examined different nutrient loading scenarios and their effects on algal growth in Beaver Reservoir. For the first scenario nitrogen and phosphorus loads were increased or decreased and tested individually and together to examine the algal response within the lake. For the second scenario, some possible changes in wastewater treatment discharge were tested. During scenario three, BLSWG identified threshold levels of sediment and nutrient loading and concentrations based on the level and sensitivity of algal growth to the various nutrient enrichment scenarios.

Element 4. The BLSWG developed site-specific water quality criteria for Beaver Reservoir and develop a technology transfer protocol to begin site-specific water quality criteria development in other Arkansas lakes and reservoirs. Criteria benchmark values were used instead of 25th and 75th percentiles as reference conditions.

Wetlands

It is unknown at this time what approach MAWPT (Multi-Agency Wetland Planning Team) intends to take for the development of water quality criteria, including nutrients, in wetlands; nor is it known when this will take place.

ADEQ is a member of MAWPT and therefore intervenes (and enforces Reg. No. 2) when water quality issues arise concerning wetlands. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

5. Order of Priority by Waterbody type

Prioritization of the States waterbodies for nutrient criteria development is necessary given limited resources to implement the various programs, goals, and objectives of the Water Division of ADEQ. Priority will first be given to those water bodies based on the water bodies' importance to the State. Waterbodies seen as having the highest importance include:

<u>Rivers/Streams</u>

1. ERW- Extraordinary Resource Waterbody
2. Drinking water supply source
3. ESW – Ecologically Sensitive Waterbody
4. Listed on the 303(d) Impaired Waterbodies List for nutrients
5. Primary Contact Recreation
6. Fisheries

<u>Lakes/Reservoirs</u>

1. Drinking water supply source
2. Listed on the 303(d) Impaired Waterbodies List for nutrients
3. Extraordinary Resource or Ecologically Sensitive Waterbody
4. Primary Contact Recreation
5. Fisheries

Other criteria will then be used to further prioritize the water bodies for development of water body specific criteria. Below is a list of criteria used to prioritize water bodies for water body specific water quality standards development.

1. Socioeconomic value to the State (recreational, scenic, industrial, or agricultural water supply)
2. Biological value to the State (endangered species present, endemic species present)
3. Data availability (amount, current, good quality, need additional data)
4. Transferability of data and standards to other similar water bodies
5. Cost of development (funding availability)
6. Water body classification
7. Other factors and concerns (political, interstate waters)

Development of nutrient criteria for lakes/reservoirs began with a pilot study of Beaver Reservoir while development of nutrient criteria for rivers/streams began with a pilot study of the Upper Saline Watershed.

ADEQ intends to first assess Beaver Reservoir, using it as a starting point and pilot for the lakes/reservoirs of the State, and then move on to other similar large public water supply lakes, or based on citizens' concerns, such as Lakes Maumelle, Ouachita, Greers Ferry, and DeGray. ADEQ intends to use the factors outlined above to rank lakes/reservoirs and streams/rivers for assessment, as well as, based on trigger values such as TP, NO_3, % Sat. D.O., etc. At this time, ADEQ does not have a list of all the lakes/reservoirs and streams/rivers that will be assessed in the future, nor the order or timeframe in which assessment will occur.

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined any specific method for assigning priority for the development of water quality criteria, including nutrients, for wetlands, nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

6. How Priorities Were Determined

Rivers/Streams

ADEQ determined the Upper Saline Watershed as the starting point and pilot for the rivers/streams of the State. ADEQ will use the factors outlined in Section 5 to rank rivers/streams. ADEQ does not have a list of all the rivers/streams that will be assessed in the future, nor the order or timeframe in which the assessment will occur.

The Upper Saline Watershed was chosen as the pilot for the rivers/streams of the State for several reasons. The Middle Fork of the Saline River has been recognized by ADEQ as an Extraordinary Resource Water (ERW) under Regulation #2. The stream is also listed under the U.S. Department of the Interior's Nationwide Rivers Inventory. Although there is concern about nutrient and dissolved oxygen concentrations, currently the streams in this watershed are meeting their designated uses. This watershed historically and currently has been of concern to the local citizens. In June, 2002 several concerned citizens requested that ADEQ initiate a survey to determine whether the Middle Fork Saline is impacted by nutrients throughout the stream reaches flowing through Hot Springs Village. Also, it was important to determine the cause of any water quality problems. ADEQ conducted a study in the watershed from 2003 to 2005 (final report underway). Due to continued interest in the area, ADEQ felt it necessary to continue studying the water quality in the watershed. In addition, due to the intensive monitoring conducted during 2003-2005 and the amount of ambient water quality sampling currently underway, ADEQ has a good database for this watershed.

In an effort to advance nutrient criteria development, ADEQ is moving forward with intensive sampling of Extraordinary Resource Waterbodies (ERWs). Preliminary data analysis of nutrient concentrations across the state suggests that among Arkansas's water quality monitoring network, ERWs are among the least-disturbed systems.

Lakes/Reservoirs

ADEQ determined Beaver Reservoir as a starting point and pilot for the lakes/reservoirs of the State. ADEQ will use the factors outlined in Section 5 to rank lakes/reservoirs. ADEQ does not have a list of all the lakes/reservoirs that will be assessed in the future, nor the order or timeframe in which the assessment will occur.

Beaver Reservoir was chosen as the pilot for the lakes/reservoirs of the State because there is a substantial water quality database available for Beaver Reservoir. There is also regional information on water quality criteria available for Missouri and Okalahoma, as well as EPA ecoregional data. All of these data are available and could be compiled for perspective and reference to Beaver Reservoir. Water quality data from DeGray, Ouachita, and Greeson Lakes will establish background conditions for Beaver Reservoir. These reservoirs have primarily forested watersheds with little development compared to many other reservoirs throughout Arkansas. The water quality gradients observed in these systems provide reasonable estimates of background conditions expected for Beaver

Reservoir. It is recognized that Beaver Reservoir has karst geology that is not present in these other reservoirs, but these effects can likely be accounted through analysis.

Beaver Reservoir is a high priority waterbody because it is the drinking water supply source for over 300,000 Arkansans. In the past decade, the population of the area has increased by over fifty percent. It is estimated by the year 2025, the population of the area will be over 730,000 (Univ. of Ark.), putting even more pressure on the reservoir.

Beaver Reservoir is affected by both point and non-point sources of contamination. The City of Fayetteville discharges about one-half of its sewage effluent into the White River about six miles upstream from the backwater of the reservoir. Nutrients, sediment, pathogenic bacteria, and other constituents enter Beaver Reservoir through its tributaries and around its shoreline. The principle agricultural activity in the area is poultry production. The area is also experiencing rapid development, resulting in increased construction and sediment loads. As a result of all the impacts, there is much concern about the current and future water quality in Beaver Reservoir.

Beaver Reservoir is already experiencing high turbidity/sediment inflows and taste and odor problems due to blue-green algae. A paper published in 1999 indicated the upper reaches of Beaver Reservoir were highly eutrophic based on data taken from August 1993 to July 1995 (Proc. Okla. Acad. Sc. 79:73-84 (1999) by Brian E. Haggard, et al.). Past and present water quality problems indicate that the current water quality criteria are not adequate to protect Beaver Reservoir from being impacted by nutrients or sediment/turbidity. For example, the current turbidity standard for all reservoirs in Arkansas is 25 NTUs. This value has a water clarity depth of less than two feet. For a deep clear water reservoir, used for recreation and as a public water supply, a water clarity depth of less than 24 inches is not suitable. With current water quality criteria, Beaver Reservoir could be severely impacted before it would be listed on the impaired waterbody list.

<u>Wetlands</u>

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined an order of priority for wetlands concerning the development of water quality criteria, including nutrients, nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

7. Classification Schemes Used for Waterbody Types.

Organizing water bodies for nutrient criteria development is essential, both from an economic and management standpoint. Identifying workable groups of water bodies (rivers/streams, lakes/reservoirs) with similar characteristics (physical, chemical, and biological) will allow the best use of resources and data comparability across watersheds. The water bodies in Arkansas will be classified as follows:

- Lakes/Reservoirs
  - Type
    - Ecoregion
      - Size/Morphology/Primary Purpose/Other
- Rivers/Streams
  - Watershed
    - Ecoregion
      - Stream Order/Other

<u>Level III Ecoregion Approach</u>

The classification of the State's waters by ecoregions is categorized by physical, chemical and biological features (ADPC&E 1987). This classification system divides the state into six ecoregions based on Omernik et al. 1981.

Delta

The Delta ecoregion occupies approximately the eastern one-third of the state. Soils are deep and generally impermeable, making drainage poor. The Delta's flatness results in its streams being sluggish, meandering, low gradient, and having low reaeration rates. Native vegetation is bottomland hardwoods and wetland timber. Land use is predominately agriculture.

Gulf Coastal Plain

The Gulf Coastal Plain ecoregion lies in the southern one-third of the state. Soils have moderate to high permeability and topography consists of gently rolling hills. Streams are characterized by meanders, low to moderate gradients, pool/riffle combinations, and a distinct "coffee-color" to the water. Native vegetation is loblolly pine, shortleaf pine, and bottomland hardwoods. Land use is predominately silviculture, followed by agriculture.

Arkansas River Valley

The Arkansas River Valley ecoregion lies in the central portion of the state. Soils are generally slowly to moderately permeable and topography is generally rolling yet some synclinal mounts and mesas exist. Streams vary from slow meandering streams following large valley floors to smaller pool and riffle types in the smaller watersheds and characteristically exhibit a light brown turbidity. Native vegetation is shortleaf pine and upland hardwoods on the higher elevations and bottomland hardwoods in the river bottoms. Land use is primarily agriculture with some coal mining and natural gas production.

Ouachita Mountains

The Ouachita Mountains ecoregion is located in the west-central portion of the state. The Ouachita Mountains are generally composed of severely folded and faulted sandstone, shale and novaculite with topography varying from rolling hills to very steep rugged terrain. Soils are moderately permeable, being thin and stony on ridges and deep in the valleys. Streams usually follow east-west valleys and are flashy in nature, streams that cut across the ridges produce rapids and waterfalls. Native vegetation is a mixture of oak, hickory, and shortleaf pine. Land use is predominately silviculture, with agriculture in the valley floors.

Ozark Highlands

The Ozark Highlands ecoregion is located in the northwestern and north-central portion of the state. Rock strata are horizontal and continuous, the flat topped mountains have rugged terrain with steep slopes and relief. Sinkholes, caves, and springs are common in this area. Soils are slowly to moderately permeable and are shallow on the hillsides and deep in the valley floors. Streams are composed of pools and riffles with moderate to high gradient and very low turbidity. Native vegetation is upland hardwood with shortleaf pine and cedar glades. Land use is diverse, consisting of agriculture and some silviculture.

Boston Mountains

The Boston Mountains ecoregion lies north of the Arkansas River Valley. Rock strata are horizontal with very little folding, with strata predominately sandstones and shales. Terrain is exceptionally steep and rugged. Soils are thin except in the valley floors and are slowly to moderately permeable. Streams are characterized by pools and riffles, flashiness, and greenish-blue tinted water. Native vegetation is upland hardwoods and some shortleaf pine. Land use in valley floors are predominately agriculture, while silviculture dominates other areas.

<u>Designated Uses</u>

Essentially, all waters of the state are classified for specific designated uses. Approximately 1,833 miles (about 16%) of Arkansas's streams are classified as high quality, outstanding state or national resources. The designated uses assigned to various water bodies include (ADEQ 2004):

(A) Extraordinary Resource Waters - This beneficial use is a combination of the chemical, physical and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values.

(B) Ecologically Sensitive Waterbody - This beneficial use identifies segments known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semi-aquatic life forms.

(C) Natural and Scenic Waterways - This beneficial use identifies segments which have been legislatively adopted into a state or federal system.

(D) Primary Contact Recreation - This beneficial use designates waters where full body contact is involved. Any streams with watersheds of greater than 10 mi^2 are designated for full body contact. All streams with watersheds less than 10 mi^2 may be designated for primary contact recreation after site verification.

(E) Secondary Contact Recreation - This beneficial use designates waters where secondary activities like boating, fishing or wading are involved.

(F) Fisheries - This beneficial use provides for the protection and propagation of fish, shellfish and other forms of aquatic life. It is further subdivided into the following subcategories:

(1) <u>Trout</u> - water which is suitable for the growth and survival of trout (Family: Salmonidae).

(2) <u>Lakes and Reservoirs</u> - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to impounded waters. Generally characterized by a dominance of sunfishes such as bluegill or similar species, black basses and crappie. May include substantial populations of catfishes such as channel, blue and flathead catfish and commercial fishes including carp, buffalo and suckers. Forage fishes are normally shad or various species of minnows. Unique populations of walleye, striped bass and/or trout may also exist.

(3) <u>Streams</u> - water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to flowing water systems whether or not the flow is perennial

(a) <u>Ozark Highlands Ecoregion</u> - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a preponderance of sensitive species and normally dominated by a diverse minnow community followed by sunfishes and darters.

(b) <u>Boston Mountains Ecoregion</u> - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a major proportion of sensitive species; a diverse, often darter-dominated community exists but with nearly equal proportions of minnows and sunfishes.

(c) <u>Arkansas River Valley Ecoregion</u> - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; a sunfish- and minnow-dominated community exists but with substantial proportions of darters and catfishes (particularly madtoms).

(d) Ouachita Mountains Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. The fish community is characterized by a major proportion of sensitive species; a minnow-sunfish-dominated community exists, followed by darters.

(e) Typical Gulf Coastal Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a limited proportion of sensitive species; sunfishes are distinctly dominant followed by darters and minnows.

(f) Springwater-influenced Gulf Coastal Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a substantial proportion of sensitive species; sunfishes normally dominate the community and are followed by darters and minnows.

(g) Least-altered Delta Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an insignificant proportion of sensitive species; sunfishes are distinctly dominant followed by minnows.

(h) Channel-altered Delta Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by an absence of sensitive species; sunfishes and minnows dominate the population followed by catfishes.

(G) Domestic Water Supply - This beneficial use designates water which will be protected for use in public and private water supplies. Conditioning or treatment may be necessary prior to use.

(H) Industrial Water Supply - This beneficial use designates water which will be protected for use as process or cooling water. Quality criteria may vary with the specific type of process involved and the water supply may require prior treatment or conditioning.

(I) Agricultural Water Supply - This beneficial use designates waters which will be protected for irrigation of crops and/or consumption by livestock.

(J) Other Uses - This category of beneficial use is generally used to designate uses not dependent upon water quality, such as hydroelectric power generation and navigation.

The previous designated uses will be taken into account when prioritizing watersheds for nutrient assessment. After the completion of the pilot studies ADEQ may choose to establish narrative nutrient criteria for specific designated uses.

Rivers/Streams

The streams in the State can best be classified first based on the designated uses of the waterbody, and then by watershed size. Ten designated uses are utilized to classify streams in the state:

Extraordinary Resource Waters
Ecologically Sensitive Waterbody
Natural and Scenic Waterways
Primary Contact Recreation
Secondary Contact Recreation
Fisheries – designated by ecoregion or trout waters
Domestic Water Supply
Industrial Water Supply
Agricultural Water Supply
Other Uses – hydroelectric power generation, navigation, et al.

Stream order, watershed size, gradient, and fluvial morphology will also be considered in stream classification.

Lakes/Reservoirs

Arkansas's significant publicly-owned lakes are divided into five categories based on a variety of characteristics. Some of these characteristics include surface area, watershed size, average depths, geography, and primary use purpose (Table 3). This classification distinguishes between those lakes managed for drinking water supply, aesthetics, and recreation, to those managed solely for fisheries, irrigation water supply, or flood control.

A second classification within each group is water body size and/or ecoregion. For example, the lakes in the Type A and Type E categories range from small impoundments of less than 1500 acres to the large reservoirs of 40,000+ acres. Each group is also distributed between three ecoregions. Likewise, the lakes in the Type B category range in size from 60 acres to almost 1000 acres, are scattered between four ecoregions, and differ in average depth from nine feet to almost 40 feet.

The overall lake classification scheme relies on the following parameters:

Lake Type (A, B, C, D, or E)
Ecoregion
Primary Purpose – recreation, fisheries, flood control, water supply…
Size – natural breaks in different lake type classifications
Depth - natural breaks in different lake type classifications
Natural trophic conditions

TABLE 3. Arkansas's Significant Publicly-Owned Lakes

NO	NAME	COUNTY	ACRES	AVERAGE DEPTH	WATER-SHED[1]	W/A[2]	ECO-REGION[3]	PURPOSE[4]	TYPE
1	WINONA	SALINE	1240	30.0	44.4	22.9	OM	W	A
2	DIERKS	HOWARD	1360	22.0	114.0	53.6	OM	F	A
3	GILLHAM	HOWARD	1370	21.0	271.0	126.6	OM	F	A
4	DEQUEEN	SEVIER	1680	21.0	169.0	64.4	OM	F	A
5	CATHERINE	HOT SPRING	1940	18.0	1516.0	500.1	OM	H	A
6	GREESON	PIKE	7200	38.7	237.0	21.1	OM	H	A
7	HAMILTON	GARLAND	7300	26.0	1441.0	126.3	OM	H	A
8	MAUMELLE	PULASKI	8900	23.0	137.0	9.9	OM	W	A
9	DEGRAY	CLARK	13200	48.8	453.0	22.0	OM	H	A
10	NORFORK	BAXTER	22200	57.0	1806.0	52.5	OH	H	A
11	BEAVER	BENTON	28200	58.0	1186.0	26.9	OH	H	A
12	GREERS FERRY	CLEBURNE	31500	60.0	1153.0	23.4	BM	H	A
13	OUACHITA	GARLAND	40100	51.0	1105.0	17.6	OM	H	A
14	BULL SHOALS	MARION	45440	67.0	6036.0	85.0	OH	H	A
15	CRYSTAL	BENTON	60	12.0	4.5	48.0	OH	A	B
16	SHORES	FRANKLIN	82	10.0	26.0	202.9	BM	R	B
17	SPRING	YELL	82	23.0	10.5	82.0	AV	R	B
18	HORSEHEAD	JOHNSON	100	16.0	17.3	110.7	BM	R	B
19	WEDDINGTON	WASHINGTON	102	16.0	3.0	18.8	OH	R	B
20	COVE	LOGAN	160	10.0	8.5	34.0	AV	R	B
21	ELMDALE	WASHINGTON	180	8.0	6.0	21.3	OH	A	B
22	FAYETTEVILLE	WASHINGTON	196	15.0	6.0	19.6	OH	R	B
23	BOBB KIDD	WASHINGTON	200	13.3	4.0	12.8	OH	A	B
24	WILHELMINA	POLK	200	10.0	13.5	43.2	OM	A	B
25	BARNETT	WHITE	245	27.0	37.5	98.0	AV	A	B
26	SUGARLOAF	SEBASTIAN	250	12.0	5.0	12.8	AV	A	B
27	NOLAN	SEBASTIAN	350	9.0	3.1	5.7	AV	A	B
28	FORT SMITH	CRAWFORD	416	28.0	73.0	112.3	BM	W	B
29	SEQUOYAH	WASHINGTON	500	8.0	275.0	352.0	OH	R	B
30	SWEPCO	BENTON	531	17.0	14.0	16.9	OH	W	B
31	SHEPHERD SPGS.	CRAWFORD	552	31.0	68.0	78.8	BM	W	B
32	CHARLES	LAWRENCE	562	8.0	18.0	20.5	OH	A	B
33	LEE CREEK	CRAWFORD	634	11.0	465.0	469.4	BM	W	B
34	BEAVER FORK	FAULKNER	900	10.0	11.5	8.2	AV	R	B
35	HINKLE	SCOTT	965	15.0	27.5	18.2	AV	A	B
36	BREWER	CONWAY	1165	20.0	36.4	20.0	AV	W	B
37	JUNE	LAFAYETTE	60	5.0	4.0	42.7	GC	A	C
38	BAILEY	CONWAY	124	8.0	7.5	38.7	AV	R	C
39	TRICOUNTY	CALHOUN	280	7.0	11.5	26.3	GC	A	C
40	COX CREEK	GRANT	300	6.0	17.0	36.3	GC	A	C
41	FRIERSON	GREENE	335	7.5	7.3	13.9	DL	A	C
42	STORM CREEK	PHILLIPS	420	7.0	8.0	12.2	DL	D	C
43	CALION	UNION	510	6.0	6.7	8.4	GC	A	C
44	POINSETT	POINSETT	550	7.0	4.5	5.2	DL	A	C
45	BEAR CREEK	LEE	625	10.0	6.0	6.1	DL	R	C
46	UP. WHITE OAK	OUACHITA	630	8.0	20.7	21.0	GC	A	C
47	ATKINS	POPE	750	5.5	10.2	8.7	AV	A	C
48	OVERCUP	CONWAY	1025	4.0	17.2	10.7	AV	A	C
49	LO. WHITE OAK	OUACHITA	1080	8.0	42.5	25.2	GC	A	C
50	HARRIS BRAKE	PERRY	1300	6.0	11.2	5.5	AV	A	C
51	CANE CREEK	LINCOLN	1620	6.0	24.0	9.5	GC	A	C
52	WILSON	ASHLEY	150	5.0	1.0	4.3	DL	A	D
53	ENTERPRISE	ASHLEY	200	5.0	2.0	6.4	DL	A	D
54	1ST OLD RIVER	MILLER	200	4.0	2.0	6.4	GC	A	D
55	PICKTHORNE	LONOKE	207	5.0	0.5	1.5	DL	A	D
56	HOGUE	POINSETT	280	4.4	2.0	4.6	DL	A	D
57	GREENLEE	MONROE	300	6.0	0.5	1.1	DL	A	D
58	MALLARD	MISSISSIPPI	300	6.0	0.5	1.1	DL	A	D
59	GRAMPUS	ASHLEY	334	6.0	2.0	3.8	DL	A	D
60	DESARC	PRAIRIE	350	6.0	1.0	1.8	DL	A	D
61	WALLACE	DREW	362	5.2	1.0	1.8	DL	A	D
62	PINE BLUFF	JEFFERSON	500	6.0	4.0	5.1	DL	A	D
63	ASHBAUGH	GREENE	500	5.0	1.0	1.3	DL	A	D
64	BOIS D'ARC	HEMPSTEAD	750	4.0	4.0	3.4	GC	A	D
65	OLD TOWN	PHILLIPS	900	3.5	23.0	16.4	DL	R	D
66	HORSESHOE	CRITTENDEN	1200	10.0	13.5	7.2	DL	R	E
67	UPPER CHICOT	CHICOT	1270	15.0	14.0	7.1	DL	R	E
68	GRAND	CHICOT	1400	7.0	5.5	2.5	DL	A	E
69	GA. PACIFIC	ASHLEY	1700	4.0	4.0	1.5	GC	W	E
70	BLUE MT.	LOGAN	2900	8.6	488.0	107.7	AV	F	E
71	COLUMBIA	COLUMBIA	2950	11.0	48.0	10.4	GC	W	E
72	NIMROD	YELL	3600	8.2	680.0	120.9	AV	F	E
73	LOWER CHICOT	CHICOT	4030	15.4	350.0	55.6	DL	R	E
74	CONWAY	FAULKNER	6700	5.0	136.0	13.0	AV	A	E
75	ERLING	LAFAYETTE	7000	7.0	400.0	36.6	GC	W	E
76	OZARK	FRANKLIN	10600	14.0	151801.0	9165.3	AV	N	E
77	FELSENTHAL	BRADLEY	14000	7.0	10852.0	496.1	GC	R	E
78	MILLWOOD	LITTLE RIVER	29500	5.2	41444.0	89.9	GC	F	E
79	DARDANELLE	POPE	34300	14.2	153666.0	2867.2	AV	N	E
	TOTAL ACREAGE		355954						

1 -- Watershed: square miles

2 -- W/A: Watershed (acres)/Area of Lake

3 -- Ecoregion: OM-Ouachita Mountains; BM-Boston Mountains; OH-Ozark Highlands; AV-Arkansas River Valley; GC-Gulf Coastal; DL-Delta

4 -- Purpose: W-Water Supply; F-Flood Control; H-Hydropower; A-Angling (public fishing); N-Navigation; R-Recreation

Further classification of lake Types A-E are as follows (ADEQ 2000):

Type A Lakes

These lakes are located in the montane areas of the state, Ozark, Ouachita and Boston Mountains, and are usually several thousand acres in size with average depths of 30 to 60 feet. Most are operated by the U.S. Army Corps of Engineers and were constructed mainly as flood control and/or hydropower lakes. The watersheds of most of these lakes are forest dominated, but some of this land is being cleared for agricultural uses such as pasture and confined animal operations. The watersheds to lake surface area ratios (W/A) were generally 20 to 100 with a median of 39.7. The smallest ratio is 9.9 and the largest is 500. The hydraulic residence time in many of these reservoirs is about one year, except for Lakes Catherine and Hamilton, which have hydraulic residence times of two and four weeks, respectively.

Type B Lakes

The Type B lakes include the smaller lakes, about 500 acres in size, located in the uplands or steeper terrain of the Ozark, Ouachita and Boston Mountains, and the Arkansas River Valley. The primary purpose of these lakes is multi-purpose recreation. Three lakes are used as a public water supply and one lake is used as a cooling water supply for an electric power plant. Average depths range 10 to 25 feet and the watershed to lake-surface area ratios range from 5.7 to 352 with a median of approximately 28. Hydraulic residence time is very short in most of these lakes. Watersheds are predominately forested.

Type C Lakes

These lakes are mainly located in the flatter, lowland areas of the Delta, Crowley's Ridge region, Gulf Coastal Plains, and the Arkansas River Valley. They generally range in size from 300 to 1000 acres. Watershed to lake-surface area ratios range between 5 and 50 with a median of 13. Those lakes with high W/A ratios and shallow average depths generally have high flushing rates. The average depth of Type C lakes is less than 10 feet. Watersheds of these lakes are mostly comprised of lowland hardwoods with some pines. There are small farms scattered throughout most of these watersheds. These lakes were mainly constructed for public fishing and other types of secondary contact recreation uses. A few have expanded to multiple recreation use designations.

Type D Lakes

These lakes are the smaller Delta ecoregion impoundments, generally between 200 to 500 acres; however, two similar lakes of 750 and 900 acres in the Gulf Coastal Ecoregion are also included. Some of these lakes are naturally occurring oxbows or cut-off lakes from main stems of larger rivers. Some of the oxbow lakes have been altered through the construction of water control structures and have been cut off from their parent stream and/or watershed by levees. Average depth of these lakes is generally less than 5 feet. Watershed to lake surface area ratios is 0.5 to 23 with a median of 3.6. Watershed uses consist primarily of row crop agriculture; however very little discharge from these activities enters directly to any of these lakes. The primary use of Type D lakes is public fishing.

Type E Lakes

These are the large lowland lakes, generally 1000 to 30,000 acres located in the Delta, Gulf Coastal Plains, and Arkansas River Valley ecoregions. Average depth in these lakes is usually less than 10 feet. Watershed to lake surface area ratios range from 1.5 to >9000. Flushing rates are also quite variable within this group because of the large variations in watershed to lake surface area ratio. The watersheds of these lakes contain a mixture of row crop agriculture, confined animal operations, pastureland and some forestland. Primary uses of these lakes include three main stem reservoirs for flood control and navigation, one of which has substantial recreation and fish and wildlife enhancement features; several for water supply; two for industrial water supply; one for municipal uses; and one primarily for public fishing.

Wetlands

In 1997, the MAWPT (Arkansas Multi-Agency Wetland Planning Team) developed the Arkansas Wetland Strategy, which identified various tasks intended to improve wetland stewardship in the state.

Wetland experts from various state and federal agencies, universities, and the private sector were brought together in a workshop and a series of field studies. The result was the development of a uniform classification system for the wetlands of the state, identification of high-quality examples of most of the wetland community types in the state, and development of a database containing specific information about selected wetlands. However, even with wetland divided into a classification, the nature of wetlands within classes change as you look at different parts of our diverse state. Hence, assessment procedures were created for each wetland subclass in each Wetland Planning Area, in order to account for any variation in wetlands that is not due to wetland condition or health.

There are five basic Hydrogeomorphic Classes represented in the state. These classes are based on the fundamental ways in which water moves into the wetland, how long it stays, and how it leaves. These hydrologic variables are often tied to the landscape position of the wetland: whether it is in the five-year floodplain, on the side of a slope, etc. Each Class is further divided into Subclasses and Community Types.

Key to Wetland Classes in Arkansas

1. Wetland is not within the 5-year floodplain of a stream	2
1. Wetland is within the 5-year floodplain of a stream	3
2. Topography generally flat, principal water source is precipitation, or if small depressions present, they do not have soils with gleying or sulphur odor, and are not dominated by cypress, tupelo, buttonbush, or swamp privet	Flat
2. Topography sloping or depressional, or principal water source is groundwater	3
3. Wetland on a slope, or generally flat with groundwater as principal water source	Slope
3. Wetland not on a slope or principal water source is other than groundwater	4
4. Wetland is in a topographic depression, or impounded	5

4. Wetland is not in a topographic depression or impounded	Riverine
5. Wetland is associated with a beaver impoundment, or with a shallow impoundment managed principally for wildlife (e.g. greentree reservoirs or moist soil units)	Riverine
5. Wetland is in an impoundment or depression other than above	6
6. Wetland is associated with a water body that has permanent water more than 2m deep in most years	Fringe
6. Wetland is associated with a water body that is ephemeral, or less than 2m deep in most years. Soils are gleyed, have sulphur odor, or are dominated by cypress, tupelo, buttonbush, or swamp privet	Depression

Key to Arkansas Wetland Subclasses and Community Types CLASS: DEPRESSION	**Subclass**	**Community Type**
1. Depression has no significant direct stream input or flooding during a 5-year event; precipitation, runoff, and groundwater are the only inflows	(2)	
1. Depression has significant direct stream input and/or is influenced by overbank or backwater flooding during a 5-year event	(4)	
2. Depression has a direct surface outlet to a stream channel	Headwater Depression	headwater swamp
2. Depression has no direct surface outlet to a stream channel	Isolated Depression	
3a. Depression on topographic bench or mountaintop		mountaintop depression
3b. Depression in limestone sink		sinkhole
3c. Precipitation-dominated depression in dunefields		sandpond
3d. Depressional feature in alluvium deposited by meandering stream, but not currently subject to 5-year flood flows		unconnected alluvial depression
3e. Depressional feature in relict braided-stream channel of valley train (glacial outwash) deposits		valley train pond
4. Perennial streamflow enters and leaves depression	Not Depression: see Riverine Class	
4. Depression not subject to perennial flow, but receives overbank or backwater flooding during 5-year events	Connected Depression	floodplain depression

CLASS: FLATS	**Subclass**	**Community Type**
1. Soil reaction circumneutral to alkaline (lake bed deposits)	Alkali Flats (2)	
2. Vegetation dominated by prairie graminoids		alkali wet prairie
2. Vegetation dominated by post oak		alkali post oak flat
1. Soil reaction acid	Non-alkali Flats (3)	

3. Vegetation dominated by prairie graminoids		wet tallgrass prairie
3. Vegetation dominated by woody species		(4)
4. Vegetation dominated by pine		pine flat
4. Vegetation dominated by hardwoods		(5)
5. Vegetation dominated by hardwoods other than post oak		hardwood flat
5. Vegetation dominated by post oak		post oak flat
CLASS: FRINGE	**Subclass**	**Community Type**
1. Wetland on the margin of a man-made reservoir	Reservoir Fringe	reservoir shore
1. Wetland on the margin of water body other than a reservoir		(2)
2. Water body is subject to overbank or backwater flooding from a stream during 5-year flood events	Connected Lacustrine Fringe	connected lake margin
2. Water body not subject to flooding during a 5-year event	Isolated Lacustrine Fringe	unconnected lake margin
CLASS: SLOPE	**Subclass**	**Community Type**
1. Groundwater reaction neutral or basic (substrate limestone or dolomite)	Calcareous Slopes	calcareous perennial seep
1. Groundwater reaction acid		Non-calcareous Slopes (2)
2a. Wetland on slope with thin soils and exposed sandstone bedrock		sandstone glade
2b. Wetland characterized by presence of sweetbay		bayhead
2c. Wetland not a glade or bayhead, water flow seasonal or ephemeral		wet weather seep
2d. Wetland not a glade or bayhead, water flow perennial		non-calcareous perennial seep

CLASS: RIVERINE	Subclass	Community Type
1. Wetland associated with headwater or high-gradient stream (Stream Orders 1-3)	(2)	
1. Wetland associated with lower gradient stream	(3)	
2. Wetland associated with channel flows that emanate directly from subsurface	Spring Run	spring run
2. Wetland associated with channel flows originating from surface sources	High-gradient Riverine	high-gradient riparian
3. Wetland associated with low-gradient stream (Stream Orders > 6, or other alluvial streams)	(5)	
3. Wetland associated with mid-gradient stream (Stream Orders 4-6)	Mid-gradient Riverine (4)	
4. Water source primarily overbank flooding or lateral saturation	mid-gradient floodplain	
4. Water source primarily backwater flooding, wetland typically located at confluence of two streams	mid-gradient backwater	
5. Wetland not an impoundment	Low-gradient Riverine (7)	
5. Wetland an impoundment	Riverine Impounded (6)	
6. Wetland impounded by beaver	beaver complex	
6. Wetland impounded for wildlife management (greentree reservoirs and moist soil units)	managed wildlife impoundments	
7. Wetland vegetation dominated by prairie graminoids	sand prairie	
7. Wetland dominated by woody vegetation	(8)	
8. Water source primarily overbank flooding (5-year zone) that falls with stream water levels, or lateral saturation from channel flow	low-gradient overbank	
8. Water source primarily backwater flooding or overbank flows (5-year zone) that remain in the wetland due to impeded drainage after stream water levels fall	low-gradient backwater	

This information was obtained from the "Classification and Characterization of the Wetlands of Arkansas — Introduction" found on the MAWPT website: http://www.mawpt.org/products.asp

8. How Criteria Will be Applied

Rivers/Streams

Nutrient criteria translators for rivers/streams will be developed and applied either on an ecoregion, watershed, or site specific basis where appropriate.

Lakes/Reservoirs

Nutrient criteria for large lakes/reservoirs will be developed state-wide. ADEQ will use the information obtained from the Beaver Reservoir project to develop or refine water quality standards that do not adequately protect large lakes and reservoirs of Arkansas. The tools and processes derived for the Beaver Reservoir project will have transfer value to other lake/reservoir systems in Arkansas, particularly other reservoirs in the White River system.

Site-specific water quality criteria for Beaver Reservoir will use benchmark values instead of 25^{th} and 75^{th} percentiles as reference conditions. The trigger value will set off a flag before the regulatory value is reached. Benchmark values (a trigger value, or flag value, and a regulatory value) for Beaver Reservoir reference conditions should identify system sensitivities and provide a more robust strategy for protecting large reservoir water quality across the state.

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) has not outlined how water quality criteria, including nutrient, will be applied for wetlands, nor is there an indication of when this action will take place. ADEQ will continue to stress the importance of water quality criteria development and will cooperate with MAWPT in the future development of nutrient criteria for wetlands.

9. Approach for Waters Shared Across Political Boundaries

Arkansas is bordered by Oklahoma, Texas, Louisiana, Missouri, Mississippi and Tennessee; however, interstate waters are limited. Interstate waters of concern include, but are not limited to: Little River, Kings River, White River and impoundments including Table Rock Lake, Norfork Lake and Bull Shoals Reservoir shared with Missouri; Illinois River and Poteau River watersheds shared with Oklahoma; McKinney Bayou, Days Creek, and Sulphur River shared with Texas; Bayou Macon, Bayou Bartholomew, Ouachita River, Boeuf River, Big Cornie Creek, Dorcheat Bayou, Bodcau Creek, and Red River shared with Louisiana, Oklahoma, and Texas; and the Mississippi River shared with Tennessee and Mississippi. ADEQ intends to perform the three level assessment, as specified in previous sections, on interstate waters. After the completion of the assessment process, ADEQ will meet with the appropriate bordering state agencies and discuss the findings and proposed criteria. Steps will be taken to reach conclusions that can be agreed upon by both states.

ADEQ has participated in workgroups, taskforces, committees, or other cooperative efforts with surrounding states on several occasions. ADEQ is working cooperatively with Oklahoma on the Illinois River in regards to nutrient loading. ADEQ has participated in TMDL development with Louisiana on Bayou Bartholomew, and with Missouri on Table Rock Lake and Little Sugar Creek. ADEQ also cooperates with all lower Mississippi River states as part of the Lower Mississippi River Conservation Committee.

<u>Multi-State Red River Nutrient Criteria Development Project</u>

ADEQ participated in a Multi-State Red River Nutrient Criteria Development project with Texas, Louisiana, Oklahoma, New Mexico and EPA Region 6.

> Phase I for Red River nutrient criteria development included the basic preliminary steps of data management and identification of data needed to develop a process for establishing interstate agreement for criteria. Phase II included analysis of calibrated loading models (or other appropriate models) and characterization of affected stakeholders. This phase may establish endpoints for nutrient criteria and therefore will include options for a facilitated decision process and negotiation between the states to develop agreement about criteria.

(*Red River Nutrient Criteria Development Phase 1*, unpublished handout, Red River nutrient criteria development technical advisory group, US EPA Dallas, TX, 2/6/07)

10. Status of Current Data Availability & Adequacy, and How Data Gaps will be Filled

Existing ADEQ Data

To produce meaningful water quality standards, a database of sufficient chemical, physical, and biological data is needed. The data must also be reliable, verifiable, and easily accessible and manipulated. The Water Division within ADEQ operates several water quality monitoring networks. These include monthly sample sites, bimonthly sample sites, special project sites, and a lake monitoring network. Currently, there are over 300 water quality monitoring stations throughout the state. In addition, ADEQ collects biological data from selected sites on an annual basis. Data from each of these networks is stored in the US EPA STORET data base system. All the data generated and the steps to produce the data are accomplished under US EPA approved quality assurance project plans. Additional details of the monitoring networks and their operation and management are outlined in the "State of Arkansas Surface Water Quality Monitoring Strategy" (Current Version).

Ambient Water Quality Monitoring Network

The Ambient Water Quality Monitoring Network (AWQMN) was initiated in 1974. It was actually an expansion and modification of an earlier intrastate monitoring network. Some of the basic objectives of the network are to provide background water quality data as well as seasonal and chronological water quality variations. Other objectives include: 1) to better assess the effects of point source dischargers upon water quality; 2) to observe the impact of known nonpoint source problems over a long term; 3) to continue to monitor the major rivers of the State; and 4) to provide long-term chemical data and monitoring of the states' least-disturbed ecoregion reference streams. Systematically collected samples over a long period of time allow for long-term trend analysis, as well as determination of pollution control efforts and reliable assessment methodologies and the development of defensible water quality regulations.

Roving Water Quality Monitoring Network

The Roving Water Quality Monitoring Network (RWQMN) was initiated in 1994 and was designed to supplement the AWQMN. This network consists of fixed stations established across the State in streams and rivers that previously had little to no water quality data. Selected stations within a certain area of the state are sampled bimonthly for a two-year period. After two years, another section of the state is sampled. The same objectives from the AWQMN apply to this network. However, this network offers more flexibility than the AWQMN. Staff are able to collect samples for specialized analyses (pesticides, total chlorine) or perform additional field measurements (flow, secchi disk transparency) when necessary. In addition, bacteria samples (*E. coli*) are collected and analyzed from the monitoring stations of the AWQMN and the RWQMN located in the area of the state that is currently being sampled.

Intensive Surveys

Data from the AWQMN and the RWQMN are used to identify watersheds that are in need of more intensive investigations. In most cases, the objectives of these surveys are to: 1) more accurately assess designated use attainment and water quality impairment(s); 2) better delineate water quality impairment cause(s); 3) identify the sources of the impairment(s); 4) prioritize sub-watersheds for restoration activities; and to 5) recommend corrective actions. Many of these surveys are used to collect data for TMDL development.

Intensive surveys are usually short-term, three to five years, and watershed based. Activities included in these surveys are watershed land use delineation, intensive water quality sampling based on flow events, diurnal dissolved oxygen profiling, biological sampling for fish and macroinvertebrate communities, physical habitat surveys, stream bank stability investigations, ground water quality sampling, and specialized parameter sampling when needed.

Special Surveys

Most special surveys are very short-term single purpose investigations (fish kills, complaints, emergency response). They are initiated with very short-term planning, and in many circumstances, the objective and/or work plan has to be modified as data is collected and analyzed. However, some are long-term or continuous projects with multiple objectives (ecoregion reference streams survey, toxicity studies, fish tissue contamination). These projects have very definite objectives and work plans that change little from year to year.

Significant Publicly-Owned Lakes

Surveying Arkansas's significant publicly-owned lakes was initiated in 1989. Arkansas has identified seventy-nine (79) impoundments as significant publicly-owned lakes. These lakes range in size from 60 acres to over 455,000 acres. Sampling and assessment of each of the lakes occurred once every five years. Water samples were collected from various transects of each lake and at different depths and analyzed for routine water quality parameters as well as chlorophyll, bacteria, metals, plankton and temperature and dissolved oxygen profiles. Surveying Arkansas's significant publicly-owned lakes will be performed as needed to fill in data gaps.

Existing Outside Data

Data from sources outside of ADEQ will also be used in developing these criteria. Possible sources include appropriate agencies, academia, and other private entities.

Quality Assurance of Data

Sampling and analysis techniques are based on EPA approved methods outlined in "Standard Methods for the Examination of Water and Wastewater". Methods for sampling and analysis are continually improving and therefore training field and laboratory personnel and updating field and laboratory equipment is an ongoing activity.

All data collection and analysis is accomplished under approved quality assurance project plans unique to each survey.

All of the water quality and biological data the Department generates is stored in on-line searchable data bases accessible from the Departments' web site at http://www.adeq.state.ar.us. The water quality data is also loaded and stored in the US EPA STORET data base. In addition, numerous water quality assessment reports, including the biennial "Integrated Water Quality Monitoring and Assessment Report" are available on line at ADEQ's web site.

All of the data generated from outside sources must meet the quality assurance requirements outlined in the "Quality Assurance Project Plan for Arkansas's Water Quality and Compliance Monitoring" (the most current version). In addition, the data must also meet the requirements outlined in ADEQ's Quality Management Plan (the most current version).

Data Gaps

Currently ADEQ maintains a Surface Water Quality Monitoring Station database consisting of data on the following parameters: D.O., D.O. % saturation, pH, water temperature, flow, ammonia -nitrogen, $NO_2 + NO_3$ – N, TKN, ortho-phosphate as phosphorus, total phosphate as phosphorus, TOC, BOD, turbidity, TSS, TDS, bacteria, anions, metals, pesticides and PCBs. This database contains data beginning in January of 1970. Data for all years and all parameters is not available for every monitoring station.

http://www.adeq.state.ar.us/techsvs/water_quality/monitors.asp

Once all of the data for a specific water body/region/selected boundary has been assimilated, it is important to determine if there is adequate data of sufficient quality, type, accuracy, and abundance to develop the criteria. If not, monitoring plans to generate the necessary data will need to be implemented.

The critical data gaps for Arkansas are the lack of known assimilation rates, benthic biomass, periphyton assemblages, and chlorophyll a data for rivers/streams and lakes/reservoirs under the numerous different climatic conditions and how these affect the biological communities present in the waterbody. These different conditions can be, but are not limited to, the size of water body, flow, percent canopy cover, ecoregion, and water constituents. Data will need to be developed to establish reference conditions as well as to examine the variability across the different occurring conditions listed above. Currently there are no macroinvertebrate data to correlate with the data from the AWQMN and the RWQMN water quality monitoring stations. Macroinvertebrate data will need to be developed for sites suspected of nutrient impairment as well as least impacted sites.

ADEQ is aware of data gaps and intends to begin filling some of these gaps during the pilot studies. Data gaps that pilot studies will help to fill include: nutrient data, physical variables, benthic macroinvertebrates, and fish community. Pilot studies will also help identify unforeseen data gaps.

Methodology Gaps

Past Studies

Pilot Study to Validate a Draft Evaluation Protocol for Indicators of Nutrients and to Initiate the Development of a Macroinvertebrate Biological Monitoring Index for Assessing Streams and Rivers within the Upper Saline Watershed in Arkansas

The purpose of the study was to validate the procedures proposed for nutrient criteria development for rivers and streams. This survey described a process of identifying water quality indicators for use in evaluating water bodies for nutrient impacts beginning with the Upper Saline Watershed in central Arkansas (HUC 08040203). The project had two main goals: 1) develop a nutrient evaluation protocol for the watershed; and 2) initiate the development of a Macroinvertebrate Biological Monitoring Index (MBMI).

Completion of the Upper Saline River Pilot Study brought forth the intrinsic study design flaws, which was the purpose of the study. During the pilot study, water quality was comparable between 25^{th} and 75^{th} percentile, and other regional studies. This was due to the original modification of Approach 1 and the calculation of 25^{th} and 75^{th} percentiles of all data and because the lack of severely nutrient impacted reaches, or in other words gradient. Because of this, macroinvertebrate assemblages exhibited little spatial or temporal differences, while fish assemblages among groups were highly variable. The final issue addressed by the Upper Saline Pilot Study was the need for a copious dataset. The small sample size of the Upper Saline Pilot Study prevented identification of nutrient concentration thresholds among biotic assemblages through the use of regression modeling.

Beaver Reservoir Water Quality Standards and Assessment Criteria Development

The goal of the Beaver Reservoir Scientific Work Group was to jointly develop sound, scientifically based numeric water quality criteria to protect the Beaver Reservoir for all its current designated uses. ADEQ will incorporate these criteria as site specific numeric water quality for Beaver Reservoir.

Completed in 2008 and based on weight-of-evidence approach, findings from the study recommend effects-based numeric water criteria for Hickory Creek on Beaver Lake for growing season geometric mean chlorophyll a concentration of 8 µg/L, annual average Secchi depth of 1.1m, and nutrient targets for total phosphorus and total nitrogen of 0.04mg/L and 0.4mg/L, respectively.

Water Quality of Potential Reference Lakes in Two Level-Three Ecoregions of Arkansas

The goals of this survey were to develop a process for identifying potential reference lakes in Arkansas; identify reference lakes in two ecoregions of

Arkansas; and collect water quality samples from those lakes to verify reference conditions.

(W*ater Quality of Potential Reference Lakes in Two Level-Three Ecoregions of Arkansas*, Work Plan)

Future Studies

Classification and Validation of Nutrient Criteria for the Extraordinary Resource Water Bodies in the Ozark Highlands Ecoregion of Arkansas

(Addendum A)

11. Major Milestones

ADEQ has set new milestones in regard to the development of a Nutrient Criteria Plan and development of nutrient criteria. Additional milestones will be set as needed as further progress is made and as funds become readily available.

<u>General</u>

- Final Nutrient Criteria Development Plan Mutually Agreed Upon by – April 2008
    - Updated Nutrient Criteria Development Plan-September 2012
- Pilot Study to Validate a Draft Evaluation Protocol for Indicators of Nutrients and to Initiate the Development of a Macroinvertebrate Biological Monitoring Index for Assessing Streams and Rivers within the Upper Saline Watershed in Arkansas
    - Initiated 2007
    - Completed 2011
- Begin additional water quality sampling for selected Type C and D ecoregion reference lakes –
    - Initiated 2009
    - Completed January 2012
- Initiate sampling of Type B lakes for determination of Potential Reference Lakes
    - Slated for 2010
    - Initiated August 2012
- Determine feasibility of assessment, incorporating results from pilot studies
    - Initiated 2007
    - Completed Spring 2011
- Begin promulgation of Beaver Reservoir site specific criteria – 2013
    - Adoption to Water Quality Standards-Regulation 2-pending
    - Begin technology transfer of Beaver Lake process to other reservoirs within the state
        - Feasibility assessment-2013
        - If applicable, as completed, begin promulgation of site specific criteria for other lakes – 2014
- Begin intensive sampling and assessment for site-specific criteria for Ozark Highland and Boston Mountain Extraordinary Resource Waterbodies
    - Project Start Date: March 2013
        - Report findings from Ozark Highland and Boston Mountain ERW assessment and if applicable move forward to Ouachita Mountain, Gulf Coastal, and Arkansas River Valley ERWs-2016
        - If applicable, as completed, begin promulgation and adoption of site specific criteria for other Ozark Highland and Boston Mountain ERWs – 2016

Rivers/Streams Pilot Project

Pilot Study to Validate a Draft Evaluation Protocol for Indicators of Nutrients and to Initiate the Development of a Macroinvertebrate Biological Monitoring Index for Assessing Streams and Rivers within the Upper Saline Watershed in Arkansas
Completed 2011

Multi-State Red River Nutrient Criteria Development Project
Completed 2011

Lakes/Reservoirs Pilot Project

Beaver Reservoir Water Quality Standards and Assessment Criteria Development
Completed 2008

Lake Ecoregion Project

Water Quality of Potential Reference Lakes in Two Level-Three Ecoregions of Arkansas
Completed 2012

Wetlands

Currently MAWPT (Multi-Agency Wetland Planning Team) does not have any specific milestones scheduled for the development of water quality criteria, including nutrient, for wetlands.

12. Administrative Steps for Adoption into Water Quality Standards

Regulation No. 8, Administrative Procedures
Part 3. Rulemaking

3.1 PUBLIC NOTICE

3.1.1 Public Notice Required

Prior to the adoption, amendment or repeal of any regulation, the Commission shall give at least twenty (20) days notice of a public hearing on the proposed rulemaking decision.

3.1.2 Publication of Notice

The notice shall be mailed to all persons requesting advance notice of rulemaking and shall be published in appropriate industry, trade, professional or public interest publications chosen by the Commission and at least twice in a newspaper of statewide circulation.

3.1.3 Contents of Notice

The notice shall include:
(1) Reference to the legal authority under which the rule is proposed;
(2) Either the terms or substance of the proposed rule and a description of the subjects and issues involved;
(3) The time, place and manner for submission of written and oral comments; and
(4) A statement that copies of the proposed rule are available at the Department and in local depositories.

3.2 PUBLIC HEARING

3.2.1 Public Hearing Required

No regulation shall be adopted, amended or repealed by the Commission until after a public hearing is held, except as provided in Section 3.3.

3.2.2 Public Hearing Proceedings

The presiding officer at the public hearing shall be any Commissioner or the Commission's designee. At the hearing, any interested person may submit comments, written or oral, on the proposed rulemaking action. Oral comments shall be stenographically or electronically recorded. At any time during a public hearing, the presiding officer may continue the hearing until all oral comments have been heard or may determine not to receive additional oral comments at that hearing if he or she determines that additional comments would not serve a useful purpose or would be repetitious or unduly time consuming.

3.2.3 Written Comments

Written comments are preferred. The period for receiving written comments shall begin on the day of publication of public notice and shall extend ten (10) business days beyond the date of the public hearing. The period for written comments may be extended by the presiding officer at the public hearing for up to an additional twenty (20) days.

Third-Party Rulemaking

3.4 Third-Party Petition for Rulemaking

3.4.1 Third-Party Petition Authorized

Any person may petition the Commission for the issuance, amendment or repeal of any regulation or part thereof.

3.4.2 Contents of Petition

The petition shall be captioned as a pleading to the Commission and shall contain a detailed explanation of the changes proposed and the reasons the changes are necessary. The petitioner shall attach a mark-up copy of the regulation, or portion thereof, indicating all changes proposed in the petition.

3.4.3 Deadline for Commission Action on Third-Party Petitions

Within sixty (60) days of the date of petition submission, the Commission shall either initiate rulemaking procedures or deny the petition. A decision to initiate rulemaking procedures does not constitute an endorsement of the proposed change to existing rules. If the Commission denies the petition, the reasons therefore shall be stated in writing to the petitioner. This denial shall constitute final Commission action for the purposes of appeal.

3.4.4 Third-Party Rulemaking Procedures

(a) If the Commission initiates rulemaking procedures in response to a third-party petition, the Commission shall cause notice of the proposed regulation to be given as provided by Section 3.1, and shall hold a public hearing as required by Section 3.2.
(b) The Commission may direct the proponent of a third-party rule to compile or produce portions of the rulemaking record required by Subsection 3.6.1. In all cases the proponent of a third-party rule shall prepare a proposed Statement of Basis and Purpose required by Subsection 3.6.2 for the Commission's review prior to its final rulemaking decision.

(c) (1) Prior to the close of the public comment period, the Department shall state its position on any proposed third-party proposal to change regulations in writing for the record.

(2) The Department shall prepare its own proposed Statement of Basis and Purpose at the close of the public comment period pursuant to the guidelines of Subsection 3.6.2. This Statement shall include a proposed responsive summary as required by Subsection 3.6.2(2).

(3) Upon consideration of the petitioner's and the Department's positions and proposed Statements of Basis and Purpose, the Commission may issue its final ruling, or order whatever further rulemaking proceedings it deems appropriate, giving due regard to the right of the public to fair notice as provided by this regulation.

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ADDENDUM A

Title: Classification and Validation of Nutrient Criteria for the Extraordinary Resource Water Bodies in the Ozark Highlands Ecoregion of Arkansas

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Problem Statement

In 2001, the US EPA published recommended numeric water quality criteria for nutrients under section 304(a) of the Clean Water Act (66 FR 1671), with the intent that this document would serve as a starting point for states, tribes, interstate commissions, and others to develop refined nutrient criteria (US EPA 2001). In February of 2005 the Arkansas Department of Environmental Quality (ADEQ) submitted the State of Arkansas Nutrient Criteria Development Plan to EPA Region 6. In this accepted plan, ADEQ outlined the initial process to assess nutrient impacts for streams and rivers. In order to validate the procedures set forth within the Nutrient Criteria Development Plan, ADEQ began the "Pilot Study to Validate a Draft Evaluation Protocol for Indicators of Nutrients and to Initiate the Development of a Macroinvertebrate Biological Monitoring Index for Assessing Streams and Rivers within the Upper Saline Watershed in Arkansas" in spring 2006 and completed it in winter 2010.

The study design of the Upper Saline River Pilot Study followed EPA's 2000 *Nutrient Criteria Guidance Manual: Rivers and Streams* (USEPA 2000). Within the guidance manual, EPA outlines three different approaches to developing numeric nutrient criteria. ADEQ modified Approach 1, which were classifications of least-disturbed and impacted streams (25^{th} and 75^{th} percentile of all available data). Modification of Approach 1 was limited to the review of the last 10 years of available water chemistry data and calculating the 25^{th} and 75^{th} percentiles of all these data. Approach 2 describes the use of predictive models while Approach 3 focuses on published nutrient thresholds, biocriteria, and stressor-response relationships. Approach 3 was also outlined within Arkansas's Nutrient Criteria Development Plan and efficacy was tested in the Upper Saline Pilot Study.

Completion of the Upper Saline River Pilot Study brought forth the intrinsic study design flaws, which was the purpose of the study. During the pilot study, water quality was comparable between 25^{th} and 75^{th} percentile, and other regional studies. This was due to the original modification of Approach 1 and the calculation of 25^{th} and 75^{th} percentiles of all data and because the lack of severely nutrient impacted reaches, or in other words gradient. Because of this, macroinvertebrate assemblages exhibited little spatial or temporal differences, while fish assemblages among groups were highly variable. The final issue addressed by the Upper Saline Pilot Study was the need for a copious dataset. The small sample size of the Upper Saline Pilot Study prevented identification of nutrient concentration thresholds among biotic assemblages through the use of regression modeling.

In light of the above, nutrient criteria development in Arkansas is moving forward. With this proposed study, ADEQ will begin investigation and subsequent classification and validation of nutrient criteria for the Extraordinary Resource Water Bodies within the Ozark Highlands ecoregion. Completion of this project is contingent upon several primary tasks. This study will begin with *a priori* classification of streams based upon historical nutrient concentrations. Classification of streams by nutrient concentrations will be based upon standard methodologies (USEPA 2000). Upon selection, ADEQ scientists will begin intensive sampling of each stream's water quality, macroinvertebrate, fish community, and periphyton assemblages.

Task 1. Quality Assurance Project Plan Update, if necessary

Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan will be updated to include any new or revised sampling and or analysis procedures, such as those for fish community and periphyton analysis, to be used during the survey.

Task 2. Historical data compilation and Site Selection

Objective: To compile and analyze historic water quality data from the Extraordinary Resource Water Bodies in Arkansas's Ozark Highlands Ecoregion.

Historic water quality monitoring data collected from ambient, roving, or special studies have been compiled and analyzed. Other data generated by outside sources has also been compiled and analyzed.

Task 3. Data Collection

Objective: To determine the current status of the biological communities in the selected streams and to establish a water quality database in those streams without current data.

Subtask 3.1 Water Quality Assessments

-Collect in-situ data during every water collection and continuous read meter deployment.
    -pH, dissolved oxygen (concentration and percent saturation), temperature
-Collect water and analyze water samples to fully assess ambient conditions with the following parameters. A minimum of twelve (12) collections will be made over two years.

-total Kjeldahl nitrogen (TKN), total organic carbon (TOC), ammonia nitrogen (NH4-N), total dissolved solids (TDS), Nitrite + Nitrate as Nitrogen (NO2+NO3 N), turbidity, total phosphorous, total suspended solids (TSS), orthophosphorus, and metals

-Diurnal dissolved oxygen assessment

-Deploy continuous read meters (YSI 600 Series) twice during critical season flows to record dissolved oxygen and temperature fluctuations

-Enter collected data into working databases

Subtask 3.2 Macroinvertebrate Assemblage Assessments

-Collect macroinvertebrates over two seasons (spring, fall) to assess the condition of the Fisheries Designated Uses.

-Macroinvertebrates will be collected following five-minute traveling kick methodologies which are described in ADEQ's SOP for Macroinvertebrate Collection in Wadeable Streams.

-Enter collected data into working database.

Subtask 3.3 Periphyton Assemblage Assessments

-Collect periphyton assemblage data over two seasons

-Quantitative assessments of periphyton biomass will be assessed using Ash-Free Dry Mass (AFDM) and Chlorophyll a

-Periphyton assemblages will be sampled following surface area methods. A quantitative algal subsample will be collected from five randomly selected cobbles at each riffle location. Each cobble will be scraped free of all algae with a wire brush, and the dislodged algae from the cobble will be rinsed with native water. Sample area and total sample volume will be recorded, and the sample will be preserved with buffered formalin.

- Laboratory methodologies will follow those described by USEPA (1992) and APHA (1995).

-Enter collected data into working database.

Subtask 3.4 Fish Community Assemblage Assessments

-Collect fish community samples during the critical season to assess the Fisheries Designated uses.

-Fish community samples will be collected following the protocols outlined in the quality assurance project plan.

-Enter collected data into working database.

Subtask 3.5 Habitat Assessments

-Percent canopy cover, bank stability, riparian habitat, vegetative protection, flow, and substrate composition will be collected during each macroinvertebrate assemblage collection

-Enter collected data into working database

Subtask 3.6 Land Use-Land Cover

-Calculate percent land use and coverage for each site. Measures of disturbance, i.e. road crossings, will also be calculated.

Subtask 3.7 Biological Sample Analysis

-Separate and identify specimens in the biological community samples.
-Analysis the data for inclusion in the final report.

Task 4. Data Analysis and Statistical Computations
Objective: Calculate descriptive and correlative statistics between nutrient concentrations and biotic assemblage metrics (response variables)

Subtask 4.1 Data Analysis

- Calculate descriptive statistics and assess all water quality parameters for each monitoring station.
- Calculate descriptive statistics and assess biological assemblages.

Task 5. Reports (Progress and Final)
-Prepare and submit semi-annual reports
-Prepare and submit final report to Region VI

Deliverables:

In-situ water quality data from each of the sites.
Diurnal dissolved oxygen, temperature, and pH data from each of the sites.
Macroinvertebrate community data
Fish community data
Semi-annual progress reports
Updated 305(b) Report

Extraordinary Resource Water Bodies Ozark Highlands Ecoregion				
Stream Name	**Planning Segment**	**HUC**	**Monitoring Station**	**County**
North Sylamore Creek	4F	11010004	No	Izard
	Near Mountain View			
Current River	4G	11010008	Yes	Randolph
	Near Pocahontas			
Strawberry River	4G	11010012	Yes	Izard, Sharp
	Near Hardy			
Field Creek	4H	11010010	No	Fulton
	Near Hardy			
Big Creek	4H	11010010	No	Fulton
	Near Hardy			
Myatt Creek	4H	11010010	Yes	Fulton
	Near Cherokee Village			
Gut Creek	4H	11010010	No	Fulton
	Near Hardy			
English Creek	4H	11010010	No	Fulton
	Near Mammoth Springs			
South Fork Spring Creek	4H	11010010	Yes	Fulton
	Near Cherokee Village			
Spring River	4H	11010010	Yes	Sharp
	Near Hardy			
Eleven Point River	4H	11010011	Yes	Randolph
	Near Pocahontas			
Buffalo River	4J	11010005	Yes	Searcy
	Near Marshall			
Kings River	4K	11010001	Yes	Madison
	Near Berryville			

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