**Illinois River Watershed Project**
**Summary Report**

## Background

The State of Oklahoma has designated six rivers as "Scenic," including the Illinois River and two of its tributaries. Oklahoma's water quality standards apply a rolling 30-day geometric mean phosphorous criterion of 0.037 mg/L to the Scenic Rivers., but levels are often found to be above the scenic river criterion at the Illinois River near the Arkansas-Oklahoma border. Oklahoma's Lake Tenkiller and portions of the Illinois River Watershed in northwest Arkansas and northeast Oklahoma are included on both states' Clean Water Act Section 303(d) lists of impaired waters. Phosphorus levels in the Illinois River are impacted by municipal discharges and nonpoint sources (i.e., runoff from poultry litter application sites). Downstream impacts to Lake Tenkiller are reflected by high chlorophyll-*a* and low dissolved oxygen concentrations in the lake, which result from nutrients including phosphorus and other environmental parameters. On an annual basis, municipal sources contribute a small percentage of the total phosphorus to Lake Tenkiller while they account for the vast majority of the flow at the state line during the recreational season. Unfortunately, prior to more recent efforts to improve water quality, neither the point sources nor the nonpoint sources in either state were doing much to control total phosphorus in discharges and runoff. This resulted in a substantial legacy total phosphorus load in the lake sediments. This legacy total phosphorus can be released from the sediments and "recycled" in the lake many times. So if the municipal sources of total phosphorus were entirely removed, the lake would still be impacted and have high chlorophyll-*a* and low dissolved oxygen from legacy and nonpoint source total phosphorus. This phosphorus flux is simulated in part by the model's dissolved oxygen profile and anoxic volume prediction.

Since late 2009, EPA Region 6 has engaged in efforts to develop robust, scientifically defensible water quality models of the Illinois River Watershed (IRW) in northeast Oklahoma and northwest Arkansas in addition to Lake Tenkiller. The modeling efforts are designed to simulate water quality conditions within the IRW and the lake. States and tribes have been engaged throughout the project. Principals made up of state and tribal water directors have been convened and calls have been held relaying progress and soliciting input on the direction of the project. The most recent Principals' call was held January 11, 2016.

In Fall 2015, EPA completed an initial calibration of the watershed and lake models as well as a sensitivity and uncertainty evaluation for those models. Since that time, EPA has been working closely with Arkansas and Oklahoma agencies as well as with the Cherokee Nation to further refine the models and to build consensus around the effort as well as the technical underpinnings of the models. EPA convened a total of six Technical Workgroup (TWG) meetings between April 2016 and November 2016 with the expressed purpose of refining the models and to garner technical consensus of the state and tribal agencies. Members of the TWG consist of representatives from Arkansas and Oklahoma agencies and the Cherokee Nation. A list of TWG members and their contact information is attached to this summary. These TWG meetings provided opportunities to identify, discuss, and resolve technical issues and to promote engagement by the states and tribe. EPA has since addressed those concerns and completed a revised and better calibrated model of the lake.

During 2015 and 2016, an Arkansas-Oklahoma Joint Committee commissioned a study to re-evaluate the Oklahoma Scenic River Total Phosphorus Water Quality Standard (WQS.) The Joint Study Committee



ED_002032_00000534-00001

recommended a six month arithmetic mean of 0.037 mg/L total phosphorus during non-storm flow dominated base flow conditions.

## Regulatory Framework and Technical Issues

The Clean Water Act (CWA) and its implementing regulations require that an upstream state's WQSs be protective of downstream states' WQSs. NPDES regulations prohibit pollutant discharges which may cause or contribute to an in-stream excursion above water quality criteria and also require that permit effluent limits be consistent with the assumptions and requirements of any approved waste load allocation (WLA).

### Technical Issues and Resolutions

As part of the consensus building efforts engaged in by the Agency, the TWG highlighted areas where the models needed to be refined in order to provide a more robust demonstration that the models were working correctly. Most of the following issues were raised by Dr. Brian Haggard of the University of Arkansas. The areas identified and the resolution agreed upon follow. Additionally, calibration was mainly evaluated at the Arkansas/Oklahoma state line and at Tahlequah, OK. Each step was evaluated based on temporal and spatial improvement as well as root mean square error calculations.

### Meteorological Data Review

NEXRAD Meteorological data used as input to the HSPF (the watershed) model was reviewed and compared to National Climatic Data Center (NCDC) data for Fayetteville, AR. NEXRAD data matched the NCDC data and was determined to be useable in the model by the Technical Workgroup. Therefore, no changes were made.

### Litter and Fertilizer Applications

A question arose as to how the watershed model was representing the timing of litter and fertilizer applications in the watershed. The Oklahoma Department of Agriculture, Food and Forestry provided data and the TWG recommended modifications which were made regarding litter application in the watershed model.

### Flow Balancing

Given the low flow (drought) conditions which spanned the 2005-2006 period included in the watershed model, the TWG completed a thorough review of the watershed model's water balance function. Based on guidance from the TWG, EPA revised the model inputs to reflect additional flow in headwater type streams which resulted in a more robust calibration of modeled to actual flow data.

### Surface and Upper Layer Fractioning

Some concern was raised regarding the watershed model's representation of nutrient distribution at various depths in the soil. The TWG evaluated data showing surface and upper soil layer contributions of nutrients from both poultry litter and seasonal fertilizer applications. After extensive review and analysis including multiple model reruns, a 10% surface and 90% upper layer allocation for litter and fertilizer was selected as yielding the most representative response.

### Atmospheric Deposition of Nitrogen

The TWG noted a calculation error in the input file regarding both wet and dry deposition of nitrogen in the model. EPA revised the model to correct the calculation error.



ED_002032_00000534-00002

### Denitrification

Denitrification rates (KNXy) were initially set based on literature rates. Those initial KNXy rates were set to the lowest possible values in the watershed model. Dissolved oxygen (DO) thresholds as well as the ammonia, nitrite, nitrate, and DO based denitrification rates were all adjusted with input and evaluation by the TWG.

### Baseline Model Run Conditions

In an effort to take into account the various changes in the watershed over the temporal model domain, the Technical Workgroup developed a baseline model run to evaluate scenarios. The baseline run utilizes the following data:

2009 Litter Application Rates

2011 National Land Cover Data

2015 DMR flows and Permit Limits

2015 Point Sources

Meteorological data from 1992 – 2009

### Conceptual Approaches and Scenarios

Conceptual approaches have been discussed at TWG meetings. An adaptive approach to managing nutrients in the watershed has been discussed by the TWG. Potential nutrient reduction scenarios need to be reviewed in detail by the TWG.

### Lake Tenkiller Model

The Lake Tenkiller model has undergone several different iterative changes since its initial derivation. However, in Fall 2017, the TWG evaluated output from a newly revised version of the Lake Tenkiller Environment Fluid Dynamic Code (EFDC) model and supported its further use. It is critical for the Arkansas portion of the Illinois River watershed to be included in the reduction plan for Lake Tenkiller.

## Current Conditions

While the TWG has not agreed, EPA believes that the watershed model may be useful for making decisions regarding water quality. The TWG reviewed output from the Lake Tenkiller model and found its output to adequately represent dissolved oxygen and Chlorophyll-*a* in Lake Tenkiller. EPA is finalizing the models, a general reduction scenario and drafting documentation that can be used to develop Total Maximum Daily Loads (TMDLs), Watershed-based Plans (WBPs) or other efforts to improve water quality in the Illinois River and Lake Tenkiller.

## Future Steps and Anticipated Actions

Our next step is for EPA Region 6 to provide our finalized models, a summary of baseline conditions and documentation which can be used to develop Total Maximum Daily Loads or Watershed-based Plans to Arkansas and Oklahoma Agencies and the Cherokee nation. Oklahoma, Arkansas and EPA should work together to evaluate the reduction scenarios and agree on a pathway forward and timeline. The State agencies have agreed to collect and evaluate comments from external stakeholders (e.g., Municipalities, Agriculture industry) the water quality models as part of their on-going outreach efforts. The states also



ED_002032_00000534-00003

intend to host informational public meeting(s) to describe the models, discuss potential next steps, and receive comments from all stakeholders. The Arkansas Department of Environmental Quality and the Oklahoma Department of Environmental Quality will review the final water quality models, associated documentation, and general load reduction scenario in order to consider the establishment of TMDLs or WBPs within their jurisdictions.



ED_002032_00000534-00004

| *Name* | *Title* | *Affiliation* | *Email* |
|---|---|---|---|
| Dr. Bob Blanz P.E. | Chief Technical Officer | Arkansas Department of Environmental Quality | blanz@adeq.state.ar.us |
| Mr. Bill Cauthron | Water Resources Division Chief | Oklahoma Water Resources Board | Bill.Cauthron@owrb.ok.gov |
| Dr. Brian Haggard | Director | Arkansas Water Resources Center | Haggard@uark.edu |
| Dr. Chris Adams | Environmental Scientist | Oklahoma Water Resources Board | Chris.Adams@owrb.ok.gov |
| Mr. David Akakpo P.E. | Professional Engineer | Oklahoma Department of Environmental Quality | david.akakpo@deq.ok.gov |
| Mr. Greg Kloxin | Assistant Director | Oklahoma Conservation Commission | Greg.kloxin@conservation.ok.gov |
| Mr. Joe Long | Watershed Planning Section Manager | Oklahoma Department of Environmental Quality | Joe.Long@deq.ok.gov |
| Ms. Julie Chambers | Environmental Programs Manager | Oklahoma Water Resources Board | Julie.Chambers@owrb.ok.gov |
| Dr. Soojung Lim P.E. | Professional Engineer | Oklahoma Department of Environmental Quality | soojung.lim@deq.ok.gov |
| Mr. Patrick Gwin | Administrative Liaison | Cherokee Nation | pgwin@cherokee.org |
| Ms. Shanon Phillips | Director | Oklahoma Conservation Commission | shanon.phillips@conservation.ok.gov |
| Mr. Tom Elkins | Administrator | Cherokee Nation | tom-elkins@cherokee.org |
| Ms. Rebecca Veiga Nascimento | Environmental Scientist | Oklahoma Water Resources Board | Rebecca.Veiga@owrb.ok.gov |
| Mr. Tate Wentz | Ecologist Coordinator | Arkansas Department of Environmental Quality | Wentz@adeq.state.ar.us |
| Mr. Jeremy Seiger | Director | Oklahoma Department of Agriculture, Food and Forestry | Jeremy.Seiger@ag.ok.gov |
| Mr. Ryan Benefield P.E. | Deputy Director | Arkansas Natural Resources Commission | Ryan.Benefield@arkansas.gov |



ED_002032_00000534-00005

ED_002032_00000534-00006