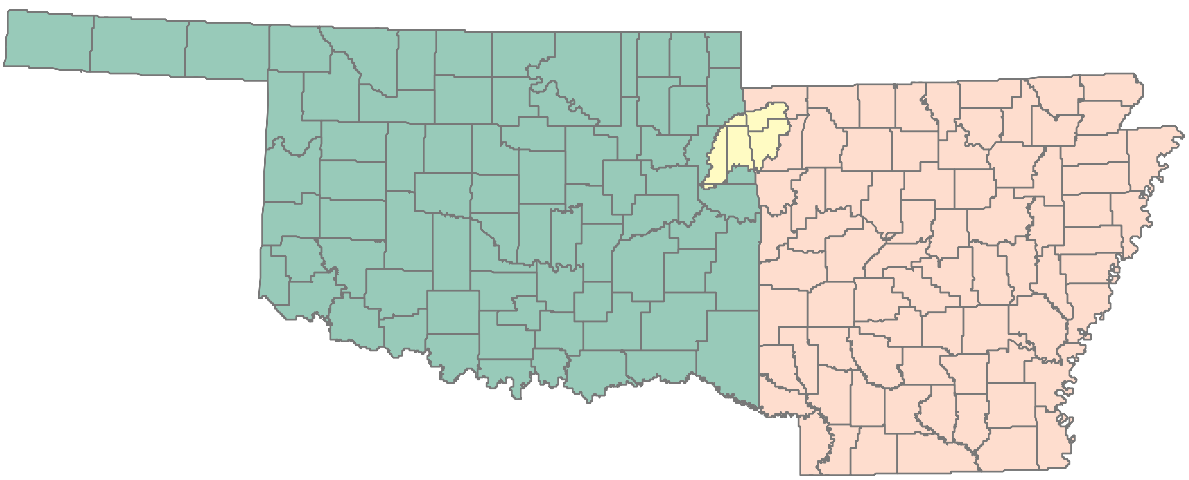
WATERSHED BASED PLAN

FOR THE

ILLINOIS RIVER WATERSHED



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OKLAHOMA CONSERVATION COMMISSION

ILLINOIS RIVER WATERSHED BASED PLAN

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PREFACE

The Illinois River watershed spans the Oklahoma-Arkansas border in the northeastern part of the state and is located in Benton, Washington, and Crawford Counties in Arkansas and Delaware, Adair, Cherokee, and Sequoyah Counties in Oklahoma. The watershed encompasses 1,069,530 total acres (approximately 1,600 square miles), with 54% located in Oklahoma. The Illinois River is designated as a State Scenic River, and, as such, it is recognized as one of Oklahoma's most valuable water resources for reasons ranging from aesthetic and recreational value to high water quality as a drinking water source. In addition, Lake Tenkiller (Tenkiller Ferry Reservoir), which was formed by impounding the Illinois River in 1953 to provide flood control and hydroelectric power, is recognized as one of the state's most aesthetic lakes, with water clear enough to provide exceptional recreational opportunities. Lake Tenkiller has also become a public water supply source for area municipalities.

Illinois River 2007

It has been recognized since at least the early 1980's that the Illinois River and Lake Tenkiller were experiencing water quality degradation, primarily perceived as decreased clarity and frequent algae blooms in the lake. As substantial research indicated that these perceptions were based on actual problems, efforts began to focus on the potential sources of the problems. Initial research concluded that the watershed was impacted by excess nutrients and indicated that potential sources included wastewater effluent from both nonpoint sources such as the substantial poultry industry, nurseries, and various other agricultural sources. Streambank erosion due to loss of riparian zones and cattle access to streams was also impacting the water resources. Much of the research concluded that watersheds with the most intense landuse, primarily those with the greatest concentration of poultry and cattle, were the greatest contributors to the water quality problems.

Lake Tenkiller received a Nutrient Limited Watershed designation in 2006 due to low dissolved oxygen and an established relationship between nutrients and algae. The Clean Lakes Study data from 1992 and 1993 showed a substantial increase in chlorophyll-*a* over that observed in the 1974 national eutrophication study. Recent OWRB monitoring shows that the increased algae levels persist (OWRB 2005). While the average Trophic State Index (TSI) is less than 62, it is frequently exceeded. The Clean Lakes study called for nutrient reductions to limit the increased levels of algae growth. Tenkiller Lake has also been shown to be impaired by low dissolved oxygen in its hypolimnion such that the Fish and Wildlife Propagation Beneficial Use is not supported. Lake Tenkiller is on Oklahoma's 2008 303(d) list of impaired waterbodies for total phosphorus, dissolved oxygen, and chlorophyll-*a*. In addition, four segments of the Illinois River, as well as Chicken Creek, Town Branch of Tahlequah Creek, Ballard Creek, Caney Creek, Barren Fork Creek, Tyner Creek, Peacheater Creek, Battle Branch, Sager Creek, and two segments of Flint Creek are not supporting designated uses due to nutrients and/or pathogens (see Table 33 for details). This corresponds to 171 miles of impaired Oklahoma streams and 13,470 acres of impaired lake water.

Two lawsuits have resulted from these documented water quality problems. In 1986, the State of Oklahoma sued to stop the City of Fayetteville's discharge into the Illinois River. The suit reached the U.S. Supreme Court in 1992, where the court ruled that the downstream state's water quality laws must be met, but the upstream state was given the liberty to determine how best to accomplish this. In 2006, the Oklahoma State Attorney General filed a lawsuit against eleven poultry integrator companies for their role in polluting the Illinois River watershed. This lawsuit is currently underway.

An extensive amount of data has been collected for many years in this watershed assessing physical, chemical, and biological parameters. In addition, considerable efforts have already been made to address the sources of the water quality problems in the basin, and extensive work is planned for the near future. These efforts include reductions in point source loading due to cooperation between the Oklahoma Department of Environmental Quality (ODEQ) and cities of Tahlequah and Stillwell, education programs developed by the Oklahoma Scenic Rivers Commission (OSRC), the Cherokee County Conservation District, and the Oklahoma Conservation Commission (OCC), and various programs to reduce nonpoint source loading from agricultural sources in the watershed. Arkansas point source discharges have been reduced, and several Arkansas programs have been implemented to address pollution in the Illinois River watershed. Many of these studies and programs will be discussed in this document.

Both Arkansas and Oklahoma have worked with the USDA Farm Services Agency to fund Conservation Reserve Enhancement Program (CREP) Riparian Restoration in the watershed. Oklahoma is seeking additional matching funding to expand the size of its CREP program beyond approximately 9,000 acres. The States of Arkansas and Oklahoma continue to work cooperatively to seek solutions to nonpoint source pollution problems in the watershed by funding programs including riparian protection, watershed education, streambank stabilization, and alternative uses or more effective uses of poultry waste such as waste to energy, waste composting, or waste conversion to more appropriately formulated fertilizer formulas which can allow excess phosphorus to be transferred out of the watershed while nitrogen can be reapplied in the watershed at levels that are environmentally sound. Through poultry waste transfer programs, the states have worked cooperatively with the poultry industry to fund approximately $1.6 million worth of poultry waste transfer out of the Illinois and neighboring Eucha/Spavinaw watersheds.

The OWRB's "1996 Diagnostic and Feasibility Study on Tenkiller Lake" recommended an 80% reduction of total phosphorus to return Lake Tenkiller to more acceptable conditions and halt the further degradation of water quality in the lake. A 40% reduction of the total phosphorus load to Lake Tenkiller, based on 1980-1993 data and the 1996 study, was agreed upon by the states of Oklahoma and Arkansas as the initial goal for implementation in the watershed. This corresponded to a decrease of 132,855 kg/yr. The U.S. Environmental Protection Agency (USEPA) is currently developing a TMDL for the entire Illinois River watershed, including Lake Tenkiller, through a contract with a national environmental firm. This TMDL is slated for release in January of 2011. Until the release of that TMDL, goals for water quality improvement will be based on the initial reduction goal from the lake study and two SWAT (Soil and Water Assessment Tool) modeling efforts by Storm et al. (2006; 2008).

The 2006 SWAT model results estimated that 330,000 kg total phosphorus per year reached Lake Tenkiller between 1997 and 2001. The model predicted that 35% of the loading was due to point sources, leaving 65% to nonpoint sources. According to this modeling, reducing the application of poultry waste to pastures, improving pastures, and reducing the discharge of the major point sources in the watershed could dramatically improve the soluble phosphorus loading in the watershed, as well as the bacteria level, in a relatively short time frame.

Specifically, it was estimated that exporting waste from the watershed could reduce that loading by 15%, eliminating overgrazed pasture could reduce phosphorus loading by 6%, and converting all pasture to forest land would reduce loading by 55%. The model predicted that 50% of the load was due to nonpoint sources such as pastures with high phosphorus level soils, grazing, row crops/small grains, and other sources. The report goes on to say that a combination of waste export, point source improvements, pasture conversion to hayland and forest, and conversion of cropland to pasture or forest will be required to meet load reduction goals that will ultimately be necessary to attain water quality standards.

The potential of BMPs to improve water quality in this watershed has been demonstrated in a subwatershed, the Peacheater Creek watershed. A paired watershed study was conducted comparing water quality in Peacheater Creek before and after implementation of BMPs with Tyner Creek, where no BMPs were implemented. After implementation of BMPs, which included animal waste management, riparian management and improvement, pasture planting and nutrient management, offsite watering, and construction of heavy use areas for animal feeding and waste storage, total phosphorus loading was approximately 66% less than would have been expected without any BMP implementation. Total nitrogen loading was decreased by 57%, and dissolved oxygen was increased by 3%. In addition, benthic macroinvertebrate communities were significantly improved during the critical summer indexing period, and streambank erosion and nutrient loading from streambank erosion were significantly reduced.

This plan will present in detail the proposed expansion of riparian protection actions which are presently occurring or planned in the Illinois River watershed, as well as attempt to summarize the main historical research on water resources in the basin and what has already been done to remediate problems in the watershed. Although the success of the project depends on cooperation between the states of Oklahoma and Arkansas, this Watershed Based Plan (WBP) will focus only on Oklahoma's pollution programs.

Arkansas is similarly developing a WBP for the Arkansas portion of the watershed. These plans will eventually be combined into one basin-wide management plan, with the ultimate goal to restore beneficial use support to all waterbodies in the watershed through the coordination of efforts, both among agencies and between states. The recommendations established in the TMDL for the watershed will be used to update this plan once the TMDL is released.

This WBP has been developed with a great deal of local support. Due to its high priority as a state resource, the Illinois River has attracted the attention of many citizens and agencies. The foundation for this WBP began as the Illinois River Watershed Comprehensive Basin Management Plan (IRCBMP), a document developed in 1999 as part of a 319 project. The IRCBMP was a compilation of existing studies, reports, management recommendations, etc. as developed by numerous entities that were active in the watershed. It was reviewed extensively by the Oklahoma NPS Working Group and was modified to meet expectations and recommendations of this review. In turn, based on Clean Water Action Plan guidelines, the IRCBMP was then modified into a Watershed Restoration Action Strategy (WRAS) which was developed in 1999. One foundational document for these plans was the Oklahoma Scenic Rivers Illinois River Management Plan developed in 1998. Each of these documents had widespread input from locals in the watershed and from Oklahoma agencies. Comments received from members of the Oklahoma Nonpoint Source Working Group after review of this draft of the Illinois River WBP are included in Appendix B.

Throughout the plan, the spelling of Barren Fork Creek may deviate slightly to include “Baron” or “Barron.” This is an artifact of early studies and errors on old maps, but all three spellings denote the same waterbody. Standardization has been attempted as much as possible, but some figures still have an erroneous spelling. In addition, due to the multitude of studies in this watershed, units of measure may switch from metric to standard throughout the text. Again, standardization has been attempted, but both metric and standard units are present, depending on the source of certain figures, tables, and estimates. The OCC will try to correct these deficiencies in future updates of this WBP.

INTRODUCTION

In 1997, a nationwide strategy to protect water quality was initiated which resulted in the development of the *Clean Water Action Plan* (CWAP). The CWAP established goals and implementation schedules for numerous strategies dealing with point and nonpoint sources. Oklahoma's Office of Secretary of Environment (OSE) was designated as the state lead agency to implement the provisions of the CWAP in Oklahoma. Under OSE's leadership, Oklahoma has successfully met the CWAP requirement to establish a *Unified Watershed Assessment* (UWA) strategy. Oklahoma's UWA is a written document whose development and implementation relied upon input from the state's UWA Work Group. Through the UWA process, the Work Group identified 150 "Category I" watersheds in Oklahoma that were recognized as significantly impaired and in need of immediate federal and state funding to target restoration activities. The top ten of these watersheds were scheduled for action to address nonpoint source (NPS) pollution. The Illinois River watershed is one of these high priority watersheds.

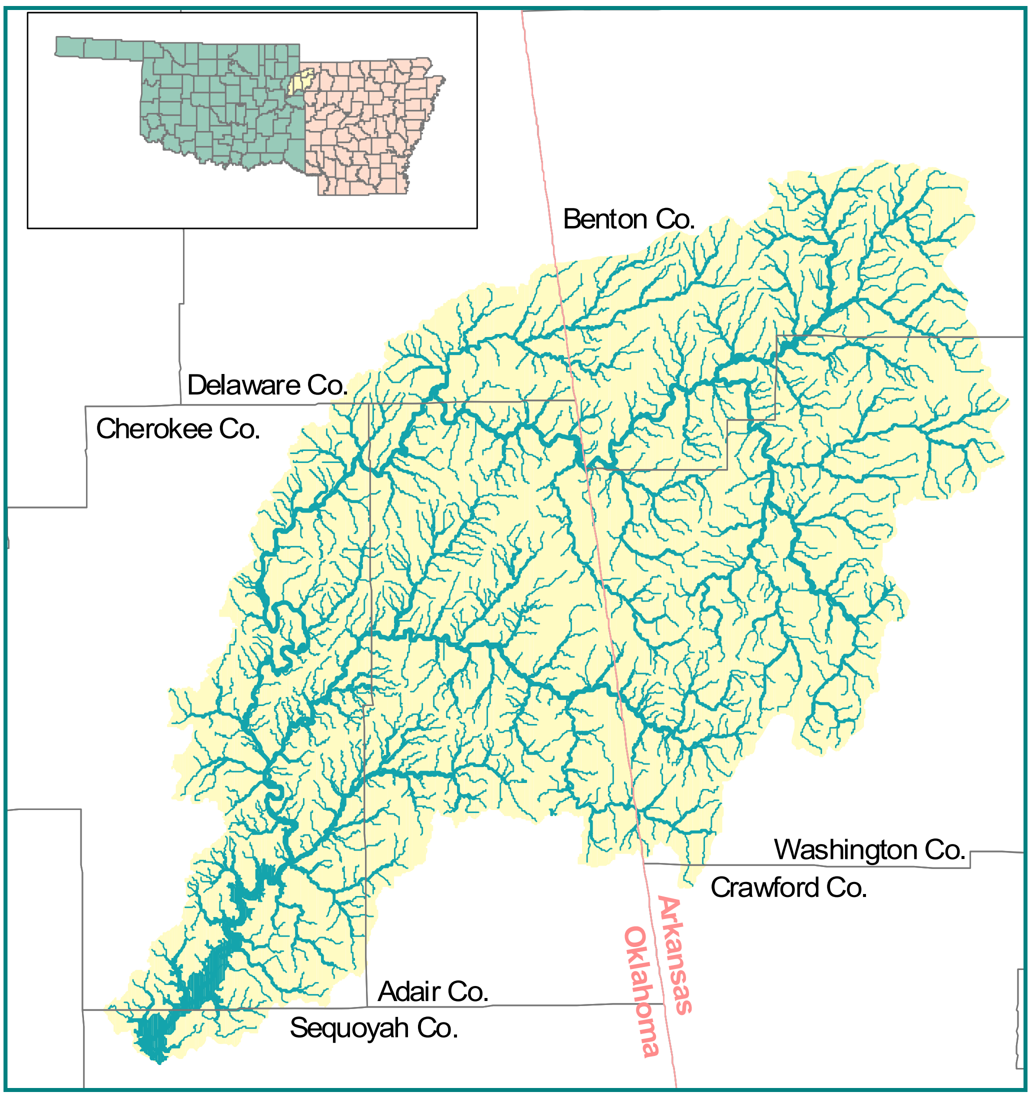


Figure 1. The Illinois River Watershed.

The Nonpoint Source Program and Grants Guidelines for States and Territories for FY 2004 and Beyond requires a *Watershed Based Plan* (WBP) to be completed prior to implementation using incremental funds. The guidance defines the 9 key components to be addressed in a watershed-based plan, much of which builds from the strategies outlined in the *Watershed Restoration Action Strategy* (WRAS). These components include: 1) identification of causes and sources that will need to be controlled to achieve load reductions, 2) estimate of load reductions expected from the management measures described, 3) a description of the management measures that will need to be implemented to achieve load reductions, 4) an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources or authorities who will bear responsibility, 5) an information/education component that will be used to enhance public understanding of the project and encourage early participation in the overall program, 6) a schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious, 7) a description of interim, measurable milestones for determining whether control actions are being implemented, 8) a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made or whether the Watershed Plan or Total Maximum Daily Load (TMDL) needs to be revised, and 9) a monitoring component to evaluate the effectiveness of the implementation efforts over time.

In order for the WBP to become an integral part of the entire watershed restoration program, it must be amenable to revision and update. The Illinois River WBP has been developed as a dynamic document that will be revised periodically to incorporate the latest information, address new strategies, and define new partnerships between watershed shareholders. Of particular note, this WBP was developed under an accelerated timeline in order to allow the Oklahoma Conservation Commission the opportunity to compete for Clean Water Act Section 319 funding in the Illinois River watershed. Consequently, this WBP may not fully incorporate all relevant data or modeling. The U.S. Environmental Protection Agency (USEPA) is currently developing a TMDL for the entire Illinois River watershed, including Lake Tenkiller, through a contract with a national environmental firm. This TMDL is slated for release in January of 2011. It is understood that the water quality goals set forth in this WBP will be revised after the release of this TMDL. The WBP will also be updated when the results of major modeling or monitoring studies are completed.

As it evolves, this WBP will become a collaborative effort with Arkansas and will continue to evolve as the partnership evolves. It is anticipated that at least biannual revisions may be necessary and that the responsibility for such revisions will rest primarily with the Oklahoma Conservation Commission (OCC), with support from the Office of the Secretary of the Environment (OSE) and the agencies involved with the NPS Working Group. Federal and state funding allocations for future water quality projects designed to address the Illinois River Watershed problems should not be based solely upon their inclusion in this WBP; rather, the WBP should be considered a focal point for initial planning and strategy development.

WATERSHED CHARACTERIZATION *(element a)*

The Illinois River watershed (Hydrologic Unit Code 11110103) extends from Northwestern Arkansas to Northeastern Oklahoma and is located in Benton, Washington, and Crawford Counties in Arkansas and Delaware, Adair, Cherokee, and Sequoyah Counties in Oklahoma. The Illinois River drains approximately 1,069,530 total acres in Arkansas and Oklahoma (approximately 54% in Oklahoma). The river is impounded to form Lake Tenkiller (Tenkiller Ferry Reservoir), and it was once impounded at the state line to form Lake Frances. The Lake Frances Dam was compromised in the 1990s, and now only the remains of the lake exist. Major tributaries into the Illinois River and Lake Tenkiller include Osage Creek, Clear Creek, Muddy Fork Creek, and Cincinnati Creek in Arkansas, and Flint Creek, Ballard Creek, Caney Creek, and Barren Fork Creek in Oklahoma (Figure 2).

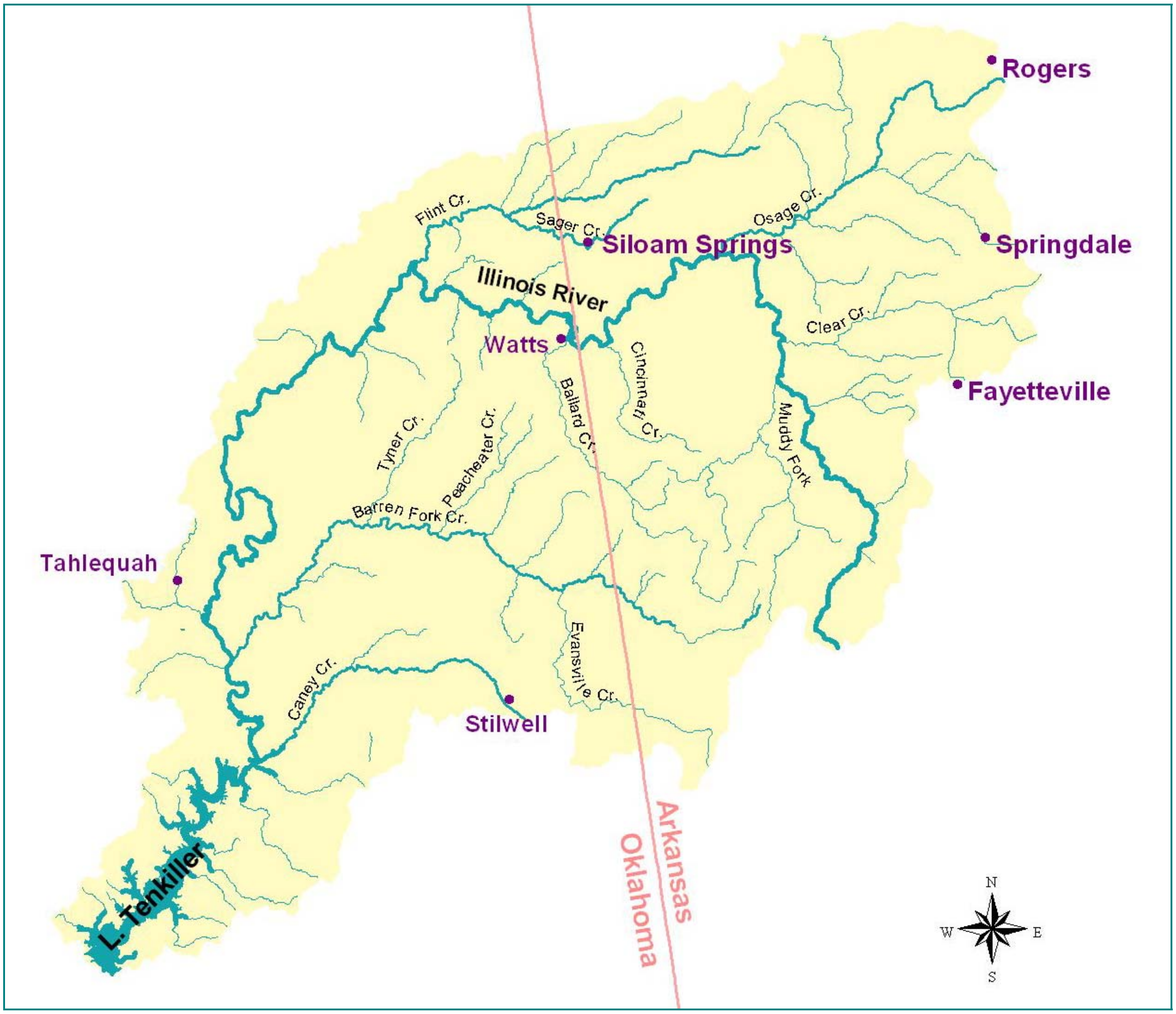


Figure 2. Major tributaries and towns in the Illinois River watershed.

Physical / Natural Features

The watershed lies within the Ozark Highlands and Boston Mountains Ecoregions, with the majority of the Oklahoma portion of the watershed in the Ozark Highland Ecoregion. The Ozark Highlands ecoregion is characterized by oak-hickory forests on well-drained soils of slopes, hills, and plains. Trees are of medium height (20 to 60 feet) with a relatively open canopy which allows a thick understory of slow-growing shrubs and trees. Areas of exposed rock are common. Blackjack oak, post oak, white oak, black hickory, and winged elm are the common overstory trees, and coral berry, huckleberry, and sassafras are representative of the understory. A taller forest community is found in protected ravines and on moist or north-facing slopes where soils are deeper and well drained. These forests are 60 to 90 feet high and consist of an overstory of sugar maples, white oaks, chinquapin oak, and hickory, with an understory of redbud, flowering dogwood, pawpaw, spice bush, sassafras and coral berry. Mosses, ferns, and liverworts are abundant on the moist forest floor. Bottomland hardwood forests of oak, sycamore, cottonwood, and elm exist along floodplains of larger streams (OCC 1998; Woods et al. 2005). Presently, rugged areas are forested and nearly level sites are used for pastureland or hayland. Elevation ranges from 300 to 1,800 ft (Figure 3).

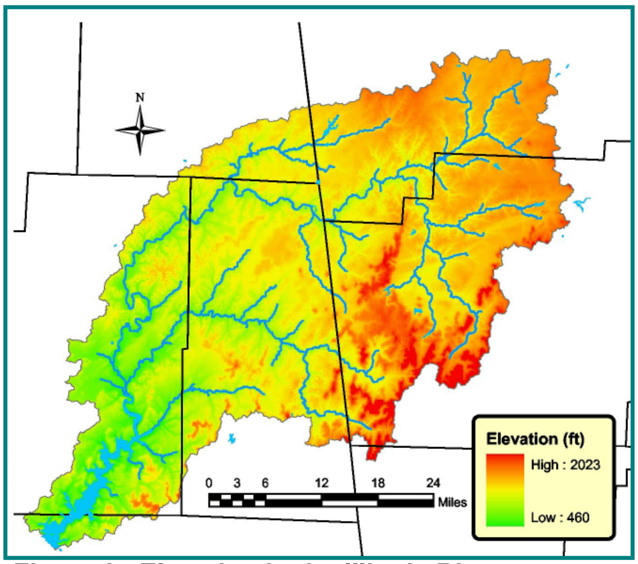


Figure 3. Elevation in the Illinois River Watershed (Storm et al. 2006)

The streams of the Ozark Highlands are typically clear, high gradient, riffle and pool type with coarse gravel, cobble, boulder, and bedrock substrates of limestone, dolomite, and chert. Base flows usually are maintained during the dry season by springs and seeps. Widespread karst features include caves, sinkholes, and springs. These features support a variety of rare species such as Gray and Ozark big-eared bats and the Ozark cavefish. Both habitat diversity and species richness are high, and sensitive fish species are common. Minnows, sunfishes, and darters are plentiful. The banded sculpin and slender madtom occur in small streams, and the southern redbelly dace inhabits headwaters. The shadow bass is nearly limited to the region. Other common fishes include the orangethroat darter, stippled darter, greenside darter, fantail darter, northern hogsucker, white sucker, Ozark minnow, cardinal shiner, and bigeye shiner. The most important game species is the smallmouth bass (ODAFF 2010c).

The Illinois River watershed provides habitat for certain species that are both dependent on high water quality and of special conservation status. For example, the Illinois River supports a significant freshwater mussel community, including populations of the Neosho mucket (*Lampsilis rafinesqueana*) and rabbitsfoot mussel (*Quadrula cylindrica cylindrica*). Both of these mussels are candidate species for listing under the Endangered Species Act

(USFWS 2009), and the mucket also is listed by the State of Oklahoma as a state endangered species (OSS 2010). The Illinois River is considered to harbor one of only two remaining viable populations of the mucket, and even these populations are experiencing declines (NMWG 2005).

The southern-most section of the watershed lies in the Boston Mountains ecoregion. This ecoregion "is mountainous, forested, and underlain by Pennsylvanian sandstone, shale, and siltstone. It is one of the Ozark Plateaus; some folding and faulting has occurred but, in general, strata are much less deformed than in the Ouachita Mountains. Maximum elevations are higher, soils have a warmer temperature regime, and carbonate rocks are much less extensive than in the Ozark Highlands...Upland soils are mostly Ultisols that developed under oak-hickory and oak-hickory-pine forests. Today, forests are still widespread; northern red oak, southern red oak, white oak, and hickories usually dominate the uplands, but shortleaf pine grows on drier, south- and west-facing slopes underlain by sandstone"(Woods et al. 2005).

The Boston Mountains ecoregion streams are clear, extremely high gradient, riffle and pool type with gravel, cobble, boulder, and bedrock substrates of sandstone, shales, and limestone. There is little streamflow in the dry season because there are few springs and seeps in the Boston Mountains. The fish fauna of the Boston Mountains are nearly as species rich and diverse as the fauna in the Ozark Highlands ecoregion. Summer flow in many small streams is limited or non-existent but isolated, enduring pools may occur. Elevation ranges from 650 to 2,600 ft (Figure 3).

Major soils within the basin are in the Captina, Clarksville, Enders, Jay, Linker, Mountainberg, Nella, Nixa, Noark, Razort, Steprock, and Waben series (USDA 1992). The majority of the higher reaches of the watershed are Clarksville-Nixa-Noark: deep, loamy cherty soils, moderately to well drained, moderately to rapidly permeable. These soils are derived from cherty limestone. Soils in the vicinity of Lake Tenkiller are Enders-Linker-Mountainberg-Nella: deep, loamy, gravelly, or stony soils derived from acid sandstone, siltstone, and shale. These well drained soils range from very slowly permeable to moderately rapidly permeable.

Average annual precipitation in the Oklahoma portion of the Illinois River watershed is about 50 inches, with May and June being the wettest months. Temperatures average near 59 degrees, with a range from an average daytime high of 91 degrees in July to an average low of 27 degrees in January (*www.climate.ocs.ou.edu*).

Land Use

Nearly half of the Oklahoma portion of the Illinois River watershed is forested, with most of the remaining land used for hay production or pasture (Table 1; Figure 4). The major agricultural industry in the Oklahoma portion of the watershed is poultry, and a significant number of cattle are also raised. Row crops and small grains comprise a small percentage of landuse (Table 1), with wheat, sorghum, soybeans, and various vegetables being grown in small quantities in the watershed.

Table 1. Land cover in the Oklahoma portion of the Illinois River basin from 2001 LandSat (Storm et al. 2006).

Land Cover	Fraction of Basin
Forest	45.90%
Hay	15.42%
Well Managed Pasture	24.34%
Poorly Managed Pasture	7.98%
Rangeland	0.60%
Roads	0.16%
Urban	2.91%
Water	2.04%
Row Crop/Small Grains	0.64%

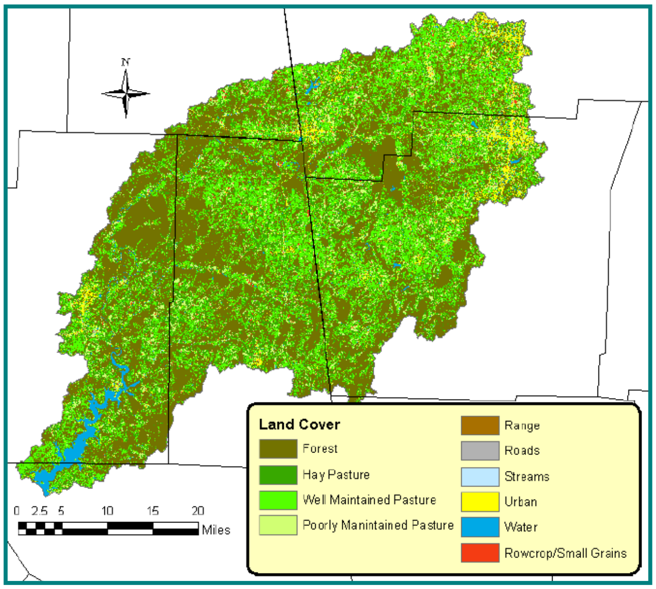


Figure 4. Landuse in the Illinois River watershed (Storm et al. 2006).

The Census of Agriculture data in Table 2 shows that poultry production, both broilers and layers/pullets, remained relatively stable from 1992 to 2002 in Adair, Cherokee, and Delaware Counties in Oklahoma, with the exception of a sharp decline in Adair County between 1992 and 1997. The number of cattle produced in the watershed increased quite significantly over this ten-year period, particularly in Delaware County. Hay production also increased during this period.

Table 2. Selected parameters from the Census of Agriculture, 1992, 1997, 2002.

County, State	Agricultural Product	2002	1997	1992
Adair, OK	Broilers	10,888,560	12,147,732	27,739,248
	Cattle & calves	59,033	56,443	51,732
	Layers and pullets	517,615	934,267	1,658,694
	Hay (acres)	38,312	40,242	32,267

County, State	Agricultural Product	2002	1997	1992
Cherokee, OK	Broilers	3,442,615	3,336,028	3,930,352
	Cattle & calves	45,573	46,277	37,103
	Layers and pullets	cannot be disclosed	101,594	cannot be disclosed
	Hay (acres)	38,450	31,390	27,097
Delaware, OK	Broilers	29,785,875	28,493,904	26,359,308
	Cattle & calves	74,719	68,997	59,856
	Layers and pullets	791,272	913,014	778,974
	Hay (acres)	59,484	51,231	45,927

The Illinois River watershed supports a poultry industry with a capacity estimated to produce over 35 million birds annually. Storm et al. (2006) estimated that a total of 231,000 tons (210,000,000 kg) of poultry waste were produced in the Illinois River basin each year from about 475 poultry houses. This amount of waste was calculated to contain approximately 10,400,000 kg nitrogen and 2,930,000 kg phosphorus.

The region's upland and bottomland forests support a small but active forest products industry. According to the U.S. Forest Service's Timber Product Output report for 2005 (USDA Forest Service 2008), roundwood timber harvest from Adair, Cherokee, Delaware, and Sequoyah counties totaled 2,298 thousand cubic feet, of which 99.7% was hardwood. This represented a 15% increase over survey data from 2002. Since 2005, the annual timber harvest has likely declined in parallel with the overall economic downturn. The primary forest products directory maintained by Oklahoma Forestry Services currently shows eight wood processing plants in or near the watershed, with 21 additional plants in Benton, Crawford, and Washington counties in Arkansas. Over the next five to ten years, in addition to traditional forest products, the region's forests will likely attract increased interest for biomass energy and wood pellets (ODAFF 2010b).

Human Population

Approximately 243,000 people live in the Illinois River watershed (2000 US Census). About 170,000 (70%) live in urban areas, with the majority residing in Arkansas. There has been rapid population growth in the watershed, especially in Northwest Arkansas, which reported a 34% increase from 1990 (115,075) to 2000 (174,691). The population of

Oklahoma cities in the Illinois River basin also increased during this time from a total of 15,365 to 20,623 (25%).

The Oklahoma portion of the Illinois River basin contains only small urban areas. The largest of these is Tahlequah, with a population of approximately 16,000 (2005 estimate). Stilwell, the county seat of Adair County, has a population of just over 3,200. According to the 2006 U.S. Census, the population of Adair County increased by 6% from 2000 to 2006 to 22,317, Cherokee County increased by 5.6% to 44,910, and Delaware County increased by 8% to 40,061.

Waterbody Conditions

Streamflow in the Oklahoma portion of the Illinois River basin is highly variable, but it generally is highest as the river reaches Tahlequah (USGS database), shortly after which it flows into Lake Tenkiller. Table 3 presents streamflow data collected at five USGS gaging stations during the 2000-2004 time period.

Table 3. Streamflow statistics based on USGS data, 2000-2004 (Tortorelli and Pickup 2006).

Station name	Drainage area (sq. mi.)	Mean annual streamflow (cfs)			Daily mean streamflow, 2000-2004 (cfs)	
		2000-2002	2001-2003	2002-2004	Minimum	Maximum
Illinois River near Watts	635	639	539	552	83	19,200
Flint Creek near Kansas	110	105	78	94	10	7,820
Illinois River at Chewey	820	745	616	645	94	26,000
Illinois River near Tahlequah	959	990	787	829	93	32,800
Barren Fork at Eldon	307	327	250	270	23	22,300

Lake Tenkiller (Tenkiller Ferry) was completed in 1952 by the U.S. Army Corps of Engineers for flood control and hydropower. At normal pool, Lake Tenkiller has a surface area of 12,906 acres, 130 miles of shoreline, and a volume of 1,054,862,170 cubic yards. The lake drains an area of approximately 1,610 square miles, has a mean depth of 52 feet, and a maximum depth of 138 feet near the dam.

HISTORICAL DATA

Numerous projects have assessed the water quality and biological communities of the Illinois River and its tributaries, starting as early as the 1950s and continuing to the present. These projects have not been coordinated to cover all areas of concern, nor have they been conducted in a consistent manner. In addition, some of the conclusions drawn from these studies may not appear completely valid based on the data presented, but rather present some of the historic viewpoints and even biases that have affected activities in the watershed throughout its history. Despite these limitations, a substantial amount of information exists upon which to characterize water quality in the basin. Many of these early studies were reviewed and summarized in 1991 in a report titled "Evaluation and Assessment of Factors Affecting Water Quality of the Illinois River in Arkansas and Oklahoma" (Meyer and Parker 1991). In 1999, the Oklahoma Conservation Commission released the "Comprehensive Basin Management Plan for the Illinois River Basin in Oklahoma" (OCC 1999a), which summarized the most important water quality studies up to that date.

This section of the WBP will include a chronological synopsis of the research in the Illinois River watershed. This summary includes some studies discussed in the 1999 document as well as older and more recent documents. The intent of this review is not to present all of the information which has been collected, but rather to give an overview of the larger, more intensive studies. The reader is referred to the original texts if additional or more detailed information is required.

A. *A Preliminary Study of the Water Quality of the Illinois River in Arkansas* (Kittle et al. 1974)

This study, paid for by the Illinois River Property owners of Arkansas, Inc. and performed by personnel from the University of Arkansas, concluded that the Illinois River was “unpolluted” based on assessment of water quality parameters and biota at eight sites along the river. This data was intended to provide a baseline from which to monitor the changes expected to occur with the proposed construction of two sewage treatment plants at Savoy and Siloam Springs, Arkansas. Sites 5-8 were located below the confluence of Osage Creek, which receives effluent from the towns of Springdale and Rogers, Arkansas. Increases in most parameters were observed at these sites relative to sites upstream of the Osage Creek confluence (Table 4). It was concluded that additional discharges would be detrimental to the future water quality of the Illinois River and lead to a more eutrophic state both in the river and in the downstream lakes.

Table 4. Physico-chemical data from the Illinois River, June 29 and 30, 1974.

Monitoring Station	Dissolved Oxygen (mg/l)	pH	Turbidity (FIU)	Chloride (mg/l)	Ammonia (mg/l)	Nitrate (mg/l)	Filterable Ortho-phosphate (mg/l)	Total Ortho-phosphate (mg/l)
IR-1	7.6	7.9	12	9.99	0.329	1.76	0.083	0.134
IR·2	9.6	8.3	10	9.99	0.486	1.84	0.085	0.996
IR-3	8.8	8.2	12	9.99	0.244	1.57	0.085	0.138
IR-4	8.5	7.5	10	9.99	0.317	1.63	0.078	0.142
IR-5	7.6	7.9	12	11.50	0.329	2.23	0.271	0.446
IR-6	8.2	8.1	14	11.00	0.289	2.19	0.267	0.460
IR-7	10.9	8.5	11	11.00	0.301	1.99	0.252	0.424
IR-8	10.3	8.4	16	10.50	0.374	1. 96	0.203	0.342
Avg.	8.9	8.1	12	10.49	0.334	1.89	0.166	0.385

B. *Report on Tenkiller Ferry Reservoir, Cherokee and Sequoyah Counties, Oklahoma* (USEPA 1977b) and *Report on Lake Frances, Adair County, Oklahoma* (USEPA 1977a)

As part of the National Eutrophication Survey, water quality data was collected and analyzed for Lake Tenkiller and Lake Frances in order to compile information on nutrient sources, concentrations, and impacts. Lake Tenkiller was found to be eutrophic and phosphorus-limited. Nonpoint sources were estimated to contribute 84.5% of the total phosphorus in the lake (Table 5). Point sources in Oklahoma were estimated to contribute 15.5% of the total annual phosphorus loading, with Tahlequah responsible for 8%, Stilwell for 6.5%, and Westville for 1%. The net annual accumulation of nutrients in Lake Tenkiller was estimated to be 49,745 kg of phosphorus and 526,670 kg of nitrogen.

Table 5. Sources of nutrient loading to Lake Tenkiller based on monthly grab samples, 1974-1975.

Source	Location	kg P / yr	% of total	kg N / yr	% of total	Flow (m^3/sec)
NPS	Illinois River	68,875	63.2	1,750,390	67.4	23.68
	Barren Fork	8,605	7.9	434,890	16.8	8.45
	Minor tributaries	13,685	12.6	321,290	12.4	9.04
Municipal STPs	Tahlequah	8,725	8	18,015	0.7	
	Westville	1,135	1	3,400	0.1	
	Stilwell	7,110	6.5	12,995	0.5	
Misc.	Septic	20	<0.1	705	<0.1	
	Direct Precipitation	895	0.8	55,265	2.1	
Total		109,050		2,596,950		

Data collected from Lake Frances similarly indicated eutrophication and phosphorus limitation, with extremely high nutrient concentrations as well as high turbidity. The net accumulation of phosphorus was estimated to be 18,240 kg/yr, while the net nitrogen accumulation in the lake was 258,240 kg/yr.

In 1981-1982, a diagnostic and feasibility study for Lake Frances was performed by the USEPA which indicated that the primary cause of the observed eutrophication was phosphorus entering from the Springdale and Rogers wastewater treatment plants (Threlkeld 1983). Nutrients were retained in Lake Frances for only a short period of time before flowing into the Illinois River. This was thought to be a major contributor to the degradation of the water quality in the Illinois River downstream of the lake.

C. *Nutrient Contributions to the Illinois River in Arkansas: A Preliminary Investigation* (Bowen 1978)

This Master's thesis examined nitrogen and phosphorus at four locations on the Illinois River in Arkansas as well as at three municipal wastewater plants discharging into the watershed. Sites on the river were sampled six times in 1977 in addition to two storm events, while two samples were obtained from each of the wastewater plants. During low flows, phosphorus loadings from municipal wastewater treatment plants accounted for approximately 90 percent of the total phosphorus within the watershed, but contributions of phosphorus and nitrogen from nonpoint sources during the base flow sampling period were significant. Based on the storm sampling results, contributions of nutrients from nonpoint sources were thought to exceed the contributions from point sources annually. Concentrations of phosphorus in the Illinois River were in exceedance of the levels set forth in 1981 Arkansas Water Quality Standards (0.100 mg/L TP in streams and 0.050 mg/L in lakes), and these levels were such that exceedance of standards would continue even if point source contributions of phosphorus were eliminated within the watershed.

D. *Water Quality Survey of the Illinois River and Tenkiller Ferry Reservoir* (OSDH 1978)

The Oklahoma State Department of Health Water Quality Laboratory conducted an intensive 3 week study of Tenkiller Reservoir and the Illinois River upstream of the reservoir in 1976 to examine point and nonpoint sources of pollution and their impact on the watershed. Water chemistry data collected from 1975-1977 at USGS ambient monitoring stations in the watershed were examined as well. Biological samples were also collected. The primary goal of this project was to provide baseline data to determine necessary regulatory actions to abate deterioration of water quality in the basin. The data obtained was limited by sample size (ranging from 1-26 samples), so the values given in Table 6 are not necessarily representative of average annual values for the sites. As stated in the report, "the design and nature of this study…are such that there may be a proclivity to overextend data or to base assumptions on limited investigations."

Table 6. Summary of OSDH water quality data. All values are in mg/L. Sample sizes are in parentheses. Site numbers correspond to the map, Figure 5.

Site #	Site Description	Total Nitrogen	Total Phosphorus	TKN
281	Illinois River-just above Lake Frances on Hwy 59 (in Arkansas)	2.3 (1)	0.14 (1)	0.9 (1)
2	Illinois River-below Lake Frances at Watts	2.9 (4)	0.20 (21)	1.3 (22)
283	Illinois River-above confluence of Flint Creek	2.2 (9)	0.13 (9)	1.1 (9)
284	Illinois River-below confluence of Flint Creek	2.1 (4)	0.10 (3)	1.6 (4)
274	Illinois River-at Comb's Bridge	1.4 (4)	0.07 (4)	0.8 (4)
301	Illinois River-east of Tahlequah	2.1 (3)	0.08 (10)	1.1 (10)
288	Illinois River-below confluence of Tahlequah Crk	2.4 (1)	0.12 (1)	1.0 (1)
291	Illinois River-above confluence of Barren Fork	2.2 (4)	0.06 (4)	1.3 (4)
256	Illinois River-below confluence of Barren Fork	2.1 (5)	0.10 (4)	0.7 (5)
200	Flint Creek-near Kansas, OK	3.3 (8)	0.12 (25)	1.2 (26)
270	Flint Creek-above confluence of Illinois River	2.6 (8)	0.11 (7)	1.2 (8)
302	Barren Fork-at Eldon	1.6 (8)	<0.09 (24)	0.8 (26)
289	Barren Fork-above Welling Bridge, above camp	1.8 (4)	<0.09 (4)	1.2 (4)
290	Barren Fork-above Welling Bridge, below camp	1.8 (4)	<0.09 (4)	1.2 (4)
202	Barren Fork-at Welling Bridge	1.4 (7)	<0.09 (8)	0.9 (7)
292	Barren Fork-above confluence of Illinois River	1.7 (4)	<0.09 (4)	1.2 (4)
20	Tahlequah Creek-above STP	2.2 (4)	0.14 (14)	0.9 (14)
201	Tahlequah Creek-below STP	2.8 (5)	1.09 (5)	0.9 (5)

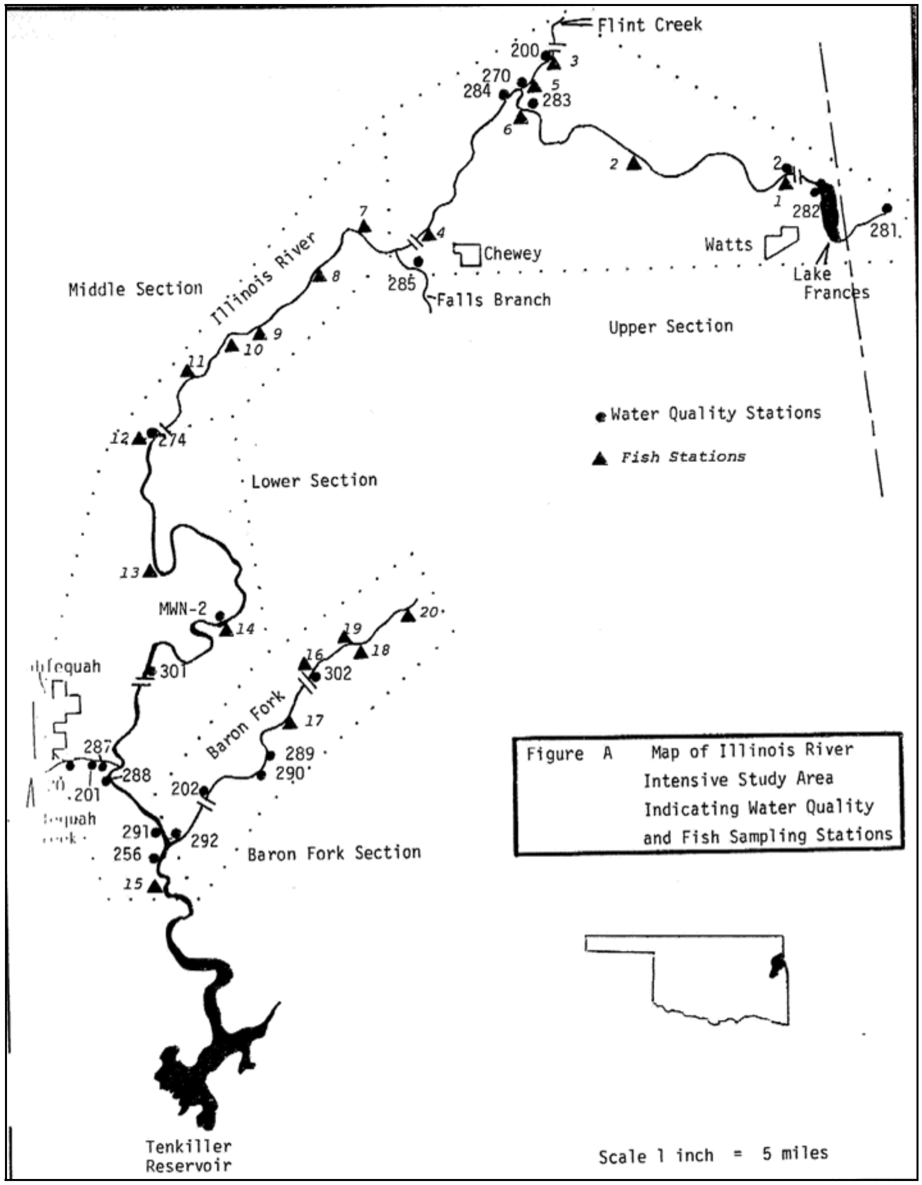


Figure 5. Map of sampling sites for OSDH survey.

Major conclusions from this study are summarized below:

1) Lake Frances was determined to be in the late stages of eutrophication due to heavy siltation and elevated nutrient levels from the Illinois River in Arkansas. Comparative water quality directly above the headwaters and at points downstream from the Lake Frances Dam suggested high nutrient loading to the Illinois River in Arkansas, which is passing through Lake Frances relatively quickly rather than being filtered out in the impoundment.
2) Flint Creek was determined to be of inferior water quality, and point source discharge from the city of Siloam Springs sewage treatment facility was surmised to be the major factor creating this condition. Flint Creek was determined to be a major contributor of nutrients to the Illinois River, particularly during high-flow conditions.

3) Recreational activities in the lower Flint Creek drainage and in various segments of the Barren Fork and the Illinois River did not appear to contribute significant nutrient loading, but biological communities appeared to be disturbed at and below areas of high public usage.
4) Based on a limited sampling regime, the Tahlequah sewage plant effluent appeared to exert little impact on the Illinois River (from less than 1% to 3% of total nutrient loading), although there was a definite increase in nutrients just below the discharge. Stormwater runoff from an urbanized area had higher nutrient loading values than rural runoff in this drainage basin.
5) The Barren Fork was determined to be of superior water quality with no detrimental impact on the Illinois River.
6) Non-point sources were determined to contribute approximately 95% of the nutrient loading to the Illinois River drainage basin in Oklahoma; hence, regulatory action was not thought to be necessary.
7) The water quality of the Illinois River was determined to improve from Lake Frances to below Barren Fork.

E. *Illinois River Data Summary 1981-1982* (OSDH 1983)

The Oklahoma State Department of Health and Oklahoma Scenic Rivers Commission monitored the Illinois River at 13 sites from 1981-1982 in order to calculate nutrient loadings. This study found that nitrogen and phosphorus levels increased below the river's confluence with Town Branch. Tahlequah's sewage treatment plant was found to discharge good quality effluent but was not able to handle sludge properly and was severely impacted by inflow and infiltration after rainfall. "Follow-up action" was taken to improve the Tahlequah plant. Nutrient levels are given in Table 7, and nutrient loads are presented in Table 8.

Table 7. Nutrient and flow data from the Illinois River watershed in Oklahoma, 1981-1982.

Site Description	Site Name	Mean Flow (MGD)	Mean Total Nitrogen (mg/L)	Mean Total Phosphorus (mg/L)
Illinois River near Watts	1955	121.5	2.00	0.278
Illinois River below hog farms at Watts and Kamp Paddletrails	OSRC 1	123.5	1.98	0.252
Illinois River 100 yards above Flint Creek confluence	OSRC 2	113.4	1.69	0.220
Illinois River at Chewey Bridge	OSRC 3	182.7	1.50	0.172
Illinois River downstream from Chewey	OSRC 4	182.7	1.60	0.196
Illinois River below Echota Public Use Area	OSRC 5	182.7	1.28	0.118
Illinois River above Tahlequah	1965	168.1	1.28	0.105
Illinois River below Town Branch (Tahlequah) confluence	0SRC 6	181.0	2.54	0.505
Sager Creek 100 feet above confluence with Flint Creek	0SRC 9	9.5	3.12	1.080
Flint Creek north of West Siloam Springs	0SRC 8	18.8	1.35	0.017
Flint Creek near Kansas	1960	26.5	1.29	0.103
Barren Fork at Proctor	0SRC 7	64.4	1.26	0.173
Barren Fork near Eldon	1970	71.0	1.37	0.081

Table 8. Nitrogen and phosphorus loadings in the Illinois River watershed in Oklahoma, 1981-1982.

Site	Kg/Yr/Ha Nitrogen	10^3Kg/Yr Nitrogen	Kg/Yr/Ha Phosphorus	10^3Kg/Yr Phosphorus
1955	2.4	403	0.3	45
OSRC 1	2.5	413	0.3	44
OSRC 2	1.7	306	0.2	34
OSRC3	2.3	492	0.2	52
OSRC4	2.6	567	0.2	49
OSRC 5	2.0	479	0.2	38
1965	1.9	468	0.2	33
OSRC 6	3.0	756	0.6	158
OSRC 9	27.6	51	7.5	14
OSRC 8	4.2	40	0.2	2
1960	2.0	58	0.2	7
OSRC 7	2.6	194	0.1	9
1970	3.0	238	0.1	11

F. *Water Quality Assessment of the Illinois River Basin, Arkansas* (Terry et al. 1984)

In 1984, the USGS and the Arkansas Department of Pollution Control and Ecology assessed the water quality of the Illinois River, Muddy Fork, Spring Creek, and Osage Creek in northwest Arkansas above Lake Frances in order to calibrate steady-state stream models (Terry et al. 1984). The models were used to simulate changes in instream water resulting from proposed changes in nutrient loading from wastewater. None of the four streams met 1981 Arkansas state standards for dissolved oxygen (4.0 mg/L), total phosphorus (0.100 mg/L), or fecal coliform bacteria (geometric mean of 200 colonies/100 mL and no more than 10% of samples greater than 400 colonies/100 mL during recreation season). The water temperature in Spring Creek and Osage Creek downstream from the Springdale and Rogers wastewater-treatment plants, respectively, also exceeded Arkansas standards. Analysis of data and modeling results indicated that significant nutrient loads were being contributed to the streams during runoff periods in addition to the load due to treatment plant effluent.

Neither the Illinois River nor Muddy Fork were projected to meet Arkansas dissolved oxygen standards (Arkansas Department Pollution Control and Ecology 1981) with any of the proposed effluents from the proposed Fayetteville and existing Prairie Grove WWTPs. Osage and Spring Creeks were projected to be able to meet standards if effluents were not allowed to exceed certain values (see report for details). The phosphorus concentrations in the Illinois River during the study period ranged from 0.03-0.61 mg/L, while the tributaries had a range of 0.03-0.80 mg/L phosphorus (approximately 45% of samples exceeded 0.10 mg/L). Organic nitrogen in both the Illinois River and its tributaries ranged from 0.00-1.10 mg/L, with stormwater runoff values between 0.71-1.50 mg/L phosphorus.

G. *An Intensive Survey of the Illinois River (Arkansas and Oklahoma) in August 1985* (Gatstatter and Katko 1986)

An USEPA study of the Illinois River basin in Oklahoma and Arkansas in August 1985 examined background phosphorus concentrations at 24 mainstem and tributary sites. Osage Creek had much higher phosphorus concentrations than the other sites; concentrations in Osage Creek were from 7 to 60 times higher than background concentrations and increased the Illinois River total phosphorus concentrations by 3 to 10 times. This was attributed to the effluent discharged into Osage Creek from the Springdale and Rogers WWTPs. The amount of phosphorus in Osage Creek was substantially affecting the water quality of the Illinois River above Lake Frances, as well as the water quality within the lake itself. In addition, this elevated phosphorus was found to affect water quality in the Illinois River as far as 20 miles downstream of Lake Frances. Muddy Creek, which receives effluent from the Prairie Grove WWTP, was found to have total phosphorus concentrations from zero to five times higher than background conditions, representing a relatively small contribution to the nutrient load in the Illinois River as a whole.

Total phosphorus concentrations in Flint Creek ranged from 4 to 7 times the background amounts, likely due to wastewater effluent from Siloam Springs; however, this was not having a significant effect on the Illinois River at its confluence since the phosphorus concentrations were high at this location (due to the Osage Creek inflow). High background inorganic nitrogen concentrations (>2.5 mg/L) were observed in the upper basin, where no point sources were located. This was thought to be due to land application of animal waste.

H. *Evaluation and Assessment of Factors Affecting Water Quality of the Illinois River in Arkansas and Oklahoma* (Meyer and Parker 1991)

This report attempted to gather all data collected up to 1986 concerning water quality in the Illinois River Basin into a single document and to interpret the results. One of the major areas of focus was the identification of trends in the data over time and space which are discussed in the following sections.

Total Phosphorus

Spatial trends - statistically significant decrease in concentration from the Arkansas border to Tahlequah.
- statistically significant increase in concentration below Osage Creek.

Temporal trends - statistically significant increases at nine of seventeen sites.

Mean values were in excess of the recommended level of 0.05 mg/L at all sites with some being exceptionally high. The data summary for phosphorus is included in Table 9.

Table 9. Illinois River Basin phosphorus data up to 1986. All sites are located on the Illinois River unless otherwise stated.

Station ID	Site Description	Site #	n (months)	Total Phosphorus as P (mg/L)		
				Mean	Median	SD
USGS 07195000	Osage Cr. nr. Elm Springs	1	134	1.082	0.755	0.927
SR 0.5	Lake Frances, SW end	2	14	0.313	0.295	0.100
USGS 07195500	Hwy 54, N of Watts	3	170	0.293	0.198	0.313
SR 1	Below Watts	4	64	0.265	0.233	0.151
SR 2	Above Flint Cr. confluence	5	66	0.225	0.192	0.176
USGS 07195860	Sager Cr., W of state line	6	117	1.496	0.820	1.021
USGS 07196000	Flint Cr. at Hwy 33	7	127	0.188	0.172	0.090
SR 3	W of Chewey	8	66	0.211	0.184	0.098
SR 4	Round Hollow State Park	9	66	0.201	0.170	0.081
SR 4.5	Comb's Bridge, W of Ellersville	10	14	0.200	0.187	0.090
SR 5	2 mi. above USGS 07196500	11	66	0.181	0.133	0.295
USGS 07196500	Hwy 62, NE of Tahlequah	12	127	0.130	0.100	0.133
SR 6	Just below Tahlequah STP	13	62	0.845	0.387	0.936
SR 6.3	Above Barren Fork confluence	14	11	0.154	0.118	0.074
USGS 07197000	Barren Fork at Hwy 51	15	126	0.079	0.044	0.102

Nitrite/Nitrate

Spatial trends - statistically significant decrease in concentration from the Arkansas border to Tahlequah.
- increase in concentration below Osage Creek.

Temporal trends - statistically significant increases at most sites.

Mean values were high at all sites and exceeded recommended values of 1.0 mg/L. The data for summary is included in Table 10.

Table 10. Illinois River Basin nitrogen data up to 1986.

Station ID	Site Description	Site #	n (months)	Total Nitrogen as N (mg/L)		
				Mean	Median	SD
USGS 07195000	Osage Cr. nr. Elm Springs	1	108	4.081	4.000	1.262
SR 0.5	Lake Frances, SW end	2	14	1.843	1.625	0.749
USGS 07195500	Hwy 54, N of Watts	3	110	1.510	1.200	0.873
SR 1	Below Watts	4	64	1.819	1.800	0.966
SR 2	Above Flint Cr. confluence	5	66	1.673	1.400	1.491
USGS 07195860	Sager Cr., W of state line	6	80	2.888	2.250	1.031
USGS 07196000	Flint Cr. at Hwy 33	7	98	1.291	1.100	0.679
SR 3	W of Chewey	8	66	1.480	1.475	0.778
SR 4	Round Hollow State Park	9	66	1.459	1.300	0.797
SR 4.5	Comb's Bridge, W of Ellersville	10	14	1.357	0.417	0.647
SR 5	2 mi. above USGS 07196500	11	66	1.293	1.200	0.953
USGS 07196500	Hwy 62, NE of Tahlequah	12	96	1.052	0.800	0.718
SR 6	Just below Tahlequah STP	13	62	2.245	1.600	1.619
SR 6.3	Above Barren Fork confluence	14	10	1.266	1.200	0.550
USGS 07197000	Barren Fork at Hwy 51	15	98	0.914	0.700	0.628

Nitrogen/Phosphorus Ratios

The ratio of nitrogen to phosphorus found during baseflow conditions is important in understanding the ability of the water to support algal growth and for management purposes, as the addition of a limiting nutrient would accelerate algal growth. There is some range of opinion concerning the N:P ratio at which one or the other element becomes the factor responsible for limiting algal growth. The majority of research indicates that at N:P ratios of less than 10-16, nitrogen is the limiting nutrient, while phosphorus becomes limiting at higher ratios.

Nitrogen/phosphorus ratios are much lower from the river main stem and main tributaries than for the smaller tributaries. It can be seen by comparing the data from the two data sets that nitrogen values are relative similar, while phosphorus values are much higher at the main stem sites. This suggests that point sources of phosphorus are playing a major role in maintaining high river values.

Nutrient Sources

Considerable attention was paid to the identification of nutrient sources, especially in regard to phosphorus loading. It was estimated that phosphorus loading from point versus nonpoint sources was approximately equal during low flow conditions but that nonpoint sources exceeded point sources during normal or high flows.

In terms of annual loading of phosphorus it was estimated that the loading at the upper end of Lake Tenkiller was 21% from point sources and 79% from nonpoint sources. Total point source loading of phosphorus was estimated to account for 12% of the Oklahoma total.

Effects on Lake Tenkiller

The primary conclusion that was drawn from the data was that phosphorus loading exceeds the level that would cause Lake Tenkiller to become eutrophic, as predicted by Vollenweider's model.

I. *Illinois River Cooperative River Basin Resource Base Report* (USDA 1992)

The objectives of this report were to better define water quality problems of the Illinois River basin, to prioritize watersheds needing project action to improve water quality, and to develop separate water quality project plans on high priority watersheds in Arkansas and Oklahoma. This report covers a wide variety of subjects, including natural resources, human resources, problems, concerns, ongoing activities, and recommendations. The main outputs of the report include three systems for designating priority watersheds developed by three different agencies: Arkansas Soil Conservation Service (SCS), Oklahoma SCS, and the Oklahoma Conservation Commission (OCC). These results are seen in Tables 11, 12, and 13. The Arkansas SCS system was developed using agricultural nonpoint potential source data, land use, municipal water supply locations, benthic data, and chemical data. The Oklahoma SCS system was developed using agricultural nonpoint potential source data, land use, and watershed size. The OCC system was developed using agricultural nonpoint potential source data and water sampling data. The highest priority watersheds for both states are generally low order streams or headwater streams. Many of the highest priority subwatersheds in Oklahoma were tributaries of the Barren Fork Creek.

Table 11. Arkansas SCS stream ranking in the Illinois River watershed.

Rank	Watershed	County	Score	Rank	Watershed	County	Score
1	Clear Creek	Washington	3202	20	Cincinnati Creek	Washington	NG
2	Upper Osage	Benton	3197	21	Lower Moores Creek	Washington	NG
3	Little Osage	Benton	3186	22	Goose Creek	Washington	NG
4	Blair Creek	Washington	2684	23	Fly Creek	Washington	NG
5	Barren Fork Creek	Washington	2400	24	Kinion Creek	Washington	NG
6	Spring Creek	Benton	2281	25	Brush Creek	Washington	NG
7	Upper Moores Creek	Washington	2279	26	Muddy Fork of Ill. River	Washington	NG
8	Ballard Creek	Washington	2163	27	Sager Creek	Benton	NG
9	Flint Creek	Benton	2134	28	Lick Branch	Benton	NG
10	Upper Illinois River	Washington	2094	29	Robinson Creek	Benton	NG
11	Lower Osage Creek	Benton	2082	30	Gallatin Creek	Benton	NG
12	Ruby Creek	Washington	2037	31	Evansville Creek	Washington	NG
13	Gum Springs Creek	Benton	NG	32	Lake Wedington	Washington	NG
14	Fish Creek	Washington	NG	33	Puppy Creek	Benton	NG
15	Little Flint Creek	Benton	NG	34	Cross Creek	Benton	NG
16	Wildcat Creek	Washington	NG	35	Frances Creek	Benton	NG
17	Galey Creek	Benton	NG	36	Chambers Creek	Benton	NG
18	Hamstring Creek	Washington	NG	37	Pedro Creek	Benton	NG
19	Wedington Creek	Washington	NG				

NG: not given in report

Table 12. Oklahoma SCS stream ranking in the Illinois River watershed.

Rank	Watershed	County	Rank	Watershed	County
1	Tyner Creek	Adair	31	Pumpkin Hollow	Adair
2	Peacheater Creek	Adair	32	Mulberry Hollow	Cherokee
3	Ballard Creek	Adair	33	Dry Creek and Bolin Hollow	Adair, Cherokee, Sequoyah
4	Green Creek	Adair	34	Cedar Hollow & Tully Hollow	Cherokee
5	Tahlequah & Kill H., Rock Branch	Adair	35	Field Hollow	Cherokee, Adair
6	Battle Branch Creek	Delaware	36	Dripping Springs	Adair, Delaware
7	Shell Creek	Adair	37	Smith Hollow	Adair
8	Evansville Creek	Adair	38	Goat Mountain	Adair
9	Mollyfield, Peavine Hollow	Cherokee	39	Walltrip Branch	Adair, Cherokee
10	Scraper Hollow	Adair	40	Tailholt Creek	Adair, Cherokee
11	Peavine Branch	Adair	41	Mining Camp Hollow North	Cherokee
12	England Hollow	Adair	42	Linder Bend & Saw Mill Hollow	Sequoyah
13	Tate Parrish	Adair	43	Luna Branch	Adair
14	Bidding Creek	Adair	44	Pettit Branch	Cherokee, Sequoyah
15	South Briggs	Cherokee	45	Pine Hollow	Sequoyah
16	West Branch	Adair	46	Park Hill Branch	Cherokee
17	Sager Creek	Delaware	47	South Proctor Branch	Adair
18	Hazelnut Hollow	Delaware	48	Snake & Cato Creek	Sequoyah

Rank	Watershed	County	Rank	Watershed	County
19	Blackfox, Winset Hollow	Adair, Cherokee, Delaware	49	Elk Creek	Cherokee, Sequoyah
20	Bluespring Branch	Cherokee	50	Terrapin Creek	Sequoyah
21	Fagan Creek	Delaware	51	Mining Camp Hollow South	Cherokee
22	Crazy Creek	Delaware	52	Burnt Cabin Creek	Sequoyah
23	Negro Jake Hollow	Adair, Cherokee	53	Sizemore Creek	Cherokee, Sequoyah
24	Fall Branch	Adair	54	Proctor Mountain Creek	Adair, Cherokee
25	North Briggs Hollow	Cherokee	55	Ross Branch & Tahlequah Cr.	Cherokee
26	Calunchety Hollow	Delaware	56	Kirk Springs & Sawmill Hollow	Adair, Cherokee
27	Falls Branch	Cherokee	57	Dripping Springs Hollow	Cherokee
28	Steeley Hollow	Cherokee	58	Dennison Creek	Adair
29	Beaver Creek	Adair, Delaware	59	Welling Creek	Cherokee
30	Five Mile Hollow	Delaware	60	Telemay & Dog Hollow	Cherokee

Table 13. OCC stream ranking in the Illinois River watershed.

Prioritization Based on Phosphorus			Prioritization Based on Nitrogen		
HU*	Name	Rank	HU*	Name	Rank
509	Tyner (Lower & Upper)	1	512	Peacheater	1
330	Kill, Rock & Tahlequah		337	Ballard	
337	Ballard (Lower)		610	Fagan	
609	Sager		604	Battle Branch	
518	Shell		518	Shell	
604	Battle Branch		514	England	
514	England		315	Mollyfield	
325	Fall Branch (East)		606	Hazelnut	
333	Tate Parrish	2	521	West	2
610	Fagan		609	Sager	
521	West		515	Green	
504	Field		509	Tyner (Lower & Upper)	
321	Fall Branch		333	Tate Parrish	
310	Cedar & Tully		330	Kill, Rock, & Tahlequah	
513	Scraper		607	Crazy	
323	Black Fox & Winset		603	Calunchety	
519	Peavine (E&W)	3	513	Scraper	3
607	Crazy		519	Peavine (E & W)	
331	Dripping Springs Br.		404	Bidding	
315	Mollyfield		334	Beaver	
309	Pumpkin		331	Dripping Springs Br.	
603	Calunchety		520	Evansville (L&U)	
512	Peacheater		325	Fall Branch (E)	
606	Hazelnut		602	Five Mile	
408	Goat	4	402	Negro Jake	4
219	Bolin & Dry		408	Goat	
507	Walltrip Branch		227	Parkhill	
334	Beaver		409	Mulberry	
520	Evansville (L&U)		323	Black Fox & Winset	
227	Parkhill		312	Steeley	

Prioritization Based on Phosphorus			Prioritization Based on Nitrogen		
HU*	**Name**	**Rank**	**HU***	**Name**	**Rank**
403	Tailholt		326	Luna	
404	Bidding		507	Walltrip Branch	
302	Ross & Town Branch	5	407	Smith	5
515	Green		309	Pumpkin	
510	South Proctor (E&W)		510	South Proctor (E&W)	
204	Linder Bend		403	Tailholt	
401	Negro Jake		321	Fall Branch	
213	Terrapin		310	Cedar & Tully	
225	Mining Camp South		502	Mining Camp North	
215	Sizemore		302	Ross & Town Branch	
218	Elk	6	216	Petit	6
207	Burnt Cabin		212	Pine	
326	Luna		504	Field	
407	Smith		219	Bolin & Dry	
312	Steeley		605	Bluespring Branch	
602	Five Mile		506	South Briggs Hollow	
216	Petit		509	Proctor Mountain	
212	Pine		307	North Briggs Hollow	
409	Mulberry	7	225	Mining Camp South	7
502	Mining Camp North		215	Sizemore	
506	South Briggs Hollow		209	Cato & Snake	
605	Bluespring Branch		204	Linder Bend	
309	Kirk Spr./Sawmill		511	Dennison	
209	Cato & Snake		319	Kirk Spr./Sawmill	
307	North Briggs Hollow		218	Elk	
314	Dog & Telemay		213	Terrapin	
	Missing Data			**Missing Data**	
226	Dripping Spr. Hollow		207	Burnt Cabin	
508	Proctor Mountain		314	Dog & Telemay	
511	Dennison		226	Dripping Spr. Hollow	
503	Welling Creek		503	Welling Creek	

HU* Hydrologic Unit Number

The report also included recommendations for improving environmental quality of the basin. Water quality plans were completed for Upper Osage, Little Osage, and Clear Creeks in Arkansas in 1992 and for Shell and Ballard Creeks in Oklahoma in 1991. These plans suggested voluntary adoption of conservation practices by producers, with technical assistance provided by the SCS, and cost share incentives provided by the ASCS, with a strong education and information program to correct and prevent agricultural source nonpoint source pollution. Additional recommendations made in the report based on a review of studies included:

1. Continued support of governor's animal waste task force in Arkansas as a means to coordinate agency programs and projects and identify inadequacies, overlap, and/or conflict in animal waste regulations or guidelines.
2. A complete review of existing regulation, legislation, and agency policies concerning animal waste in Oklahoma to determine deficiencies.
3. A comprehensive study of groundwater quality coordinated with nonpoint source programs where possible, and continued support of ongoing groundwater monitoring.
4. Continued streamlining and development of new practices to protect water quality.
5. Further development and support of technology to compost and market poultry waste as a soil improvement.
6. Continued development of water quality farm plans, particularly in priority watersheds in response to local concerns and needs.
7. Development of an intensive educational program to educate the public, landowners, and operators about the extent of the nonpoint source pollution problem, the potential of their operation to contribute to the problem, and sources of available assistance.
8. Encouragement of innovative development and implementation of measures to protect, improve, or enhance water quality in the basin by:
    - evaluation of existing programs, laws, and policies to determine potential contributions to water quality improvement and necessary modifications and expansions.
    - identification of need and development of new programs.
    - establishment of an effective monitoring program.
    - establishment of a governor's advisory group in Oklahoma to support water quality issues and provide a forum for economic growth while minimizing impacts on the environment.
9. Development of phosphorus discharge limits based on the cumulative phosphorus capacities in Lake Tenkiller and the Illinois River, to be included in all point source discharge permits.

J. *Water Quality in the Subwatersheds of the Illinois River Basin (OCC 1992)*

Sixty-two small streams in the Illinois River watershed were monitored by the OCC during 1990-1992 to determine the extent of nonpoint source (NPS) pollution occurring from land uses in small watersheds and to rank the watersheds as part of the BMP implementation process. Streams were monitored on a quarterly basis under baseflow conditions and twice per year during runoff events. The data from these collections are summarized in Table 14.

Table 14. Water quality data from small streams in the Illinois River basin, 1990-1992.

	Total Nitrogen Baseflow (mg/L)	Total Phosphorus Baseflow (mg/L)	N:P Ratio Base flow (%)	Total Nitrogen Runoff event (mg/L)	Total Phosphorus Runoff event (mg/L)	Nitrogen (runoff/baseflow) (%)	Phosphorus (runoff/baseflow) (%)
Minimum	0.18	0.001	8.51	0.24	0.004	0.41	0.31
Maximum	6.40	0.752	660	6.63	0.731	3.39	32.00
Mean	1.48	0.041	79	1.74	0.058	1.23	1.93*
* = maximum value omitted (value = 2.41 with outlier)							

From column 3 it can be seen that the average N:P ratio is much greater than 16. In only 4 of 64 streams was the N:P ratio less than 16, and only one was less than 10. From these data it was inferred that, as a basin-wide phenomenon, phosphorus availability is much more important in determining levels of algal growth than nitrogen; therefore, the discussion of nutrient levels focused on phosphorus. It was also inferred from this ratio and the high average nitrogen value that adequate nitrogen existed in these streams to support luxuriant algal growth.

Phosphorus values were distributed as follows:

Range (mg/L)	# of stream segments
<0.005 - <0.020	31
0.020 - <0.050	20
≥0.050	13

From these data it was concluded that phosphorus was adequate to support rich algal growth in many streams of the Illinois River Basin, although it was inadequate in concentration relative to the amount of nitrogen present. This conclusion may seem somewhat contradictory as it suggests that phosphorus is both plentiful yet limiting. This type of contradictory evidence supports an assertion that algal productivity is closely tied to the abundance of some other nutrient or factors such as light or substrate. The identity of this nutrient or factor could not be determined from study results.

The mean total nitrogen for all stream segments tested was 1.48 mg/L with the values being distributed as follows:

Range (mg/L)	# of stream segments
0.18 - 0.89	23
0.90 - 2.00	21
≥2.00	20

These data indicated that approximately two-thirds of the streams in the basin had nitrogen values which could result in eutrophic conditions. With twenty streams having values greater than 2.00 mg/L, it was apparent that nitrogen levels were high enough to be a cause of concern for stream quality as well as downstream loading. These data also supported the conclusion that nitrogen was not a limiting factor for algal growth.
The data was also examined in terms of the relative concentration of nutrients under baseflow versus runoff conditions. As can be seen in the last two columns of Table 8,

both nitrogen and phosphorus were elevated in runoff conditions. In some cases this was extreme while in other streams, water appears to have been diluted. However, on average, nitrogen concentration increased approximately 23% while phosphorus increased 93%. Given the increased discharge during runoff events and the fact that the values gathered probably do not represent maximum event concentrations, it was concluded that runoff of nutrients was an important contributor to stream and subsequently river water quality.

K. *Illinois River Basin—Treatment Prioritization Final Report* (Sabbah et al. 1995)

The OCC contracted with Oklahoma State University to use more sophisticated methods such as geographical information systems analysis to coordinate different types of data and prioritize subwatersheds in the Illinois River Basin (Sabbah et al. 1995). This report was an attempt to more closely relate land use and water quality information. The effort used the SIMPLE (Spatially Integrated Models for Phosphorus Loading and Erosion) modeling system developed by OSU to estimate watershed-level sediment and phosphorus loading to surface water bodies.

A section of the report dealt with identification and rank of potential phosphorus and sediment sources in the Peacheater Creek and Battle Branch Creek watersheds. Data layers were assembled including a digital elevation model, soil data, and current land use information assembled by the Oklahoma Cooperative Extension Service. Historical rainfall records (1950-1989) were used to run 40 one-year simulations. Long-term averages of runoff, sediment, and phosphorus loadings were estimated for each field and used to predict fields with high environmental risk potentials.

Average annual sediment loading from fields in the Battle Branch Watershed ranged from 0.00 - 0.88 Mg/ha. Predicted sediment loading was highest along the stream channel and from pasture, crop land, and hay meadows as opposed to woodlands. Average annual total phosphorus loading to the stream ranged from 0.00 kg/ha - 9.34 kg/ha. Highest loadings came from fields with high soil test phosphorus levels and from cropped fields, pastures, and hay meadows. Highest loadings were also seen in the headwaters of the watershed, as opposed to lower in the watershed, suggesting BMP implementation should focus on headwater areas and then move downstream.

Average annual sediment loading from fields to Peacheater Creek ranged from 0.00 - 0.96 kg/ha. Again, predicted sediment loading was highest along stream channels and from hay meadows and crop land. Average annual total phosphorus loading to the stream in Peacheater Creek ranged from 0.01 - 34.88 kg/ha. Highest loadings came from hay and pasture land and were associated with high soil phosphorus levels. These high soil P levels were believed to result from application of poultry waste and perhaps from pasturing cattle. Again, areas providing the highest phosphorus loading were concentrated in the headwaters. This suggested BMP implementation should focus in headwaters before downstream areas.

Two critical ideas are supported by this report. The first is that much of the soil erosion in these watersheds happens along stream courses and is probably associated with stream bank erosion. The second is that much of the phosphorus comes from the headwaters of the watershed, thus remediation efforts should concentrate in this area.

L. *Oklahoma Scenic Rivers Commission—River Trend Study (Lynch 1992)*

The data from samples collected by the Oklahoma Scenic Rivers Commission was analyzed to determine existing and historic water quality conditions, as well as any trends which might be present. An excellent historic data base exists for several sites where monthly samples were collected since December 1980. This report covered the analysis of approximately 120 samples collected between 12/1980 and 10/1992 from each of the following sites: Kamp Paddle Trails, Fiddlers Bend, Chewey Bridge, Round Hollow, Echota Bend, Illinois River below the Tahlequah Creek confluence, Flint Creek, and Sager Creek.

Other sites were sampled less frequently due to changes in sample site location and other factors; therefore, less data existed from these sites, and that which exists may be temporally disrupted or may cover a limited duration. Despite these limitations, some of this data was very useful in interpreting stream conditions. This included the following sites: Peavine Hollow, No Head Hollow, Barren Fork Creek, Hwy 59 bridge (Arkansas), Hwy 16 bridge (Arkansas), Illinois River above Osage Creek (Arkansas), and Illinois River above Flint Creek.

Trend analysis was used to determine long-term changes in water quality using the Seasonal Kendall Tau test. Taken as a whole, the data from the long-term sites showed few trends, and those trends which existed were of a low magnitude. This indicated that there was little change in the quality of water at these sites over the almost twelve year sampling period. However, there was a high degree of variance in the data such that the values fluctuated widely from month to month. Some of this fluctuation was due to changes in river volume; therefore, if values could have been looked at in terms of loading, the data would probably have been more uniform. The wide degree of data variance probably masked some trends. Trends which were found to be statistically significant (95% confidence level) are listed in Table 15.

Table 15. Significant water quality trends from 1980-1992.

Site	Trend	Parameter	Site	Trend	Parameter
Kamp Paddle Trails	positive	turbidity	Round Hollow	negative	COD
Fiddlers Bend	negative	COD	Echota Bend	negative	COD
Fiddlers Bend	negative	phosphorus	Echota Bend	positive	turbidity
Chewey Bridge	negative	COD	IR blw. Tahlequah Cr.	negative	COD
Chewey Bridge	positive	phosphorus	IR blw. Tahlequah Cr.	positive	turbidity
Chewey Bridge	positive	turbidity			

The best overall conclusion that could be drawn from this data was that chemical oxygen demand (COD) appeared to be dropping at several sites, but turbidity seemed to be increasing. Given the amount of variance in the data, these analyses were largely unsatisfactory; therefore, long-term changes were looked using time sequence data to compare average values during early years to that of later years. In this case, data averages for the first two years were compared to those of the last two years of sample collection as listed in Table 16. On the whole, averages from the two time periods were not very different, which corroborates the findings that there was not much of a trend over the years of the study. Again, there was considerable variation within the two-year periods; therefore, mean values may have been weighted by unusual events, and differences in means may not be statistically significant.

Table 16. Comparison of water quality data from 1980-1981 with data from 1991-1992.

Site	Date	COD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Turbidity (NTU)
Kamp Paddle Trails	80/81	10.6	2.02	0.253	17.6	11.1
	91/92	6.6	2.49	0.236	20.1	12.3
Fiddlers Bend	80/81	7.1	1.78	0.223	9.5	4.1
	91/92	3.7	2.22	0.170	6.4	3.9
Chewey Bridge	80/81	6.3	1.62	0.195	7.2	4.4
	91/92	4.5	1.98	0.170	4.3	5.0
Round Hollow	80/81	6.6	1.71	0.196	6.3	3.2
	91/92	4.0	2.02	0.166	5.2	3.1
Echota Bend	80/81	6.8	1.40	0.090	5.4	2.8
	91/92	4.1	1.93	0.115	5.9	2.8
IR blw. Tahlequah	80/81	8.7	2.45	0.475	11.9	4.7
	91/92	7.6	4.37	0.825	4.5	2.5
Barren Fork Creek	80/81	4.6	1.59	0.152	2.2	1.2
	91/92	4.4	1.85	0.315	2.7	1.5
Flint Creek	80/81	4.5	1.54	0.041	3.1	2.7
	91/92	3.7	2.14	0.111	4.5	1.5
Sager Creek	80/81	6.9	3.13	1.008	2.4	1.1
	91/92	11.3	5.76	0.724	1.8	1.9

Total nitrogen increased at all sites between the two periods. Although these increases were not generally of a large magnitude, the fact that they occurred at all sites led to the conclusion that nitrogen loading had increased in the Illinois River. There was no consistent increase or decrease in total phosphorus values among the sites, but these values were all very high.

Of all the data, the increases in Flint Creek and Barren Fork Creek were the most significant. The values from the samples collected the first year at Flint Creek were uniformly low and often below the detection limit of 0.005 mg/L. These values began to rise during 1982, but the two-year average was still quite low compared to other sites. The 1991-1992 values from this site were much higher and indicated a real change in phosphorus concentrations over the study period. A similar situation occurred in Barren

Fork Creek, where seventeen of the first twenty-four samples collected contained phosphorus concentrations below the detection limit. The 1991-1992 values were greatly increased, indicating a definite change in water quality in this river.

The concentration of TSS did not change much over the study period. The values were similar down the course of the river with the exception of Kamp Paddle Trails, which was much higher than other sites, probably due to the dislodging of sediments from Lake Frances. From the data in this study, it could not be concluded that any observable changes had occurred between 1980 and 1992.

Results of the data analysis indicated that a significant portion of the nutrients in the river were coming from across the Arkansas border; however, significant contributions were occurring within Oklahoma, too. From the data it was obvious that sewage treatment plant discharges posed a major threat to river quality, although it was difficult to assess the magnitude of this contribution relative to that from non-point sources based on these data. Contributions of nutrients within Oklahoma between Fidler's Bend and Tahlequah were surmised to be almost entirely nonpoint source in nature.

The contribution of nutrients and sediment from Lake Frances was of concern, also. Given the deteriorating structural conditions of the dam in 1992, it was possible that almost all of the accumulated lake sediment would eventually be discharged into the river as it meandered across the lake bed unless corrective measures were taken. Given the levels of nutrients in the river, it was not surprising that Lake Tenkiller was experiencing nutrient problems as demonstrated by accelerated eutrophication. The lake is expected to continue to degrade at a rapid rate until these nutrient levels are significantly reduced.

M. *Report on Water Quality for the Illinois River* (Canty 1996)

As an expansion of the river trend study summarized above, the OSRC and OCC continued monitoring at 14 sites in the Illinois River watershed monthly from 1992-1996. Observed nutrient concentrations were excessive at all 10 Illinois River sites as well as at the sites on three tributaries. Nitrate and ortho-phosphorus were the predominant contaminants, and total phosphorus levels greatly exceeded the suggested USEPA concentration of 0.05 mg/L. Total phosphorus values typically ranged from 0.16 – 0.25 mg/L, with Sager Creek, located approximately three miles from the Siloam Springs WWTP, having the highest average of 0.62 mg/L. Total nitrogen values were also very high, ranging from 1.37-2.69 mg/L, approximately ten times higher than USEPA "unpolluted" values.

Table 17. Four year averages for each OCC sampling location along the Illinois River, selected parameters (1992-1996).

SITE	SITE (abbrev.)	Total Nitrogen	TKN	$N0_3$	Total Phosphorus	Ortho-Phosphorus	TSS	Turbidity	COD
IR upstream of Osage Creek	IRUO	2.26	0.47	1.81	0.14	0.08	20.32	9.47	6.89
IR at Highway 16	HWY	2.66	0.47	2.19	0.25	0.20	60.05	6.57	8.58
IR at Kamp Paddle Trails	CMP	2.69	0.51	2.19	0.22	0.18	45.97	34.08	5.58
IR upstream of Flint Creek	IRUF	2.38	0.39	1.96	0.17	0.11	6.64	5.27	3.51
Flint at Fagan Creek	FAG	2.51	0.52	2.02	0.12	0.07	6.62	3.40	3.84
Sager Creek	SAG	5.90	0.55	5.56	0.62	0.53	5.09	3.64	5.83
Flint Creek upstream of IR	FLT	2.36	0.36	1.99	0.12	0.10	8.20	3.11	3.22
IR downstream of Flint Creek	IRDF	2.43	0.43	2.00	0.20	0.14	26.84	12.55	4.91
IR at Round Hollow	RND	2.35	0.46	1.68	0.18	0.14	24.84	4.60	5.96
IR at No Head Hollow	NH	2.17	0.42	1.75	0.18	0.12	33.17	7.38	5.91
IR at Echota Bend	ECH	2.06	0.44	1.63	0.16	0.12	24.51	4.50	4.94
IR at Tahlequah	TAL	1.95	0.37	1.63	0.17	0.10	27.33	9.98	5.61
IR upstream of Barren Fork	IRUB	1.85	0.36	1.52	0.17	0.13	25.52	5.82	5.16
Barren Fork Creek	BFK	1.37	0.30	1.12	0.12	0.06	9.67	2.96	3.62

Review of the four year average nutrient data (Table 17) indicated an increase in turbidity at four sites (Kamp Paddle Trails, No Head Hollow, Flint Creek near Fagan Creek, and Echota Bend); however, only one site was of significant concern. Kamp Paddle Trails had an increasing trend of 0.59 NTU/year which was thought to be due to eroding lake bed sediments from Lake Frances. Conversely, turbidity at Sager Creek decreased. Four sites experienced a small but significant decrease in the amount of total phosphorous (Kamp Paddle Trails, the Illinois River upstream of Flint Creek, Round Hollow, and Sager Creek). Trend analysis at Sager Creek indicated a more significant decrease of 0.044 mg/L per year in phosphorous over the fifteen year time period, which was assumed to be due to the sewage treatment plant upgrade implemented by the city of Siloam Springs. Significant, positive trends in total nitrogen were observed at all seven sampling sites evaluated, with the increase in concentration varying from 0.036 to 0.232 mg/L per year. The reason for the increase in nitrogen was probably due to increased agriculture, recreation, and urban development in the watershed; however, no responsible source of pollution could be identified by this study.

Review of the four year average nutrient data indicated an increase in nutrient pollution (nitrate, total nitrogen, orthophosphate, total phosphorous, and COD) between the Illinois River upstream of Osage Creek and the Highway 16 sampling locations. The increase in pollution was thought to be due to nutrient loading coming from Osage Creek, which contains wastewater effluent from the cities of Springdale and Rogers along with nonpoint source pollution from the surrounding watershed. Since the flow volume of Osage Creek is considerably greater than the Illinois River prior to the confluence, it was assumed that the elevated nutrient concentrations observed at the Highway 16 site were due primarily to watershed activities in the Osage Creek area, specifically those activities related to the tremendous urban development in the watershed. Nutrient concentrations increased as follows: nitrate increased 1.2 times, orthophosphate more than doubled (0.08 mg/L to 0.20 mg/L), and total phosphorous increased from 0.14 mg/L to 0.25 mg/L.

Sager Creek, which receives sewage treatment effluent from the city of Siloam Springs, also had elevated concentrations of nutrients, notably higher than any other site for nitrate, total nitrogen, orthophosphate, and total phosphate. Sager Creek had historically shown exceptionally high levels of nutrients. Despite these findings, the effects of the wastewater treatment plant on Sager Creek appeared minimal based on fish and macroinvertebrate assessments as well as periphyton monitoring.

In order to assess the nutrient load due to Oklahoma contributions, the point where the river enters Oklahoma (Kamp Paddle Trails site) and the Tahlequah sampling points were compared. Since the river increases in volume by roughly 1.5 times between these two locations, it can be misleading to make a direct comparison of nutrient concentration without correcting for flow. As a means for direct comparison, the nutrient loadings in kilograms per year were calculated for the total phosphorous and total nitrogen parameters at these two sites. Average discharge volumes from the USGS gauging stations at Watts and Tahlequah from 1990-1994 were used for flow estimates. Average nutrient concentrations from the 1992-1996 time period were used to represent average river concentrations. Loadings were calculated by multiplying average concentration (mg/L) by average discharge (cfs) to produce an annual load (kg/yr) (Table 18).

Water quality data from the USGS and ODEQ were compared with the OCC data to verify accuracy of the loading estimates (Table 18). Moderate differences were expected due to temporal and spatial sampling variation, but there was no statistical difference between the data sets with the exception of the Tahlequah total phosphorous data. The USGS Tahlequah site had a significantly lower total phosphorous value than the OCC and the ODEQ data. Low sample size was thought to be the cause of the lower USGS value, and the OCC and ODEQ estimates were considered more accurate.

Table 18. Nutrient load calculations for the Camp Paddle Trails and the Tahlequah sampling locations along the Illinois River.

Agency and Site	Avg Discharge (cfs)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Total Phos. Loading (kg/yr)	Total Nitrogen Loading (kg/yr)
OCC Kamp Paddle Trails	863.6	0.22	2.68	169,500	2,065,000
OCC Tahlequah	1313.6	0.17	1.97	199,200	2,309,000
USGS Watts	863.6	0.208	2.55	161,800	1,964,000
USGS Tahlequah	1313.6	0.085	1.77	99,600	2,065,000
DEQ Watts		0.296	2.37		
DEQ Tahlequah		0.150	1.74		

Analysis of the loading data indicated that approximately 169,500 kg/year of total phosphorous and 2,065,000 kg/year of total nitrogen were entering the state of Oklahoma from Arkansas. Comparing these figures with the Tahlequah values suggested that there was a significant increase in total phosphorous and total nitrogen within the state of Oklahoma (29,700 and 244,000 kg/year, respectively). This suggests that watershed influences within Oklahoma are contributing significantly to the nutrient load in Lake Tenkiller.

N. *Clean Lakes Phase I Diagnostic and Feasibility Study of Lake Tenkiller* (Jobe 1996)

The OWRB contracted with Oklahoma State University Water Quality Research Laboratory to conduct an USEPA Phase I Clean Lakes Study on Lake Tenkiller to diagnose the problems and recommend solutions. OSU WQRL studied the lake intensively between April 1992 and October 1993. Samples were collected at eight stations in and below the lake. Water quality in the Illinois River and its tributaries was also analyzed for purposes of the study.

The study determined that water quality in Lake Tenkiller was showing signs of degradation. Symptoms included periodic algae blooms, excessive algal growth, and extensive hypolimnetic anoxia throughout stratified periods. The lake was classified as eutrophic based on nitrogen, phosphorus, and chlorophyll *a* concentrations, which were excessive when compared to published criteria (Table 19).

Table 19. Lake Tenkiller nutrient data, 1992-1993.

PARAMETER	STATION	MEAN	MEDIAN	SD	n
o-PHOSPHATE (mg/l)	1	0.11	0.09	0.05	16
	2	0.05	0.04	0.03	18
	3	0.04	0.03	0.03	18
	4	0.04	0.03	0.03	18
	5	0.03	0.02	0.03	18
	6	0.02	0.01	0.02	18
	7	0.02	0.01	0.02	18
TOTAL PHOSPHORUS (mg/l)	1	0.14	0.12	0.07	16
	2	0.08	0.08	0.03	18
	3	0.08	0.08	0.04	18
	4	0.08	0.07	0.04	18
	5	0.05	0.05	0.03	18
	6	0.04	0.02	0.04	18
	7	0.03	0.02	0.04	18
NITRATE (mg/l)	1	1.27	1.18	0.56	16
	2	0.53	0.46	0.44	17
	3	0.49	0.36	0.45	18
	4	0.46	0.34	0.42	18
	5	0.38	0.21	0.38	18
	6	0.44	0.30	0.40	18

PARAMETER	STATION	MEAN	MEDIAN	SD	n
	7	0.47	0.30	0.36	18
TOTAL NITROGEN (mg/l)	1	2.25	2.18	1.00	16
	2	1.45	1.16	0.75	17
	3	1.40	1.23	0.77	17
	4	1.34	1.17	0.66	17
	5	1.06	0.79	0.60	17
	6	0.97	0.74	0.59	17
	7	1.01	0.74	0.64	17

The study estimated the total nutrient loading to the lake and partitioned that estimate by source. These estimates (Table 20) represent loading to the lake from both Oklahoma and Arkansas. The loads were predominantly derived from nonpoint sources during high flows, although point sources contribute significant amounts of nutrients during low flows. These nutrient loads, especially the nonpoint fractions, had increased significantly since 1974 but had stabilized since 1985-1986. The load estimates in Table 20 have been adjusted downward based on calculations to account for instream nutrient decay. Estimated nutrient loading from point sources before application of this decay correction is shown in Table 21, and detailed explanation of the load calculations is located in the study.

Table 20. Estimated nutrient loads, by source and type, for three flow regimes into Lake Tenkiller.

Source	Estimated Average Load at Horseshoe Bend kg/yr (%)		Estimated Low Flow Contribution at Horseshoe Bend kg/yr (%)		Estimated Medium Flow Contribution at Horseshoe Bend kg/yr (%)		Estimated High Flow Contribution at Horseshoe Bend kg/yr (%)	
	N	**P**	**N**	**P**	**N**	**P**	**N**	**P**
Background	550000 (23.9)	25000 (11.0)	35200 (22.8)	1600 (9.7)	208450 (23.9)	5225 (10.9)	306350 (24.0)	18175 (11.2)
Point Source	61605 (2.7)	12547 (5.5)	35793 (23.2)	7290 (44.1)	19406 (2.2)	3952 (8.2)	6407 (0.5)	1305 (0.8)
Nonpoint Source	1688980 (73.4)	190078 (83.5)	83345 (54.0)	7628 (46.2)	643869 (73.9)	38968 (80.9)	961795 (75.5)	143482 (88.0)
Total	**2300585**	**227625**	154338 (6.71)	16518 (7.26)	871725 (37.89)	48145 (21.15)	1274552 (55.40)	162962 (71.59)

Table **21. Estimates of point source discharge quantities of total phosphorus to the Horseshoe Bend Area of Lake Tenkiller (1991 to 1993 data).**

Discharger	Estimated Load at Source (kg P/yr)	Distance to Horseshoe Bend (mi)	Estimated Corrected Load at Horseshoe Bend			Estimated Annual Total Load (kg P/yr)
			Low Flow (kg P/yr)	Medium Flow (kg P/yr)	High Flow (kg P/yr)	
Prairie Grove	1200	100	19	28	23	70
Rogers	21600	99	355	519	417	1292
Fayetteville	4500	97	80	114	90	283
Springdale	43150	95	820	1150	893	2862
Lincoln	1200	81	38	46	31	115
Gentry	1700	68	85	91	56	232
Siloam Springs	10000	62	623	628	362	1614
Watts	500	62	31	31	18	81
Westville	2900	28	615	441	187	1243
Midwestern Nursery	600	14	211	131	49	391
Tahlequah	4700	6	2200	1267	441	3908
Cherokee Nation	530	5	257	147	51	454
Total	92580		5335	4593	2619	12547

The excessive nutrient loads have increased algal growth and thus compromised water clarity throughout the lake and its tributaries. Nutrient limitation analysis indicated that the lake was phosphorus limited in the lower end (near the dam), variably limited (phosphorus, nitrogen, and light) in the midreaches, and probably light limited in the headwaters. Based on these results, it was concluded that source control of phosphorus loading was the optimum management alternative. Accumulation of toxics in the lake water and sediments and resident fish did not appear to be a problem.

After considering the feasibility and effectiveness of control measures, the report recommended a 30 - 40% reduction in headwater phosphorus loads be implemented as a short-term goal and a 70 - 80 % reduction as a long-term goal. Since both of these goals still indicated a significant risk of hypolimnetic anoxia, it was further recommended that re-aeration devices be installed in the tailrace to protect the downstream trout fishery.

The report recommended the following programs be initiated to attempt to reduce phosphorus contamination within the basin:

1. Voluntary switch to non-phosphate detergents by all lakeside residents and the cities of Tahlequah and Watts, OK and Rogers and Springdale, AK.
2. Implementation of best management practices upstream from Lake Tenkiller to minimize contributions of phosphorus in surface water runoff from agricultural fertilizer and waste and poultry waste applications.
3. Continue to work with point source dischargers, to the extent possible within the watershed, to minimize discharges of nutrients, including phosphorus

4. Establish a citizens' monitoring group for basic water quality analysis and evaluation, thus affording a more robust assessment of management effectiveness.

O. *Determining the Nutrient Status of the Upper Illinois River Basin Using a Lotic Ecosystem Trophic State Index (*Matlock et al. 1996)

The Clean Lakes Study determined that Lake Tenkiller was phosphorus limited at the lower end, variably limited by nitrogen, phosphorus, and light availability in the mid-reaches, and light limited at the upper end. However, it was unknown whether the Illinois River was limited by the same factors. One goal of this study was to determine which nutrients most often limit primary productivity in tributaries to the Illinois River.

The watersheds of three tributaries to the Illinois River were chosen based on availability of historical water quality data, similar land use, and similar size. These were Peacheater Creek, Tyner Creek, and Battle Creek. Although Battle Creek watershed was smaller than Peacheater and Tyner Creek watersheds, all had predominantly pasture and range land use (63 to 68 percent) and substantial forest cover (32 to 36 percent). The main difference in land uses among the three watersheds was the degree of anthropogenic activity.

The study used *in situ* nutrient limitation assays to estimate limiting nutrients in the three creeks. Six nutrient enrichment treatments were tested: 1) Nitrate - 5 ppm, 2) Phosphate - 5 ppm, 3) Nitrate and phosphate - 5 ppm, 4) Micronutrients - from Weber et al. (1989) at 200 times concentration, 5) Total nutrients, consisting of treatments 3 and 4, combined, and 6) Control- deionized water. Periphytometers were colonized in a run 0.3 m deep above a riffle for 14 days. Growth surfaces were protected from grazers with an aluminum screen. Assays were conducted in April and October 1995.

Comparisons of the treatment means suggested that Battle Creek was phosphorus limited in the spring 1995 but limited by something other than nutrients during the fall, possibly light availability, which would be affected by turbidity. Peacheater Creek appeared to be co-limited by nitrogen and phosphorus during both spring and fall sampling. Tyner Creek appeared to be limited by some factor other than nutrients during the spring and co-limited during the fall. Conclusions of the report focused on the variable status of growth limiting factors in tributaries of the Illinois River. The variability of growth limiting factors in these streams suggests they are primarily impacted by nonpoint source pollution. Nonpoint sources vary temporally as well as they do in substance and nature of pollution. A stream impacted by point sources would be expected to have a more consistent growth limiting factor between seasons than was seen in these results. The findings of this report support conclusions of previous studies that nutrients and sediment are problematic in the Illinois River Basin and that nonpoint sources as well as point sources are contributing to the water quality problems.

P. *Analysis of Bank Erosion on the Illinois River in Northeast Oklahoma* (Harmel 1997)

One source of increased turbidity in the Illinois River, its tributaries, and Lake Tenkiller, as well as increased bedload in the Illinois River and its tributaries, was believed to be streambank erosion. However, the magnitude of the contribution of streambank erosion had not been investigated until OSU and the OCC completed a survey of bank erosion on the Illinois River in 1996-1997. This project involved completion of several milestones:

1. Initial bank characterization, selection of banks for detailed study, and detailed characterization of selected banks were performed and reported in the Bank and Reach Characterization Report.
2. Long-term bank erosion was measured from aerial photographs and reported in the Aerial Photograph Erosion Analysis Report.
3. Short-term bank erosion was measured in the field at selected sites along the length of the river.

Initial Bank Characterization

In July 1996, 193 bank segments along the length of the Illinois River from below Lake Frances dam to Horseshoe Bend on the upper portion of Lake Tenkiller were characterized. Data was generally collected only on eroding banks; however, several stable banks were characterized to provide a comparison. Data collected included length, height, angle, river position, location, material, vegetation type and percent cover, root depth and density, maximum water depth, bankfull depth, and percent flow in the near bank region under bankfull flow conditions. Banks were then grouped according to physical and vegetative conditions and hydrologic influence. At least one bank from each group (36 sites) was selected for detailed characterization. Selected sites were characterized with Rosgen Level III stream reach condition evaluation. Twenty-three of the 36 sites were characterized as C4c-channels, 11 as C4, and 2 as F4. C4c and C4 channels are gravel dominated, slightly entrenched, gentle gradient, riffle/pool channels with high width/depth ratios. These channels, characterized by depositional features, are very susceptible to shifts in stability caused by flow changes and sediment delivery from the watershed. F4 channels have similar characteristics but are entrenched. Channel bars were common, and bank erosion rates were likely high due to mass-wasting of the steep banks.

Aerial Photograph Erosion Analysis

USDA-SCS 1:7920 scale aerial photographs taken in 1958, 1979, and 1991 were analyzed to estimate long-term bank erosion. Analysis yielded information on the 193 initially characterized sites in addition to 28 other significant erosional / depositional areas (generally greater than 0.5 acres lost by erosion or gained by deposition). Measurements included maximum lateral erosion, lateral erosion and/or deposition, land surface area, and length. For the period between 1958 and 1979, maximum lateral erosion averaged 67 ft, lateral erosion averaged 37 ft or 1.7 ft/yr, and lateral deposition averaged 47 ft or 2.2 ft/yr. A total of 64 acres of land was eroded, and 78 acres was deposited. The length of eroding areas averaged 1014 ft, and the length of depositional areas averaged 999 ft. For the period from 1979 to 1991, maximum lateral erosion averaged 74 ft, lateral erosion averaged 41 ft or 3.6 ft/yr, and lateral deposition averaged 5 ft or 0.4 ft/yr. A total of 195 acres of land surface area was eroded and 13 acres was deposited. The length of eroding areas averaged 1131 ft. and the length of depositional areas averaged 665 ft.

The river width, measured at each 0.5 river mile from bank tracings indicated that the river was widening, with increased width in the downstream direction. Average river width for 1979 and 1991 was 175 ft and 206 ft, respectively. River width in the first 21 mile section averaged 147 ft in 1958, 158 ft in 1979, and 185 ft in 1991. For miles 21 to 42, average width increased from 169 ft in 1979 to 195 ft in 1991. Average width on the lower third of the river increased from 199 ft in 1979 to 239 ft in 1991. Overall, the Illinois River became an average of 18% wider between 1979 and 1991.

The impact of riparian vegetation was measured using long-term erosion data. Relationships tested included maximum lateral erosion rate for forested, grassed, and mixed sites, maximum lateral erosion rate for forested, grassed, and mixed sites given the site eroded between 1958 and 1991, and percent of grassed, forested, and mixed bank length that eroded or received deposition. Between 1979 and 1991, mean erosion was greater on grassed and mixed land than on forested land but the change was not statistically significant. From 1958 to 1979, mean values were significantly different between forested, grassed, and mixed sites. Although mean values were generally lowest on forested areas, data indicated that major erosion could occur on forested as well as grassed and mixed sites and minor erosion could occur on grassed and mixed vegetation sites as well as forested sites.

The lengths of erosional and depositional areas were compared to vegetation data to determine the percent of forested, grassed, and mixed vegetation area length that eroded or received deposition. In both time periods, grassed areas had the greatest percent length of erosion and deposition and forested areas had the least. Over the two comparison periods, grassed areas were almost twice as likely to experience detectable erosion compared to mixed vegetation areas and 3.5 times more than forested areas.

Field Measurement of Bank Erosion

Short-term streambank erosion was measured with bank pins and cross-section surveys from September 1996 to July 1997. Erosion was measured after major flow events (exceeding 9000 cfs at the Tahlequah gage station) in September 1996, twice in November 1996, and in February 1997. Erosion was measured for 33 and 29 sites (out of 36 sites) after the second and fourth major flow events, respectively. After the first and third events, only 11 and 18 sites were measured due to lost pins.

Cumulative erosion after the four major flow events averaged 4.5 ft and ranged from -0.03 to 26.5 ft. Erosion was also measured once after two at or near bankfull events that occurred in spring and summer 1997. Erosion from these two events from averaged 0.40 ft and ranged from 0.00 to 2.35 ft. This study was conducted during a wet year when streamflow volume and frequency of significant flow events exceeded normal conditions. The average flow was 1123 cfs from August 1, 1996 to July 31, 1997, representing a 20% increase from normal conditions and a 3.0 year return period. Flow events also occurred with greater or equal to a 2 year return period during the course of this sampling. Data from the surveys indicated that several sites experienced moderate to major aggradation. Other sites experienced degradation, although to a lesser degree than the aggrading sites experienced aggradation.

The impact of riparian vegetation was evaluated on short-term erosion data. Cumulative erosion for 27 sites after four major flow events was compared to riparian vegetation data. Differences in bank erosion between forested, grassed, and mixed sites suggested mean erosion from grassed and mixed sites exceeded that of forested sites. However, large variability among the vegetation types caused none of the differences to be statistically significant. Substantial erosion occurred on some forested sites while little erosion occurred on some grassed sites.

Conclusion

One of the major sources of sediment in the Illinois River basin was likely streambank erosion. Much of the watershed was grassland or forested (92%). Although clearing of forested areas for pasture was increasing, this area still represented only a small portion of the watershed. Estimated inputs of sediment from bank erosion (3.5 million tons of material between 1979 and 1991) indicated this to be a significant, perhaps the major source, contributing to bedload in the river and sedimentation of Lake Tenkiller.

Long-term erosion analysis indicated that natural riparian forested vegetation was important in reducing and preventing bank erosion on the Illinois River. Grassed banks were 3.5 times more likely to erode than forested banks and almost twice as likely at mixed vegetation banks.

In addition, the river was changing to a wider, shallower, perhaps braided river. Data showed that in addition to extensive bank erosion, the river had widened from an average of 175 ft in 1979 to 206 ft in 1991. Both the width to depth ratio and the sinuosity in many reaches of the river approached or fulfilled the Rosgen criteria for a braided channel. Many channel reaches showed signs of aggradation, which can follow a cycle of high sediment input (either from upland or bank erosion), increased in-channel deposition, and increased bank erosion.

Q. *An Investigation of the Sources and Transport of NPS Nutrients in the Illinois River Basin in Oklahoma and Arkansas* (Gade 1998)

The focus of this study was to estimate the quantity of nutrients delivered to Lake Tenkiller at the Horseshoe Bend area, as well as to identify the sources of those nutrients. Autosamplers were installed at two locations in Oklahoma, one on Barren Fork Creek and the other on the Illinois River near Tahlequah. In 1993, two high flow events were analyzed at the first site, and three high flow events were assessed at the other site. Results indicated that nitrogen concentrations decreased with initial increase in discharge due to dilution. Phosphorus concentrations gradually declined after an initial peak due to runoff. High flows delivered the greatest mass of nitrogen and phosphorus (54% and 61%). Osage Creek was found to be the main point source contributor to the Illinois River.

Historical water quality data from 1980-1993 was examined for eight USGS sites in the basin in order to determine whether changes had occurred over time. A significant increase in both the concentrations and loads of both nitrogen and phosphorus was seen at most sites during this time period. Gade estimated (from a QUAL2EU model) that 2-3% of the total nitrogen entering Lake Tenkiller was from point sources and that about 73% was from nonpoint sources (NPS) (Table 21). About 84% of the total phosphorus load entering the lake was from NPS and 6% was from point sources (Table 22). During low or base flow, a larger percentage of the phosphorus load was from point sources (about 44.1%), but this was dramatically reduced when the flow increased.

Table 22. Estimated distribution of total nitrogen load between background, point, and nonpoint sources at the Horseshoe Bend area of Lake Tenkiller.

Source	Estimated Average Total Nitrogen Load at Horseshoe Bend (kg/yr)	Estimated Low Flow Contribution at Horseshoe Bend (kg N /yr)	Estimated Medium Flow Contribution at Horseshoe Bend (kg N /yr)	Estimated High Flow Contribution at Horseshoe Bend (kg N /yr)
Background	550,000 (23.9%)	35,200 (22.8%)	208,000 (23.9%)	306,000 (24.0%)
Point Source	61,600 (2.7%)	35,800 (23.2%)	19,400 (2.2%)	6,400 (0.5%)
Nonpoint Source	1,690,000 (73.4%)	83,400 (54.0%)	644,000 (73.9%)	962,000 (75.5%)
Total	2,300,600	154,400	871,400	1,274,400
		(6.7% of Total)	(37.9% of Total)	(55.4% of Total)

Table 23. Estimated distribution of total phosphorus load between background, point, and nonpoint sources at the Horseshoe Bend area of Lake Tenkiller.

Source	Estimated Average Total Phosphorus Load at Horseshoe Bend (kg/yr)	Estimated Low Flow Contribution at Horseshoe Bend (kg P /yr)	Estimated Medium Flow Contribution at Horseshoe Bend (kg P /yr)	Estimated High Flow Contribution at Horseshoe Bend (kg P /yr)
Background	25,000 (11.0%)	1,600 (9.7%)	5,230 (10.9%)	18,200 (11.2%)
Point Source	12,500 (5.5%)	7,290 (44.1%)	3,950 (8.2%)	1,300 (0.8%)
Nonpoint Source	190,000 (83.5%)	7,630 (46.2%)	39,000 (80.9%)	143,000 (88.0%)
Total	227,500	16,520	48,180	162,500
		(7.3% of Total)	(21.2% of Total)	(71.4% of Total)

SIMPLE models showed that areas with high soil phosphorus (due to long-term waste application) were the greatest contributors of NPS phosphorus. Specifically, Osage, Barren Fork, Flint, Benton, and Clear Creeks were the subbasins that delivered the greatest quantities of nutrients. Gade noted the dramatic increase in number of poultry houses since 1980 in the Illinois River basin and observed that the subbasins with the greatest densities of poultry houses delivered the greatest amount of nutrients.

QUAL2EU models were used to estimate the effects of 25% and 50% NPS nutrient reduction on loading and concentration in the basin and Lake Tenkiller (Tables 23-26). Loading of both phosphorus and nitrogen to Lake Tenkiller was found to be excessive even in the absence of NPS contributions (100% reduction).

Table 24. Relative reduction in mean annual total phosphorus concentration and load with a 25% reduction in nonpoint source inputs.

USGS GagingStation Identification	Simulated Mean Annual Total Phosphorus Conc. (mg/L)	Simulated Mean Annual Total Phosphorus Conc. With 25% NPS Reduction (mg/L)	Change (%)	Simulated Mean Annual Total Phosphorus Load (kg/yr)	Simulated Mean Annual Total Phosphorus Load With 25% NPS Reduction (kg/yr)	Change (%)
07194800	0.37	0.29	-22	39,400	30,200	-23
07195400	0.48	0.40	-17	197,000	161,000	-18
07195500	0.32	0.26	-19	189,000	154,000	-19
07196500	0.24	0.20	-17	223,000	183,000	-18
Horseshoe Bend	0.23	0.19	-17	291.000	241,000	-17
07195000	0.39	0.36	-17	88,700	80,800	-9
07196000	0.29	0.24	-17	37,400	31,000	-17
07196900	0.24	0.19	-21	11,900	9,310	-22
07197000	0.16	0.12	-25	51,200	40,900	-20

Table 25. Relative reduction in mean annual total nitrogen concentration and load with a 25% reduction in nonpoint source inputs.

USGS GagingStation Identification	Simulated Mean Annual Total Nitrogen Conc. (mg/L)	Simulated Mean Annual Total Nitrogen Conc. With 25% NPS Reduction (mg/L)	Change (%)	Simulated Mean Annual Total Nitrogen Load (kg/yr)	Simulated Mean Annual Total Nitrogen Load With 25% NPS Reduction (kg/yr)	Change (%)
7194800	2.9	2.2	-24	303,000	234,000	-23
7195400	3.8	2.9	-24	1,540,000	1,180,000	-23
7195500	2.6	2	-23	1,510,000	1,180,000	-22
7196500	2.1	1.7	-19	1,960,000	1,550,000	-21
Horseshoe Bend	1.9	1.5	-21	2,480,000	1,970,000	-21
7195000	2.4	1.9	-21	543,000	433,000	-20
7196000	2.4	1.9	-21	308,000	243,000	-21
7196900	2.1	1.7	-19	102,000	81,000	-21
7197000	1.5	1.2	-20	495,000	404,000	-18

Table 26. Relative reduction in mean annual total phosphorus concentration and load with a 50% reduction in nonpoint source inputs.

USGS GagingStation Identification	Simulated Mean Annual Total Phosphorus Conc. (mg/L)	Simulated Mean Annual Total Phosphorus Conc. With 50% NPS Reduction (mg/L)	Change (%)	Simulated Mean Annual Total Phosphorus Load (kg/yr)	Simulated Mean Annual Total Phosphorus Load With 50% NPS Reduction (kg/yr)	Change (%)
07194800	0.37	0.20	-46	39,400	20,900	-47
07195400	0.48	0.30	-38	197,000	124,000	-37
07195500	0.32	0.21	-34	189,000	120,000	-37
07196500	0.24	0.15	-38	223,000	142,000	-36
Horseshoe Bend	0.23	0.15	-35	291,000	189,000	-35
07195000	0.39	0.32	-18	88,700	72,600	-18
07196000	0.29	0.19	-34	37,400	24,500	-34
07196900	0.24	0.14	-42	11,900	6,730	-43
07197000	0.16	0.09	-44	51,200	30,400	-41

Table 27. Relative reduction in mean annual total nitrogen concentration and load with a 50% reduction in nonpoint source inputs.

USGS GagingStation Identification	Simulated Mean Annual Total Nitrogen Conc. (mg/L)	Simulated Mean Annual Total Nitrogen Conc. With 50% NPS Reduction (mg/L)	Change (%)	Simulated Mean Annual Total Nitrogen Load (kg/yr)	Simulated Mean Annual Total Nitrogen Load With 50% NPS Reduction (kg/yr)	Change (%)
07194800	2.9	1.6	-45	303,000	165,000	-46
07195400	3.8	2.0	-47	1,540,000	822,000	-47
07195500	2.6	1.5	-42	1,510,000	854,000	-43
07196500	2.1	1.2	-43	1,960,000	1,130,000	-42
Horseshoe Bend	1.9	1.1	-42	2,480,000	1,460,000	-41
07195000	2.4	1.4	-42	543,000	321,000	-41
07196000	2.4	1.4	-42	308,000	177,000	-43
07196900	2.1	1.2	-43	102,000	59,700	-41
07197000	1.5	0.9	-40	495,000	312,000	-37

R. *Recent Total Phosphorous Loads in the Illinois River Watershed in Arkansas Compared to Loads in 1980-1993* (Maner 1998)

This investigation assessed decreasing phosphorus loads in the Arkansas portion of the Illinois River watershed. An overall phosphorus load reduction of 20.1% was observed during the 1991-1995 period as compared to the 1980-1993 period. Further improvement was noted in the 1993-1997 period, with a 22.9% load reduction from the 1980-1993 period and a total phosphorus concentration of 0.210 mg/L versus 0.311 mg/L (Table 27).

Table 28. Phosphorus trends in the Arkansas portion of the Illinois River watershed.

	Phosphorus concentration (mg/L)			Phosphous load (kg/yr)			
	1980-1993	1991-1995	1993-1997	1980-1993	1991-1995	1993-1997	% reduction
Total IR watershed	0.311		0.21	221,425	176,948	146,665	22.9
Sager Cr.	1.102	0.844		20,668	14,488		29.9
Barren Fork	0.151	0.104		7,692	5,434		23.4
Flint Cr.	0.077	0.055		3,483	3,047		12.5

The point versus nonpoint sources loads were estimated to be 17% and 68% of the total phosphorus load based on observed in-stream decay rates of the known point source load. Considering “end-of-pipe” values from point sources with no decay of phosphorous, the point source contribution comprised 45% of the total phosphorus load, the nonpoint source load was 40% of the total load, and background sources accounted for 15% of the load. It was assumed that the actual load contributions are somewhere between the two estimates.

S. *Phosphorus and Nitrogen Concentrations and Loads at Illinois River, South of Siloam Springs, AR 1997-1999* (Green and Haggard 2001)

In this USGS report, an analysis of phosphorus and nitrogen collected bimonthly from 1997-1999 and during storm events is discussed. The results indicated that both point and nonpoint sources were affecting water quality. Annual flow-weighted concentrations and yields were determined using regression load estimates based on data collected from 1997-1999.

Flow-weighted nutrient concentrations and nutrient yields were 10-100 times greater than national averages for undeveloped basins. Most of the phosphorus load was contributed during surface runoff, while nitrogen showed a different trend (Table 28): about 15% of total phosphorus from base flow and 85% from runoff; 72% of soluble reactive phosphorus was from runoff; about 46% total nitrogen from base flow and 54% from runoff; 42% nitrate-nitrite nitrogen from runoff and 58% from base flow.

Table 29. Annual loads for total phosphorus, soluble reactive phosphorus, total nitrogen, and dissolved nitrite plus nitrate nitrogen at Illinois River south of Siloam Springs, AR. All values in kilograms per year.

	1997	1998	1999
Total phosphorus			
All data	257,000	217,000	260,000
Baseflow (BF)	38,000	33,700	39,200
Surface runoff (SRO)	201,000	248,300	194,000
Sum of BF plus SRO data	239,000	282,000	233,200
Soluble reactive phosphorus			
All data	150,000	130,000	160,000
Baseflow (BF)	34,300	30,700	35,000
Surface runoff (SRO)	100,000	115,300	104,000
Sum of BF plus SRO data	134,000	146,000	139,000
Total nitrogen			
All data	2,000,000	1,700,000	2,100,000
Baseflow (BF)	1,100,000	750,000	1,200,000
Surface runoff (SRO)	1,100,000	1,300,000	1,200,000
Sum of BF plus SRO data	2,200,000	2,050,000	2,400,000
Dissolved nitrite plus nitrate nitrogen			
All data	1,310,000	1,160,000	1,440,000
Baseflow (BF)	967,000	682,000	1,070,000
Surface runoff (SRO)	593,000	652,000	659,000
Sum of BF plus SRO data	1,560,000	1,334,000	1,729,000

T. Phosphorus Sources in an Ozark Catchment, USA: Have We Forgotten Phosphorus from Discrete Sources? (Haggard et al. 2003)

Water samples were obtained from 30 sites in the Illinois River basin, and USGS data from 1997-2001 was used in order 1) to determine the average annual phosphorus load in the Illinois River near the Oklahoma-Arkansas state line, 2) to assess the relative contributions of point and nonpoint sources of phosphorus, and 3) to identify major phosphorus sources at base flow. Results from this study indicated that total phosphorus levels in the Illinois River were 7 to 9 times the criterion of 0.037 mg/L, with runoff values ranging between 11 and 12 times the criterion and baseflow values 5 to 6 times the criterion. Total phosphorus increased significantly during surface runoff events, with an average annual phosphorus load during base flow of approximately 34,000 kg and 174,000 kg during surface runoff conditions. This corresponds to 84% of the average total load being transported during surface runoff conditions.

Of the average total load from 1997 through 2001, almost 45% was thought to be from municipal WWTPs in the basin. Springdale WWTP contributed almost 83% of the total average annual phosphorus load from point sources. About 35% of the phosphorus observed during runoff conditions was surmised to be from resuspension of instream sediment. These findings suggest that discrete sources of phosphorus and sediment-bound phosphorus must be considered in facilitating reductions of instream phosphorus concentrations.

U. *Water Quality and Biological Assessment of Selected Segments in the Illinois River Basin and Kings River Basin, Arkansas* (Parsons 2004)

This report presented water quality and aquatic biological data for several streams in the Illinois River basin in Arkansas in order to provide data that could be used to evaluate support of aquatic life criteria. The primary concern of this project was the impact of excessive nutrient concentrations on instream biological communities. Water quality data was collected and analyzed three times at each of eight sites in Arkansas. Sites included locations above and below the WWTPs of Rogers, Springdale, Prairie Grove, and Berryville. In addition, two biological and habitat assessments were performed at each location.

The results indicated that low dissolved oxygen and exceedances of the Arkansas 24-hour dissolved oxygen fluctuation standard subjected aquatic life to stress. Nutrient levels and total dissolved solids were consistently higher at sites downstream of wastewater treatment plants (WWTP) as opposed to sites upstream of the plants. Fourteen percent of the TDS samples exceeded Arkansas standards. Total phosphorus surpassed the 0.1 mg/L guideline for TP in Arkansas' Water Quality Standards in 58% of samples, most notably at every site located immediately downstream of a WWTP. Total nitrogen values ranged from 0.987 to 8.498 mg/L, with the highest values detected downstream of the Springdale WWTP (from 4.672 to 8.498 mg/L). This study found that nutrient loading at the sites selected was due to WWTP discharge but noted that these findings could have been influenced by the nature of the low flow condition sampling.

Studies cited prior to this found that instream sediments acted as a phosphorus sink at sites immediately downstream of WWTPs, releasing high levels of phosphorus to the streams. Another Arkansas study compared total phosphorus data from previous studies with recent collections. The results indicated that total phosphorus concentrations in storm flow had decreased while those of base flow remained stable, suggesting that best management practices in the watershed were reducing the amount of total phosphorus reaching the Illinois River (Parsons 2004).

The two sites on the Illinois River immediately upstream of Oklahoma yielded results indicating habitats supportive of aquatic life, despite high phosphorus levels and an overabundance of periphyton. However, the lack of many sensitive macroinvertebrate species was noted as a concern. Sedimentation and alteration of the hydrologic regime were proposed reasons for the reduced numbers of pollution intolerant species. Urban and agricultural sediment loads contributed phosphorus to the stream while decreasing valuable habitat for aquatic organisms. In the headwaters, sediment seemed to be the pollutant of greatest concern, as opposed to lower in the watershed, where phosphorus was the primary pollutant.

A previous study (1995-1996) had indicated that fish communities in the Illinois River at 10 sites were affected by Rogers, Springdale, and Fayetteville WWTP discharges. The findings were consistent with those expected in nutrient-enriched waters, including increased populations of primary feeding fishes (planktonic and periphytonic feeders) below the discharges (particularly stonerollers), and reduced sensitive species, including flow sensitive darters. Habitat differences did not appear to be the source of this observed effect (ADEQ 1997). The current study had similar results, with the fish communities downstream of the Rogers and Springdale WWTPs being "impacted."

V. *Water Quality Monitoring Report: Illinois River Basin Arkansas-Oklahoma Compact* (OWRB 2004)

Oklahoma and Arkansas, through the Arkansas-Oklahoma Compact Commission, focused on water quality at eight sites in the Illinois River basin, using data from 1980 to 2002 (Figure 6). Four of these sites were in Oklahoma: two at USGS sites on the Illinois River, one near Watts, and the other near Tahlequah. Average annual phosphorus values are depicted in Figure 7 for all sites.

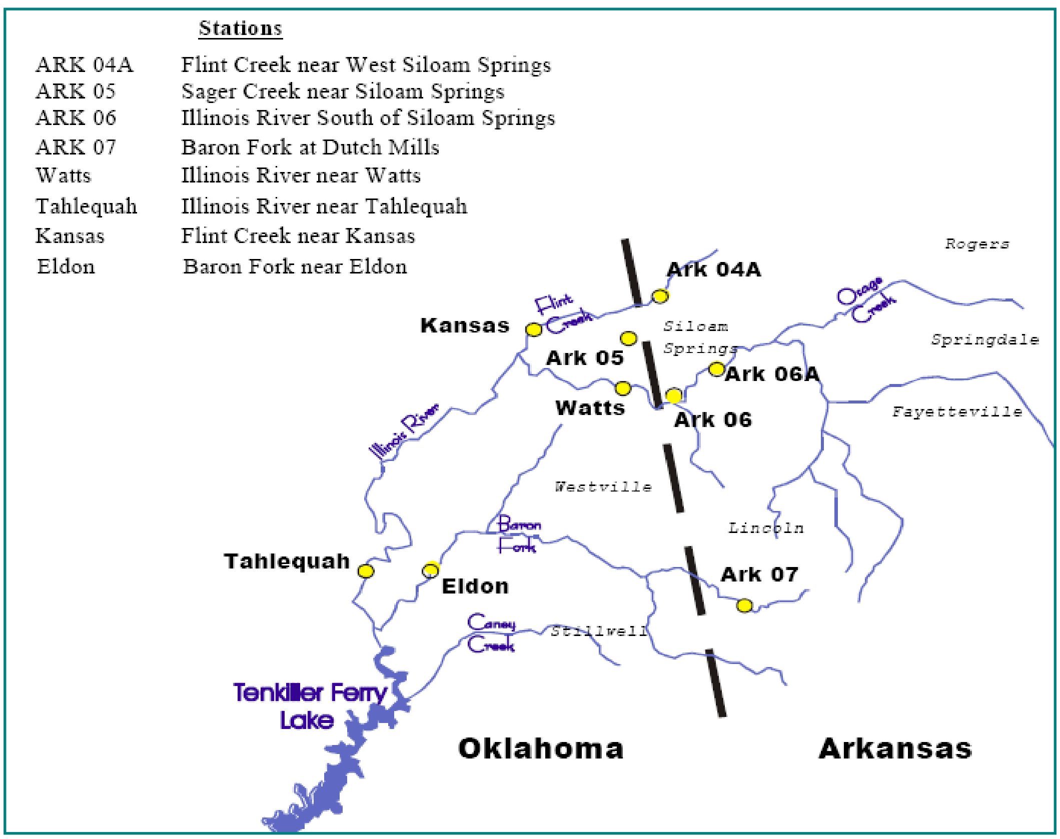
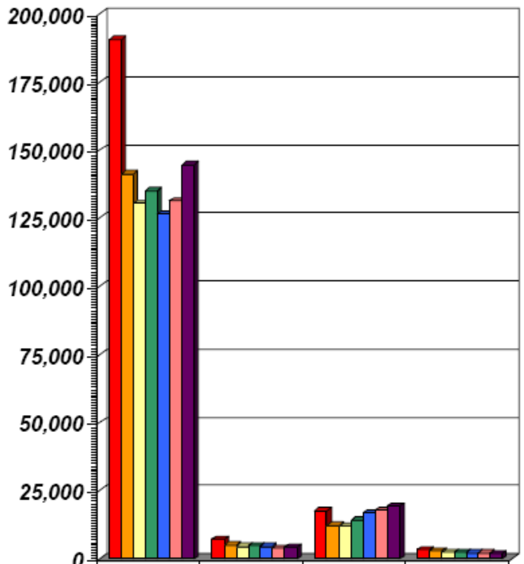
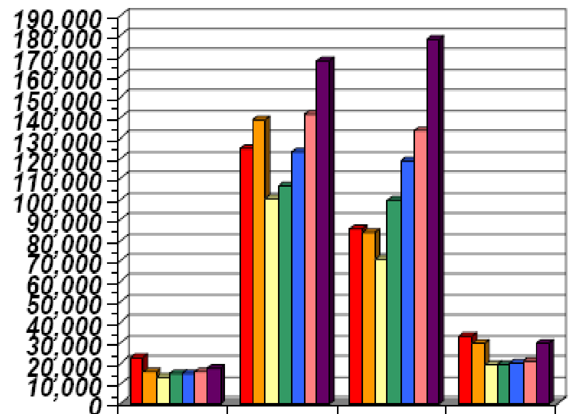


Figure 6. USGS monitoring sites 1980-2002.



	Illinois River ARK06	Baron Fork ARK07	Sager Creek ARK05	Flint Creek ARK04a
Total P 80-93	190,577	7,160	17,566	3,267
Total P 93-97	141,386	5,036	12,426	2,875
Total P 94-98	130,567	4,519	12,133	2,488
Total P 95-99	134,951	4,874	14,284	2,555
Total P 96-00	126,713	4,571	16,796	2,187
Total P 97-01	131,495	4,002	18,008	2,213
Total P 98-02	144,642	4,354	19,332	2,043



	Flint Creek near	Illinois River near Watts	Illinois River near Tahlequah	Baron Fork near Eldon
Total P 80-93	22,279	124,832	85,235	33,001
Total P 93-97	15,755	138,816	83,799	29,482
Total P 94-98	12,947	100,039	70,389	19,230
Total P 95-99	14,790	106,044	99,418	19,211
Total P 96-00	14,588	122,787	118,361	20,129
Total P 97-01	15,467	141,107	133,392	21,142
Total P 98-02	17,075	167,479	177,677	29,713

Figure 7. Average annual total phosphorus (kg/yr) at Arkansas sites (left) and Oklahoma sites (right) from 1980 to 2002.

Each site was examined separately to determine any trends (Figure 8). In Oklahoma, the Watts and Tahlequah sites yielded similar results in total phosphorus loadings, with peaks in 1993 and declines in 1997. A gradual increase in loadings from 1998 through 2001 occurred at the site near Watts, with levels reducing from 2001 to 2003. The highest level during this time was 200,549 kg/year in 2001, falling to the lowest level of 48,035 kg/year in 2003. The site at Tahlequah increased rapidly from 1998 to 1999, falling gradually to 145,766 kg/year in 2001. After a brief increase from 2001 to 2002, total phosphorus loadings fell to 42,690 kg/year in 2003 in conjunction with a corresponding decrease in stream flow. These variations in loading are highly correlated with runoff and rainfall volumes. For instance, 2003 was a much drier year than 2001 or 2002.

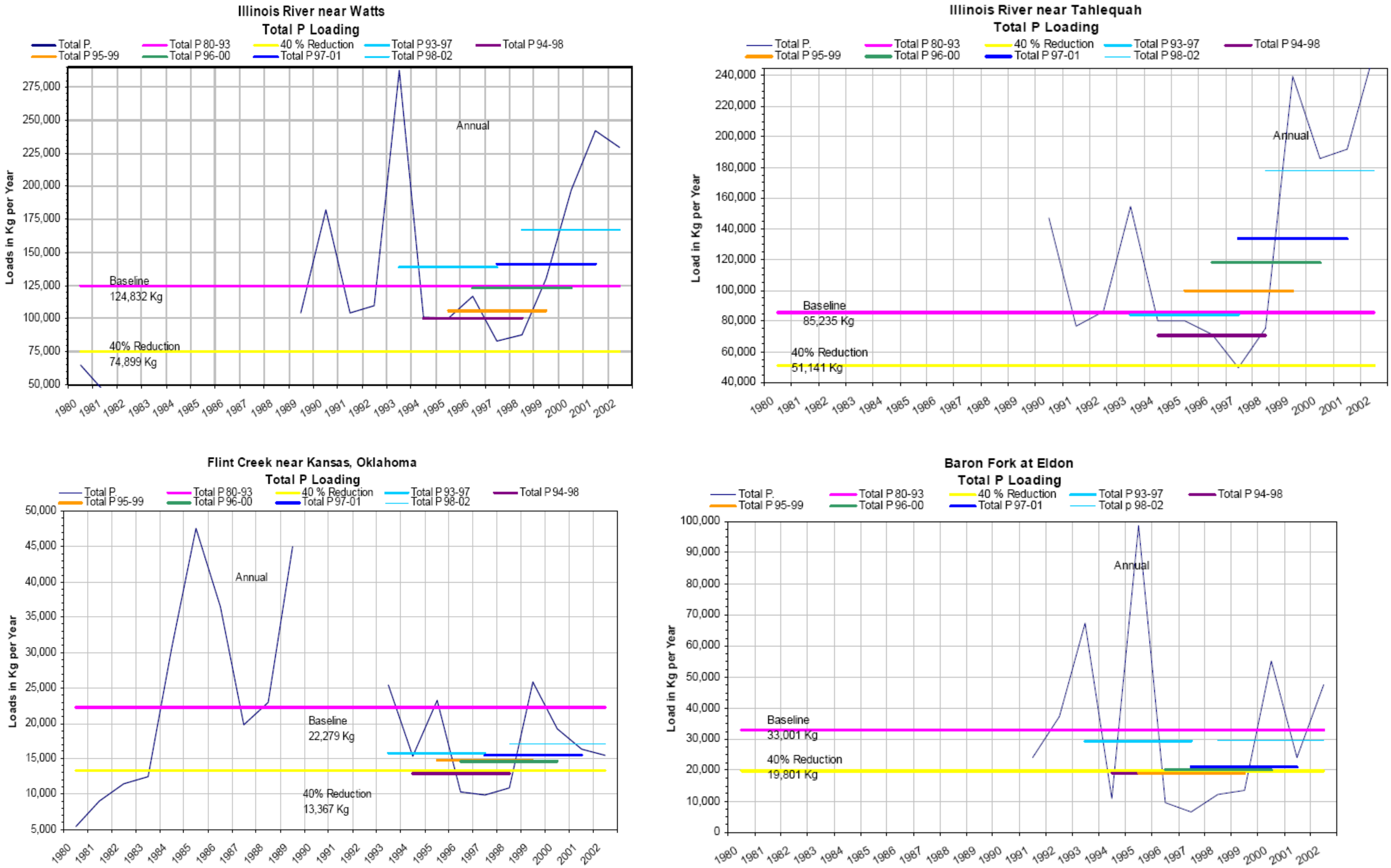


Figure 8. Total phosphorus trends at Oklahoma sites from 1980 to 2002.

At the USGS site located on Flint Creek near Kansas, OK, total phosphorus loading increased from 1980 through 1985, with a very rapid rise in the loadings occurring from 1983 to 1985, when loadings rose from 12,415 kg/year to 47,591 kg/year. A rapid decrease in total phosphorus loading took place from 1985 to 1987 when total phosphorus loadings fell to 19,840 kg/year, with another rise in levels from 1987 to 1989. After a hiatus in monitoring, total phosphorus loadings appeared to have decreased upon the resumption of monitoring in 1993. Levels ranged from 9,871 kg/year to 25,359 kg/year, with annual increases and decreases in loading between 1993 and 2003.

The final Oklahoma site in this study was located on Barren (Baron) Fork Creek at Eldon. This site also exhibited variable total phosphorus loadings, with levels increasing from 1991 to 1993, falling from 1993 to 1994, and peaking at 98,819 kg/year in 1995. Loadings significantly decreased in 1996, with the lowest level reported in 1997 when levels were 6,671 kg/year. After a gradual increase over the years from 1997 to 2000, levels began to decrease, achieving a new low of 3,237 kg/year in 2003, also associated with a corresponding decrease in flow. Both this site and Flint Creek near Kansas had lower loadings than either site on the Illinois River.

W. *Effect of Reduced Effluent Phosphorus Concentrations at the Illinois River, Northwest Arkansas, 1997-2004* (Haggard 2005)

Phosphorus concentrations were measured at multiple sites along the Illinois River and its major tributaries (Clear/Mud Creek, Osage Creek, and Spring Creek) in Arkansas. Sites were sampled approximately 14 times from 2002-2004, and the data was compared with previously collected data from 1997-2001. The major focus of the investigation was to examine changes in phosphorus due to improvements at the Rogers, Springdale, and Fayetteville wastewater treatment plants. Specifically, Fayetteville upgraded to tertiary treatment in the mid-1990s and has an effluent limit of 1.0 mg/L total phosphorus. Both Rogers and Springdale have advanced secondary treatment. Rogers has implemented an effluent limit of 1.0 mg/L total phosphorus since about 1997, while Springdale began attempts to maintain a total phosphorus limit of 1.0 mg/L in 2002 but was still updating as of 2005.

Analysis of the data showed significant levels of phosphorus in the Illinois River that originated from the Springdale WWTP. Levels as high as 10 mg/L soluble reactive phosphorus (SRP) were observed during 2002. Significant decreases in the phosphorus levels downstream of the Springdale discharge were noted in 2003 and 2004; however, the amount of total phosphorus in the streams was still much higher than required by the “scenic river” criteria. Noticeable spikes in phosphorus were evident just below the effluent discharge of all three WWTPs relative to values above the WWTPs, and the phosphorus level at the Arkansas-Oklahoma state line was about 0.10 mg/L throughout the study, about three times higher than the Illinois River criteria.

X. *Illinois River and Baron (Barren) Fork Watershed Implementation Project* (OCC 2005)

The OCC analyzed data collected by the USGS and the Oklahoma Water Resources Board (OWRB) concurrent with the Barren Fork implementation project at stations potentially affected by the project in order to determine whether measurable water quality results could be observed during the project period. Overall, water quality data collected during the project period did not show discernable water quality changes associated with the implementation project. Three of the sites analyzed in the Arkansas-Oklahoma Compact Study (OWRB 2004) occurred in the focus area of this project: the Illinois River near Watts and near Tahlequah and Barren Fork Creek near Eldon. Both base flow and high flow data from these three sites were used in the analysis. In addition, data was obtained from five USGS stations: the Illinois River near Chewey, near Moodys, and near Park Hill, Caney Creek near Barber, and Barren Fork Creek near Welling. Data from 1999 through 2004 was obtained for these sites, although the USGS discontinued monitoring the Illinois River site near Chewey in 2000, Barren Fork Creek near Welling in 2001, and the remaining sites in 2002. The OWRB monitored the Illinois River sites near Watts and near Tahlequah, Barren Fork Creek near Eldon, and Caney Creek near Barber through 2004.

Table 30. Mean water quality values, 1999-2004, in or near the Barren Fork basin (OWRB and USGS).

Site	Discharge (cfs)	DO (mg/L)	Ammonia (mg/L)	Total Phosphorus (mg/L)	OrthoPhosphorus (mg/L)	TSS (mg/L)
Illinois R nr Watts	2497	9.38	0.050	0.296	0.192	128
Illinois R nr Chewey	3861	9.60	0.035	0.314	0.167	146
Illinois R nr Moodys	5507	9.24	0.050	0.427	0.191	270
Illinois R nr Tahlequah	3580	9.14	0.041	0.180	0.102	112
Illinois R nr Park Hill	495	10.31	0.032	0.092	0.079	27
Caney Creek nr Barber	190	9.50	0.041	0.089	0.041	279
Barren Fork nr Eldon	2035	9.02	0.055	0.102	0.034	156
Barren Fork nr Welling	751	10.58	0.027	0.093	0.035	17

Dissolved oxygen (DO) levels were generally at appropriate levels to support aquatic biota (Table 29). The only site to fall below 4.0 mg/L DO was Caney Creek near Barber.

Dissolved phosphorus levels were higher at all sites on the Illinois River than those on Barren Fork Creek or Caney Creek. The site on the Illinois River near Watts had the highest measured concentration at 0.680 mg/L. Caney Creek near Barber tended to have the lowest dissolved phosphorus levels, never exceeding 0.09 mg/L. Orthophosphate concentrations were highest on Caney Creek near Barber and the Illinois River near Watts. Total phosphorus for all sites typically exceeded Oklahoma's Scenic River 0.037 mg/L standard. The site on the Illinois River near Moodys maintained higher total phosphorus levels than the other sites (Table 29). Total phosphorus concentrations on the Illinois River at the sites near Watts, Chewey, Moodys, and Tahlequah were all above 0.1 mg/l.

Dissolved nitrogen-ammonia concentrations were generally similar among sites with most remaining below 0.050 mg/L the majority of the time. The highest reported concentration was 1.530 mg/L on Barren Fork Creek near Eldon. All other sites never surpassed 0.090 mg/L. Nitrogen-ammonia plus organic nitrogen concentrations were highest at the site on the Illinois River near Moodys and lowest at Barren Fork Creek near Welling. The site at Barren Fork Creek near Eldon achieved the highest level at 4.400 mg/L, while the site on the Illinois River near Park Hill never exceeded 0.380 mg/L.

Nitrite plus nitrate concentrations ranged from a low of 0.030 mg/L at the site on the Illinois River near Watts to 3.740 mg/l at the same site. The site on the Illinois River near Moodys tended to have higher concentrations than the other sites. Caney Creek near Barber reported the lowest concentrations of nitrite plus nitrate. Nitrite levels at all sites remained below 0.050 mg/L. The site maintaining higher levels was Caney Creek near Barber at 0.050 mg/L.

Suspended sediment was much higher at the Illinois River near Moodys in comparison to the other sites. Barren Fork Creek near Welling regularly exhibited lower suspended sediment concentrations than the other sites, while the site at Barren Fork Creek near Eldon exhibited the most variation.

The Barren Fork Implementation Project was designed to demonstrate best management practices to reduce nutrient and sediment loading in the watershed. It is expected that a reduction in phosphorus loading of approximately 30% could result from the BMPs that were installed in the watershed. Details of this project are discussed in the management measures section of this WBP.

Y. *Illinois River 2000-2005 Pollutant Loads at AR Highway 59 Bridge* (Nelson and Soerens 2002; Nelson et al. 2006)

In 1995, Arkansas Water Resource Center automatic water samplers and a USGS gauging station were installed on the Illinois River at the Highway 59 bridge in Arkansas. Flow-weighted mean concentrations were calculated based on grab samples and storm event samples annually. Comparison of annual flow-weighted mean concentrations from 1996-2001 indicated increasing concentrations for all parameters, with the exception of a drop in nitrogen between 1999 and 2000 and a very slight decrease in TKN and TSS concentrations between 1998 and 1999 (Table 30). In 2002 and 2003, all parameters showed decreases in concentration relative to concentrations observed in 2001, followed by increases in 2004 and another decrease in 2005.

Nelson and Cash found that total phosphorus loads increased by 70,000 kg/year from 1997 to 1999 and then decreased by about 30,000 kg/year from 1999 to 2003 (Table 31). These variations in average concentration and loading may be correlated with runoff volume (2003 was a much drier year than 2001 or 2002). When loads were examined over time, a decreasing trend in base-flow loads in the last four years (2002-

2005) was noted. The reduction in total phosphorus base-flow loads correlated well with the reduction of phosphorus discharged by the municipal WWTPs into the Illinois River basin.

Table 31. Flow-weighted nutrient concentrations, calculated by dividing the annual load by the annual discharge (mg/L).

Parameter	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
$N0_3$-N	2.00	2.24	2.37	2.45	2.06	2.86	2.52	2.04	2.13	2.61
TKN	0.74	0.66	0.82	0.81	0.86	0.84	0.55	0.50	0.91	--
Total Phosphorus	0.29	0.28	0.39	0.42	0.53	0.48	0.41	0.22	0.50	0.27
TSS	89	40	123	121	118	133	73	41	163	86

Table 32. Annual loads for the Illinois River at Highway 59 bridge in Arkansas.

Parameter	1997 Loads	1998 Loads	1999 Loads	2000 Loads	2001 Loads	2002 Loads	2003 Loads	2004 Loads	2005 Loads
Discharge (m^3)	458,460,000	588,000,000	635,000,000	536,000,000	532,000,000	531,000,000	289,188,000	565,760,000	390,894,159
N03-N (kg/yr)	1,020,000	1,390,000	1,560,000	1,100,000	1,520,000	1,340,000	591,000	1,207,000	1,018,744
TKN (kg/yr)	301,000	481,000	514,000	462,000	447,000	294,000	144,000	512,000	--
TP (kg/yr)	127,000	232,000	267,000	283,000	256,000	218,000	64,000	281,000	106,979
TSS (kg/yr)	18,400,000	72,600,000	77,100,000	63,600,000	70,800,000	39,000,000	11,845,000	92,080,000	33,560,475

When the phosphorus data from the first five years of monitoring (1996-2001) was plotted using linear regressions, an increasing trend in both base flow and storm flow mean concentrations was observed. Base flow mean concentrations of phosphorus were increasing approximately 0.02 mg/L per year, while storm flow concentrations were increasing by 0.10 mg/L annually (Nelson and Soerens 2002), indicating that nonpoint sources were contributing increasingly more phosphorus to the Illinois River than point sources during that time period. More recently (in 2005), storm event phosphorus loading was estimated to be nearly four times as great as base-flow phosphorus loading (Nelson et al. 2006).

Z. *Phosphorus Concentrations, Loads, and Yields in the Illinois River Basin, Arkansas and Oklahoma, 1997-2001* (Pickup et al. 2003) *and 2000-2004* (Tortorelli and Pickup 2006)

Water-quality samples were collected at five USGS stations in Oklahoma from 1997 to 2004 in order to summarize phosphorus concentrations and estimate phosphorus loads, yields, and flow-weighted concentrations in the Illinois River basin. The results of this monitoring effort were presented in two separate USGS reports, one encompassing data collected from 1997-2001 and the other with data from 2000-2004. The USGS, with assistance from the OWRB, initiated runoff event sampling in 1999 to supplement the fixed bimonthly sampling; hence, data collected from 1997-1999 had relatively few runoff samples.

Phosphorus concentrations in the basin were significantly greater in runoff samples than in baseflow samples for all monitoring stations and all time periods (Table 32). The potential causes of this difference include instream phosphorus resuspension, stream bank erosion, and the addition of phosphorus from nonpoint sources such as fertilized pastures. The Barren Fork Creek site had the lowest phosphorus levels, which is probably due to the lack of a point source discharge in this watershed (both Flint Creek and the Illinois River received phosphorus from point sources).

Table 33. Phosphorus loads and concentrations in the Illinois River, 1997-2004.

Station Name	3-yr. period	Mean annual total phosphorus load (lb/yr)	Mean annual base-flow phosphorus load (lb/yr)	Mean annual runoff phosphorus load (lb/yr)	Mean flow-weighted phosphorus concentration (mg/L)
Illinois River near Watts	1997-1999	164,000	69,600	96,200	0.120
	1998-2000	329,000	73,500	256,000	0.233
	1999-2001	438,000	97,700	356,000	0.320
	2000-2001	515,000	116,000	399,000	0.409
	2001-2003	384,000	96,100	288,000	0.362
	2002-2004	366,000	63,900	302,000	0.337
Flint Creek near Kansas	1997-1999	40,200	11,900	29,500	0.186
	1998-2000	80,400	12,200	68,300	0.335
	1999-2001	87,700	12,700	73,400	0.362
	2000-2001	70,000	11,100	58,900	0.339
	2001-2003	32,300	10,200	22,000	0.211
	2002-2004	49,500	12,000	37,500	0.269
Illinois River near Chewey	1997-1999	292,000	74,300	217,000	0.185
	1998-2000	438,000	74,200	382,000	0.265
	1999-2001	548,000	79,400	465,000	0.339
	2000-2001	549,000	94,900	454,000	0.374
	2001-2003	348,000	77,300	271,000	0.287
	2002-2004	405,000	59,100	346,000	0.319
Illinois River near Tahlequah	1997-1999	307,000	68,800	238,000	0.156
	1998-2000	511,000	67,000	446,000	0.238
	1999-2001	621,000	68,600	543,000	0.289
	2000-2001	559,000	65,700	493,000	0.287
	2001-2003	331,000	60,900	271,000	0.214
	2002-2004	355,000	53,400	302,000	0.217
Barren Fork Creek at Eldon	1997-1999	32,800	4,570	28,400	0.045
	1998-2000	124,000	4,920	120,000	0.165
	1999-2001	135,000	5,980	128,000	0.190
	2000-2001	154,000	5,660	148,000	0.239
	2001-2003	59,000	5,360	53,600	0.120
	2002-2004	120,000	5,000	115,000	0.226

In the first report, 1997-2001, the annual average phosphorus load entering Lake Tenkiller was about 577,000 pounds per year, and more than 86 percent of the load was transported to the lake by runoff. Most of the load appeared to originate along the mainstem of the Illinois River, versus Flint Creek and Barren Fork Creek. Estimated mean annual phosphorus loads were substantially greater at the Illinois River stations than at Flint Creek and Barren Fork Creek.

In the second report, 2000-2004, the estimated mean annual phosphorus load entering Lake Tenkiller ranged from 391,000-712,000 lb/yr, with 83-90 percent of the load from runoff. The decrease in phosphorus at all sites during the 2001-2003 period compared to the 2000-2002 period is thought to be due to an observed drop in mean annual streamflow during that time.

Flow-weighted phosphorus concentrations increased through time at all sites until the 2001-2003 period; during this time period, all sites showed slightly lower concentrations. Flint Creek consistently had the highest flow-weighted phosphorus concentrations of the five sites during the first three time periods. During the last three time periods, the Illinois River had higher phosphorus concentrations than Flint Creek. Barren Fork Creek consistently had the lowest phosphorus concentrations until the final time period, when the Illinois River site near Tahlequah had a lower concentration.

Conclusions Based on Historical Data

It is generally agreed that nutrient loading in the Illinois River Basin is a major source of concern for both current conditions and long-term trends. Studies as late as the mid-1970s indicated good quality water quality in the Illinois River as well as its tributaries and the impounded lakes in the basin. However, by the late 1970s, both Lake Tenkiller and Lake Frances were beginning to show signs of eutrophication. The plethora of research in the Illinois River watershed overwhelmingly supports the hypothesis that phosphorus, predominantly from nonpoint source runoff, is the main cause of the eutrophic conditions that continue in the basin at present. Point sources, particularly from WWTPs in growing urban areas in Arkansas, have contributed and continue to contribute significantly to the elevated nutrient content in the basin; however, improvements in these facilities along with lower permitted discharge limits have reduced the impact of point sources in recent years.

Although Arkansas has a greater loading capacity for nutrients, both point and nonpoint source, into the Illinois River, Oklahoma also has sufficient loading capacities to continue the eutrophication process of Lake Tenkiller even if the Arkansas load was reduced. This emphasizes the importance of cooperation between the two states in order to improve the water quality of the Illinois River watershed, although individual state removal of phosphorus would have some beneficial impact.

Oklahoma has set a numerical criterion for phosphorus of 0.037 mg/L for its scenic rivers, including the Illinois River. The USEPA water quality criteria state that phosphates should not exceed 0.05 mg/L if streams discharge into lakes or reservoirs and 0.025 mg/L within a lake or reservoir to control algal growth (USEPA 2001). Surface waters that are maintained at 0.01 to 0.03 mg/L of total phosphorus tend to remain uncontaminated by algal blooms.

For the streams sampled in the Illinois River Basin it can be seen that, on average, baseflow phosphorus values almost always exceed the upper end of the USEPA-recommended range and have for decades. There is relatively little information suggesting maximum recommendations for nitrogen, but a generally accepted upper limit for preventing the development of eutrophic conditions is 1.0 mg/L total nitrogen. Again, waterbodies in the Illinois River basin have tended to exceed this value for a number of years.

CAUSES AND SOURCES *(element a)*

Causes

The designated beneficial uses for streams in the watershed include some or all of the following: public and private water supply (PPWS), fish and wildlife propagation (FWP; some are cool water aquatic community (CWAC) while others are warm water aquatic community (WWAC)), agriculture, primary body contact recreation (PBCR), aesthetics, industrial and municipal process and cooling water (I&M), and fish consumption. Lake Tenkiller is designated for WWAC, agriculture, PBCR, aesthetics, I&M, PPWS, hydropower, and fish consumption.

In addition, a number of the streams or stream segments are designated as "outstanding resource" waters (ORW), such that no degradation of water quality is permitted. The Upper Illinois River from Tenkiller Dam, including Tenkiller Reservoir upstream to the Barren Fork Creek confluence, is also designated a "high quality water" (HQW) and "nutrient limited watershed" (NLW). The river is classified as a state scenic river from the Lake Frances Dam down to its confluence with Barren Fork Creek, a distance of approximately 70 miles. A 35 mile segment of Barren Fork Creek and a 12 mile segment of Flint Creek are classified as scenic rivers upstream from their confluence with the Illinois River.

The entire Illinois River watershed is comprised of several federally-designated Sensitive Watersheds at the 11-digit Hydrologic Unit Code (HUC) level. These are areas occupied by federally-listed endangered, threatened, candidate, and proposed aquatic or aquatic-dependent species. These watersheds provide important habitat for the continued survival of many species protected under the Endangered Species Act of 1973. Water pollution and stream degradation have been associated with the widespread decline of the two mussel species in this watershed that are candidates for the endangered species list (USFWS 2009). In addition, the endangered gray bat, present in this watershed, feeds on flying insects over bodies of water including rivers, streams, and reservoirs. Practices that result in increased turbidity and siltation in the watershed can be detrimental to the bats since the abundance of their primary prey, mayflies, caddisflies, and stoneflies (all sensitive aquatic species in the larval forms), will be reduced.

In general, phosphorus, bacteria, and sediment are the primary causes of poor water quality in the watershed. Table 33 indicates the impaired designated uses of the streams in the watershed on the Oklahoma 2008 303(d) list (ODEQ 2008). Causes of these impairments which resulted in the listing are given as well. Recently, extremely high levels of mercury were measured in rainfall near Stilwell. While the source of this contaminant is unknown at present, it is expected that research will be conducted to investigate the span and the effects of this substance in the area. It is possible that Lake Tenkiller will be listed for mercury exceedance in the future.

Table 34. Impaired streams in the Illinois River watershed in Oklahoma (ODEQ 2008).

OKWBID	Name	Impaired Designated Uses	Cause of Impairment
OK121700020110_00	Chicken Creek	WWAC	Fishes bioassessment
OK121700030010_00	Illinois River	Aesthetic, PBCR	Total phosphorus, *Enterococcus*
OK121700030040_00	Tahlequah Creek (Town Branch)	PBCR	*E. coli*
OK121700030080_00	Illinois River	Aesthetic, CWAC, PBCR	Total phosphorus, Lead, *E. coli*, Fecal coliform
OK121700030280_00	Illinois River	Aesthetic	Total phosphorus
OK121700030290_00	Flint Creek	Aesthetic, CWAC	Total phosphorus, Low DO
OK121700030350_00	Illinois River	Aesthetic, CWAC, PBCR	Total phosphorus, Turbidity, *Enterococcus*
OK121700030370_00	Ballard Creek	PBCR	*Enterococcus*
OK121700040010_00	Caney Creek	PBCR	*Enterococcus*
OK121700050010_00	Illinois River, Barren Fork	Aesthetic, PBCR	Total phosphorus, *Enterococcus*
OK121700050090_00	Tyner Creek	PBCR	*Enterococcus*
OK121700050120_00	Peacheater Creek	PBCR	*Enterococcus*
OK121700060010_00	Flint Creek	Aesthetic, PBCR	Total phosphorus, *Enterococcus*
OK121700060040_00	Battle Creek	PBCR	*Enterococcus*
OK121700060080_00	Sager Creek	PBCR, PPWS	*Enterococcus*, Nitrates
OK121700020020_00	Tenkiller Ferry Lake	Aesthetic, WWAC, PPWS	Total phosphorus, Low DO, chlorophyll-a
OK121700020220_00	Tenkiller Ferry Lake, Illinois River Arm	WWAC	Low DO

Sources

A number of potential sources that are causing the documented pollution exist in the Oklahoma portion of the Illinois River watershed. The summary of "historical data" in the Illinois River watershed, presented earlier in this document, gave some indication of the potential sources of pollution in the basin. More recent research has continued to support and refine the conclusions of those works. For example, the latest modeling conducted by Dr. Dan Storm from Oklahoma State University (OSU) indicates that nonpoint sources (NPS) are the major contributors to the phosphorus exceedances in this watershed, although point sources contribute significantly to the problems in the watershed as well (Storm et al. 2006). These conclusions are not new, but the Soil and

Water Assessment Tool (SWAT) modeling performed by Storm allows quantification of the amounts of nutrients emanating from various sources under given environmental conditions.

According to Storm's 2006 modeling of the watershed, approximately 35% of the total phosphorus reaching Lake Tenkiller is from point sources. The model indicated that 330,000 kg/yr of total phosphorus reached Lake Tenkiller between 1997 and 2001. Of that, 88,000 kg/yr was in soluble mineral forms. The model predicted that over 60,000 kg of phosphorus was transported to the lake in a single day in early January 1998, demonstrating that extreme events can wash out sediment-bound phosphorus in significant quantities. It is possible for much of the average annual phosphorus load predicted by SWAT to be transported in just a few days of extreme rain.

Point Sources

Point sources are defined as "discernable, confined, and discrete conveyances…from which pollutants are or may be discharged to surface waters" (USEPA website). Point source discharges which are permitted through the national pollutant discharge elimination system (NPDES) can be grouped into three subcategories: municipal and industrial wastewater treatment dischargers (WWTPs), municipal and industrial stormwater dischargers, and confined/concentrated animal feeding operations (CAFOs).

Point source discharges have been documented as a significant source of pollution in the Illinois River basin since the early 1980s at least. Numerous studies, some which were reviewed in the "historical data" section, concluded that effluent from WWTPs in the watershed dominates stream flow during baseflow conditions. Poorer water quality downstream of discharge points relative to upstream has been observed almost universally in the watershed for decades, accompanied by significant amounts of algae and, often, impaired biological communities (e.g., ADPCE 1984).

Reductions in nutrient outputs from these facilities have been mandated, with phosphorus limits of less than 1.0 mg/L written into permits, and improvements have resulted in lower concentrations of phosphorus being discharged into streams. However, the total amount of phosphorus (load) entering the waters may not have changed or even may have increased due to higher discharge associated with the recent drastic population growth in the watershed, especially in Arkansas.

Storm et al. (1996) examined the point source nutrient loading to Lake Tenkiller from the entire watershed in both Oklahoma and Arkansas. They noted that there were twelve permitted point sources discharging upstream of Lake Tenkiller at Horseshoe Bend (considered to be the beginning of the lake): Prairie Grove, Rogers, Fayetteville, Springdale, Lincoln, Gentry, Siloam Springs, Watts, Westville, Midwestern Nursery, Tahlequah, and the Cherokee Nation. The estimated point source loading to the stream are given in Table 34. The combined total loading to the lake was estimated to be 93,000 kg of phosphorus per year.

More recently, Storm et al. (2006) reexamined loads from WWTPs in the watershed (from 1990 to 2001), as shown in Table 35 and Figure 9. Comparing the loads from 1991-1993 with those from 1990-2001, the annual load has more than doubled for Siloam Springs and has increased significantly for Springdale. The Cherokee Nation is now connected to the Tahlequah WWTP. Most of the other loads have remained about the same, with some even decreasing in the more recent years. However, Storm found that the overall load in the basin has increased to a total of 122,738 kg of phosphorus per year.

Table 35. Estimates of point source discharge quantities of total phosphorus to the Horseshoe Bend area of Lake Tenkiller, 1991 to 1993 (Storm et al. 1996).

Discharger	Estimated Load at Source (kg P/yr)
Prairie Grove	1,200
Rogers	21,600
Fayetteville	4,500
Springdale	43,150
Lincoln	1,200
Gentry	1,700
Siloam Springs	10,000
Watts	500
Westville	2,900
Midwestern Nursery	600
Tahlequah	4,700
Cherokee Nation	530
Total	92,580

Table 36. Estimated annual phosphorus loads from WWTPs in the Illinois River basin from 1990-2001 (Storm et al. 2006).

WWTP	Flow (m^3/sec)	Organic P (kg/yr)	Mineral P (kg/yr)	Total P (kg/yr)
Fayetteville	0.34	3,840	1,568	5,409
Siloam Springs	0.21	16,238	6,495	22,733
Gentry	0.02	949	475	1,424
Lincoln	0.02	939	469	1,408
Prairie Grove	0.01	516	258	773
Rogers	0.20	12,948	5,201	18,149
Springdale	0.43	46,574	18,656	65,231
Tahlequah	0.11	1,196	1,196	2,392
Stillwell	0.06	3,726	1,494	5,220
Basin Total	1.40	86,925	35,813	122,738

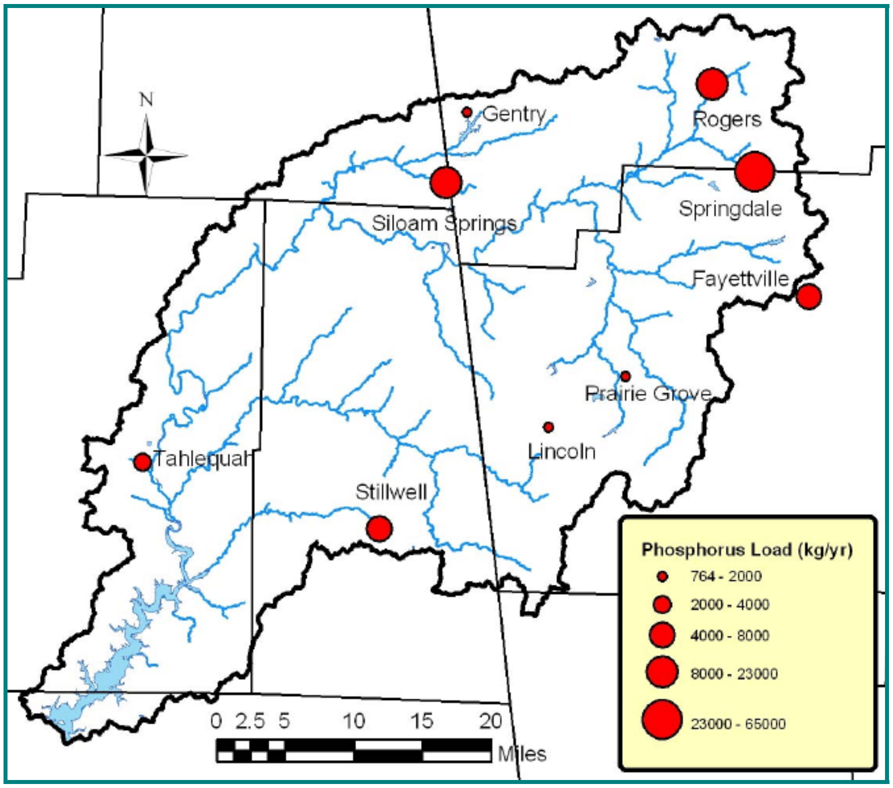


Figure 9. Total phosphorus loads from Waste Water Treatment Plants with a significant discharge in the Illinois River basin (Storm et al. 2006).

Finally, Storm et al. (2010) obtained estimated annual effluent loads from wastewater treatment plants in the Illinois River basin from 2007-2020 from the ODEQ (Table 36). These estimates were based on current effluent loads and potential or proposed upgrades to current facilities. Three new point sources in the watershed (all in Arkansas) were proposed: the Northwest Arkansas Conservation Authority Bentonville, the Northwest Arkansas Conservation Authority Osage, and the Fayetteville WWTP (Figure 10 and Table 36). Currently, the Osage and Bentonville WWTPs have been combined into a single WWTP, the Northwest Arkansas Conservation Authority WWTP, which is scheduled to be in operation by the end of 2010. Based on these estimates, the total overall load from all point sources, current and proposed, is expected to be approximately 96,980 kg of phosphorus per year, a 21% reduction from Storm's last calculations.

Table 37. Estimated annual effluent loads from wastewater treatment plants in the Illinois River basin from 2007-2020 (Storm et al. 2010).

Facility Name	Receiving Stream	Flow (MGD)	Flow (cfs)	Flow (ac-ft/hr)	TN (#/day)	TP (#/day)	BOD (#/day)	TN (mg/L)	TP (mg/L)	BOD5 (mg/L)	NH3-N (mg/L)
Current Point Sources											
Town of Prairie Grove	Muddy Fork	0.50	0.77	0.0639	64.17	8.35	50.07	15.38	2.00	10.00	8.50
City of Fayetteville (offline)	Mud Creek	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Town of Lincoln	Bush Creek	0.50	0.77	0.0639	70.38	8.35	50.07	16.87	2.00	10.00	15.00
City of Springdale	Osage Creek	24.00	37.13	3.0669	2564.20	200.28	3004.20	12.80	1.00	12.50	2.75
City of Rogers	Osage Creek	14.00	21.66	1.7890	1484.06	116.83	2102.94	12.70	1.00	15.00	2.62
Town of Gentry	Swepco Lake	0.50	0.77	0.0639	62.46	8.35	125.18	14.97	2.00	25.00	7.20
City of Siloam Springs	Sager Creek	4.40	6.81	0.5623	470.10	36.72	660.92	12.80	1.00	15.00	2.75
SW Electric Power Co.	Little Flint Cr.	7.03	10.88	0.8984	0.00	0.00	0.66	0.00	0.00	0.01	
City of Tahlequah	Tahlequah Cr	5.27	8.15	0.6734	510.24	43.98	334.23	11.60	1.00	7.60	1.50
Town of Westville	Shell Branch	0.30	0.46	0.0383	35.83	2.50	34.79	14.31	1.00	11.58	5.46
Stilwell Area Development	Caney Creek	1.50	2.32	0.1917	167.73	25.04	212.85	13.40	2.00	14.17	3.64
Proposed Points Sources											
Northwest Arkansas Conservation Authority - Osage	Osage Creek	0.50	0.77	0.0639	54.18	8.35	50.07	12.99	2.00	10.00	3.00
City of Fayetteville	Goose Creek	10.00	15.47	1.2779	1031.89	83.45	901.26	12.37	1.00	9.00	2.22
Northwest Aransas Conservation Authority - Bentonville	Osage Creek	5.00	7.74	0.6389	534.21	41.73	751.05	12.80	1.00	15.00	2.75
USDA FS		0.014	0.02	0.0018	1.59	0.58	1.40	13.61	5.00	10.00	4.00

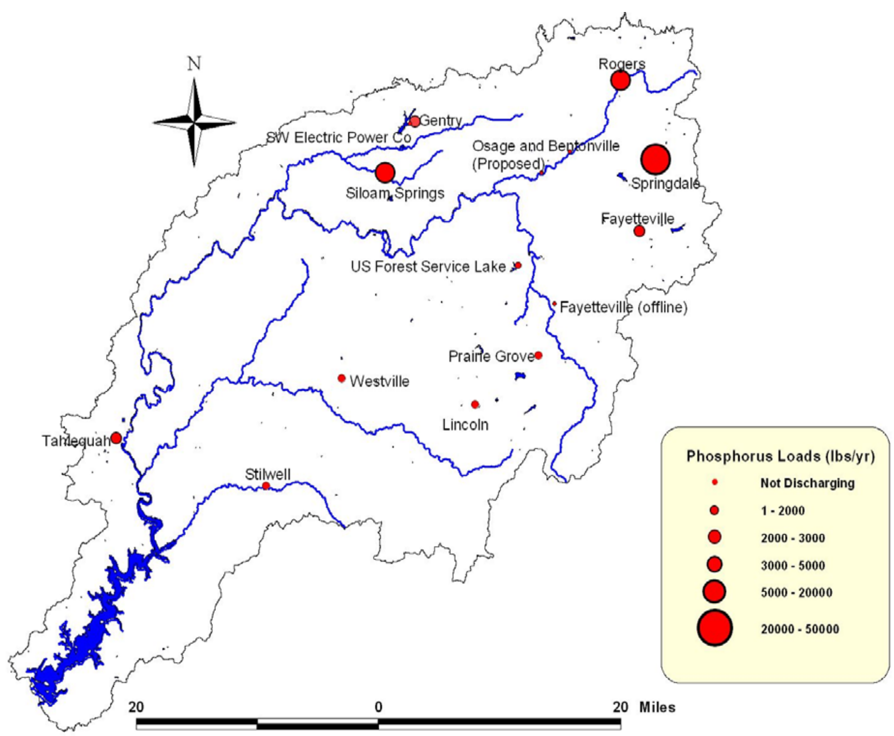


Figure 10. Significant urban locations and total phosphorus loads from wastewater treatment plants in the Illinois River basin (Storm et al. 2010).

Although point source discharges in Oklahoma did not account for the majority of the nutrient loading to the river and Lake Tenkiller, the load was significant enough to warrant reduction. Significant upgrades have already been implemented at point sources in Oklahoma due to efforts by the Oklahoma Department of Environmental Quality (ODEQ), Cities of Tahlequah and Stillwell, and the U.S. Environmental Protection Agency (USEPA). There are six NPDES permits in the Illinois River watershed in Oklahoma. Three of the NPDES permits are for publicly owned facilities: the Tahlequah WWTP and the Stilwell WWTP (both major dischargers), and the Westville WWTP. In addition, there is Mrs. Smith's Bakery in Stilwell and a concrete company and the Cherokee County rural water district in Tahlequah.

Water samples from Public Water Supply wells at a number of recreational facilities along the Illinois River were reported as having Maximum Contaminant Level (MCL) violations for nitrate (10 ppm) during 2006 (ODEQ 2006). These violations suggest that either the groundwater along the river is highly contaminated with nitrate or that there is a significant amount of localized contamination around the intakes for these PWS facilities. Localized contamination is likely due to improperly functioning septic tanks and other methods of sewage disposal. It will be important to determine whether human derived contaminants are escaping from their treatment areas and contaminating both drinking water and river water.

Poultry operations of a certain large size are designated as CAFOs, whereas numerous smaller houses are not considered point sources but cumulatively have a large effect on phosphorus loading in the watershed. According to ODAFF, there were 92 poultry operations (Figure 12 shows locations) in the Illinois River watershed in Oklahoma in 2005, with a total of 429 houses and an 8,001,330 bird capacity (at any given time). Current records (unpub., ODAFF 2007) indicate 73 operations, with a total of 395 houses which produce between 34,894,630 and 42,214,730 birds per year. Soil test phosphorus (STP) values obtained at poultry operations in 2002 indicated that over 39% of samples exceeded 250 lbs/acre.

There are three non-poultry CAFOs in the Oklahoma portion of the watershed. Two of these are swine operations, one with a 425 animal capacity and the other with 6,400 animals. The remaining CAFO permit is for a cattle operation with 160 animal units (a combination of heifers and dairy). CAFOs can be potential contributors of both pathogens and nutrients in the water since large quantities of animal waste are concentrated in a small area and can be washed into the water during rainfalls, although only "25-year, 24-hour events" should cause overflow at these facilities. Figure 11, below, shows the locations of CAFOs, along with a few other types of permitted sources.

Prior to land application, solid and liquid wastes may be held in total retention lagoons. These lagoons may leak or overflow during storms, thus affecting water quality. There are nine total retention lagoons in the watershed (Figure 11), most of which are located very near the lake.

There are four coal-fired power plants in close proximity of Stilwell, one each in Muskogee, Mayes, and Rogers counties in Oklahoma and a fourth in Benton County, AR, which may be the sources of the high mercury observed recently.

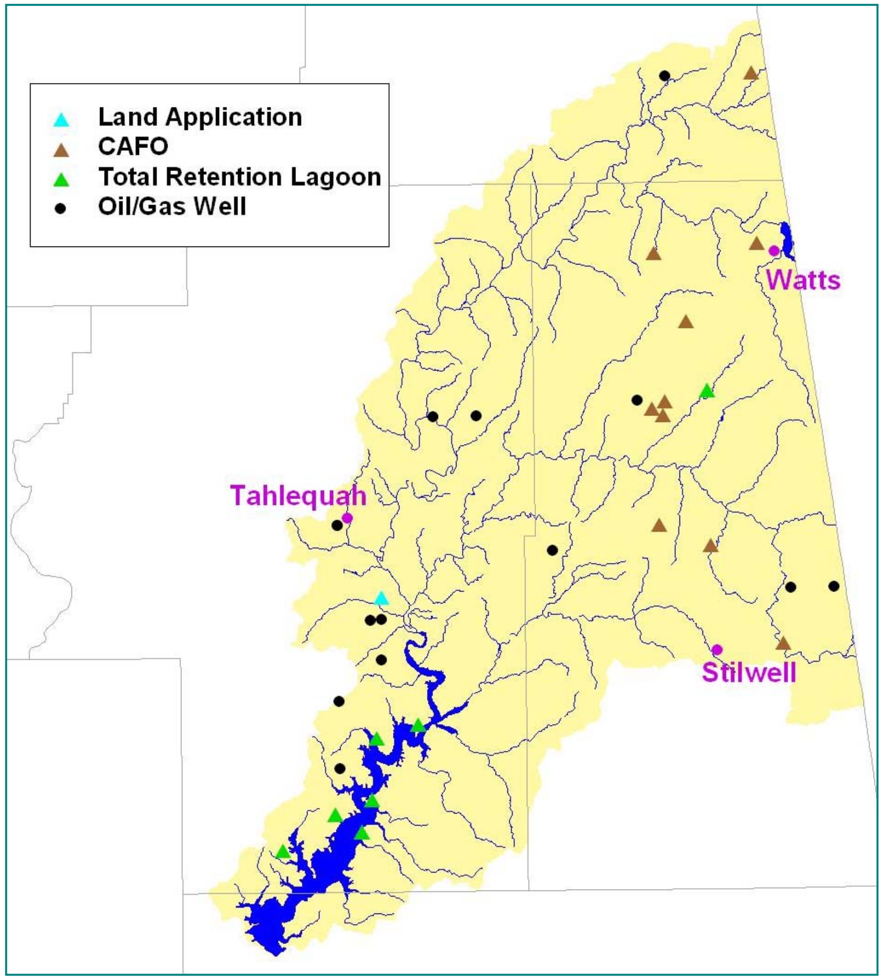


Figure 11. Permitted potential pollution sources in the Illinois River watershed.

Nonpoint Sources

Nonpoint sources are those which supply pollutants to surface water diffusely, rather than as a definite, measurable quantity at a single location. These sources typically involve land activities that contribute bacteria, sediment, and/or nutrients to surface water as a result of runoff during and following rainfall. SWAT modeling has indicated that nonpoint sources contribute significantly to the Oklahoma water quality standards violations in the Illinois River watershed.

Animal Production Operations

Animal Production Operations, specifically those involving poultry and cattle, provide the majority of agricultural income in the Illinois River watershed and are the largest industry in the basin. The poultry industry is more concentrated in the Arkansas portion of the watershed, as shown in Table 37. Table 38 shows the potential impact of the poultry industry just in the Oklahoma side of the Illinois River basin.

Table 38. 1988 estimates of commercial animals in the Illinois River watershed (SCS 1989).

	Oklahoma	Arkansas
Broilers	8,469,865	74,253,000
Layers	2,274,235	2,650,000
Breeder Hens	--	384,000
Pullets	418,720	3,025,000
Turkeys	683,948	1,236,000
Swine	--	4,500
Feeder Pigs	--	90,135
Dairy Cows	4,675	3,100
Beef Cows	--	60,000
Cornish Hens	88,000	--

Table 39. Estimated number and type of birds produced in the Oklahoma portion of the Illinois River basin based on the Oklahoma Department of Agriculture licensed poultry operators database (Storm et al. 2006).

Bird Type	Houses	Birds at Any Given Time	Birds per House	Litter per Animal Capacity (lb/yr)	Litter (ton)
Broilers	365	6,940,757	19,016	13	43,380
Layers/breeders	42	450,093	10,716	42	9,452
Pullets	30	230,660	7,689	8	923
Turkeys	38	344,300	9,061	31	5,337
Sum	475	7,965,810	16,770		59,091
				Litter per House (ton)	124

Unfortunately, the influx of feed necessary to grow animals in such operations has resulted in an imbalance of the nutrient transport in the watershed. More nutrients enter the watershed in feed than leave the watershed in animal products. The result is that these leftover nutrients, in the form of animal waste, often remain in the watershed and ultimately make their way to the streams and the lake. Land application of animal wastes, especially poultry waste (Figure 12), is a common practice which can be misused. That is, waste may be applied at incorrect concentrations or at inopportune times, both of which may negatively impact water quality. In addition, poultry processing plants (located in Arkansas) create a large phosphorus load which goes to the area WWTPs and contributes to the nutrient-rich discharge from these facilities.

A 1997 survey of confined animal operations in the watershed identified sites in the watershed, noted the number of houses present, and observed whether or not they were in production. Based on this survey and literature-supported estimates of nutrient production for various livestock, approximately 13,256,000 lbs. of nitrogen and 4,284,800 lbs. of phosphorus were excreted annually by confined animals in the watershed.

The survey also reported estimates that chickens produce 36% and 34%, turkeys produce 9% and 10%, dairy cattle produce 2% and 5%, hogs produce 9% and 10%, and beef cattle produce 44% and 41%, respectively, of the nitrogen and phosphorus in the watershed. These numbers indicate that, although the poultry industry contributes a significant amount of nutrients, an even larger portion is created by beef cattle.

This is important because beef cattle management is such that cattle often have direct access to streams. Thus, cattle may act as a point source and deposit nutrients and bacteria directly into the stream, while poultry waste enters the stream mainly through overland and subsurface flow. In addition, pasture management is not always optimal. Grazing land is scarce, and pastures can be overgrazed, resulting in poorer pasture with a lower capacity to convert animal waste into biomass and prevent it from reaching the stream. Animals loafing in a stream, particularly cattle, can also contribute to turbidity problems by stirring up sediment and eroding banks as they enter and leave.

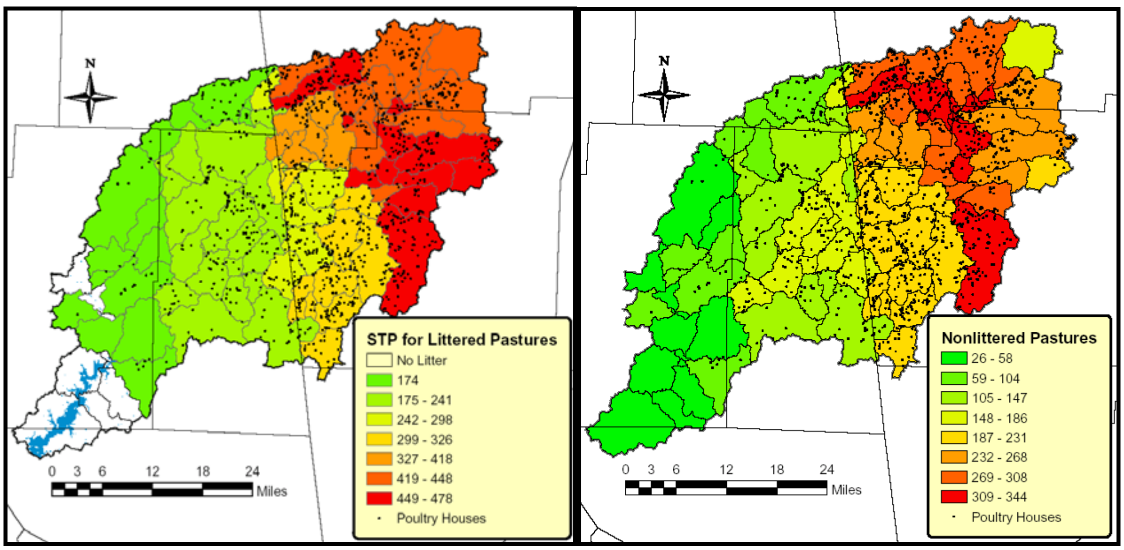


Figure 12. Estimated average soil test phosphorus for pastures a) receiving poultry waste (litter) and b) not currently receiving poultry waste ("litter") (Storm et al. 2006). ***Note: the STP values corresponding to specific colors are different in the two graphics—refer to the key.***

The application of poultry waste to pastures in the watershed has helped to improve the productivity of pastures and allowed the cattle industry to expand to larger numbers, as reflected in Table 2, discussed earlier. However, as shown in Figure 12, pastures with waste applied have much higher soil test phosphorus levels than pastures without waste. Even in pastures without poultry waste application, background conditions in the soils of the watershed due to previous years of spreading waste onto fields could be a significant source of nutrients, specifically sediment-bound phosphorus, which may eventually run off into the streams. Based on modeling simulations in the Illinois River watershed, the pasture/rangeland use accounted for 95 percent of the total nonpoint source phosphorus loading to the basin (Storm et al. 1996).

Figure 12 represents "hotspot" areas for NPS pollution and confirms that phosphorus is present in higher quantities in the soil around poultry houses. Until the USEPA's TMDL is completed, it will be assumed that areas with the highest soil test phosphorus are areas to be targeted for BMP implementation.

Streambank Erosion

Streambank erosion, primarily due to elimination or poor maintenance of riparian zones, bridge construction, upstream or downstream changes in channel morphology, and/or various upstream land use changes, is occurring at an alarming rate (OCC 1999a). Erosion of the cherty upland soils and streambanks has resulted in large gravel loads being transported through the stream channels. Although these streambeds naturally consist of gravel, bedrock, and cobble, current gravel loads are choking out other streambed types, filling in pools, destabilizing riffles, widening channels, and causing further downstream bank erosion, ultimately resulting in loss of crucial habitat for benthic macroinvertebrate and fish populations. Although this degradation is most evident in the river and its tributaries, it will become increasingly apparent in the upper reaches of Lake Tenkiller as mud flats develop and turbidities increase.

Estimates of the loading from bank material suggest that eroding banks have the potential to contribute a significant amount of the total nutrient and sediment load in Illinois River streams; approximately 3.5 million tons of material have entered the river between 1979 and 1991 (Harmel 1997). In Peacheater Creek, a small stream in the watershed, assessment of streambank erosion showed that a large gravel load that was filling in aquatic habitat and causing the stream to run subsurface in many areas. This gravel load also threatened channel stability downstream. Analysis of streambank material and measurement of bank erosion over time suggested that a considerable portion (ranging from 20 to 90 percent) of nutrient loading to the creek could be the result of streambank erosion. Although nutrient loading is probably the greatest threat to the Illinois River and Lake Tenkiller, preliminary results from monitoring in this small stream suggests that streambank erosion, gravel loading, and loss of riparian habitat may be the greatest threat to the smaller streams in the watershed (OCC 1999b).

In addition, sediment-bound phosphorus may be swept into the stream system and resuspended as banks erode. Haggard et al. (2003) found that over 35% of the phosphorus transported during surface runoff conditions in the Illinois River was likely from resuspension of phosphorus retained by stream sediments.


Lake Frances, 2007

The collapse of the Lake Frances Dam in 1991 resulted in an additional source of nonpoint source pollution to the Illinois River basin in Oklahoma. The collapse exposed over a hundred thousand tons of nutrient-enriched lake bed to potential erosion, particularly during storm events. Given the soft nature of the sediments, the potential for much of the lake sediment to be dislodged into the river was initially high; however, water quality data taken during 1992 and 1993 from sites above and below the former lake show that, although river turbidity increased below the lake, the increase was not significant.

A 1994 study found that the old bed of the lake was tightly compacted and primarily clay; it concluded that there was not much potential for the old bed sediments to be readily transported downstream (Hill and McQuiddy 1994). The streambed appears to have stabilized itself, and the former lake bed now exhibits many of the characteristics of a wetland.

Urban Land Use

Commercial fertilizer, pet waste, and soil erosion contribute the most significant portions of NPS loading from urban sources. Given the low population density (based on the US Census) in most of the Oklahoma side of the Illinois River watershed, urban runoff is unlikely to be a major contributor to the bacteria and nutrient problem. However, since the population is increasing in the surrounding areas, urban runoff may need to be considered as a potential significant nonpoint source of pollution for the future.

Urban runoff combines the effect of both point sources and nonpoint sources in that, at times, it contains pollution from point sources (in the form of overflows and system breaks) as well as overland flow. The urban areas in the Oklahoma portion of the watershed are small and, thus, likely produce only a small portion of the total pollutant load to the watershed (not counting discharged treated wastewater).

Septic Systems

Approximately 70% (170,000) of the total population of the Illinois River basin live in urban areas with Municipal Waste Water Treatment Plants (WWTP) (2000 US Census). The remaining 30% (73,000) are assumed to use septic systems. In Oklahoma, the majority of the human population in the watershed relies on septic systems to dispose of residential wastes (Table 39). The 1990 US Census estimated that over 27,000 septic systems were in place in the three main Oklahoma counties of the watershed.

Table 40. Public sewer data for Oklahoma counties in the Illinois River watershed (U.S. Census Bureau Structural, Plumbing, and Equipment Characteristics 1990).

County	Population	Housing Units	% Public Sewer	# Public Sewer
Adair	18,421	7,124	29.1	2,073
Delaware	34,049	16,808	19.8	3,328
Cherokee	28,070	15,935	37.8	10,610
Total	80,540	39,867		16,011

Previous work in a small subwatershed in the basin (Battle Branch) suggested only about 25% of the on-site waste disposal systems met state requirements (OCC 1993). These inadequacies ranged from insufficient lateral lines, lack or insufficient septic tanks, direct disposal of grey water to streams, ditches or land surfaces, and improperly located tanks and lateral lines. Extrapolation to the whole watershed suggests the potential for 75% of rural households to have sub-standard systems.

Assuming that each person produced 0.50 kg P/year (Sarac et al. 2001), a total of 36,500 kg P/yr would be produced. Some of this phosphorus would be trapped in sludge at the bottom of the septic tank, while some of it would bind to soil particles in the leaching field of a newer septic system. A phosphorus-saturated leaching field could transmit phosphorus to receiving water, but the contributions of a properly installed and functioning septic system would likely be very small. However, many septic systems are quite old and less than ideal, and a leaky or improperly installed system could convey phosphorus to streams.

Gravel Mining

In-stream and near-stream gravel mining threatens water quality and the overall aquatic community through exposure of bed load and stream banks to erosion. Recent investigation into the impact of gravel mining on the Barren Fork Creek revealed that mining activities had significantly impacted the riparian community and changed the morphology of the channel to an unstable configuration (Rosgen D classification) which is unlikely to restabilize itself without major structural modifications (OCC 1999a). The resulting changes in stream morphology led to a wider, shallower, less stable stream.

As of 2006, there were four permitted gravel mining operations in the basin within Oklahoma, as well as several small unlicensed operations on river tributaries. The Oklahoma Department of Mines (ODM) has established strict regulations for operation in Scenic River watersheds, including 1) maintenance of a 100-foot (minimum) border of natural vegetation between the water's edge and any mining site, 2) prohibition of mining or driving in any wetted portion of the riverbed, and 3) prohibition from changing the course of the river. These new regulations should ensure that further degradation of the watershed due to gravel mining is minimized or prevented.

Recreation

The recreation industry has been a potentially significant source of pollution in the form of human waste and trash. Although the actual impact to water quality from the recreation industry is difficult to measure, it is not hard to imagine the effects of over 400,000 river users and 1,500,000 lake users annually given the lack of restroom facilities and the visible trash left behind. The recreation impact is likely more severe on the river than the lake due to the fact that an average 2,400 people per weekend float the river during peak months and, until 1994, only one or two inadequately maintained toilet facilities were available.

Projects conducted primarily by the Oklahoma Scenic Rivers Commission in cooperation with the Oklahoma Conservation Commission (OCC), Cherokee County Conservation District, and USEPA have resulted a dramatic increase in the quality and quantity of facilities available to river users. These improvements include canoe-only access areas complete with toilet, picnicking, and camping facilities, properly maintained pit and portable toilet facilities dispersed along the river route (cleaned out twice daily during peak season), and the provision of trash bags and trash collection points along the river route. This change has resulted in the removal of over 7,500 gallons of raw sewage from the canoe access areas alone that would likely have otherwise reached the river. Additional portable toilets are made available in the summer months, preventing another 7,800 gallons of sewage from entering the river each summer. In addition, an estimated 110-120 tons of waste which may have otherwise remained in the river are removed annually due to the trash bag program.

Nurseries

Two major plant nurseries are located along the Illinois River. Irrigation tailwaters from these facilities have been shown to contribute significant quantities of nutrients to the basin. The Oklahoma State Department of Agriculture estimated in 1993 that one of the nurseries on the river contributed as much as 0.3% of the nitrate load and 0.19% of the yearly total phosphorus load to the river. This loading was based on irrigation return flows, without considering storm runoff from the nurseries. Stormwater runoff could have an even more significant impact. In 1998, one of the nurseries completely contained their runoff, so that the potential for pollution now occurs only during large rainfall events (runoff) at this location. Both nurseries signed voluntary compliance agreements with ODAFF (in 1996) to reduce the yearly average nitrate level to 10 mg/L and the phosphorus level to 1.0 mg/L. These actions should reduce the potential for significant pollution from this source.

Silviculture

As described in previous sections, timber harvesting and silvicultural activities are common in the watershed, ranging from small-scale firewood cutting to large-scale commercial operations associated with local sawmills. Cutting methods range from selection harvesting systems to clearcutting operations where forest land uses are sustained through natural regeneration. In some cases, harvesting activity may be followed by land conversion to pasture or other non-forestry uses. In areas of steep terrain, erodible soils, Karst formations, and near waterbodies, logging activity has the potential to impact water quality unless forestry best management practice guidelines are followed. Forest roads are generally recognized as the largest contributor to sediment production from forestry activities. Following appropriate BMP recommendations concerning the width, basal area, and integrity of streamside management zones (SMZ) can minimize sediment impacts on streams (ODAFF 1991).

Oklahoma Forestry Services has monitored forestry BMP compliance across eastern Oklahoma since 2004. Compliance rates in the northeastern counties for the past two survey periods ranged from 82.3% on 7 randomly-selected sites in 2006 to 86.1% on 5 sites in 2010 (ODAFF 2007; 2010a). These results are in contrast to the 92.1% and 92.3% compliance rates respectively in the southeastern counties where the timber industry is much better developed. Although approximately 45% of the Illinois River watershed is forest, SWAT modeling did not indicate significant loads resulting from forestry operations.

Other

A number of other nonpoint sources exist in the watershed, including roads and construction, wildlife, natural background loading due to geology and natural vegetation of the basin, illegal dumping, and smaller livestock facilities such as people who keep a few head of horses or cattle. Although all of these other sources currently seem to be insignificant, reduction in the impacts from other sources may magnify the effects of these sources. Thus, it may be necessary to revisit and better define the magnitude of these sources once steps have been taken to reduce the impacts of known significant sources.

Research is currently being conducted to investigate the significance of nutrient storage in groundwater in the Illinois River watershed. It is hypothesized that alluvial systems, common in the Illinois River watershed area, act as transient storage zones for nutrients which may contribute significantly to baseflow phosphorus levels in surface waters. In addition, nutrients stored in groundwater may be transported subsurface during runoff events and enter surface waters due to hydraulic connectivity which may be present in these types of systems. It is possible that this effect could be a significant source of nutrient loading in the watershed. Results of this research will be discussed further as they become available.

Relative contributions of sources

Storm et al. (2006) determined that the relative load allocations in the Illinois River watershed can be delegated to three main categories: 1) point sources, responsible for 35% of the total phosphorus load; 2) poultry waste ("litter") application, contributing 15% of the load; and 3) "other" nonpoint sources, which supply 50% of the load (Figure 13). The effect of increased soil phosphorus from years of poultry waste application, which would give an increased total phosphorus load, was not considered in Storm's model.

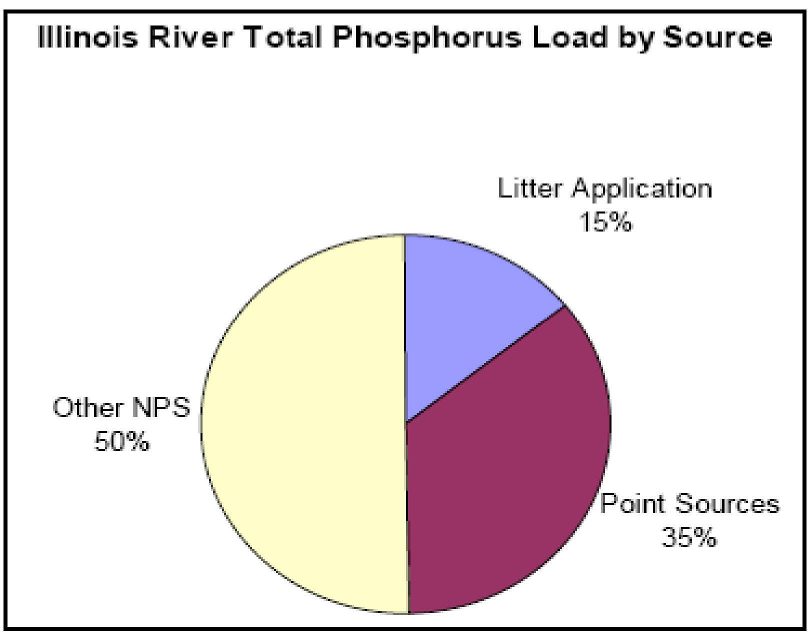


Figure 13. Per unit area sediment yield by land cover from upland areas as predicted by the SWAT model of the Illinois River basin (Storm et al. 2006).

Storm et al. (2006) further delineated the landuse in the basin in order to determine the relative sources of both phosphorus and sediment in the watershed (Table 40; Figures 14 and 15). Roads were the highest contributor of both phosphorus and sediment per unit area in the model results; however, the total load from roads is low due to the small percentage in the watershed (0.16% of landuse). Poorly managed pastures without applied poultry waste and wheat also yielded a high level of sediment per unit area (Figure 15).

Table 41. Modified land cover distribution in the Illinois River basin (Storm et al. 2006).

Land Cover	Fraction of Basin
Forest	45.90%
Hay Without Litter	10.71%
Hay Litter Odd Years	2.30%
Hay Litter Even Years	2.41%
Well Managed Odd Years	4.37%
Well Managed Even Years	3.90%
Well Managed No Litter	16.07%
Poorly Managed Pasture Litter Odd Years	1.02%
Poorly Managed Pasture Litter Even Years	1.10%
Poorly Managed Pasture Without Litter	5.87%
Rangeland	0.60%
Roads	0.16%
Streams	0.09%
Urban	2.91%
Water	1.95%
Row Crop/Small Grains	0.64%

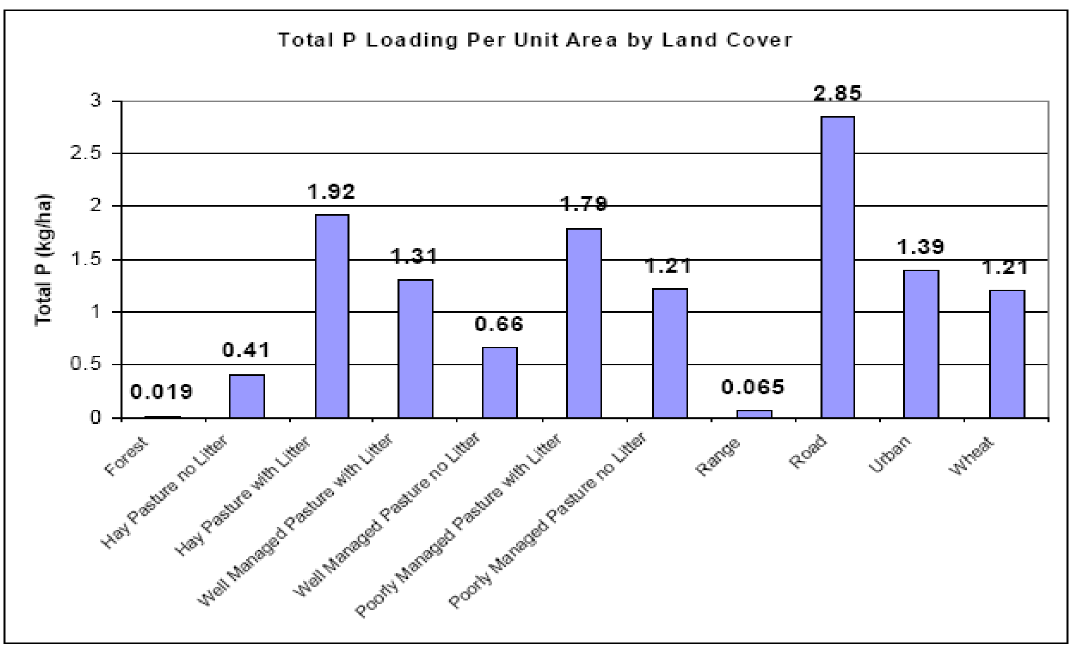


Figure 14. Total phosphorus load per unit area as predicted by the SWAT and instream models in the Illinois River basin (Storm et al. 2006).

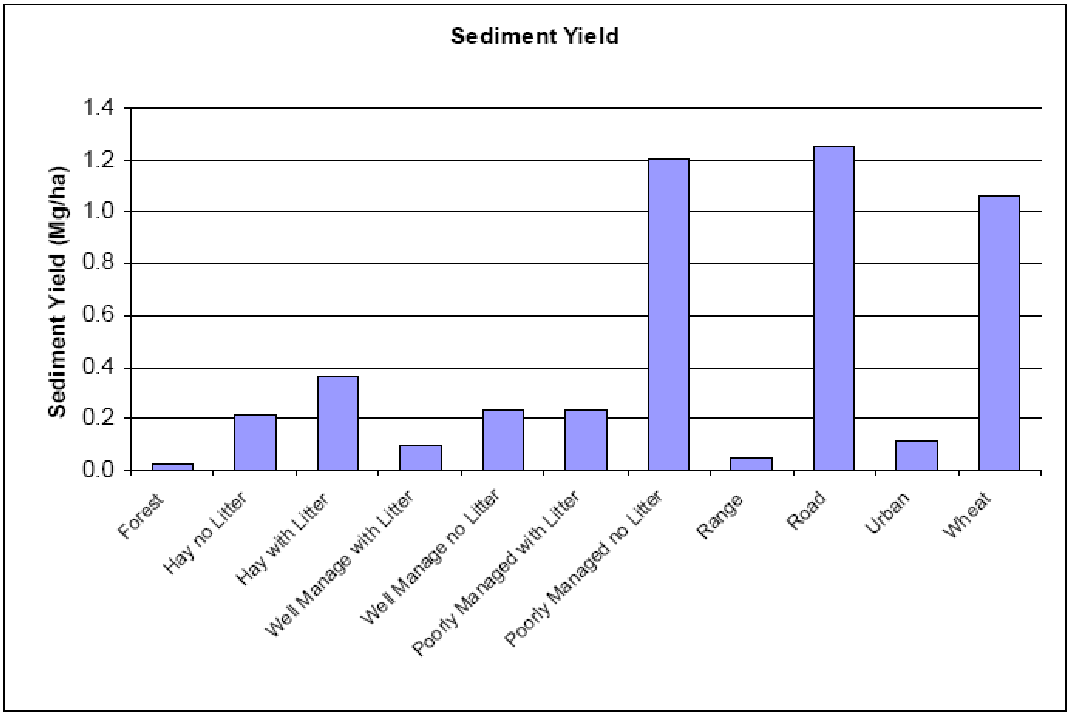


Figure 15. Sediment yield per unit area by source as predicted by the SWAT and instream models in the Illinois River watershed (Storm et al. 2006).

The application of poultry waste/litter onto pastures, whether well managed, poorly managed, or used only for hay production, resulted in high per unit area phosphorus loads (Figure 14). Unfertilized, poorly managed pastures also produced high per unit area phosphorus loads; the model predicted that well managed pastures receiving waste had a approximately the same per unit area total phosphorus load as unfertilized over-grazed pastures. However, this effect was probably due, at least in part, to elevated STP even in pastures without poultry waste application (Storm et al. 2006).

In a more recent modeling effort, Storm et al. (2010) were able to break down the nonpoint source activities more specifically than in the previous study. There are slight differences in total loads from specific sources (see Figure 16), with point sources contributing 40% of the phosphorus load, and pastures, poultry waste, and soil phosphorus contributing most of the remaining phosphorus. This effort included data from 1990 through 2006 and examined the entire Illinois River basin, including the

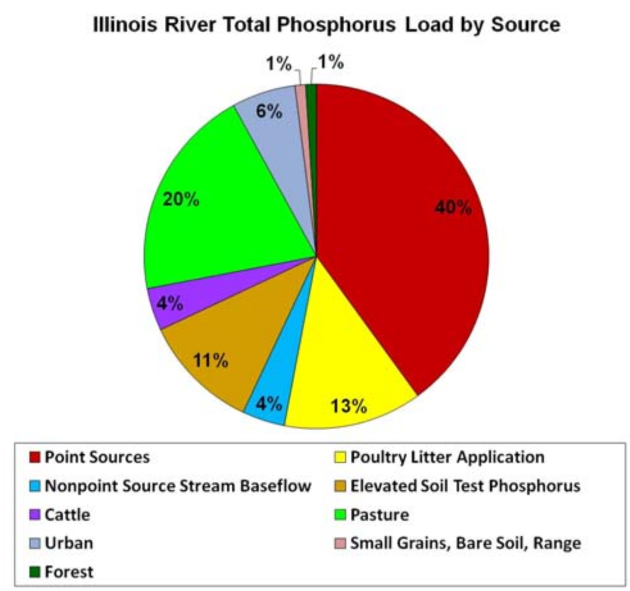


Figure 16. Total phosphorus reaching Lake Tenkiller by source as predicted by SWAT with new in-stream model (1990-2006) (from Storm et al. 2010).

Arkansas portion, using a new in-stream modeling component. As shown in Figure 17, the Arkansas portion of the watershed contributes more phosphorus from pastures and bare soil and less from urban areas than the Oklahoma portion of the watershed.

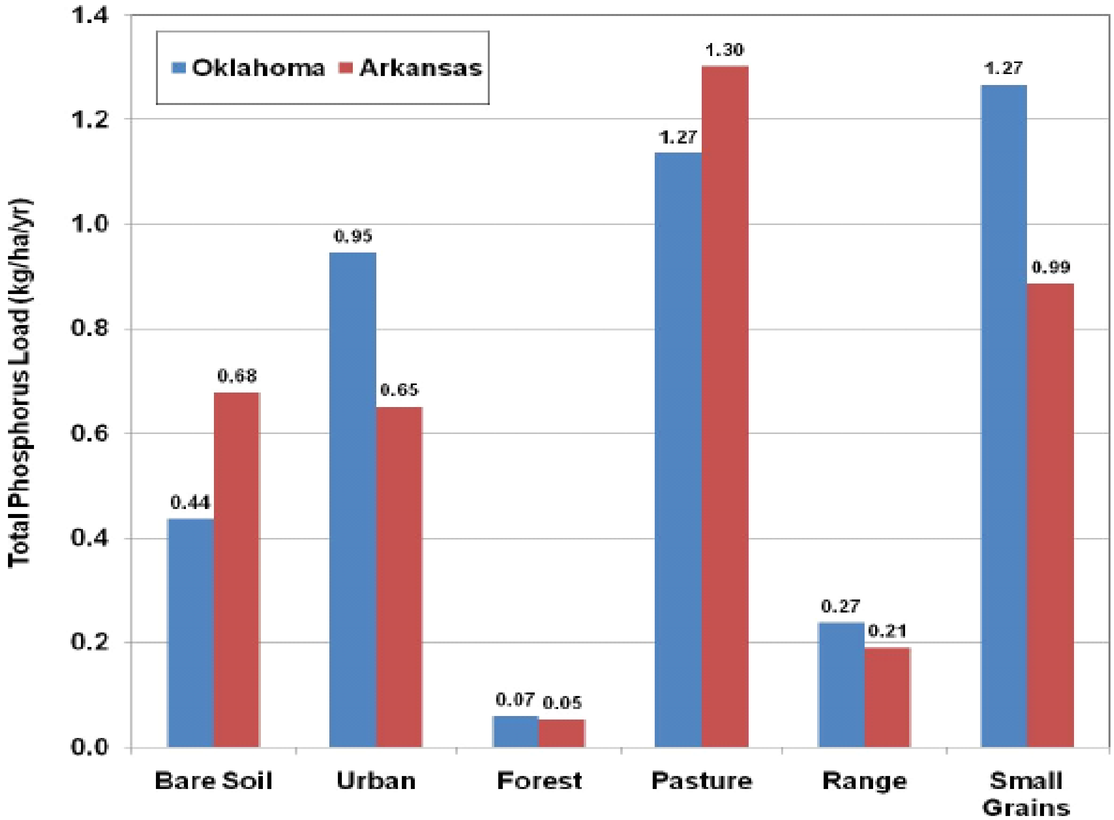


Figure 17. Upland total phosphorus load per unit area by land cover and by state as predicted by the SWAT model in the Illinois River basin (1990-2006) (from Storm et al. 2010).

The results of the Illinois River TMDL will be included in this WBP once it is released in order to further examine the impact of different sources on total phosphorus loads.

LOAD REDUCTIONS *(element b)*

Based on data from 1997 to 2001, an estimated 330,000 kg of total phosphorus per year reaches Lake Tenkiller, of which 88,000 kg/yr is in soluble mineral forms (Storm et al. 2006). The "Diagnostic and Feasibility Study on Lake Tenkiller" (OWRB 1996) estimated that a 70 to 80% reduction in total phosphorus loading would be required to produce a decrease in algal growth in the lake. An initial goal of 30 to 40% reduction of total phosphorus loading to Lake Tenkiller was agreed upon by the states of Oklahoma and Arkansas and was to be enforced by the Oklahoma-Arkansas Compact Commission. These recommendations were based on the phosphorus loading to the lake in the mid-1990s. Since the amount of phosphorus entering the watershed currently has increased, a larger reduction may now be necessary to achieve full attainment of beneficial uses; however, a reduction of 40% of the originally calculated load, or 132,000 kg/yr, will be the initial goal of this WBP. After the completion of the TMDL currently in development by the USEPA Region 6, expected in 2011, load reduction goals will be adjusted based on TMDL recommendations.

Modeling by Storm et al. (2006) suggests that reductions in total phosphorus from point sources are vital to achieving the 0.037 mg/L phosphorus criterion, and the authors conclude that point source discharges may need to be reduced to 0.25 mg/L to achieve that criterion. Barren Fork Creek is the only location where the phosphorus criterion is presently met, "almost certainly due to the lack of a major point source" (Storm et al. 2006). Table 41, below, indicates the relative contributions of phosphorus from five subwatersheds, and the locations of the gages are shown in Figure 18.

Table 42. Contributions of total phosphorus at subbasin gages in the Illinois River watershed (from Storm et al. 2006).

USGS Gage Station (ID)	Drainage Area (km^2)	Observed TP load (kg/yr)
Illinois River near Tahlequah (07196500)	2,253	215,912
Flint Creek near Kansas (07196000)	299	30,951
Barren Fork near Eldon (07197000)	806	67,668
Illinois River near Watts (07195500)	1,630	195,094
Illinois River near Chewey (07196090)	2,190	218,630

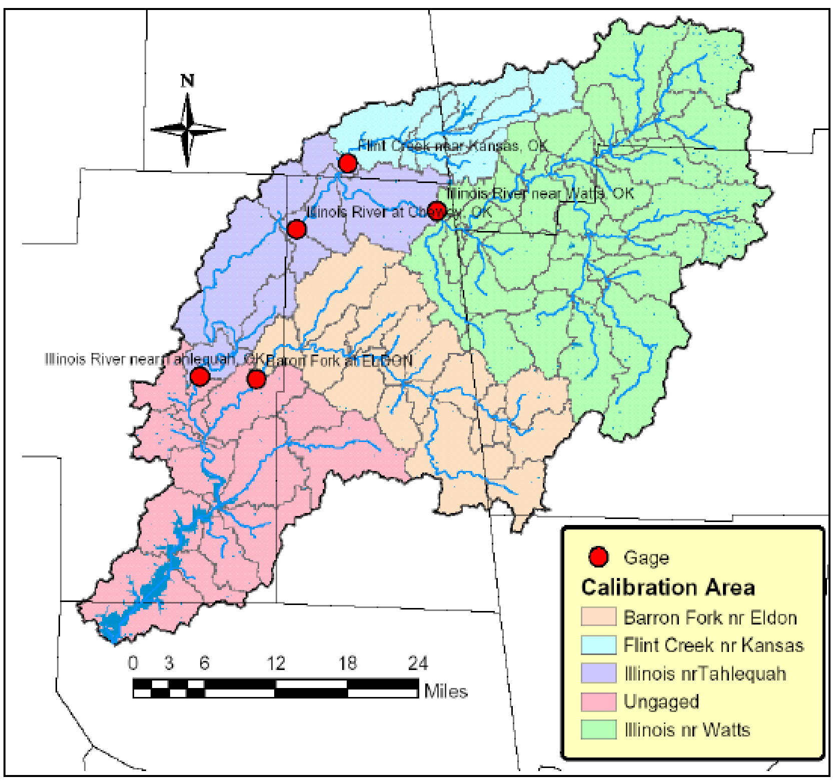


Figure 18. Locations of USGS gaging stations used to calibrate the SWAT model (Storm et al. 2006).

Storm et al. (2006) ran several different scenarios through a SWAT model in order to determine what practices would result in the required load reductions. They found that with 100% of the waste in the watershed exported rather than land-applied, three sites still had mean phosphorus above 0.037 mg/L. However, waste export would reduce the total phosphorus load in the watershed by approximately 15% (see below), a significant amount. Other possible practices and the expected reduction from each, as calculated by Storm et al. (2006), are presented below:

Practice or modification	***Reduction***
Export all poultry waste out of watershed, no land application	15%
No over-grazed pasture	6%
Replacement of poultry waste with commercial nitrogen (grazed hay pasture)	22%
Hay pasture only (no cattle)	21%
Hay pasture only (no cattle), replace poultry waste with commercial nitrogen	34%
Convert all pastures to forest	55%
No point source phosphorus discharge	35%
Halt all row crop/small grains cultivation	1%

If some of the above practices are combined, the following overall phosphorus reductions are possible, based on the model's predictions:

1) Convert some pasture to forest; eliminate all row crop/small grains, poultry waste application, cattle, and point sources; and cut pastures for hay only = will reduce the load by (34%+35%+1%) = 70%
2) Convert all pasture to forest; and eliminate point sources = will reduce the load by (55%+35%) = 90%
3) Eliminate all row crop/small grains, poultry waste application, cattle, and point sources; cut pastures for hay only; and convert 25% of pasture to forest = will reduce the load by approximately 75% ((90%-70%) * 25% + 70%)

Other fractional combinations of the above scenarios have the potential to produce the required load reductions as well. Table 42, below, shows the estimated phosphorus loads under various waste application rates and point source discharge concentrations. If only changes in waste application and point source discharges are considered, in order to achieve the 40% initial load reduction (to a maximum of 198,000 kg/yr), waste application rates must be reduced to at least 50% of the current rate, ***and*** point source discharges must be reduced to 0.50 mg/L or less. Table 43 shows total phosphorus loads based on several different management scenarios.

Table 43. Predicted phosphorus loads to Lake Tenkiller at various waste application rates and point source concentrations at the five USGS gages used in SWAT calibration (Storm et al. 2006).

Litter Application (Fraction of Current)	Point Sources (mg/l)	Soluble P Load kg/yr	Total P Load kg/yr
1	Current	88,209	330,019
1	1	44,451	258,996
1	0.5	26,397	236,158
1	0.25	16,814	224,781
1	0.1	10,634	217,989
1	0	5,459	213,522
0.75	Current	87,380	319,532
0.75	1	43,912	248,491
0.75	0.5	25,992	225,668
0.75	0.25	16,472	214,287
0.75	0.1	10,335	207,489
0.75	0	5,228	203,017
0.5	Current	86,323	306,896
0.5	1	43,243	235,845
0.5	0.5	25,496	213,040
0.5	0.25	16,058	201,648
0.5	0.1	9,985	194,838
0.5	0	4,955	190,351
0.25	Current	85,396	298,549
0.25	1	42,652	227,499
0.25	0.5	25,051	204,703
0.25	0.25	15,693	193,306
0.25	0.1	9,673	186,490
0.25	0	4,716	181,999
0	Current	83,902	282,164
0	1	41,682	210,991
0	0.5	24,325	188,183
0	0.25	15,111	176,772
0	0.1	9,175	169,935
0	0	4,342	165,429

Table 44. Total phosphorus load reaching Lake Tenkiller for different scenarios based on SWAT model predictions (1990-2006) (from Storm et al. 2010).

Scenario	Total Phosphorus Load (kg/yr)	Total Phosphorus Load Reduction (%)
Current Point Source Discharges		
0% Poultry Litter Export	206,175	0%
25% Poultry Litter Export	200,135	3%
50% Poultry Litter Export	192,586	7%
75% Poultry Litter Export	186,440	10%
100% Poultry Litter Export	178,705	13%
No Poultry Litter Export		
Current Point Source Discharges	206,175	0%
Point Source 1.0 mg/l total phosphorus	158,172	23%
Point Source 0.5 mg/l total phosphorus	144,671	30%
Point Source 0.1 mg/l total phosphorus	128,011	38%
Point Source 0.0 mg/l total phosphorus	123,777	40%
Current Point Source Discharges and No Poultry Litter Export		
No Cattle Production	197,607	4%
Conversion of All Wheat to Forest	193,261	6%
STP at Background/Forest Levels	184,794	10%
Conversion of All Pasture to Forest	107,000	48%
Conversion of 50% Pasture to Forest	156,693	24%
Current Point Source Discharges and 100% Poultry Litter Export		
All Pasture STP at Minimum 65 lbs/ac	178,724	13%
All Pasture STP at Minimum 120 lbs/ac	179,540	13%

Based on the 2010 study, Storm et al. found that Flint Creek was not likely to meet the 0.037 mg/L phosphorus standard even if no poultry waste (litter) was applied and the point sources discharges were eliminated. Hence, other management practices may need to be installed to allow attainment of water quality standards, as discussed in the following section. The standard could potentially be met at Tahlequah by reducing the point sources to somewhere between 0.1 and 0.5 mg/L total phosphorus. The standard could be met at Barren Fork at Eldon by reducing the point source discharges to 0.5 mg/l total phosphorus.

Other impairments in the watershed are expected to improve concomitantly as a result of the implementation of the suggested practices to reduce phosphorus. Load reductions have not yet been calculated for bacteria, and the WBP will be amended accordingly as these estimates are completed. The following section of the WBP addresses the management measures necessary to achieve the initial and long-term load reductions.

NPS MANAGEMENT MEASURES (PAST and ONGOING) *(element c)*

Despite the extensive efforts to **assess** the condition of the Illinois River and the sources of pollution in the watershed, basin-wide plans to **address** pollution sources have only recently been adopted. Attempts to improve river quality should be based upon a comprehensive approach covering the entire basin; however, political history indicates that a diversity of opinion exists concerning pollution sources and their relative contribution to the problem, and this has hindered some attempts at cooperative management plans. The TMDL will help determine the types and extent of management measures necessary in the watershed, but for now, management measures are based on modeling by Storm et al. (2006; 2008) and on observations obtained from previous work in both the Illinois River watershed and similar watersheds in the state.

The focus of the proposed management measures discussed in this WBP will be nonpoint source issues, although, as already discussed, point source improvements are essential to successfully attaining significant improvements in water quality. Much of this section of the WBP is derived from the "Comprehensive Basin Management Plan for the Illinois River Basin in Oklahoma" (OCC 1999a), and many of the proposed management measures are extensions of ongoing programs in the Illinois River watershed. It is recognized that not any one activity could realistically result in the required substantial phosphorus reduction; instead, numerous strategies and agencies will have to work together to achieve restoration of beneficial uses in this watershed. **Riparian protection and streambank stabilization will be essential tools toward reducing nonpoint source pollution and will be the sole focus of BMP implementation in the watershed through this plan until the release of the TMDL. Following release of the TMDL, implementation design will be revisited and this plan will be updated accordingly.**

Successful load reductions have resulted in similar watersheds where riparian protection has been a key element, and estimates of load contributions from streambank erosion in this watershed support the necessity of reducing erosion to reduce nutrient loads. In addition, the high stream density in this watershed means that nearly every significant potential source activity is in close proximity to a stream, and there is a strong relationship between alluvial aquifers and instream concentrations. Analysis of predicted loading rates from watershed models indicates that areas with intermittent streams often play a critical role in load delivery to streams. Hence, widespread riparian buffer restoration has been and will continue to be one of the primary goals of implementation.

Objectives of ongoing and future projects include:

- Implement practices in the Illinois River Watershed that will reduce nutrient loading to help meet load reduction goals;
- Support the Oklahoma Conservation Reserve Enhancement Program (CREP) to protect riparian areas with the greatest potential to reduce nutrient loading;

- Implement streambank stabilization projects to reduce streambank erosion and improve aquatic habitat in the Illinois River Watershed;
- Support the developing poultry waste transport industry by subsidizing waste movement out of the watershed toward non-nutrient threatened watersheds in Oklahoma;
- Promote alternative uses of poultry waste such as the waste to energy project;
- Provide technical assistance to producers in the development of total resource conservation plans.

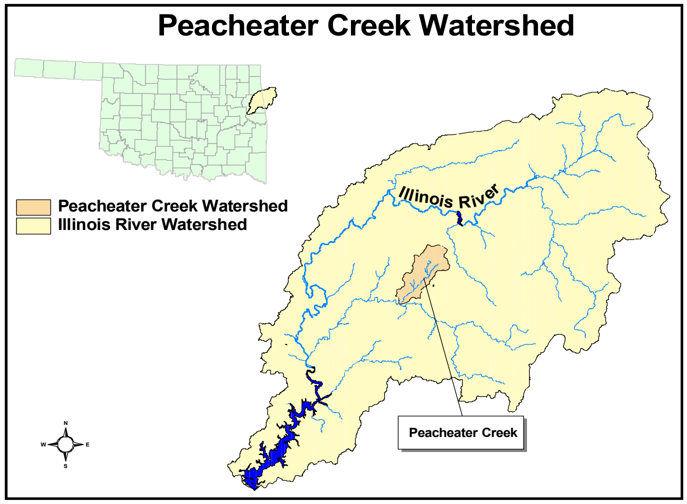
Past OCC Projects

In the early 1990s, the OCC began to develop implementation projects in the Illinois River watershed. The OCC has maintained a presence in the area almost continuously since this time. The lessons learned through these early projects have guided successive projects and continue to be useful in developing the larger-scale implementation effort being applied to the entire Oklahoma portion of the Illinois River watershed.

The first OCC implementation project began in 1990 in the **Battle Branch** watershed, part of the larger Flint Creek watershed. Best management practices (BMPs) focused on nutrient management, specifically the development of conservation plans and waste management plans and the installation of rural wastewater systems, poultry composters, waste storage structures, and riparian tree plantings. Approximately 84% of the landowners in the watershed participated in this three year project, which was a significant factor behind its success. The project resulted in significantly reduced nutrient concentrations, with nitrate levels during runoff decreased as much as 72 percent and total phosphorus levels as much as 35 percent in this subwatershed (OCC 1993).

The **Barren Fork** Watershed Implementation Program began in 1996 and was continued in 1999. The goal of the project was to implement practices to reduce nonpoint pollution from the most significant sources in the Illinois River watershed. The program was implemented through the local conservation district under the direction of the OCC. A Watershed Advisory Group (WAG) was assembled to determine acceptable cost-share rates for BMPs. Then, animal waste management and farm plans were developed for and implemented by producers in the area. Practices were prioritized, with the highest priority category being “Riparian Area Management and Establishment.” “Animal and/or Human Waste Management Systems” and “Pasture Management” were also areas addressed by BMPs. While significant improvements in water quality were not observed during the project period, it was estimated that the practices implemented in this program could ultimately reduce phosphorus loading from this subwatershed by as much as 30% (OCC 2004).

Additionally, the OCC developed and implemented a very successful **National Monitoring Program Paired Watershed Project** in the 1990s. Implementation of this program provided information on the effectiveness of specific BMPs and on the type of monitoring necessary to document water quality improvement. Specifically, monitoring was conducted from 1995-1998 both in the Peacheater Creek watershed, a small subwatershed in the Illinois River basin where BMPs were to be installed, and in a control watershed (Tyner Creek), where no management measures were planned. Best management practices were implemented from 1998-2002 in the Peacheater watershed, and then post-implementation monitoring was performed from 2002-2005. Monitoring results showed significant improvements in the Peacheater area relative to the Tyner Creek basin. Implementation of BMPs resulted in a 71% decrease in expected total phosphorus loading to Peacheater Creek, as well as significant reductions in nitrogen loading. Streambank erosion was also reduced significantly due to the BMPs implemented in the project. This project was nationally recognized by the USEPA for significantly improving water quality. Details on this project can be found in several reports (OCC 1999b; OCC 2006; OCC 2007).



Ongoing / Planned Projects

In 2007, the OCC began the **Illinois River Watershed 319 Riparian Protection Project** to complement a $20,652,500 **Conservation Reserve Enhancement Program (CREP)** which was initiated in the Illinois River watershed and the neighboring Eucha/Spavinaw watershed in April 2007. The CREP, a partnership between the USDA Farm Services Agency (FSA), the state of Oklahoma, and local entities, provides 15-year contracts for the establishment of 9,500 acres of riparian buffers and filter strips which will reduce nutrient, sediment, and bacteria loadings to the streams and lake. It was vital to partner the 319 program with the federal CREP in order to increase the overall effectiveness and practicality of both programs. The FSA funds, which constitute approximately 80% of the CREP, can only be used for implementation of riparian practices and must be available on a first-come, first-served basis according to NRCS specifications. The FSA does not pay for riparian establishment in areas with existing trees. Since few, if any, producers have floodplain pastures that do not have at least pockets of trees, the landowners are responsible for fencing through these areas and are not eligible for rental payments from these areas. This significantly decreases the impact of the incentive on CREP-eligible areas and, thus, reduces producer interest in the program. The 319 program enhances CREP enrollment by cost-sharing on riparian practices that are not eligible for CREP funding such as fencing through wooded areas, alternative watering supplies further than 1500’ from the stream (to encourage use of upland pasture for grazing and floodplain pastures for haying), and winter feeding facilities. The CREP program would be largely unsuccessful in these types of watersheds without additional funds to pay for riparian protection in non-CREP eligible areas, and some of the most critical areas of nonpoint source pollution in the watershed would remain without BMPs.

The goal of the collaborative 319/CREP riparian protection projects is to target protection of the most critical riparian areas in the watershed either by extending the intermittent stream cost-share rate to the level of perennial streams or by enrolling non-CREP eligible land in a fifteen year protection agreement. The 319 project coordinator is working with the State CREP Coordinator to include landowners in the most critical areas of the watershed in the program. Implementation funding is based on a ranking system (Appendix A) which allows for high priority, "targeted" areas to receive implementation before lower, non-targeted areas are funded. Once those landowners in critical areas have been afforded the opportunity to participate, remaining available monies will be available for non-CREP eligible landowners who are not necessarily in areas that are currently critical but who have riparian areas that may be in danger of development during the next fifteen years. Implementation of these programs collaboratively could result in at least a 9% reduction in phosphorus loading (21% of the 40% overall reduction goal) and a 10% reduction in nitrogen loading to the watershed.

The ranking system used for prioritizing areas for BMP implementation is based on a study by Storm et al. (2008) which identified areas in the watershed that should be targeted for riparian buffer establishment. The study evaluated the effectiveness of riparian buffers at all potential sites within the watershed in order to guide placement of buffers in targeted areas to generate the most environmental benefit per dollar spent. The watershed was divided into 117 transects (Figure 19), and then the results of the modeling effort were overlaid onto 2001 NLCD aerial photos of each transect to identify areas likely to benefit from riparian buffers (Figure 20). Areas with little vegetation or erosive land uses were natural candidates for riparian BMPs. Targeting was primarily based on land cover within the riparian zone. Other metrics considered included stream sinuosity, measured migration, and flow accumulation.

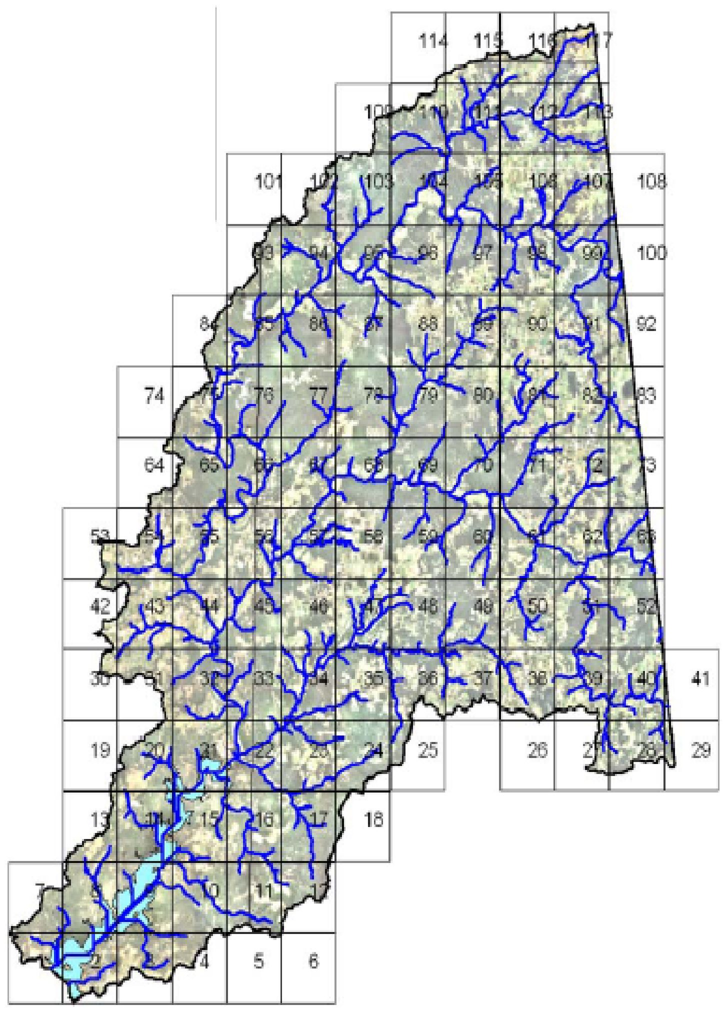
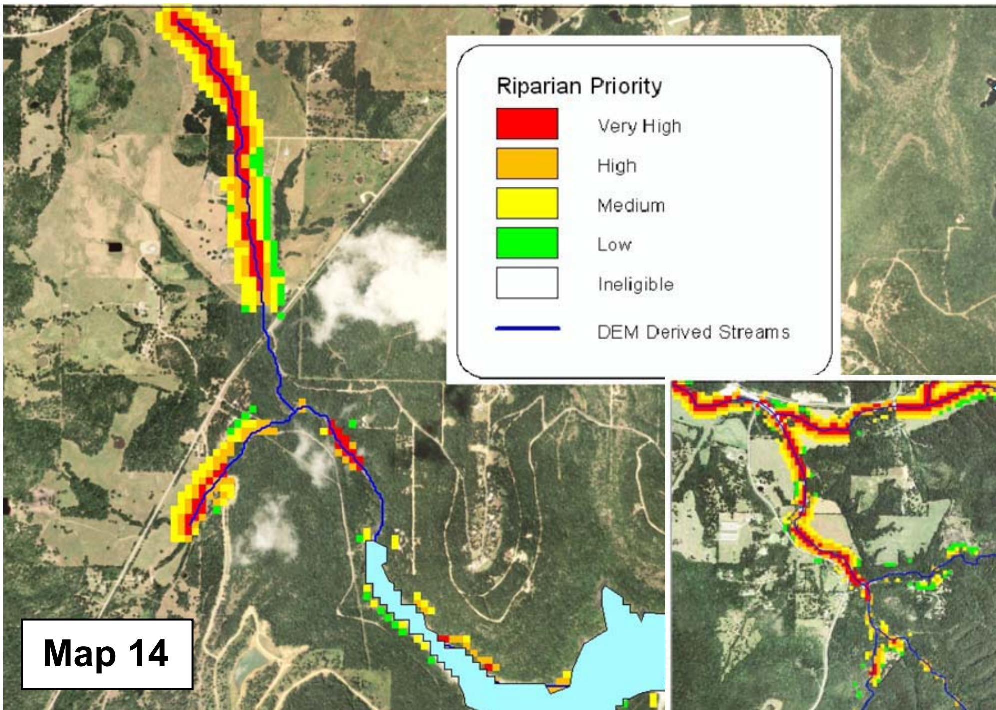


Figure 19. Index map for riparian targeting book delivered to the Oklahoma Conservation Commission for field use (Storm and White 2008).



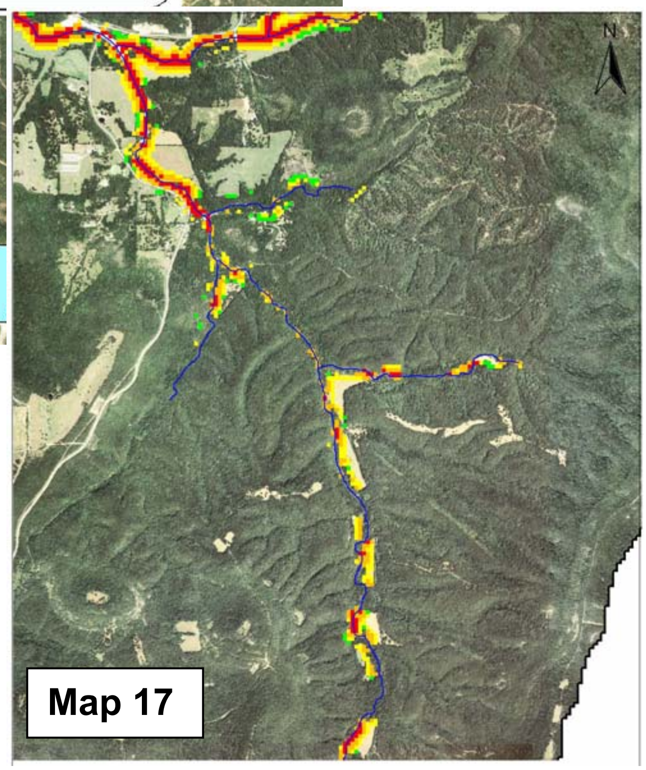


Figure 20. Example of modeling result for riparian targeting. Riparian area targeting is overlaid on color aerial imagery (Storm and White 2008).

A book of the 117 individual 8.5" x 11" color targeting maps (see example in Figure 20) was produced, which covered the entire Oklahoma portion of the Illinois River Basin (Storm and White 2008) and given to the Oklahoma Conservation Commission for use in field offices or other locations where access to computers and GIS software was limited. OCC project staff have used and continue to use these detailed maps to rank funding for riparian area BMPs in the watershed.

Recent research regarding subsurface nutrient transport in the watershed suggests that rotational grazing may be critical to reducing nutrient loading to the system. Therefore, in addition to riparian protection practices, the 319 program is offering cross-fencing in pastures and alternative water supplies in cross-fenced areas as an incentive for landowners to sign a CREP contract. Landowners must protect riparian areas before they can sign up for cross-fencing in order to eliminate the potential for landowners to participate only to get cross-fencing and then back out from the riparian protection at a later date.

CREP currently has over 300 acres of riparian land enrolled in the Illinois River watershed, with approximately 600 additional acres pending. The 319 project has also been very successful and has fully obligated all available funds. This project has currently installed over one million dollars of BMPs (Table 45). The primary focus of the current 319 program is riparian area establishment, but once livestock are fenced out of this area, alternative water supplies must be provided. In addition, proper pasture management must be encouraged in addition to proper waste management, so the BMPs being implemented reach beyond just the riparian area, as shown in Table 45 below. Based on STEPL model predictions, the BMPs implemented just in 2009 are estimated to have reduced phosphorus loading by 1,766 lbs/year, nitrogen loading by 16,187 lbs/year, and sediment loading by 229 tons/year. In addition, the program has generated a waiting list of at least another $600,000 worth of practices.

Table 45. Best Management Practices installed through the 2007 Illinois River 319 Riparian Protection Project.

General BMP Category	**Best Management Practices**	**Total Installed 2008-2009**
Riparian establishment	Riparian acres protected	352.7
	Riparian fencing (feet)	11,320
Alternative water supply (aids riparian and pasture management)	Ponds	2
	Watering tanks	30
	Wells	8
Pasture management	Cross-fencing (feet)	22,445
	Heavy use areas (gravel or concrete)	48
Waste management	Waste storage / Winter feeding facilities and Cake-out waste storage buildings	9
	Rural waste replacements (septic systems)	37

The implementation plan for this 2007 project, which shows implementation guidelines for all BMPs offered as part of the ongoing project, as well as a ranking sheet to prioritize implementation, is included as Appendix A (page 148). This implementation plan will allow evaluation of the completeness of the initial effort such that a follow-up effort can be developed as necessary to target producers who did not participate initially but who could have a significant impact on water quality in the watershed. This plan has been presented to NRCS (at the state and local levels) in an attempt to facilitate cooperation between the 319 program and the use of CREP and EQIP funds, as well as other agencies implementing agricultural BMPs in the watershed, such as ODAFF (see below).

The long-term commitment of the OCC has helped to change attitudes in the watershed. Interest in the cost-share program continues to exceed the funding available for BMP implementation, so OCC will extend the 319 Riparian Protection Project. In future projects, the OCC will continue to implement similar BMPs, with the results from the TMDL modeling incorporated into the targeting of high priority areas for BMP implementation.

Management measures that may be promoted in future projects, depending on TMDL recommendations, include:

(1) nutrient management / soil testing
(2) buffer zone establishment, to include fencing
(3) heavy use areas
(4) animal waste storage facilities/composters
(5) no-till farming/conversion of cropland to forest
(6) pasture management/pasture establishment
(7) riparian establishment, to include fencing, vegetative establishment, off-site watering, and livestock shelters
(8) streambank stabilization, to include fencing and vegetative plantings
(9) on-site wastewater systems (septic systems)
(10) export of waste from the watershed


Poultry waste storage

The OCC has secured two million dollars in American Recovery and Reinvestment Act (ARRA) funds to implement streambank stabilization projects in the Illinois River and Eucha-Spavinaw watersheds (approximately one million dollars to be spent in each watershed). Currently, the OCC, the Oklahoma Department of Wildlife Conservation (ODWC), and other partners are compiling a list of all eroding streambanks where landowners are seeking assistance. A prioritization scheme is being developed to ensure that funds target the most environmentally significant of those sites to achieve maximum water quality benefits. The OCC and ODWC will use the principals of fluvial geomorphology to restore the natural structure of the streams and stabilize the eroding banks in order to improve water quality, improve fish habitat, and protect infrastructure such as roads and bridges that are threatened by eroding streams. Oklahoma Department of Agriculture, Food, and Forestry (ODAFF) foresters may assist landowners with tree planting recommendations and follow-up assistance in support of this project. Site locations will be included in the WBP once these have been selected.

Other programs have also helped to address the pollution issues in the Illinois River basin. Currently, the EQIP program is active in this watershed and has been for several years. In 1997, the Illinois River/Barren Fork Creek watershed was designated as a "priority area" by the NRCS, and, in 2000, a portion of the Illinois River basin was designated as a "special emphasis" area (the Cherokee Nation Tribal Lands). Proposed activities supported by EQIP focus on waste management plans which will detail waste production and application/disposal, especially at the numerous poultry houses and dairies in the area. Practices include but are not limited to: composters, cakeout storage structures, nutrient management, pest management, and waste utilization. Small areas of streambank erosion are being addressed in order to protect and improve water quality. Priority is given to water quality concerns over all other resource concerns, with the goal of this program to improve water quality in the Lake Tenkiller watershed.

Past efforts to improve the water quality of the Illinois River have included cooperative programs between the OCC and Oklahoma Scenic Rivers Commission (OSRC) to reduce nonpoint source pollution from recreation activities on the river. These projects included installation and maintenance of restroom, picnicking, and trash collection facilities along the river to reduce the impacts from canoers and other river users. Another project involved cooperation with Oklahoma State University (OSU) to reduce pesticide and nutrient pollution from plant nurseries in the watershed by collecting and recycling irrigation water rather than letting it run offsite.

The Oklahoma Scenic Rivers Commission (OSRC) developed a management plan for the river corridor (generally the land within 1/4 mile on either side of the river; includes the Illinois River from the Oklahoma state line downstream to the confluence with Barren Fork Creek, along with its two major tributaries, Flint Creek and Barren Fork Creek) in 1998 (OSRC 1998). Many of the ideas in this plan are applicable basin wide and, hence, some measures will be extended to the larger watershed. In addition, the state of Arkansas is developing a watershed based plan which, when combined with Oklahoma's plan, will provide a complete Illinois River Basin management plan.

The Oklahoma Department of Agriculture, Food, and Forestry (ODAFF) has set a goal of reducing 100% of the agricultural-related pollution in the scenic river watersheds within 10 years (OSE 2006). In support of this goal, ODAFF is currently 1) assisting poultry growers in developing Animal Waste/Nutrient Management Plans; 2) ensuring compliance with these plans; 3) testing soil samples for STP; 4) exploring cost-effective alternative ways to dispose of excess poultry waste; 5) coordinating with other agencies to develop Comprehensive Nutrient Management Plans for point and nonpoint sources in impaired watersheds. In April 2005, ODAFF signed a Cooperative Agreement with NRCS to develop Comprehensive Nutrient Management Plans (CNMP) for Poultry Feeding Operations (PFOs) located in the eastern part of the State, including those in the Illinois River watershed. Growers are required to sign and follow the directions and BMPs described in the CNMP in storing, handling, and land-applying waste. Recently, ODAFF applied for a Pollution Prevention (P2) grant with USEPA Region 6 to provide technical assistance and on-site training to PFO growers in efficiently implementing the BMPs and strictly following the land application rates and setbacks recommended in the CNMPs. Soil samples of the fields where waste is applied will also be collected for Soil Test Phosphorus (STP) analyses for inventory purposes, as well as to verify the actual STP levels compared to the projected ones. The grant has been approved by USEPA, and the three year project will start in November 2010.

ODAFF's Forestry Division completed the Oklahoma Forest Resource Assessment in 2010 (ODAFF 2010c). The State Assessment is a comprehensive analysis of the state's forestlands and associated resources. It identified six critical issues likely to affect the long-term health and sustainability of the state's forests, one of which deals with water. The Assessment also identified priority forestland areas, including the Illinois River Watershed, which the agency will use to focus its resources in the next five years. The companion document, the Oklahoma Forest Resource Strategy, describes specific goals, objectives, and strategies that will address the critical issues.

Considerable attention will be directed toward forestry BMP implementation. As discussed in the section on sources of pollution, roads have a high potential to contribute to sediment loadings if constructed and maintained without appropriate BMPs. Proper application of forest road BMPs controls surface runoff, reduces channelized flow, reduces sediment production, and minimizes stream impacts. These practices should be recommended as preventive measures on all unpaved roads.

Arkansas passed legislation in 2003 that regulates poultry waste as well as other nutrient sources in sensitive watersheds. Poultry growers are required by law to have a comprehensive nutrient management plan and must be trained and certified to spread waste. Waste application is now based on soil test phosphorus rather than on nitrogen, as in the past. Oklahoma and Arkansas signed a "Statement of Joint Principles and Actions" in 2003 which focused on efforts by both states to reduce phosphorus loading in Scenic River watersheds.

Improvements in point source discharges have been implemented and are expected to continue improving. Arkansas municipalities have agreed to upgrade treatment facilities to meet the 1.0 mg/L effluent limit for phosphorus which is mandated for Oklahoma municipalities, and some cities are below that limit already. In Oklahoma, the following "urban" efforts will be or are being undertaken to further improve the water quality of Scenic Rivers in Oklahoma:

- Tahlequah WWTP has a reduced phosphorus limit of 1.0 mg/L
- Tahlequah has applied for a MS4 stormwater permit
- Westville WWTP reduced its phosphorus limit to 1.0 mg/L by constructing a new WWTP

Storm et al. (2010) estimated the average annual total phosphorus load based on projected 2020 land cover changes and the addition of two proposed point sources at Bentonville and Osage. These two proposed new point sources have now been combined into a single WWTP, the Northwest Arkansas Conservation Authority WWTP, which will be operational by the end of 2010. Table 46 shows the average annual loads at Lake Tenkiller, Flint Creek, Tahlequah, Barren Fork and the six sites at the Arkansas-Oklahoma state line. With the new land cover projections, the loads increased at each site except for Flint Creek and one of the Barren Fork tributaries at the state line. The phosphorus loads at Lake Tenkiller, the Illinois River at Tahlequah, and the state line increased with the addition of the new WWTP in Arkansas. Surprisingly, the model predicted a decrease in total phosphorus load when high soil test phosphorus (STP) pasture was converted to low STP urban; although urban areas produced higher runoff volumes, the reduced STP had a greater effect on total loading.

Table 46. Annual total phosphorus loads for 1990-2006 SWAT model, 1990-2006 SWAT model with two new point sources, and 2020 SWAT model with land cover change projections.

Stream/River (Subbasin Number)	Total Phosphorus Load (kg/yr)		
	1990-2006 SWAT Model	1990-2006 SWAT Model with New Point Sources	2020 SWAT Model with Projected Land Cover Changes
Tenkiller Lake (68)	206,175	208,935	243,361
Flint Creek (79)	45,472	45,472	44,995
Illinois River at Tahlequah (80)	217,815	221,281	254,641
Baron Fork at Eldon (83)	64,343	64,343	73,417
At State Line			
Flint Creek (62)	7,416	7,416	8,181
Flint Creek Tributary (61)	5,613	5,613	6,141
Illinois River (64)	177,211	180,672	192,356
Illinois River Tributary (65)	6,603	6,603	7,403
Baron Fork Tributary (66)	18,995	18,955	18,205
Baron Fork Tributary (67)	2,685	2,685	2,843

CRITERIA *(element h)*

The ultimate goal of this WBP is to reduce the total phosphorus loading to the Illinois River and Lake Tenkiller by approximately 80% per year, as well as reduce the pathogen and sediment loads, so that all designated uses of waterbodies in the watershed are fully attained. These goals are guided by the water quality criteria described in this section, all of which are based on Oklahoma's Water Quality Standards (OWRB 2008a). The interim target for improvement is a 40% reduction in total phosphorus, which corresponds to 132,855 kg/yr.

Designated beneficial uses for the Illinois River and its tributaries include public and private water supply (PPWS), fish and wildlife propagation (FWP; some cool water aquatic community (CWAC), some warm water aquatic community (WWAC)), agriculture, primary body contact recreation (PBCR), aesthetics, and fish consumption.

Lake Tenkiller is designated for WWAC, agriculture, PBCR, aesthetics, PPWS, hydropower, and fish consumption.

In addition, a number of the streams or stream segments are designated as outstanding resource waters (ORW), and the Upper Illinois River from Tenkiller Dam to the Barren Fork confluence also has high quality water (HQW) and nutrient limited watershed (NLW) designations. Segments of the Illinois River, Barren Fork Creek, and Flint Creek are classified as state scenic rivers.

As shown in Table 35, a number of impairments exist in the watershed which have prevented the attainment of all designated uses. Only criteria relevant to the waterbody impairments in the watershed are presented below. These criteria stem from Oklahoma's Water Quality Standards (OWRB 2008a). The procedures by which the data must be collected and analyzed to verify whether or not these criteria have been met are identified in Oklahoma's Use Support Assessment Protocols (OWRB 2008b). Both of these documents fall under the jurisdiction of the Oklahoma Water Resources Board.

The initial goal of the WBP is to reduce the phosphorus loading to Lake Tenkiller by approximately 40%. Although this reduction is not predicted to result in complete designated use attainment, significant improvement should result once this goal is attained. The recommended 70-80% total phosphorus load reduction, estimated to result in complete attainment of the 0.037 mg/L total phosphorus criterion, is based on the following, according to Oklahoma's Water Quality Standards (OWRB 2008b):

To attain **Aesthetics** use for **lakes**:

- Nutrients (Phosphorus). Must have a Carlson's trophic state index (TSI) below 62, based on a minimum of 20 chlorophyll-*a* samples.

To attain **Aesthetics** use for **streams**:

- Phosphorus. In waters designated "Scenic River," data shall include samples from at least six storm events per calendar year, or, if fewer than nine storm events occurred in that year, the majority of the storm events that occurred that year must be sampled. The three-calendar-month thirty-day geometric mean concentration (that month together with data from preceding two calendar months) shall not exceed 0.037 mg/L total phosphorus. In addition, no more than 25% of samples shall exceed 0.037 mg/L total phosphorus, based on a minimum of 10 samples.

To attain **Primary Body Contact Recreation** use:

Samples must be collected during the recreation season, from May 1-September 30, and at least 10 samples are required to make an attainment assessment.

- Fecal coliform bacteria
    a) No more than 25% of total samples will exceed 400 colonies/100 ml
    b) Geometric mean of less than 400 colonies/100 ml

- *Enterococcus* bacteria
    a) No sample shall exceed 406 colonies/100 ml
    b) Monthly geometric mean of less than 33 colonies/100 ml
- *Escherichia coli* (*E. coli*)
    a) No sample shall exceed 406 colonies/100 ml
    b) Monthly geometric mean of less than 126 colonies/100 ml

To attain the **Public and Private Water Supply** use:

- Nitrates. No more than 10% of the samples shall exceed 10.0 mg/L for nitrate as nitrogen
- Bacteria. In cases where both public and private water supply and primary body contact recreation uses are designated, as is the case in this watershed, the primary body contact criteria applies (see above)
- Chlorophyll-*a*. The long term average chlorophyll-a concentration at a depth of 0.5 meters below the surface shall not exceed 0.010 milligrams per liter in…Tenkiller Ferry Reservoir nor any water body designated SWS (Sensitive Water Supply)…Wherever such criterion is exceeded, numerical phosphorus or nitrogen criteria or both may be promulgated.

To attain **Fish and Wildlife Propagation--Cold Water Aquatic Community** use:

- Turbidity. No more than 10% of samples shall exceed 10 NTUs, based on a minimum of 10 samples

To attain **Fish and Wildlife Propagation--Warm Water Aquatic Community** use for **lakes**:

- Dissolved oxygen (DO)
  a) A minimum of 50% of the lake water column must have a DO concentration of at least 2.0 mg/L, based on a minimum of 20 samples **AND**
  b) At least 90% of the surface samples, defined as the top 5 to 10 percent of the water column, must have a DO concentration of at least 5 mg/L (or 4.0 mg/L from June 16-October 15)

To attain **Fish and Wildlife Propagation--Warm Water Aquatic Community** use for **streams**:

- Biological criteria. Biological criteria have been established for various ecoregions in eastern Oklahoma. Fish communities, measured by indices of biotic integrity (IBIs), shall not exhibit degraded conditions as indicated by one or both of the following:
  a) Comparative regional reference data from a station of reasonably similar watershed size or flow, habitat type, and FWP designation
  OR
  b) Comparison with historical data from the waterbody being evaluated

The State criteria are evaluated every two years to produce the Integrated Report which includes the 305(b) and 303(d) lists. Any improvement in the parameters described above will be considered indicative of progress toward success in the watershed.

An annual report will be submitted to EPA Region 6 detailing the progress of the 319 project toward meeting goals as described in the workplan. Effects of implementation programs in the watershed on phosphorus, nitrogen, and sediment loading to Lake

Tenkiller from the various sources will be evaluated and reported to EPA every year in the Grants Reporting and Tracking System (GRTS). This system uses a STEP-L model to estimate load reductions due to implementation in addition to reporting on rates of new cooperator sign-ups for BMP installation, rates of BMP contract completion, and rates of practice installation.

In addition, the OCC's annual report to EPA will summarize the progress of any ongoing 319 programs in the watershed. Approximately every three to five years (or at the end of each project), the level of implementation and load reductions achieved through the project will be examined to determine whether any changes in strategy need to be instituted to continue progress toward the long-term goals in the watershed. Following that evaluation, this Watershed Based Plan will be revised to reflect new information and address short-comings identified with earlier plans.

It is expected that complete attainment of the water quality criteria will not occur for several years after implementation of BMPs, especially in the lake itself, since there is a lag time between BMP implementation and observable water quality changes, especially in large waterbodies. After release of the TMDL, more specific interim criteria can be set.

The OCC will continue to use a paired watershed approach, comparing water quality from runoff events in a control watershed with water quality from watersheds located within implementation project areas, or comparing upstream data with downstream data, to estimate the loading reductions resulting from BMP implementation (see monitoring section for further details). As future projects are implemented by the OCC or other entities, the WBP will be updated, and expected load reductions will be calculated. Data from ambient monitoring in the watershed will be assessed on a regular basis and compared with modeling results to determine whether progress is being made and whether revisions implementation plans are necessary.

PUBLIC OUTREACH *(element e)*

The success of the water quality assessment and enhancement programs in the Illinois River watershed depends upon widespread public support and buy-in and involvement of stakeholders. This section identifies agencies, organizations, and services that have been or are already active in the watershed or that will be asked to participate in the project. These groups will help develop the WBP and assist in other planning efforts in the watershed to varying degrees.

The specific roles of the groups and programs which are likely to contribute to the public outreach efforts in the Illinois River Watershed are summarized in no particular order below:

1. Local Conservation District Offices – Oklahoma and Arkansas

   The Adair County CD, Cherokee County Conservation District (CD), and

Delaware County CD, in partnership with the OCC, NRCS, and OSU Cooperative Extension Service (OCES), will be among the primary agencies responsible for public outreach in the Oklahoma portion of the watershed. The districts and NRCS work one-on-one with citizens of the watershed to reduce pollution and educate about the importance of protecting water resources, and, thus, will be crucial to the promotion of the 319 program. In addition, the Conservation Districts must approve the cost-share rates and BMPs that are offered through any project.

Some of the specific public outreach objectives of the project which will be addressed by the conservation districts are to: 1) promote consistency in animal waste plans written in Oklahoma and Arkansas; 2) promote protection and re-establishment of buffer zones and riparian areas; 3) provide technical assistance to producers in the development of total resource conservation plans; 4) provide educational and technical assistance to producers through producer meetings, workshops, and individual contacts; and 5) demonstrate management practices in the watershed to achieve the nutrient control needed to protect Lake Tenkiller.

2. Illinois River Watershed Advisory Group (WAG)

An Illinois River Watershed Advisory Group (WAG) was established by the OCC in 1999 to give guidance on the implementation program in the watershed. The WAG consisted of 16 local shareholders representing multiple interests in the watershed (2 poultry producers, a poultry integrator, a nursery representative, a homeowner in the watershed, a cattle producer, a dairy producer, a minority representative, a river recreational outfitter rep, City of Tahlequah staffer, Lake Tenkiller representative, environmental representative, Scenic Rivers Commission staffer, and forest landowner). Members of the WAG helped direct the 319 program based on information supplied to them by technical agencies and their knowledge of the needs of the watershed residents. The WAG discussed issues in the watershed, decided how to best promote BMP implementation, and recommended a series of practices and cost-share rates to be offered as part of the 1999-2004 BMP demonstration effort. Those recommendations formed the basis of the Watershed Restoration Action Strategy (WRAS), which is the document upon which this current WBP is based. The WAG helped insure that the 319 program worked effectively and efficiently toward reducing water quality impacts but, at the same time, met the needs of and was acceptable to the local producers and other landowners. Producers on the WAG contributed significantly toward local education through a "show and tell" approach.

In addition to the WAG, an EdWAG (Education Watershed Advisory Group) was formed during the 1999 project. This group guided education efforts in the watershed, and again, the ongoing educational programs in the watershed are based on the original suggestions of the EdWAG. If the TMDL identifies additional BMPs that should be implemented to achieve load reductions, a WAG may be reconvened to determine how to implement new practices.

3. NRCS Local Offices – Oklahoma and Arkansas

The United States Department of Agriculture Natural Resource Conservation Service (USDA/NRCS) has been involved with the Illinois River watershed as part of the Environmental Quality Incentives Program (EQIP) since 1997, when the watershed was designated as an EQIP Priority Area. In addition, part of the watershed is located in a NRCS special emphasis area, the Cherokee Nation Tribal Lands. Funds are available through the NRCS to implement practices intended to reduce phosphorus loading to Lake Tenkiller, and any educational materials developed through the NRCS for this watershed will be utilized. Examples of materials produced for other projects include: 1) Animal Waste Management Handbooks; 2) Table Top Display to highlight water quality and conservation practices; and 3) Grassland/Wildlife Handbook for use in watershed protection. In addition, NRCS has added an incentive payment to the EQIP program to facilitate poultry waste transport out of nutrient sensitive watersheds.

Prior to implementing the EQIP program in the basin, the NRCS also participated with the OCC in educating residents in the Peacheater Creek watershed about how to protect the water quality of the Illinois River. Starting in 1993, the NRCS held public meetings, tours, field days, seminars, and youth day camps and outings in the watershed to educate producers and residents about pollution prevention, especially waste management. Newsletters and newspaper articles were used to promote these events and to educate a wider audience. Demonstration plots showed that excess poultry waste runs off during rain events and is both wasteful and damaging to the environment as well as showing that appropriately applied poultry waste can improve production. Educational efforts such as these are expected to continue in the watershed.

4. Oklahoma State University Cooperative Extension Service (OCES)

The Oklahoma Cooperative Extension Service promotes water quality education efforts in the State, working closely with the conservation districts and the NRCS to promote water quality awareness. The OCES provides one-on-one meetings and education with landowners along with group presentations and other forms of technical assistance to improve awareness in the watershed. The OCES also develops and utilizes test plots and demonstration sites to educate producers about the effectiveness of certain best management practices. For example, test plots have been used to demonstrate methods of integrated pest management and effectiveness of more managed fertilizer application in wheat production.

The OCES also holds public meetings and workshops to educate landowners on topics such as pesticide and fertilizer management, animal waste issues, and general Best Management Practices (BMPs). OSU has a website on Animal Waste Nutrient Management which provides all the background information needed for developing Nutrient Management Plans and Animal Waste Management Plans. OCES has organized Animal Waste Management Conferences and has developed overall producer-education programs for watersheds that focus on livestock production, grazing management, riparian protection, silviculture, and overall nutrient management. These programs will be coordinated with programs developed and presented by the Arkansas Cooperative Extension Service.

5. OSU: Publications, Fact Sheets, and Web Page

OSU has developed several fact sheets including: 1) “Soil Quality and Animal Manure," 2) "Manure and Raising Soil pH," and 3) "Using Poultry Litter as Fertilizer." Other publications include a water quality driven soil handbook, "Oklahoma Soil Fertility Handbook." OSU will also produce a promotional video on poultry waste management and utilization that will support the marketing and export of poultry waste. Specific instances of loading, trucking, and spreading of poultry waste will be covered. Relevant publications will be distributed at various events in the watershed to increase public knowledge.

In 1998, OSU’s Department of Agricultural Economics established what has become the Oklahoma Litter Market website "... to promote better understanding of the movement and application of poultry litter in Oklahoma." This market web site is designed for agricultural producers wanting bulk amounts of poultry waste as a soil fertilizer and / or soil amendment, thereby helping to move poultry waste out of sensitive watersheds. The web address is http://www.ok-littermarket.org/ and includes a list of contract haulers.

6. Oklahoma Scenic Rivers Commission (OSRC)

As the state agency charged with the protection of the Illinois River and its tributaries, the OSRC has been extremely active in educating river users about pollution and the importance of maintaining the water quality of the river. OSRC holds 1-3 river cleanup events each year, often with 200+ participants. They also organize educational events at public schools, fairs, campgrounds, and other pertinent venues, including an annual Environmental Fair with educational booths and activities. OSRC employees board buses of river floaters to educate them about littering and give floaters printed trash bags with the message “Pack it in, pack it out” (66,000 distributed in 2009). Their Visitor Center near the Illinois River contains a wealth of environmental education information. In addition, newsletters and a website are used to inform river visitors and stakeholders about water quality in the area.

7. Volunteer Monitoring Programs

The OCC and the Conservation Districts have worked to implement the Blue Thumb volunteer monitoring education program in the watershed. Currently, there are several active monitoring sites in the Illinois River watershed. The Blue Thumb program is developing a website to keep volunteers updated on Blue Thumb activities as well as inform the general public about the program. A portion of this webpage will focus on priority watershed projects, like the one in the Illinois River Watershed. In the past, the OWRB’s Oklahoma Water Watch Program has monitored sites on Lake Tenkiller and will likely continue this activity in the future. The program was put on hold in late 2009 due to state budget cuts.

8. OCC Education Programs

The education component of any OCC Illinois River Watershed Implementation Project will be coordinated and implemented by a Project Education Coordinator employed by the OCC. Education plans developed for and used in other OCC implementation projects will be modified to produce an education plan for the Illinois River Watershed. The Education Plan will focus on specific educational goals which include:

(1) Work with Conservation Districts, NRCS, OCES, ODAFF, and OSRC to coordinate education activities.
(2) Write monthly articles for area newsletters and/or newspapers about project activities in the watershed.
(3) Develop and present a school educational component.
(4) Develop a display/exhibit for the project that can be used to educate the public on the 319 Program. Display should include basic information on the program, its cooperators, and contact people of ongoing programs in the watershed (including 2004 project contacts).
(5) Plan and conduct educational meetings to include: tours, earth days, fairs, etc. These education programs will be designed to explain the water quality problems and what can be done to reduce potential impacts, both agricultural and urban.
(6) Work with Conservation Districts on expanding the Blue Thumb program in the watershed.
(7) Develop a recognition program for project cooperators.
(8) Track how participation in the education program has changed people's behaviors. Project Education Coordinator will follow ten percent of people intercepted through different aspects of this and related project activities and will contact them on an annual basis throughout the project period to determine whether they have made any changes that would affect NPS pollution.
(9) Develop a demonstration farm for the Illinois River Watershed similar to the ones developed for previous projects in the Eucha-Spavinaw and Honey Creek watersheds. This farm will be open to landowners throughout the area and will demonstrate many of the types of BMPs that will be offered through the Illinois River Watershed Project. The Project Education Coordinator will also develop a series of demonstration farm tours for local citizens and youth to spread the word about how these practices lead to improved water quality in the streams, rivers, and lakes.

9. Oklahoma Department of Agriculture, Food, and Forestry (ODAFF)

The ODAFF established a toll-free poultry waste hotline in 1998 to match buyers and sellers of poultry waste. The hotline was established to develop mechanisms for marketing excess animal waste in the impaired watersheds (e.g. Illinois River and Eucha/Spavinaw) to areas that can benefit from land application of poultry waste. Interest in the hotline has waned substantially since its development, and it is largely maintained at this point as a website.

The ODAFF hotline is also available on OSU's Cooperative Extension Service web site at http://www.ok-littermarket.org/. Poultry growers in the Arkansas portion of the watershed are encouraged to contact the ODAFF hotline regarding export assistance. ODAFF maintains information concerning Arkansas sources of poultry waste through the voluntary assistance of private individuals, since the ODAFF cannot directly target Arkansas growers who may have poultry waste to sell. BMPs, Inc. will provide information to be listed on the website about certified haulers, and, as they are willing, producers seeking to sell their poultry waste as well as landowners interested in purchasing waste.

The ODAFF Water Quality Forester for the region will also play a key role toward developing an education program that focuses on environmentally sound silvicultural practices for the watershed. Oklahoma Forestry Services has provided technical assistance to the Oklahoma Scenic Rivers Commission in the preparation of the Illinois River Management Plan and on tree planting practices. Forestry Services installed forest road BMPs on a demonstration road in cooperation with OCC on the Spavinaw Creek Demo Farm in 2006. Practices used included broad-based dips, turnouts, gravel, proper grading, and an improved stream crossing installed by ODWC.

In recognition of the importance of forest landowner and logger education concerning forestry practices and BMPs, Forestry Services provides logger training across the region in cooperation with the Arkansas Timber Producers Association. With support from OCC and the Scenic Rivers Commission, Forestry Services carried out a series of BMP workshops and logger "tailgate sessions" from 2004 to 2008 on the Illinois River and Spavinaw Creek watersheds.

Foresters provide technical forestry assistance to landowners throughout the area, and the Forest Stewardship Program provides interested landowners with a comprehensive written forest management plan developed in consultation with other natural resource specialists. Local foresters are assisting the NRCS with delivery of the Healthy Forest Reserve Program to improve forest habitat for endangered bat species in the area. Agency foresters also assist cities and towns with forest management and tree related issues through its Urban and Community Forestry Program.

Pine and hardwood seedlings are available from Forestry Services' Regeneration Center for forest conservation plantings. Forestry Services also participates in public and landowner information or awareness programs to make people aware of the opportunities for forestry practices to help solve environmental problems on the watershed, the use of forestry BMPs, how to properly conduct a timber sale and/or harvest timber, etc. A variety of educational materials, including a Forestry Note series on water quality and forest road practices, is available.

Forestry Services also offers free loan of timber bridgemats from its Tahlequah office to help loggers cross streams and minimize road impacts.

10. Oklahoma Department of Environmental Quality (ODEQ)

ODEQ, OCC, and OSRC are cooperating with the USEPA for development and implementation of a TMDL for Illinois River Watershed. The results of the completed TMDL will help focus outreach and implementation in the Illinois River watershed.

11. Poultry Integrators / BMPs, Inc.

Presently, the poultry industry is actively represented by officials from Tyson Foods, Simmons Foods, Georges, Inc., Peterson Foods, and Cobb-Vantress. These integrators represent the majority of all poultry production in the Illinois River watershed. All are actively pursuing public outreach and public education initiatives through their relationships with their contract growers and have established dialogue with their growers concerning Oklahoma legislative and regulatory requirements on animal production and poultry waste issues.

Integrators are also substantial contributors to efforts to address pollution problems related to the industry. The poultry industry provided $1.1 million to the Oklahoma Scenic Rivers Commission in four installments from 2005 to 2009. A significant portion of this money went to education and outreach activities.

Many of the integrators are involved in water quality education programs and River Clean-ups through the Poultry Community Council, Poultry Partners and through involvement with the Illinois River Watershed Partnership in Arkansas.

The principal integrators have agreed to supply technical data on animal production and generation and disposal of poultry waste and have actively pursued several alternative animal waste control measures such as detailed questionnaires to all growers about animal production and waste generation, use of alum in bedding to reduce phosphorus runoff, intensified research on phytase as a means to reduce phosphorus in feed, assisting growers with development of Animal Waste and Nutrient Management Plans, postponing spring clean-outs of poultry houses to reduce nutrient runoff, and direct funding of statewide education of growers and poultry waste haulers as required by recent Oklahoma legislation. Integrators also contribute significantly towards varying efforts to reduce the impacts of the poultry industry including producer education, research into alternative uses and disposal methods for the poultry waste, and the collection of environmental data necessary to monitor the impacts of pollution reduction strategies.

BMP’s, Inc., is a group responsible for ensuring that additional avenues of reducing the amount of poultry waste spread in the watershed (including waste transport outside of the watershed, alternative uses and markets for the waste) are explored and implemented. BMP’s, Inc. is funded by the Poultry Integrators, as established in the Eucha-Spavinaw lawsuit settlement, and is working in the Illinois River watershed as well.

12. Poultry Federation

The Poultry Federation, representing Missouri, Oklahoma, and Arkansas, is currently involved with education of integrators and growers about legislative and water quality issues dealing with poultry production. This organization has become an important voice for the poultry industry. The Poultry Federation relies upon an effective education program for its members and will likely increase its involvement with the rural stakeholders in the watershed. Among other educational events, this organization holds an annual Processor Workshop with past topics including global food safety initiatives, sustainability, phosphorus index, and performance-based sanitation.

13. Other Nonprofit Groups

The Sierra Club has ongoing public education and volunteer cleanup actions in the Illinois River watershed as well as coordinated efforts at NPS reduction with the Arkansas Chapter. Several active citizens groups have been established specifically with the intent of helping to preserve or improve the water quality of the Illinois River watershed. Other community groups have recently become involved in the effort, and all play a role in educating the general public on water pollution issues. These include: Save the Illinois River (STIR), Greater Tenkiller Area Association (GTAA), Keep Oklahoma Beautiful, Concerned Citizens for Green Country Conservation, Indian Nations Audubon Society, Illinois River Outfitters Association, The Nature Conservancy, the Illinois River Watershed Partnership (Arkansas), among others. Outreach from these groups has included radio and TV ads, newspaper articles and ads, websites, tables at fairs and other community events, cleanups, etc.

14. Arkansas Agencies

The Arkansas Soil and Water Conservation Commission (ASWCC) has ongoing 319 programs to transport poultry waste outside of sensitive watersheds and to develop a waste bank to facilitate transport of waste. ASWCC is also cooperating with the OCC to demonstrate a method of deriving liquid fertilizer, and ultimately, electricity from poultry waste, as well as exploring additional programs to develop alternative uses for poultry waste including on-farm burning units to provide heat to the poultry houses. Other Arkansas state agencies are also involved in the effort to educate the public on water quality issues and implement BMPs in the Illinois River watershed, including the Arkansas Department of Environmental Quality (ADEQ), Arkansas Association of Conservation Districts (AACD), Arkansas Water Resources Center (AWRC), and Arkansas Department of Pollution Control and Ecology (ADPCE), among others.

15. USFWS Local Offices

The U.S. Department of Interior Fish and Wildlife Service (USFWS) has lead responsibilities for designating and recovering imperiled species and their habitats in cooperation with other public and private entities. This includes species formally protected under the Endangered Species Act and also candidate species for which the USFWS conducts assessments and promotes voluntary conservation measures. The Oklahoma and Arkansas Ecological Services Field Offices work to identify the needs of imperiled species in the Illinois River watershed, to ensure those needs are provided for, and to increase public awareness of those needs.

16. City of Tahlequah

The City of Tahlequah developed a Storm Water Management Plan in 2006. Part of this plan includes a public education/public participation program. A multi-media approach is being used in Tahlequah's program, which includes education via posters, brochures, cable channel information, Blue Thumb education programs, and a website: http://www.cityoftahlequah.com/city/departments/stormwater/stormwater_new.htm

17. Oklahoma Nonpoint Source Working Group

The State of Oklahoma Nonpoint Source Working Group includes representatives of state, local, and federal agencies and is led by the Oklahoma Conservation Commission. This group is convened relatively infrequently but plays an important role in NPS management in the state. In 2000 (updated in 2006), the NPS Working Group prioritized watersheds in Oklahoma in order of importance for protection and improvement. Based on the recommendations of this group, the OCC began implementation projects in several watersheds, including the Illinois River watershed. The members of the NPS working group review all implementation project workplans, as well as providing input into project specific watershed based plans, including this one.

In general, newspaper articles and other media submitted by the OCC, OCES, Conservation Districts, and NRCS will be used to inform citizens in the watershed about programs focused on water quality. Articles may serve as promotions for various upcoming trainings or other events. Other media related activities such as radio spots and logo contests may be used to further the efforts of the program.

Youth education is a significant effort which will continue to be pursued by OCC, OCES, NRCS, and the conservation districts. Most youth education activities focus on general water quality maintenance and improvement and include activities such as 4-H group water quality monitoring and education, "Earth-Day-Every-Day" activities fair where hundreds elementary school children and some of their parents are exposed to environmental education, and various other training sessions.

Under the OCC Project Education Coordinator, current outreach programs in the watershed will be expanded and perhaps partially redirected to work towards more measurable results and to insure that the target audience is being reached. The target audience is the people whose change of behaviors could have the most substantial benefits to water quality; in the Illinois River Watershed, this should include cattle and poultry producers, among others.

The success of water quality protection programs in the watershed depends on the approval and cooperation of the local landowners and various government agencies. In summary, public outreach to assure support of this and future evolutions the Watershed Based Plan will come from:

- Public meetings and listening sessions held throughout the watershed.
- Regular media coverage of activities/issues (both at local and State levels).
- Education programs that involve segments of the community ranging from school children to agricultural producers to homeowners.
- Programs that encourage local citizens to experience "ownership and understanding" of environmental issues such as volunteer monitoring, clean-up events, and other educational grassroots efforts to address the problem.

The ultimate goal of the public outreach portion of this project is to develop a program that will help the citizens of the Illinois River Watershed reduce NPS pollution. A coalition of the various local, tribal, state, and federal agencies and organizations mentioned in this section could provide the most efficient means to coordinate all activities in the watershed. The education program should ensure widespread adoption of best management practices over the entire Illinois River watershed and should also be established in a fashion such that it will continue past the life of the project.

TECHNICAL AND FINANCIAL ASSISTANCE NEEDED *(element d)*

Funding needs are difficult to anticipate and will likely change over time. Currently identified funding needs focus on several primary areas (BMP implementation, education/outreach, monitoring, and modeling) and are based on past projects which addressed similar efforts and goals, some of which are presented in the tables below for reference. The estimated costs associated with the various implementation strategies are highly conservative and will likely change as targeting of the watershed is finalized and further information becomes available. In addition, funding for some of these efforts has already been identified and implementation is already underway; therefore these figures do not entirely represent additional funds needed. Future iterations of the plan will work to update existing estimates, but also better identify categories where current funding and technical assistance needs are not well known. A summary of the funds already used in the watershed, as well as an initial estimate of the funds needed to further address the primary load reduction strategies is seen below.

BMP Installation: The projects associated with **installation of BMPs** to reduce NPS loading are listed in Table 47. Several of the projects have been completed, while others are ongoing or planned. Overall implementation of BMPs to meet at least a 40% reduction in total phosphorus load is expected to require millions of dollars.

Table 47. Specific BMP projects/efforts identified for implementation. Dates in parentheses are approximate start dates for each project. Completed projects are included as reference for project costs.

Task	Federal	State	Cooperator	Total	Agency	Status
Battle Branch Project (1990)				Approx. $100,000	OCC and partners	Completed
Canoer access areas with toilets (1992)	$45,767		$3,643 (OSRC)	$49,409	OCC and OSRC	Completed
Toilet facility improvements on IR (1992)	$128,250	$6,750		$135,000	OSRC and OCC	Completed
Echota Bend bank stabilization (1994)	$78,518	$26,173		$104,691	OCC	Completed
Illinois Jones Porta-potties and Trash Bags Project (1995)	$66,250	$44,166		$110,416	OCC	Completed
Nursery Tailwater Project (1996)	$ 94,500	$ 63,000		$157,500	OCC and partners	Completed
Peacheater Creek 319 Project (1995)	$108,000	$72,000	$85,000	$265,000	OCC and partners	Completed
Illinois River Management and Implementation Project (1996)	$215,464	$180, 000 (some cooperator cost-share)		$395,464	OCC	Completed
Barren Fork / Illinois River 319 Project (1999)	$763,475	$333,533	$238,852	$1,335,860	OCC and partners	Completed
Riparian easements (2002)	$189,545	$100,954		$290,499	OSRC and OCC	Ongoing
Poultry waste hauling/manure marketing project	$96,300 (pilot study)	$64,200 (pilot study)		$160,500 (pilot study)	OSU; OCC; BMPs, Inc.	Completed
Poultry waste transport (IR and Eucha watersheds)	$460,000	$306,666		$766,666	OCC; BMPs, Inc.	Completed
Poultry waste transport (2002)	$300,000		$200,000	$500,000	OCC	Completed
Conversion of poultry waste to fertilizer / energy (2002)	$400,000		$100,000	$500,000	OCC	Ongoing
Comprehensive Nutrient Management Plan Development (2005)	$180,300* (total project)			$180,300* (total project)	ODAFF	Completed
Illinois River 319 Riparian Protection Program and CREP (2007)	$2,165,000	$894,000	$866,000	$3,925,000	OCC; USDA-FSA	Ongoing
Illinois River Cost-share Program Supplement					OCC	Planned
Stormwater BMPs, including education				$169,000 (2008-2009); $282,000 (2009-2010)	City of Tahlequah	Ongoing

Task	Federal	State	Cooperator	Total	Agency	Status
Streambank stabilization (2010)	$2,000,000			$2,000,000	ARRA and OCC	Planned
Habitat restoration	$150,000	$100, 000		$250,000	OCC	Planned
EQIP Program	$150,000 - $200,000 annually	$37,500 - $50,000 annually			NRCS	Ongoing
Pollution Prevention at PFOs and Soil Testing	$67,000** (total for 3 years)	$67,020** (total for 3 years)		$134,020*** (total for 3 years)	ODAFF	Ongoing (starting 11/2010)

*estimated cost spent in Illinois River watershed is approximately 14% of $180,300 or $25,250;
** estimated cost spent in Illinois River watershed is approximately 14% of $67,000 or $9,400;
*** estimated cost spent in Illinois River watershed is approximately 14% of 134,200 or $18,800.

Technical assistance needs are delivered in general by the many partners recognized under the Public Outreach section. Specific technical assistance needs associated with Implementation of Best Management Practices will be primarily from NRCS in the form of design and certification of the installation of most BMPs, given that specifications are generally drafted by NRCS. Therefore, NRCS plays a vital role in overseeing BMP design and installation and also in training OCC conservation planners. ODEQ also plays an important role in septic system certification, although numerous programs are available to fund installation of BMPs.

Education and Outreach: Maintenance and expansion of ongoing **education and outreach** efforts is estimated to require $100,000 - $500,000 annually and is detailed in Table 48, below.

Table 48. Identified education and outreach funding efforts.

Task	Federal	State or local	Total	Agency	Status
Small Farm Livestock Pollution Prevention Program (1995)			$274,262	OCES and OCC	Completed
Illinois River Basin Education Project (1996)	$56,700	$37,800	$94,500	OCC and OCES	Completed
Illinois River Management and Implementation Project (1996)	$53,600	$35,734	$89,334	OCC	Completed
OSRC Illinois River Education Program (1997)	$30,000	$20,000	$50,000	OSRC	Completed
Watershed Protection through Manure Marketing (1997)	$93,300	$62,200	$155,500	OCES and OCC	Completed
Barren Fork / Illinois River 319 Project (1999) WAG & EdWAG			$161,560	OCC	Completed
Blue Thumb Volunteer Monitoring and Education		???	Approx. $6,000 annually	OCC	Ongoing
Stormwater education program			Approx. $4,500 annually	City of Tahlequah	Ongoing
Pollution education in the Illinois River watershed			Approx. $40,000 annually	OSRC	Ongoing

Task	Federal	State or local	Total	Agency	Status
Nonpoint Source Education Program for Producers	$172,848	$116,120	$288,968	OCES	Ongoing
Soil Sampling Technique and Nutrient Variability Demonstration	$28,402	$18,935	$47,337	OSU	Ongoing
Poultry Growers and Waste Applicators Education Programs			???	ODAFF and OCES	Ongoing
Stakeholder (citizen involvement)	???	>$21,000	???	Multiple	Ongoing

Technical assistance for education and outreach to stakeholders will be delivered in general by the many partners recognized under the Public Outreach section. Specific assistance will depend on the degree of the water quality problems in the watershed, consequences of inaction, potential solutions, stakeholder involvement, updates on program progress, etc. OCC, OSRC, OWRB, ODEQ, Cooperative Extension, Conservation Districts, and numerous other groups have ongoing education programs in the watershed that must continue to educate watershed stakeholders including watershed landowners, watershed users, Oklahoma legislators, and citizens of the State.

Monitoring: Continuation and expansion of ongoing **monitoring** efforts in the watershed will require $200,000 - $500,000 per year, as specified in Table 49, below.

Table 49. Identification of specific monitoring funding needs.

Task	Federal	State	Total	Agency	Status
Ambient Monitoring			Approximately $40,000 every five years for this watershed	OCC (Rotating Basin Program)	Ongoing
	$125,950 startup, $24,000 annually		$125,950 startup, $24,000 annually plus $___ for gage maintenance	USGS	Ongoing
			$90,000 annually every other year for lake monitoring	OWRB (BUMP)	Ongoing
Peacheater Creek 319 Project (1995-2003)	$350,000	$233,337	$583,337	OCC	Completed
Illinois River Project (1996)	$53,435	$21,766	$75,201	OCC	Completed
Illinois River Project (2007)			$82,230	OCC	Ongoing
Stormwater Monitoring			$95,000	City of Tahlequah	Ongoing
Continuous Water Quality Monitoring for Real-Time Reporting			$201,000 first year; $170,000 annually	OSRC, USGS	2011-2014

Technical assistance for water quality data collection, maintenance, and evaluation will come from numerous agencies including, but not limited to, the OSRC, ODEQ, USGS, OWRB, and USACE, which are all actively involved in data collection in the watershed. This data is shared among agencies for the good of the state's waters and is utilized to characterize water quality challenges, assess program progress, and characterize sources.

Modeling: Computer **modeling** to assess the effect of implementation efforts is estimated to require $100,000 - $250,000 for the entire Illinois River watershed approximately every five years. Table 50, below, indicates the amount that has been identified to date for the Oklahoma portion of the watershed, although the amount budgeted for the USEPA funded TMDL is unknown at this time.

Technical assistance needs include assistance with the evaluation of TMDL load reduction goals in order to identify the most efficient option(s) for implementation to reduce pollutant loading. Computer modeling experts such as OSU Biosystem and Agricultural Engineering and ODEQ can utilize information provided by stakeholders to recommend the most efficient scenarios that can be implemented to achieve load reduction goals.

Table 50. Specific funding identified for computer modeling.

Task	Federal	State	Total	Agency	Status
Spatially Integrated Model for Phosphorus Loading and Erosion (SIMPLE) model development (1996)	$100,000	$66,667	$166,667	OSU and OCC	Completed
Soil and Water Assessment Tool (SWAT) model development (2006)			$110,630	OSU and ODEQ	Completed
TMDL development (2010)			???	USEPA	Ongoing
Trend analysis of high flow data			$110,000	OSRC, USGS	Proposed

Additional technical assistance needs for all aspects of the project will be identified in updated versions of the watershed based plan.

IMPLEMENTATION SCHEDULE / INTERIM MILESTONES *(elements f & g)*

Past education, cost-share, and demonstration efforts have been successful at slowing the continued degradation of water quality in the Illinois River watershed. Now that point source reductions are being implemented, priority in the watershed must be given to reducing the overall NPS load of nutrients reaching Lake Tenkiller, especially that due to improper nutrient management. A TMDL is expected to be released by the USEPA in 2011 which may affect schedule and load reduction goals presented in this WBP. Ongoing implementation of best management practices, focused on demonstration of pollution reduction strategies in the Illinois River Watershed, will continue. Implementation of future Illinois River 319 demonstration projects is expected to continue for at least 15 years as a supplement for CREP and other programs.

The ongoing Illinois River Watershed 319 Riparian Protection Project, initiated in 2007, complements the twenty million dollar Conservation Reserve Enhancement Program (CREP) in the Illinois River watershed and the neighboring Eucha/Spavinaw watershed. The CREP program would be largely unsuccessful in this watershed without additional funds to pay for riparian protection in non-CREP eligible areas, and some of the most critical areas of nonpoint source pollution in the watershed would remain without BMPs. The OCC hopes to continue providing 319 funding to enhance the CREP as long as landowner interest remains strong.

The goal of the collaborative 319/CREP riparian protection projects is to target protection of the most critical riparian areas in the watershed either by extending the intermittent stream cost-share rate to the level of perennial streams or by enrolling non-CREP eligible land in a fifteen year protection agreement. The 319 Project Coordinator is working with the State CREP Coordinator to include landowners in the most critical areas of the watershed in the program. Once those landowners in critical areas have been afforded the opportunity to participate, remaining available monies will be available for non-CREP eligible landowners who are not necessarily in areas that are currently critical but who have riparian areas that may be in danger of development during the next fifteen years. Implementation of these programs collaboratively could result in a 9% reduction in phosphorus loading (21% of the 40% overall reduction goal) and a 10% reduction in nitrogen loading to the watershed.

Effects of implementation programs in the watershed on phosphorus, nitrogen, and sediment loading to Lake Tenkiller from the various sources will be evaluated and reported to EPA every year in the Grants Reporting and Tracking System (GRTS). This system uses a STEP-L model to estimate load reductions due to implementation. In addition, the OCC's annual report to EPA will summarize the progress (money spent, BMPs implemented, number of cooperators, etc.) of any ongoing 319 programs in the watershed.

Approximately every three to five years (or at the end of each project), the level of implementation and load reductions achieved through the project will be examined to determine whether any changes in strategy need to be instituted to continue progress toward the long-term goals in the watershed. Following that evaluation, this Watershed Based Plan will be revised to reflect new information and address short-comings identified with earlier plans.

The initial goal is that at least a forty percent phosphorus load reduction will be measured after the first five years. Until this load reduction can be proven with water quality data, it will at least be demonstrated by modeling the expected load reductions from implemented practices. Table 51 details the schedule of the goals and actions of the WBP, as well as the interim milestones (within three to five years of implementation) and long-term goals for each action.

The USGS, OWRB, and OCC have ongoing, long-term monitoring programs to assess water quality throughout the watershed. In addition, the State of Arkansas maintains long-term monitoring stations in the Arkansas portion of the watershed. These monitoring programs are in the process of coordinating to insure that they are adequate to determine whether watershed loading reduction goals are being met throughout the project period. At least every two years, all water quality data from the watershed will be analyzed for the State's Integrated report, at which time progress toward beneficial use support restoration will be measured.

Table 51. Schedule and Load Reduction Goals (Interim and Long-term Milestones) Associated with Activities Planned.

Goal	Action	Year to Begin	Interim Goal to Attain (within 3 to 5 years)	Evaluation Criteria for Necessary Changes	Long-term Goal to Attain
Characterize NPS contributions and evaluate nutrient dynamics and impacts in watershed	Targeting	2007	Model sources of pollution in the watershed	If major landuse changes in watershed, redo model.	Map of high priority areas for implementation
	TMDL development	2010	NA		TMDL
	Watershed Based Plan	2010	Complete draft WBP	Initial rewrite after TMDL release. Consider at least biannually, "Have major changes occurred in the watershed or major projects been completed?"	Update plan to incorporate TMDL results and biannually after that unless major changes have occurred in the watershed
Evaluate point source discharger contributions and implement strategy to reduce	TMDL	2010	NA		TMDL
	Upgrade WWTPs	2011	Start upgrades toward achieving TMDL goals	Pending TMDL results	Implement upgrades to comply with TMDL results
Develop education and outreach programs	Maintain Blue Thumb program in the watershed	2007	Volunteers in watershed will continue monthly monitoring and quarterly QA events	Evaluate semiannually throughout project period. If volunteers quit, hold a new volunteer training event.	Continued volunteer monitoring and programs
Implement BMPs	Riparian establishment	2007	10% of degraded riparian areas restored	Evaluate annually. Document progress in implementation and in load reductions in annual report and in GRTS. Modify public outreach efforts to increase landowner participation in program if annual goals are not met.	Total 70-80% NPS phosphorus load
	Streambank stabilization		5% of severely eroding streambanks stabilized		
	Nutrient / Waste BMPs		100% of cooperators in 319 project have nutrient management plans		
	Export poultry waste		15% NPS phosphorus load		
	Pasture land BMPs		6% NPS phosphorus load		
	Stormwater upgrades		Pending TMDL results		
	LID practices		Pending TMDL results		

<table>
<tr><td rowspan="6">Monitor water quality</td><td>OWRB – Beneficial Use Monitoring Program</td><td>1998</td><td rowspan="6">NA</td><td rowspan="6">Evaluate all data biannually as part of State's Integrated Report Assessment. Coordinate monitoring sites; if overlap or redundancy in monitoring sites, move sites to maximize funding spent on monitoring.</td><td rowspan="6">Effective monitoring of watershed.</td></tr>
<tr><td>OCC – Rotating Basin Monitoring Program, Priority Watersheds, and Blue Thumb Program</td><td>2003</td></tr>
<tr><td>USGS / OSRC</td><td>Ongoing</td></tr>
<tr><td>ODEQ – toxics monitoring, NPDES permitting</td><td rowspan="2">Ongoing</td></tr>
<tr><td>TMDL monitoring</td></tr>
<tr><td>City of Tahlequah</td><td>2006</td></tr>
</table>

The specific timeline for the ongoing 319 Illinois River project is described in Table 52, below. Additional projects in the watershed will have similar timelines included in project-specific workplans, which will be submitted to EPA as required. These will be incorporated into each revision of the WBP.

Table 52. Schedule for 2007 Illinois River Watershed 319 Riparian Protection Program.

Milestone Description	Completion Date
Hire Project Coordinator	October 2007
Project Coordinator Completes NRCS Conservation Certification Training	October 2007
QAPP	October 2007
Complete Project Targeting	October 2007
Develop Project Implementation Plan	January 2009
Begin Sign-up (advertise program to targeted areas)	December 2007
Implementation of Practices	December 2007 – August 2011
Track BMP Implementation through use of NRCS Toolkit software and/or ArcView GIS software	December 2007 – August 2011
Estimate load reductions due to Implementation of BMPs through the use of computer modeling.	January of 2008, 2009, 2010 (to be entered in GRTS)
Submit Final Report to EPA	December 2011

MONITORING PLAN *(element i)*

Every Watershed Based Plan requires a monitoring plan to gage overall success of restoration and remediation efforts. Methodologies developed for use in this WBP will be selected to provide: 1) quantifiable measures of changes in parameters of concern, 2) measures of success that can be easily understood by cooperators and stakeholders with a variety of technical backgrounds, and 3) consistent, compatible information throughout the watershed.

A "Joint Arkansas/Oklahoma Scenic River Monitoring Proposal" was drafted in 2004 which detailed a coordinated monitoring program in partnership with the Arkansas/Oklahoma Arkansas River Compact Commission. A Scenic River Monitoring Technical Workgroup, comprised of representatives from the Arkansas Department of Environmental Quality (ADEQ), Arkansas Soil and Water Conservation Commission (ASWCC), Oklahoma Conservation Commission (OCC), Oklahoma Department of Environmental Quality (ODEQ), and Oklahoma Water Resources Board (OWRB), was formed to develop a water quality monitoring program to address specific questions about data collection and usage. The following monitoring objectives were devised:

1. Determine if the Oklahoma Scenic River total phosphorus criterion is being met.
2. Determine if water quality is improving in the Scenic River watersheds.
3. Determine if Oklahoma and Arkansas are meeting the AR/OK Arkansas River Compact Commission 40% phosphorus reduction goal using the current agreed upon methodology.
4. Develop a monitoring plan that meets the requirements of the Watershed Plan.

This group's efforts have been hampered for several years by the ongoing poultry lawsuit, but after the USEPA releases the TMDL which goes across state boundaries and after the resolution of the lawsuit, attempts will be made to revive this working group.

At present, the monitoring plan for this WBP addresses only Oklahoma sites and provides for development of individual monitoring plans and associated quality assurance plans and Standard Operating Procedures for each underlying project or effort working toward the ultimate goal of restoration of beneficial use support. These monitoring efforts will need to be based on Oklahoma's Water Quality Standards and Use Support Assessment Protocols which define the process by which beneficial use support can be determined. Technical assistance in developing these plans can come from various sources including the Oklahoma State Agency peer review process.

At this time, the following parameters will continue to be monitored by various agencies in the Illinois River watershed:

- Water quality: nutrients, sediments, suspended solids, fecal bacteria, dissolved oxygen, temperature, pH, conductivity, alkalinity, hardness, turbidity, chlorophyll-a, metals, pesticides, BOD
- Sediment quality: nutrients, metals, pesticides, and other organics of concern

- Hydraulic budget: in-stream flows, infiltration rates, aquifer recovery, groundwater levels
- Groundwater quality: nutrients, metals, pesticides, pH
- Landuse/Land cover: acreage in different landuses, quality and type of land cover, timing and other variables of associated management practices
- Riparian condition: extent and quality of riparian zones in the watershed, to include quality and type of vegetation, degree of impact or stability, condition of streambanks, and primary source of threat or impact.
- Aquatic biological communities: assessment of the condition of fish and benthic macroinvertebrate communities related to reference streams and biocriteria
- BMP and other implementation efforts: type, extent, and when possible, specific location of practices to include an estimate of the potential load reduction affected by implementation
- Behavioral change: participation in Watershed Based Plan-related activities and behavioral changes of communities

Some agencies are assessing these parameters continuously, while others are only collecting samples during stormwater events (details follow). It is anticipated that this list may change as the WBP evolves and after release of the TMDL. With each WBP-related program, as well as for the WBP as a whole, baseline conditions will be established and monitored prior to BMP implementation. A monitoring schedule and Quality Assurance Project Plan (QAPP) will be developed based on the type of project and timing of its implementation. Monitoring results will be reported to the appropriate entities as defined in project-specific QAPPs. For further detail on the current project's monitoring protocols, refer to Appendix B of the *Priority Watershed and Special Projects Water Quality Monitoring: Quality Assurance Project Plan (approved and on file at EPA Region 6).*

Baseline Data

The historical studies summarized in the first section of this WBP can be used to gather baseline data for the Illinois River watershed. Work by the primary agencies still present in this watershed is given below.

Ambient Water Quality

Considerable water quality monitoring has occurred in the watershed, as detailed in the earlier part of this WBP. The OCC, ODEQ, and other appropriate entities will use portions of this data to establish baseline conditions. A TMDL is being developed; until then, water quality in this WBP will be guided by the following:

Oklahoma Integrated Report – CWA Section 303(d) List of Waters needing a TMDL, 2008. Lake Tenkiller and portions of the Illinois River and some of its tributaries are of concern because they are listed on the 2008 (and previous) Category 5 (303(d)) list for phosphorus, nitrates, bacteria, turbidity, low dissolved oxygen, and/or poor fish assessments.

OCC Rotating Basin Monitoring Project – Two sites within the Illinois River watershed are included in Basin Group 3 of the Rotating Basin Project (Table 53). As such, monthly monitoring at these sites occurred from 2003-2005, from 2008-2010, and will recur 2013-2015.

OWRB BUMP monitoring – There are six BUMP stream monitoring sites in this watershed (Table 53) in addition to the monitoring that occurs in Lake Tenkiller. The stream sites have been monitored monthly since 1998, while Lake Tenkiller is monitored quarterly for one year every other year (since 1994).

USGS – The USGS has seven permanent stations in the Illinois River watershed (Table 53). These sites are monitored for water quality parameters monthly, with data going back as far as the 1950s.

Table 53. Ambient stream monitoring stations in the Illinois River watershed.

Agency	Station ID	Station Name	Period of Record
OCC	OK121700-06-0040G	Battle Creek	3/1990-8/1994; 5/2003-4/2005; 5/2008-4/2010
OCC	OK121700-03-0370G	Ballard Creek	3/1990-7/1992; 5/2003-4/2005; 5/2008-4/2010
OWRB	AT197000	Barren Fork Creek near Eldon	11/1998-present
OWRB	AT197369	Caney Creek near Barber	9/1999-present
OWRB	AT196000	Flint Creek near Flint	11/1998-present
OWRB	AT195500	Illinois River near Watts	11/1998-present
OWRB	AT196500	Illinois River near Tahlequah	11/1998-present
OWRB	AT195865	Sager Creek near West Siloam Springs	11/1998-present
USGS	7195500	Illinois River near Watts	9/1955-present
USGS	7196000	Flint Creek near Kansas	9/1955-present
USGS	7196090	Illinois River near Chewey	7/1996-present
USGS	7196500	Illinois River near Tahlequah	8/1955-present
USGS	7197000	Barren Fork Creek at Eldon	5/1958-present
USGS	7195865	Sager Creek near West Siloam Springs	5/1991-present
USGS	7197360	Caney Creek near Barber, OK	8/1997-present

Sediment Quality

1997 Oklahoma Conservation Commission Clean Lakes Study – A 1997 Phase 1 Clean Lakes Study performed by the OCC analyzed sediments for nutrients and metals. None of the detected quantities of metals exceeded the USEPA Sediment Screening Values (USEPA 1995).

The Oklahoma Water Resources Board's 2001 "Water Quality Evaluation of the Eucha/Spavinaw Lake System" – This study found that lake sediments in Eucha contributed as much as 7% of the Lake's annual phosphorus load and that 80% of the phosphorus entering Lake Eucha is retained in the lake, as opposed to being passed downstream. The sediment in Lake Tenkiller may exhibit similar properties.

USGS's "Phosphorus Concentrations, Loads, and Yields in the Illinois River Basin, Arkansas and Oklahoma, 1997-2001" (Pickup et al. 2003) – This study indicated that release of phosphorus from the streambed and eroding stream banks contribute to the increased phosphorus concentrations.

USEPA's "Water Quality and Biological Assessment of Selected Segments in the Illinois River Basin and Kings River Basin, Arkansas" (Parsons 2004) – This study found that benthic sediments act as a sink for phosphorus in streams immediately downstream of WWTPs in the Illinois River Watershed.

ODAFF – The Oklahoma Department of Agriculture, Food, and Forestry monitors waste application, soil phosphorus content, and waste phosphorus content in the watershed.

Hydraulic Budget

- ***USGS*** – gauging system
- ***OWRB*** – lake level and discharge monitoring

Groundwater Quality

- ***USGS*** – Reconnaissance of hydrology, water quality, and sources of bacterial and nutrient contamination in the Ozark Plateaus aquifer system

Landuse/Land Cover

- ***NRCS and OCC*** – Color digital orthophotos (2003)
- ***OSU Biosystems and Agricultural Engineering*** –
  - Basin-wide Pollution Inventory for the Illinois River Comprehensive Basin Management Program (1996)
  - Illinois River Upland and In-stream Phosphorus Modeling (2006)

Riparian Condition

- ***NRCS*** – Color digital orthophotos (2003)
- ***OSU Biosystems and Agricultural Engineering*** –
  - Basin-wide Pollution Inventory for the Illinois River Comprehensive Basin Management Program (1996)
  - Illinois River Upland and In-stream Phosphorus Modeling (2006)
- ***OCC*** – As part of the Rotating Basin Group 3 project, a 400 meter habitat assessment was performed for each of the two sites in the Illinois River watershed in 2003 and in 2008.

Aquatic Biological Communities

- ***OCC*** – Two sites within the Illinois River watershed are included in Group 3 of the Rotating Basin Project (Table 53). As part of this project, macroinvertebrates were collected twice a year from 2003-2004 and 2008-2009, and fish collections were obtained in 2003 and 2008.
- ***OWRB*** – Macroinvertebrates and fish are collected at the six BUMP stream sites in the watershed. Macroinvertebrates are collected twice a year in two

successive years out of every five years, and fish are collected once every four to five years (see Table 54, below).

- ***USFWS*** – In support of ODWC and Oklahoma Biological Survey, the status of mussel communities at 52 Illinois River sites was assessed in 1995. This included comparisons to limited historical records from the river made in 1911 and 1989.

Best Management Practices and other Implementation Efforts (Coverages)

- o ***NRCS/FSA*** – Records of locations, specific practices installed, and associated costs of programs such as EQIP, WRP, CRP, etc. (ongoing)
  - ***OCC*** –
    - o Records of locations, specific practices installed, and associated costs of locally-led State Cost-share Program (ongoing)
    - o Records of locations, specific practices installed, and associated costs of 319 priority watershed implementation programs (see Table 46, above, for list of programs)
- ***OSU and OCC*** – Estimates of load reductions related to installation of specific practices through computer modeling (future)
- ***ODEQ*** – Permit upgrades for NPDES permitees in the watershed
  - ***ODAFF*** – Compliance records of poultry operators, including records of poultry waste application and soil phosphorus and poultry waste phosphorus content in the watershed; conduct periodic forestry BMP compliance monitoring on randomly selected timber harvest sites in the watershed (ongoing), and estimate sediment load reductions attributable to the use of forestry BMPs (future)

Data Collection Responsibilities

Responsibility for the collection of additional data of the types described above will reside with project managers of the individual projects as spelled out their individual work plans. These project managers will be responsible for ensuring that the data is submitted to the ODEQ for inclusion in the Oklahoma State Water Quality Database, which will ultimately be uploaded to the National STORET database. Data reporting under individual workplans will also be the responsibility of the project managers. Monitoring results for all projects will be made public through the posting of final reports on agency websites.

In addition to those monitors to be identified in the workplans of the individual projects under this WBP, the following groups will be involved in monitoring activities:

- Oklahoma Water Resources Board (OWRB): Beneficial Use Monitoring Program (Lake Tenkiller and river/streams)
- Oklahoma Conservation Commission (OCC): Rotating Basin Monitoring Program, 319 Priority Watershed Project Monitoring, CREP Monitoring, and Blue Thumb Monitoring
- U.S. Geological Survey (USGS): surface and groundwater quality and quantity monitoring and special studies

- Oklahoma Department of Agriculture, Food, and Forestry (ODAFF): soil sampling associated with CAFO regulations
- Oklahoma Scenic Rivers Commission: surface water quality monitoring with a focus on bacteria monitoring during the recreational season
- City of Tahlequah: stormwater monitoring

Monitoring Details

Stream Monitoring

Oklahoma Conservation Commission (OCC):

The OCC monitored the water quality of Battle Creek and Ballard Creek (Table 54; Figure 21) from 2003-2005 and from 2008-2010 as part of the Rotating Basin Monitoring Project. Monitoring on these waterbodies will recur from 2013-2015 during the third rotation of the rotating basin program. All parameters listed in Table 53, below, are collected every five weeks at the Rotating Basin sites over a two year period.

To assess BMP effectiveness as part of the 2007 Illinois River 319 Riparian Protection Project, and in turn, CREP, automated samplers were installed at four locations, as shown in Table 54 and Figure 21. The autosamplers were located strategically to achieve a paired watershed design in a couple of different ways. The Barren Fork Stateline site is upstream of the BMP implementation area, while the Barren Fork Welling location is downstream of the implementation area. The comparison of these sites will allow estimation of the effectiveness of BMPs in the Barren Fork subwatershed using an “upstream-downstream” paired analysis. In addition, the Flint Creek location within the Illinois River basin will be compared to Saline Creek, a control watershed just west of the Illinois River watershed. This will allow an additional estimation of BMP effectiveness in another subwatershed (Flint). Monitoring has been occurring since before BMPs were implemented (2007). This monitoring design and the methods used are specified under an EPA-approved QAPP with Data Quality Objectives (DQOs) specifically focused on evaluation of effectiveness of NPS program BMP installations.

Parameters collected and sampling frequency is given in Table 55. Water from autosamplers is collected and analyzed once a week, or more frequently when high flow events occur. In addition, *in situ* measures and grab samples are collected monthly at these sites.

Table 54. Current OCC monitoring sites in the Illinois River watershed (*Saline is a control site, not in the IR watershed).**

Site Name	Latitude	Longitude	County	SiteType
Ballard Creek	36.1060	-94.5650	Adair	Rotating Basin Ambient
Battle Creek	36.2100	-94.6840	Delaware	Rotating Basin Ambient
Flint Creek	36.1961	-94.7078	Delaware	Project Autosampler
Barren Fork Creek @ Welling	35.8933	-94.8657	Cherokee	Project Autosampler
Barren Fork Creek @ State line	35.9062	-94.5191	Adair	Project Autosampler
Saline Creek ***	36.2820	-95.0929	Mayes	Control Autosampler

Table 55. OCC analytical parameters and sampling frequency for autosampler sites.

Parameter	Collection Frequency
Dissolved Oxygen, Conductivity, pH, Temperature, Alkalinity, Turbidity, Nitrite Nitrogen	Monthly + 6 high flow events per year
Total Phosphorus, Instantaneous Discharge, Nitrate Nitrogen, Ammonia-Nitrogen	Monthly grab samples + 6 high flow events per year; Weekly autosampler samples
Ortho-phosphorus, Total Kjeldahl Nitrogen	Weekly autosampler samples
Benthic Macroinvertebrates	Twice yearly (summer / winter)
Fish	Once per Rotating Basin cycle
Habitat	Once (with fish) per Rotating Basin cycle
Total Coliform, *E. coli*, and *Enterococcus*	Weekly from May 1 – September 30

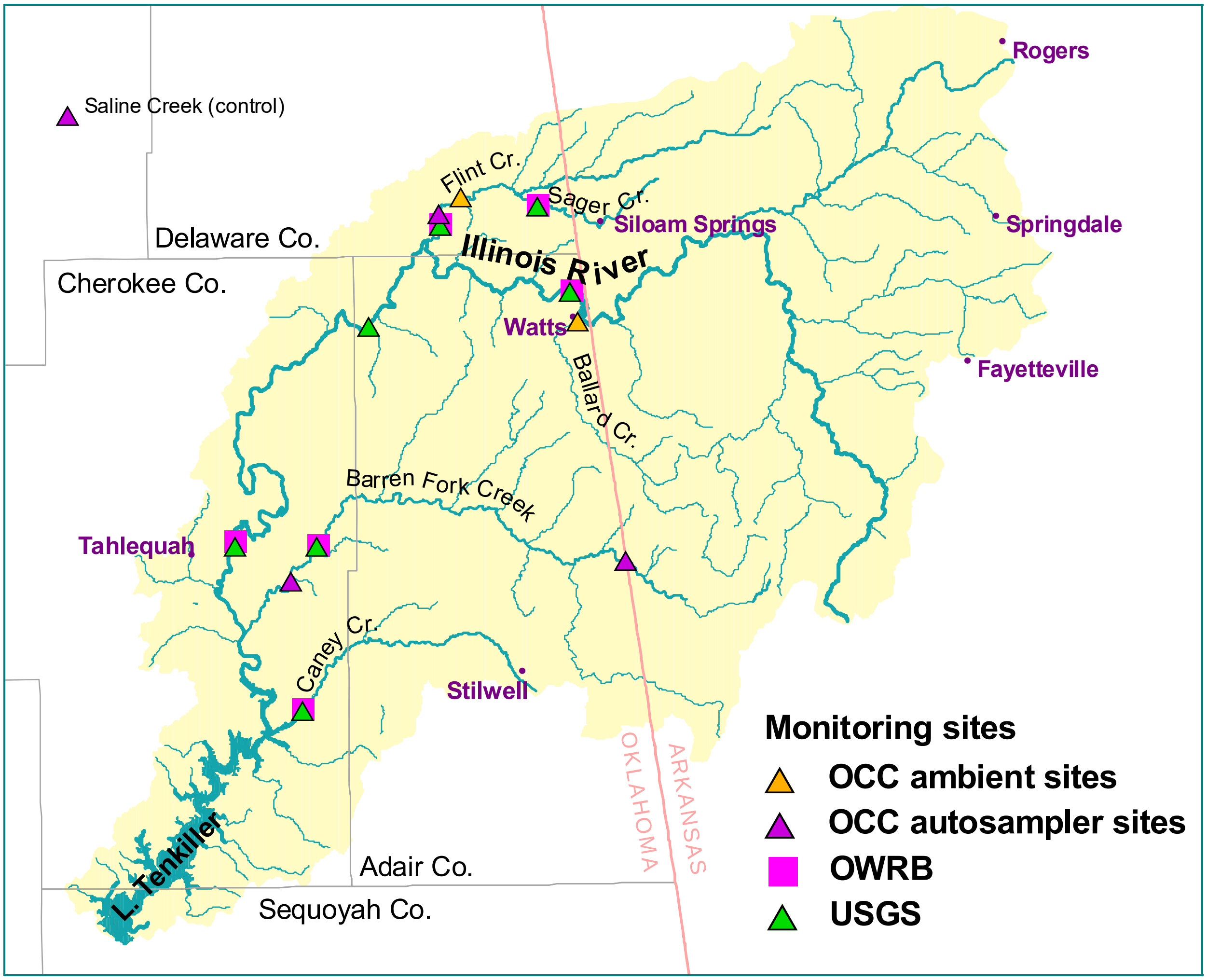


Figure 21. Monitoring sites in the Illinois River watershed.

USGS and OSRC:

The United States Geological Survey (USGS) has an ongoing intensive stream monitoring program in the Illinois River Watershed, collecting monthly and storm-event water quality data and continuous hydrologic data. The Oklahoma Scenic Rivers Commission (OSRC) provides financial support for data collection at these stations. A system of sequential downstream monitoring sites (includes 5 USGS water quality stations; Figure 21 above) allows quantification of nutrient inputs from particular tributaries or subbasins. These sites, along with several non-gaged tributary sites, also provide general water quality information. Other USGS water quality stations provide information for determining outflow from lake, changes in storage, annual lake water budget, and surface-water discharge, as well as bedload contributions. Table 53 indicates the scope of work by site and sampler, and Table 56 below shows the frequency of sampling and parameters collected.

Instrumentation at gage stations includes a continuous stage recorder and some rainfall data. Data for these parameters from gage stations are logged at 15-minute intervals to one-hour frequency (depending upon hydraulic characteristics of site), uploaded via satellite to USGS's Water Control Data System, and then downloaded via satellite to become available to the public, real-time, via the USGS web site. This real-time monitoring, especially of phosphorus and bacteria, is important in order to be protective of users as well as of the resource itself. Frequent monitoring will allow more accurate estimations of parameters of concern and may help assess the sources of spikes in these parameters.

USGS stream water-quality samples are collected utilizing the equal-width-increment methodology (EWI). Over the course of several years, a sufficient amount of sample points along the hydrograph will provide an adequate representation of the entire hydrograph. The samples are collected during six storm run-off events each year, once per storm, at each of the five sites. Currently, USGS has at least ten years of high-flow and base-flow data.

Table 56. USGS parameters and sampling frequency for streams.

Parameter	Sampling Frequency
Alkalinity, Ammonia-N, Dissolved Oxygen, Dissolved Oxygen (% Sat.), Hardness, Nitrite, Ortho-Phosphorus, Nitrite + Nitrate, pH, Redox Potential, Specific Conductance, Temperature, TKN, Total Phosphorus, Turbidity	Monthly + 6 high flow (20% increase) events per year
Total Dissolved Phosphorus, TSS	6 high flow (20% increase) events per year

These data will provide information about relative quantities of nutrients transported during both base flow and surface runoff conditions, as well as load contribution from each basin and trends in pollutants of concern. As more data are collected, loading estimates will become more accurate. Loads will be estimated using a statistical multiple regression-loading model. Load estimates over time will be used to compute yields (area normalized loads) for the contributing drainage areas of each site. Hydrograph separation techniques will be used to distinguish base-flow nutrient discharge from total annual nutrient discharge. Base-flow loads and yields (attributed to ground-water discharges and point sources) will be compared against surface-runoff loads and yields (attributed to non-point sources).

The USGS and OSRC have proposed a project to update annual load and yield estimates and assess trends in nutrient and sediment concentrations and loads in the Illinois River Basin using LOADEST and ESTREND models. This project would be extend earlier projects (e.g., Pickup and Tortorelli 2006) to incorporate at least 10 years of stormflow data from six sites rather than the three examined in the earlier studies. In addition, as part of this project, real-time monitoring of physical water-quality parameters (pH, conductance, dissolved oxygen, temperature, and turbidity) will be performed for two of the sites. Estimates of real-time constituent concentrations and loads will be posted online for real-time viewing.

OWRB:

The OWRB has six stream sites in the watershed that are monitored regularly as part of the Beneficial Use Monitoring Program (BUMP) (Figure 21). Fixed monitoring sites are monitored bimonthly. Table 57, below, describes the parameters that the OWRB collects from both stream and lake sites.

Table 57. OWRB stream and lake monitoring sample variables.

SAMPLE VARIABLES		
General Water Quality – Sampled 8 to 10 times annually for streams & quarterly for lakes		
Dissolved Oxygen (D. O.)	PH	Specific Conductance
Temperature	Oxidation/Reduction Potential	% D. O. Saturation
Salinity	Total Alkalinity	Total Hardness
Chloride	Nephelometric Turbidity	Sulfate
Total Dissolved Solids	Chlorophyll-*a*	Secchi Disk Depth
Nutrients – Sampled 8 to 10 times annually		
Kjeldahl Nitrogen	Ortho-Phosphorus	Total Phosphorus
Nitrate Nitrogen	Nitrite Nitrogen	Ammonia Nitrogen
Metals – Sampled as needed		
Arsenic	Cadmium	Chromium
Copper	Lead	Mercury
Nickel	Selenium	Silver
Zinc	Thallium	
Organics – Site specific sampling as needed		
Analysis of Pesticides, Herbicides, Fungicides, and other organics		
Bacteriological Communities – Sampled 5-10 times annually (during recreational season)		
Fecal Coliform	*Escherichia coli*	Enterococci
Biological Communities – Sampled as described below		
Sestonic Chlorophyll-a (10 times annually—site specific)	Benthic Chlorophyll-a (as needed during summer)	Fish (once every 4-5 years)
Benthic Macroinvertebrates (2 summer/2 winter 2 out of every 5 years)	Habitat (sampled with fish and macroinvertebrate sampling)	

USFWS:

The USFWS is involved in continued monitoring, research, and conservation of the freshwater mussel community of the Illinois River, including the Neosho mucket and rabbitsfoot mussel. These efforts involve support form various cooperating agencies, including the Oklahoma Biological Survey and the Oklahoma Department of Transportation. The USFWS is also involved in continued monitoring, research, and recovery of gray bats inhabiting the Illinois River watershed. These efforts involve support from various cooperating agencies, including the Oklahoma Department of Wildlife Conservation and Rogers State University.

City of Tahlequah:

The City of Tahlequah began monitoring tributaries of the Illinois River in 2008 in support of the following goals:

1. Protect, maintain and restore high quality chemical, physical, and biological conditions in the waters of the state of Oklahoma according to the anti-degradation policy;
2. Reverse the past trends of stream deterioration through improved water best management practices (BMPs);
3. Maintain physical, chemical, biological, and stream habitat conditions in city streams that support aquatic life, along with appropriate recreational, water supply, and other water uses;
4. Restore streams damaged by inadequate water management practices of the past by reestablishing the flow regime, chemistry, physical conditions, and biological diversity of natural stream systems as closely as possible;
5. Promote and support educational and volunteer initiatives that enhance public awareness and increase direct participation in stream stewardship and the reduction of water pollution.

The Tahlequah monitoring program consists of obtaining four base flow grab samples and two stormwater grab samples per year at two sites: a tributary site approximately one mile above the confluence with the Illinois River and a site 0.3 mile above the wastewater effluent. The parameters being assessed include ammonia, total phosphorus, total suspended solids, and fecal coliform. In addition, *in situ* measures of dissolved oxygen, pH, conductivity, turbidity, and temperature are being recorded. An automated flow logger will be installed at one site.

Point Source Monitoring

Information on discharges from waste water treatment plants (WWTPs) will be obtained through Discharge Monitoring Reports (DMR) in order to monitor maximum nutrient, bacteria, and TSS concentrations and exceedance violations during the project period.

Lake Monitoring

OWRB:

The OWRB has monitored Lake Tenkiller since 1994. Seven sites (Figure 22) are monitored in the lake quarterly during alternate years. The parameters monitored include: temperature, pH, dissolved oxygen, salinity, dissolved oxygen % saturation, oxidation-reduction potential (redox), specific conductance, total dissolved solids (TDS), turbidity, Secchi disk depths, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, Kjeldahl nitrogen, orthophosphorus, total phosphorus, true color, chloride, sulfate, total alkalinity, chlorophyll-a, and pheophytin. Vertical water quality profiles are recorded at one meter intervals from the lake surface to the lake bottom for at least three sites per reservoir: in the central pool area near the dam (lacustrine zone), in the upper portion of the lake and in the major arms of the water body (riverine zone), and in the area between the lacustrine zone and the riverine zone (transitional zone).

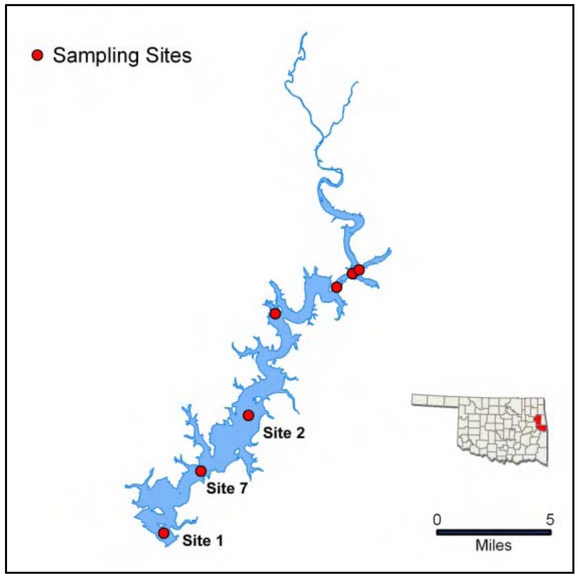


Figure 22. OWRB monitoring sites on Lake Tenkiller.

Army Corps of Engineers (ACOE):

The ACOE has monitored Lake Tenkiller for a number of years. Recent analyses focused on identification and quantification of toxic blue-green algae. Future analyses may examine the presence and quantification of mercury in the lake, a response to the recent finding of very high levels of atmospheric mercury in the area.

Benefits of the Monitoring Plan

Implementation of this monitoring plan will provide support for the goal of the WBP, which is ultimately to restore beneficial use support to waters of the Illinois River / Lake Tenkiller Watershed. Funding for monitoring programs, especially the existing USGS gauging network, has decreased, while costs for sampling and analysis continue to rise. Monitoring has provided the data needed to develop a phosphorus TMDL for the watershed, and it will continue to provide support for future TMDLs as well as help define areas of the watershed where restoration activities should be focused to realize the optimum benefit for the investment. In addition, the impacts (realized and potential) of implementation efforts will be evaluated, at least in part, based on the monitoring data collected as described in this WBP. Collection of the data described under this monitoring plan will help verify the relative contributions from various sources in the watershed and the processes contributing to water quality degradation in the watershed. Collection of this data will help Oklahoma and Arkansas work together to arrive at a mutually agreed upon solution for the watershed. Finally, continued collection of data and evolution of the monitoring plan for the watershed will allow the program to adapt to meet the changing needs of watershed protection in the Illinois River / Lake Tenkiller Watershed.

CONCLUDING REMARKS

The Illinois River watershed is one of Oklahoma's most important water resources ecologically, culturally, and economically. A multitude of recreational activities associated with the river and Lake Tenkiller stimulates the local economy, and the watershed provides vital habitat for several threatened and endangered species. Through the work of various state, federal, and local groups, the water quality of the Illinois River watershed is slowly improving, or at least holding steady, after drastically declining in previous years. It is vital to continue monitoring, implementation, and education in this watershed to build upon the progress made so far and continue the behavior modification momentum that is being observed by project staff working directly with landowners on the ground. When the OCC began working in this watershed in the early 1990s, the idea of riparian buffers was distasteful to most, who viewed this concept as a waste of good grazing land. Now, landowners are approaching OCC and conservation district staff for technical assistance in installing fencing to create riparian buffers, even without cost-share assistance. It is the hope of the Oklahoma Conservation Commission that funding continues to be made available to ensure that all interested landowners are able to install BMPs, both in Oklahoma and Arkansas, so that the water quality and other natural resources of this unique watershed are preserved for future generations.

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Appendix A: Implementation Plan for the 2007 Illinois River 319 Cost-share Program

POLICIES AND APPROVED CONSERVATION PRACTICES FOR ILLINOIS RIVER WATERSHED §319 NON-POINT SOURCE POLLUTION COST-SHARE PROJECT

FY 2007 319 (h) Project 12, Output 12.2
#C9-996100-14
Illinois River Watershed Implementation Project

Beginning December 15, 2007
Ending June 30, 2010

Developed by:

Oklahoma Conservation Commission

In Cooperation with:

Delaware County Conservation District
Adair County Conservation District
Cherokee County Conservation District

Oklahoma Conservation Commission

Guidelines
For The
Illinois River Watershed
319 Non-Point Source Cost-Share Project

Program Years 1-3 and Approved Practices

I. General

The Oklahoma Conservation Commission hereby declares that the following problems are having a detrimental effect on the state's water resources in the Illinois River watershed. The Illinois River watershed is on the Oklahoma 2002 Integrated Report Category V list, and the 2002 OWRB BUMP report states that Lake Tenkiller is impaired by turbidity and that TSI for chlorophyll-a indicates that the lake is hypereutrophic. In addition, areas of Lake Tenkiller fail the dissolved oxygen criterion.

Oklahoma's water resources are an important foundation of the state's economic infrastructure. Natural climatic events as well as human activity are impacting the state's water resources. As long as farmers and ranchers produce food from the land to feed the world and rain falls, we will continue to see impacts on the state's water. Our task as stewards of the natural resources is to minimize these impacts. Protecting these vital natural resources is paramount in preserving the state's economic future. In order to accomplish this goal, the Commission hereby establishes the following objectives to address the problems affecting our renewable natural resources: 1) Make cost-share funds available to conservation districts so they can implement cost-share practices, which will protect our natural resource of water; and 2) provide promotional, planning, and technical assistance to districts to facilitate the implementation of best management practices.

The Conservation Commission herein establishes the complete list and description of the Conservation Cost-Share Program policies and conservation practices. These policies and practices were approved by the Oklahoma Conservation Commission for use during this three (3) year program (see section II for the approved list of conservation practices). BMP unit cost will be implemented using the Oklahoma Natural Resources Conservation Service (NRCS) state average unit cost, which are updated annually. Unit cost rates will be adjusted when the current actual price/unit is at least 20% greater than the unit cost in force. Upon approval by the appropriate conservation district(s), with the concurrence of the Water Quality Division Director and approval by the Oklahoma Conservation Commission new unit costs may be approved. Unit costs for rural waste septic systems (which are not included in the NRCS state average unit cost) will be revised and set as needed by the local conservation district boards with the concurrence of the Water Quality Division Director and the approval of the Oklahoma Conservation Commission. Costs for rural septic systems will not exceed $4,375. When a project agreement (contract) has been developed with an applicant, unit cost to be used will be the unit cost in effect at the time the practice is completed. Any variances in the best management practices or cost-share percentage rates must be approved by the appropriate conservation district and the Oklahoma Conservation Commission Water Quality Director, and the Oklahoma Conservation Commission. These variances must be approved prior to implementation.

Allocation of Funds:

To date, the Legislature has appropriated $125,000 of the Priority Watershed Conservation Cost-Share Funds for the purpose of matching federal 319 funds. Additional funds ($305,687) should be allocated in State FY 2008 and subsequent years.

State Funds	Budgeted	$430,687
State Funds	FY2007 Appropriated	$125,000
State Funds	Still needed in order to utilize all 319(h) funds.	$305,687
Federal Funds	Budgeted	$463,592
Landowner Contribution	Budgeted	$223,570
Total Project Implementation	Budgeted	**$1,117,849**

The funds for the project will become available at various times during the life of the program. The project will have $312,500 available at the time of the first sign up period. This includes $125,000 of state money (FY 2007) and $187,500 of federal money.

Targeting:

The Conservation Commission Water Quality Staff, with the concurrence of the Environmental Protection Agency, has designated the following means to be used for targeting methodology: (1) utilization of remotely-sensed and electronically mapped data; (2) on site assessments with the aid of aerial photographs, soil surveys, (3) the use of a priority ranking system similar to the one used by NRCS for the EQIP program and (4) prior participation in the CREP. Those individuals desiring to participate in the program will receive a preliminary site visit from our conservation plan writer. The Plan Writer will do a preliminary investigation as to the extent to which the particular landowner contributes to the water quality problems in the watershed and assign a ranking index based on the practices that would need to be implemented, the cost for implementation, and the expected impact on water quality improvement. A concerted effort will be made to identify the areas that are contributing the larger amounts of sediment and nutrients such that the remediation cost per unit mass of pollutant is minimized.

Using targeted areas in the Illinois River Watershed as shown on targeting maps, a Priority Ranking System was developed, based on the following criteria:

#1 priority: rural septic systems and/or land areas enrolled in CREP and/or with other riparian buffers

- Participation in the Conservation Reserve Enhancement Program (CREP) - Applicants participating in the CREP or other riparian buffer establishment or protection program or plan will be ranked ahead of all applicants not participating in such programs. This includes those who already have riparian buffers installed that meet the minimum CREP standards. If eligible for the CREP, applicants must enroll qualifying land with the CREP prior to consideration for the 319 program.
- Applicants applying for riparian buffers under the 319 program, while ranked above all who do not have a buffer or are signed up to install a buffer, will be prioritized by the amount of flow intercepted by the proposed buffer. This will be determined by a model or a site visit.

#2 priority: areas with no riparian buffer planned or implemented

High, Medium and Low Potential Phosphorus Loss as identified on the Target Map;

Usage of a Comprehensive Nutrient Management Plan;

Distance from a confined livestock facility or livestock feeding area to a USGS Blue Line stream or other flow path;

Topography between a confined livestock facility to a USGS Blue Line stream or other water body;

Development of filter strips;
Replacement of existing septic systems.

Sign Up:

The Project Coordinator will work with the Delaware, Cherokee, Mayes, Sequoyah and Adair County CREP coordinator and Conservation Districts to obtain a listing of all landowners in the Illinois River watershed. A list will be developed to be used for the initial mailing notifying landowners of the program. In addition, newspaper ads will be placed in the Tahlequah, Jay and Stillwell newspapers.

A three week initial sign up period will be established, with concurrence of the participating conservation district, for taking applications for cost-share assistance. After the initial 3 week period, all applications will be ranked and considered. Applications will be taken at the district offices and at public meetings to be held. After the perspective cooperator signs up, the conservation planners will contact each applicant and: (1) determine eligibility; (2) set priority ranking (using the priority ranking form); (3) develop a conservation plan to determine needs; (4) with applicant's concurrence, a project agreement will be developed in accordance with the Oklahoma Conservation Commission Cost-Share Program; (5) the completed conservation plan and project agreement will be presented for approval to the appropriate conservation district ; (6) the final approval will be authorized by the designated OCC representative. **NOTE: Absolutely no reimbursements will be made for work begun on any project until the OCC staff representative has approved the plan and project agreement as so indicated by his/her signature on the agreement form.**

Personal contacts will be made with landowners who have not responded to written notification of the project. Contacts will be made to the non-responsive landowners in the highest targeted areas first, then each succeeding targeted areas from high to low.

At regular intervals a review/audit of the program will be made by the OCC water quality representative. This will be used to determine compliance with the program objectives and if modifications are necessary. The distribution of funds will be re-evaluated as more funds become available. In the event that adjustments are needed, the OCC Water Quality Staff Representative will make the needed adjustments.

Eligibility Criteria:

The following criteria must be satisfied for an applicant to participate in the Illinois River Priority Watershed Cost-Share Program: (1) must own or operate land in the Illinois River Watershed above the dam of Lake Tenkiller; (2) must have a need for one of the Priority Best Management Practices; (3) if it is determined that the applicant requires a priority practice, he/she must be willing, with cost-share assistance, to install the needed BMPs; and (4) the applicant will be required to maintain the BMP for the life of the practice as specified by NRCS.

All residents in the Illinois River Watershed are eligible to receive cost-share assistance regardless of size of land ownership. There will be no minimum cost-share payment to any applicant. A cap for the maximum cost-share assistance to any one participant has been established. The cap has been set at $25,000. If this is deemed too small to meet the water quality needs for the watershed, the appropriate Conservation District Board will review this matter and approve any variances with concurrence of the Water Quality Division Director.

Conservation Commissioners, Conservation Commission Staff, Conservation District Employees, or the spouses of any of these individuals shall not be eligible to participate in the Conservation 319 Cost-Share Program. Conservation district directors are eligible and encouraged to participate in the Illinois River Watershed Cost-Share Program. If district directors choose to participate, the following OCC policy will apply: in order to provide for an impartial legal majority, no more than two district directors from the County Conservation District shall participate in any 319 cost-share program for the Illinois River Watershed. In addition, the directors who desire to apply for the cost share program shall refrain from discussing or voting on any items or issues pertaining to the cost share program. This includes rates, practices, maximum payment, and applicants for the program.

Contract Compliance:

The Oklahoma Conservation Commission Water Quality Staff, approved by the aforementioned conservation district and Oklahoma Conservation Commission, have developed standard forms in administration of this program: (1) CC/HC Project Cost-Share Assistance Pre-Application Form; (2) CC/HC Project Priority Ranking System; and (3) CC/FCR Cost-Share Evaluation Form.

The cooperator will be required to sign a project agreement with the County Conservation District and follow a specified schedule of operations. The schedule of operations form details a year by year plan of the Best Management Practices (BMPs) to be installed and a time frame within which to install them. The project coordinator will conduct annual status reviews on the anniversary of the signing of the Performance Agreement. If a cooperator is found to be out of compliance with the schedule of operations due to circumstances beyond their control, a revision schedule may be, at the discretion of the project coordinator, discussed and completed. These revisions will not require conservation district board approval. In the event a cooperator is not in compliance due to lack of interest the district board has the discretion to terminate the contract. The idle funds can then be utilized by another cooperator. The importance of the cooperators keeping on schedule must be stressed by the planner. The three year lifespan of the project dictates the need for schedule compliance. All funds for BMP installation must be expended by June 30, 2010.

II. List of Recommended Conservation Practices and Cost-Share Rates

Contained in this section is a master list of Best Management Practices (BMP), cost-share rates, and component parts for each BMP that has been recommended for implementation in the Illinois River Watershed Project. The following list of Priority and Best Management Practices has been approved for recommendation to the Commission Members. The BMPs have been approved by the respective Conservation District Boards and the Oklahoma Conservation Commission.

	Cost-Share Practices			Cost-Share Rate
BMPs #1	Riparian Area Establishment and Management			
		Components:	(1) Incentive payments	100%
			(2) Off-site watering	80%
			(3) Tree planting	90%
			(4) Riparian fencing	90%
			(5) Special BMPs, as determined by OCC representatives	
BMPs #2	Buffer Strip Establishment and Streambank Protection			
		Components:	(1) Incentive payments	100%
			(2) Fencing	80%
			(3) Vegetative planting	90%
			(4) Critical area improvements	80%
			(5) Special BMPs, as determined by OCC representatives	
BMPs #3	Animal Waste Components			
		Components:	(1) Composter	75%
			(2) Composter with dry waste storage	75%
			(3) Cake out storage	75%
			(4) Full clean out storage	75%
			(5) Waste storage/animal feeding structure	60%
BMPs #4	Proper Waste Utilization (Poultry Waste Producers)			
		Incentive Payments for Proper Utilization Components:		
	Poultry waste moved out		$0.25/lb P of the Illinois River Watershed into a non-phosphorous threatened or non-NLW watershed (cannot be moved into Eucha/Spavinaw, Grand Lake, Wister, Claremore Lake, Spiro Lake, or Tenkiller Lake Watersheds)	
BMPs #5	Heavy Use Areas			
		Components:	(1) Concrete pads	75%
			(2) Gravel	75%
			(3) Grading and shaping	75%
			(4) Geo-textile	75%
BMPs #6	Rural Waste Septic Systems (Human Waste)			
		Components:	(1) Septic systems with tank; pump out (when needed); DEQ permit; installation; percolation test; lateral lines	80%
			(2) Rock and other anaerobic Systems	80%

(3) Soil profiling 90%

The maximum allowable invoice cost for septic system upgrade/replacement is currently set at $4,375. Increasing costs throughout the program period may require this cap to be raised, based on District Board recommendation and Conservation Commission approval. However, due to diversity of soil types, geology and other factors throughout the 3-county area of the watershed, ODEQ regulations may require more extensive lateral lines or special types of septic systems that would exceed the cap. In these instances, the Conservation District Board may approve cap exceedance if they feel it is warranted.

BMPs # 7 Pasture Management
Components: (1) Cross fencing 80%
(2) Watering facilities 80%

Cost-share Rates and Unit Costs for Components[1]

1:	**Riparian Area Management and Establishment**				
391		**1a: Incentive Payments**			
		1a-1: Total Exclusion	acre	100%	$ 90.00
		1a-2: Total Exclusion with hay production	acre	100%	$ 45.00
		1b: Off-site Watering			
378		1b-1: Pond	cu yd	80%	$ 1.94
642		1b-3: Well Drilling	ft	80%	$ 18.85
614		1b-4 Freeze Proof Water Tank - pre-cast concrete Rubber tire tank Energy free fountain	each DIFT Gallon	80% 80% 80%	$ 1,111.00 $ 151.50 $ 34.19
516		1b-5: Pipeline PVC	DIFT	80%	$ 1.34
561		**Access Lane to Stream**			
		1b-6: Grading & Shaping	cu yd	80%	$ 1.55
		1b-7: Gravel Fill	cu yd	80%	$ 31.98
		1b-8: Geo-cell	sq ft	80%	$ 2.76
		1b-9:Geo-textile	sq yd	80%	$ 2.60
391		**1c: Riparian Forest Buffer**			
		1c-1: Barerooted	each	90%	$ 0.88
		1c-2: Potted	each	90%	$ 1.00
		1c-3: Seedbed Preparation	acre	90%	Included above

[1] Unit costs may be updated with NRCS revisions or following the processes outlined earlier where based on at least 20% increase in the cost of installation over current NRCS unit costs, Conservation Boards may request OCC approval of increases to the unit cost rates.

382		**1d: Fencing**			
		1d-1: 4-wire permanent Standard Critical Areas	L ft	90%	$ 2.40
		1d-2: Woven wire- critical areas	L ft	90%	$ 2.40
		1d-3: Other NRCS approved permanent fencing	L ft	90%	Current approved unit cost
		1e: Special BMP Note: This will only be used when a BMP is needed that is not covered under the list of approved BMPs.			
2: 393	**Buffer-Filter Strip Establishment & Stream Stabilization**				
		2a: Incentive Payments	**acre**	**100%**	**$ 45.00**
		2b: Vegetative Establishment			
512		2b-1: Bermuda Grass Sprig	acre	90%	$ 97.56
		2b-2: Winter Hardy Bermuda Grass Seed - Wrangler	acre	90%	$ 60.04
		2b-3: Tall Fescue	acre	90%	$ 60.04
		2b-4: Native Mixtures	acre	90%	$ 80.96
		2b-5: Other Grasses Cost from OK State Cost List			
590		2b-6: Liming (Soil Test)	ton	90%	$ 28.17
		2b-7: Fertilizer (Soil Test)	acre	90%	$ 28.17
		2b-8: Seedbed Preparation	acre	90%	Included above
		2b-9: Drill & Tractor	acre	90%	Included above
391		Riparian Forest Buffer			
		2b-10: Barerooted	each	90%	$ 0.88
		2b-11: Potted	each	90%	$ 1.00
		2b-12: Seedbed Preparation	acre	90%	Included above
382		**2c: Fencing**			
		2c-1 4-wire Permanent Standard Critical Area	L ft	80%	$ 2.40
		2c-2: Woven Wire	L ft	80%	$ 2.40
		2c-3: other approved NRCS permanent fencing	L ft	80%	Current approved unit cost

		2d: Special BMP Note: This will only be used when a BMP is needed that is not covered under the list of approved BMPs.			
3:	**Composters - Animal Waste Storage Facilities**				
317		3a: Composters	sq ft	75%	$ 8.33
313		3b: Cake Out Storage w/ Concrete Floor	sq ft	75%	$ 7.08
		3b-1: Cake Out Storage w/ Earthen Floor	sq ft	75%	$ 7.79
		3d: Full Clean Out Storage Note: will be cost shared on houses that only rotate their flock once or twice a year			
		3d-1: Earthen Floor	sq ft	75%	$ 7.79
		3e: Animal feeding/waste storage facility (floor under heavy use spec)	sq ft	60%	$ 7.79
4:	**Proper Waste Utilization (for poultry waste producers)**				
		4a: Poultry waste moved out of the Illinois River Watershed into a non-phosphorous threatened or non-NLW watershed Note: cannot be moved into Eucha/Spavinaw, Grand Lake, Wister, Claremore Lake, Spiro Lake, or Tenkiller Lake Watersheds	Lb P		$ 0.25
5: 561	**Heavy Use Area**				
		5a: Establish permanent feeding areas away from water sources (creeks, drainage ways, etc.)			
		5a-1: Concrete Pads for Round Bale Feeding or Frost Free Tanks	cu yd	75%	$ 272.55

		5a-2: Gravel for Heavy Livestock Use Areas (.22 tons/sq yd - 6" depth)	cu yd	75%	$ 31.98
		5a-3: Grading and Shaping	cu yd	75%	$ 1.53
		5a-4: Geo-textile	sq yd	75%	$ 2.60
6:	**Rural Waste System**				Total invoiced cost not to exceed $4,375 or most recent cap set by the OCC
		6a: Septic Tank			
		6a-1: 1000 gallons	each	80%	invoice
		6a-2: Pump out existing tank	each	80%	invoice
		6a-3: Installation of tank	each	80%	invoice
		6a-4: Percolation test and certification (DEQ)	each	80%	Invoice
		6b: Installation of Lateral lines, material, machinery and labor	L ft	80%	invoice
		6c: Rock, geotextile, 1000 gal. tank, 100' lateral lines, labor and machinery	Cu Ft	80%	invoice
		6d: Anaerobic systems	each	80%	Invoice
		6e: Soil Profiling	each	90%	Invoice
7:	**Cross Fencing**				
		7-a-1: 4-wire permanent Cross fencing	L ft	80%	$1.80
		7a-2: Woven Wire	L ft	80%	$ 2.40
		7a-3: Other NRCS approved permanent fencing	L ft	80%	Current approved rate

III. Conservation Cost-Share Practice Standards Specifications:

Cost-share practices shall be implemented according to the standards and specifications of the Natural Resources Conservation Service. See Natural Resources Conservation Service Standards and Specifications in the Field Office Tech Guide, Section IV. The Department of Environmental Quality Bulletin 640, Special Qualification Guidelines for Septic Systems, contains the information for septic systems. Riparian and streambank restoration standards are determined by the OCC.

- **Description of Approved Priority Practices**

Riparian Areas and Buffer Zones—Establishment/Management (priorities 1 and 2)

Definition
Riparian areas are the lands adjacent to water bodies-from creeks and rivers to lakes, ponds, and wetlands. Riparian areas consist of trees, trees and shrubs, or trees, shrubs and non-woody vegetation. Buffer zones are strips or small areas of land in permanent vegetation adjacent to water sources or field edges.

Purpose
Reduce excess amounts of sediment, organic material, nutrients, pesticides and pathogens in surface runoff and shallow water flow.

Establishment
The riparian areas and buffer zones will be planned and designed according to NRCS specifications. The conservation water quality planner representing the local districts will complete the plan.

Management
The conservation planner will make recommendations to the applicant on management according to NRCS specifications. As a part of the management, exclusion incentives will be offered as follows:

Total Exclusion $90.00/acre/yr. for 3 years*
** Hay Production $45.00/acre/yr. for 3 years*

*These exclusion incentives are 100%. **Hay can only be accomplished in Zone 3 of the riparian area as determined by the conservation planner. ***The grazing periods will be determined by the conservation planner using NRCS standards. These exclusion incentives will be limited to no more than an average of 300' on each side of the stream bank. To qualify for these incentive payments, one or more practices to improve water quality must be completed and certified by the project coordinator.

Best Management Practices
Off-site watering facilities, riparian fencing, pasture establishment, forest buffer establishment, critical area improvements.

Composters, Cake-Out, and Cleanout Storage Buildings and Waste Storage/Animal Feeding Facilities (priority 3)

Definition
Construction of composters, cake-out and cleanout storage buildings to store dead poultry (and aid in the decomposition process) and waste until it can be spread onto fields as designated in a waste management plan. Also, construction of animal waste/animal feeding facilities for winter feeding, especially cattle, and storage of waste until weather and soil conditions are acceptable for spreading of the waste.

Purpose
To address the proper disposal of dead animals (poultry) and proper storage of animal waste, as well as to enable winter feeding of animals in a manner that will reduce the potential for erosion and manure associated with the soil around the feeding area.

Establishment
The composter, cake-out, and cleanout structures will be constructed pursuant to NRCS specifications. The waste storage/animal feeding facility will be constructed pursuant to the OCC specifications.

Proper Waste Utilization (priority 4)

Purpose
To insure proper application of animal waste and not to exceed the phosphorus level as established by NRCS and the application plan developed by a nutrient management specialist.

Best Management Practices
An animal waste management plan will be required, along with soil and waste analyses. All criteria and practices required by state law for movement and application of poultry waste must be achieved.

Heavy Use Areas (priority 5)

Definition
The stabilization of areas frequently and intensively used by animals. This is accomplished by establishing vegetation, surfacing with suitable materials, and/or installing needed structures.

Purpose
This practice is used as part of a conservation management system to support the following practices: improve water and air quality, reduce erosion and subsequent movement of soil and animal waste, improve livestock health.

Human Waste Management (priority 6)

Purpose
To insure that rural residents have adequate means of disposing of human waste.

Components
Excavation, septic tanks, lateral lines, percolation tests, or soil profiling components are necessary for the safe disposal of human waste.

Qualifications Criteria for Septic Systems
Cost-Share assistance for septic systems will be allowed only for non-commercial single family dwellings that are used for permanent and primary residence. The dwelling must be within the Tenkiller Lake watershed. The cost-share funds can not be spent on new homes or new mobile homes. Recreational trailers are not eligible for cost-share assistance.

Cross Fencing (priority 7)

Purpose
To insure the proper care and maintenance of pastureland and therefore reduce erosion of soil and movement of nutrients and bacteria from pastures to streams by enhancing the prolonged life of desirable species and reducing overgrazing through construction of fencing to allow for rotational grazing systems.

Components
The components needed for this practice include structural practices such as cross-fencing and installation of alternative water supplies.

V. Tenkiller Lake Watershed Components Parts List

1. Use Exclusion - 472

Definition
The management practice of excluding animals, people, or vehicles from an area.

Purposes
This practice aids in prevention of access to an area to maintain or improve the quality or quantity of natural resources.

Components
The practice requires fences along with an alternate watering source for livestock.

2. Pond - 378

Definition
A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

Purposes
Ponds are used to provide water for livestock, fish, wildlife, recreation, fire control, crop and orchard spraying, and other related uses to maintain or improve water quality by providing a water source away from protected creeks, streams or lakes.

Components
Excavation or embankment, barrel and/or riser, blanket material, trash guard, and clay liners are needed for a pond.

3. Pipeline - 516

Definition
The pipeline is a means of conveying water in a closed conduit to an alternate site. The pipeline must have an inside diameter of 8” or less.

Purposes
Pipelines are used to convey water from a source of supply to points of use for livestock, or other uses.

Components
The practice requires pipe (steel or plastic) that meets the NRCS requirements, a trencher, and a water supply.

4. Water Well - 642

Definition
A hole that is drilled, dug, driven, bored, or otherwise constructed to an aquifer.

Purposes
The wells provide water for livestock, wildlife, and humans to facilitate proper use of vegetation on pastures and to provide water away from protected waterbodies.

Components
Water wells require excavation, drilling, casing, and wellhead protection.

5. Trough or Tank - 614

Definition
A tank or trough (with needed devices for water control and waste) installed to provide drinking water for livestock.

Purposes
A tank is installed to provide watering facilities for livestock that will protect vegetative cover and eliminate the need for livestock to be in streams.

Components
These watering facilities need concrete, water tank, freeze proof hydrants or other water sources and are used in conjunction with heavy use areas (561).

6. Solar Pump/Windmill - 533

Definition
A pumping facility installed to transfer water for a conservation need.

Purpose
Provide a dependable water source for water management for livestock.

Components
These pumping facilities require a storage tank capable of storing water for three days per animal unit. Quotes for electrical hook-ups and the pumping facility must be obtained prior to installation and the lesser amount will be utilized.

7. Fence - 382

Definition
A constructed barrier to exclude livestock, wildlife, or people or to provide for rotational grazing of livestock.

Purposes
Fencing is used as part of a conservation management system to aid in treatment of water and other resource concerns.

Components
The proper height, size, spacing, and type of posts should be used to provide the needed protection for the task. Labor, posts, wire, and other equipment are needed to construct this practice.

8. Riparian Forest Buffer - 391

Definition
An area of predominantly trees and/or shrubs located adjacent to watercourses or water bodies.

Purposes
These buffers reduce sediment and nutrient loading in watercourses. They also create shade to lower water temperatures to improve the habitat for aquatic organisms.

Components
Seed bed preparation, grass planting, tree and shrub planting, nutrient management, and pest management are necessary for establishment.

9. Stream bank and Shoreline Protection

Definition
The structural and managerial treatment used to protect banks of streams, constructed channels, and lakes.

Purposes
The practice is used in preventing the loss of land and improving water quality by reducing erosion and run off.

Components
The practice calls for vegetative planting (grasses, trees, and or shrubs), and/or structural practices.

10. Tree/Shrub Establishment - 612

Definition
The establishment of woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

Purposes
The establishment of the woody plants provides for long term erosion control, filter pollutants from run off, provide for wildlife habitat, and improve water quality.

Components
Tree/shrub establishment calls for correct planting dates for seeds or seedlings, exclusion of livestock to allow for growth, and site preparation.

11. Grade Stabilization Structure - 410

Definition
A structure used to control the grade and head cutting in natural or artificial channels.

Purposes
The structures are used to stabilize the grade and control erosion in channels to prevent the advance of gullies and enhance the water quality.

Components
Grade stabilization structures require excavation, concrete or rock, drop pipes, vegetative establishment, and/or embankment practices.

12. Critical Area Planting - 342

Definition
The planting of vegetation, such as trees, shrubs, vines, grasses, or legumes on highly erodible or critically eroding area.

Purposes
This is used to stabilize the soil, reduce damage from sediment and runoff to downstream areas.

Components
Seedbed preparation, nutrient management, mulching, pest management, grass planting, tree and shrub planting, lime are needed for the practice.

13. Composters/Animal Waste Storage Facilities - 313

Definition
A waste storage impoundment made by fabricating a structure.

Purposes
To temporarily store wastes such as manure, wastewater and contaminated runoff as a storage function component of an agricultural waste management system.

Components
Construction and/or shaping, concrete, gravel, wood, forms, rebar, trusses, sheet metal. NRCS specifications will be followed on all composters, cake-out and cleanout structures. Specifications provided by the Project Coordinator will be followed for animal waste/animal feeding facilities.

14. Proper Waste Utilization - 633

Definition
Using agricultural waste such as poultry waste and cattle manure

Purposes
Protect water and air quality. Provide fertility for crop, forage, fiber production and forest products. Improve or maintain soil structure.

Components
Soil and waste analysis are required prior to removal and application of waste from storage site. An animal waste management plan shall be followed for any application of waste.

15. Heavy Use Area Protection - 561

Definition
The stabilization of areas frequently and intensively used by animals. This is accomplished by establishing vegetation, surfacing with suitable materials, and/or installing needed structures.

Purposes
This practice is used as part of a conservation management system to support the following practices: Improve water and air quality, reduce erosion, improve livestock health.

Components
The components needed for this practice include: vegetative establishment, structural practices, and/or installation of materials such as geotextile, geocell, concrete, and/or rock.

16. Septic Systems

Definition
An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

Purposes
To insure that rural residents have adequate means of disposing of human waste.

Components
The necessities for septic systems are: Septic tank, lateral lines, rock/reed fields, and/or residential sewer lagoons. The septic systems will be designed according to Department of Environmental Quality (DEQ) bulletin 640-Special Qualification Guidelines for Septic Systems.

Checklist of Procedures for Implementation

1. Open Application Period.
2. Keep list of all applications received.

3. Water Quality representatives will determine eligibility, complete farm visits, and prepare a Priority Ranking sheet on each applicant.
4. Develop a case file on each applicant. (Refer to Case File Checklist)
   Note: If and when the applicant is approved for funding and the conservation plan is developed, all items in the case file should be placed in the cooperator's plan file.
5. After all evaluations have been completed, the water quality representatives will rank all applicants. These rankings will be based on the priority ranking criteria set in the Illinois River Implementation Plan (this document).
6. Successful applicants will be notified and a Performance Agreement will be signed by applicant, district board, and OCC Water Quality Representative. Note: Absolutely no work can begin or materials purchased by any applicant until all three signatures have been obtained on the Performance Agreement. In the event this happens, no reimbursement of costs will be made to the cooperator.
7. Conservation plans will be developed on all approved applicants using the NRCS Customer Service Toolkit or a comparable program. Three copies of the conservation plan will be made with the landowner receiving one copy and the Water Quality Representative retaining two copies (one copy will be kept at the representative's office with the other going to the Oklahoma Conservation Commission WQ office).
8. Arrangements are then made for the designated NRCS and/or OCC Water Quality Representatives to design the approved conservation practices.
9. Certify work is complete and authorize payment through the Conservation Commission. The notarized cost-share payment claim must be accompanied by a copy of all invoices, Performance Agreement, Consent Form (if applicable), Certification of Completion and Acceptance, Cost-Share Payment Calculation Sheet, the cooperator's Schedule of Operations, and a completed Vendor Form. These will be forwarded to OCC for payment.
10. Upon receipt of payment from OCC, the district will obtain the signature of the participant on the Release of Warrant Form and place in the conservation plan case file. The disbursement of the funds to the cooperator will be completed to finalize the procedure.
11. Annual Status Reviews will be performed up to two months before and no later than the anniversary of the completion date for the practice.

Case File Checklist

1. Application for allocated funds
2. Copy of Priority Ranking sheet
3. Property map, soils map and soil technical descriptions
4. Farmer-Rancher Conservation Agreement with DCCD
5. Performance Agreement and any amendments
6. Schedule of Operations and any amendments
7. Completed Cultural Resources documentation
8. Vendor form
9. Maintenance Agreement and any amendments
10. Complete copies of all claims and certifications sent to OCC for processing
11. Copies of all vouchers and cost-share payment checks
12. Consent Form, if applicable
13. Release of Warrant Form
14. Any correspondence to and from the participant
15. Any note of relevant conversations with the participant
16. Applicable NRCS standards and specifications
17. Annual Status Reviews

Note: These items can be placed in the conservation plan folder in the district/project office after preparation of the plan.

	ILLINOIS RIVER 319 NON-POINT PRIORITY WATERSHED PRIORITY RANKING SYSTEM 2006		
Producer:		Total Acres:	
Legal:	Section ______ Township _____ Range ______	**Total Points:**	

Water Quality- High Potential Phosphorus Loss on Targeted Riparian Area and Grazing Lands (Maximum Total: 100 pts)		
	Poor Condition Pastures as identified on Target Maps (20 pts)	
	High Potential Phosphorus Loss areas identified on Target Maps (20 pts)	
	Medium Potential Phosphorus Loss areas identified on Target Maps (10 pts)	
	Low Potential Phosphorus Loss areas identified on Target Maps (zero (0) pts)	
	Land offered will apply a Comprehensive Nutrient Management Plan if applying poultry waste according to an animal waste management plan. (20 pts)	
	Distance from confined livestock facility or heavy use feeding area to USGS Blue Line Stream or other water body. Adjacent (15pts) <1/4 mile (10pts) 1/4-1/2 mile (5pts) >1/2 mile (0pts)	
	General topography between confined livestock facility or heavy use feeding area and USGS Blue line stream, channelized flow path or Water Body. >8% slope (10pts) 3% - 8% slope (5pts) 0% - 3% slope (0pts)	
Riparian Buffers (Maximum Total: 100 points)		
	Application being made for buffer with total width (including both sides of the channel) of equal to or greater than 400 feet and greater than or equal to 660 feet in length, OR buffer of this size already established but rental payments are not being received and that there is no permanent conservation easement on requiring said buffer. (100 points)	
	Application being made for buffer with total width (including both sides of the channel) of less than 400 feet but greater than 199 feet and greater than or equal to 660 feet in length, OR buffer of this size already established but rental payments are not being received and that there is no permanent conservation easement on requiring said buffer. (50 points)	
	Application being made for buffer with total width (including both sides of the channel) of equal to or less than 199 feet OR buffer of this size already established but rental payments are not being received and that there is no permanent conservation easement on requiring said buffer. Note that there is no length requirement for this category. (25 points)	
Rural Waste On-site Disposal Systems - Rural Septic System Concerns (Total: 100 pts)		
	Offer includes replacement of existing septic system by installation of 1,000 gallon tank, lateral lines, percolation test, and DEQ permit (100pts)	
	Total Evaluation Points:	

This form will be used to determine priorities for planning and fund distribution. The applicants with the highest number of points, as determined by the planner, will be the first priority for planning and fund allocation.

Appendix B: Comments from the Oklahoma Nonpoint Source Working Group on the Draft WBP

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
9014 East 21st Street
Tulsa, Oklahoma 74129
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/

September 9, 2010

Shanon Phillips
Director, Water Quality Division
Oklahoma Conservation Commission
2800 North Lincoln Boulevard, Suite 160
Oklahoma City, Oklahoma 73105-4210

Dear Ms. Phillips:

The U.S. Fish and Wildlife Service (Service) has received your August 19, 2010, letter and an accompanying draft of a new Watershed Based Plan (WBP) for the Illinois River watershed. The WBP would establish an updated framework for the Oklahoma Conservation Commission (OCC) to lead efforts to improve water quality in the Illinois River watershed, through implementation of nonpoint source pollution controls. Your letter explained the unexpected need for the OCC to submit the WBP immediately to the U.S. Environmental Protection Agency (EPA) in order to continue receiving funding for pollution controls through Section 319 of the Clean Water Act. In view of the accelerated timeframe to finalize the WBP, the Service has performed a quick review of the draft and offers only limited general and specific comments at this time.

General Comments

In general, and despite preparation under an accelerated schedule, the WBP is a very informative and well written document. It represents a considerable improvement over the Watershed Restoration Action Strategy presently in place for the Illinois River (OCC 1999). The WBP appears to cover all nine elements required by EPA for inclusion in watershed plans funded with Section 319 funds (U.S. EPA 2008). Inclusion of these nine elements in watershed plans has been found to provide an effective basis for pursuing water quality improvements in river basins affected by nonpoint pollution sources.

Your letter also points out that the EPA currently is developing a Total Maximum Daily Load model (TMDL) for the entire Illinois River watershed. Many results of the TMDL will relate to issues discussed in the WBP (e.g., desired pollution load reductions and management measures), indicating a need for close coordination between completion of the TMDL (slated for December 2011) and refinement of the WBP. The Service supports intentions expressed in your letter and the WBP to revise the plan after release of the TMDL. Arkansas agencies and cooperators separately are planning and implementing restoration projects in the Arkansas portion of the Illinois River watershed. Increased coordination between state-based efforts in Oklahoma and

Arkansas also would be desirable, especially considering the upstream location of the river portion in Arkansas. The WPB states an intention for this to occur as the plan evolves.

Your letter mentions that one section of the WBP, "Causes and Sources," was released for peer review in March 2010. While further details of the peer review are not provided, the Service does not have record of receiving the indicated section. Also, no such recent accounting of pollution causes and sources is

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included among reports posted at the OCC's Water Quality Project Reports website. The Service requests that you check your records to ensure that we are included in all distributions of material to the Nonpoint Source Working Group.

Specific Comments

Our specific comments on the WBP are identified briefly here but demonstrated more fully by recommended text revisions shown as tracked changes in excerpted plan pages attached to this letter. Although the Service recommends these revisions, we recognize that the OCC may choose to use alternative language in the final WBP it produces.

The watershed characterization section of the WBP (p. 12-58) summarizes prominent features of the Illinois River as well as many of the larger studies that have been performed on the watershed. This section emphasizes water quality research on the river but presents little information about biological features and studies. This is mostly understandable, given the importance of water quality and the large body of research and management information available for the Illinois River. However, the river provides habitat for certain species that are both water quality dependent and of special conservation status. The Service recommends that these biological features be recognized in future planning and implementation efforts.

For example, the Illinois River supports a significant freshwater mussel community, including populations of the Neosho mucket (*Lampsilis rafinesqueana*) and rabbitsfoot mussel (*Quadrula cylindrica cylindrica*). Both the Neosho mucket and the rabbitsfoot are candidate species for listing under the Endangered Species Act (USFWS 2009), and the mucket also is listed by the State of Oklahoma as a state endangered species (OSS 2010). Water pollution and related forms of stream degradation have been associated with widespread declines of both mussel species (USFWS 2009). For the Neosho mucket, the Illinois River has been considered to harbor one of only two remaining viable populations, and even these populations are experiencing declines (NMWG 2005). Although there is no legal requirement to protect candidate species, many public and private entities choose to do so in an interest of avoiding a need for federal listing in the future. Should the Neosho mucket and/or rabbitsfoot mussel be listed in the future, human activities subject to the Endangered Species Act will need to consider water quality and other habitat requirements of these species. Thus, these requirements are important in identifying water quality problems, load reductions, monitoring programs, and performance criteria as elements of the WBP.
The endangered gray bat (Myotis grisescens) feeds on flying insects over bodies of water including rivers, streams, lakes and reservoirs. Mayflies, caddisflies, and stoneflies make up the major part of their diet, but beetles and moths also are consumed (Harvey, 1994; Tuttle and Kennedy, 2005). Gray bats are known to travel up to 35 kilometers from caves to prime feeding areas (La Val et al., 1977; Tuttle and Kennedy, 2005). However, most caves are within 1-4 km (0.6 – 2.5 miles) of foraging areas (Tuttle, 1976). Practices that result in increased pollution, turbidity and siltation in waterways over which gray bats forage, such as development and agricultural activities and the clearing of woody riparian zones, can be detrimental by reducing the local abundance of important prey, especially species sensitive to aquatic pollution such as mayflies, caddisflies, stoneflies (Tuttle, 1979; USWFS, 1982).

The Public Outreach section (p. 89-97) lists entities that are active in the Illinois River watershed and are likely to contribute to public outreach efforts and development of the WBP. The Service could be added to this list, and the attached pages include sample text we have drafted to describe our potential role.

The Monitoring Plan section (p. 103-111) lists entities that have collected baseline data in the Illinois River watershed and/or are continuing to collect data there. The attached pages include sample text we have drafted to more fully explain our role in monitoring activities.

The Service appreciates the opportunity to review the draft WBP. If you have questions about our comments or require additional assistance, please contact David Martinez or Kevin Burgess of this office at 918-581-7458.

Sincerely,

Kemet D. Frazer

for Dixie L. Birch, Ph. D.
Field Supervisor

cc: Regional Administrator, EPA, Region 6, Dallas, TX
Director, ODWC, Oklahoma City, OK
Executive Director, ODEQ, Oklahoma City, OK
Executive Director, OWRB, Oklahoma City, OK
Administrator, OSRC, Tahlequah, OK

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Attachment, from Watershed Based Plan, page 14

spice bush, sassafras and coral berry. Mosses, ferns, and liverworts are abundant on the moist forest floor. Bottomland hardwood forests of oak, sycamore, cottonwood, and elm exist along floodplains of larger streams (OCC 1998; Woods et al. 2005).

The streams of the Ozark Highlands are typically clear, high gradient, riffle and pool type with coarse gravel, cobble, boulder, and bedrock substrates of limestone, dolomite, and chert. Base flows usually are maintained during the dry season by springs and seeps. Widespread karst features include caves, sinkholes, and springs. Elevation ranges from 300 to 1,800 ft (Figure 3).

The southern-most section of the watershed lies in the Boston Mountains ecoregion. This ecoregion "is mountainous, forested, and underlain by Pennsylvanian sandstone, shale, and siltstone. It is one of the Ozark Plateaus; some folding and faulting has occurred but, in general, strata are much less deformed than in the Ouachita Mountains. Maximum elevations are higher, soils have a warmer temperature regime, and carbonate rocks are much less extensive than in the Ozark Highlands...Upland soils are mostly Ultisols that developed under oak-hickory and oak-hickory-pine forests. Today, forests are still widespread; northern red oak, southern red oak, white oak, and hickories usually dominate the uplands, but shortleaf pine grows on drier, south- and west-facing slopes underlain by sandstone"(Woods et al. 2005).

The Boston Mountains ecoregion streams are clear, extremely high gradient, riffle and pool type with gravel, cobble, boulder, and bedrock substrates of sandstone, shales, and limestone. There is little streamflow in the dry season because there are few springs and seeps in the Boston Mountains. The fish fauna of the Boston Mountains are nearly as species rich and diverse as the fauna in the Ozark Highlands ecoregion. Summer flow in many small streams is limited or non-existent but isolated, enduring pools may occur. Elevation ranges from 650 to 2,600 ft (Figure 3).

The Illinois River supports a significant freshwater mussel community, including populations of the Neosho mucket (*Lampsilis rafinesqueana*) and rabbitsfoot mussel (*Quadrula cylindrica cylindrica*). Both the Neosho mucket and the rabbitsfoot are candidate species for listing under the Endangered Species Act (USFWS 2009), and the mucket also is listed by the State of Oklahoma as a state endangered species (OSS 2010). Water pollution and related forms of stream degradation have been associated with widespread declines of both mussel species (USFWS 2009). For the Neosho mucket, the Illinois River has been considered to harbor one of only two remaining viable populations, and even these populations are experiencing declines (NMWG 2005). Although there is no legal requirement to protect candidate species, many public and private entities choose to do so in an interest of avoiding a need for federal listing in the future. Should the Neosho mucket and/or rabbitsfoot mussel be listed in the future, human activities subject to the Endangered Species Act will need to consider water quality and other habitat requirements of these species. Thus, these requirements are important in identifying water quality problems, load reductions, monitoring programs, and performance criteria as elements of the WBP.

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Attachment, from Watershed Based Plan, page 58

CAUSES AND SOURCES

Causes
The designated beneficial uses for streams in the watershed include some or all of the following: public and private water supply (PPWS), fish and wildlife propagation (FWP; some are cool water aquatic community (CWAC) while others are warm water aquatic community (WWAC)), agriculture, primary body contact recreation (PBCR), aesthetics, industrial and municipal process and cooling water (I&M), and fish consumption. Lake Tenkiller is designated for WWAC, agriculture, PBCR, aesthetics, I&M, PPWS, hydropower, and fish consumption.

In addition, a number of the streams or stream segments are designated as "outstanding resource" waters (ORW), such that no degradation of water quality is permitted. The Upper Illinois River from Tenkiller Dam, including Tenkiller Reservoir upstream to the Baron Fork confluence, is also designated a "high quality water" (HQW) and "nutrient limited watershed" (NLW). The river is classified as a state scenic river from the Lake Frances Dam down to its confluence with the Baron Fork, a distance of approximately 70 miles. A 35 mile segment of the Baron Fork River and a 12 mile segment of Flint Creek are classified as scenic rivers upstream from their confluence with the Illinois River.

Federally-Designated Sensitive Watersheds are areas occupied by Federally-Listed Endangered, Threatened, Candidate and Proposed aquatic or aquatic-dependent species. These watersheds provide important habitat for the continued survival of many species protected under the Endangered Species Act of 1973. The entire Illinois watershed is comprised of several of these sensitive sub-watersheds as designated by 11-digit Hydrologic Unit Code (HUC). The U.S. Fish & Wildlife Service recommends specific Best Management Practices (BMPs) to be used in these areas to reduce physical, chemical, and biological contaminants that degrade water quality and other important habitat.

Ms. Phillips 7

Attachment, from Watershed Based Plan, page 96

pollution issues. These include: Save the Illinois River (STIR), Greater Tenkiller Area Association (GTAA), Keep Oklahoma Beautiful, Concerned Citizens for Green Country Conservation, Indian Nations Audubon Society, Illinois River Outfitters Association, the Nature Conservancy, the Illinois River Watershed Partnership (Arkansas), among others. Outreach from these groups has included radio and TV ads, newspaper articles and ads, websites, tables at fairs and other community events, cleanups, etc.

14. Arkansas Agencies

The Arkansas Soil and Water Conservation Commission (ASWCC) has ongoing 319 programs to transport poultry waste outside of sensitive watersheds and to develop a litter bank to facilitate transport of waste. ASWCC is also cooperating with the OCC to demonstrate a method of deriving liquid fertilizer, and ultimately, electricity from poultry litter, as well as exploring additional programs to develop alternative uses for poultry waste including on-farm burning units to provide heat to the poultry houses. Other Arkansas state agencies are also involved in the effort to educate the public on water quality issues and implement BMPs in the Illinois River watershed, including the Arkansas Department of Environmental Quality (ADEQ), Arkansas Association of Conservation Districts (AACD), Arkansas Water Resources Center (AWRC), and Arkansas Department of Pollution Control and Ecology (ADPCE), among others.

15, USFWS Local Offices – Oklahoma and Arkansas

The United States Department of Interior Fish and Wildlife Service (DOI/FWS) has lead responsibilities for designating and recovering imperiled species and their habitats, in cooperation with other public and private entities. This includes species formally protected under the Endangered Species Act and also candidate species for which the FWS conducts assessments and promotes voluntary conservation measures. The Oklahoma and Arkansas Ecological Services Field Offices work to identify the needs of imperiled species in the Illinois River watershed, to ensure those needs are provided for, and to increase public awareness of those needs.

In general, newspaper articles and other media submitted by the OCC, OCES, Conservation Districts, and NRCS will be used to inform citizens in the watershed about programs focused on water quality. Articles may serve as promotions for various upcoming trainings or other events. Other media related activities such as radio spots and logo contests may be used to further the efforts of the program.

Youth education is a significant effort which will continue to be pursued by OCC, OCES, NRCS, and the conservation districts. Most youth education activities focus on general water quality maintenance and improvement and include activities such as 4-H group water quality monitoring and education, "Earth-Day-Every-Day" activities fair where hundreds elementary school children and some of their parents are exposed to environmental education, and various other training sessions.

Attachment, from Watershed Based Plan, page 106

Groundwater Quality

- ***USGS*** – Reconnaissance of hydrology, water quality, and sources of bacterial and nutrient contamination in the Ozark Plateaus aquifer system

Landuse/Land Cover

- ***NRCS and OCC*** – Color digital orthophotos (2003)
- ***OSU Biosystems and Agricultural Engineering*** –
  - Basin-wide Pollution Inventory for the Illinois River Comprehensive Basin Management Program (1996)
  - Illinois River Upland and In-stream Phosphorus Modeling (2006)

Riparian Condition

- ***NRCS*** – Color digital orthophotos (2003)
- ***OSU Biosystems and Agricultural Engineering*** –
  - Basin-wide Pollution Inventory for the Illinois River Comprehensive Basin Management Program (1996)
  - Illinois River Upland and In-stream Phosphorus Modeling (2006)
- ***OCC*** – As part of the Rotating Basin Group 3 project, a 400 meter habitat assessment was performed for each of the two sites in the Illinois River watershed in 2003 and in 2008.

Aquatic Biological Communities

- ***OCC*** – Two sites within the Illinois River watershed are included in Group 3 of the Rotating Basin Project (Table __). As part of this project, macroinvertebrates were collected twice a year from 2003-2004 and 2008-2009, and fish collections were obtained in 2003 and 2008.
- ***OWRB*** – Macroinvertebrates and fish are collected at the six BUMP stream sites in the watershed **(FREQUENCY??? PERIOD OF RECORD?)**
- ***ODWC*** – fish data **(FREQUENCY??? PERIOD OF RECORD?)**
- ***USFWS*** – In support of the ODWC and Oklahoma Biological Survey, assessed the status of mussel communities at 52 Illinois River sites in 1995. This included comparisons to limited historical records from the river made in 1911 and 1989.

Best Management Practices and other Implementation Efforts (Coverages)

- ***NRCS/FSA*** – Records of locations, specific practices installed, and associated costs of programs such as EQIP, WRP, CRP, etc. (ongoing)
- ***OCC*** –
  - Records of locations, specific practices installed, and associated costs of locally-led State Cost-share Program (ongoing)

Ms. Phillips 9

Attachment, from Watershed Based Plan, page 110

OSRC:

The Oklahoma Scenic Rivers Commission (OSRC) has conducted sampling at seven locations along the Illinois River and monitored for turbidity, total nitrogen, nitrate, ortho-phosphate, and total phosphorus. **The OSRC may continue monitoring at certain locations????**

USFWS:

The USFWS is involved in continued monitoring, research, and conservation of the freshwater mussel community of the Illinois River, including the Neosho mucket and rabbitsfoot mussel. These efforts involve support from various cooperating agencies, including the Oklahoma Biological Survey and Oklahoma Department of Transportation.

The USFWS also is involved in continued monitoring, research, and recovery of gray bats inhabiting the Illinois River watershed. These efforts involve support from various cooperating agencies, including the Oklahoma Department of Wildlife Conservation and Rogers State University.

Point Source Monitoring

Information on discharges from waste water treatment plants (WWTPs) will be obtained through Discharge Monitoring Reports (DMR) in order to monitor maximum nutrient, bacteria, and TSS concentrations and exceedance violations during the project period.

ODEQ—anything to add on this???

Lake Monitoring

OWRB:

The OWRB has monitored Lake Tenkiller since **1994. Six** sites are monitored in the lake quarterly during alternate years. The parameters monitored include: temperature, pH, dissolved oxygen, salinity, dissolved oxygen % saturation, oxidation-reduction potential (redox), specific conductance, total dissolved solids (TDS), turbidity, Secchi disk depths, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, kjeldahl nitrogen, orthophosphorus, total phosphorus, true color, chloride, sulfate, total alkalinity, chlorophyll-a, and pheophytin. Vertical water quality profiles are recorded at one meter intervals from the lake surface to the lake bottom for at least three sites per reservoir: in the central pool area near the dam (lacustrine zone), in the upper portion of the lake and in the major arms of the water body (riverine zone), and in the area between the lacustrine zone and the riverine zone (transitional zone).

Army Corps of Engineers (ACOE):

The ACOE has monitored Lake Tenkiller since ___. Recent analyses focused on identification and quantification of toxic blue-green algae. **Future analyses may examine the presence and quantification of mercury in the lake, a response to the recent finding of very high levels of atmospheric mercury in the area.**

Benefits of the Monitoring Plan

Comments on the Draft Illinois River Watershed Based Plan (IRWBP) Developed by Oklahoma Conservation Commission of August 2010

By Agricultural Environmental Management Services (AEMS) and Consumer Protection Services (CPS) Divisions of ODAFF

PP. 39 (Table 20) and 60 (Table 34): Table 20 under a study by Jobe, 1996 indicated an estimated average load at Horseshoe Bend from Point Sources of 12,547 kg/yr of P; while Table 34 under a Study by Storm, 1996 indicated a total loads of all point sources discharges to the lake from 1991-1993 (at Horseshoe Bend) of 92,500 kg/yr of P?

Typo: page 51 is marked on two consecutive pages;

Page 60: 4th paragraph, about ¾ from the top of the paragraph: Tahlequah and Cherokee Nation Wastewater Treatment Facilities were identified as two points sources discharge to Lake Tenkiller, **downstream of Horseshoe Bend**. Please verify this fact.

Page 73, second paragraph on "Nurseries": Revisions should be made on lines 7 and 8 as follows: (deleted: stricken through, added: underlined)

Two major plant nurseries are located along the Illinois River. Irrigation tailwaters from these facilities have been shown to contribute significant quantities of nutrients to the basin. The Oklahoma State Department of Agriculture estimated in 1993 that one of the nurseries on the river contributed as much as 0.3% of the nitrate load and 0.19% of the yearly total phosphorus load to the river. This loading was based on irrigation return flows, without considering storm runoff from the nurseries. Stormwater runoff could have an even more significant impact. In 1998, one of the nurseries ~~became~~ completely ~~containerized,~~ contained their runoff, so that the potential for pollution now occurs only during large rainfall events (runoff) at this location. Both nurseries signed voluntary compliance agreements with ODAFF (in 1996) to reduce the yearly average nitrate level to 10 mg/L and the phosphorus level to 1.0 mg/L. These actions should reduce the potential for significant pollution from this source.

Page 79: Reduction of P by Practice and Modification calculated by Storm (1996) showed that:

Alt.#1: Export all litter out of watershed, no land application would reduce: 15%
Alt. #3: Replacement of litter with commercial Nitrogen would reduce: 22%;

As no litter is used in Alt. #3, 15% reduction in P would be materialized (per Alt. #1); commercial Nitrogen used in the field would support crop growth, which in turn removing P from the soil. The P removal rate should depend on the type of crop grown; rather than additional 7% reduction (to make a total of 22%) as stated in alternative #3.

Page 87, 3rd paragraph: Addition the following languages (underlined) to the end of this paragraph;

The Oklahoma Department of Agriculture, Food, and Forestry (ODAFF) has set a goal of reducing 100% of the agricultural-related pollution in the scenic river watersheds within 10 years (OSE 2006). In support of this goal, ODAFF is currently 1) assisting poultry growers in developing Animal Waste/Nutrient Management Plans; 2) ensuring compliance with these plans; 3) testing soil samples for STP; 4) exploring cost-effective alternative ways to dispose of excess litter; 5) coordinating with other agencies to develop Comprehensive Nutrient Management Plans for point and nonpoint sources in impaired watersheds. In April 2005 ODAFF signed a Cooperative Agreement with NRCS to develop Comprehensive Niutrient Management Plans (CNMP) for Poultry Feeding Operations (PFOs) located in the Eastern part of the State, including those in the Illinois River watershed. Growers are required to sign and follow the directions and

BMPs described in the CNMP in storing, handling and land applying litter. Recently ODAFF applied a Pollution Prevention (P2) grant with EPA Region 6 to provide technical assistance and on-site training to PFO growers in implementing efficiently the BMPs and strictly following the land application rates and setbacks recommended in the CNMPs. Soil samples of the fields, where litter was applied, will also be collected for Soil Test Phoposrus (STPs) analyses for inventory purpose as well as to verify the actual STP levels compared to the projected ones. The grant has been approved by EPA and the project will start in November of this year (2010) and continued for three years.

Page 101: Addition to the end of Table 46, "Specific BMP Projects/Efforts identified for Implementation", following the EQIP program performed by NRCS, of projects conducted by ODAFF (in blue characters):

Task	Federal	State	Cooperator	Total	Agency	Status
EQIP Program	$150,000 - $200,000 annually	$37,500 - $50,000 annually			NRCS	Ongoing
Comprehensive Nutrient Management Plan Development	$180,300* (total project)			$180,300* (total project)	ODAFF	Completed (from 2005-2010)
Pollution Prevention at PFOs and Soil Testing	$67,000** (total for 3 years)	$67,020** (total for 3 years)		$134,020*** (total for 3 years)	ODAFF	Ongoing (starting 11/2010)

*estimate.cost spent in Illi.Riv. watershed is approximately 14% of $180,300 or $25,250;
** estimate.cost spent in Illi.Riv. watershed is approximately 14% of $67,000 or $9,400;
*** estimat.cost spent in Illi.Riv. watershed is approximately 14% of 134,200 or $18,800.

Contact person: Quang Pham, AEMS Division, ODAFF, phone: 522-3553

ODAFF Forestry Services Review Comments on OCC's Draft Watershed Based Plan for the Illinois River Watershed

August 31, 2010

Introductory Comments

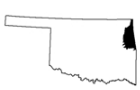
Forestry Services reviewed the draft Watershed Based Plan for the Illinois River Watershed prepared by the Oklahoma Conservation Commission and provides the following comments and recommendations. Our interests within the watershed are primarily in two areas. First, we want to assure that the needs of the area's forestlands and landowners are addressed and any land management practices associated with forestry have minimal impact on water quality. Second, we believe that trees, forests and forestry practices, including riparian area protection and establishment, streamside management zones, erosion control plantings and road BMPs, can help mitigate the impacts of other land uses if appropriately applied.

The watershed is nearly 46% forested. Even though forestry's contribution to water quality problems in the watershed is relatively small, acknowledging the role of forestry and the Forestry BMP Guidelines is important.

We are pleased to see that conversion of some non-forest lands to forest cover is recommended, although high rates of conversion are unlikely. We suggest that plans for planting trees on extensive areas of non-forest land be coordinated closely with the State's Forest Regeneration Center to assure availability of appropriate and adapted plant materials. Forestry Services is expanding the use of containerized hardwoods that are well-suited for planting under typical riparian area conditions, and we have the capacity to produce trees to meet agency expectations. However, we need to know expected quantities at least a year in advance. For example, to have supplies of native, locally-sourced trees available for the 2011-2012 planting season, we need estimated seedling needs by the fall of 2010. Closer coordination with local foresters on planning, species recommendations, scheduling of plantings and landowner assistance would improve the effectiveness of the overall effort.

Specific Comments on the Draft Plan

Pages 13-14 – In the section on Physical/Natural Features, consider using the following ecoregion description of the Ozark Highlands published in the Oklahoma Forest Resource Assessment in June 2010 (citation at end).



> The Ozark Highlands ecoregion is a level to highly dissected plateau composed of flat-lying, cherty limestone and dominated by the oak-hickory forest type. Mean annual rainfall in this humid ecoregion is 41 to 49 inches. The forests are medium-tall to tall, and become savannah-like in parts of the region. Dominant species include post oak, white oak, red oak, black oak, bitternut hickory and shagbark hickory. On better soils, black walnut, pecan, elm, sycamore, ash and other species occur. Hickory becomes less common in the western parts of the area. The extension of this forest into Oklahoma is unusual because it contains sugar maple, beech and basswood, species more commonly found much farther east. Today, rugged areas are forested and nearly level sites are pastureland or hayland. The main land uses are logging, recreation, and especially, poultry and livestock farming. Rapid suburbanization, intensive grazing, and fields receiving waste from poultry farms have significantly increased fecal coliform, phosphorus, and nitrite-nitrate concentrations in receiving waters.
>
> A well-developed forest industry taps the resource for a variety of products, including hardwood lumber, railroad ties, pallets, and specialty products. Protection of water quality, scenic views and wildlife habitat are important considerations for forestry activities. Several high quality and designated scenic rivers occur in the area and support a large recreational industry, and numerous man-made reservoirs provide drinking water and recreational opportunities for Tulsa and surrounding

communities. Karst features are common and numerous caves support a variety of rare species such as Gray and Ozark Big-eared bats, and the Ozark cavefish.

Both habitat diversity and species richness are high, and sensitive fish species are common. Minnows, sunfishes, and darters are plentiful. The banded sculpin and slender madtom occur in small streams, especially where aquatic macrophytes are present, and the southern redbelly dace inhabits headwaters. The shadow bass is nearly limited to the region. Other common fishes include the orangethroat darter, stippled darter, greenside darter, fantail darter, northern hogsucker, white sucker, Ozark minnow, cardinal shiner, and bigeye shiner. The most important game species is the smallmouth bass.

Pages 15-16 – In the section on Land Use, add the following paragraph to characterize the forest industry in the area:

The region's upland and bottomland forests support a small but active forest products industry. According to the U.S. Forest Service's Timber Product Output report for 2005, roundwood timber harvest from Adair, Cherokee, Delaware and Sequoyah counties totaled 2,298 thousand cubic feet, of which 99.7% was hardwood. This represented a 15% increase over survey data from 2002. Since 2005, the annual timber harvest has likely declined in parallel with the overall economic downturn. The primary forest products directory maintained by Oklahoma Forestry Services currently shows eight wood processing plants in or near the watershed, with 21 additional plants in Benton, Crawford and Washington counties in Arkansas. Over the next five to ten years, in addition to traditional forest products, the region's forests will likely attract increased interest for biomass energy and wood pellets.

Page 17 – Although Forestry Services has historically been active in the watershed with landowner assistance, tree planting, education and other activities, we have not undertaken any in-stream water quality monitoring projects to include in this section.

Page 43 – In the next to the last paragraph on this page, change the word "at" to "as" in the third line.

Page 64 – In the last paragraph, spell out "Arkansas" and insert "in rainfall" after "observed." You could relate this statement to your previous statement near the bottom of page 58.

Page 65 – In the first paragraph under Nonpoint Sources, next to last line, please clarify the use of the term "violations" - violations of what specifically?

Page 71 – Substitute the following paragraph for the Silviculture section:

As described in previous sections, timber harvesting and silvicultural activities are common in the watershed, ranging from small-scale firewood cutting to large-scale commercial operations associated with local sawmills. Cutting methods range from selection harvesting systems to clearcutting operations where forest land uses are sustained through natural regeneration. In some cases, harvesting activity may be followed by land conversion to pasture or other non-forestry uses. In areas of steep terrain, erodible soils, Karst formations and near water bodies, logging activity has the potential to impact water quality unless forestry best management practice guidelines are followed. Forest roads are generally recognized as the largest contributor to sediment production from forestry activities. Following appropriate BMP recommendations concerning the width, basal area and integrity of streamside management zones (SMZ) can minimize sediment impacts on streams. Oklahoma Forestry Services has monitored forestry BMP compliance across eastern Oklahoma since 2004. Compliance rates in the northeastern counties for the past two survey periods ranged from 82.3% on 7 randomly-selected sites in 2006 to 86.1% on 5 sites in 2010. These results are in contrast to the 92.1% and 92.3% compliance rates respectively in the southeastern counties where the timber industry is much better developed. Although approximately 45% of the Illinois River watershed is forest, SWAT modeling did not indicate significant loads resulting from forestry operations.

Page 72 – As discussed in the last paragraph on this page, roads have a high potential to contribute to sediment loadings if constructed and maintained without appropriate BMPs. Proper application of forest road BMPs controls surface runoff, reduces channelized flow, reduces sediment production and minimizes stream impacts. These practices should be recommended as preventive measures on all unpaved roads, regardless of the land use with which they are associated.

Pages 77-78 – At the bottom of page 77 and continued in the discussion on page 78, the potential nutrient load reductions described are purely hypothetical based upon the model. Instead of stating them as absolute values, it is more realistic to use ranges or make it clear that these are "hypothetically" possible in the last sentence on page 77.

Page 80 – In the third paragraph, the fifth line, make the word "supports" singular. Here, the draft plan includes considerable emphasis on protection, management and restoration of riparian areas and streambanks to minimize release of sediment and nutrients into streams. We strongly support the role of forests and forestry practices in improving watershed conditions and protecting water quality within the watershed. As mentioned in this paragraph, the high density of perennial and intermittent streams throughout the watershed may act as a disincentive to landowners if SMZ protection requirements are overly stringent or mandatory. In Oklahoma's Forestry BMP Guidelines, we recommend a minimum SMZ width of 50 feet on each side of all perennial and intermittent streams and also recommend leaving an average of at least 50 square feet of tree basal area within the SMZ. In the Illinois River area, these guidelines could result in a high percentage of the land base being in designated SMZs from the standpoint of timber harvesting. Although State statutes provide for a riparian buffer tax credit, participants are limited to those involved with specified government incentives programs. Broadening the tax credit to include owners that are voluntarily retaining, protecting or restoring their SMZs, with or without government assistance, may create additional incentives and encourage greater landowner participation. An example of this approach is the Riparian Buffers Tax Credit in Virginia.

In addition, consider promoting agroforestry practices that combine grazing/hay production with more widely-spaced trees. Landowners may find it more palatable to add tree rows to their grazing and haying operation rather than to convert them to forest cover entirely. This approach may help slow surface runoff, enhance the uptake of nutrients which are then stored in the wood and are subsequently removed from the watershed with timber harvest, sequester carbon and provide timber income while sustaining some level of forage production.

Page 84 – In the third paragraph, work is described under ARRA by OCC and ODWC to restore and stabilize high priority streambanks. ODAFF foresters are available to assist landowners with management plans, tree planting recommendations and follow-up technical assistance in support of this activity.

Page 85 – The third paragraph describes ODAFF activities related to agriculture. Here is an addition concerning forestry:

ODAFF's Forestry Division completed the Oklahoma Forest Resource Assessment in 2010. The State Assessment is a comprehensive analysis of the state's forestlands and associated resources. It identified six critical issues likely to affect the long-term health and sustainability of the state's forests, one of which deals with water. The Assessment also identified priority forestland areas, including the Illinois River Watershed, which the agency will use to focus its resources in the next five years. The companion document, the Oklahoma Forest Resource Strategy, describes specific goals, objectives and strategies that will address the critical issues. Considerable attention will be directed toward forestry BMP implementation.

Page 92 – In item 8, bullet (1), include ODAFF as another agency involved in educational activities in the watershed.

Page 94 – Please replace the first two paragraphs on this page with the following:

The ODAFF Water Quality Forester for the region will also play a key role toward developing an education program that focuses on environmentally sound silvicultural practices for the watershed. Oklahoma Forestry Services has provided technical assistance to the Scenic Rivers Commission in the preparation of the Illinois River Management Plan and on tree planting practices. Forestry Services installed forest road BMPs on a demonstration road in cooperation with OCC on the Spavinaw Creek Demo Farm in 2006. Practices used included broad-based dips, turnouts, gravel, proper grading and an improved stream crossing installed by ODWC.

In recognition of the importance of forest landowner and logger education concerning forestry practices and the BMPs, Forestry Services provides logger training across the region in cooperation with the Arkansas Timber Producers Association. With support from OCC and the Scenic Rivers Commission, Forestry Services carried out a series of BMP workshops and logger 'tailgate sessions' from 2004 to 2008 on the Illinois River and Spavinaw Creek watersheds.

Foresters provide technical forestry assistance to landowners throughout the area, and the Forest Stewardship Program provides interested landowners with a comprehensive written forest management plan developed in consultation with other natural resource specialists. Local foresters are assisting the NRCS with delivery of the Healthy Forest Reserve Program to improve forest habitat for endangered bat species in the area. Agency foresters also assist cities and towns with forest management and tree related issues through its Urban and Community Forestry Program.

Pine and hardwood seedlings are available from Forestry Services' Regeneration Center for forest conservation plantings. Forestry Services also participates in public and landowner information or awareness programs to make people aware of the opportunities for forestry practices to help solve environmental problems on the watershed, the use of forestry BMPs, how to properly conduct a timber sale and/or harvest timber, etc. A variety of educational materials, including a Forestry Note series on water quality and forest road practices, is available. Forestry Services also offers free loan of timber bridgemats from its Tahlequah office to help loggers cross streams and minimize road impacts.

Page 107 – In the ODAFF bullet at the top of this page, include the following after the word 'watershed': "; conduct periodic forestry BMP compliance monitoring on randomly selected timber harvest sites in the watershed (ongoing), and estimate sediment load reductions attributable to the use of forestry BMPs (future)"

Additional References:

Arkansas Forestry Commission website: http://www.forestry.state.ar.us/manage/fidirectory.html

ODAFF, 2010. *Oklahoma Forest Resource Assessment, 2010*. Oklahoma Department of Agriculture, Food & Forestry - Forestry Services, Oklahoma City, Oklahoma

ODAFF, 2007. *Implementation of Forestry Best Management Practices in Eastern Oklahoma, Results of 2004-2006 BMP Implementation Monitoring*, ODAFF-Forestry Services, Oklahoma City

ODAFF, 2010. *Implementation of Forestry Best Management Practices in Eastern Oklahoma, Results of Round Three BMP Implementation Monitoring*, ODAFF-Forestry Services, Oklahoma City

ODAFF, 1991. *Forestry Best Management Practice Guidelines for Water Quality Management in Oklahoma*, Oklahoma Department of Agriculture, Food & Forestry – Forestry Services, Oklahoma City (revision in progress)

ODAFF, 2010. *Oklahoma Forest Resource Strategy – 2010 to 2015 and Beyond*, Oklahoma Department of Agriculture, Food & Forestry - Forestry Services, Oklahoma City

Oklahoma Forestry Services website: http://www.forestry.ok.gov/sawmills

OSU, 1993. *Riparian Forest Buffers*, OSU Extension Fact Sheet No. 5034, Oklahoma State University, Stillwater

USDA Forest Service, 2008. *Oklahoma's Timber Industry-An Assessment of Timber Product Output and Use, 2005*. Southern Research Station, Resource Bulletin SRS-136, Asheville, North Carolina
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August 31, 2010

Stacey Day
Oklahoma Conservation Commission

Dear Stacey,

Although Save the Illinois River, Inc., STIR, is not a member of your watershed group, the OCC's proposed watershed plan is of great interest to us and we would appreciate an opportunity to comment on the draft plan.

Although we had little time to review the very large and detailed document, we have read it and would like to make the following observations for your consideration:

First, in view of the pending TMDL study by U.S. EPA, and in view of the pending Federal District Court lawsuit filed by Oklahoma accusing poultry companies of polluting the Illinois River watershed, it may be wise to withhold the draft plan until these matters are resolved. Certainly the impacts of these matters will have a dramatic bearing on your draft plan.

Further, STIR believes it may be important for your draft plan to recognize and acknowledge the differences in water quality sampling protocols used by Arkansas and Oklahoma to sample nutrients in the Illinois River watershed (stormwater sampling). These differences may account for "forward looking", optimistic study results for phosphorus in the Arkansas portion of the Illinois River watershed.

Further, STIR believes your draft report should recognize and acknowledge the recent agreement by the Northwest Arkansas Conservation Authority to limit phosphorous discharge to less than point-one parts per million at the Osage Creek wastewater treatment facility for Bentonville and Tontitown, Arkansas. This is a significant agreement that may have an impact on future discharge limits for other cities in Arkansas and Oklahoma.

Your draft report states: "There were two remaining permitted point sources that discharged downstream of Horseshoe Bend: Tahlequah and the Cherokee Nation". We believe this is an error as Tahlequah discharges above Horseshoe Bend and the Cherokee Nation no longer has a wastewater treatment plant. Also, there are a couple of references to the OSRC as the OSCR.

STIR is grateful for the opportunity to read your detailed, informative, and very well prepared draft plan and to comment on the plan.

Sincerely,
Ed Brocksmith
Secretary-Treasurer

Copy:
STIR Board of Directors
Robert Kellogg
Ed Fite, OSRC

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ED FITE
ADMINISTRATOR

BRAD HENRY
GOVERNOR

STATE OF OKLAHOMA
OKLAHOMA SCENIC RIVERS COMMISSION

September 3, 2010

Shanon Phillips, Director
Water Quality Division
Oklahoma Conservation Commission
2800 North Lincoln Boulevard, Suite 160
Oklahoma City, OK 73105

Subject: "Draft" *Watershed Based Plan for the Illinois River Watershed*

Dear Shanon,

I'm hopeful the receipt of this letter finds you doing well.

The letter is written to compliment your water quality team and you on the wonderful job accomplished in writing the "draft" *Watershed Based Plan for the Illinois River Watershed (Plan).*

As we've discussed, it is unfortunate that your team was forced by recent USEPA mandate to advance the *Plan* prior to that own agency's completion of a *Total Maximum Daily Load Plan* for the Illinois River Watershed. Nonetheless, your team made the necessary adjustments in your work program and has published an excellent first draft.

While the first draft *Plan* may not be all-encompassing, it certainly addresses all the major issues that Arkansas and Oklahoma have been discussing and working together for almost four decades related to improvement of biological, chemical and physical characteristics of the Illinois River Watershed.

Simply, your team has drafted a *Plan* that Illinois River Watershed Stakeholders may use as their cornerstone to build upon related toward the goal of ever-increasing improvement of water quality, quantity, aesthetics and other considerations.

For your convenience, please find attached a "marked-up" copy of the *Plan* that contains a number of suggested changes. Also attached are additional copies of those recommendations previously provided to your team from Dr. Riley Needham and Mr. Rick Stubblefield, who are members of the Oklahoma Scenic Rivers Commission.

Page 2 – September 3, 2010 OSRC Comment Letter OCC Water Quality Re: *WBPIRW*

Please feel free to contact us if you have any questions or if we may be of further assistance to your team and you.

Thank you for affording our agency the opportunity to review and provide comments on the *Plan*.

Sincerely,

Ed Fite
Administrator

cc: OSRC Board of Commissioners

Attachments

Riley Needham
4000 Silver Lake Road
Bartlesville, OK 74006
August 29, 2010

Ed Fite, Administrator
OKLAHOMA SCENIC RIVERS COMMISSION

Re: Comments on Draft "Watershed Based Plan for the Illinois River Watershed" dated August 2010.

Dear Ed:

I would like to recognize and commend OCC, the cooperating agencies and stakeholders for the data and information in the plan. Taking the lead on work to improve water quality in the Illinois River watershed is a huge responsibility on behalf of the Citizens of Oklahoma and OCC has my support for that goal.

At this time, I can not add monitoring data taken from the Illinois River Watershed. I would like to focus my comments on the issue of monitoring and the setting of the goals to protect the beneficial uses of the waters. Although water gardens, tree plantings, trash pickup, sediment control, bank stabilization, septic tank monitoring and etc, all have a role to play, we must not divert out site from the "center stage performer"---Total Phosphorus. Total phosphorus is the engine driving the major cause of the pollution of the watershed.

My specific comments and suggestions are:

1. Target the development of an inventory of the total phosphorus (TP) into and out of the watershed. Evaluate how to limit the input and increase the safe output from the watershed. Sending the TP out through our water is not acceptable. I think basic data on the major sources are available from the watershed plan. From the data in the plan we can see major contributions from both point sources and non-point sources. From the point source data we are not close to the capability of the WWTP technology for effluent TP. I will provide information on this at one of the upcoming OSRC meetings.

   From my perspective, we have yet to develop and adopt a comprehensive and effective management system for the control of the non-point sources.

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Aug 30 10 09:31a Debbie Walker 1-918-682-2047 p.3

2. We are not monitoring all of the important parameters to access water quality for its beneficial uses. I found no data on measurements of toxin concentrations produced from algae that are known to be a health hazard for full body contact and also for use as a source of drinking water.

   We all know of some of the difficulties that Tulsa had with the drinking water quality caused by algae in the Spavinaw/Eucha water source.

   The body contact hazard with toxins from algae has not been recognized in the monitoring of water in Oklahoma.

3. The scientific basis of the monitoring program for beneficial use attainment is flawed. Using a Carlson TSI of 62, as the basis for attainment of the aesthetic benefit is ridiculous from a science based evaluation. Go back and review the TSI used in the Wetzel report on Spavinaw/Eucha to get a "science judgement based" number for manageable waters. The recommendation was a TSI of ~50 or less!

   The TSI measurement method used in the beneficial use monitoring program is not correct. Biological parameters---Chlorophyll a and transparency---must be measured for the Carlson TSI at the peak growing season—not year around. We do not measure the growth potential of bermuda grass in January! Likewise, the Carlson TSI uses only the peak growing season months for evaluation. The bias caused by the method of measurement is estimated to cause a reported reduction in TSI of 2-3 units. At the Hypereutrophic level of Lake Tenkiller this has a huge impact.

   I will further document the science basis of my comments, as time is available.

   Thank you and OCC for the opportunity to review and comment on the Watershed Plan. I look forward to being a part of the development of a plan ans system to improve the quality of the water of the Illinois Watershed.

Respectfully,

Riley Needham

Riley Needham

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