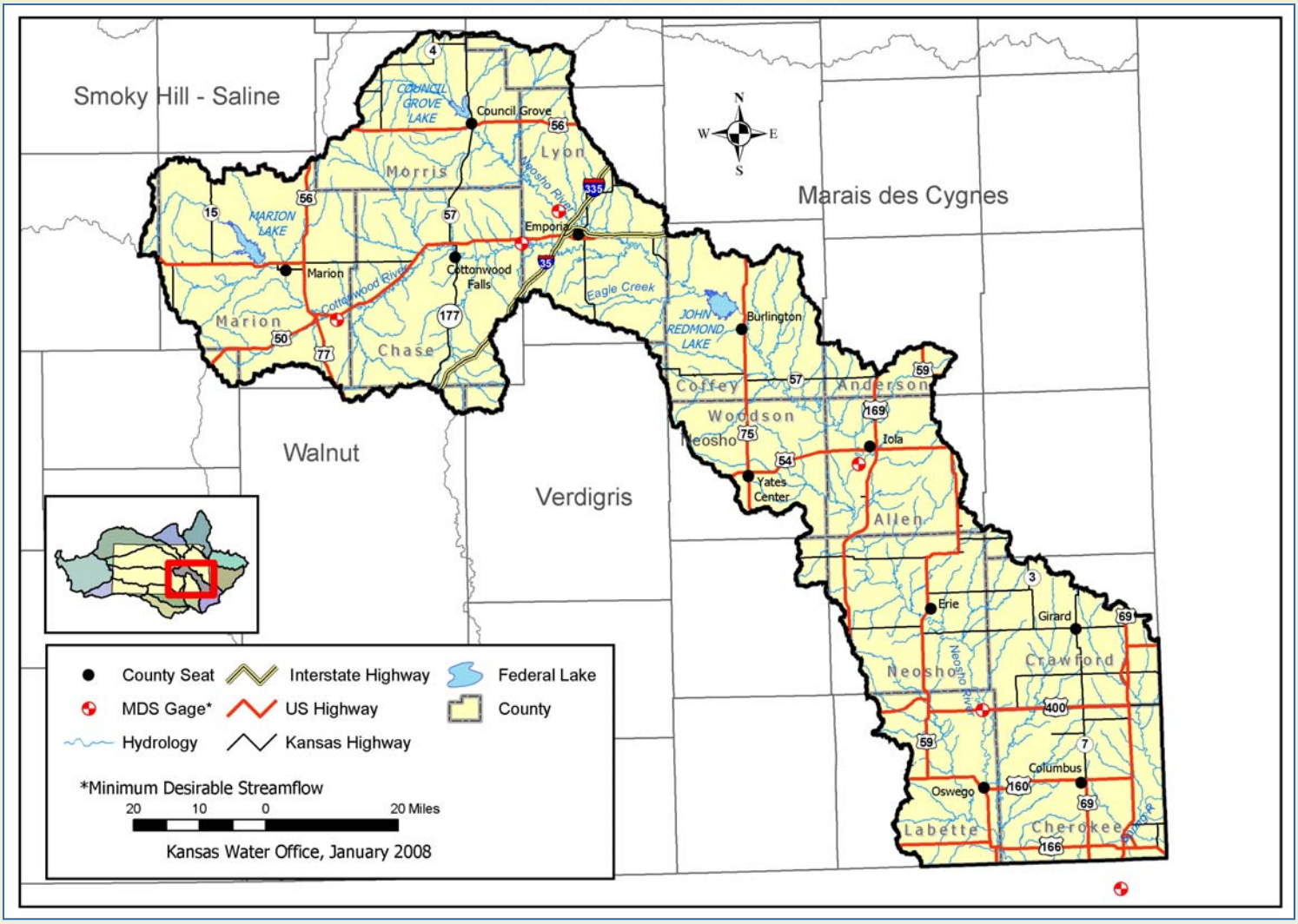
Neosho River Basin

January 2009



General Description

The Neosho River basin covers approximately 6,300 square miles and encompasses all or parts of 18 counties in southeastern and east central Kansas. The area is drained by the Neosho River and its tributaries which also drain parts of Missouri, Arkansas, and Oklahoma. The Neosho Basin includes HUCs 11070201 through 11070207 in Kansas.

The major streams in the basin are the Neosho River and two major tributaries: the Cottonwood River and the Spring River. The Neosho River rises in Morris County and flows southeast to join the Arkansas River near Muskogee, Oklahoma. The Cottonwood River rises in Marion County and joins the Neosho River in Lyon County east of Emporia. The Spring River in the southeast part of the state originates in Missouri and drains about 500 square miles in Kansas. It enters Cherokee County in the east, flows across the southeastern corner of that county, and joins the Neosho River in Oklahoma a short distance below the Kansas state line.

The larger tributaries of the Cottonwood River are South Cottonwood River, Mud Creek, Clear Creek, Doyle Creek, Cedar Creek, Middle Creek, Diamond Creek, and South Fork Cottonwood River. Tributaries to the Neosho with drainage areas greater than 70 square miles are Rock and Allen Creeks above Emporia, and Eagle Creek, Long Creek, Big Creek, Turkey Creek, Deer Creek, Elm Creek, Owl Creek, another Big Creek, Flat Rock Creek, Lightning Creek, Cherry Creek, and Labette Creek below Emporia.

Elevations in the basin range from 1,320 feet in Marion County at the top of the basin to 826 feet in Cherokee County at the bottom of the basin in Kansas.

There are three major federal reservoirs in the river system: Marion Reservoir is on the Cottonwood River and Council Grove and John Redmond Reservoirs are on the mainstem of the Neosho River. Ground water is found in alluvial deposits along major streams.

***Population and Economy*[8]**

Major cities in the basin include, proceeding generally from northwest to southeast, Hillsboro, Marion, Council Grove, Strong City, Emporia, Burlington, Iola, Chanute, Parsons, Oswego, Pittsburg, Galena and Baxter Springs.

Downtown Council Grove.
Photo courtesy Kansas Geological Survey

There were an estimated 174,000 residents in the basin in the year 2000. The population of 13 of the counties that have significant land area in the basin was 204,349 in 2000 and is projected to decline to 189,127 by the year 2040. No counties in the basin are expected to gain population during this time but the more rural counties are projected to lose proportionally more population than the counties having regional urban centers. For example, the population of Chase County is projected to have a 15% decrease, while the population of Crawford County is projected to have only a 2 percent decrease by the year 2040.[9]

The local economy is based primarily on agriculture, general manufacturing, and retail trades. The major crops grown in the basin include wheat, grain sorghum and soybeans. The value of crop production in 2006 was estimated to be $372,524,860. The production of beef cattle is another important part of the area's agricultural economy. The value of livestock production in 2006 was estimated to be $261,789,300.[5]

The Neosho basin has a greater variety of minerals than any other area in Kansas. The production of oil and gas is a relatively small but important component of the economy. A significant amount of coal, lead and zinc mining occurred historically in the southeastern portion of the basin. Strip mining of coal is the only one of these mining activities which continues today. Lead and zinc mining peaked in 1926 and by 1958, mining of these minerals had all but ceased. Legacy heavy metal pollution[11] and dangerous underground mine shafts still plague southeast Kansas.

Natural resources of economic importance to area economies are oil, gas, cement, ceramic materials, coal, lead, zinc, stone, and sand and gravel. An additional component of the local economy is the only nuclear powered generating plant in Kansas, located near Burlington. The Wolf Creek Nuclear Power Plant is the largest single water user in the basin. A large biodiesel plant is under construction (November 2007) in Emporia.

Wolf Creek Nuclear Power Plant. Photo courtesy KGS

Water based recreation is important to the economy of the basin with three federal reservoirs, a State Fishing Lake in every county, and nine community lakes attracting boaters, anglers, hunters and campers. State Parks and commercial marinas are located on and around the federal reservoirs in the basin.

Located on the broad, flat flood plain below the junction of Flat Rock Creek and the Neosho River, the Mined Land Wildlife Area is a man-made marsh developed by the Kansas Department of Wildlife and Parks (KDWP) in 1960.

The area covers 3,246 acres. The five largest pools on the area represent 1,675 acres of the 1,787 of intensively managed wetlands. There are 16 independently managed wetlands throughout the area. The area was primarily designed, and is managed to, furnish a resting and feeding place for migratory waterfowl.

Emporia State University and Pittsburg State University provide opportunities for higher education as well as numerous community colleges including Ft. Scott, Labette County and Neosho County community colleges.

Physical Characteristics

Geology and Soils

The Neosho Basin lies chiefly in the Osage Cuestas section of the Central Lowlands Ecoregion.(2) However, all three subdivisions of that ecoregion occur in the Neosho Basin: The Flint Hills Upland, the Osage Cuestas, and the Cherokee Lowlands. The Flint Hills, in the western part of the basin, are an area of outcrop of flint-bearing Permian rocks. The Osage Cuestas division occupies over one half of the basin and is characterized by many east-facing escarpments which trend irregularly from north-northeast to south-southwest across the basin. Southeast of the Osage Cuestas section of the basin is the Cherokee Lowlands area. This is an erosional plain which slopes to the west at about 10 feet per mile.

Most of the consolidated surface rocks in the basin are of Pennsylvanian and Permian age. These rocks consist of alternating thin beds of limestone and shale. Coal is present in some areas. Mississippian age rocks are exposed in a small area in the extreme southeast corner of Cherokee County. Mostly composed of limestones and cherty limestones, these areas contain lead and zinc ores. Small areas of Cretaceous and Tertiary rocks are exposed in Marion and McPherson counties. The flood plains and terraces associated with the streams consist of deposits of clay, silt, sand, and gravel, which are mostly of more recent Quaternary age.

There are nine major soil groups in the basin. Soil types include fine textured low permeability types, silt loams, sand silt loams, dense claypans, and alluvial and terrace soils. More detailed soil information can be found on county soil maps.(12)

Clements stone arch bridge over Cottonwood River
Photo courtesy Kansas Geological Survey.

Land Use/Land Cover

The predominant features in the basin are the grasslands of the Flint Hills in the northwestern part of the basin, crop land in the Neosho River and other flood plains, in the Marion Reservoir watershed, and in the Cherokee County area, and the urbanized areas described previously.

Plant communities in the study area include Oak-Hickory Forest, Floodplain Forest, Cross Timbers, Cedar Glades, Bluestem Prairie, and Bluestem-Grama Prairie. Grassland (56%), and row crops, (38%) are the most widespread land cover classes covering about 3,738,540 acres of the basin.

In 2006, there were 8,530 farms covering 4,708,000 acres in the thirteen counties with significant area in the basin. The average farm size was 551 acres.(3)

The basin contains many important highway and rail transportation arteries. The basin map shows locations and coverage.

According to the 2003 Assessment of Riparian Areas Inventory by the Kansas Geological Survey (KGS), of the 37,257 bank miles of riparian area, within a 100 ft corridor along each bank in the basin, the dominant riparian cover is pasture/grassland (31%).

The second most common cover is forest land (25%), and third most common cover is a mixture of pasture and trees (20%)

The remaining riparian cover types, in descending order of dominance, are crop land, crop land/tree mix, shrub land, urban, urban/tree mix, and barren land. Overall land use/land cover in the basin mirrors riparian land use/cover with grassland covering 56% of the area, crop land covering 32%, and woodlands covering about 7 percent. The balance is made up of urban uses and water.(6)

Climate

The climate of the Neosho basin is humid in the southeastern half and sub-humid in the northwestern half. The annual precipitation in the basin varies from approximately 30 inches in the western-most part of the basin to almost 42 inches in the southeast. Approximately 70% of this precipitation falls between April and September. Ten to 18 inches of snow falls in an average winter. Table 1 illustrates variation in annual average precipitation and temperature, and freeze dates from areas in the northern, middle, and southern parts of the basin.

Table 1
Climate Summary
Neosho Basin

	Average Annual[1]		Freeze Dates (32 F.)[2]		
Location	Precipitation (inches)	Temperature (deg. F.)	Last in Spring	First in Fall	Frost Free Days
Cottonwood Falls	35.91	54.3	Apr. 19	Oct. 14	179
Iola	41.84	55.8	Apr. 11	Oct. 23	195
Columbus	44.47	56.2	Apr. 13	Oct. 22	192

[1] Source: National Climatic Data Center (1971-2000 data)
[2] Source: KSU Weather Data Library (1961-1990 data)

Wildlife and Habitat

The Tallgrass Prairie National Preserve in the Flint Hills, covering 1,895 acres, was established in 1997. The preserve protects a nationally significant example of the once vast tallgrass ecosystem. Of the 400,000 acres once covered in the North American Continent, less than 4 percent remains, primarily in the Flint Hills of Kansas. The Flint Hills National Wildlife Refuge above John Redmond Reservoir is one of a system of over 500 refuges administered by the U.S. Fish and Wildlife Service (USFWS) dedicated to the preservation and conservation of wildlife. Named for the Flint Hills Region just to the west, the refuge consists of 18,500 acres located on the upstream portion of John Redmond Reservoir on land owned by the U.S. Army Corps of Engineers (Corps).

Established in 1966, the refuge is managed primarily for migratory waterfowl. Intensive use by ducks and geese occurs during the spring and fall migration. Surrounding farmlands are managed on a share basis with area farmers with the refuge share providing food for migrating waterfowl and resident wildlife. Numerous ponds and a system of shallow marshes provide additional waterfowl habitat. Waterfowl and bald eagle management requires that portions of the refuge be closed and that public access be restricted during periods of intensive waterfowl use.

Shermerhorn Cave, South of Galena.
Photo courtesy Kansas Geological Survey.

Schermerhorn Park, just south of Galena in the southeast corner of the basin, contains a small part of the Ozark oak-hickory forest ecosystem. Many of the threatened and endangered (T & E) species live in the “Kansas Ozarks”. The area is characterized by sinkholes, caves, swift streams, and steep cliffs.

Much of the original Ozark oak-hickory forestlands still remain in this region. Spring River and Shoal Creek are in this area and provide unique aquatic habitat for many species.

There are 36 T&E species in the Neosho basin. Of these, one is an insect, three are mammals, 10 are mussels, seven are birds, and four are fish. For additional information on critical habitat for these species, please see the KDWP[13] website in the references.

Because the basin covers a large geographic area with many ecosystem types and diverse land uses, the potential for habitat alteration is widespread resulting in pressures on populations of important species.

Water Resources

There are three federal reservoirs in the basin: Marion, Council Grove, and John Redmond. Coffey County State Fishing Lake provides cooling water for the Wolf Creek Nuclear Power Plant. All counties have state fishing lakes. Council Grove City Lake serves as a water supply for the city of Council Grove. Other localized resources that provide various services including water supply, recreation and habitat, include Jones Park Pond, Olpe City Lake, Gridley City Lake, Altamont City Lake, Bartlett City Lake, Lake Kahola, Mined Land Resources Area and Lake, Parsons Lake, Pittsburg College Lake, Marion County Lake, New Strawn City Lake, and Playter's Lake.

Lake Kahola spillway
Photo courtesy Kansas Geological Survey.

Eighty percent of the streams in the basin are intermittent and 20% are perennial streams, for a total of 16,696 miles. Average stream density is 2.7 stream miles/square mile of area, the second highest density of all 12 basins in the state.

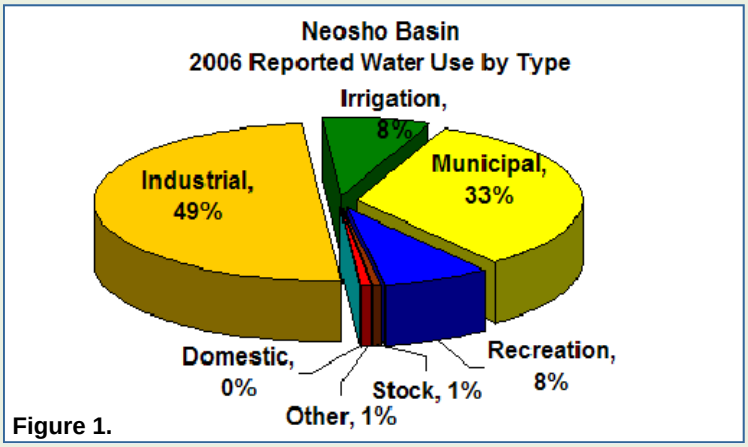


Figure 1.

The Ozark Plateau aquifer system and Spring River are water resources shared by Arkansas, Kansas, Missouri, and Oklahoma. Demand for water in the region is growing rapidly and concerns about water level declines and potential water quality degradation have prompted long-term management actions. See the Ozark Aquifer Priority Issue in this section for more information.

Nearly 77% of water used in the basin is from surface sources (2006 water use). About 49% of water used is for industrial use, (54% of this from surface water and 45% from ground water), making it the highest use type in the basin, followed by 33% for municipal use, about 8 percent for recreational use and 8 percent for irrigation use (Figure 1).[7]

Water Management

Significant water management entities include conservation districts throughout the basin, the See-Kan, Flint Hills and Lake Region Resource Conservation and Development Councils RC&Ds and 15 active watershed districts. By virtue of its responsibility for three major reservoirs, the Corps is another important water manager in the basin.

Watershed Restoration and Protection Strategy (WRAPS) groups are an emerging water management entity in the basin. These are coordinated by various entities including the See-Kan and Flint Hills RC&Ds, and local conservation districts.

Voluntary watershed management plans are developed by local stakeholders. The plans include management goals intended to improve the overall condition of land and water in the watershed. WRAPS groups have been formed above all three federal reservoirs, along Eagle Creek, the Spring River, and the area below John Redmond Reservoir.

The cities of Parson, Pittsburg, and Emporia are permitted under the KDHE Phase II Stormwater Permit Program. These municipalities are responsible for developing stormwater management programs to address both the quality and quantity of stormwater runoff within their boundaries.

Resources

1. KS Water Plan 2003—Neosho Basin Section.
2. Geology and Soils – Kansas Water Resources Board Preliminary Assessment reports; Ecoregion descriptions.
3. United States Geological Survey 2000. K. E. Juracek. Report No. 00-4177 “Estimation and Comparison of Potential Runoff Contributing Areas in Kansas Using Topographic, Soil, and Land Use Information.
4. Kansas Water Office Reservoir Fact Sheets.
5. USDA, Kansas 2006-2007 County Farm Facts, Agricultural Statistics and Ranking.
6. Wilson, Brownie, Assessment of Riparian Areas Inventory, State of Kansas, 2003. http://hercules.kgs.ku.edu/geohydro/ofr/2003_55/riparian/ofr_2003_55e.htm.
7. WRIS database, Division of Water Resources, December 13, 2007.
8. US Census Data—2000.
9. County Population Estimates. KS Division of Budget. 2007.
10. Verdigris Unit Report—Kansas Water Resources Board Water Plan Studies.
11. Residual effects of lead and zinc mining on freshwater mussels in the Spring River Basin (Kansas, Missouri, and Oklahoma, USA. Robert t. Angelo, M. Steve Cringan, Diana L. Chamberlain, Anthony J. Stahl, Stephen G. Haslouer, Clint A. Goodrich. Kansas Department of Health and Enviroment, may 2007.
12. http://www.ks.nrcs.gov/news/annual_rpt02/soil.html
13. http://www.kdwp.state.ks.us/news/other-services/Threatened-and-Endangered-species

Impacts of Historic Mining Activities

Galena is a rural community located in southeast Kansas, within the Tri-State Mining District EPA Superfund Site in Cherokee County. For over a century, lead and zinc were mined in the region and resulted in production of nearly 3,000 abandoned mine shafts in Cherokee County. Even though lead and zinc mining activities subsided in the latter half of the 20th century, numerous environmental problems and other hazards remain.

Waste mine tailings, also known as chat, which are byproducts of the mining and milling processes for lead and zinc ore, cover 4,000 acres in southeastern Cherokee County according to the KGS. Chat hazards were not limited to just the tailings piles because the wind blew fine metal-bearing dust from tailings piles, spreading the contamination. In addition, leaching from the waste mine tailings has contaminated wells and ground water, with runoff moving contaminants into nearby streams and rivers.

Another by-product of mining operations was highly acidic mine drainage (acidic water, containing metals that can contaminate streams). When the lead and zinc mines were abandoned, they filled with water, and began contaminating local aquifers and surface waters.

Mining waste at Galena. Photo courtesy Kansas Geological Survey.

Neosho River Basin Management Categories

January 2009

WATER CATEGORIES

The following categories include issues identified in the Neosho River basin plan as items that require attention in addition to the basin priority issues. These issues are addressed within the following management categories:

- Water Management
- Water Conservation
- Public Water Supply
- Water Quality
- Wetland and Riparian Management
- Flood Management
- Water-Based Recreation

These categories also correspond to the statewide management categories and policies of the *Kansas Water Plan* found in Volume II. These documents contain new policy issues and the existing policy and statutory framework that relate to the management categories.

ISSUE: WATER MANAGEMENT

Applicable *Kansas Water Plan* Objectives

- Achieve sustainable yield management of Kansas surface and ground water sources outside of the Ogallala-High Plains aquifer and areas specifically exempt by regulation. Sustainable yield management would be a goal that sets water management criteria to ensure long term trends in water use will move as close as possible to stable ground water levels and maintenance of sufficient streamflows.

Applicable Programs

The following programs help to meet the objectives in the Water Management (quantity) category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Geological Survey and Kansas Department of Agriculture-Division of Water Resources: Water Well Measurement
- Kansas Geological Survey: Stream Aquifer Interactions
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program
- Kansas Water Office: Water Marketing Program
- Kansas Water Office: Water Assurance Program

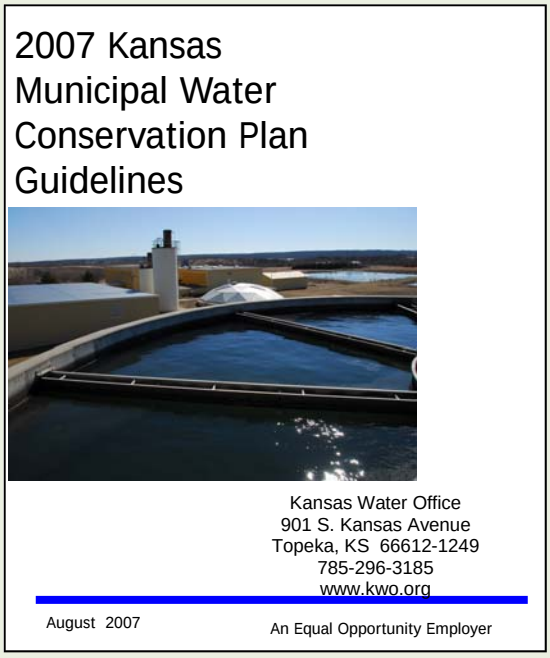
ISSUE: WATER CONSERVATION

Water conservation is essential for the effective management of water resources in the basin to assure that a sufficient, long-term supply of water is available for the beneficial uses of the people of the state. Conservation is defined as a careful preservation and protection of something, especially the planned management of a natural resource to prevent exploitation or destruction.

Water conservation activities apply to all uses; irrigation, municipal, industrial, etc, from all sources. Municipal (33%) and industrial uses (49%) account for the majority of water used in the basin. Irrigation and recreation uses both accounted for 8 percent with stock water (1 percent) and other uses (1 percent) making up the balance (2006).

Of the 111 public water suppliers in the basin 83 have developed a water conservation plan as of 2006. Twenty four plans following the new 2007 guidelines have been updated.

Most water utilities consider water as a commodity and encourage the use of water by their customers by striving to keep rates low. The availability of plentiful inexpensive water is promoted by communities in attracting new growth. More recently, communities are adopting rate structures that result in increased unit cost with increased use. This is one form of demand management.



The four basic types of water rate structures used in Kansas are described as flat rate, decreasing block rate, uniform block rate, and increasing block rate. Utilities with a flat rate charge each customer a fixed amount per month regardless of the amount of water used. With a decreasing block rate, the unit cost of water decreases

Neosho River Basin Management Categories

as usage increases. The unit cost of water is the same for all levels of usage with a uniform block rate. With an increasing block rate, the unit cost of water rises as usage increases.

The type of rate structure can affect gallons per capita per day (gpcd) usage. Systems with flat rates tend to use considerably more water per capita than systems that meter customer use. The other three types of rate structures, in which cost depends on amount of water used, have a less dramatic effect on gpcd. Decreasing block rates are assumed to discourage conservation because customers are charged lower rates for high-volume usage. Increasing block rates are considered an effective way to promote conservation among high-volume users while keeping the cost of moderate use affordable. However, the use of these types of rate structures does not appear to influence usage by individual customers as much as does the total monthly water cost and the geographic area in which they live.

Municipal Water Conservation Plans include drought stage triggers (Table 1) that are the signals that water shortage or other conditions indicative of drought have reached certain stages or levels. They act as the signal to begin implementation of actions appropriate to the stage. Triggers may be related to supply conditions or demand levels. A given stage should have more than one trigger to confirm that conditions are worsening. A water utility or other municipal water entity should enact the appropriate stage whenever the agreed upon set of triggers is reached. Delay in action may lead to a major disruption of the water supply system at a later time.

Table 1

Drought Stage Triggers used by public water suppliers with surface water sources:

1. Lake level in terms of elevation or capacity.
2. Stream level in terms of flow or stage.
3. Water level in relation to the dam.
4. Peak daily demand levels.
5. Percent capacity of treatment plant operations over a number of days.
6. Capacity of water system storage and ability to recover.
7. The provider for purchased water has issued a drought stage.
8. Emergency conditions related to repairs or water quality.
9. The Kansas Water Office has issued a drought stage based on the remaining water marketing storage in a basin reservoir.

Unaccounted for water includes any unmetered uses such as water used for fire fighting, plus water loss in the distribution system. Technical assistance is available through KWO for systems with more than 30% unaccounted for water. High amounts of unaccounted for water may result from water line breaks, under registering customers, unmetered uses, faulty metering, or inaccurate accounting. The statewide average percentage of unaccounted for water use in 2006 was 14%. Management of unaccounted for water is a fundamental tool in providing adequate water supply. Some unaccounted for water represents water that has been treated and then has been wasted and lost the potential to be put to beneficial uses.

Applicable *Kansas Water Plan* Objectives

- Reduce the number of public water suppliers with excessive “unaccounted for” water by first targeting those with 30 percent or more “unaccounted for” water.
- All non-domestic points of diversion meeting predetermined criteria will be metered, gaged, or otherwise measured.
- Conservation plans will be required for water rights meeting priority criteria under K.S.A. 82a-733 if it is determined that such a plan would result in significant water management improvement.

Applicable Programs

The following programs help to meet the objectives in the Water Conservation management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas State University Research and Extension: Water Conservation and Management Program
- State Conservation Commission: Water Resources Cost-Share Program
- Kansas Water Office: Water Conservation Program
- USDA-Farm Services Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

See Water Supply Management and Conservation Basin Priority Issue.

In addition to the Basin Priority Issue Water Supply Management and Conservation, there are continuing needs

Neosho River Basin Management Categories

to ensure that programs are in place and managed to address reducing the number of public water supply systems that are vulnerable to drought, and ensuring that systems have the technical, financial and managerial capacity to meet future needs for water quality and quantity.

Drought vulnerable water supplies are those suppliers most likely to be first impacted by drought due to basic source, distribution system or treatment capacity limitations; or that rely on a single well as a water supply source. Drought vulnerable water supplies were surveyed in 2003 and 2006. The number of public water suppliers considered drought vulnerable decreased from five to zero between the two surveys. There are currently no drought vulnerable water supplies in the basin. These reductions can be attributed to the Kansas Department of Health and Environment efforts in the Technical, Financial and Managerial and the KANCAP Programs.

There are 111 public water suppliers in the Neosho basin, of which 56 are rural water districts. There are six public wholesale water supply districts (PWWSDs) in the basin. About 77% of water used is from surface sources. The Cottonwood/Neosho River Basin Assurance District is also active in the basin. The Corps operates Council Grove, Marion and John Redmond reservoirs in coordination with the state to meet assurance district member's needs during periods of low flow.

Water usage in gpcd is calculated for each water system in the state from reported data on water use and population served. Average gpcd figures for large, medium, and small water suppliers are calculated in eight regions of the state based on similar geographic areas. The Neosho basin is located in regions 7 and 8. Average gpcd for large, medium and small suppliers in region 7 are 148, 107, and 96 respectively. Average gpcd in region 8 are 130, 102 and 84 for large, medium and small suppliers. This serves as a reference to indicate if individual suppliers are above or below average usage for the region.

Applicable *Kansas Water Plan* Objectives

- Ensure that sufficient surface water storage is available to meet projected year 2040 public water supply needs for areas of Kansas with current or potential access to surface water storage.
- Less than five percent of public water suppliers will be drought vulnerable.
- Ensure that all public water suppliers have the technical, financial and managerial capability to meet their needs and to meet Safe Drinking Water Act requirements.

Applicable Programs

The following programs help to meet the objectives in the Public Water Supply management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Department of Health and Environment: Public Water Supply Program
- Kansas Water Office: State Water Planning Program
- Kansas Water Office: Water Conservation Program

ISSUE: WATER QUALITY

See the Watershed Restoration and Protection Basin Priority Issue

Water quality and related water resource issues are addressed through a combination of watershed restoration and protection efforts utilizing voluntary, incentive-based approaches, as well as regulatory programs.

Applicable *Kansas Water Plan* Objectives

- Reduce the average concentration of bacteria, biochemical oxygen demand, solids, metals, nutrients, pesticides and sediment that adversely affect the water quality of Kansas lakes and streams.
- Ensure that water quality conditions are maintained at a level equal to or better than year 2000 conditions.
- Reduce the average concentration of dissolved solids, metals, nitrates, pesticides and volatile organic chemicals that adversely affect the water quality of Kansas ground water.
- Maintain, enhance, or restore priority wetlands and riparian areas.
- Nutrient reduction goals will be included in all WRAPS projects within the basin.
- All public water suppliers will complete and implement a source water protection plan.

Applicable Programs

The following programs help to meet the objectives in the Water Quality management category. For more information on the programs and associated policies, see the Programs Manual.

Neosho River Basin Management Categories

- Kansas Department of Health and Environment: State Water Plan Program (Contamination Remediation)
- Kansas Corporation Commission: Conservation Division Programs
- Kansas Department of Health and Environment: Local Environmental Protection Program
- Kansas Department of Health and Environment: Watershed Management Section/WRAPS
- State Conservation Commission: Nonpoint Source Pollution Control Program
- State Conservation Commission: Water Resources Cost-Share Program

ISSUE: WETLAND AND RIPARIAN MANAGEMENT

See the Watershed Restoration and Protection Priority Issue for a discussion of current activities concerning wetland and riparian area protection.

The primary approach to wetland and riparian management in the basin focuses on providing technical and financial assistance to landowners to protect and restore these resources in priority watersheds through the implementation of best management practices.

Applicable *Kansas Water Plan* Objectives

- Maintain, enhance or restore priority wetlands and riparian areas.

Applicable Programs

The following programs help to meet the objectives in the Wetland and Riparian Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Forest Service: Forest Stewardship Program and Conservation Tree Planting Program
- State Conservation Commission: Riparian and Wetland Protection Program
- State Conservation Commission: Kansas Water Quality Buffer Initiative
- Kansas Water Office: State Water Planning Program
- Kansas Department of Wildlife and Parks: Wildlife Habitat Improvement Program

ISSUE: FLOOD MANAGEMENT

The primary approach to flood management in the basin focuses on floodplain management through community participation in the National Flood Insurance Program (NFIP) administered by the Kansas Department of Agriculture-Division of Water Resources (DWR) and the reduction of rural flood damages through the construction of watershed dams in organized watershed districts.

The Neosho basin has 42 communities (cities and counties) participating in the NFIP. One community has been suspended from the program and nine communities with identified flood hazard areas do not participate. The counties, and incorporated cities within each, shown in Table 2 are in the process of updating their flood maps and will receive new flood hazard zone maps by September 2010. The counties and incorporated communities within each, listed in Table 3 have received new Flood Insurance Rate maps.

There are 15 active watershed districts in the basin.

Applicable *Kansas Water Plan* Objectives

- Reduce the vulnerability to damage from floods within identified priority communities or areas.

Table 2
Updating Flood Hazard Maps

Allen County
Crawford County
Marion County
Labette County
Neosho County

Table 3
New Countywide Flood Insurance Rate Maps

Lyon County	Feb. 20, 2008
Cherokee County	Nov. 19, 2009

Applicable Programs

The following programs help to meet the objectives in the Flood Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Structures Program/Floodplain Management
- State Conservation Commission: Watershed Dam Construction Program
- State Conservation Commission: Watershed Planning Assistance Program

Neosho River Basin Management Categories

ISSUE: WATER-BASED RECREATION

Rivers, streams and lakes of Kansas represent a valuable recreational resource. Consideration of water based recreation problems and concerns are addressed in the Water-Based Recreation Policy Section. Even though the Neosho basin has a wide variety and fairly high number of public water recreation sites proportional to the area covered, there is a demand for more water based-recreation facilities to meet the needs of the population.

The Neosho River and its tributaries are not among the three rivers in the state legally open for public access. The approach to enhancing opportunities for recreation is to improve access to water bodies that exist in the basin that are open to public use.

Applicable *Kansas Water Plan* Objectives

- Increase public recreational opportunities at Kansas lakes and streams.

Applicable Programs

The following programs help to meet the objectives in the Water-Based Recreation management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Wildlife and Parks: Rivers and Stream Access
- Kansas Department of Wildlife and Parks: Community Fisheries Assistance Program
- Kansas Water Office: State water planning.

ISSUES FOR FUTURE CONSIDERATION

Comprehensive Flood Assessment.

Neosho Basin High Priority Issue
Watershed Restoration and Protection
January 2009

Issue

Watershed Restoration and Protection efforts are needed to address a variety of water quality and water resource concerns such as achieving Total Maximum Daily Loads (TMDL), Nutrient Reduction goals, development of Source Water Protection Plans, reduction of sedimentation in reservoirs and lakes, and protection or restoration of wetland and riparian habitats.

Description

There are three federal reservoirs in the Neosho basin: Marion, Council Grove, and John Redmond. All of these reservoirs are operated by the U.S. Army Corps of Engineers (Corps). All three reservoirs are used for public water supply programs that serve numerous cities and rural water districts. The reservoirs are also managed by the Corps for flood control and recreation.

All three reservoirs, and many streams and tributaries that connect them, are experiencing water quality impairments. Fecal coliform bacteria and low levels of dissolved oxygen are the most prevalent stream impairments. Sedimentation and eutrophication are the most prevalent reservoir and lake impairments.

Reservoir sedimentation is a major water quantity concern, particularly in reservoirs where the state owns storage for the Water Marketing Program, or where an assurance district owns storage. As sediment accumulates in a reservoir's multi-purpose pool, the capacity for water supply storage is reduced. Figure 1 shows the estimated percent of multipurpose pool capacity lost, including water supply storage, to sediment deposition in federal reservoirs in the Neosho basin since construction.

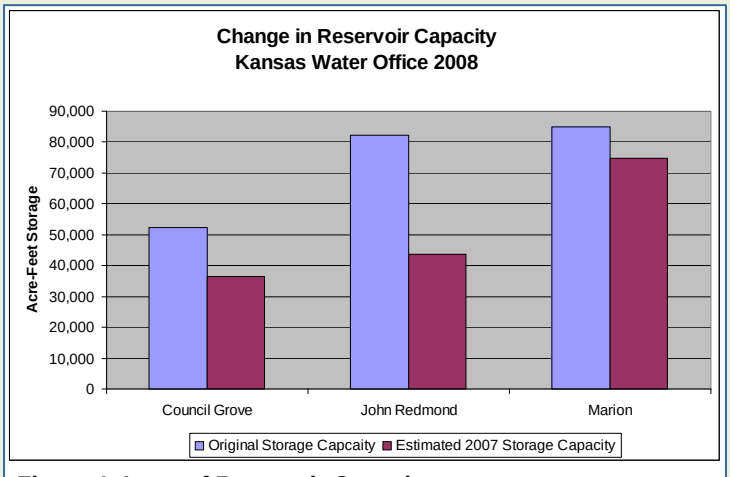


Figure 1. Loss of Reservoir Capacity

Loss of capacity in John Redmond Reservoir is the most pressing issue among the three reservoirs. Efforts are underway to determine the sources of sediment and to identify actions most likely to result in improvement in long term reservoir storage capacity. These efforts are described in other parts of this section.

Water Quality Impairments

Water quality protection and improvement is most effectively addressed at the watershed level, using regulatory and non-regulatory programs. Surface water quality monitoring is conducted to assess the level of pollutants in the water and the health of the biological community. If monitoring indicates that a river segment or other water body is consistently violating surface water quality standards, the water is classified as water quality impaired. Water bodies not meeting water quality standards for their designated use(s) are identified on the 303(d) list. The 303(d) list is used to identify those waters targeted for the development of Total Maximum Daily Loads (TMDLs). A TMDL is the maximum amount of a pollutant that a water body can receive without exceeding water quality standards. Since pollution can arrive via point and nonpoint sources, the TMDL process distributes responsibility for the pollutant load reductions among those contributing sources. TMDLs are assigned high, medium, or low priority status for implementation. High priority TMDLs are targeted for financial assistance programs. Medium priority TMDLs are addressed if resources are available after high priority TMDL needs are satisfied. Low priority TMDLs are monitored to track their status and are addressed last.[8]

The Kansas Department of Health and Environment (KDHE) has completed the first two rounds of TMDLs within the Neosho basin based on the 1998 and 2004 303(d) lists. There are 60 approved TMDLs within the Neosho basin that describe the strategies and goals to reduce pollution to achieve water quality standards. The 2008 303(d) list submitted to the Environmental Protection Agency (EPA) identifies watersheds associated with 26 stream chemistry sampling stations and two biological monitoring stations as water quality impaired. Among the streams, dissolved oxygen (D.O.) depletion, zinc, total phosphorus and copper cause the greatest number of impairments. Among the lakes, eutrophic conditions indicative of excessive algae production are the predominant cause of impairment. Many of the stream segments, configured in a watershed setting, have a TMDL applied to them as a whole. KDHE has reviewed and revised Neosho basin TMDLs and submitted them to EPA in late summer 2008. The following changes are

proposed: a new high priority Eutrophication and Siltation TMDL for Council Grove Reservoir, and a revision of the current Marion Reservoir High Priority TMDL.

Spring River Metals TMDL Review

Spring River and its tributaries in the far southeastern part of the basin, including Shoal Creek, Short Creek, Shawnee Creek, Turkey Creek and Center Creek in Cherokee County, is a valuable biological resource in the basin, providing habitat for many unique and some threatened or endangered species (HUC 11070207). Of particular concern are mussel populations that have been in decline since the start of heavy metal mining. Due to historic mining activities in the area, these waters are contaminated by lead, zinc, copper and cadmium. TMDLs have been developed for these streams. The ultimate endpoint for this TMDL is to achieve the established metals criteria for the Aquatic Life Use of the Spring River and its tributaries under the Kansas Water Quality Standards. However, because of the interdependency of the water quality criteria, total hardness and flow, the endpoints desired for the metal concentrations seen in the Spring River and tributaries will vary with flow condition. In addition, biological endpoints are included. See KDHE TMDL website Neosho River basin Total Maximum Daily Load for a complete description of this TMDL.[7] This TMDL has been evaluated during this round of TMDL submissions. No changes are being recommended.

Dissolved Oxygen TMDL Priority Review

KDHE completed a regional study of D.O. conditions and causes of low levels during 2007. As a result of this evaluation, KDHE has recommended that several D.O. TMDLs be moved from high priority to medium priority (Turkey and Mud creeks) and the Neosho Basin Advisory Committee (BAC) concurs with this recommendation.

Table 1 provides information on rivers and lakes within the basin that are designated high priority for TMDL implementation following the recommendations of moving several of the currently listed high priority D.O. TMDLs to medium priority. Figure 2 shows the location of these watersheds within the basin.

Needs Inventory

A component of the TMDL process is to quantify the cost to implement best management practices and technical assistance necessary to address the impairments. The State Conservation Commission has prepared a "needs inventory" to estimate costs associated with reducing nonpoint source pollution in this basin, and to guide implementation of best management practices. Programs are targeted at achieving high priority TMDL goals.

Table 1
Neosho River Basin High Priority TMDLs 2008

Map ID	Waterbody	Impairments	HUC 8 Watersheds
Stream Segments			
1	Spring River	Cd, Cu, Pb, Zn	11070207
2	Labette Creek	DO	11070205
3	Cherry Creek	DO	11070205
4	Eagle Creek	DO	11070201
5	Mud Creek	E. coli	11070202
6	Turkey Creek	E. coli	11070204
Lakes			
7	Marion Lake	E	11070202
8	Council Grove Lake	E, Silt	11070201
9	Olpe City Lake	E, Silt	11070201

Key:
DO: Low dissolved oxygen in upper 3 meters of water column over deepest location in water body
E: Eutrophication, biological community impacts and excessive nutrient/organic loading
FCB: Fecal Coliform Bacteria
E. Coli Indicator bacteria with FCB
HUC: U.S. Geologic Survey Hydrologic Unit Code
Silt: Observed siltation and/or chronic turbidity that impacts development of trophic state
Cd Cadmium
Pb Lead
Cu Copper
Zn Zinc

Surface Water Nutrient Reduction

The impacts of nutrients originating in Kansas have been well documented – Gulf of Mexico hypoxia, excessive productivity in Kansas and downstream reservoirs, and taste and odor problems in drinking water originating from reservoirs. Reduction and control of nutrients is needed to begin mitigating those impacts. Nutrient sources within the basin include both point and nonpoint sources. The major point sources in the basin include large wastewater treatment plants, which are regulated under the National Pollutant Discharge Elimination System (NPDES) (Figure 3).[4] Neosho basin water quality is also a concern in Oklahoma, particularly for nutrient loading in the Grand River and Grand Lake of the Cherokees. Several interstate watershed groups have been formed to develop regional strategies to implement restoration and protection objectives.

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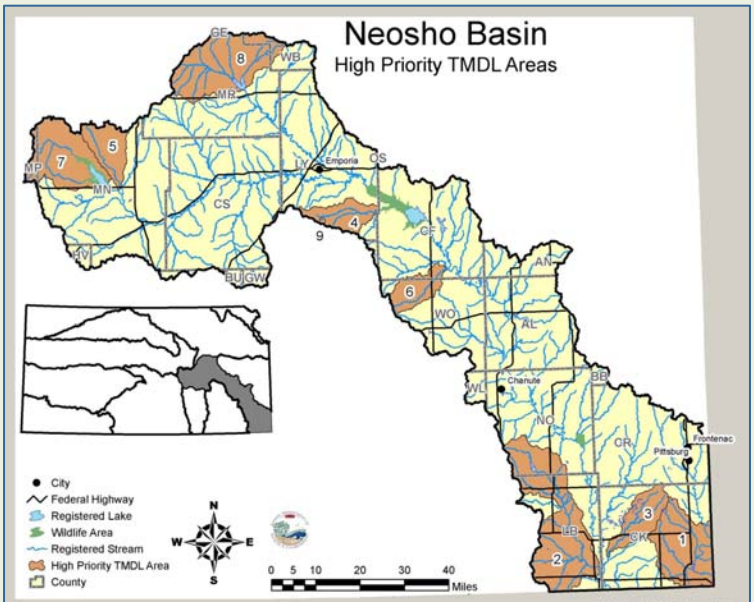

Figure 2. Neosho Basin High Priority TMDL Map

Nonpoint sources of pollution include both agricultural and urban areas. Table 2 shows the relative contribution of point and nonpoint sources in the Neosho basin for total phosphorus (TP) and total nitrogen (TN) leaving the state.

The Kansas Surface Water Nutrient Reduction Plan,[12] developed by KDHE, outlines a statewide strategy for reducing the export of TN and TP in surface waters leaving the state. This involves additional reductions in nutrients from point source discharges through the NPDES Program and reductions in nonpoint sources through development and implementation of Watershed Restoration and Protection Strategies (WRAPS). The Nutrient Reduction Plan includes Improvement Potential Index (IPI) maps for Kansas counties for TP and TN reductions

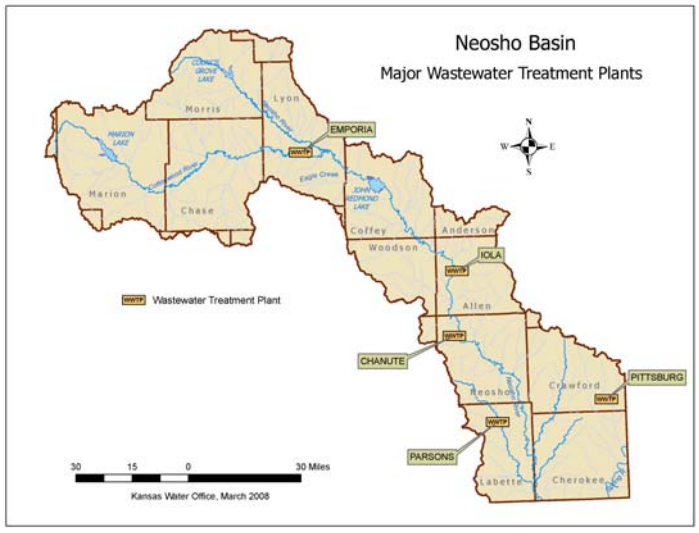

Figure 3. Neosho Basin Major Wastewater Treatment Plants

Table 2
Neosho Nutrient Reduction Data
Source: KDHE Bureau of Water – February 14, 2006
Statewide Perspective

Parameter	State Total	Neosho	% of State Total
TN Leaving State (Ton/yr)	51,000	9,260	18
TP Leaving State (Ton/yr)	7,700	832	11
Point Source TN (Ton/yr)	9,215	583	5
Point Source TP (Ton/yr)	1,925	231	7
Nonpoint Source TN (Ton/yr)	41,785	8,677	22
Nonpoint Source TP (Ton/yr)	5,775	601	12

Basin Perspective					
Parameter	Total	PS	PS %	NPS	NPS%
TN (Ton/yr)	9,260	583	6	8,677	94
TP (Ton/yr)	832	231	28	601	72

(see maps in Water Quality Policy Section). In the Neosho basin, Cherokee and Labette counties showed the highest improvement potential for TP and TN.

U.S. Army Corps of Engineers John Redmond Feasibility Study[6]

The Kansas Water Office (KWO) is participating in a Feasibility Study with the Tulsa District Corps of Engineers in the watershed above John Redmond Reservoir. This study will provide information to the WRAPS project stakeholders as they develop their WRAPS plan (see description of this program further in this issue description). Specific objectives of the study include:

a. Preserve storage in John Redmond Reservoir for flood control, water supply, and other authorized purposes.
b. Revitalize John Redmond Reservoir for flood control, water supply, and other authorized purposes.
c. Reduce watershed contributions of sediment and harmful chemicals, such as phosphorous, into John Redmond Reservoir.
d. Restore riparian habitat (including native grass buffer zones) that improves the value and function of the ecosystem.
e. Restore wetlands that improve the value and function of the ecosystem.
f. Restore aquatic riverine habitat that improves the

value and function of the ecosystem.

g. Preserve riparian habitat (including native grass buffer zones) essential to the value and function of restored habitat above.
h. Preserve wetlands essential to the value and function of restored habitat above.
i. Preserve aquatic habitat essential to the value and function of restored habitat above.
j. Protect public resources, utilities, including power, water, and transportation, from the impacts of flooding, bank erosion, and channel changes.
k. Protect wetland and grasslands from invasive plant species.

Logjam Study, Sediment Monitoring, and Sub-watershed Assessment

Figure 4. Neosho River Logjam. Photo courtesy TWI

The KWO has also contracted a study of a logjam that has developed over more than 20 years at the inflow to John Redmond Reservoir, near the Jacob's Creek landing boat ramp (Figure 4). This logjam is largely a result of sedimentation at John Redmond where the Neosho River slows to form the reservoir. Input of large woody material from the watershed has resulted in accumulation of this material over about a 2.5 mile reach, blocking access to the river. Possible options to restore access to the river have been evaluated and recommendations as to the most cost effective solution have been provided and are under consideration. In addition, the USGS has installed several continuous monitoring stations in the watershed to gain a better understanding of sediment delivery dynamics to the reservoir. Efforts are underway to assess sub-watersheds within the basin to prioritize areas for streambank stabilization and riparian area improvement.

More information on project activities can be found at www.kwo.org.

Source Water Assessment Program[9]

Source Water Assessments were completed for all public water supplies across the state, either by the public water supplier or utility, or KDHE, in 2004. Source water may be ground water in the form of wells, surface water intakes on rivers and streams, or a combination of these. Source water assessments involve delineation of the source water assessment area, an inventory of potential contamination sources within the delineated area, and a susceptibility analysis and score. Assessments use a standardized system to identify all potential sources of pollution to surface and ground water within the contributing watershed, and conduct a susceptibility analysis to evaluate the threat from each potential pollutant to the water supply. A susceptibility score generated from the susceptibility analysis indicates whether the susceptibility range is low, moderate, or high for potential threats of contamination in an assessment area.

KDHE provided public water suppliers susceptibility scores in the following contaminant categories: microbiological, nitrates (applicable for ground water only), pesticides, inorganic compounds, synthetic organic compounds, volatile organic compounds, sedimentation (surface water only), and eutrophication-phosphorus (surface water only).

Of the 37 public water suppliers using ground water in the Neosho Basin, 68% had low susceptibility scores and 32% had moderate scores. Of public water suppliers using surface water, 32% had low scores, 53% had moderate scores and 16% had high scores. The most commonly identified problems with ground water were inorganic compounds, pesticides, and nitrates. The most commonly identified problems with surface water were pesticides, microbial contamination, and inorganic compounds. Of the 56 public water suppliers in the basin which treat raw water, 19 use surface water, 37 use ground water and one uses alluvial wells. Most residents in the basin get their water from the Cottonwood, Neosho, or Spring Rivers, ground water, or from one of the three major federal reservoirs. Ground water is a significant source in the southeastern part of the basin.

For communities using ground water, development of a wellhead protection plan is recommended. For communities using surface water, the development of a Water-

shed Restoration and Protection Strategy (WRAPS) is the best mechanism to ensure water quality protection for their public water supply. The Neosho basin has nine complete and approved source water protection plans in place.

Under the Source Water Assessment Program, about two thirds of the Neosho basin has been designated as critical area for protecting public water supplies, as defined by the stream reaches with a 24-hour or less travel time to a surface water diversion point. Much of the information from the assessment and risk rating can be used to develop WRAPS plans that can work to meet both TMDL goals and protect public water supplies from sources of pollution.

Five public water supplies were recommended by the EPA for participation in a five year, 2003 Atrazine monitoring program. This Atrazine risk reduction program includes runoff prevention in watersheds feeding public water supplies. These types of activities can help reduce pollution loading in the watersheds. As of 2005[10], the most recent year for which data are available, no system has exceeded the EPA criteria for Atrazine levels in public drinking water supplies.

Reservoir Sedimentation

Protection of the three federal reservoirs in this basin is another aspect of source water protection. The state has made significant investments in acquiring storage space in Council Grove, Marion, and John Redmond reservoirs for municipal and industrial use. Reducing sedimentation into the lakes is a water quality as well as water quantity issue. Efforts such as streambank stabilization can help reduce sedimentation.

Zebra mussels

Zebra mussels were confirmed to be present in Marion Reservoir in the summer of 2008. Despite efforts by the Kansas Department of Wildlife and Parks, and other agencies and organizations, to prevent infestations of the mussels spread from other reservoirs, this additional infestation is particularly troublesome due to the position of Marion Reservoir upstream from John Redmond Reservoir. John Redmond Reservoir supplements cooling water in the lake used by the Wolf Creek Nuclear Power Plant (Figure 5). Zebra mussels, once established, are almost impossible to eradicate, and cause hundreds of thousands of dollars, and sometimes millions of dollars, worth of damage to public water supply and industrial plant water intakes and other infrastructure. Efforts to prevent infestation of the mussels into John Redmond Reservoir and the Wolf Creek Lake are of utmost importance.

**Figure 5. Wolf Creek Nuclear Power Station.
Photo courtesy Kansas Geological Survey.**

Wetland and Riparian Area Management

Wetland and riparian areas are another focus of watershed protection and restoration. The primary approach to wetland and riparian area management in the basin focuses on providing technical and financial assistance to landowners to protect and restore these resources in priority watersheds through the implementation of best management practices (BMPs). Wetland and riparian areas are transitional lands between aquatic and upland locations. Wetlands include areas with hydric soils where standing water or wet soil conditions predominate. Riparian areas include streamside and floodplain areas where the vegetation, soils, or topography are distinguishable from that on adjoining uplands. Healthy riparian areas are an important component in filtering out pollutants and sediment from the streams and lakes. Healthy riparian areas can also control bank erosion, provide habitat and slow surface water runoff that leads to flooding. An analysis of the Neosho basin[11] indicates about 23% of the streams have crop land as the riparian land use. Wetlands provide unique wildlife habitat, and serve as flood water detention areas. Wetlands and riparian areas also provide aesthetic value.

An emerging concern is management and maintenance of forested riparian areas to prevent the entry of debris (dead and fallen trees, etc.) into the tributary/river system. Due to recent ice storms and catastrophic flooding, along with unstable streambanks, the potential for woody debris to collect in and clog bridges and culverts has been elevated. Preventing entry of woody debris into the system can help to manage this. The log jam discussed above is a consequence of this condition.

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The KWO is proposing a new policy that will provide a systematic approach to the assessment, protection and restoration of wetland and riparian areas and for the restoration of stream channels. The policy promotes a comprehensive evaluation of stream reaches and watershed wetland and riparian area condition.

Watershed Restoration and Protection Strategy (WRAPS) Groups

Citizens in sub-watersheds of the Neosho basin have formed WRAPS stakeholder leadership teams to assess their watersheds, water quality impairments, habitat needs, and other issues, and develop goals and objectives for addressing them. WRAPS groups develop stakeholder driven watershed management plans designed to address multiple water resource issues within a specific watershed. The WRAPS process provides a means to integrate objectives from multiple local, state and federal programs into a comprehensive, coordinated strategy for a specific watershed. This can include TMDL attainment, nutrient reduction, source water protection, reduced reservoir sedimentation, riparian and wetland management, and other natural resource objectives.

Watersheds above the three federal reservoirs in the basin that serve public water supply needs have been identified as watersheds of significant state interest for development and implementation of WRAPS. Implementation plans are being developed that will assist local groups to make the best use of existing funds to address the most critical problem areas first. Figure 6 shows the status of WRAPS groups in the basin.

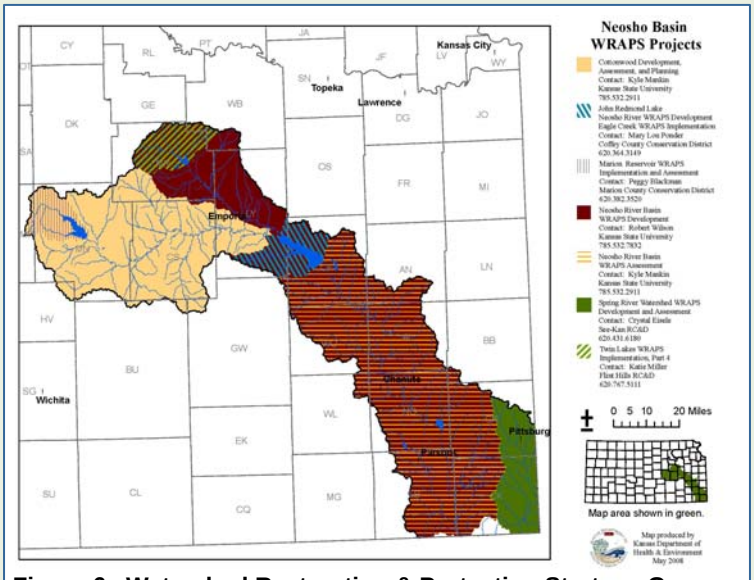

Figure 6. Watershed Restoration & Protection Strategy Groups

Several interstate groups have also formed to ensure high quality water in Grand Lake of the Cherokees in Oklahoma. A large part of the watershed draining into this highly used recreational and public water supply reservoir is in Kansas. An interstate effort involving Arkansas, Missouri, Oklahoma, and Kansas representatives is cooperatively developing a watershed based plan for the area. The efforts of WRAPS groups already underway in Kansas serve as a model for plan development and will be incorporated into the implementation plan.

A consideration for watershed restoration and protection in this basin is urbanization. As the amount of impervious surface in a watershed (i.e. rooftops, roads, parking lots, etc.) increases, water resources can be adversely impacted from increases in runoff volume and additional pollutants associated with urban environments. Efforts made by local governments and urban residents to minimize these adverse impacts through sound land use planning and stormwater management help to address these issues.

Local land use planning and zoning authorities provide cities and counties effective tools to minimize the potential impacts of development on water resources. Urban stormwater management programs can be implemented to manage the amount of impervious surface in urbanizing watersheds and properly control increased runoff resulting from urbanization. Programs that provide technical assistance and education to urban residents regarding actions that can reduce or eliminate potential pollution sources also play an important role. These programs can be integrated with WRAPS projects to ensure a comprehensive approach to watershed management in urban areas. In the Neosho basin, the cities of Emporia, Parsons and Pittsburg are required by the EPA Phase II Stormwater Program to develop management plans to minimize pollution entering receiving waters from within the boundaries of their municipalities.

Another consideration for watershed restoration and protection in the basin is the potential for conversion of Conservation Reserve Program (CRP) acreage back to production agriculture as contracts expire. Recently with commodity prices on the rise, this is even more of a concern. In the 12 counties contained wholly or partly in the Neosho basin, contracts on 37,259 acres covering 891 contracts expired on September 30, 2007. Lyon County had the highest number of expired contracts at 10,078 acres. If land is taken out of permanent grass cover, implementation of best management practices will be needed to minimize potential adverse impacts to water resources within the basin. CRP grass cover is very ef-

fective at trapping sediment and nutrients.

Other Watershed Related Activities

- All counties, excluding Chase County, either wholly or partly within the basin have adopted local sanitary/ environmental codes or participate in the Local Environmental Protection Program.
- Seven of the 12 counties have countywide planning and zoning programs.
- All conservation districts in the basin have adopted nonpoint source pollution control management plans. Grants under the State Water Quality Buffer Initiative have also been awarded in six counties supporting buffer coordinators and facilitating enrollment of stream buffers in continuous CRP in FY 2008.
- As of December 2007, there were 21 active contamination sites being remediated through the State Water Plan Contamination Remediation Program. Most of the contamination is from heavy metals resulting from past mining and smelting activities. Additional contamination is caused by volatile organic compounds, carbon tetrachloride and nitrate.
- There are 15 organized and active watershed districts in the basin.

Recommended Actions

1. Continue development and support of local WRAPS groups, with technical assistance from state and federal agencies to develop management plans. Coordinate funding from among sources to address highest priority problems first. Focus state resources towards high priority watersheds, particularly those that include high priority TMDLs, high biological priority, and source water protection.

2. Target resources to the improvement and management of riparian areas in priority watersheds.

3. Coordinate with the Kansas Department of Wildlife and Parks and other organizations and agencies to prevent the spread of Zebra mussels in the basin.

4. Continue cooperative inter-state efforts to improve water resource conditions in the entire Neosho/Grand River Lake of the Cherokees watershed.

5. Complete Corps John Redmond Feasibility study and incorporate results into WRAPS and other cooperative planning efforts.

6. Work with local governments, including conservation districts, local environmental protection programs, and stormwater utilities to develop and implement comprehensive urban stormwater and source water management plans.

7. Continue public outreach efforts to educate the public and landowners about the benefits of best management practices.

8. Encourage other agencies and entities in partnerships and participation to support WRAPS initiatives, activities and funding.

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Resources

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3. Kansas Department of Health and Environment. August 2003. website:http://www.kdhe.state.ks.us/nps/index.html for Local Environmental Protection

4. Kansas Department of Health and Environment. National Pollutant Discharge Elimination System Program. http://www.kdheks.gov/water/download/implementation_permitting.pdf

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6. U.S. Army Corps of Engineers, 2006. John Redmond Feasibility Study Plan.

7. Kansas Department of Health and Environment, 2008. http://www.kdheks.gov/tmdl/download/spring_metals.pdf

8. Kansas Department of Health and Environment. 2008. http://www.kdheks.gov/tmdl/index.htm

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11. Wilson, Brownie, Assessment of Riparian Areas Inventory, State of Kansas, 2003, http://hercules.kgs.ku.edu/geohydro/ofr/2003_55/riparian/ofr_2003_55e.htm.

12. http:/ww.kdheks.gov/water/download/KS-nutrient_reduction_plan_final.pdf

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Issue

Evaluation of surface water supply, demand, management, and conservation, is needed to improve reservoir sustainability and provide adequate public water supply to meet long-term needs in the Neosho basin.

Increasing population and development in portions of the Neosho basin along with aging reservoirs (Figure 1) and public water supply infrastructure indicate a need to evaluate the long-term water system capacity to meet demands in the basin. The Neosho River has been having increasingly frequent low flow problems which have caused aquatic life stress and more frequent administration of water rights. Administration of water rights in the Spring River system occurred for the first time in 2006. The Neosho River is an area of high biological importance in the state with populations of freshwater mussels, sensitive fish species such as the Neosho Madtom, and populations that have declined from historic levels such as the paddlefish.(8) The viability of the river to support aquatic life and meet minimum desired stream flows needs to be maintained, while balancing the availability of water for public water supply.

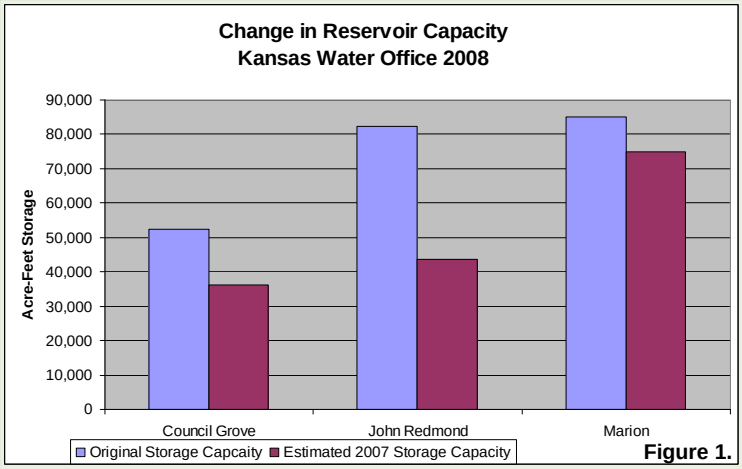

Figure 1.

In 2007, the Kansas Water Office (KWO) initiated an analysis of water supply and demand in several eastern Kansas river basins.(1) The analysis utilized historic climate and flow and current census information to predict the total water supply and demand in the Neosho basin over time. The preliminary finding for the Neosho basin is that in those counties primarily served by the Neosho River and tributaries, demand could exceed supply during a 2 percent probability drought by the year 2012 (Figure 2). This analysis did not include the far southeastern counties in the basin in which ground water and the Spring River are the primary water supplies. See the Management of the Ozark Plateau Aquifer System and the Spring River System issue for information on that area.

Of the four major southeastern Kansas river basins evaluated with this method, the Neosho basin has predicted water supply shortfalls the soonest. Enhanced modeling is underway to better understand where shortages could occur in specific reaches and to develop a means of evaluating alternatives and scenarios for water management, conservation and development that can be used for future planning and operations of the system.

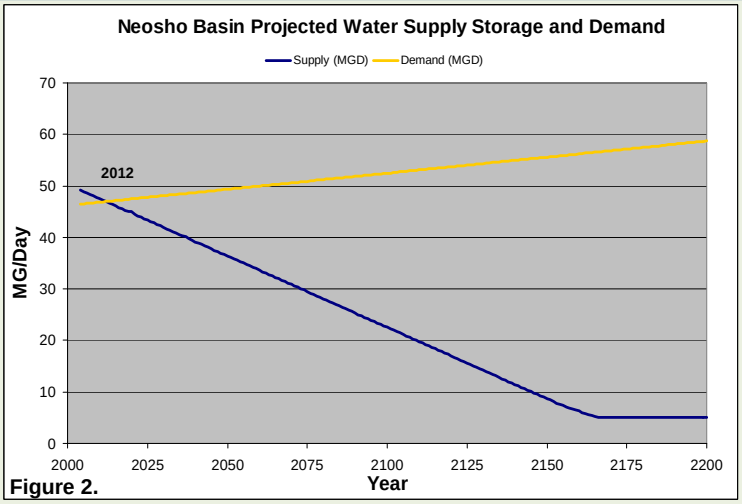

Figure 2.

Description

Water Supply

Water supply in the basin is provided primarily by three federal reservoirs, Marion, Council Grove, and John Redmond, along with numerous multipurpose or city owned small lakes, and natural stream flows. Coffey County State Fishing Lake provides cooling water for the Wolf Creek Nuclear Power Plant. Based on bathymetric survey information, federal reservoir water supply pool yields were used in the 2007 KWO analysis of supply and demand in the Neosho basin. This analysis combined the yield available from the federal reservoirs in the basin along with natural flows to calculate the total available water supply in a dry condition (Figure 3). Smaller city owned lakes were not included in this analysis.

The analysis described above was not structured to account for the quantity of water supply available in location specific areas under different conditions. A more refined modeling process using the OASIS (Operational Analysis and Simulation of Integrated Systems) model to identify water supply and demand at specific points in

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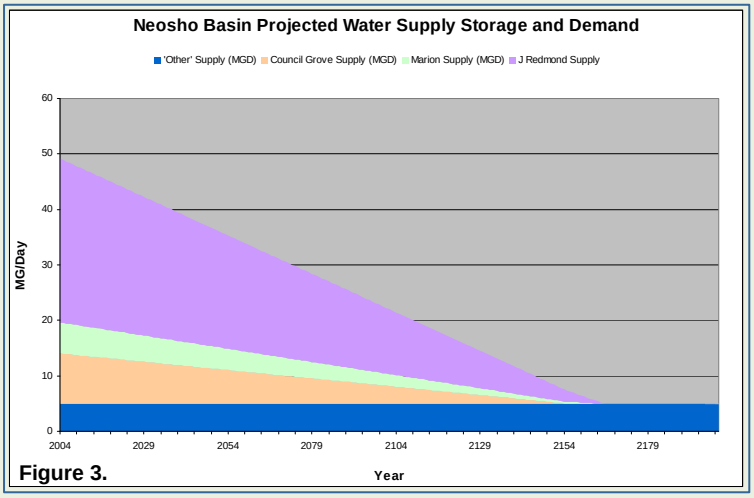

Figure 3.

the basin is being calibrated by the KWO in the Neosho basin. Once complete, the available water supply at specific demand points under various conditions in the basin will be able to be estimated. To assist with developing the model, KWO staff have been assigned to work directly with water supply utilities, industries, other water users, and the Neosho Basin Advisory Committee (BAC), to obtain detailed information on expected water demand in the future. Minimum desirable stream flows for aquatic and wildlife support are accounted for in the model.

Marketing and Assurance

Reservoirs are used, in part, to provide dependable water supplies in streams with highly variable flow. The 1958 Federal Water Supply Act made storage in federal reservoirs available to local governments if the local entities agreed to repay the cost of construction, operation, and maintenance of the water supply storage. The State of Kansas has purchased water supply storage in each of the federal reservoirs in the basin. All three reservoirs support both the Water Marketing and the Water Assurance Programs.

In 1985, through a Memorandum of Agreement between the State of Kansas and the U.S. Army Corps of Engineers (Corps), water quality storage in all three federal reservoirs in the basin was reallocated to water supply storage and purchased by the state at the original cost of storage. The state purchased the maximum amount made available in the reallocation. In exchange for the significant reduction in cost, the state agreed to obtain water reservation rights for water quality storage and to protect water quality releases from diversion by water right holders. In addition, the state developed the Water Assurance Program to operate the reservoirs as a coordinated system, maximizing the use of the water. A Water Assurance District (WAD) was formed in 1993 by the municipal and industrial water rights holders on the Cottonwood and Neosho Rivers. The WAD has purchased a portion of the state-owned storage in all three reservoirs and repays the state's capital cost investment along with annual operation and maintenance costs. Operation agreements under the Water Assurance Program allow the municipal and industrial water right holders in the Neosho basin to own storage that is released during dry periods to support their water rights.[4]

Water Demand

Municipal and Industrial Demand

In the 2007 KWO supply and demand analysis,[1] demand was combined for the basin in the same manner as water supply. Since all population projections were developed from the county level, entire counties were assigned to the basin based upon predominance of area *and* existence of larger incorporated areas. The Neosho River corridor included Allen, Chase, Coffey, Labette, Lyon, Marion, Morris, Neosho and Woodson counties.

Water demand (Figure 4) associated with the population projections is based on municipal water use as gallons per capita per day usage (gpcd) reported to the Kansas Department of Agriculture-Division of Water Resources (DWR) for 2000 through 2004 by suppliers in the Neosho basin.[2] The quantity of water that municipalities sold for non-domestic use is not included in gpcd calculations and was added to the total for this analysis. To develop the projected water use from industry, commerce, agriculture, and recreation, all non-municipal surface water points of diversion within five miles of the mainstem of each basin were selected.

The surface water demand increase on the Neosho River corridor is primarily associated with the anticipated demand increase of Lyon County, specifically the industrial sector growth seen in Emporia in the past 12 to 15 years. Also considered is future demand by the Wolf Creek Nuclear Power Generating Plant. Although a significant increase in demand was demonstrated in Neosho County, specifically in the recreational sector in the last 12 -15 years, that sector's growth was limited to current levels, since it is understood there is little to no desirable land remaining near the mainstem in Neosho County that has not already been developed for recreational use. Crawford and Cherokee counties were excluded from the future demand projections because of the ground water supplies and the supply from Spring River available to them.

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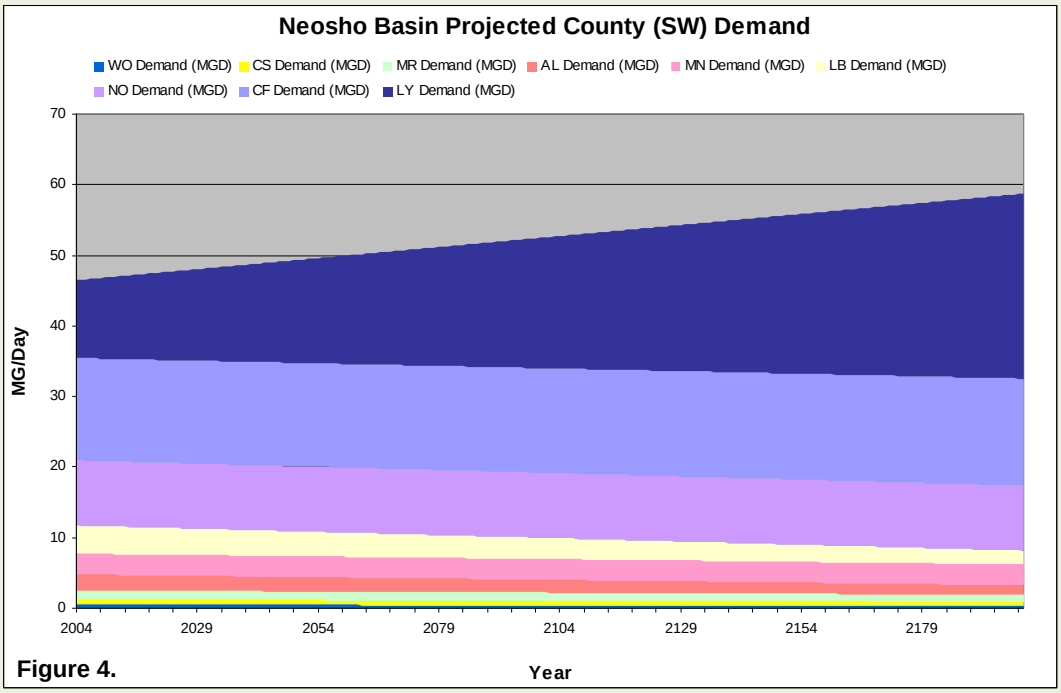

Figure 4.

Location Specific Demand

Further modeling in the Neosho basin will identify demand in specific locations and project this demand over time. The KWO is using the OASIS model to analyze the supply and demand projections for the Neosho basin. OASIS models the operations of a river reservoir system by simulating the routing of water though a system represented by nodes (reservoirs, cities, etc.) and arcs (rivers). OASIS can account for physical constraints such as reservoir capacity, evaporation, and sedimentation. The model can also account for system management issues such as minimum release requirements and lake level management plans.

The advantages of OASIS are that it can simulate the interaction of multiple reservoirs and rivers in a system. It improves the ability to simulate system management issues. OASIS can also identify "problem" areas in a system and evaluate alternative improvements to the system (off-stream storage, new reservoirs, reallocation, etc.). The KWO will be working with all users in the Neosho River corridor to get inputs for the model and then presenting the results upon completion of the model.

Nearly all the growth and associated water demand in the Neosho basin is associated with expansion of the Emporia area. In the southern part of the Neosho basin, interest in expansion of the old Army Ammunition Plant might add demand in that area. Depending on the results of location specific modeling, communities may need to consider water demand of future industries based on the projected supply.

Conservation

The objective of water conservation is to achieve efficient use of the limited water resources of the state through cost-effective practices to curtail the waste of water and to ensure water use does not exceed reasonable needs. In the Neosho basin, conservation includes efficiency management in public water supply along with maintaining existing reservoir storage and water supply. See the Watershed Restoration and Protection Strategy (WRAPS) basin priority issue in this section for additional information about efforts underway to improve water quality and preserve storage capacity of reservoirs in the basin.

Local land use planning and zoning authorities provide cities and counties with effective tools to minimize the potential impacts of development on water resources. Counties with planning and zoning regulations often require landscape plans for new development. While landscaping can provide aesthetic and environmental benefits, heavily irrigated landscape designs can increase demand on public water supplies.

Demand management is an important component of extending water supplies but has not typically been incorporated into water utility operations. With the recognition of the potential for future water shortages, water suppliers and communities should begin to incorporate this concept into operational planning. Demand management may include less water intensive landscaping, low water use plumbing, conservation design for urban areas, water reuse, and other elements including responsible use of water. A movement beyond excessive use of water into more sustainable long-term management is needed. Increases in consumptive use cannot occur under existing, vested, or otherwise fully perfected water rights. If a municipality is considering substantial changes in their system to reuse water, the DWR must be consulted.

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Conservation of reservoir storage has received attention as the impacts of sedimentation become increasingly apparent. While supply in the Neosho basin is being evaluated to develop management strategies, recreational impacts are also occurring, along with low flows in streams which can impact aquatic organisms. Research has been conducted addressing the causes of reservoir storage loss and identifying solutions. These measures generally fall into short-term strategies such as efficiency of reservoir operations or longer-term restoration of storage. Examples of reservoir efficiency include pool reallocation, raising dams/pools, modification of operational rules, and treatment of the upstream watershed to limit erosion. Restoration includes dredging, reservoir flushing, or other means of removing accumulated sediment.

Recommended Actions

1. Continue the calibration of the OASIS basin model with location specific supply and demand information.

2. Identify options for supply and demand management: reservoir pool raise, pool reallocation, dredging, off-channel storage, new supplies, modify reservoir operations, conservation measures, reverse levee operations.

3. Refine model to reflect possible outcomes of identified options and share results.

4. Implement the most beneficial and cost-effective options.

5. Begin incorporation of water demand management into utility operating plans. Demand management should also include education of and interaction with the development community and include existing local authorities.

Resources

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6. Public Water Supplies Drought Vulnerability Assessment. 2006. Kansas Department of Health and Environment.

7. Public Water Suppliers, Sources and Purchasers. 2006. Kansas Department of Agriculture, Division of Water Resources.

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Management of the Ozark Plateau Aquifer System and the Spring River
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Issue

Increased understanding and adjustment of management of the Ozark Plateau aquifer system and the Spring River system is needed to ensure a sustainable water supply for southeast Kansas.(1)

Description

The Ozark Plateau is in a four-state region located primarily in southern Missouri and northern Arkansas, including smaller areas in northwest Oklahoma and southeast Kansas (Figure 1). The Ozark Plateau consists of four physiographic regions: the Springfield Plateau, Salem Plateau, Saint Francois Mountains and Boston Mountains. Of these four regions only a small portion of the Springfield Plateau extends into the far southeastern corner of Kansas. Under this corner of Kansas lies a small but important part of the Ozark Plateau aquifer system.(2)

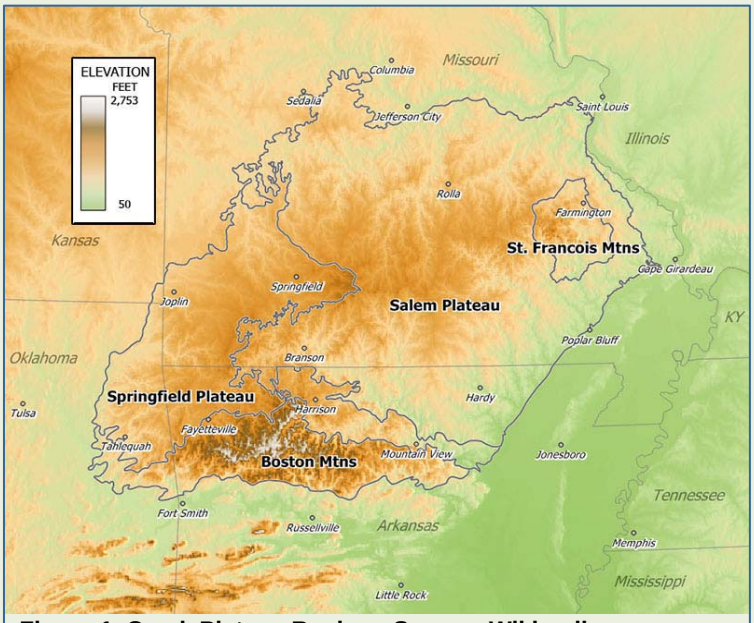

Figure 1. Ozark Plateau Region. Source: Wikipedia

The Neosho River and the Spring River are the two major river systems in Kansas that occur within the boundary of the Ozark Plateau aquifer system. The lower Neosho River flows through Neosho and Labette counties, and briefly flows through the southwest corner of Cherokee County before flowing out of Kansas into Oklahoma. The Spring River enters Kansas on the eastern side of Cherokee County, flows through Cherokee County, and exits the state in the southern part of the county into Oklahoma (Figure 2). Both river systems are monitored by the United States Geological Survey (USGS) and streamflow gages are positioned near Parsons, Kansas on the lower Neosho River, and near Quapaw, Oklahoma and Waco, Missouri on the Spring River (Figure 3).

Water Supply and Quality Concerns

The Ozark Plateau aquifer and Spring River systems serve as important water supply sources in southeastern Kansas, southwestern Missouri and northeastern Oklahoma, an area known as the Tri-State Region. The demand for water in the region is growing rapidly, particularly in southwestern Missouri. Jasper and Newton counties in Missouri, have had strong population growth that has led to an increased water demand. All the high capacity wells in Jasper and Newton counties are drilled into the Ozark aquifer. Some of the well fields have been unable to meet their production goals. As new wells are installed, pumping interference becomes increasingly likely.(4)

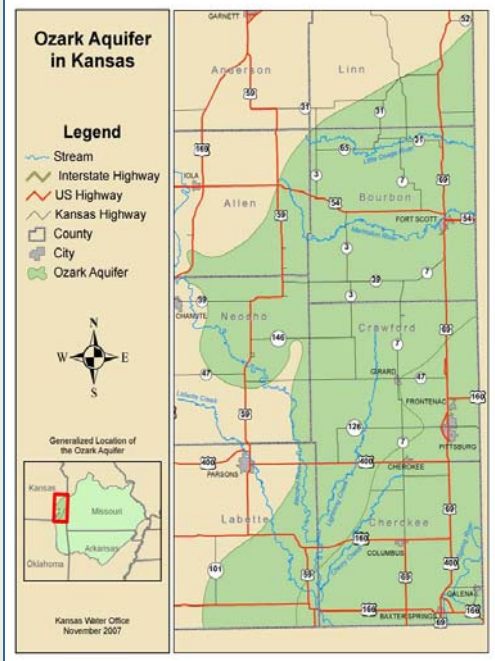

Figure 2. Ozark Aquifer in Kansas

Figure 3. Stream Gages in the Ozark Plateau Aquifer Area

Ground water in the Ozark Plateau aquifer system originates in Missouri and flows into the southeastern corner of Kansas and into Oklahoma. In-

creased withdrawals in Missouri will impact the amount of water moving into Kansas. This portion of southeast Kansas is almost entirely dependent on surface and ground water originating from Missouri. A study commissioned by Missouri American Water Company[7] (2003) projects possible water shortages in as few as 10 years (2013), during drought conditions, given the increasing water demands with the expected continued growth in the region (Figure 4).

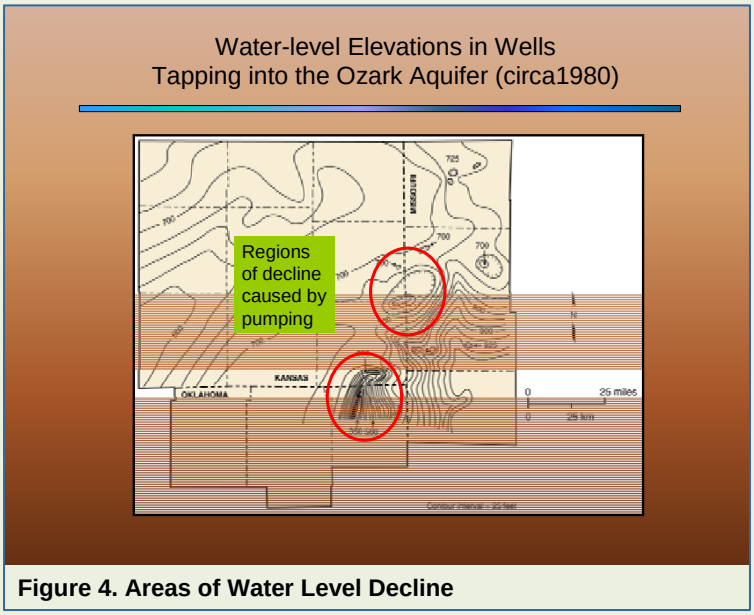

Figure 4. Areas of Water Level Decline

Water quality of the Springfield Plateau aquifer, which overlies the Ozark aquifer in Kansas, is poor and may be unfit for domestic use due to lead and zinc concentrations from extensive lead and ore mining in the area. Mining shafts have allowed contaminated water to move from the surface into the aquifer. The underlying Ozark aquifer contains usable water in southeast Kansas and is the source for most of the ground water supplied to area municipalities and rural water districts. At the bottom of the Ozark aquifer is a brine layer (salt water) that is moving west to east across Kansas. There is concern that significant ground water pumping in some areas could potentially cause upwelling of brines within the aquifer and adversely impact water quality.

The Ozark aquifer was heavily used during lead and zinc mining operations from the late 1880s up into the 1950s. Mining activities are generally inactive at this time but legacy heavy metal contamination in surface and ground water persists. Concerns about water level declines and potential water quality degradation have prompted the need for long-term management actions (Figure 5). In 2003, this issue was identified as a *Kansas Water Plan* basin priority issue by the Neosho River Basin Advisory

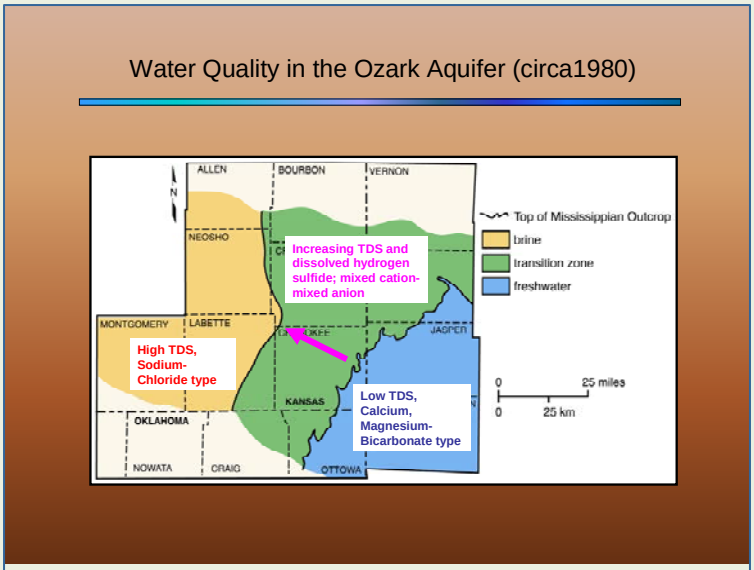

Figure 5. Water Quality in the Ozark Aquifer

Committee (BAC) and the Kansas Water Authority (KWA). Activities to address this issue have been initiated and are described below.

Water Rights Moratorium

Due to uncertainty about the available water supply in the Ozark aquifer, as well as water quality concerns, at the request of the Neosho BAC, in 2004 the Kansas Department of Agriculture's Division of Water Resources (DWR) established a moratorium on new appropriations from the aquifer in Kansas, except for some specified exceptions. K.A.R. 5-3-29 established the moratorium which is still in effect, with a December 31, 2010 deadline for evaluation of permit status. The moratorium exempts domestic wells, appropriation requests for less than five acre-feet under the provision of K.A.R. 5-3-16a, and allows both temporary and term permits from the Ozark Plateau aquifer system. Moratorium term permits may be filed, as long as the permittee can demonstrate availability of an alternate source of water supply. Moratorium permits are allowed through the December 31, 2010 deadline when the DWR will extend, convert, dismiss, or amend the term permits once the ground water model described below is complete.

The DWR has opened a satellite Field Office in Parsons, which is staffed with an environmental scientist under the enhanced water management program. The scientist in Parsons is specifically focused on the Ozark Plateau aquifer system and adjacent moratorium area, and is performing field work and monitoring in this area, as well as addressing water management aspects. An "Ozark Plateau 2007 Field Analysis Summary" has been pre-

pared that provides detailed information on the status and characteristics of the area.[8]

Regional Ground Water Model and Water Quality Assessment Study

To address water supply and quality issues, the state initiated a study supported by the water agencies in the three states that is being conducted by the USGS. Using MODFLOW computer software, a model of the Ozark and Springfield Plateau aquifers is being developed and calibration is almost complete as of April 2008. The model simulates ground water flow within both aquifers and includes interaction between ground and surface water. The model also allows simulation of the effect of withdrawal (diversion) of additional water from the aquifer. The study also will define and assess the current water quality conditions in the Ozark and Springfield Plateau aquifers.

In the spring of 2006, the depth to water was measured in more than 200 wells throughout the three-state region. The Ozark Aquifer Technical Advisory Committee, made up of representatives from the three states' water agencies, the USGS, the City of Monett, Missouri and a representative of local public water suppliers in Kansas, meets quarterly to discuss the study's progress. Annual public meetings that began in the fall of 2006 provide area residents with information about the study. The 3-year study is co-funded by the State of Kansas and the USGS. The ground water model and water-quality study reports are scheduled for publication in March 2009[9].

Well Monitoring Network

In 2004, a ground water well monitoring network was re-established for the Ozark aquifer moratorium area by the DWR. The network consists of 24 wells that are screened within the Springfield Plateau aquifer, the Ozark aquifer, or both aquifers (referred to as the Ozark Plateau aquifer system), and are measured on a quarterly basis (Figure 6). Also, in order to detect the potential eastward movement of salt water, a network consisting of 12 wells has been established from which water quality samples are taken quarterly. Lastly, three continuous monitoring wells have been drilled. Two of the monitoring wells are located in the Ozark aquifer at McCune and Pittsburg and one is located in the Springfield Plateau aquifer, also located at Pittsburg. All three wells have transducers installed and are equipped with satellite telemetry capabilities.

Assessment of Water Quality Changes

The recharge to this aquifer is from the overlying Springfield aquifer, which has numerous mining and industrial contaminants. Declines in the lower aquifer levels, if this is occurring, would induce recharge from the overlying aquifer and the contaminants. In addition, there exists an eastward migrating transition area of brine water, with increasing total dissolved solids, chloride concentrations and hardness, from south central Kansas. One municipal public water supply and a few industrial wells have been abandoned due to taste and odor problems with the brine transition water.

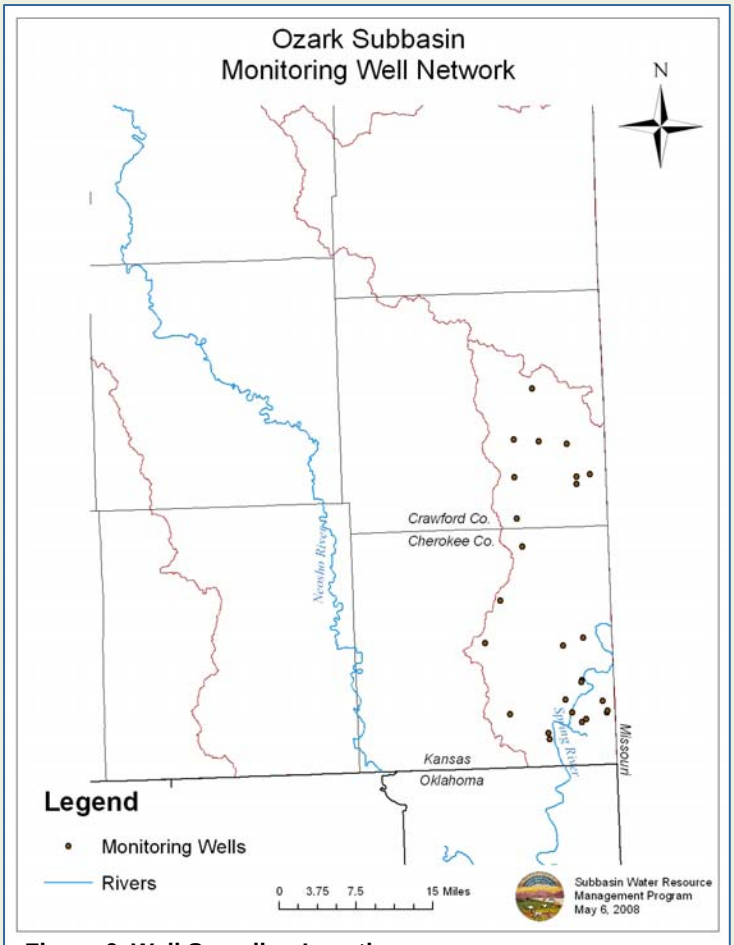

Figure 6. Well Sampling Locations

The Kansas Geological Survey (KGS) is in the second year of a study to assess the influence of pumping over time on the chemical quality of ground water produced by single and multi-aquifer wells within the Ozark aquifer water-quality transition zone in Kansas. This transition zone extends across most of Cherokee County and all of Crawford County; the depth to its top is variable. During the project's first year, monthly water sample collection

for chemical analysis, water-level surveys, and reports of ground water pumpage were used to assess seasonal changes in water quality. The project also compared water quality results from the recent sampling to results from samplings conducted 25 years ago. In its second year the project is focusing on water quality changes during periods of pumping. This report was made available in October 2008.

Tri-State Water Resource Coalition

The Tri-State Water Resource Coalition, a group of municipalities and rural water districts in the region organized in 2003, was formed to determine the region's water needs, better understand available water resources, and make recommendations to provide a long term supply of good quality, affordable water.(6) The Coalition retained Black and Veatch Engineering and the U.S. Army Corps of Engineers (Corps) to evaluate the area's water supply needs to the year 2045 and long-term water supply options to meet that need. The study was completed in the fall of 2006 and cited water supplies from Grand Lake of the Cherokees in Oklahoma, Table Rock Lake in Arkansas, or the construction of a new reservoir in southeast Missouri as the best alternatives. The Coalition has raised $140,000 to match a grant of $50,000 from the Missouri Department of Natural Resources to conduct a study to determine sites that are suitable for a new reservoir and the costs associated with construction. Tri-State Water Resource Coalition members from Kansas include: Baxter Springs, Cherokee Rural Water District No. 3, the City of Pittsburg and the Kansas Rural Water Association. The DWR employee in Parsons is a member of this group.

Figure 7. Spring River near Galena. Photo courtesy G. Manders

Multi-Basin Regional Watershed Council

This recently formed group is involving stakeholders from Arkansas, Oklahoma, Kansas and Missouri to address regional water concerns. Included are concerns about drinking water, wastewater, and water quality/watershed issues. While the recent focus has been on water quality/watershed issues, the Ozark aquifer is part of the overall discussion.

4-All Collaborative

This group also has representation from all four states draining into Grand Lake of the Cherokees. Their recent emphasis has been on education and coordination of the various groups in the four states that are involved in watershed planning. They have sponsored two Environmental Conferences and a third is in the planning phase.

Grand Lake of the Cherokees Alliance Foundation (GLCAF)

The GLCAF is developing a Grand Lake Watershed Management Plan (Plan) with technical and planning assistance from the Oklahoma Conservation Commission. Development of the Plan involves a four state stakeholder-driven approach to watershed management. Once the Plan is developed the GLCAF will solicit private funding to implement recommendations in the plan with an emphasis on installation of targeted Best Management Practices. To date, the watershed has been characterized in all four states, common impairments, pollution sources and causes have been identified, priority impairments and desired reductions have been targeted, and basin-wide management strategies are under development. The Plan recognizes that sub-basin Watershed Restoration and Protection Strategy (WRAPS) plans in Kansas are also under development and seeks to support them through inclusion in the Grand Lake Watershed Management Plan. Once private funding is available from the GLCAF, it is anticipated that some of it will directed to implement Kansas Neosho basin WRAPS plans for priority projects in priority areas.

Spring River Watershed Restoration and Protection Strategy (WRAPS)

The Spring River (Figure 7) is the second largest unallocated water supply in the state. Although most of the

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Ozark aquifer is currently the source of most public water supply in the area, the Spring River is another potential supply. Construction of a dam in southwest Missouri on the Spring River could impact the ability of public water suppliers in this area to use the Spring River as a future supply (see Tri-State Coalition discussion above). In addition, legacy heavy metal contamination (Figure 8) is still present in surface waters and Total Maximum Daily Loads have been developed to address this problem. See the Neosho basin Watershed Restoration and Protection Strategy for more information on Spring River water quality.

Figure 8. Acid rock drainage colors a body of water reddish-orange near Treece, KS. Source Lawrence Daily Journal World 2008.

Conversations among stakeholders in the Kansas portion of the Spring River began in 2006 and a WRAPS group has been formed to assess the water resource and watershed and formulate goals and objectives to maintain or improve them. Because stream flow is related to ground water levels, this group can serve as an important link for information and education related to the underlying aquifer. Efforts are underway to involve participation from stakeholders in Missouri, Arkansas, and Oklahoma.

Recommended Actions

1. Continue and complete the inter-agency strategy to address the complex water issues of multistate cooperative management, ground water declines and quality, surface water contamination, and public water supply concerns.

2. Use the USGS Regional Ozark Aquifer Study as a management decision support tool to assist DWR in determining the need for continuation or removal of the moratorium on new ground water rights in southeast Kansas, and develop appropriate management strategies.

3. Use the water quality monitoring network established by DWR as a decision support tool.

4. Continue interstate communications concerning the development of new water supplies or the use of existing supplies in adjoining states.

5. Support public water supplier (PWS) efforts to work cooperatively and acquire funding for infrastructure needs for cooperative regional supply systems.

6. Coordinate with Spring River WRAPS and other groups to provide additional information to the public.

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