

General Description

The [Missouri basin](#) covers about 1,600 square miles of the northeastern corner of Kansas including [Hydrologic Unit Codes](#) 10240007, 10240008, 10240005 and 10240011. This represents a small fraction of the entire Missouri River watershed which covers all or part of ten states and extends into Canada. The basin covers all or part of Marshall, Nemaha, Brown, Doniphan, Atchison, Leavenworth and Wyandotte counties in Kansas and is the smallest of the 12 major basins in the state, accounting for about two percent of the total land area.

Tributary streams include the South Fork of the Big Nemaha River which along with other tributaries in Washington, Nemaha and part of Brown County drains northward into Nebraska as part of the Big Nemaha River watershed which enters the Missouri River just upstream of the Kansas border. Tributaries of the Missouri River in Kansas include the Wolf River and numerous smaller creeks. There are no federal reservoirs in the basin. Ground water sources available in the region include alluvial and glacial deposits. For planning purposes, that portion of the Blue River drainage in Johnson County,

which joins the Missouri River in Jackson County, Missouri is included in the Kansas-Lower Republican basin.

Elevations in the basin range from 1,340 feet above mean sea level (MSL) near Corning at the headwaters of the South Fork of the Big Nemaha River to 706 feet at the confluence with the Kansas River in Kansas City. The basin contains the cities of Leavenworth, Atchison, Troy, Hiawatha, Seneca and Kansas City, Kansas along with many smaller communities.

Population and Economy

There were an estimated 143,000 residents in the basin in the year 2000 (KWO estimate). According to the U.S. Census Bureau, the total population of the seven counties that are contained in whole or in part within the Missouri basin had a population of 284,011 in 2000.⁽¹⁾ By 2040, the [population](#) of these counties is projected to increase by about 16% to 330,470. However, nearly all this increase is projected to occur in Wyandotte and Leavenworth counties. The population in the remainder of the basin is projected to decrease by approximately eight percent.

This illustrates major demographic changes which are taking place in Kansas. In the past 40 years, two trends have dominated the state and the basin.

Rural counties have lost population, sometimes more than 10% every decade. Urban counties are gaining population, particularly Leavenworth which is projected to grow 36% by 2040. Every predominately rural county in the basin is expected to lose population except Brown and Marshall counties which are expected to grow by 694 people by 2040.



Confluence of the Missouri and Kansas Rivers. Photo courtesy KGS.

Wyandotte County is one of the most heavily developed areas of Kansas with little agricultural land. Expanding retail, entertainment and residential development in the western portion of the county will likely result in conversion of any remaining open land in the coming years and affect adjoining areas of southern Leavenworth County. Fort Leavenworth and the Leavenworth Federal Penitentiary along with the Lansing State Prison are major economic drivers in Leavenworth County. Private colleges are located in Leavenworth and Atchison and public community colleges are located in Highland and Kansas City, Kansas.

In the remainder of the basin, agricultural production is the primary economic activity. Corn, wheat, soybeans and grain sorghum are the primary [crops](#) with the highest quantity of harvested acres in the northern tier of counties. Beef cattle and hog production are also concentrated in the northern counties with significant dairy production in Leavenworth and Nemaha counties. The value of crops grown in the seven counties either wholly or partly within the Missouri basin exceeded \$324 million in 2006 while [livestock](#) and dairy production topped \$94 million.

While the basin lacks large federal reservoirs and associated wildlife areas, there are two State Fishing Lakes and a number of county and city lakes which support public recreation. Waterfowl hunting along the Missouri River and associated riparian areas attracts sportsmen

to both private (with permission) and public lands.

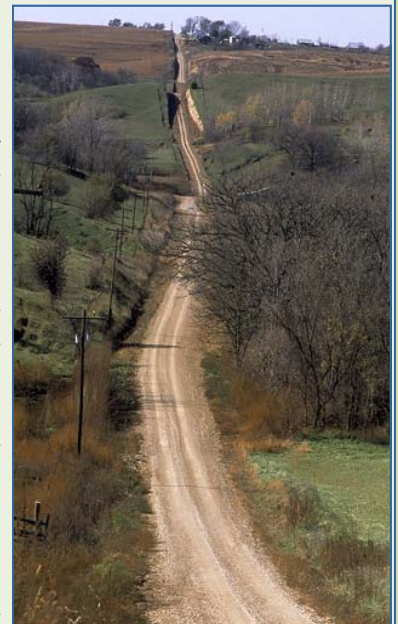
Physical Characteristics

Geology and Soils

The topography of the Missouri basin is influenced by glacial deposits of the Pleistocene age. The area is part of the glaciated region physiographic province and is also described as the Dissected Till Plains section of the Central Lowlands. In the upland areas between major streams, the land surface is flat to undulating with rounded hills and resembles the unaltered drift topography left after the last period of glaciation. The valleys of the smaller streams tend to be narrow and deep. Adjacent to the Missouri River, loess deposits replace the glacial drift and later erosion of this material created hilly terrain and steep bluffs.

Over much of the basin, glacial drift covers bedrock of Pennsylvanian and Permian systems which consist primarily of alternating layers of limestone and shale with some local sandstone. Glacial material is composed of unconsolidated till and outwash and reaches a thickness of up to 250 feet. Rock outcrops occur where principal streams have cut through the glacial drift.

Four major soil associations occur in the basin. The Monona and Marshall silt loams along the Missouri River bluffs are derived from loess and are productive for agriculture but prone to erosion. Further west, the Sharpesburg silty clay loam along with the Shelby and Marshall silt loams are less steep but still erodible. The western third of the basin contains the Grundy and Pawnee silty clay loams and the Burchard and Shelby silt loams. The clay loams are relatively level but have low permeability. The silt loams occupying the steeper slopes are more permeable. The alluvial soils which occupy the floodplains of the Missouri and larger streams are deep and productive.



Loess Hills, Doniphan County
Photo courtesy KGS

Land Use/Land Cover

The predominant features in the basin are the crop land in the Missouri River floodplain and urbanized areas of Atchison, Leavenworth/Lansing and Kansas City, Kansas. Cropland (56%) and grassland (24%) are the most widespread land cover classes covering nearly 81% of the basin. In 2006 there were an estimated 4,920 farms containing 1,968,900 acres in the seven counties either partly or wholly within the basin, with the average farm about 400 acres. Within the 100-foot corridor along each bank of streams within the Missouri River basin, 39% of the land is forested followed by cropland (18%) and mixed trees and crops (15%).

The basin contains many important highway and rail transportation corridors. U.S. Highways 73, 75 and 159 cross the basin from north to south while U.S. 36 crosses from east to west. The Union Pacific Railroad services most of the basin. The Missouri River as it borders Kansas is also maintained for barge traffic by the U.S. Army Corps of Engineers although activity has been reduced in recent years by extended drought in the upper basin.

Climate

The climate of the Missouri River basin in Kansas is classified as humid continental with cold winters and hot summers. Normal mean temperature generally increases from northwest to southeast across the basin. The average annual mean temperature of the basin is 54 deg. F. Most of the [precipitation](#) falls in the growing season with June typically being the wettest month with a basin-wide average precipitation of 38 inches. Flood events, such as in July 1993 and the drought experienced from 1952-1956, underscore the variability in precipitation.

Location	Average Annual ¹		Freeze Dates (32 F.) ²		
	Precipitation (inches)	Temperature (deg. F.)	Last in Spring	First in Fall	Frost Free Days
Atchison	38	54	Apr. 13	Oct. 21	192

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

Wildlife and Habitat

The Missouri basin encompasses a variety of wildlife habitats ranging from cultivated bottomland to rolling uplands with a mixture of crops and grasslands. The Missouri River serves as a corridor for many migratory bird species. Habitat loss due to urban development is an issue, particularly in the lower basin.

Nineteen state or federally listed threatened or endan-

gered species of wildlife share a probable or historic range within the basin. A total of nine fish, seven birds, two reptiles and one insect are listed as threatened or endangered in the Missouri basin, including designated critical habitat for ten species.

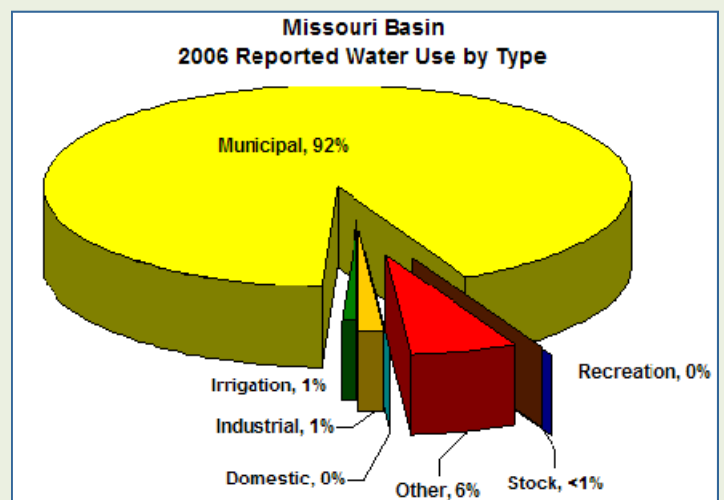
Water Resources

There are 3,341 stream miles in the Missouri basin. About 1,038 miles of these streams are considered perennial and 2,303 intermittent. Stream density is 2.3 stream miles per square mile which is typical for the eastern part of Kansas.

The Missouri River as it borders Kansas is greatly influenced by water releases from the six federal reservoirs located in Montana, North Dakota, South Dakota and Nebraska. Water releases from these reservoirs support commercial navigation and other downstream uses. After eight consecutive years of drought in the Missouri basin, reservoir storage in the upper reservoirs has been significantly reduced resulting in shortened navigation seasons. The maximum daily discharge for the Missouri River at Kansas City for the period of 1958-2001 was 529,000 cubic feet per second (cfs). Mean daily flow at this location is 42,100 cfs and target flow for full navigation services is 41,000 cfs.

There is one state Multipurpose Small Lake, Pony Creek, in the basin which serves as the water supply for the City of Sabetha. Water is piped to the city which is located just south of the Missouri basin watershed divide.

Surface water is the primary source for the 33 [public water suppliers](#) in the basin, accounting for more than 93% of the use in 2006. Ground water sources available in the basin include alluvial and glacial deposits. Ninety-two percent [water use](#) in the basin is for public water supply.



Water Management

There are six [watershed districts](#) in the basin primarily engaged in flood control. Watershed districts are formed to construct, operate and maintain structures and improvements for water management. Each county also has a Conservation District dedicated to improving water quality and reducing soil erosion. Much of the basin is covered by the Glacial Hills Resource Conservation and Development Program.⁽⁶⁾

Watershed Restoration and Protection Strategies (WRAPS) are stakeholder-driven management plans designed to address multiple water resource issues within a specific watershed. A basin-wide Missouri River WRAPS is currently being developed.⁽⁵⁾ It is anticipated that WRAPS projects in the basin will encompass priority areas for water quality improvement, source water assessment areas and priority areas for wetland and riparian protection.

Resources

1. U.S. Census Data, 2000.
2. USDA. *Kansas 2006-2007 Farm Facts, Agricultural Statistics and Ranking*.
3. Wilson, Brownie, 2003. *Assessment of Riparian Areas Inventory, State of Kansas*
4. Kansas Department of Agriculture-Division of Water Resources. 2007. Water Rights Information System (WRIS).
5. Kansas Department of Health and Environment. Accessed Jan. 2009. Watershed Restoration and Protection Strategies (WRAPS) www.kswraps.org
6. Natural Resources Conservation Service. Accessed Jan. 2009. Resource Conservation and Development Information. www.ks.nrcs.usda.gov/partnership.rcd/



Pony Creek Reservoir

The Missouri River Mitigation Project

The Missouri River Mitigation Project is designed to mitigate, or compensate, for fish and wildlife habitat losses that resulted from past channelization of the Missouri River. Managed by the U.S. Army Corps of Engineers, the Project extends from Sioux City, Iowa to the mouth of the Missouri River near St. Louis, a distance of 735 river miles.

Restoration will be accomplished by means of land acquisition from willing sellers, dredging filled-in areas, reopening historic chutes, bank stabilization, dike notching, pumping, dike/levee construction, vegetative plantings, and vegetation and land management.

In Kansas, three bottomland tracts have been acquired or are in the acquisition process. The project includes the 2,112-acre Benedictine Bottoms area which is managed by the Kansas Department of Wildlife and Parks for three habitat types that existed in the area before development: timber, native grass and wetlands.



Constructed Wetland, Benedictine Bottoms
Photo courtesy of the Corps of Engineers

Missouri River Basin Management Categories

January 2009

WATER MANAGEMENT CATEGORIES

The following categories include issues identified in the [Missouri basin](#) plan as items that require attention in addition to the basin priority issues. These issues are addressed with the following management categories:

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

These categories 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

The mainstem of the Missouri River and the glacial aquifer are the major sources of water supply in the basin. All the major streams in the basin are open to new appropriations. There are no sites in the basin where minimum desirable streamflows have been set.

Flows in the Missouri River are influenced by management of several mainstem reservoirs in Montana and the Dakotas. These reservoirs are operated by the U.S. Army Corps of Engineers for flood control, navigation and other purposes in accordance with the *Missouri River Master Manual*.



Missouri River from Benedictine College. Photo courtesy KGS

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
- U.S. Army Corps of Engineers: Missouri River Reservoir Control Program
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive 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 is part of maintaining a long-term water supply for Kansas.

Water conservation activities apply to all uses: irrigation, municipal, industrial, etc., and from all sources. Municipal water supply (92%) accounts for the majority of [water used in the basin](#). Industrial and irrigation each represent one percent of water use with stock water and other uses making up six percent (2006).

Eighteen [public water suppliers](#) in the Missouri basin have approved municipal conservation plans. Plans for two suppliers were developed based on guidelines from 1986 with the remainder based on the 1990 guidelines. All these plans should be updated to incorporate the changes in the *2007 Municipal Water Conservation Plan Guidelines*.

Water conservation plans include drought stage triggers that are the signals that a water shortage or other condi-

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tions 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. Appropriate conservation practices in the areas of education, management and regulation should be listed under each stage. Delay in action may lead to a major disruption of the water supply system at a later time.

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 often promoted by communities to attract new growth. More recently, some communities have adopted rate structures that result in higher unit cost with increased use. This is one form of demand management.

The four basic types of water rate structures used by public water suppliers 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 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 water usage as measured in gallons per capita per day (gpcpd). Systems with flat rates tend to use considerably more water per capita than systems that meter customer use. The other

three types of rate structure, in which cost depends on amount of water used, have a less dramatic effect on gpcpd. Decreasing block rates are assumed to discourage conservation because customers are charged lower rates for high-volume usage. Increasing block rates are consid-

2007 Kansas Municipal Water Conservation



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ered an effective way to promote conservation among high-volume users while keeping the cost of moderate use affordable. However, the type of rate structure 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.

Applicable *Kansas Water Plan Objectives*

- 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 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 Water Office: Water Conservation Program
- Kansas Department of Health and Environment: Kansas Public Water Supply Loan Fund
- USDA-Farm Services Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

The primary approach to addressing public water supply issues in the basin focuses on ensuring that there are adequate supplies of surface and ground water within the basin to meet future water demands, 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.

There are 32 [public water suppliers](#) in the basin, including 13 rural water districts. There are currently no public wholesale water supply districts in the basin; however, negotiations are in progress to develop a district along with a portion of the Kansas River basin. [Surface water](#) is the primary source for most public water supplies, accounting for more than 93% of the total supply. There is one state multipurpose small lake in the basin which serves as the water supply for the City of Sabetha. Water from Pony Creek Reservoir is piped across the Mis-

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souri basin watershed boundary to Sabetha, which is located just south of the basin.

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 [Missouri basin](#) is located in region 8 with an average gpcd of 130, 102 and 84 for large, medium and small suppliers, respectively. This serves as a reference to indicate if individual suppliers are above or below average usage for the region.

Reducing “unaccounted for” water is a focus of water conservation efforts in the Missouri basin. Unaccounted for water includes any unmetered uses plus water loss in the distribution system. Technical assistance is available through the Kansas Water Office (KWO) for systems with more than 30% unaccounted for water. High amounts of unaccounted for water may result from water line breaks, under registering meters, 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.

Drought vulnerable public water supplies are those systems most likely to be the first ones 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. The KWO and the Kansas Department of Health and Environment (KDHE) identified drought vulnerable water suppliers in 2006. Three public water suppliers were considered drought vulnerable in the Missouri basin. The KDHE Capacity Development Program has been beneficial in reducing drought vulnerability throughout the state as communities assess their systems and identify areas in need of improvement.

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.
- Reduce the number of public water suppliers with excessive “unaccounted for” water by first targeting those with 30% or more “unaccounted for” water.

- 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 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 Priority Issue](#) for a discussion of current issues concerning water quality.

Water quality is addressed through a combination of restoration and protection efforts using both voluntary, incentive-based approaches and 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 category. For more information on the

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programs and associated policies, see the [Programs Manual](#).

- Kansas Department of Health and Environment: Watershed Management Section/WRAPS
- Kansas Department of Health and Environment: Watershed Planning Section/TMDL Program
- 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
- State Conservation Commission: Nonpoint Source Pollution Control Program
- State Conservation Commission: Water Resources Cost-Share Program



Loess Hills, Doniphan County. Photo courtesy KGS

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.

The U.S. Army Corps of Engineers conducts the Missouri River Mitigation Program to restore habitats in the floodplain. See the [Increase Recreational Use and Access Priority Issue](#) for additional information on this program.

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
- Kansas Water Office: State Water Planning Program
- Kansas Department of Wildlife and Parks: State Parks and Wildlife Areas Planning and Development
- Kansas Department of Wildlife and Parks: Wildlife Habitat Improvement Program
- State Conservation Commission: Kansas Water Quality Buffer Initiative

ISSUE: FLOOD MANAGEMENT

The primary approach to flood management in the basin focuses on community participation in the National Flood Insurance Program and reduction of rural flood damages through construction of watershed dams within organized [watershed districts](#).

As of 2003, the basin had 19 communities (cities and counties) participating in the National Flood Insurance Program. One community has been suspended from the program and three communities with identified flood hazard areas do not participate. There are six watershed districts organized in the basin.

Applicable *Kansas Water Plan Objective*

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

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

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Management

- State Conservation Commission: Watershed Planning Assistance Program
- Federal Emergency Management Agency (FEMA): National Flood Insurance Program
- Kansas Division of Emergency Management: Hazard Mitigation Grants Program

ISSUE: WATER-BASED RECREATION

See the [Increased Water Recreation Use and Access Priority Issue](#) for a discussion of current activities concerning water-based recreation in the basin.

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 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 Program

ISSUES FOR FUTURE ACTION

- Increased public participation by federal, state and tribal entities in water management.
- Water management to maintain instream flows for fish, wildlife and their habitats.



Missouri Riverbank Catfishing Spot. Photo courtesy KGS

Missouri Basin High Priority Issue Missouri River Bed Degradation Impacts January 2009

Issue

Lowering of the Missouri River bed in the reach bordering Kansas threatens water intakes, bridge abutments and other “hard points” along the river channel. Wildlife habitat in the river and along its banks has also been negatively impacted by channel degradation.

Some impacts from bed degradation are well documented, such as the lowering of surface water levels at water intakes in Kansas City, Kansas. Others, such as the status of foundations of bridge abutments and piers, are less known. Another unknown is the rate of degradation. Observations from the Missouri River near Kansas City indicate that the rate of degradation is accelerating.

Missouri River bed degradation in Kansas potentially impacts water intakes for drinking water suppliers and electric power plants, underground pipelines, bridge and channel structures, levees and bank stabilization structures, recreational boat ramps and habitat for fish and wildlife including those federally listed as threatened or endangered. Old bridge piers previously removed to a certain level to guard against navigation obstructions are being exposed.

Description

The Missouri River System

The Missouri River has been heavily modified from pre-settlement conditions. Starting in 1930, the Kansas City District of the U.S. Army Corps of Engineers (Corps) has placed rock fill (revetments) on the bank of nearly every outer bend of the Missouri River.⁽³⁾

The Corps operates a system of six reservoirs on the Missouri River main stem controlling runoff from approximately half the basin. Together, they comprise the largest system of reservoirs in the United States. The upper three reservoirs, Fort Peck in Montana, Garrison in North Dakota, and Oahe in both North and South Dakota are the Corps’ three largest reservoirs. Their water storage at normal pool represents more than 50 times the combined storage of Tuttle Creek, Milford and Perry

lakes in the Kansas River basin.⁽⁵⁾ The reservoir system also provides flood control and navigation benefits to Kansas.

The Missouri River is a significant source of water supply to the Kansas City metropolitan area and other communities of northeast Kansas along the river and beyond (including water for cooling at power generation facilities).

In addition to reservoirs, the Missouri River navigation channel is maintained by a complex series of dikes and revetments. These structures concentrate the flow of the river to maintain a channel depth sufficient for commercial barge traffic. The Missouri River flood plain also contains a system of levees and dikes to contain flood flows.

With the construction of reservoirs and bank stabilization structures in the 1960s, sediment concentrations in the Missouri River have decreased by approximately 80%.⁽³⁾ Along the Kansas reach of the river, there are major stream gaging stations at Leavenworth, Kansas and at St. Joseph and Kansas City in Missouri. During several years of drought through 2007, these gages have recorded all-time low river levels each year.⁽³⁾

The Missouri River is exhibiting a significant bed degradation trend as illustrated on Figure 1. The most severe degradation is in the Kansas City reach between river miles 340 and 400⁽¹⁾, but is also occurring at other locations. Degradation on the Missouri is considered to be causing the lower Kansas River to degrade as well (see [Kansas River Bed Degradation](#)).

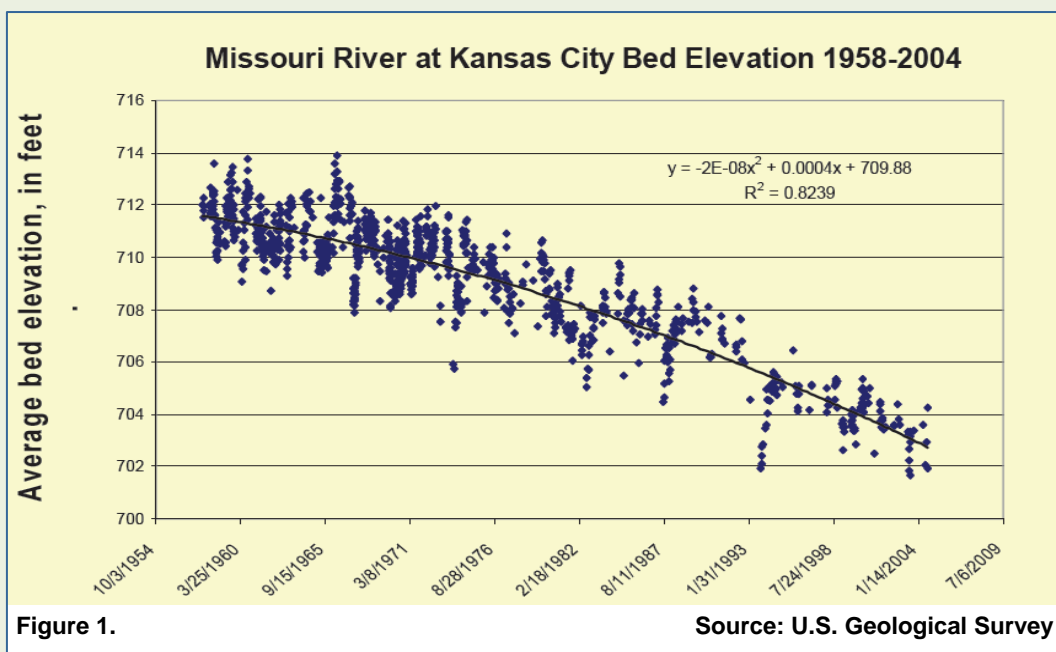


Figure 1.

Source: U.S. Geological Survey

Missouri Basin High Priority Issue

Missouri River Bed Degradation Impacts

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Corps of Engineers Actions

On August 20, 2007, the Corps issued a joint decision regarding commercial dredging operations in the Missouri River. The decision stated that due to increasing bed degradation throughout the river reach between St. Louis and Rulo, Nebraska, there would be no authorizations for dredging after December 31, 2009, without completion of an Environmental Impact Statement as required by the National Environmental Policy Act (NEPA).⁽¹⁾

The Corps has received funding to conduct a reconnaissance study to determine federal interest in Missouri River bed degradation. The purpose of the study is to gather existing data and assess the need for additional data, develop a plan for modeling requirements and conduct preliminary geomorphology and sediment modeling. The Corps study will begin with the formation of a focused team of national experts and agencies such as U.S. Geological Survey. Together they will coordinate with river stakeholders to develop a coalition of sponsoring partners for the next phase of detailed investigations and design of any corrective action.

Known Impacts

In their proposal for the reconnaissance study, the Corps estimates the regional financial impact of Missouri River bed degradation as follows: Intake low-water costs from 2000 to 2004: \$18,773,321; intake costs for actively planned projects in the near future: \$63,159,120; low water future infrastructure: \$286,075,000; federal levee upgrades: \$250 million.⁽¹⁾

The Wyandotte County Board of Public Utilities has detailed costs of retrofitting two electrical generating stations due to lowering of the water surface elevation on the Missouri.⁽³⁾ While considered to be related to bed degradation, reduced flow due to drought in the upper [Missouri basin](#) and other factors also may contribute to the decrease in surface elevation.

The Nearman Creek Power Station is a 235 megawatt base load unit located at river mile 378.4. From 1999 to 2006, the surface water elevation had an average reduction of 15 feet. The intakes were designed for a river level of 735.5 above mean sea level. At elevation 725.5, cavitation begins, adding air and causing pumps to lose efficiency. Temporary pumps have been employed to lift water from elevations as low as 721 feet.



Nearman Creek Power Station

These changes required the construction of a new cooling tower at the Nearman Station at a cost of \$20 million and \$1.2 million for emergency pumps.

The Quindaro Station, a 78 megawatt power plant at river mile 373.3, required installation of emergency pumps at a cost of \$1,400,000. Total impact of water level declines due to bed degradation to date with capital, operation and maintenance and purchased power is estimated by the Wyandotte County Board of Public Utilities to exceed \$35 million.

The Kansas City (MO) Water Service has monitored historic bed degradation at their primary water treatment intake. Between 1930 and 1950, they recorded approximately 1.5 feet of degradation of the Missouri River bed. In 1951, they constructed a new intake. Between 1950 and 1970, there were two additional feet of degradation. Between 1970 and 1990, there were 2.5 additional feet of degradation with an additional five feet of degradation between 1990 and 2005. These changes have required the use of auxiliary pumps which are subject to ice damage.

Missouri Basin High Priority Issue

Missouri River Bed Degradation Impacts

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Recommended Actions

1. Investigate the application in Kansas of infrastructure modifications from other states with similar conditions.
2. Monitor impacts to riparian habitats and species related to degradation.
3. Conduct an inventory of bridges, pipelines and other channel infrastructure considered to be susceptible to bed degradation.
4. Monitor and assist with the U.S. Army Corps of Engineers reconnaissance study of bed degradation on the Missouri.
5. Track the cost of past and ongoing repair for retrofit of water intakes (power and water supply) required due to bed degradation.

Resources

1. U.S. Army Corps of Engineers, Kansas City District. 2007. *Missouri River Degradation: Kansas and Missouri, Proposal under General Investigations, Section 216 of the Flood Control Act of 1970.*
2. U.S. Army Corps of Engineers, Kansas City District. 2007. News Release: *Missouri River Commercial Dredging Permits.*
3. Mid America Regional Council. March 2007. River Degradation meeting notes and presentations, North Kansas City, Missouri.
4. Kansas Water Office. January 2005. *Kansas Water Plan Concept Paper: Channel Degradation in the Kansas River.*
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Missouri Basin High Priority Issue

Increased Water Recreation Use and Access

January 2009

Issue

A lack of access to water-based recreational resources in the [Missouri basin](#) inhibits recreational activity and the associated economic, educational and stewardship benefits.

The Missouri basin does not contain the large federal reservoirs that support most water-based recreation in Kansas. There are two state fishing lakes managed by the Kansas Department of Wildlife and Parks (KDWP) plus ten county and community lakes in the basin.

The Missouri River borders Kansas for 1212 miles and is one of three rivers legally open to public recreational access. There are currently public boat ramps in Leavenworth, Atchison, Elwood, White Cloud and Kansas City, Kansas. There are additional ramps and accesses on the Missouri side of the river.

Benedictine Bottoms near Atchison was acquired by the U.S. Army Corps of Engineers (Corps) and has been managed for wildlife habitat and hunting since 1999 by the KDWP. Benedictine College also conducts biological research at this location. Two new parcels acquired under the Missouri River Mitigation Program will more than double the acreage in Kansas under this program. While management emphasis will be on habitat restoration, expanded recreational opportunities may be available at the new mitigation sites.

Description

The Missouri basin has the smallest land area of the twelve major river basins in Kansas. According to the U. S. Census Bureau, the total [population](#) of the seven counties that are contained in whole or in part by the Missouri basin was 284,011 in 2000, or about 10.5% of the State population. By 2040, the population of these counties is projected to increase by about 16% to 330,470. However, nearly all this increase is projected to occur in Wyandotte and Leavenworth Counties which are influenced by the Kansas City metropolitan area which is the largest potential recreational user base in the state.

There are no state parks within the basin. As measured from the City of Atchison in the central portion of the basin, the closest state parks are Perry (44 miles), Clinton (58 miles) and Hillsdale (81 miles). In Missouri, Lewis and Clark and Weston Bend State Parks border the Mis-

souri River. The Missouri Basin Section of the *2003 Kansas Water Plan* identified an issue for future action on development of a "Missouri River Bluffs State Park." Due to the lack of a suitable location and funding constraints, action has been deferred on this issue.

The Missouri basin contains two state fishing lakes managed by the KDWP.⁽⁴⁾ Brown County State Lake is a 60 acre impoundment near Robinson with an adjoining 188 acre wildlife area open to public hunting. In addition to fishing, picnicking and primitive camping are allowed at the lake with limited facilities. Atchison County State Fishing Lake northwest of Atchison contains 66 surface acres of water and 182 acres of land of which approximately 136 acres, plus the lake, are open to hunting. A rental cabin is under construction at Atchison State Fishing Lake to complement the existing primitive camping facilities.

One of the more widely distributed water-based recreational resources in the Missouri basin are small lakes and parks operated by cities and counties. Collectively known as community lakes, they have been developed and maintained by local governments with assistance through the Community Fisheries Assistance Programs, Land and Water Conservation Fund (parks), both administered by KDWP.⁽¹⁾ Table 1 identifies community lakes in the Missouri basin.

Lake	Water Area	Managed By:
Atchison City Lakes 1-4, 6-9, 23, 24	90 acres	City of Atchison
Atchison County Lake	60 acres	Atchison County
Hiawatha City Lake	7 acres	City of Hiawatha
Lansing City Lake	1 acre	City of Lansing
Leavenworth - Jerry's Lake	¾ acre	Leavenworth County
Sabetha City Lake	100 acres	City of Sabetha
Troy 4-H Lake	5 acres	City of Troy
Wyandotte Co. - Big 11	3 acres	Unified Gov. - KCK, WYCO
Wyandotte Co. Lake	407 acres	Unified Gov. - KCK, WYCO
Wyandotte Co. - Pierson Park Lake	12 acres	Unified Gov. - KCK, WYCO

The Missouri River typically flows at four to five miles per hour creating potentially hazardous conditions for boaters. Wing dams, buoys, bridges, barge traffic and sand dredges can present hazards to watercraft when combined with the speed of the current. Due to the wide channel, high winds affect canoes and kayaks.⁽⁶⁾ It is legal to camp along the river below the normal high water mark but sand bars are often covered during summer due to navigation releases from upstream of Kansas reservoirs.

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The distance between access points is important to unpowered recreational water craft. While access points are well-spaced in the upper river, access points are further apart above Kansas City.

The Missouri River Mitigation Project is administered by the Corps to acquire and develop aquatic and terrestrial habitat to compensate for losses resulting from past channelization of the Missouri River.⁽³⁾ In Kansas, the 2,111 acre Benedictine Bottoms was purchased in 1994 and developed in 1998. Along with habitat restoration, the area supports research, fishing, bird watching, hiking and hunting (by special permit). Overnight camping, campfires, and/or motorized vehicles are not allowed on the mitigation lands.

Two additional properties have been acquired under the Mitigation Project near Elwood and Atchison. These additional parcels will approximately double the area managed under the program. While habitat restoration will be the primary purpose of these areas, options may exist to develop compatible recreational activities.

In 1989, the KDWP found that 30% of Kansas State Park users drive more than 50 miles for access to public lands and waters.⁽¹⁾ Fuel prices are likely to play a larger role in recreational use than in the past, making local access to parks, lakes and natural areas increasingly important. While the availability of public lands is not likely to significantly increase, planning to make optimal use of existing recreational resources will be needed.



Benedictine Bottoms. Photo courtesy Corps of Engineers

Recommended Actions

1. Evaluate the placement of existing access points on the Missouri River in both Kansas and Missouri, to determine the need for additional access points in Kansas.
2. Encourage recreational use of private lands through access programs such as walk-in hunting and fishing and other programs administered by Kansas Department of Wildlife and Parks.
3. Develop recreational opportunities on Missouri River Mitigation Program properties as consistent with the primary purpose of habitat restoration.
4. Emphasize the educational potential of existing water resources through interpretive signage and programs.
5. Investigate non-governmental support and funding to develop water-related recreation and educational opportunities in Kansas.

Resources

1. Kansas Wildlife and Parks. 2005. *Strategic Plan, Seventh Edition*.
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4. Kansas Wildlife and Parks Locations. Accessed September 2008. http://www.kdwp.state.ks.us/news/kdwp_info/locations
5. HTNB Corporation. April 2002. *Missouri River Recreation Study*.
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Missouri Basin High Priority Issue Watershed Restoration and Protection Approved January 2008

Issue

Water quality is addressed through a combination of restoration and protection efforts using both voluntary, incentive-based approaches and regulatory programs. The protection and restoration of watersheds draining to the Missouri River is a high priority in the [Missouri Basin](#). With the urbanization of the southern part of the basin, protection and restoration of these watersheds has become more important.

Water Quality Impairments

Many streams within the basin are experiencing water quality impairments. Fecal coliform bacteria and biological stressors are the most prevalent stream impairments. Sedimentation and eutrophication due to nutrient loading are the primary water quality problems affecting reservoirs in this basin.

Surface waters not meeting water quality standards in the basin are included on the 2006 303d list of impaired waters.⁽¹⁾ High priority Total Maximum Daily Loads (TMDLs) for impaired surface waters in the Missouri basin were originally submitted to the Environmental Protection Agency for approval in 1998 by the Kansas Department of Health and Environment (KDHE). An additional round of TMDL development was completed in 2007. High priority TMDL watersheds are identified to target technical and financial assistance for implementation of non-point source pollution management practices to address designated pollutants.

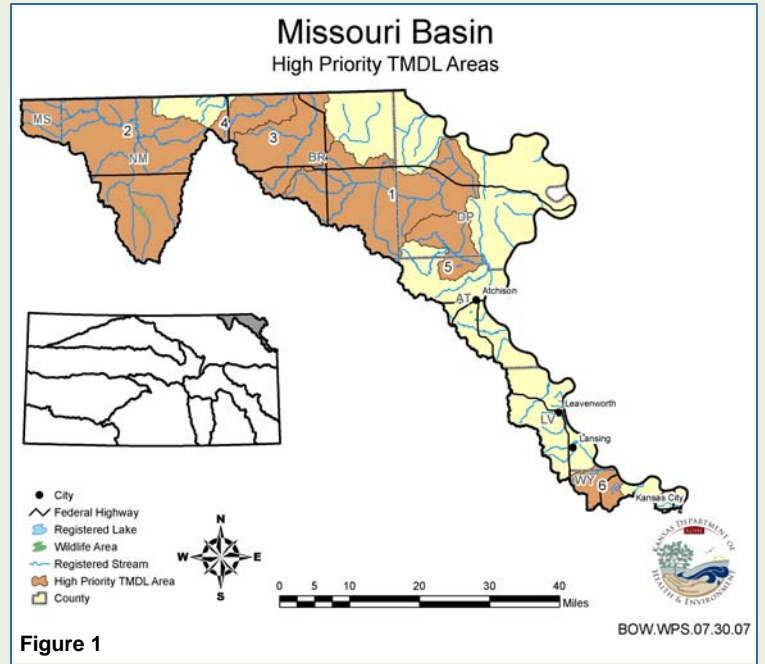


Figure 1

A TMDL is the maximum amount of a pollutant that a water body can receive without violating water quality standards. Since pollution can arrive via point and non-point sources, the TMDL development process identifies contributing sources for the pollutant loads. High priority TMDL areas are shown in Figure 1 and Table 1.⁽¹⁾

**TABLE 1
MISSOURI BASIN HIGH PRIORITY TMDLS**

MAP ID	WATERBODY	IMPAIRMENTS	HUC 11 WATERSHEDS
STREAM SEGMENT			
1	Wolf River	FCB, BIO	10240005060
2	Big Nemaha River	FCB, BIO	10240007010
			10240007021
			10240007030
3	Walnut Creek	FCB	10240008050
LAKES			
4	Pony Creek Lake	E	10240008050
5	Atchison State Fishing Lake	E	10240011010
6	Wyandotte Co. Lake	E	10240011030

Note: For each of the high priority lakes in the basin, the TMDL only applies to the area upstream of the lake.

Key:
 E: Eutrophication, biological community impacts and excessive nutrient/organic loading
 BIO: Biology
 FCB: Fecal Coliform Bacteria
 HUC: U.S. Geologic Survey Hydrologic Unit Code
 See the KDHE TMDL website for additional information⁽¹⁾

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Surface Water Nutrient Reduction

Nutrient sources within the basin include both point and non-point sources. The major point sources in the basin include large wastewater treatment plants which are regulated under the National Pollutant Discharge Elimination System (NPDES) Program (Figure 2) administered by KDHE.

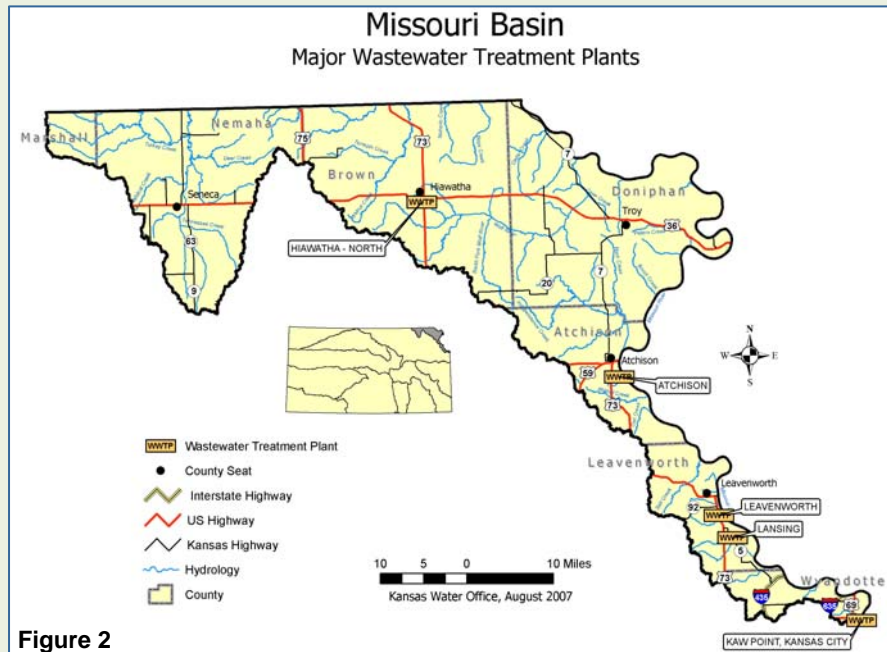


Figure 2

The *Kansas Surface Water Nutrient Reduction Plan*,⁽²⁾ developed by KDHE, outlines a statewide strategy for reducing the export of total nitrogen (TN) and total phosphorus (TP) in surface waters leaving the state. This involves additional reductions in nutrients from point source discharges through the NPDES Program and reductions in non-point 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.⁽²⁾ A scale (low potential improvement to high potential improvement) was developed for: phosphorus fertilizer use, excess on-farm manure phosphorus quantity, nitrogen fertilizer use, nitrogen fertilizer transport potential and excess on-farm manure nitrogen quantity.

These values were used to calculate IPI values for nitrogen (scale 1-20) and phosphorus (scale 1-10) on a county-by-county basis. The higher the ranking value, the greater the relative potential for improvements produced within that county. It should be noted that the IPI is a relative measure. It does not mean a county with an

IPI of eight can make twice the improvement of a county with an IPI of four. The higher IPI only suggests there is a greater possibility of improvement. In the Missouri basin, Nemaha County showed an improvement potential range of 8.1 - 12.0 for TN with Brown County showing a range of 4.1 - 8.0 TN. The IPI index range for TP was 6.1 - 8.0 for both counties. All other counties in the basin had an IPI index of less than 2 for TN and TP.

Nonpoint sources of pollution include both agricultural and urban areas. KDHE has not assigned nonpoint source nutrient loads to the Missouri River due to the impractical nature of sampling for Kansas specific inputs. The Missouri basin, however, has one of the largest nutrient point sources in the state at the Kaw Point wastewater treatment plant in Kansas City, Kansas. While no data on nutrient reduction are available for the Kansas portion of the Missouri basin because of a lack of non-point source data, efforts are being made to work with Kansas City, Kansas to study nutrient reduction at the Kaw Point treatment plant.

Source Water Protection

All [public water suppliers](#) in the basin completed source water assessments in cooperation with KDHE in 2004.⁽³⁾ The next step, is the development of voluntary source water protection plans.

Of the 17 public water suppliers in the basin which treat raw water, four use [surface water](#) and 14 use ground water (one uses both). Each source water assessment included a susceptibility score which can help communities determine which contaminants pose the most significant threat to their water supply. A 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 public water suppliers using ground water in the Missouri basin, 64% had low susceptibility scores and 36% had moderate scores. Of public water suppliers using surface water, 25% had low susceptibility scores and

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75% had moderate scores. The most commonly identified problems with ground water were volatile and synthetic organic compounds, pesticides and microbes. The most commonly identified problems with surface water were volatile and synthetic organic compounds, inorganic compounds, sediment and eutrophication/phosphorus.

For communities using ground water, development of a wellhead protection program is recommended. For communities using surface water, the development of a watershed restoration and protection strategy (WRAPS) is the best mechanism to ensure water quality protection for their public water supply. The Missouri basin has three complete and approved source water protection plans as of 2004.⁽³⁾

Wetland and Riparian Area Management

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. Water quality has been a primary focus with implementation efforts targeted to high priority TMDL watersheds (Figure 2). All conservation districts in the basin have developed wetland and riparian protection plans.

Watershed Restoration and Protection Strategies

Watershed Restoration and Protection Strategies (WRAPS) are stakeholder-driven 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, riparian and wetland management and other natural resource objectives.

A basin-wide Missouri River WRAPS is currently being developed.⁽⁶⁾ It is anticipated that WRAPS projects in the basin will encompass priority areas for TMDL implementation, areas with a high improvement potential index for nutrient reduction, source water assessment areas and priority areas for wetland and riparian protection.

An important consideration for watershed restoration and protection in this basin, particularly in the southern portion of the watershed, is urbanization. Between 2000 and

2006, the population of Leavenworth County increased by 4,929 or 7.2%. All other counties in the basin experienced declines in population. Although Wyandotte County declined in population by 1.5% over the period, it remains the most urbanized county in the basin.

As the amount of impervious surface in a watershed (i.e. rooftops, roads, parking lots, etc.) increases, water resources can be adversely impacted. Runoff volume increases and additional pollutants associated with urban environments may enter streams and ponds unless preventive steps are taken by local government and urban residents. Sound land use planning and storm water management are essential to limit adverse effects.

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.

Another consideration for watershed restoration and protection in the basin will be the potential for conversion of Conservation Reserve Program (CRP) acreage back to production agriculture as contracts expire. Of the 90,251.6 acres enrolled in six of the seven Kansas counties contained wholly or partly in the Missouri basin, contracts on 18,942.1 acres expired on September 30, 2007.⁽⁴⁾ The total CRP acreage in Wyandotte County is restricted under the Freedom of Information Act, but is considered to be minimal. 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.

Other Watershed Related Activities

- The seven counties either wholly or partly within the basin have adopted local sanitary/environmental codes or participate in the Local Environmental Protection Program.
- Doniphan, Leavenworth and Wyandotte counties have countywide planning and zoning programs.
- All conservation districts in the basin have adopted nonpoint source pollution management plans.

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Grants under the State Water Quality Buffer Initiative have also been awarded in Doniphan, Marshall and Nemaha counties to support buffer coordinators and facilitate enrollment of stream buffers in continuous CRP.

- Of cities in the basin, Kansas City, Kansas, Leavenworth and the Kansas portion of St. Joseph located west of the Missouri River have been issued Phase II Permitted Municipal Separate Storm Sewer System under the NPDES Stormwater Program.
- As of December 2006, there were three active contamination sites being remediated through the State Water Plan Program (Contamination Remediation)
- There are six organized [watershed districts](#) in the basin.

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.

Basin Specific Objectives

- Over 25% of the high priority TMDLs identified in 2001 and 2007 for the Missouri basin will have data supporting their delisting as impaired on the 2012 Kansas 303(d) list.
- All public water suppliers will complete and implement a source water protection plan.
- Nutrient reduction goals will be included in all WRAPS projects within the basin.
- Integrate urban stormwater management goals into all urban area WRAPS and support the implementation of urban stormwater management projects as outlined in WRAPS action plans.

Recommended Actions

1. Work with stakeholder groups to incorporate TMDL implementation, nutrient and sediment reduction, and urban stormwater management goals into applicable WRAPS projects.
2. Target technical and financial assistance programs for water quality protection and restoration to implement TMDLs and WRAPS action plans.

Resources

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