

General Description

The Verdigris River is a tributary of the Arkansas River and the basin includes Hydrologic Unit Codes 11070101, 11070102, 11070103, 11070104, and 11070105. The Arkansas River originates in central Colorado, where it flows southeast into and across Kansas before crossing into Oklahoma just south of Arkansas City. The Verdigris River mainstem rises in the southeastern corner of Chase County and flows in a general south-southeasterly direction for about 350 miles to its junction with the Arkansas River near Muskogee, Oklahoma. Elevation ranges from about 1,650 feet at the headwaters to about 680 feet at the state line. The Verdigris basin in Kansas covers approximately 4,440 square miles and encompasses all or parts of 11 counties in the southeastern part of the state. Near the City of Grove Oklahoma, the Verdigris River is dammed to form Oolagah Reservoir, a major drinking water supply storage for the City of Tulsa. Approximately two-thirds of the watershed above this reservoir is in Kansas.

Four federal reservoirs were constructed in the basin between 1949 and 1981; from oldest to youngest they are [Fall River](#), [Toronto](#), [Elk City](#) and [Big Hill](#).

Major transportation routes include Highways 54 and 400 which run generally east to west through the basin. Highways 169 and 75 run north and south. See the [basin map](#) for locations.

Population and Economy⁽⁷⁾

There were an estimated 103,000 residents in the Kansas portion of the basin in the year 2000 and the [population](#) is expected to decrease to around 78,527 by 2040 according to Kansas Water Office (KWO) projections. No counties in the basin are projected to gain population. Major population centers include Independence, Coffeyville, Eureka, Neodesha and Fredonia.

Outside of major population centers, the population is generally rural with small agricultural communities.

The local economy is based primarily on agriculture with some manufacturing and light industrial activity including the Cobalt boat production facility in Neodesha. The major [crops](#) grown in the basin are wheat, grain sorghum and soybeans and the production of beef cattle is an important part of the agricultural economy. In 2006 there were an estimated 3,690 farms, with 2,632,000 acres in the five major counties in the basin. The average farm size was 713 acres. Crop value in 2006 was estimated by the Kansas Department of Agriculture at about \$113 million. [Livestock](#) production value was estimated to be about \$119 million.⁽⁴⁾



Toronto Lake Dam. Photo courtesy Kansas Geological Survey.

Education, health and social services, forestry, fishing and hunting, and mining also contribute to the local economy. Another significant contributor is the production of oil and gas. Along with this comes historic contamination from oil and gas production before more stringent regulations were in place to manage brine waste. Thousands of abandoned wells dot the landscape.

Coffeyville and Independence community colleges offer opportunities for higher education.

The four federal reservoirs in the basin offer water based recreation, hunting and other opportunities for experiencing natural environments. A 980 acre park at Fall River Reservoir features forested floodplains, blackjack oak savannahs and tallgrass prairie. Toronto Reservoir has a 4,700 acre park with riparian timber areas, grassland, and wetland communities. Native prairie and timbered areas can be enjoyed on 1,320 acres at Big Hill Reservoir, and Elk City Reservoir has 857 acres of native prairie, limestone bluffs, and deciduous forest. All parks offer camping, swimming, boating, water skiing, hiking, picnicking, bird watching, and photographic opportunities. Public wildlife areas are managed for both game and non-game species. The recreational resources these reservoirs provide are important to the local economy as visitors purchase amenities while in the area.

Physical Characteristics

Geology and Soils

The area is generally characterized as being in the Osage Cuestas Ecoregion with a physiography of cuestas and gentle undulating plains dissected by perennial and intermittent streams. Silty and clayey residuum and colluvium with alternating layers of Pennsylvanian sandstone, limestone, and shale characterize area geology. Glacial drift is fairly abundant in the extreme northern part of this ecoregion. Soils in the western part of the basin were developed from the underlying limestones and shales and in most parts of the area the soils are relatively shallow, making them best suited for native pastures. In the eastern part of the basin, soils are generally sandy residual soils which are low in fertility and quite erosive. These soils occur on undulating to hilly topography and are relatively shallow. In general, this area is more suitable for grazing than for cultivation.

Land Use/Land Cover

[Land cover](#) is a mosaic of grassland (74%), cropland (14%), and woodland (9 percent). All other land cover types represent less than 1 percent of the total land cover except for water which represents about 1.5 percent of the land cover. Most of the land use is for agriculture, either grazing and haying or crop production. Most of the crops are grown in the floodplains of the Verdigris River and its tributaries. Natural vegetation transitions from mostly tallgrass prairie in the west to a combination of tallgrass prairie and oak hickory woodland in the east. Upland forests are dominated by shagbark hickory, bitternut hickory, red oak, white oak, and black oak, with Ohio buckeye, American bladderpod, and pawpaw common understory trees. A remnant of the Cross Timbers Forest occurs in the basin.

According to the 2003 Assessment of Riparian Areas Inventory by the Kansas Geological Survey⁽⁵⁾ (KGS), of the 25,722 miles of stream bank riparian area in the basin, the dominant riparian cover in a 100 foot zone from the streambank is pasture/grassland (34%).

The second most common cover is forest land (29%), and third most common cover is a mixture of pasture and trees (19%). The remaining riparian cover types, in descending order of dominance, are crop land, crop land/tree mix, shrubland, urban, urban/tree mix, and barren land.

The Natural Resources Conservation Service (NRCS) completed a Rapid Watershed Assessment (RWA) on HUC 11070101 in the basin.⁽¹⁰⁾ The RWA report provides a detailed accounting of land uses and the application and condition of best management practices in this HUC unit. While the information cannot be directly extrapolated as being descriptive of the rest of the basin, it is likely that general trends are comparable.

The Upper Verdigris sub-basin described in the RWA is comprised of 767,225 acres in southeast Kansas including Chase, Lyon, Greenwood, Neosho, Wilson, and Woodson Counties. According to the National Land Cover Data (NLCD), approximately 12% of the sub-basin is in grain and row crop; 78% is in grassland, pasture, and hay; and the rest is in other various land uses. These percentages correspond well with the larger basin.

Resource concerns are numerous in the RWA sub-basin. They include, but are not limited to, soil erosion, soil compaction, diminishing surface water quality, deteriorating plant conditions and inadequate water for domestic livestock. Economic issues such as the high capital costs of crop production and farm operation and unreliable profits may delay the acceptance and implementation of conservation practices on agricultural lands in the subbasin.

There are approximately 811 farms and 1,168 operators in the Upper Verdigris subbasin. The estimated average farm size in 2002 was 809 acres, an increase of 15% from the 1987 estimate.

Six NRCS service centers, six county conservation districts, the Upper Verdigris Watershed District and the Flint Hills and See-Kan Resource Conservation and Development (RC&D) councils provide conservation assistance in the sub-basin.

With the exception of Chautauqua County, all counties in the Verdigris basin have adopted and are enforcing envi-

ronmental codes. Five of the 11 counties have adopted land use zoning regulations.

Climate

Annual [precipitation](#) in the basin varies from approximately 34 inches in the west to almost 40 inches in the southeast corner. Approximately 70 percent of this precipitation falls between April and September. Between 11 and 18 inches of snow falls in an average year. The average temperature varies from 34 degrees in the winter to 79 degrees in the summer.

Table 1 summarizes average annual precipitation, temperature and freeze data for years between 1971 and 2000 for the cities of Eureka in the western part of the basin and Independence in the southeast part of the basin.

Table 1.					
Climate Summary Verdigris Basin					
	Average Annual ¹		Freeze Dates (32 F.) ²		
Location	Precipitation (inches)	Temperature (deg. F.)	Last in Spring	First in Fall	Frost Free Days
Eureka	37.78	55.6	Apr. 17	Oct. 16	182
Independence	43.46	57.1	Apr. 10	Oct. 23	198

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



Pasture in Chase County. Photo courtesy Kansas Geological Survey.

Wildlife and Habitat

Numerous threatened and endangered (T&E) species occur in the Verdigris basin. Of these, there is one reptile, one invertebrate, and one mammal. Seven are mussels, seven are birds and three are fish.

The Verdigris River basin provides habitat for several species of T&E mussel species. The presence of mussels generally indicates good water quality since they are not able to move easily from one habitat to another. Mussels provide important filtering functions where they occur, helping to keep the water free of pollutants.



Ouachita Kidneyshell Mussel

Water Resources

Surface water is abundant during rainfall/runoff events and many streams are perennial; however the streams are flashy, characterized by flooding during storm events, followed by low flows during dry weather. There is no assurance that water is present when and where it is needed on a consistent basis. Of the 11,411 stream miles in the basin, 9,724 miles are intermittent, with the remaining 15%, or 1,688 miles, perennial. Stream density of both types is 2.6 stream miles/square mile area, making this basin tied with third place in stream density of the 12 basins in the state.

Due to numerous intermittent streams, surface water is undependable for public water supplies. This, combined with historic flooding, led to construction of four federal reservoirs in the basin, beginning in 1949, with the most recent completed in 1981.

The major streams in the basin are the Verdigris, Elk, Fall, Caney and Little Caney Rivers, and Big Hill and Caney Creeks. Elk and Fall Rivers and Big Hill Creek

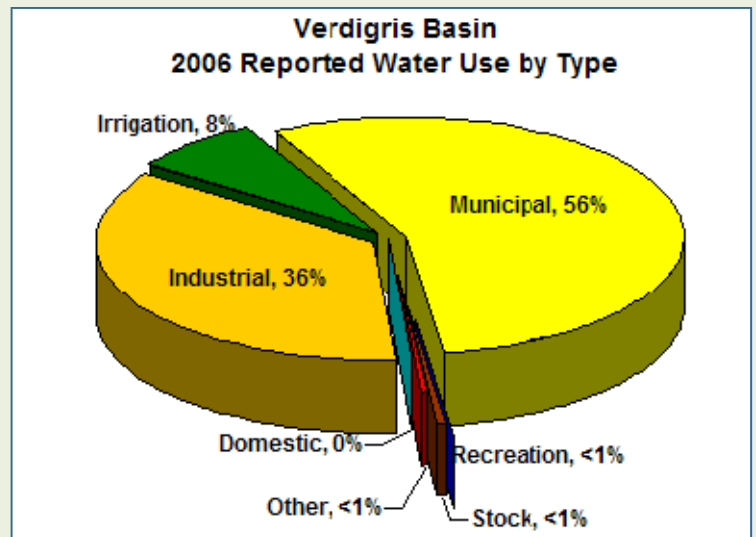
are tributaries to the Verdigris River in Kansas, while the Caney joins the river in Oklahoma.

In addition to the federal reservoirs in the basin, all counties have state fishing lakes. Other community water resources include the Woodson Wildlife area, Cherryvale City Lake and LaClaire Lake.

Ground water supplies are quite limited in the basin, occurring mostly in alluvial aquifers.

Watershed Districts in the basin have constructed flood control structures to address rural flooding. Most impound water even during non-flood conditions. Several of these are available as back up sources of drinking water. Most are also used for livestock watering.

Surface water is the predominant source of water for beneficial uses in the Verdigris basin, with a very small amount, about one percent overall, derived from alluvial deposits along streams. In the Kansas part of the basin, surface water makes up over 98% of the water used. The majority of water used is for industrial (36%) and municipal (56%) purposes. Recreation (<1 percent), irrigation (8 percent), stockwater (<1 percent) and other uses (<1 percent) make up the remainder of the water used in the basin.⁽⁶⁾



Water Management

Significant water management entities include conservation districts throughout the basin, public water suppliers, the See-Kan Resource Conservation and Development Council (RC&D), and 12 watershed districts. By virtue of its responsibility for the four major reservoirs in the basin, the Corps is an important water management entity.

The City of Coffeyville is permitted under the Kansas Department of Health and Environment (KDHE) Phase II Stormwater Program which gives the city responsibility for managing surface water quality and quantity.

Watershed Restoration and Protection Strategy (WRAPS) groups are an emerging water management entity in the basin. These are coordinated by either the See-Kan RC&D or the Flint Hills RC&D. 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.

Resources

1. KWP-Verdigris Basin Section. November 2003.
2. U.S. Geological Survey 2000. K.E. Juracek. Report No. 00-4177 "Estimation and Comparison of Potential Runoff Contributing Areas in KS Using Topographic, Soil, and Land Use Information.
3. Kansas Water Office [Reservoir Fact Sheets](#).
4. USDA, Kansas 2006-2007 County Farm Facts, Agricultural Statistics and Ranking.
5. 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
6. WRIS database, DWR, December 13, 2007.
7. U.S. Census Data—2000.
8. County Population Estimates. KS Division of Budget 2007.
9. Verdigris Unit Report-Kansas Water Resources Board Water Plan Studies.
10. <ftp://ftp-fc.sc.egov.usda.gov/ks/outgoing/web-files/tecchnical-resources>

Cross Timbers Forest

Large tracts of ancient deciduous forest still occur on the ridges and rugged escarpments of southeast Kansas, Oklahoma, and central Texas. These woodlands are dominated by centuries-old post oak (*Quercus stellata*) and are part of the Cross Timbers ecosystem. The Cross Timbers are a complex mosaic of upland forest, savanna and glade which form the broad ecotone between the eastern deciduous forests and the grasslands of the southern Great Plains. The pre-settlement Cross Timbers are believed to have covered some 30,526 square miles extending from central Texas across Oklahoma into southeastern Kansas. The short, stout oaks of the Cross Timbers were not ideal for lumber production, so the original Cross Timbers have often survived on steep terrain that was unsuitable for farming. Literally thousands of ancient post oak can still be found in this region, and there is no doubt that the Cross Timbers is one of the least disturbed forest types left in the eastern United States.

**Cross Timbers Forest**

Verdigris River Basin Management Categories

January 2009

WATER MANAGEMENT CATEGORIES

The following categories include issues identified in the [Verdigris 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

See [Protecting and Enhancing Instream Flow Basin Priority Issue](#)

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.
- Meet minimum desirable streamflow at a frequency no less than the historical achievement for the individual sites at time of enactment.

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
- USDA-Natural Resources Conservation Service: En-

vironmental 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 a part of maintaining a long-term water supply for Kansas.

Unaccounted for water includes any unmetered uses such as water used for fire fighting and watering of public areas, 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 customers, unmetered uses, faulty metering or inaccurate accounting. The statewide average percentage of unaccounted for water use in 2006 was 14% statewide. 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.

Of the 66 [public water suppliers](#) in the Verdigris basin, 42 have an approved municipal conservation plan. Of those suppliers with approved plans, only two have submitted updated plans under the 2007 KWO Municipal Conservation Plan Guidelines. All other plans were developed based on guidelines from 1990 and should be updated to incorporate the 2007 changes.

2007 Kansas Municipal Water Conservation



Kansas Water Office
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Topeka, KS 66612-1249
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August 2007

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Verdigris River Basin Management Categories

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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 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 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.

Drought Stage Triggers (Table 1) 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 the appropriate 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.

Every public water supply drought response plan should be set up in stages, each one more stringent than the one before it. Triggering mechanisms should be identified to signal the start of a given stage and specific goals should be identified as the desired outcome for each stage. Finally, appropriate conservation practices in the

areas of education, management and regulation should be listed under each stage. Stages are appropriate to implement drought response practices or actions because the impact of conservation practices of a moderate stage may preclude the need for the municipal water entity to enact more severe conservation practices at a subsequent stage.

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 KWO has issued a drought stage based on the remaining water marketing storage in a basin reservoir.

Drought vulnerable public 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 supplies considered drought vulnerable decreased from 21 to 10 between the two surveys (Table 2). Delivery of the Kansas Department of Health and Environment (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.

Table 2.		
Supplier Name	New to List	Limitation
Cedar Vale	No	Basic Source
Grenola	No	Basic Source
Hamilton	Yes	Unknown
Longton	No	Basic Source
Madison	Yes	Basic Source
Neodesha	Yes	Unknown
Wilson RWD 01	No	Contractual
Wilson RWD 02	No	Contractual
Wilson RWD 05	No	Contractual
Wilson RWD 07	No	Contractual

Verdigris River Basin Management Categories

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Applicable Kansas Water Plan Objectives

- Reduce the number of public water suppliers with excessive “unaccounted for” water by first targeting those with 30% 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 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 Service Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

Also see [Surface Water Management and Conservation Basin Issue Paper](#).

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 66 [public water suppliers](#) in the basin, including 36 rural water districts. There are currently four public wholesale water supply districts (PWWSD) in the basin. Surface water is the primary source for most public water supplies, accounting for over 99% of the total supply. Streamflows in the basin are highly variable within the year, and from one year to another. [Fall River](#), [Toronto](#), [Elk City](#) and [Big Hill](#) reservoirs are operated through a memorandum of agreement to maximize use of the stored water.

A Regional Public Water Supply Planning Grant to PWWSD #24 (Elk City, Howard, Longton, Severy and Moline) was completed in 2007. The district is pursuing consolidation with PWWSD #20 as the best solution to water supply vulnerability concerns. Construction of the project will decommission five small surface water treatment plants that are currently out of compliance with Safe Drinking Water Act requirements. The other PWWSDs are #4, which utilizes Big Hill Reservoir as a water source for 16 cities and rural water districts, and #23, that is under development and plans to upgrade and utilize the Fredonia treatment plant and distribution system.



Water Tower South of Cherryvale.
Photo courtesy KGS.

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 Verdigris basin is located in region 7. Average gpcd for large, medium and small suppliers in region 7 are, 148, 107 and 96 respectively. This serves as a reference to indicate if individual suppliers are above or below average usage for the region. The average gpcd water consumption is 105 in the Verdigris basin.

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.

Verdigris River Basin Management Categories

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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 [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 Watershed Restoration and Protection Strategy (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 programs and associated policies, see the [Programs Manual](#).

- 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 Program
- State Conservation Commission: Nonpoint Source Pollution Control Program
- State Conservation Commission: Water Resources Cost-Share Program



Verdigris River near Coffeyville. Photo courtesy KGS.

ISSUE: WETLAND AND RIPARIAN MANAGEMENT

See the [Watershed Restoration and Protection Basin 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](#).

Verdigris River Basin Management Categories

January 2009

- 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
- Kansas Department of Wildlife and Parks: Conservation Easement Program

ISSUE: FLOOD MANAGEMENT

See [Comprehensive Flood Assessment Basin Priority Issue](#).

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

Applicable Kansas Water Plan Objectives

- 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 Management
- State Conservation Commission: Watershed Dam Construction Program
- State Conservation Commission: Watershed Planning Assistance Program
- Kansas Division of Emergency Management: Hazard Mitigation Grants Program
- FEMA: National Flood Insurance Program

ISSUE: WATER-BASED RECREATION

The state's rivers, streams and lakes represent a valuable recreational resource. Consideration of water basin recreation issues, problems and concerns are addressed in the [Water Based Recreation Policy Section](#). Even though the Verdigris basin has four large federal lakes

that have recreation components, there is still a demand for more water based recreation facilities, particularly for fishing, hiking, motor boating and water skiing. The Verdigris River and its tributaries are not among the three rivers in the state considered open for public access.

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 Water Office: State Water Planning Program
- Kansas Department of Wildlife and Parks: Fishing Impoundments and Stream Habitats (F.I.S.H.) Program/Walk-in Fishing
- Kansas Department of Wildlife and Parks: Walk-in Hunting Access Program
- Kansas Department of Wildlife and Parks: Community Fisheries Assistance Program

ISSUES FOR FUTURE ACTION

- Recreational use of the Verdigris River.

Verdigris Basin High Priority Issue Watershed Restoration and Protection January 2009

Issue

The restoration and protection of watersheds, particularly those watersheds above public water supply reservoirs, is a priority in the [Verdigris basin](#). The Verdigris and Caney rivers drain south into Oklahoma so interstate water quality issues are also important to ensure high quality water crossing the state line.

There are four federal reservoirs: [Fall River](#), [Toronto](#), [Elk City](#) and [Big Hill](#), in the Verdigris basin. All of these reservoirs are operated by the U.S. Army Corps of Engineers (Corps). All four reservoirs are used for public water supply programs that serve numerous cities and rural water districts in the basin. The reservoirs are also managed by the Corps for flood control and recreation.

Many streams within the basin are experiencing water quality impairments. Fecal coliform bacteria and low levels of dissolved oxygen (D.O.) are the most prevalent stream impairments.

Reservoir sedimentation is a major water quantity concern, particularly in reservoirs where the state owns storage for the Water Marketing and Water Assurance programs. 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 multi-purpose pool capacity lost, including water supply storage, to sediment deposition in federal reservoirs in the Verdigris basin since construction.

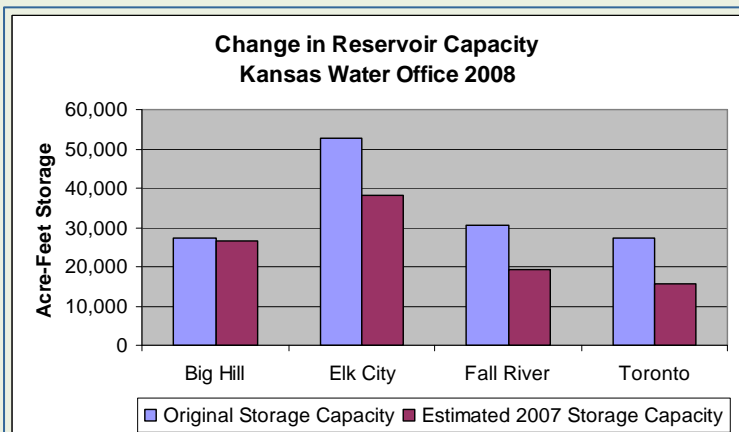


Figure 1. Changes in Reservoir Capacity Since Construction.

Description

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.

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 uses 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. High Priority TMDL watersheds are used to target technical and financial assistance for implementation of nonpoint source pollution management practices that can address designated pollutants.

Surface waters not meeting surface water quality standards in the basin are included on the 2006 303(d) list. The Kansas Department of Health and Environment (KDHE) completed the first round of TMDLs within the Verdigris basin based on the 1998 303(d) list. There are 20 approved TMDLs within the Verdigris 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 six stream chemistry sampling stations and two biological monitoring stations as water quality impaired. There are seven lakes in the Verdigris River basin listed as water quality impaired. Among the streams copper causes the greatest number of impairments. Other pollutants of concern in Verdigris streams include zinc, lead, D.O. deficiency and E. coli bacteria. Among the lakes eutrophic conditions indicative of excessive algae production, D.O. depletion, and siltation are the causes of impairment.

Each parameter causing impairment requires a TMDL. Many of the stream segments configured in a watershed setting have a TMDL applied to them as a whole. KDHE has reviewed and revised Verdigris basin TMDLs and submitted them to EPA in late summer 2008. The following changes are proposed: a new high priority eutrophi-

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cation, D.O., and siltation TMDL for Fall River, a new high priority eutrophication, D.O., and siltation TMDL for Toronto Reservoir, a new high priority eutrophication TMDL for Big Hill Reservoir, a new medium priority siltation TMDL for Eureka Lake and a new medium priority eutrophication and siltation TMDL for Elk City Reservoir. The TMDL for Elk City Reservoir will remain a medium priority until a viable Watershed Restoration and Protection Strategy (WRAPS) group is formed in the watershed above it.

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

Table 1 provides information on rivers and reservoirs within the basin that are designated a 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.⁽⁶⁾

trients 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) Program (Figure 3).

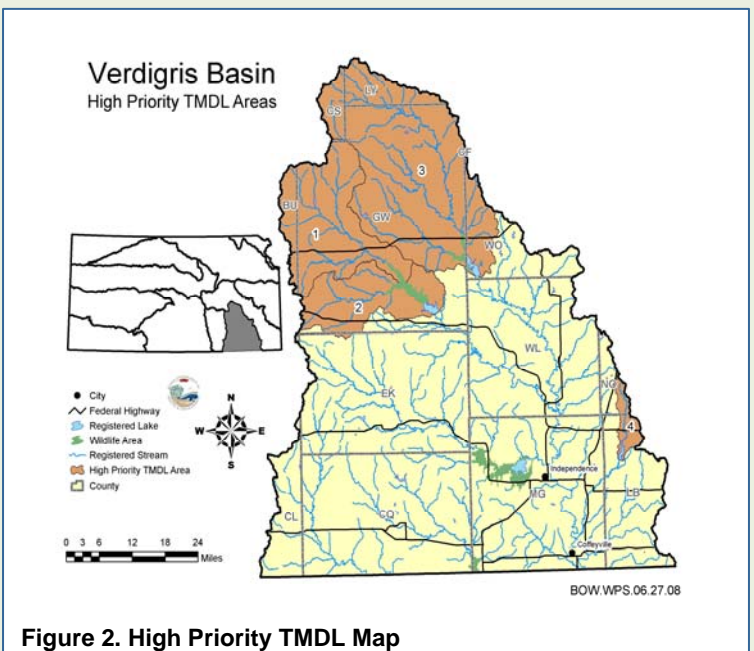


Figure 2. High Priority TMDL Map

TABLE 1 VERDIGRIS BASIN HIGH PRIORITY TMDLS			
MAP ID	WATERBODY	IMPAIRMENTS	HUC 8 WATERSHEDS
STREAM SEGMENTS			
1	Fall River	FCB	11071020
LAKES			
2	Fall River Lake	E, DO, Silt	11070102
3	Toronto Lake	E, DO, Silt	11070101
4	Big Hill Lake	E	11070103
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 HUC: U.S. Geologic Survey Hydrologic Unit Code Silt: Observed siltation and/or chronic turbidity that impacts development of trophic state			

Surface Water Nutrient Reduction

The impacts of nutrients originating in Kansas have been well documented. These include 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 nu-

Nonpoint sources of pollution include both agricultural and urban areas. Table 2 shows the relative contribution of point and nonpoint sources in the Verdigris basin for total phosphorus (TP) and total nitrogen (TN) leaving the state. The Kansas Surface Water Nutrient Reduction Plan, 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 WRAPS. The Nutrient Reduction Plan includes Improvement Potential Index (IPI) maps for Kansas counties for TP and TN reductions (see maps in [Water Quality Policy Section](#)). In the Verdigris basin, no counties currently show high improvement potential for TP and TN. However, with the recent development of high priority TMDLs for all four reservoirs in the basin, this could change as the plan is updated. Any actions taken in the basin to reduce nutrients in surface waters will also benefit downstream water users in Oklahoma.

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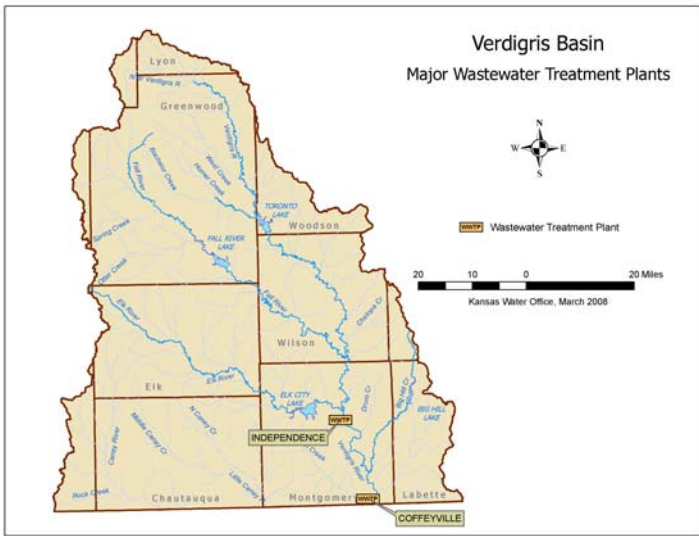


Figure 3. Major Wastewater Treatment Plants

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 susceptibility score was generated from the susceptibility analysis and 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 25 public water suppliers in the basin which treat raw water, 19 use [surface water](#) and 6 use ground water. Most residents in the basin get water from the Verdigris or Fall River, major tributaries or one of the four federal reservoirs in the basin.

Of public water suppliers using ground water in the Verdigris basin, 83% had low susceptibility scores and 17% had moderate scores. Of public water suppliers using surface water, 74% had low scores and 26% had moderate 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, microbes, and inorganic compounds.

**Table 2
VERDIGRIS Nutrient Reduction Data
Source: KDHE Bureau of Water – February 14, 2006**

Statewide Perspective				
Parameter	State Total	Verdigris	% of State Total	
TN Leaving State (Ton/yr)	51,000	3,468	7	
TP Leaving State (Ton/yr)	7,700	385	5	
Point Source TN (Ton/yr)	9,215	369	4	
Point Source TP (Ton/yr)	1,925	58	3	
Nonpoint Source TN (Ton/yr)	41,785	2,925	7	
Nonpoint Source TP (Ton/yr)	5,775	347	6	

Basin Perspective					
Parameter	Total	PS	PS %	NPS	NPS%
TN (Ton/yr)	3,468	441	13	3,027	87
TP (Ton/yr)	385	83	21	314	79

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 3). All conservation districts in the basin have developed wetland and riparian protection plans. 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.

Source Water Protection

All [public water suppliers](#) in the basin completed Source Water Assessments⁽³⁾ in cooperation with the KDHE in 2004. The next step, which is voluntary, is the development of source water protection plans. For communities using ground water, development of a wellhead protection program is recommended. For communities using surface water, the development of a WRAPS is the best mechanism to ensure water quality protection for their public water supply. No source water or wellhead protection plans have been developed in the Verdigris basin.

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The Kansas Water Office 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 condition.

As part of the WRAPS effort described below, a partial inventory of riparian area and streambank condition on the mainstem of the Verdigris River has been completed. A similar assessment of the Fall River and tributaries has also been completed.



Elk Falls on the Elk River. Photo courtesy KGS.

Zebra mussels

Confirmation of Zebra mussel infestation has not yet occurred in any Verdigris basin federal reservoir or other impoundment. However, new occurrences of Zebra mussels in reservoirs in other basins continue to be documented. Zebra mussels cost hundreds of thousands of dollars to control once they become established and begin to build up on water intake and other structures. The most effective mechanism for prevention of future infestations is information and education of boaters and anglers to drain, wash and dry their equipment and boats when leaving any water body and before entering another one. Water quality impacts of Zebra mussels are being monitored, along with changes in biological communities.

Watershed Restoration and Protection Strategies

Watershed Restoration and Protection Strategies (WRAPS)⁽⁴⁾ are stakeholder-driven watershed management plans designed to address multiple water resource issues within a specific sub-watershed within a river ba-

sin. 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, habitat enhancement and other natural resource objectives.

Watersheds above the four 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. WRAPS projects have been initiated in two (Fall River and Toronto) of the watersheds above the federal reservoirs and efforts are underway to organize stakeholders in the watersheds above Elk City and Big Hill reservoirs. Watersheds with WRAPS projects currently underway in the basin encompass high priority areas for TMDL implementation, source water assessment areas and priority areas for wetland and riparian protection.

Figure 4 shows WRAPS projects coverage and contact information for projects in the basin.

Oologah WRAPS Interstate Cooperation

The Verdigris River exits Kansas and is impounded in Oklahoma to form Oologah Reservoir, a drinking water source for the city of Tulsa. About two-thirds of the watershed for Oologah Reservoir is in Kansas, so discharge of clean water across the state line is a priority for the Verdigris basin. In 2002, the City of Tulsa entered into an agreement with the Tulsa District Corps of Engineers to perform a feasibility study to evaluate watershed pollution potential and possible impacts to the reservoir from water flowing into it. The Soil and Water Assessment Tool (SWAT) model has been calibrated for the watershed draining into the reservoir. In Kansas, the watershed area below the four federal reservoirs is included in the model. Various scenarios are being evaluated to guide the implementation of best management practices (BMPs) throughout the watershed and will be used by the Kansas WRAPS groups. Staff from water resource agencies in both states, including the city of Tulsa, have been meeting to coordinate activities and funding to help ensure high quality water flowing into Oologah Reservoir. BMP implementation will focus on actions to achieve nutrient and sediment reduction goals.

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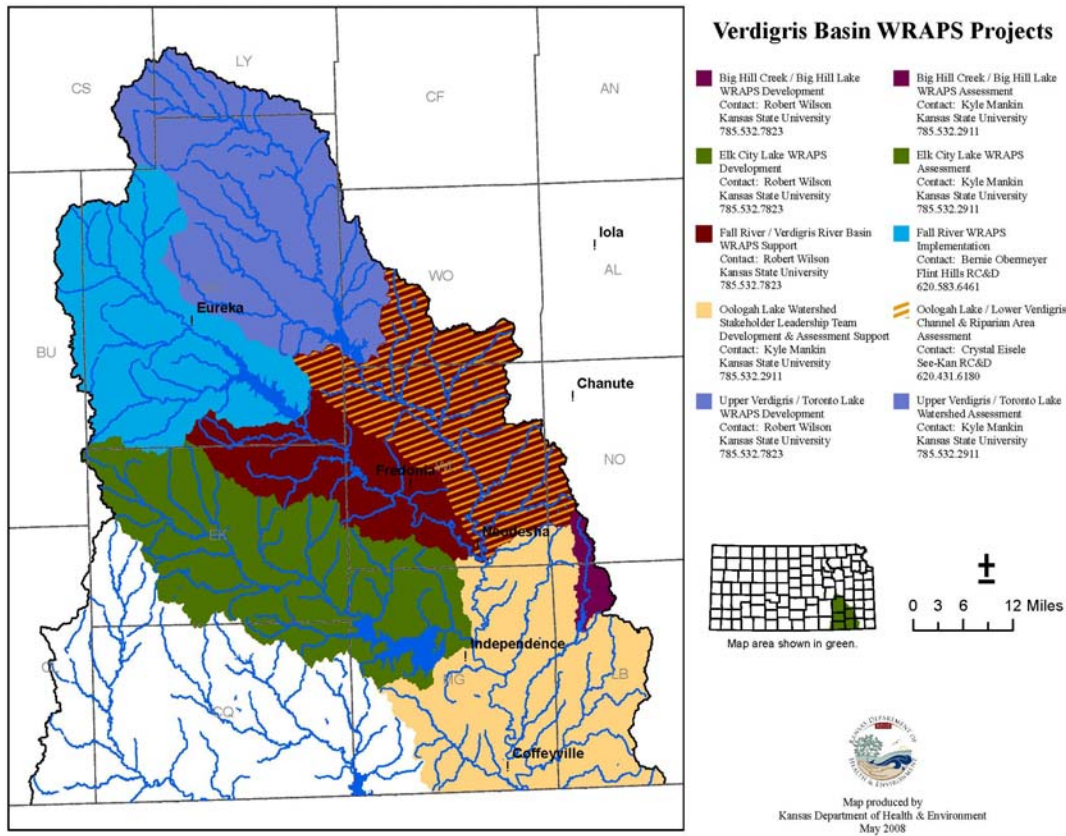


Figure 4. Watershed Restoration and Protection Strategy Groups.

grams can be integrated with WRAPS projects to ensure a comprehensive approach to watershed management in urban areas.

An important 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. Eight hundred twenty three contracts on 39,131 acres enrolled in the 12 Kansas counties contained wholly or partly in the Verdigris basin expired on September 30, 2007.⁽⁷⁾ If land is taken out of permanent grass cover, implementation of BMPs will be needed to minimize potential adverse impacts to water resources within the basin.

Local Authorities for Water Quality Management

While no counties in the [Verdigris basin](#) are projected to substantially increase in population, some communities are experiencing growth and expansion which increases impervious areas. 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 pro-

Other Watershed Related Activities

- Ten counties either wholly or partly within the basin have adopted local sanitary/environmental codes or participate in the Local Environmental Protection Program (LEPP). Chautauqua County has no local sanitary code and does not participate in the LEPP.
- Five counties in the basin have countywide planning and zoning programs.
- All conservation districts in the basin have adopted nonpoint source pollution management plans. Grants under the State Water Quality Buffer Initiative have also been awarded in four counties in the basin supporting buffer coordinators and facilitating enrollment of stream buffers in continuous CRP.
- Of cities in the basin, Coffeyville is subject to the Phase II Permitted Municipal Separate Storm Sewer System under the NPDES Stormwater Program.
- As of December 2007, there were six contamination sites being investigated or remediated through the State Water Plan Contamination Remediation Program.⁽²⁾
- There are 12 organized [watershed districts](#) in the basin.

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Recommended Actions

1. Work with stakeholder leadership 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. Coordinate with development of Source Water Protection Plans.
 3. Continue coordination efforts with the City of Tulsa to ensure good water quality entering Oklahoma from the Verdigris River in Kansas.
 4. Complete assessment projects with particular attention to riparian and wetland assessments to target resources. Encourage private landowner efforts to maintain riparian areas to prevent introduction of excess woody debris into the tributary and river system.
 5. Continue public outreach efforts to educate the public and landowners about the benefits of best management practices. Encourage other agencies and entities in partnerships and participation to support WRAPS initiatives, activities and funding.
 6. Continue efforts to prevent the spread of Zebra mussels from infected water bodies.
5. Kansas Department of Health and Environment, Bureau of Water. December 2004. *Surface Water Nutrient Reduction Plan*. www.kdheks.gov/water.
 6. Kansas Department of Health and Environment, Bureau of Water. 2007. *Watershed Planning and TMDL Program*. www.kdheks.gov/tmdl.
 7. USDA Farm Service Agency. 2007. *Summary of Active and Expiring CRP Cropland Acres by County*. www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crt

Resources

1. *Kansas Water Plan*. 2006. Water Quality Policy and Institutional Framework Section. Kansas Water Office.
2. Kansas Department of Health and Environment, Bureau of Environmental Remediation. December 2005. *Basin Updates and Site Accomplishments*.
3. Kansas Department of Health and Environment, Bureau of Water. 2004. *Kansas Source Water Assessment Report*. www.kdheks.gov/nps/swap.
4. Kansas Department of Health and Environment, Bureau of Water. 2007. *Kansas Watershed Restoration and Protection Strategy*. www.kdheks.gov/nps/wraps.

Verdigris Basin High Priority Issue Water Supply Management and Conservation January 2009

Issue

Reservoirs, community lakes, and streams in the [Verdigris basin](#) provide water for municipal and industrial water supply, irrigation, recreation, and aquatic life. There is a need for a comprehensive management and conservation strategy by communities within the basin to make efficient use of the water resource.

Description

The rural nature of the Verdigris basin led to many small communities developing their own water supplies, either from direct intakes on the major rivers and streams or from construction of individual community lakes. Over time, as communities have grown and in many cases gotten smaller, water demands have changed. As treatment requirements have increased and become more expensive, numerous communities have faced challenges in meeting water supply needs, especially during drought conditions. Federal reservoirs have been built which also provide water supply and efforts are underway to operate them more efficiently for this purpose.

Water Supply

All of the streams in this basin are restricted so that no new appropriation rights are available for the time period July to September (typically the irrigation season) unless there is an alternate source of water shown to be available. There are four federal reservoirs in the basin: [Fall River](#), [Toronto](#), [Elk City](#) and [Big Hill](#) along with numerous multipurpose or city-owned small lakes, and natural stream flows available for water supply.

An assessment of long-term water supply availability for public water supply systems in the basin completed in 2002⁽⁸⁾ indicated that additional authorized quantities of water were needed for 11 public water supply systems to meet their projected 2040 demands (1998 data). In 2007 the Kansas Water Office (KWO) completed a preliminary water supply and demand analysis⁽¹⁾ in the Verdigris basin (Figures 1 & 2) and in four other basins in the eastern part of the state. In all counties included in the Verdigris basin study, population and demand for water is projected to decrease in the future. That projection could change should a major industry locate in the basin. Even so, the supplies available are decreasing and the needs of an albeit decreasing [population](#) must still be met.

Reservoirs are used, in part, to provide dependable water supplies in streams with highly variable flow. Fall

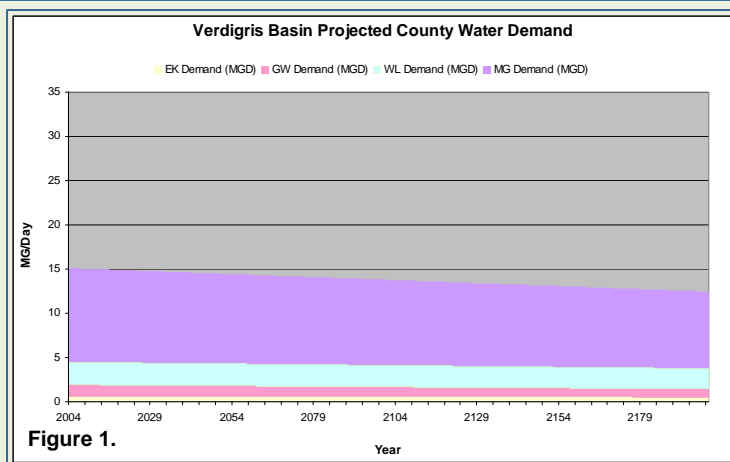


Figure 1.

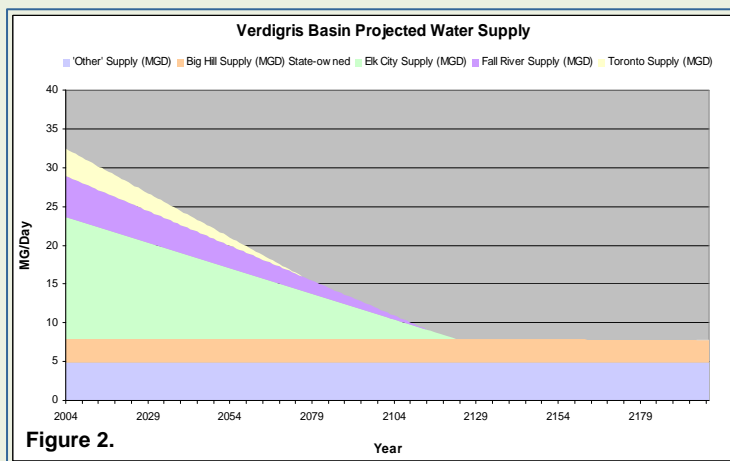


Figure 2.

River and Toronto Reservoirs, among the oldest reservoirs in the state, were constructed with water supply storage capacity built in, before the federal supply law requiring state or local financial participation for water supply storage was enacted. The state may ask for municipal and industrial releases from these reservoirs without having to pay for the storage. In the other two basin reservoirs, Elk City and Big Hill, that were built after the local cost share requirement, the state does own [water marketing storage](#) and is required to pay for that storage capacity along with annual operation and maintenance payments. All four of these reservoirs are used to satisfy water supply demand in various parts of the basin.

Communities along the main stem of the Fall and Verdigris rivers explored the possibility of establishing a water assurance district during 2004-2005 in order to better manage the system of reservoirs to distribute stored water throughout the basin when and where it is needed. An assurance district would also reduce the inequity in the system caused by the fact that payment is only required for use of water stored in Elk City and Big Hill reservoirs. As of 2008, no assurance district has been established.

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Releases are made from federal reservoirs in the basin to satisfy downstream water supply needs in accordance with a Memorandum of Agreement (MOA) between the KWO and the Kansas Department of Agriculture-Division of Water Resources (DWR). The MOA was updated in 2006 and provides that water needs in the upper portion of the basin are satisfied with releases from Fall River and Toronto reservoirs. Water needs in the lower part of the basin, below the confluence of the Elk River with the Verdigris River, are satisfied with releases from Elk City Reservoir. Water supply storage in Elk City Reservoir is used by the City of Coffeyville and Coffeyville Resources through water marketing contracts.

The update of the MOA incorporated a more comprehensive reservoir system management approach to operations of the reservoirs in the basin in which Toronto, Fall River and Elk City reservoirs are operated as a single system. Releases from the reservoirs for industrial and municipal water supply are coordinated to achieve greater benefit from the water stored in the reservoirs while still meeting water supplier's needs. This approach also helps to ensure that water quality and quantity goals are met throughout the basin. An assurance district, or an alternative arrangement for assuring adequate supply to downstream users, would further improve the ability of the state to maximize water storage releases from the reservoirs in the most beneficial manner.

Water Demand

Municipal and Industrial Demand

Based on the 2007 KWO supply and demand analysis, demand for water could exceed existing supplies in the basin by the year 2073 during a 2 percent probability drought similar to the 1950s (Figure 3). All four reservoirs in the basin are accumulating sediment and if current sedimentation trends continue, this accumulation

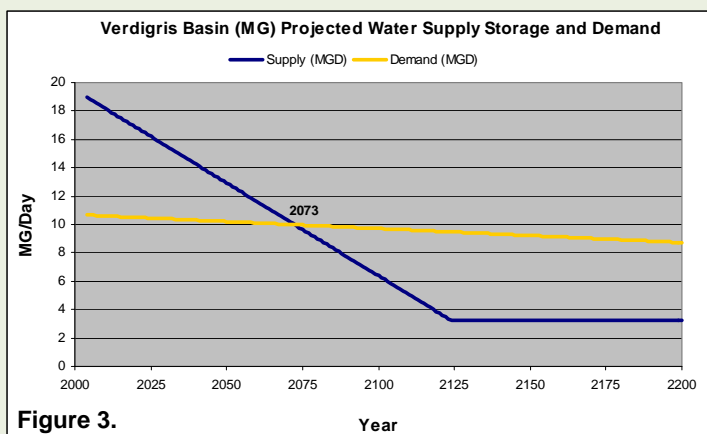


Figure 3.

will result in reduction of supply of stored water. More detailed analysis is needed to determine location specific water demands. Efforts are being made to reduce the rate of sedimentation in the reservoirs to extend the existing supply further into the future as part of the [Reservoir Sustainability Initiative](#).

Water Conservation and Demand Management

The objective of water conservation⁽³⁾ is to achieve efficient use of the state's limited water resources through cost-effective practices to curtail the waste of water and to ensure water use does not exceed reasonable needs. In the Verdigris basin, conservation strategies include 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.

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. By Kansas law, 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.

Conservation of reservoir storage has received attention as the impacts of sedimentation become increasingly apparent. While supply in the basin is being evaluated to develop management strategies, reservoir recreational impacts are also occurring, along with increasing occur-

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rence of low flows in streams. 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 and 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.

Resources

1. Kansas Water Office. 2007. Surface Water Supply and Demand Projections for Selected Basins in Eastern Kansas.
2. Kansas Water Office. 2006. Kansas Municipal Water Use.
3. Kansas Water Office. 2007. Kansas Municipal Water Conservation Plan Guidelines.
4. Kansas Water Office. 2002. Status Report: State of Kansas, Water Marketing and Assurance Programs, Multipurpose Small Lakes Program.
5. Kansas Department of Health and Environment. 2006. Public Water System Capacity Development Assessment.
6. Kansas Department of Health and Environment. 2006. Public Water Supplies Drought Vulnerability Assessment.
7. Kansas Department of Agriculture, Division of Water Resources. 2006. Public Water Suppliers, Sources and Purchasers.
8. Kansas Water Office. [Kansas Water Resources Conditions](#).

Recommended Actions

1. Develop a basin model of the hydrologic system with location specific supply and demand information.
2. Identify options for supply and demand management: reservoir pool raise, pool reallocation, dredging, new supplies, modification of reservoir operations and conservation measures.
3. Refine models to reflect possible outcomes of identified options.
4. Based on results from model scenarios, implement the most beneficial and cost-effective options.
5. Compare the benefits of development of a water assurance district or an improved river/reservoir water management system to ensure sufficient supplies for all water users served by Fall River, Toronto and Elk City reservoirs.
6. Begin incorporation of demand management into water utility plans. Demand management should also include education of and interaction with the development community and include existing local authorities.

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Issue

Persistent flood damages in the [Verdigris basin](#) indicate a need for a comprehensive evaluation of existing flood control infrastructure and storage to determine current status, mapping funding needs, and opportunities for flood management actions and flood damage reduction in the future.

During the weekend of June 30-July 1, 2007 heavy rains caused the Verdigris River to overflow its banks, top protective levees and flood the cities of Fredonia, Neodesha, Independence and Coffeyville, including the Coffeyville Resources refinery and nitrogen fertilizer operations. Numerous smaller communities throughout the basin were also affected. Heavy rain persisted in the area for two weeks, pushing the Verdigris River out of its banks forcing up to 3,000 people from their homes.



Summer 2007 Flooding in the Verdigris Basin

Although the upstream federal flood control reservoirs functioned properly, and numerous smaller watershed dams also detained water, this catastrophic event served as a reminder that even with extensive structural efforts to control flooding, excessive rainfall over successive days will overcome the ability of the system to prevent damage.

Description

Summer 2007 Flooding

The Verdigris River at Independence rose to a record 52.4 feet on July 1, 2007, exceeding the old mark of 47.6 feet and more than 20 feet above flood stage. The river crested in Coffeyville at 30.4 feet - 12 feet above flood level and 4.2 feet above a protective levee. The Caney River, in the southwestern portion of the basin, crested at 21.8 ft on July 2nd.

Nearly \$40 million dollars in 20 southeast Kansas counties, including the Verdigris basin, was approved by the Federal Emergency Management Agency (FEMA) and the U.S. Small Business Administration (SBA) to assist the State of Kansas and the Kansas Division of Emergency Management (KDEM) in the recovery from the severe storms and flooding June 26-July 25, 2007. Thousands of residents throughout the basin were forced to evacuate their homes and businesses and the National Guard was called in to assist. Water and

wastewater treatment plants and industrial facilities were shut down for weeks. Roads were covered for several days, cutting off parts of the basin from access by emergency vehicles.

A total of 56 watershed district flood control structures in the basin sustained a conservative estimate of \$2,107,500 in damages during the 2007 summer flood. In Montgomery County, a reach of stream-

bank was destabilized, threatening a county road that was estimated to cost \$135,100 to repair.

Rivers and streams in the Verdigris basin have historically been prone to flooding during high rainfall events. Most of the basin [land cover](#) is native prairie with fairly steep slopes and shallow soils making it unsuitable for crop production. As a result, row crop agriculture occurs mainly in the fertile floodplains of rivers and streams. Most communities and cities are sited near stream channels and several, including Neodesha, Independence and Coffeyville, are located at the confluence of major rivers in the basin, making them vulnerable to flood damage.

Four federal reservoirs to manage flooding and provide reliable water supply were constructed in the basin between 1949 and 1981; from oldest to youngest they are [Fall River](#), [Toronto](#), [Elk City](#) and [Big Hill](#). The 13 [watershed districts](#) in the basin have constructed 222 water retention structures on tributaries within the basin. Several levees have been constructed in Montgomery County.

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Expansion of urban development in floodplains increases the potential for flood damage. Future flood damages may be reduced by preventing inappropriate development in flood prone areas and by converting land uses subject to flood damage in existing flood prone areas to other more compatible uses. Local governments can implement floodplain management through use of planning and zoning authority and in some cases through requirements in county sanitary codes. There is no state requirement for local units of government to implement floodplain management. The Kansas Department of Agriculture-Division of Water Resources (DWR) provides technical assistance to local governments and offers the following publication for landowners: Quick Facts. Floodplain Management Guide.⁽¹⁾

By minimizing structural development in floodplains, the floodplain area is available to allow flood waters to spread out on the floodplain, slowing the water, allowing

sediment to settle out, and reducing its erosive potential. Culverts and bridges can be designed to minimize flood damage by allowing adequate space for floodwater conveyance through them which also reduces backwater effects and damage to upstream areas. Design of these structures can consider total anticipated build out (according to comprehensive plans) land use flows. Consideration can be given to allowing enough space for instream structures to allow adequate movement of floodwater through them without backing up. Roads can be designed to be at elevations high enough to minimize floodwater encroachment. Increased watershed storage of floodwater in key areas can also reduce the volume of runoff. This can reduce the amount of time it takes to convey the water through structures, reducing localized flooding.



Summer 2007 Flooding in the Verdigris Basin

In 2002 Senate Bill 436 was passed that directed the Secretary of Agriculture and the Chief Engineer, DWR to evaluate the Department of Agriculture's current policies regarding stream obstructions (roads, bridges, culverts,

levees) and present a report outlining the strengths and weaknesses of a watershed approach to the permitting of dams and other stream obstructions. The Secretary and the Chief Engineer were to make recommendations to the Legislature with regard to clarifying the Water Structures Program's obligations to upstream and downstream landowners. A questionnaire was sent to city and county governments, the Kansas Department of Transportation (KDOT), and other interest groups to gather their input on pros and cons of a watershed based approach to permitting of stream obstructions. The approach would have required more rigorous hydrologic and hydraulic modeling to evaluate the effect of structures further upstream and downstream of proposed projects than was currently required. Several alternatives were evaluated that would have imposed various levels of increased requirements.

Two public hearings were held. As a result of the evaluation and public input, the approach was not adopted due largely to concerns of local governments on increased costs and time to process permits. In addition, local governments did not recognize that the current procedures were causing problems and the benefits did not seem to justify the increased cost and work load. Some changes were

made to the program including increased notification of upstream and downstream land owners of pending permits. An in-house evaluation was conducted on several streams with permitted structures to determine the downstream flooding impact resulting from the structures.

Accumulation of debris within and behind bridges, culverts and other structures is another concern. These accumulations obstruct the flow of water and can exacerbate the ability of the stream to carry flood water through permitted stream obstructions. It is important that permitted obstructions be kept clear of log jams caused by trees, utility poles and other debris that wash into streams during high flows. Management of riparian

management of riparian

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areas to prevent debris from entering the system and causing blockages is an important part of a preventive and routine maintenance program. Well managed and healthy riparian and wetland areas along streams also benefit flood reduction by storing water on floodplains.

Non-structural flood management measures also include flood forecast and warning systems. The National Weather Service provides river stage and flood forecasts for the basin through its River Forecast Center located at the Arkansas-Red River basin office in Tulsa. The Kansas [Mesonet](#) Steering Committee selected priority counties for new automated weather stations in 2008. River Forecast Center needs were considered in this process and additional near real-time hourly [precipitation](#) data stations are planned for Woodson and Elk counties. This network will become increasingly informative and valuable if the developing trend towards increased frequency of heavy rainfall continues. This information may prove valuable for future design standards for permitted stream obstructions.

Existing Programs and Activities

Federal Emergency Management Act and National Flood Insurance Program⁽²⁾

The [Flood Management Policy Section](#) of the *Kansas Water Plan* describes flood related activities of the FEMA and the National Flood Insurance Program (NFIP). The DWR provides coordination and technical assistance for the NFIP in Kansas.

To be eligible to participate in the NFIP, communities must enact flood control ordinances designed to limit floodplain development and to protect those buildings that are constructed in the floodplain from flood damage. Management of floodplain development is the first priority to prevent flood damage.

The DWR assists communities with the development of flood control ordinances and is responsible for approving them. In the Verdigris basin, Wilson County and 17 individual communities have enacted flood plain ordinances. These communities are eligible to buy flood insurance through the NFIP program.

No counties in the basin are in the top ten list of counties in the state for flood insurance dollars paid from 1978-2007. Montgomery County has received the most flood insurance money in the basin, followed by Wilson County. The same is true for the amount of claims filed.

In 1997, FEMA initiated a plan to modernize the flood mapping program. The plan proposed a seven-year upgrade to the flood map inventory and an enhancement of the associated products and services. Most existing FEMA flood maps were produced using now outdated manual cartographic techniques. The desire was to produce digital maps compatible with computerized geographic information system software. Federal funding to implement the map modernization plan has not been made available as of 2008. Of communities that need updated FEMA maps, the highest priority is Montgomery County.



Elk Creek Falls, Elk County, Kansas. Photo courtesy KGS.

Kansas Hazard Mitigation Plan

The Kansas Hazard Mitigation Plan (Plan)⁽³⁾ was updated in November 2007 by the KDEM. In the prioritization of risk associated with 22 hazards that was conducted as part of the planning process, flooding and winter storms ranked second behind only tornadoes in the degree of risk present. The updated Plan contains the following in the Mitigation Action Strategy Summary (Table 4.7, p. 4.53): "Integrate flood mitigation into KDOT construction projects." Lead agency: KDOT; Support Agency: Kansas Department of Agriculture. This is shown as having a medium planning priority. It is noted that this action applies to all new construction projects and that more coordination with other agencies is needed. This recommendation also addresses some aspects of watershed based planning and permitting discussed above.

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In the Plan, KDEM included a summary of high and significant risk dams. A high hazard dam (Class C Dam) is a dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high volume roads that meet the requirements for hazard class C dams or a high volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described in Hazard class B. A significant hazard dam (Class B) is a dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet the requirements for hazard class B dams, damage low volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons. Dam hazard ratings are based on the risk for loss of life and/or property damage and are not related to the condition of the structure. DWR requires emergency action plans to be developed for high hazard dams. In May 2007, this requirement was extended to include significant hazard dams (Table 1).

County*	Population	Total Dams	High Hazard (w/out plans)	Significant Hazard
Butler	63,147	232	11 (5)	9
Chase	3,070	83	0	7
Chautauqua	3,953	84	3 (1)	1
Cowley	34,931	128	4 (3)	14
Elk	3,077	85	4 (4)	5
Greenwood	7,067	155	3 (3)	9
Labette	22,203	58	0	3
Lyon	35,369	108	2 (1)	12
Montgomery	34,692	40	2 (1)	0
Neosho	16,298	65	1 (1)	1
Wilson	9,889	41	1	0
Woodson	3,507	42	0	1

* Counties either wholly or partly within the Verdigris Basin.

Development downstream of some small dams has resulted in changes in hazard class and necessitated upgrade of the structures. Since 1983, any dam classified as high hazard is required to have a breach inundation map prepared to identify the extent of downstream flooding that would occur if the dam were breached during a catastrophic event. These maps are available to be

used by local governments to limit development of houses or other structures in these inundation zones. In the Verdigris basin, there are 31 high hazard dams, of which 19 are in need of breach inundation mapping. There are 62 significant hazard dams.

The Plan also includes a summary of known flood control levees in Kansas. Levees, along with dams, are engineered to withstand floods with a computed risk of occurrence (100-year flood). The only county with known levees is Montgomery County (Table 2).

County*	Levee Design Standard	Flooding Source	Protected Community	Federal Levee?
Montgomery	100-yr	Duck Creek	Elk City	unknown
Montgomery	100-yr	Verdigris River	Independence	unknown
Montgomery	100-yr	Verdigris River	Coffeyville	unknown

*Includes only counties subject to flooding by Verdigris River and tributaries.

Watershed Districts

The 13 [watershed districts](#) in the basin have developed general plans, approved by the DWR that describe the location and floodwater storage capacity of flood control retention and detention structures recommended to address rural flooding and protection of infrastructure. Most impound water even during non-flood conditions and may have benefits in addition to flood control. Several are available as back up sources of drinking water and some also provide recreational opportunities. Many are used for livestock watering and also protect local roads and bridges. General plans include watershed protection actions including construction of terraces, grassed waterways, and grade control structures to control sediment delivery to the structures.

General plans have been developed, modified and updated since the program was authorized in Kansas in 1953. Modifications to plans generally occur when structures are de-authorized or relocated, or when structures are added to the plan. Funding for construction comes from federal, state and local sources and there has been a downward trend in funding in recent years. Figures 1 and 2 show the trends in state and federal funding for watershed structures.

Construction under the Natural Resource Conservation Service (NRCS) P.L. 566 program ended in the Verdigris

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basin in 1988 with 172 structures built. There has been no funding in Kansas under the program since 2006. Ninety two additional structures have been funded with State Conservation Commission (SCC) funding. SCC statewide funding for watershed structures through the Watershed Planning Assistance Program peaked in 1994 at about 1.6 million dollars. In all, 1,147,326 acres in the basin drain into watershed flood control structures.

Local Floodplain Development and Management and Watershed Restoration and Protection Coordination

The 2005 Flood Management Policy Section in the *Kansas Water Plan* recommends multi-objective management of flood prone areas and the incorporation of non-structural measures into watershed district plans to further enhance the reduction of damages from floods while also providing other benefits. The 2007 Kansas Hazard Mitigation Plan⁽³⁾ supports incorporating nonstructural measures into watershed plans, such as those being developed as part of the Watershed Restoration and Protection Strategy (WRAPS) (see [WRAPS Priority Issue](#)), to further enhance the reduction of damage from floods while also providing other benefits.

Since 2005, the state has coordinated the development of WRAPS development. WRAPS groups develop management plans to address locally identified priority issues. Figures 3 and 4 illustrate the common boundaries between watershed districts and WRAPS groups.

Congressional Appropriations Small Watershed Funds⁽⁶⁾

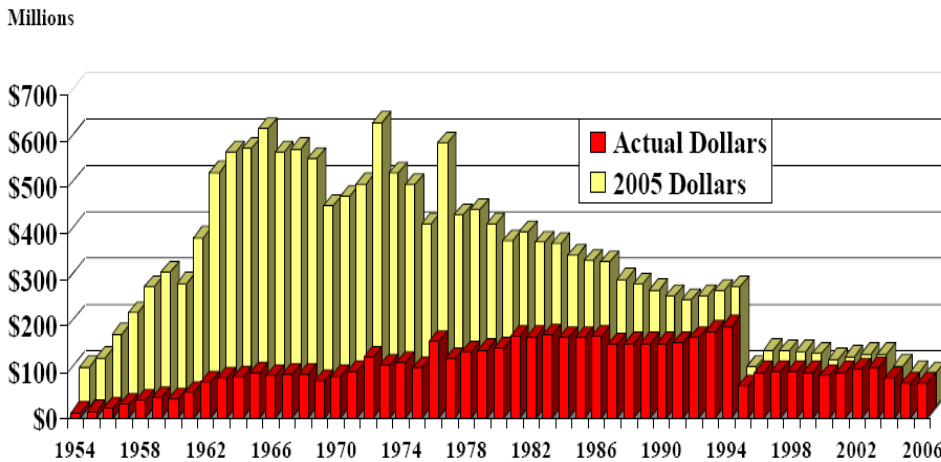


Figure 1. Federal Funding

Watershed districts have the authority to levee taxes on residents within the district to be used for operating expenses, new construction, and routine maintenance of infrastructure. Local funding can also be used to implement best management practices such as wetlands and riparian areas that also provide flood detention benefits.

Because of recent changes in permitting procedures for new dams by the U.S. Army Corps of Engineers (Corps), environmental issues have emerged that must be addressed before a permit can be issued. These issues are becoming increasingly challenging to address and construction of new dams has slowed in the past 10 years. It is unlikely that all dams proposed in the general plans will be constructed due to these challenges and decreased funding.

Many WRAPS groups have identified flooding as issues of concern in their watersheds. Watershed Districts and WRAPS groups can work together to address multiple

State Conservation Commission New Construction, Rehabilitation & Inundation Maps

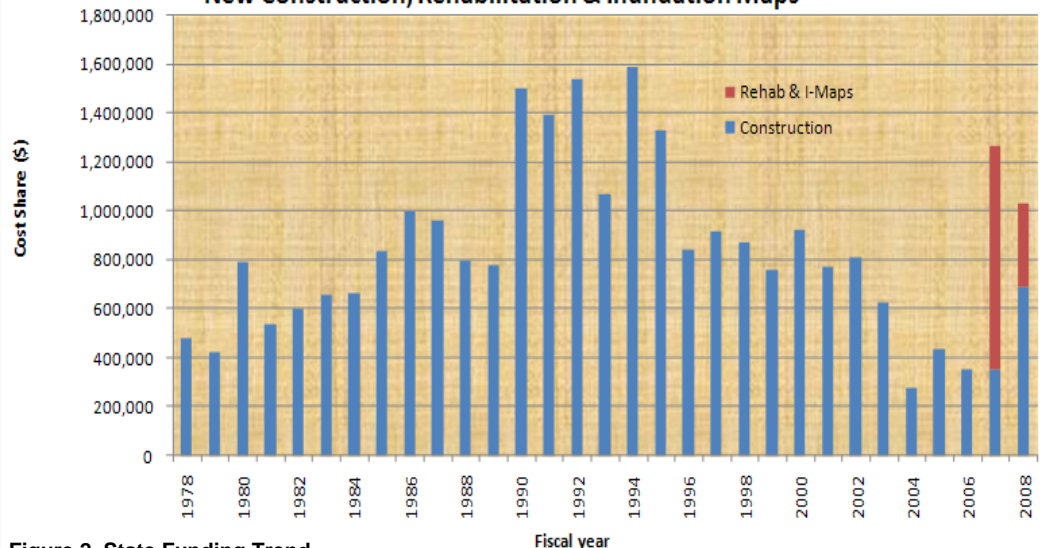


Figure 2. State Funding Trend

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resource concerns through implementation of best management practices. Actions taken to address total maximum daily load concerns, such as establishing or maintaining healthy riparian areas, can also positively impact flood flows. A one acre wetland has the potential to provide storage for 1.5 million gallons of floodwater, while also filtering pollutants before discharge. Management of riparian areas to prevent debris accumulation can also be addressed by WRAPS. By sharing resources and expertise, multiple objectives can be achieved.

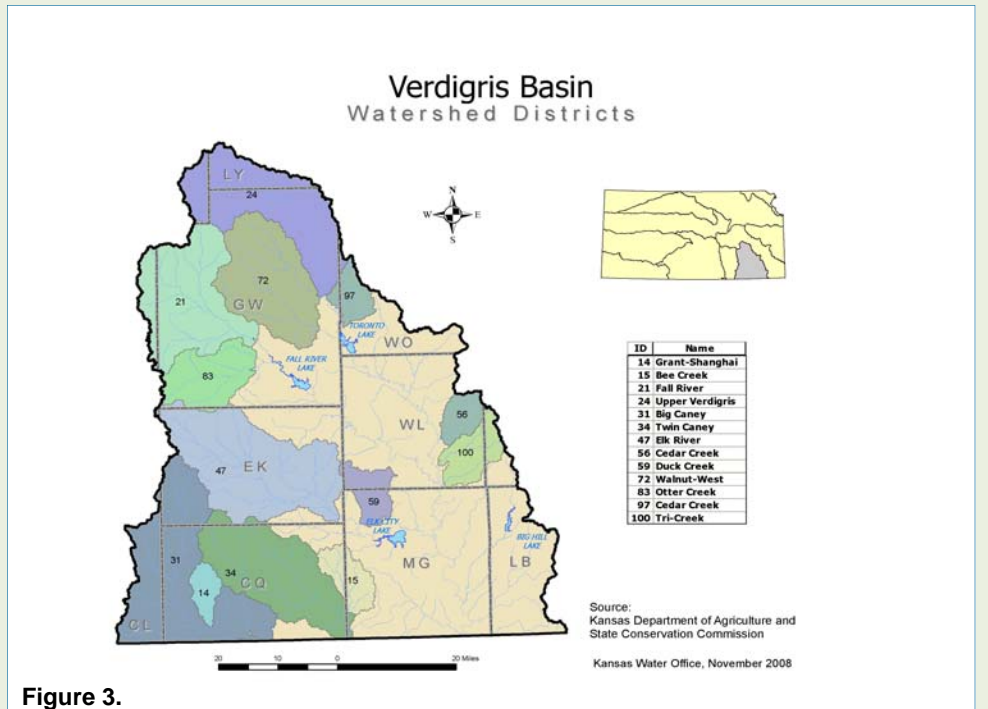


Figure 3.

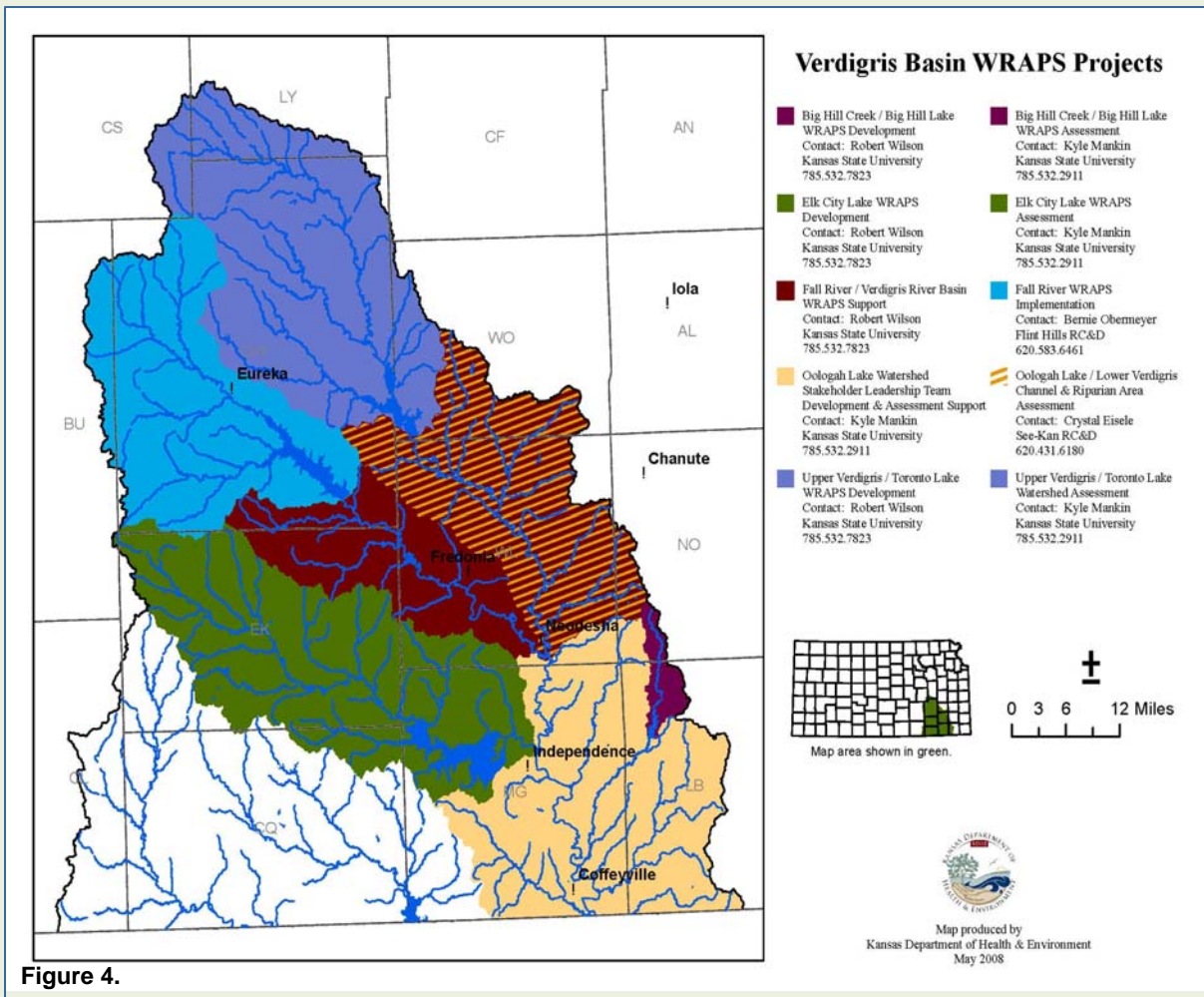


Figure 4.

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Recommended Actions

1. Assess the effectiveness of existing flood control infrastructure and develop plans to reduce flood damage to this infrastructure. Ensure that stream obstructions are maintained and free of debris accumulation.
2. Complete repairs of damaged flood control structures and deferred maintenance needs.
3. Determine the current floodplain status and promote NFIP participation, model ordinances and BMPs to local units of government. Limit development in the 100 year floodplain using Flood Insurance Rate Maps to delineate prohibited areas.
4. Engage in WRAPS to integrate comprehensive watershed based flood management with exiting floodplain, wetland, and riparian programs. Assess and inventory watersheds to identify potential locations for non-structural flood control measures.
5. Develop emergency plans for high hazard dams still needing them.
6. Complete breach zone mapping.
7. Coordinate with the DWR Water Structures Program to determine if increased hydrologic and hydraulic evaluation of stream obstructions should be considered in the Verdigris basin or in parts of the basin particularly prone to flooding. Identify and evaluate flood prone areas that may be attributed to permitted stream obstructions. Consider costs to repair damages against costs to implement the program.

Resources

1. Kansas Department of Agriculture-Division of Water Resources. Floodplain Management Guide. http://www.ksda.gov/includes/document_center/structures/Floodplain/ksqg_web.pdf
2. Federal Emergency Management Agency. August 1, 2002. *National Flood Insurance Program: Program Description*.
3. Kansas Division of Emergency Management Adjutant General's Department, November 2007. *Kansas Hazard Mitigation Plan*.
4. Kansas Water Office. July 2005. *Small Dam Safety and Rehabilitation*. Kansas Water Plan Background Paper No. 76.
5. The *Kansas Water Plan* Fiscal Year 2005 Update; July 2003. Final Draft. *Flood Management Policy Section*.
6. USDA Natural Resources Conservation Service. *Kansas 2006 Update: Watershed Protection and Flood Prevention Program (PL-566)*. Salina, Kansas: March 23, 2006.

Verdigris Basin High Priority Issue

Protecting and Enhancing Instream Flows

January 2009

Issue

Streams in Kansas are to meet water quality standards, support a healthy aquatic and riparian habitat, and maintain access to diversions for beneficial uses. The Verdigris River and associated tributaries have been having increasingly frequent occurrences of low flow conditions. Low flows have caused aquatic life stress and impaired water quality. Threatened and endangered species, especially mussels, in the Verdigris River system are impacted by these conditions. Many streams within the basin are experiencing water quality impairments. *E. coli* bacteria and low levels of dissolved oxygen (D.O.) are the most prevalent stream impairments.

Description

The Verdigris River is an area of high biological importance in the state with populations of freshwater mussels and other sensitive species, and populations that have declined from historic levels. Mussel species are the fauna most consistently in peril throughout the state. Their survival and viability depends on a complex interaction of flow regime, water quality, and the presence of appropriate fish species. Efforts are needed now to begin restoration of streams to a condition where these populations remain viable in the long term.

The droughts of 2000 and 2002 raised concerns in the [Verdigris basin](#), and elsewhere, on maintaining adequate flows for fish and other aquatic life and water quality standards in the Verdigris River. Instream flow needs were not met on several occasions during these droughts. A water issue strategic plan (WISP) working group has been established to evaluate instream flow needs and recommend strategies to meet those needs. The goal of the WISP is to develop instream flow management concepts and apply where flow protection is



Verdigris River. Photo courtesy Kansas Geological Survey.

needed to maintain the ecological functions and processes of a stream. The Upper Verdigris and Fall River were identified as pilot areas for developing these strategies. For more information on the goals of this team effort, refer to the Water Management Policy Section of the *Kansas Water Plan*.

All of the streams in this basin are restricted so that no new appropriation rights are available for the time period July 1 through September 30 (typically the irrigation season). Instream flow needs have been determined for the Verdigris River between Toronto Dam and Neodesha, and the Fall River between Fall River Dam and Neodesha. In 2006, the Kansas Department of Agriculture-Division of Water Resources (DWR) released a report titled "*Instream Flow Assessment of the Neosho and Verdigris River Basins*".⁽²⁾ The concept of instream flow is the idea of protection and recovery of streamflow as it relates to habitat, species, and water quality. The term instream flow recognizes that some minimum flow is needed to maintain suitable aquatic habitat and water quality.

The two key objectives of the study were: 1. To develop and apply a means of evaluating [surface water](#) availability in the basins; and 2. To consider management options available to the State of Kansas, given that a means of evaluating surface water availability could be adopted as a basis for decisions governing further appropriations. The study sought to determine a way to quantify a safe yield in the Verdigris basin in order to determine how much water is available under various conditions and how much could be appropriated for desired uses.

Water right appropriations are based on the diversion of an authorized quantity of water to be applied to an authorized place of use according to the prior appropriation doctrine in Kansas Water Law. The concept of a water right for an authorized quantity of water flowing in a stream is not supported by Kansas Water Appropriation Act (KWAA). The report contains recommendations for necessary changes to statutes and regulations to incorporate this concept.

No changes have been made to the KWAA that would allow for recommendations in the report to be implemented. However, progress has been made toward a means to determine safe yield for surface water similar to ground water that could eventually incorporate instream flow needs.

A memorandum of agreement (MOA) between the Kan-

Verdigris Basin High Priority Issue

Protecting and Enhancing Instream Flows

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ansas Water Office (KWO) and the DWR allows for reservoir operations that maintain target flows at gaging stations in the basin. Target flows recognize the importance of instream flows and the MOA currently serves as an indirect means of ensuring available water for aquatic life. However, many of the challenges for maintaining aquatic habitat and species diversity occur in tributary streams where flow regulation supplemented by upstream federal reservoirs is not an option. In these cases, additional options such as acquisition of abandoned water rights associated with currently unused city water supply lakes need evaluation for providing flow to the tributary and mainstem system.

It is recognized that one solution will not be able to address instream flow problems throughout the basin and that site specific implementation will be needed in many cases. Updated bathymetric surveys are being completed to provide a better understanding of how much water is currently stored in federal and other reservoirs. This information will be used in the Operational Analysis and Simulation of Integrated Systems (OASIS) model to further evaluate the ability of the river-reservoir system to support additional instream flows. The WISP working group continues to meet to consider how other states have responded to similar situations, develop recommendations for changes to statutes and regulations, complete site identification, develop recommendations for pilot implementation for specific areas, and other concerns in need of interagency coordination.

Resources

1. Kansas Water Office. 2003. Fiscal Year 2005 *Kansas Water Plan*.
2. Instream Flow Assessment and Verdigris and Verdigris River Basins. 2006. Kansas Department of Agriculture, Division of Water Resources.

Recommended Actions

1. Continue to work towards coordinated management of the reservoir system to ensure that instream needs are met.
2. Evaluate the potential for using abandoned surface water rights on tributaries to provide flow.
3. Continue water issue strategic plan meetings to ensure intrastate coordination.
4. Identify scenarios and create site specific criteria for improvement. Identify pilot reaches for implementing site specific projects.
5. Participate in interstate discussions to evaluate other states instream flow programs and their applicability to Kansas.
6. Complete the scheduled bathymetry on reservoirs in the basin and use in conjunction with the OASIS model as a decision support tool.