Upper Arkansas River Basin

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General Description

The Upper Arkansas basin covers 10,300 square miles of west central Kansas. The basin includes all or parts of 20 counties. The Arkansas River is the dominant river. It receives water from snow and rain run off resulting in periodic high flows. There are no major tributaries to the Arkansas River until Mulberry Creek in Ford County; west of this, flows are highly dependent on flows entering from Colorado. The Pawnee River, Walnut Creek and Coon Creek are major tributaries of the Arkansas River in this basin. Declines in the alluvial aquifer have reduced or ceased baseflow contributions for most of the river west of Kinsley, with discharge from the alluvial aquifer only after high flow events have recharged bank storage. Some or all of the Arkansas River flow is lost as infiltration from the stateline to Dodge City. Whitewoman Creek and James Draw drain a portion of the basin but end in depressions. Remaining areas of the basin are drained by numerous small direct tributaries of the Arkansas River.

Kansas Arkansas River basin overlies the High Plains aquifer. The High Plains aquifer, of which the Ogallala is the dominant portion, has been identified as a national concern regarding water quantity.

Population and Economy

There were an estimated 128,500 residents in the basin in the year 2000.(1) According to the Kansas Division of Budget, the total population of the 19 counties that are contained in whole or in part by the Upper Arkansas basin had a population of 171,733 in 2000. By 2040, the county population is projected to decrease to 163,207.(2)

This basin illustrates major demographic changes that are taking place in Kansas. In the past 40 years, two trends have dominated the state and the basin: 1) Rural counties have lost population, sometimes more than 10 percent every decade; 2) Urban counties particularly in the great Wichita area and Kansas City area are gaining population at an even greater rate.

In the Upper Arkansas basin counties with meat packing plants in the immediate vicinity are gaining population. Finney County went from a population of 16,093 in 1960 to 40,712 in 2000.

Ford County went from a population of 16,093 in 1960 to 40,712 in 2000. Other rural counties, however, are losing population. Greeley County, with a population of 2,087 in 1960, had only 1,537 people in 2000. Ness County, which had 5,470 people in 1960, lost more than 2000 residents by the year 2000.

The economy of the basin is based primarily on agriculture and manufacturing. The major crops are wheat, grain sorghum, corn and alfalfa with a sizable portion of this acreage being irrigated. Irrigation has helped stabilize the agricultural economy in this area of marginal precipitation.(5)

The total value of regional economic activity was about $10.3 billion in 2003. Manufacturing, where meat packing and other food processing is represented, is by far the largest economic sector. Regional employment totaled more than 83,000 jobs. This economic activity generated about $3.8 billion in value added income, the most important measure of regional household welfare associated with regional economic activity.(3)

Dodge City, Garden City and Barton County Community Colleges offer opportunities for higher education.

Recreation is an increasing part of the economics of the basin. The state parks and associated recreation and wildlife areas draw hunters to the region. There is one Multipurpose Small Lake, Jetmore Lake in Hodgeman County, located in the basin. In April 2008, construction began on HorseThief Reservoir, a 450-acre watershed lake. The lake will provide flood control and water-based recreation for the region.

A growing contribution to the basin economy is related to energy production, including ethanol. As of December 2008, two ethanol plants are located in Finney County and one in Wichita County. One additional ethanol plants is planned for Ford County.

Physical Characteristics

Geology and Soils

The Tertiary and Quaternary undifferentiated sediments deposits in the area are underlain by Cretaceous age bedrock deposits. The bedrock has an east-to-southeast drainage trend. Major structural controls are the Bear Creek fault in Hamilton and Kearny counties, and Crooked Creek-Fowler fault in Ford County. These faults created a vertical displacement up to 250 feet, and bound a subsidence that filled with the younger, unconsolidated sediments of the aquifer. West of Bear Creek fault, alluvial sediments overlie Cretaceous bedrock and the High Plains aquifer is not present. The impermeable nature of this bedrock allows for minimal to no infiltration beyond the alluvial deposits. East of the fault, the alluvial sediments overlie the Tertiary and Quaternary deposits in which the High Plains aquifer occurs.

Land features are comprised predominantly of level to gently rolling tableland that is dissected with narrow drainage ways. Soils are deep on the ridge tops and moderately deep to shallow on the side slopes. Soil texture ranges from medium to fine.

Several different soil associations are found in the basin. Along the Arkansas River floodplain and terraces, sandy, loamy and clay soils predominate. South of the river, there are also areas of sand hills, classified as duny soils.

Land Use/Land Cover

Land use in the basin typically is dominated by cropland (64.6%) or grassland (24.1%) or Conservation Reserve Program land (10.3%). Less than one percent of land within the basin is comprised of residential, commercial/industrial and municipal use, open water and barren ground.

The Upper Arkansas basin has 28,531 stream bank miles. Within a 100-foot corridor along each bank, about 52% of the land is pasture/grassland followed by cropland (37%).

While comprising less than one percent of the bank miles, the Upper Arkansas basin has the most animal production stream bank area of the Kansas basins.[6]

Climate

The basin climate is characterized by the extremes and variability of precipitation and temperature common to mid-continent locations. Average annual precipitation increases from approximately 16 inches at the Colorado border to 26 inches in the east These annual quantities are subject to wide fluctuation, with thunderstorms accounting for most of the annual rainfall. Most of the precipitation occurs between April and September.

Temperatures tend to increase from west to east across the basin in response to declining elevations. At Garden City the average annual temperature is 53.1° F. while at Great Bend it is 56.0° F. The frost free period shows a similar west-to-east pattern (Table 1).

Drought is a naturally recurring feature of this climate as exemplified by the Dust Bowl of the 1930s and the severe drought of 1952-1957. It is perhaps the most pervasive natural hazard affecting Kansas and other agricultural areas of the central United States. Kansas has been impacted by severe drought periodically throughout the present decade.

The Upper Arkansas River basin is greatly affected by reductions in precipitation that are offset by ground water pumping to irrigate cropland that has not received sufficient rainfall. Drought increases the demand on the available water supply. Precipitation events moisten the soils near the surface but soil moisture needed for crops is lacking, reservoirs water levels are at record lows and streamflow is down.

Wildlife and Habitat

The Upper Arkansas River basin encompasses a wide array of habitat types that support rich and extremely diverse wildlife populations. The wildlife community includes 54 reptiles and amphibians, 48 fish, 54 mammals, and 283 bird species. Fifteen state or federally listed threatened or endangered species share a probable or historic range or critical habitat within the basin.

In 1996, the U.S. Geological Survey (USGS) reported that Kansas has about 435,000 acres of wetlands, which include sandhill pools along the Arkansas River, playa lakes in western Kansas, freshwater marshes such as those in Cheyenne Bottoms, and salt marshes such as those in Quivira National Wildlife Refuge.

Kansas has lost about one-half its wetlands during the last 200 years, mostly due to conversion to cropland, and depletion of surface and ground water by irrigation withdrawals.

Water Resources

The Arkansas River receives water from snow and rain run off resulting in periodic high flows associated with precipitation. Colorado Rocky Mountain snowmelt and runoff have a major impact on water flowing in the river as well as runoff in Kansas. There are no major tributaries to the Arkansas River in Kansas until Mulberry Creek in Ford County.

The principal sources of ground water in the basin are the saturated sands, gravels and silts in the thick deposits of Tertiary and Quaternary age. This includes the alluvial deposits along the river and tributaries and the Ogallala Formation of the High Plains aquifer.

The thickness of the Arkansas River alluvium ranges from about 10 feet to over 80 feet. Alluvial ground water levels are highly variable but a steady decline throughout the basin has occurred, with significant declines east of Garden City.

The Upper Arkansas basin contains 13,165 miles of intermittent and 843 miles of perennial streams for a total of 14,008 stream miles. The density of 1.3 stream miles per square mile, places the basin second to last among the twelve major river basins.

Minimum Desirable Streamflow (MDS) has been set for two USGS gages inside the basin: one near Great Bend and one near Kinsley. On average, streamflow has been insufficient to meet the MDS goals at these locations (Great Bend, 66-88%; Kinsley 55-66%). During the recent drought, the frequency at which these locations have been able to meet MDS has decreased.

Ground water is the source for 96% of supply for all reported uses in 2006. Irrigation accounted for nearly 95%of all reported water pumped or diverted. Municipal use accounted for two percent of water used in the basin, industry for one percent and recreation, stockwater and other uses combined equal about two percent (2006).[7]

Authorized withdrawals for irrigated agriculture use the majority of all water used in the Upper Arkansas River basin. The ground water levels have declined due to the withdrawals that exceed recharge. Saturated thickness of the aquifer system in the basin has decreased generally between 10 and 50 ft, but as much as 150 feet in parts of the Finney County. This translates to greater than 60% reduction in saturated thickness since predevelopment of irrigation in the 1940s.[14]

Water Management

Groundwater Management District Nos. 1, 3, and 5 are major local water management entities in the basin.

Several townships in the Arkansas River basin are closed to new appropriations. The closures were proposed by the local GMDs, under authorities established in the Groundwater Management District Act. The adoption of these rules and regulations eliminated the possibility of additional appropriations being approved in many areas of the basin.

In 1986 and amended in 1987, the Chief Engineer ordered an Intensive Groundwater Use Control Area (IGUCA),[13] which closed the Arkansas River corridor in Hamilton, Kearny, Finney, Gray and Ford counties to further ground or surface water appropriations. An IGUCA can provide more comprehensive water management tools than provided under strict water right administration based on priority.

Arkansas River flows in Colorado are contained and then released from John Martin Reservoir near Lamar Colorado. An interstate compact between Kansas and Colorado apportions the river flows with minimum flows at the State line and required usage prior to the gage at Garden City. These flows are primarily withdrawn by irrigation districts.

Six active irrigation ditches, Frontier, Amazon, Great Eastern, Garden City, South Side and Farmers, in southwest Kansas are supplied from streamflow in the Arkansas River. The irrigation ditches historically served approximately 70,000 acres; more recently, they have provided surface water supply to approximately 44,000 acres in Hamilton, Kearny and Finney counties.

Parts of five watershed districts are included in the basin: Cimarron Watershed District No. 3, James Draw Watershed Joint District No. 87, Lakin Watershed District No. 49, Pawnee Watershed Joint District No. 81 and Wet Walnut Creek Watershed Joint District No. 58.

The county conservation district is the primary local unit of government responsible for the conservation of soil, water and related natural resources within the county boundary. Each county within the Upper Arkansas River basin has a county conservation district. Four Resource Conservation and Development (RC&D) districts serve the counties of the Upper Arkansas basin: the Santa Fe Trail, Coronado Crossing, Central Prairie and Smoky Hill. The RC&Ds are designed to help community leaders develop rural economies by improving and conserving local natural, human and economic resources.[8]

Upper Arkansas River Compact

Kansas and Colorado have had a long history of litigation over the apportionment of the waters of the Arkansas River with interstate litigation filed before the United States Supreme Court in the early 1900s. As Special Master Arthur Littleworth described it, “The meaning of the Arkansas River Compact cannot be fully understood apart from the rich history of controversy over the river, and the early efforts to apportion its waters between the two states. Nor can its meaning be divorced from the views of the men in both states who fought the apportionment issues for more than a decade ….”[11] The Arkansas River Compact, ratified in 1948, was the culmination of decades of failed settlements and temporary agreements. The Compact sought to protect the status quo between the states as well as allocate the benefits of John Martin Reservoir. The Compact recognized there would be additional development in both states, but such development should not materially deplete flows that would otherwise be available to Kansas.

What the Compact did not do was provide a definite allocation of water supply to either state. With regard to water stored (conservation storage) in John Martin Reservoir, either state acting alone or both states together, could release that water up to a maximum rate. Without a specific allocation, both Kansas and Colorado sought to utilize any stored water quickly, before the other state used it all up, causing what was known as the ‘race to the reservoir.’ If one state called for a release, the other state generally called for its release as well.

In the late 1970s it was recognized that conservation storage in John Martin Reservoir could be used more effectively. In 1980, an operating plan was developed that provided water stored in John Martin Reservoir

under the Compact would be allocated 40% to Kansas and 60% to Colorado. This allocation was accomplished through the use of separate accounts for each state. These separate accounts have allowed both states to improve the effectiveness of the use of water stored in John Martin Reservoir.

There are six active Kansas irrigation ditches which divert surface water from the Arkansas River between the Colorado-Kansas stateline and Garden City. These ditches benefit under the terms of the operating plan, since they can call for water at any time and any rate, while being assured 40% of the water stored under the Compact. This allows the Kansas ditches to call for water during peak growing demand of summer crops, usually in July. This is in stark contrast to when Kansas had to call for water in April or May when releases were being called for by Colorado ditches.

The Arkansas River flows in both States have been appropriated by existing water rights and are diverted from the Arkansas River. Therefore, the river flow in southwestern Kansas is highly dependent on the irrigation demands of Kansas ditches, which have been diverting surface water since the 1880s. Water called for by the six Kansas irrigation ditch companies is put to beneficial use in Hamilton, Kearny and western Finney county as permitted under their vested water rights.

Since the adoption of the Compact, Colorado allowed the construction of hundreds of high capacity wells along the Arkansas River. Kansas filed Kansas v. Colorado, No. 105, Original, in 1985 to enforce the terms of the Arkansas River Compact. In 1994, Special Master Littleworth recommended that the Supreme Court determine that Colorado had violated terms of the Arkansas River Compact by means of post-compact well pumping in Colorado. The United States Supreme Court agreed. As the result of the damages and remedies phase, Colorado paid Kansas more than $34 million for Colorado's compact violations during the period 1950 through 1999. In 2006, Colorado paid Kansas an additional $1.1 million. This money has been deposited in three funds created by statute that specify generally how and where the money will be spent. One fund, the Western Water Conservations Projects Fund, is administered by Southwest Kansas Groundwater Management District No. 3 with input from the Arkansas River Litigation Fund Advisory Committee, and is to be spent on improved water efficiencies, water conservation, recharge and similar projects in the area impacted by past compact violations. The Director of the Kansas Water Office must approve all final projects.

The Special Master submitted his Fifth and Final Report[(12)] to the United States Supreme Court in January 2008, including the Judgment and Decree which was jointly developed by Kansas and Colorado. Colorado compliance with the Compact will be determined using a hydrologic-institutional model and accounting procedures as set out in the decree. In December 2008, the Special Master's Fifth and Final Report and the Kansas Exception went before the U.S. Supreme Court.

Resources

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10. Kansas Water Resources Board. June 1962. *Water Plan Studies, Upper Arkansas basin.*

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Upper Arkansas River Basin Management Categories

WATER MANAGEMENT CATEGORIES

The following categories include issues identified in the Upper Arkansas 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
- Flood Management
- Water-Based Recreation
- Wetland and Riparian Management

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

The Southwest Kansas Groundwater Management Districts (GMD) No. 3 (GMD3), the West Central Kansas GMD No. 1 (GMD1) and Big Bend GMD No. 5 (GMD5) are major local water management entities in the basin. Most townships in the basin are closed to new appropriations.

There are five organized watershed districts in the basin, including the Pawnee Watershed District, the largest watershed district in the United States.

Minimum Desirable Streamflow (MDS) levels have been set for two sites in the basin: one near Great Bend and one near Kinsley. According to an assessment conducted by the Kansas Water Office (KWO) in 2006, both MDS gages in the basin have shown declines in the annual frequency, magnitude or duration of meeting MDS.

The *Kansas Water Plan* directed the need for further water resource management in the Pawnee River Valley. The Kansas Department of Agriculture-Division of Water Resources (DWR) Subbasin Water Resources Management Program began work with stakeholders in 1996 to evaluate the hydrologic properties of the alluvial valley and recommend long-term management strategies for the Pawnee Buckner subbasin. The committee recommended in their 2000 management proposal that the Chief Engineer amend the order establishing the Pawnee Valley Intensive Groundwater Use Control Area (IGUCA) to include the part of the subbasin within Hodgeman and Ness counties, in addition to the area within Pawnee County, and require water resource management during drought conditions (Figure 1).

In 2007, the Chief Engineer gave an order to expand the boundaries of the Pawnee Valley IGUCA. A phase II hearing would identify the goals to be accomplished with the amended IGUCA, and the corrective control provisions.

An IGUCA has closed the Arkansas River corridor in Hamilton, Kearny, Finney, Gray and Ford counties to any further ground or surface water appropriations, and to prevent re-drilling a well closer to the river.
In 2006, the KWO calculated the median annual water level changes in wells from 1981 to 2005 GMD3. Based upon the assessment, the data indicates that sustainable yield has not yet been attained in GMD3.

On December 20, 2007, the U.S. Department of Agriculture (USDA)-Farm Service Agency, in partnership with

the State Conservation Commission, began accepting applications to enroll land in the Conservation Reserve Enhancement Program (CREP). This voluntary program seeks to provide incentives and cost sharing to participants that enroll their land into eligible conservation practices such as native vegetation establishment or wildlife conservation for a period of 14 to 15 years. The CREP project area lies within 10 counties along the Arkansas River corridor, covering 1,571,440 acres. As of December 2008, nearly 8,200 acres were enrolled in the CREP program. For the acres enrolled into the CREP program, 16,479 acre feet of the authorized water quantity will be permanently retired from irrigation.

The GMD3 has contracted with the Kansas Geological Survey (KGS) to map the practical saturated thickness (PST) of the Ogallala-High Plains aquifer in their district. The PST, as determined primarily by well logs, is the net thickness of saturated sediments that significantly contribute to well yield from the water table down to the bedrock surface. It differs from the saturated thickness which is the total thickness of saturated sediments between the water table and the bedrock surface. The PST can provide a more accurate picture of water availability and may also provide insight into future water level trends at the scale of an individual well.

In 2007, the KWO, GMD3, and the U.S. Bureau of Reclamation (Bureau) contracted with the KGS for the development of a hydrologic model of the GMD3 region. The model will provide additional information on the water budget, and be able to project aquifer and streamflow responses to various future management scenarios.

Applicable *Kansas Water Plan* Objectives

- Reduce water level decline rates within the Ogallala aquifer and implement enhanced water management in targeted areas.
- Achieve sustainable yield management of Kansas surface and ground water sources outside of the Ogallala 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 Quantity Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Department of Agriculture, Division of Water Resources, Subbasin Water Resource Management Program
- Kansas Geological Survey, Kansas Department of Agriculture-Division of Water Resources: Water Well Measurement
- Kansas Water Office and U.S. Bureau of Reclamation: Assessment and Evaluation Program/Ogallala Special Study Phase II, Cooperative Agreement
- Kansas Water Office: State Water Planning Program
- Kansas Geological Survey: High Plains Aquifer Technical Assistance Program
- Kansas Geological Survey: Stream Aquifer Interactions
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program (EQIP)
- USDA–Farm Services Agency: Conservation Reserve Enhancement 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 in Webster Dictionary 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.

Water conservation activities apply to all uses: irrigation, municipal, industrial, etc., and from all sources. Irrigation accounted for nearly 95% of all reported water pumped or diverted in the basin. Municipal use accounted for two percent of water used in the basin, industry one percent, while recreation, stockwater and other uses combined equaled about two percent (2006 water use reports).

Of the 614 public water suppliers in Kansas that have an approved conservation plan in place as of December 31, 2008, 43 plans have been approved in the Upper Arkansas basin. Three hundred and twenty one plans have been approved for irrigation water rights. The number of diversion points in western Kansas that reported irrigation application rates over the regional average decreased during the period from 1991 to 2005. Of the total number of wells in the Upper Arkansas basin that were reported to have diverted water in 2006, more than 90% had meters.

The DWR Subbasin Water Resources Management Program began work with stakeholders in 1998 in the Middle Arkansas basin to address water concerns. In 2004, the team created water management strategies, which they presented to the Chief Engineer. These include encouragement of a 10% water use reduction, based from the 1988–2000 water use reports, as well as development of water conservation plans. The KWO and DWR contracted with the KGS for development of a hydrologic model of the Middle Arkansas subbasin. The computer model was able to provide information on the water budget and project aquifer and streamflow responses to various future conditions and possible management scenarios (Figure 2).

Applicable *Kansas Water Plan* Objectives

- Reduce the number of public water suppliers with excessive unaccounted for water by first targeting those with 30 percent or more unaccounted for water.
- Reduce the number of irrigation points of diversion for which the amount of water applied in acre-feet per acre (AF/A) exceeds an amount considered reasonable for the area.
- All non-domestic points of diversion meeting predetermined criteria will be metered, gaged, or otherwise measured.
- Conservation plans will be required for water rights meeting priority criteria under K.S.A. 82a-733 if it is determined that such a plan would result in significant water management improvement.

Applicable Programs

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

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Department of Agriculture-Division of Water Resources: Subbasin Water Resources Management Program
- Kansas State University Research and Extension: Water Conservation and Management Program
- State Conservation Commission: Water Resources Cost-Share Program
- Kansas Water Office: Water Conservation Program
- Kansas Water Office: State Water Planning Program
- Kansas Water Office: Weather Modification Program
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program (EQIP)
- USDA-Farm Service Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

The primary approach to addressing public water supply issues in the basin focuses on ensuring that there are adequate supplies of surface and ground water within the basin to meet future water demands, reducing the number of public water supply systems that are vulnerable to drought, and ensuring that systems have the technical, financial and managerial capacity to meet future needs for water quality and quantity.
There are 46 public water suppliers in the basin, including two rural water districts. There are no public

wholesale water supply districts in the basin. Ground water is the primary source for most public water supplies, accounting for 96% of the total supply.

Coping with drought presents a challenge for public water suppliers. During drought periods, the amount of raw water available typically is reduced at the same time customer demand for water increases. Although ground water is not as susceptible to droughts as surface water, public water suppliers that have an insufficient number of wells or capabilities to meet increase demand are vulnerable. While all suppliers may be potentially impacted, some are particularly vulnerable. Of the public water suppliers in the basin, seven (16%) were considered drought vulnerable in 2006.

Applicable *Kansas Water Plan* Objectives

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

Applicable Programs

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

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

ISSUE: WATER QUALITY

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 (see Watershed Restoration and Protection Basin Priority Issue).

All the counties within the basin with the recent addition of Haskell County have a sanitarian funded by the Local Environmental Protection Program (LEPP). All counties in the basin, except Kearny and Ness, have countywide planning and zoning programs. All conservation districts in the basin have adopted nonpoint source pollution management plans. Buffer coordinators have also been employed in six counties in the basin to facilitate enrollment of stream buffers in the continuous conservation reserve program and State Water Quality Buffer Initiative. Dodge City, Garden City, and Great Bend are included in the Phase II National Pollutant Discharge Elimination System (NPDES) Stormwater Program as having Municipal Separate Storm Sewers (MS4s).

Applicable *Kansas Water Plan* Objectives

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

Applicable Programs

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

- 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

ISSUE: FLOOD MANAGEMENT

Kansas Water Plan flood management guidance emphasizes targeting watershed dam construction assistance to priority watersheds; encouraging participation in the National Flood Insurance Program; and preparing updated floodplain maps for priority communities. All counties in the basin, except Ness County, have county wide breech zoning plans.

In 1993, the DWR launched the *Kansas Flood Mapping Initiative.* The FY 2005 *Kansas Water Plan* Flood Management Policy Section identified three priority counties to be mapped, remapped or to have existing information digitized in the Upper Arkansas basin. These counties are Barton, Hamilton, and Rice. Financial assistance from the *State Water Plan Fund* has been provided for this mapping. The Barton County map conversion into a digital format is near completion.

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
- Kansas Department of Agriculture-Division of Water Resources: Water Structures Program/Dam Safety
- Kansas Division of Emergency Management: Hazard Mitigation Grants Program
- FEMA: National Flood Insurance Program
- State Conservation Commission: Watershed Dam Construction Program
- State Conservation Commission: Watershed Planning Assistance Program

ISSUE: WATER-BASED RECREATION

While frequently dry within the basin, the Arkansas River is one of the three streams in the state that are considered navigable (as determined at time of statehood), and therefore is considered public land up to the channel's high water mark. Water-based recreation opportunities are limited in the basin. Fishing is popular at the few county fishing lakes. Jetmore Lake and Scott State Park Lake both provide fishing, boating and camping. Horsethief Reservoir began construction in 2008. When completed and filled, Horsethief will offer swimming, boating, fishing and camping. Horsethief Reservoir is a 450 acre lake located 18 miles north of Dodge City. Cheyenne Bottoms is a designated wetland of international importance, and provides excellent birding and hunting opportunities. In 2008, construction began on a Wetland Interpretive Center at Cheyenne Bottoms to expand public awareness of the Bottoms and the nearby Quivira wetland complex.

Applicable *Kansas Water Plan* Objectives

- Increase public recreational opportunities at Kansas lakes and streams.

Applicable Programs

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

- Kansas Department of Wildlife and Parks: Rivers and Stream Access

ISSUE: WETLAND AND RIPARIAN MANAGEMENT

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. Wetland and riparian management is addressed as a basin priority issue in the Upper Arkansas basin (see Watershed Restoration and Protection Basin Priority Issue).

Riparian lands in the Upper Arkansas basin have been seriously impacted by the infestation of non-native phreatophytes. Of greatest concern are the effects tamarisk (salt cedar) and Russian olive have on the basin's native riparian ecosystems.

Applicable *Kansas Water Plan* Objectives

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

Applicable Programs

- 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

Upper Arkansas River Basin High Priority Issue
Management of the Ogallala High Plains Aquifer
January 2009

Issue

Management of the Ogallala-High Plains aquifer and alluvial aquifer is needed to reduce the rate of decline and to conserve the life of the aquifer.

Vision

Sufficient water resources in western Kansas to support healthy, economically strong communities and rural lifestyles, today and for future generations.

Goal

Conserve and extend the life of the Ogallala - High Plains aquifer through management by aquifer subunits, by targeting water conservation activities to high priority subunits, improved characterization of the aquifer and implementing strategies for improved agricultural practices with limited water resources.

Description

The High Plains aquifer is the primary source of water in western Kansas. Nearly all of the reported water used in the Upper Arkansas basin is from ground water. The High Plains aquifer is composed of several hydraulically connected aquifer units of which the largest is the Ogallala. The Ogallala has been intensely developed, mostly for irrigation, leading to significant ground water declines. The Ogallala portion of the High Plains aquifer (Ogallala-High Plains aquifer) is characterized by low recharge and high declines. The expected "usable life" of the aquifer, or when the aquifer is no longer able to support the current high rates of pumping, varies widely due to differences in amount of saturated thickness, hydraulic conductivity, withdrawals and other variables. The total irrigated acres in the Kansas High Plains increased from 2,681,000 to 2,746,000 acres between 1991-1993 and 2001-2003, a 2.4% increase.[8] During the same time period, there has been an increase in corn, soybeans and alfalfa acres, crops that are traditionally water intensive, as well as wide spread adoption of more efficient irrigation systems.[8] The annual water level measurements indicate that in most areas, for a five year or more trend, the Ogallala-High Plains aquifer is declining.[1, 9]

It has long been known that the aquifer was in decline in western Kansas, at least for localized areas.[4] Kearny, Finney and Gray counties have had water level drops of over 30 feet in the past ten years. In general, southwestern Kansas still has significant amounts of ground water in storage, with many areas of the Upper Arkansas basin projected to have enough ground water to support widespread pumping for 50 years or more, even if the past water level decline trends continue (Figure 1). However, most of the aquifer within Greeley, Wichita and Scott counties has already declined to where the saturated thickness is below the minimum threshold needed to support widespread pumping. Areas within Finney, Gray and Stanton counties may face a similar situation within 25 years.[10]
Figure 1 is an estimated projection of how many more years the aquifer could support an assumed level of pumping, in this case with a well every quarter section, pumping at 400 gpm for 90 days. It projects the ground water level trends from 1996 to 2006 into the future. If the past trend had been increasing, the area is shown as blue.[10]

Southwest Kansas Groundwater Management District (GMD) No. 3 (GMD3), West Central Kansas GMD No. 1 (GMD1) and Big Bend GMD No. 5 (GMD5) are major local water management entities in the basin. A majority of the basin is closed or restricted for new water appropriations. Intensive Groundwater Use Control areas (IGUCA)[11] have been established for the Arkansas River corridor, Wet Walnut Creek and Pawnee River valley to provide increased management of ground water in those areas.

The High Plains aquifer is highly variable in Kansas. The amount of water in storage, the depth to water, the hydraulic conductivity (how readily the water moves through the sediments in the aquifer), the amount of withdrawals and the recharge rates all vary significantly throughout western Kansas.

Water Appropriations

Approximately 1,514,000 acre feet of ground water are appropriated for use within the Ogallala aquifer portion of GMD3 in the Upper Arkansas basin. There are about 4,567 active Ogallala–High Plains water rights from 5,592 wells.

Water Use

Ground water was the source for 96% of supply within the basin for all reported uses in 2006. Irrigation accounted for nearly 95% of all reported water pumped or diverted. Municipal use accounted for two percent of water used in the basin, industry for one percent, and recreation, stockwater and other uses combined to equal two percent. The 2006 reported water use from the Ogallala-High Plains in the basin was 874,563 acre feet.[6]

There has been widespread adoption of more efficient irrigation systems in the Kansas High Plains, from flood and center pivot to center pivot with drop nozzles.[8] A companion study by Kansas State University[2] found that the number of acres irrigated is a more important determinant of changes in water use than the adoption of more efficient irrigation systems. The authors concluded that if the irrigated acres are held steady after conversion to a more efficient irrigation system, net water use would, on average, change little. Therefore, it is with a decrease in irrigated acres that a reduction in water use is assured.[2]

Activities and Progress

Various programs and activities have been initiated to reduce the decline rate of the Ogallala-High Plains aquifer in order to extend and conserve the aquifer. Tools such as ground water and surface water computer models and more detailed aquifer characterization have been developed. In the Upper Arkansas basin, the determination of Ogallala-High Plains aquifer subunit priority areas, setting subunit goals and developing management plans to reach these goals has been the responsibility of the GMDs and Kansas Department of Agriculture–Division of Water Resources (DWR) for areas outside the districts.

Good data are essential to the determination of decline rates and aquifer characteristics. An important management tool is the development and calibration of interactive surface and ground water models. Water flow meters, now required on almost all wells, provide improved information on withdrawals. Annual winter water level measurements, continuous measurements from an index well in Haskell County, and weather station data, provide valuable input information to hydrologic models.

Under a Cooperative Agreement between the U.S. Bureau of Reclamation (Bureau) and the Kansas Water Office (KWO), the state and GMD3 have contracted with the Kansas Geological Survey (KGS) to develop a computer water model of the GMD3, incorporating stream-aquifer interactions where applicable to further characterize the hydrologic system and water availability. The model will provide more information on water in storage and project likely aquifer responses to possible future conditions and management scenarios.

Voluntary programs have been offered and targeted to areas determined by the management entity responsible for that area, GMD3 within district boundaries and in the fringe areas by DWR. The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) provides grants to transition from irrigated land to dryland production for a minimum of four years.

On December 20, 2007, the USDA Farm Service Agency began accepting applications to enroll land in the Conservation Reserve Enhancement Program (CREP) (Figure 3). This voluntary program seeks to provide incentives and cost-sharing to participants that enroll their land into eligible conservation practices such as native vegetation establishment or wildlife conservation for a period of 14 to 15 years. The CREP project area lies within 10 counties along the Arkansas River corridor within the basin, covering 1,571,440 acres. In the

CREP area, 718,683 acres are authorized for ground water irrigation; approximately another 10,680 acres are authorized for irrigation from surface water. The program allows enrollment up to 20,000 acres. Reducing irrigation demands on the stream-aquifer system will help slow the aquifer declines, mitigate the spread of saline waters into the aquifer, and help restore stream and riparian health throughout the CREP area.

As of December 30, 2008, 8,198 acres had been enrolled in the CREP program with additional offers pending. For the acres enrolled into the CREP program, 16,479 acre feet of authorized quantity will be permanently retired from irrigation.

Regulatory programs have included the DWR Blatant and Recurring Overpumpers (BRO) program which makes special requirements on irrigators that have pumped in excess of their water rights to get them back into compliance. In addition, Kansas Water Appropriation laws protect senior water rights from impairment by junior water right pumping. In 2008, DWR administered a junior water right that was impairing a senior right in Stevens County.

Progress toward reducing the aquifer decline rate was evaluated by the KWO in 2006 using water level data. The median annual water level changes were calculated for each region and standardized or indexed to antecedent moisture conditions using the Palmer Drought Severity Index for the appropriate region. The comparison of 1981-1993 and 1993-2005 periods concluded that there was no discernable change in the rate of water level declines in the Ogallala –High Plains region. Also concluded that as of 2005, in the southwest and western Ogallala aquifer area (GMD3, GMD1, and DWR fringe areas), there has been no statistically significant change, at a 5 percent error level in the rate of decline.

It should be noted that the reduction of total water use through the voluntary and regulatory programs is small. A measurable reduction in decline rates will likely take many years or decades to be recognizable unless participation in reductions are greater.

Recommended Actions

1. For priority aquifer subunits, develop specific goals and management strategies to extend and conserve the life of the aquifer.

2. Develop and maintain a ground water flow model of GMD3 area for evaluating management decisions and establishing conservation goals.

3. Kansas Water Office will continue coordination among the GMDs, DWR, stakeholders and other agencies.

4. Provide opportunities to permanently and temporarily reduce water use through voluntary programs (state, federal and local).

5. Educate water users, decision makers and the general public on the conditions of the aquifer and methods and opportunities to reduce water use.

6. Develop local ownership and leadership of aquifer issues, to assist in local adoption of specific conservation goals and programs.

7. Evaluate the long-term impact of climate change on supply and demand for water resources in the basin.

8. Seek crop insurance option for limited irrigation crops from USDA Risk Management Agency.

9. Consider interstate discussions on water conservation and planning where aquifer subunits cross state boundaries and are not directly impacting an existing surface water compact.

10. Explore opportunities to augment natural aquifer recharge through artificial recharge during flood events and other means as may be feasible.

11. Support research into high value, lower water-use crops that would be suitable for this region.

Resources

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Upper Arkansas River Basin High Priority Issue
Middle Arkansas Subbasin
January 2009

Issue

Reduction of ground water withdrawals is necessary to stabilize the hydrologic system in the Middle Arkansas subbasin.

Description

The water resources in the Middle Arkansas subbasin, which covers all or parts of Stafford, Edwards, Barton, Pawnee, Kiowa, Rush and Rice counties, have been heavily developed (Figure 1). Irrigation accounts for approximately 82% of the authorized water use, with recreation the next highest user. Most of the recreational use is for Cheyenne Bottoms Wildlife Area. Cheyenne Bottoms has a fairly senior water right in the subbasin, at file number 2427, which authorizes 18,185 acre feet from the Arkansas River and 19,175 acre feet from the Wet Walnut Creek. There are three appropriations up for certification that authorize additional quantities from the Dry Walnut, Blood Creek and Deception Creek. There are 1,836 points of diversion for an authorized 258,147 acre feet of water in the subbasin. Annual reported use is typically about 60% of the authorized amount. The Arkansas River streamflow, as measured at the Kinsley gage, has reduced drastically in recent decades, as shown in the median monthly streamflow from 1945-1973, and 1974-2002. Ground water is withdrawn from both the alluvial aquifer and the Great Bend Prairie aquifer, part of the High Plains aquifer. The ground water table has had significant decreases and at times no longer contributes water to the Arkansas River, resulting in depletion of the stream baseflow. With ground water levels stabilized, during normal or wetter climatic conditions, it could rise to streambed elevation and baseflow be re-established.

Arkansas River streamflow at Kinsley has been around 0.1 cubic feet per second (cfs) for much of 2007-2008, with increases in September 2007 and January 2008 to almost 0.4 cfs. Drops in streamflow to zero, which has occurred as recently as 2006, suggest that the ground water elevation has dropped below the streambed, so that the stream is not in hydraulic contact with the aquifer and baseflow has apparently ended. Long-term streamflow recovery most likely depends on aquifer recovery.

The Kansas Water Appropriation Act[8] was amended in 1984 to protect waters necessary to preserve and maintain streamflows at or above the minimum desired levels. Although not a water right in itself, the Chief Engineer, Kansas Department of Agriculture-Division of Water Resources (DWR), is to withhold from appropriation that amount of water needed to maintain Minimum Desirable Streamflow (MDS).[9] MDS established before July 1, 1990 have a priority date of April 12, 1984. The purpose of MDS is to protect flow from depleted conditions as a result of extensive water appropriation.

A MDS is set at the US Geological Survey (USGS) stream gage near Kinsley. The MDS is set at a high of 5 cfs in May and June, to a low of 1 cfs in August through September. Minimum desirable streamflows protect flow for instream uses relative to fish, wildlife, water quality, general aesthetics and downstream domestic and senior water rights.

The DWR has worked with water users and others in the Middle Arkansas subbasin to address the water shortages. This effort began in 1998 to develop a water management plan that identifies strategies to reduce water withdrawals, and works toward a sustainable hydrologic system.[4] The management plan proposal was approved by the Chief Engineer in 2004.[5] The goals are to stabilize the ground water levels, return ground water levels to channel elevation and maintain a baseflow in the river under normal climatic conditions. A number of strategies are identified, one of which is more efficient irrigation systems. One recommendation is to remove end-guns from center pivot irrigation systems.

Kansas State University, under contract for the Kansas Water Office (KWO), evaluated the water use efficiency of end guns in the region to crop production and farm economy. One tool developed is a computer spreadsheet program for individual site assessments. Users enter general system and field characteristics; the

model will provide expected yields, water use efficiency values and costs associated with the use of the end gun in that site's operation.

Circle K Ranch

The Circle K Ranch, located in the Middle Arkansas subbasin, is owned by the Cities of Hays and Russell. The ranch has 8,039 acre feet of water rights appropriated for irrigation. In 2004, it was proposed that the State of Kansas purchase the ranch to be managed by the Kansas Department of Wildlife and Parks, possibly for a wildlife viewing and hunting area. The goal is to reduce water use in this area while minimizing the economic impact to the region.[3] The Middle Arkansas Modflow model was used to evaluate the effect of the retirement of these water rights and it was shown there would be a localized benefit. As of 2008, no state purchase of Circle K Ranch has been made and it appears unlikely to occur. In 2007, a significant number of water rights were enrolled into a 10-year Water Right Conservation Program at DWR, to protect the right from abandonment while not used. The associated acres were enrolled into a U.S. Department of Agriculture, Natural Resources Conservation Services (NRCS) program to transition to dryland.

EQIP Quick Response Areas

A number of irrigated acres have been enrolled in the USDA NRCS Environmental Quality Incentive Program (EQIP) as quick response areas to transition to dryland for four years. Many of the associated water rights enrolled in the DWR Water Right Conservation Program for 10 years, which protects water right from abandonment during a period of non-use. NRCS provides payments to transition to dryland use, such as farming, pasture or grass. The EQIP program requires the land remain non-irrigated a minimum of 4 years, but it does not require the water right to be permanently retired. The Groundwater Management Districts' boards make the initial recommendation for the quick response areas, which is then reviewed by the Kansas Technical Committee and determined by the State Conservationist. For areas outside a district, DWR makes recommendations for quick response areas.

Conservation Reserve Enhancement Program (CREP)

On December 20, 2007, the Kansas Farm Service Agency began accepting applications to enroll land in the Conservation Reserve Enhancement Program (CREP).

This voluntary program provides incentives and cost– sharing to participants that enroll their land into eligible conservation practices such as native vegetation establishment or wildlife conservation for a period of 14 to 15 years.[6] The CREP project area lies within 10 counties along the Arkansas River corridor, covering 1,571,440 acres. In the CREP area, 718,683 acres are authorized for ground water irrigation; approximately another 10,680 acres are authorized for irrigation from surface water. The state seeks to enroll up to 20,000 acres into the program over the next several years. Reducing irrigation demands on the stream-aquifer system will help slow the aquifer declines, mitigate the spread of saline waters into the aquifer, and help restore stream and riparian health throughout the CREP area and within the Middle Arkansas subbasin.

As of December 30, 2008, 8,198 acres had been enrolled in the CREP program. For the acres enrolled into the CREP program, 16,479 acre feet of authorized quantity will be permanently retired from irrigation.

Ground Water Model

The DWR and the KWO contracted with the Kansas Geological Survey to develop a Modflow water model to provide additional information on the nature of stream-aquifer interactions and the effect of ground water pumpage, for use in planning and management of water resources in the Middle Arkansas subbasin.[7] The computer model extends from northeast Ford County through much of Edwards and Pawnee counties to north-central Stafford and southern Barton counties (Figure 3).

Five different scenarios were simulated with the model: 1) increased streamflow from 1980-2004, 2) continued pumping at current levels; 3) no pumping; 4) 24% reduction of pumping in the proposed area for the CREP, and 5) retirement of water rights in the Circle K Ranch.

Regulatory Options

One recommended action under the current *Middle Arkansas Subbasin Management Plan* is to implement regulatory options to help achieve water conservation.[5] In 1978, the Kansas Legislature enacted provisions for designation of Intensive Groundwater Use Control Areas (IGUCA) within the Groundwater Management District Act.[10] These statutes allow the Chief Engineer to implement additional corrective control provisions in areas where it is determined, through a public hearing process, that ground water levels are declining excessively, the rate of ground water withdrawal exceeds the rate of ground water recharge, unreasonable deterioration of ground water quality has occurred or may occur, or other conditions exist warranting additional regulation to protect public interest.

Recommended Actions

1. Coordinate interagency efforts to implement strategies identified in the *Middle Arkansas Subbasin Management Plan*, as approved by the Chief Engineer.

2. Use the hydrologic model to evaluate future management scenarios and strategies that may be needed to achieve the subbasin goals.

Resources

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Upper Arkansas River Basin High Priority Issue
Salt Cedar and Other Non-Native Phreatophyte Control
January 2009

Issue

Salt cedar (Tamarisk), Russian olive and other invasive high water consuming vegetation are choking out native riparian habitat along the upper Arkansas River and other western streams in Kansas.

Description

Riparian lands in Kansas have been seriously impacted by the infestation of non-native phreatophytes. Of greatest concern are the effects tamarisk and Russian olive have on our native riparian ecosystems.[4, 5] Tamarisk is a tenacious shrub/small tree that has a deep root system (up to 100 feet) and leaves a salt residue on the soil surface. Tamarisk, a native of southern Europe and central Asia, is classified as a deciduous shrub that rapidly attains a height of five to twenty feet and grows best in sandy soils along streams. Tamarisk was brought to the United States for ornamental purposes and most likely was first established in Kansas in the early 1900s when it was planted in windbreaks. It has been widely used for bank stabilization and windbreaks since it is well suited for the western United States. There are many different species of tamarisk that are referred to with different common names. These problematic and invasive tamarisk species are commonly referred to as salt cedar.

Tamarisk can adapt to poor subsurface water quality. Tamarisk utilizes salt to increase the osmotic potential of its deep, extensive root system, which allows it to draw water from greater depths than the native vegetation. Therefore, tamarisk tends to out-compete native obligate phreatophytes during drought periods. The salt is excreted by the leaves and is concentrated in the leaf litter, thus impeding the growth of native species where tamarisk has gained a foothold. Tamarisk uses significant quantities of water. Actual water use by tamarisk depends on several factors, water availability, climate, water quality, population density, stresses, etc. However, it has been found that tamarisk will consume more water than some native vegetation in the same setting.[1, 2]

Russian olive, a different type of invasive phreatophyte shrub or small tree, was introduced in Kansas for windbreaks and wildlife plantings. The Russian olive, with its tendency to spread quickly, is a menace to riparian woodlands, threatening hardy native Kansas species like cottonwood and willow trees. Russian olive outcompete native vegetation, interferes with natural plant succession and nutrient cycling, and chokes irrigation canals in Kansas.

The resulting invasive thickets of tamarisk and Russian olive provide poor habitat for livestock and wildlife, increase fire hazards, decrease water quality and generally use more water than native vegetation. The vegetation does, however, provide shelter protection for livestock. Infestations of phreatophytes in Kansas are roughly estimated to occupy greater than 50,000 acres.

Scientists with the U.S. Department of Agriculture (USDA) have stated that, "*tamarisk infestation has reached epidemic proportions and is one of the greatest disasters to ever befall native riparian areas in western United State,".*[3] The National Invasive Species Council has identified tamarisk as one of its primary targets for control.

Tamarisk affects the water supply in both quantity and quality. The decrease in alluvial ground water levels due to tamarisk increases the transit loss of water delivered from John Martin Reservoir in the Arkansas River. Tamarisk affects water quality by reducing in-stream flows and the concentration of naturally occurring salts in tamarisk stands.

Thick tamarisk stands promote narrowing of river and stream channels. The U. S. Army Corps of Engineers have studied the Upper Arkansas River channel capacity and documented that tamarisk is occupying space within the channel and flood zone, thus increasing the potential risk of flood damage.[7, 8] Since tamarisk

replaces native species, there is a loss of biodiversity in the infested areas. Wildfires are more intense in tamarisk infested areas, however, due to the nature of the tamarisk root crown, it recovers from fires quicker than native vegetation. Thus, fires tend to promote additional infestation. Tamarisk infestation is problematic in Kansas because it negatively impacts water quantity and quality, results in the loss of land utilization options and value, as well as a loss of wildlife habitat.

Estimates of the number of acres infested in the United States are between one and two million acres. Tamarisk has been identified in nearly every county in Kansas, but is concentrated along streams and lakes in the western portion of the state. Tamarisk is prevalent along the mainstem and tributaries to the Arkansas and Cimarron rivers, as well as the shorelines of several of the state's federal reservoirs.

Helicopter surveys of the Upper Arkansas River were conducted in 2004 and 2005 by the Kansas Department of Agriculture. Estimates from these surveys indicate that more than 15,000 acres of the riparian corridor from the Colorado-Kansas state line east to the Rice County line along the Arkansas River are infested with tamarisk (Table 1) . According to a statewide county survey, more than 50,000 acres of the land surveyed in Kansas are infested with tamarisk.

Recommended Actions

1. Continue to work with agencies and groups on the water issue strategic plan and 10-Year Strategic Plan to coordinate and implement the variety of programs, research and educational efforts that are occurring or recommended.

2. Cooperate with stakeholders in Colorado to implement tamarisk control projects that cross state lines.

3. Promote education on invasive plants and seek local input through the Basin Advisory Committees.

4. Continue an evaluation of the most effective and cost-efficient control measures for the Upper Arkansas River basin, and provide cost share on tamarisk control and shelter belt replacement.

5. As an effective control measure is identified for the basin, implement a wide-scale, watershed-based control effort, and combine with plans for successful beneficial vegetation that helps stabilize the soil, has potential for windbreaks and other benefits.

6. Research and evaluate biological control of tamarisk using leaf beetles and/or other suitable organisms, but pilot it with extreme caution to avoid unintended consequences.

7. Deliver educational materials and technical information to legislators, property owners and the public within the basin related to non-native phreatophyte research and control through Kansas State University Agricultural Experiment Station and Cooperative Extension Service.

8. Quantify the actual non-beneficial use of water by tamarisk in the basin's different ecological settings. Existing research should be used and augmented with on-the-ground measurements of changes to both streamflow and ground water before and after tamarisk control activities. This research will help to establish the difference in water consumption in Kansas between non-native phreatophytes and typical riparian plant communities.

9. Evaluate the recovery benefits after tamarisk control to provide valuable information on the specie's true impact to water quality, wildlife habitat, water quantity, grazing land, reduction of risk from flood damage and other features that impact the basin's ecology and economy.

10. Determine the potential value of tamarisk biomass for various value-added products such as ethanol, bedding, fiberboard, and fuel pellets, or if not suitable for alternative uses, determine how to dispose of dead plant materials.

Resources

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Upper Arkansas River Basin High Priority Issue
Bioenergy and Water
January 2009

Issue

Renewable fuel production is a growing issue in the Upper Arkansas basin, where increased biofuel production provides economic opportunity. As new biofuel facilities are sited and changes are made to the basin's cropping patterns, more evaluation is needed of the impacts from the increased demand on both water supply and water quality.

Description

Gas and oil production is the second largest industry in Kansas and is very important to the Upper Arkansas basin economy. The growing industrial contribution to the basin economy is also related to bioenergy production, primarily ethanol. As of December 2008, three operating ethanol plants are located in the basin in Wichita and Finney counties. One ethanol plant is permitted in Ford County (Figure 1).

Water Quantity

Ethanol production, like many industrial and agricultural practices, involves a consumptive use of water. A 50-million gallon per year (MGY) ethanol plant uses about 200 MGY of water (or about 550,000 gallons per day), primarily from evaporation during cooling and wastewater discharge. Ethanol production technology uses water more efficiently; plants today use about 50 percent less water than 10 to 15 years ago. It currently takes roughly three to four gallons of water to produce one gallon of ethanol. Under Kansas law for appropriating water, ethanol plants, as any other industry, must purchase water from a rural water district, a municipality or acquire a water right. Most of the basin is closed to new water appropriations; in closed areas, any new venture must purchase an existing water right, and any change in use of that appropriation must be approved by the Chief Engineer, Kansas Department of Agriculture-Division of Water Resources (DWR), to ensure that the net consumptive use does not increase.

Nonetheless, some have raised concerns that increased corn production, a water-intensive crop, may cause additional water table declines over time.[3, 4]

Most U.S. ethanol is made from corn, but it can also be produced from other feedstocks such as grain sorghum, wheat, barley or potatoes. In Kansas, more than half of the ethanol produced comes from grain sorghum, with most facilities using corn and sorghum interchangeably.[3] This new demand for corn, and the new opportunities for value-added processing and cattle production in rural communities, has created a significant economic development opportunity in Kansas and throughout the Upper Arkansas basin. However, the potential changes to the basin cropping patterns, specifically increasing the number of irrigated corn acres, may negatively impact the aquifer and stream conditions.

According to the U.S. Department of Agriculture National Agricultural Statistics Service (NASS) the number of irrigated corn acres in west central Kansas grew from 103,000 acres in 1990 to 139,000 in 2007 (Figure 2).[6] Improved agronomic practices and crop genetics have led to higher corn yields. In west central Kansas, while there was a 15% increase in irrigated corn acres from 1993 to 2003, there was a 79% increase in irrigated corn production.[13] In 2006, approximately 16% of Kansas corn and sorghum crops were used for ethanol production, up from 13% in 2000. Corn production in Kansas may be slowing down. According to NASS, producers intended to plant eight percent fewer corn acres in 2008, as a result of multiple factors including crop rotation considerations and high input costs. In 2008, Kansas was expected to plant their largest soybean crops in history.[6]

Water Quality

Wastewater from ethanol plants is regulated by the Kansas Department of Health and Environment (KDHE),

which administers both the federal National Pollution Discharge Elimination System (NPDES) permits and Kansas Water Pollution Control permits. In most instances, KDHE issues the state-level permit, which requires ethanol plants to use the wastewater for beneficial land applications rather than simply discharging into streams and rivers.

A rise in the number of corn acres may also impact the basin water quality through increased fertilizer application and soil erosion. In Kansas, corn has the greatest application rates of both fertilizer and pesticides per acre, higher than for soybeans and mixed-species grassland biomass. The switch from other crops or noncrop plants to corn may lead to higher application rates of highly soluble nitrogen. Harvested row crops, such as corn, have a higher potential for soil erosion than grasses or perennial crops. The potential water quality impact of an increased demand for corn may be mitigated through Best Management Practices (BMPs), especially those addressing soil erosion and herbicide applications.(1)

The restoration of watersheds with impaired water quality and the protection of watersheds above public water supply reservoirs and ground water sources used for drinking water supplies are also a high priority issue in the Upper Arkansas basin.

Biodiesel

Biodiesel is produced using oils extracted from crops, animal fat or waste vegetable oil using a chemical process called transesterification. Most U.S. biodiesel is produced from soybean oil, although other vegetable oils such as canola, corn, cottonseed, flax seed, sunflower or peanut oil can be used. As of December 2008, no biodiesel plants are permitted in the Upper Arkansas basin.

Biodiesel production uses roughly three gallons of water per gallon biodiesel, about a gallon of which is consumptive use. Wastewater from biodiesel plants, which may contain high amounts of oxygen, grease and oils, is regulated by KDHE.

Biogas

Kansas has more than 36,000 farms with cattle and calves and ranks first nationwide in commercial cattle processed with more than eight million head.(8) Because of the high number of livestock facilities in the state and in the Upper Arkansas basin, anaerobic digestion of wastes and the capture of methane gases may provide an alternative fuel source, while increasing the value-added potential of the industry. The key by-products of anaerobic digestion include digested solids and methane, the primary component of “biogas”. Biogases can be used to fuel a variety of cooking, heating, cooling and lighting applications, as well as to generate electricity. Capturing and using methane, a potent greenhouse gas, also reduces its release to the atmosphere.(5)

Cellulosic Ethanol

Cellulosic ethanol uses lignocellulose, the main structural material in any plant, as a feedstock. Cellulosic feedstocks require an extra step to break down the lignocellulose into fermentable starch, thus increasing production costs. The bulkier cellulosic feedstocks are also more costly to harvest, transport and store. Processing of cellulosic materials would require more water than corn, as the feedstock is dry. Research on cellulosic feedstocks (such as switchgrass, wood chips, and corn stover) is ongoing. The U.S. Department of Energy has set 2012 as a target year to achieve technological advances to make cellulosic ethanol cost competitive with corn ethanol. In 2007, Abengoa Bioenergy, a Spanish energy company, announced that Hugoton would be the site of the state’s first cellulosic ethanol plant. In conjunction with cellulosic ethanol research, some researchers are investigating the use of perennial polyculture crop systems for cellulosic feedstocks.

Production of cellulosic ethanol may have greater positive environmental impacts than grain-based ethanol such as reduced greenhouse gas emissions, decreased fertilizer application and less reliance on water intensive crops.

Corn Research and Varieties

Breeding of corn hybrids that maximize yield for ethanol production while reducing additional strains on water supplies has been a focus of much research by universities and corn breeding companies. Drought tolerant hybrids, specifically transgenic, drought-resistant corn, are especially important in areas of western Kansas where rainfall averages fewer than 16 inches per year. In addition to drought tolerant varieties, industries are identifying corn varieties that produce higher yield and more ethanol per acre. High total fermentable ethanol corn hybrids provide higher levels of fermentable starch, consisting of the sum of all starches and simple sugars that ferment during the typical dry grind process.[6,9]

Recommended Actions

1. Coordinate, where applicable, the development, implementation and public input process between the *Kansas Water Plan* and Kansas energy policy.

2. Maintain regulatory oversight by state and local government on the siting of ethanol and biodiesel plants, with special emphasis on the water supply and availability.

3. Look for water recycling opportunities within the biofuel facilities.

4. Promote research for less water-dependent corn varieties and improved irrigation scheduling that maintains or increases crop yield without increasing water use.

5. Promote research and pilot projects for viable, commercial cellulosic ethanol production and other biofuels that are less dependent on water intensive crop production.

6. Increase corn water use efficiency (amount of grain produced per inch of water) through research and extension efforts. Educational emphasis should be placed on utilization of irrigation scheduling tools such as KanSched and the Mobile Irrigation Lab.

7. Evaluate the biofuel facility watershed and watersheds of input crops, and identify potentially environmentally sensitive areas. Target programs to mitigate environmental impacts, such as stream buffers, grass filters, BMPs, etc.

8. Provide education and/or incentives for marginal lands that have expiring Conservation Reserve Program contracts that will not be renewed to stay in a conservation planting, with special consideration to acres that could return to irrigation.

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Upper Arkansas Basin High Priority Issue
Interstate Cooperation to Address Water Quality
January 2009

Issue

Interstate cooperation and management is needed to address poor quality surface water that is impacting or threatening public water supply wells along the Arkansas River corridor. Protection of the fresh ground water in the region is critical for municipal, industrial and agricultural uses.

Description

The Arkansas River in western Kansas is among the most saline in the country. The contamination is caused by high levels of salinity in the river as it enters Kansas from eastern Colorado (Figure 1).[6] In 2000, Kansas began to address the salinity issue by developing a Total Maximum Daily Load (TMDL) on the upper Arkansas River for sulfate. The Colorado Water Quality Control Division (Division) was consulted in the development of the TMDL. One of the outcomes after the TMDL approval was establishment of a comparable water quality criterion for sulfate. The sulfate TMDL is now consistent between Kansas and Colorado. In this phase of the TMDL, an interim endpoint is to reduce the long term average sulfate concentration below the current average of 1875 mg/L that occurs at Pierceville, near Garden City.

In 2007, the Kansas Department of Health and Environment (KDHE) completed a TMDL to address selenium water quality impairments along the Arkansas River from the Colorado stateline to Pierceville. Selenium concentrations are high during summer (April to September) when deliveries to Kansas irrigation ditches are made by Colorado pursuant to the Arkansas River Compact. Moreover, concentrations during the irrigation off-season (October to March) remain elevated with the onset of drier conditions. The greatest concentrations of selenium are seen in the immediate vicinity of the river where large-scale irrigation diversion of ground water begins east of the Bear Creek fault in Kearny County. In short, irrigation return flow deliveries from Colorado are poorer water quality than main stem deliveries, and the best water quality is from releases from John Martin Reservoir that never is diverted for Colorado farmland irrigation. The diminishment of streamflow east of Garden City confines the intrusion of saline water to the immediate alluvium of the river above this point.

Data from the U.S. Geological Survey and the Kansas Geological Survey (KGS) show uranium concentrations in the river during saline low flows generally exceeding the Environmental Protection Agency (EPA) drinking water standards. The dissolved concentrations of uranium are well correlated with sodium, sulfate, and chloride concentrations.

In general, selenium and uranium concentrations increase with increasing salinity of the surface and ground waters. Just as the primary source of the sulfate in the waters is natural (leaching of rocks and soils), the primary source of the uranium is natural. However, the high concentrations of both sulfate and uranium in the Arkansas River surface water and ground water affected by the river are not natural but the result of the evapotranspiration consumption of water in Colorado, leaving the residual salts dissolved in a much smaller volume of water.

The saline water from the Arkansas River seeps into the subsurface alluvial aquifer and then the Ogallala-High Plains aquifer in Kansas, thereby contaminating the ground water with high sulfate and uranium concentrations (Figure 1). In some cases, additional uranium may be derived from the sediments in which ground waters reside, and in other cases, some uranium may be removed by chemical conditions in ground water or by the sediments.

Stakeholders from Kansas, including KDHE, Kansas Department of Agriculture–Division of Water Resources (DWR), Southwest Kansas Groundwater Management District No. 3 (GMD3), KGS, and Kansas Water Office (KWO) have been actively engaged in discussions with stakeholders from Colorado, including Colorado Water Quality Control Commission and Colorado State University to discuss the common issues and concerns related to the water quality along the Arkansas River.

Tamarisk Control

Infestations of tamarisk, a non-native, high water consuming plant, along the Arkansas River also impacts the water quality in the basin. Tamarisk is prevalent along the mainstem and tributaries to the Arkansas River; surveyed infested riparian acres exceed 15,000 within the Upper Arkansas basin. To a lesser extent, Russian olive has also infested the river corridor, and control measures for tamarisk and Russian olive are similar. In order to achieve true, long-term successful tamarisk control, Kansas will need to actively coordinate with Colorado on this issue. Working collaboratively will allow Kansas to identify opportunities that make the most effective use of our collective resources.

In 2008, Kansas and Colorado initiated plans to implement a cooperative control project in Prowers County, Colorado and Hamilton County, Kansas. The project seeks to build partnerships and develop local leadership so long-term tamarisk control will be successful. Treating tamarisk infestation in the watershed will improve the limited streamflow and the interconnected alluvial and Ogallala-High Plains aquifers along the Arkansas River where tamarisk has become a significant problem.

Conclusion

The Arkansas River system is excessively high in total dissolved solids, one of which is sulfate, impairing the environmental and economic uses of the river on both sides of the stateline. This issue highlights the need for Kansas and Colorado to derive common goals for future water quality conditions, including the components of selenium and sulfate. Kansas recognizes the complications between achieving the goals of the Clean Water Act and water quality standards, while maintaining compliance with the Arkansas River Compact. However, both can be achieved through development of joint solutions.

Recommended Actions

1. Initiate meetings in 2008 and 2009 between Kansas and the Colorado water quality and water appropriation agencies to discuss proposals to improve water quality in the Arkansas River within the context of the Arkansas River Compact. Coordinate with water compact representatives. Identify pilot areas in the Arkansas River valley in 2009 to test remedial measures for lowering salinity in the river.

2. Cooperate with Colorado State University in the investigation of nitrate management as a means to reduce selenium loadings in irrigated areas below John Martin Reservoir.

3. Investigate, through the KGS, radionuclide loading from the Arkansas River into the aquifer sources of Kansas communities such as Deerfield and Lakin.

4. Collaborate between Colorado State University and KGS on the use of a model to identify salinity loading regions and the potential impact.

5. Initiate installation of Best Management Practices in pilot areas along the Arkansas River over 2010-2012 to determine the effect of those practices on water quality improvement and water management under the Compact.

6. Based on results from the pilot efforts, jointly obtain funding with Colorado in 2012 to implement salinity reduction measures throughout the Arkansas River valley, including EPA Targeted Watershed Grants, Water Resource Development Act (WRDA) environmental restoration projects and state funded projects.

7. Cooperate with Colorado on joint tamarisk and other non-native phreatophyte control in the Arkansas River watershed.

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Upper Arkansas Basin High Priority Issue
Watershed Restoration and Protection
Approved January 2007

Issue

The restoration of watersheds with impaired water quality and the protection of watersheds ground water sources used for drinking water supplies and irrigation are high priority in the Upper Arkansas basin. Three main components guide water quality efforts; achievement of Total Maximum Daily Loads (TMDL), development of Source Water Protection Plans, and restoration and protection of wetland and riparian areas.

The Upper Arkansas River has problems with both low flows and very saline water quality as it enters Kansas from Colorado.[14] The flow in the Arkansas River has been impacted by uses of water in Colorado since the late 1940s and the operation of John Martin Reservoir through the provisions of the Arkansas River Compact. The streamflow issue is being addressed with improved Arkansas River Compact compliance and monitoring. Improved water quality is necessary as the river crosses the state border. Poor quality surface water is seeping into and degrading the good water quality High Plains aquifer along the river corridor. The degradation is impacting or threatening public water supply wells along the river corridor. Protection of the fresh ground water in the region is critical for municipal, industrial and agricultural uses.

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.

The state continues to protect its interest in the Arkansas River Compact with Colorado. Final resolution of the reimbursement for past damages of the Kansas v. Colorado No. 105 lawsuit over compact violations by Colorado resulted in monetary awards. These funds have been credited according to law.[15] After litigation expenses were recovered, two thirds of the monetary award was deposited into a Water Conservation Projects Fund and one third was credited to the State Water Plan for water conservation projects. The Water conservation Projects Fund is now the Western Water Conservation Fund, administered by the Southwest Kansas Groundwater Management District No. 3.

Water Quality Impairments

Surface waters not meeting surface water quality standards in the basin are included on the 303d list.[16] High priority TMDLs for impaired surface waters in the Upper Arkansas basin were approved by the Environmental Protection Agency (EPA) in September 2000 and again in February 2008. Table 1 provides information on rivers and lakes within the basin that are designated as high priority for TMDL implementation. Figure 1 shows the location of these areas within the basin. High priority TMDL watersheds are used to target voluntary, incentive based programs that provide technical and financial assistance for implementation of nonpoint source pollution management practices that can address designated pollutants.[9]

A selenium TMDL on the Arkansas River from Coolidge to Pierceville was approved in 2008. Biological data from the Kansas Biological Survey indicate that selenium is accumulating within the biota of the river, often above the fish tissue criteria proposed by EPA. Previous analyses indicate ambient in-stream selenium levels regularly exceed existing state criteria for aquatic life. Current analysis by Colorado State University is focusing on the increase in selenium seen between John Martin Dam in Colorado and the stateline, the reason for the high selenium levels since the cessation of surplus water in the valley in June 2000, and reviewing ongoing research on Best Management Practices.

Colorado currently has adopted a temporary modification to its Table of Value Standards for dissolved selenium on the Arkansas River (22.5 ppb). The Colorado Arkansas River Water Quality Standards were revised in 2007. In 2007, Kansas Department of Health and Environment (KDHE) provided testimony to Colorado to highlight the need for reduced selenium concentrations. As part of the Colorado Water Quality Standards review process, Kansas proposed stateline selenium levels of 7 ppb in April through October and 10

ppb in November to March, consistent with the TMDL.

KDHE's testimony focused on establishing the desired selenium level for the Kansas segment of the Arkansas River and collaborative management of Arkansas River water quality by the two states.

A complete description of each TMDL is available on the KDHE TMDL website.[17]

Surface Water Nutrient Reduction

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 2).

A major component of the Kansas Surface Water Nutrient Reduction Plan (Plan) involved looking at nitrogen transport to the Gulf of Mexico.[8] In order to calculate the contribution of nitrogen to the Gulf, nitrogen concentrations of waters exiting the state borders were collected and estimated. Since there are no "exit points" for the Upper Arkansas basin, all contribution from this basin is added to the Lower Arkansas basin where the Arkansas River exits Kansas into Oklahoma. Therefore, for the purpose of the Plan, the Upper and Lower Arkansas River basins were combined as a single composite basin.

As predicted by studies from the U.S. Geological Survey, only a small amount of nitrogen is expected to be transported from watersheds in the upper part of the Arkansas River basin to the Gulf of Mexico. Thus, to try to predict the contribution the Upper Arkansas basin makes to the Lower Arkansas basin would be difficult. It should also be noted that while the Upper Arkansas basin is not predicted to produce a significant surface water impact, infiltration to local aquifers could produce significant ground water impacts. Furthermore, TMDLs on the Arkansas River between Great Bend and Hutchinson are influenced by nutrient loading coming from the Upper Arkansas basin. Therefore, some degree of nutrient reduction should be expected from the eastern portion of the Upper Arkansas basin. Additionally, nutrient loading leaving Kansas along the Arkansas River may be implicated for causing eutrophication problems in Kaw Lake in Oklahoma.

The primary nonpoint sources of pollution are agricultural. Table 2 shows the relative contributions of point and nonpoint sources in the Upper Arkansas and Lower Arkansas basins for total phosphorous and nitrogen leaving the state.

Based on land use, the nonpoint sources in this basin are overwhelmingly agricultural. To add urban in as a "co-primary source" may leave the impression that urbanized areas play more of a role than they actually do. The three urban areas in the basin, Garden City, Great Bend and Dodge City all fall under the Phase 2 stormwater rules, so their runoff is addressed as a point source under NPDES.

The Kansas Surface Water Nutrient Reduction Plan, developed by KDHE, outlines a statewide strategy for reducing the export of total nitrogen (TN) and total phosphorus (TP) in surface waters leaving the state. This involves additional reductions in nutrients from point source discharges through the NPDES program and reduction in nonpoint sources through development and implementation of Watershed Restoration and Protection Strategies (WRAPS). The Nutrient Reduction Plan includes Improvement Potential Index (IPI) maps for Kansas counties for TP and TN reductions (see Water Quality Policy Section for statewide maps; Figure 3 & 4). In the Upper Arkansas basin, Barton, Rice and Stafford counties showed the highest improvement potential for both TN and TP. These counties should receive priority consideration for the installation of nutrient management and reduction practices.

Source Water Protection

All public water suppliers in the basin have completed Source Water Assessments in cooperation with KDHE. The next step, which is voluntary, is the development of source water protection plans.[6]

There are 46 public water suppliers in the Upper Arkansas basin, two of which are rural water districts. Ground water is the primary public water supply source in the basin. The major source of ground water is the Ogallala-High Plains aquifer.

Each Source Water Assessment included a susceptibility score that can help communities determine which contaminants pose the most significant threat to their water supply. A susceptibility score was generated from an analysis that indicates whether the susceptibility range is low, moderate, or high for potential threats of contamination in an assessment area. Each public water supplier received susceptibility scores in the following contaminant categories: microbiological, nitrates (ground water only), pesticides, inorganic compounds, synthetic organic compounds, volatile organic compounds, sedimentation (surface water only) and eutrophication-phosphorus (surface water only).

Of the public water suppliers using ground water in the Upper Arkansas River Basin, 50% had low susceptibility scores, 50% had moderate scores.

The Kansas Corporation Commission (KCC) regulates rates, service and safety of public utilities, as well as, oil and gas production. KCC has established minimum surface casing requirements for oil and gas pipelines in each county in the Upper Arkansas River Basin to protect fresh and usable water.[4] Water well construction and abandonment is regulated by the KDHE.

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.

Wetland and Riparian Area Management

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. Water quality has been a primary focus with implementation efforts targeted to high priority TMDL watersheds (Figure 1). In addition, several watersheds have been identified in the *Kansas Wetlands and Riparian Areas Protection and Restoration Implementation Plan* as areas of high biological importance and a priority for implementation activities. Seventeen conservation districts in the basin have developed wetland and riparian protection plans.

Channel capacity and conveyance is an inter-related problem with water quality and streamflow. Reduced flows over an extended period and the reduction of peak flows have allowed channel encroachment. Encroachments are from a variety of sources, including agricultural land use, sand mining and non-native vegetation. The heavy growth of tamarisk (salt cedar) has significantly altered the conveyance of the channel as well as the flow patterns. These findings were consistent with an aerial survey conducted by the Kansas Department of Agriculture in 2004-2006. According to the survey, approximately 56% of the corridor from the stateline to Hutchinson is infested with tamarisk with the heaviest infestation closer to the stateline. Tamarisk is a nonnative, invasive plant that quickly displaces native vegetation, interfering with natural plant succession and nutrient cycling, and chokes irrigation canals in Kansas. The resulting invasive thickets provide poor grazing and forage for wildlife and livestock; however, it does provide a windbreak. The dense growths also increase fire hazards, decrease water quality and generally use more water than native vegetation. Activities and programs targeted at reducing tamarisk infestation are outlined in the *10-Year Strategic Plan for the Comprehensive Control of Tamarisk and Other Non-Native Phreatophytes*.

Watershed Restoration and Protection Strategies

Watershed Restoration and Protection Strategies (WRAPS) are stakeholder-driven watershed management plans designed to address multiple water resource issues within a specific watershed. The WRAPS process provides a means to integrate objectives from multiple local, state and federal programs into a comprehensive, coordinated strategy for a specific watershed.[7] This can include TMDL attainment, nutrient reduction, source water protection, riparian and wetland management and other natural resource objectives.

WRAPS projects have been initiated in the eastern portion of the Upper Arkansas River watershed (see WRAPS Project Status Map in the Water Quality Policy Section).[1] WRAPS projects currently underway in the basin encompass priority watersheds for TMDL implementation, areas with a high improvement potential index

for nutrient reduction, source water assessments areas, and priority areas for wetland and riparian protection.

consideration for watershed restoration and protection in the basin will be the potential for conversion of Conservation Reserve Program (CRP) acreage back to production agriculture as contracts expire. Of the acres enrolled in the nineteen Kansas counties contained wholly or partly within the Upper Arkansas basin, 522,448 CRP acres expired in 2007. Of those, 85,393 acres (16%) were offered a 5-year reenrollment option and 102,773 acres (20%) received a 10-year reenrollment option.[(11)] If land is taken out of permanent grass cover, implementation of best management practices will be needed to minimize potential adverse impacts to water resources in the basin.

In December, 2007, the State of Kansas entered into an agreement with United States Department of Agriculture (USDA) for the purpose of encouraging irrigators along the upper Arkansas River corridor to enroll in a Conservation Reserve Enhancement Program (CREP). The state seeks to enroll up to 20,000 acres into the program over the next five years. In return for annual payments, irrigators permanently retire water rights and put acres in a conservation planting for 14-15 years. Reducing irrigation demands on the stream-aquifer system will help slow the aquifer declines, mitigate the spread of saline waters into the aquifer, and help restore stream and riparian health.

Other Watershed Related Activities

- All the counties within the basin have a sanitarian funded by the Local Environmental Protection Program (LEPP).
- All counties in the basin, except Kearny and Ness, have countywide planning and zoning.
- All conservation districts in the basin have adopted nonpoint source pollution management plans. Buffer coordinators have also been employed in six counties in the basin to facilitate enrollment of stream buffers in the continuous CRP and State Water Quality Buffer Initiative.
- There are five organized watershed districts in the basin.
- Western Water Conservation Project Fund conservation activities recognize water quality issues and are taking water quality impacts into consideration.

Recommended Actions

1. Work with stakeholder groups to incorporate TMDL implementation and nutrient and sediment reduction 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.

3. Continue coordination of agencies' programs and activities to achieve the high priority TMDLs, and show water quality improvements. Lead state agencies include KDHE, SCC, along with Kansas Department of Wildlife and Parks and Kansas Water Office (KWO). Include others as appropriate.

4. Continue inter-agency cooperation and update the water issue strategic plan (WISP) to address the complex inter-state Upper Arkansas Water Quality concerns. Key state agencies include KDHE, SCC, Kansas Department of Agriculture – Division of Water Resources (DWR), and KWO. Include others as appropriate.

5. Encourage enrollment in the Conservation Reserve Enhancement Program (CREP) with emphasis on acres enrolling in the Conservation Practice (CP9) to develop or restore shallow water areas.

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