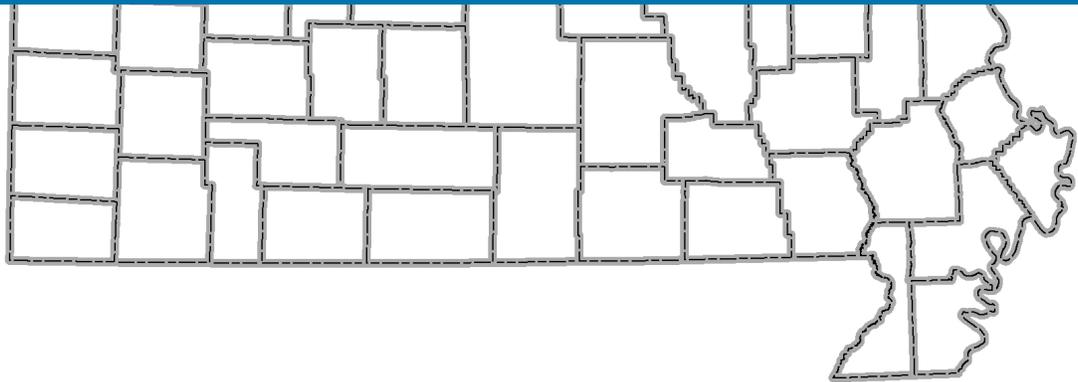


The State of *Our Missouri Waters*

Lower Missouri - Crooked Watershed



The Missouri Department of Natural Resources seeks to improve the availability of water resource information to communities where impact to these water resources is felt most.

The information presented in this summary is intended to increase awareness of how activities on land and in water have an influence on water resource quality and quantity.

The department greatly values local input and engagement regarding the mission of ensuring safe and ample water resources, and will continue to seek local guidance to further focus department efforts and funding strategies for the betterment of *Our Missouri Waters*.

Lower Missouri - Crooked Watershed

The State of Our Missouri Waters

Importance of Water Quantity and Quality

Water shortages can have severe and expensive consequences. Adequate water supplies are vital not only to human health and safety, but also to the prosperity of our state. Whether it is for crop irrigation, industrial manufacturing or power generation, water is at the core of human existence and sustainability. A few decades ago, the supply of water in Missouri was considered virtually unlimited. As population and industry have increased, a need for statewide water planning has emerged.

Water quality impairments can also have severe impacts on human health and the environment and be extremely expensive. Unfortunately and more importantly, many water quality impairments are only discovered once the consequences of poor water quality have been realized. For this reason, it is important that locals are involved in the protection of their water quality and quantity so as to prevent irreversible consequences.



Key Points

The Lower Missouri-Crooked Watershed drains an area of 2,698 square miles from portions of 11 counties in Missouri and one county in Kansas. The watershed contains both an urban corridor in two counties with the remaining portions of nine counties as rural areas. The surface of the basin is glacial till (a mixture of sediments left behind after a melting glacier) overlain by loess (a yellowish general uniform particle size of wind blown soil) between 8 and 32 feet. The loess deposits are deepest near the Missouri River. The agricultural uses are primarily located along the Missouri River corridor and radiating outward. The undeveloped lands are primarily used for hay and pasture sources. There are two high yield aquifers, the St. Francois and the Ozark aquifers, located under the region. The watershed also contains six mapped but unnamed springs as well. The water use is made up of 96 percent surface water and 4 percent groundwater. The watershed contains 62 community drinking water systems serving 1,062,000 people using both surface water and groundwater sources. There are 768 total wells located in the watershed with 652 as private wells.

The Lower Missouri-Crooked Watershed has 10 impaired waterbodies, three lakes and seven streams including the Missouri River. The impairments are mercury in fish tissue, bacteria, chloride and low dissolved oxygen. The majority of the permitted point sources are located in Jackson and Clay counties. The permit types are distributed as 52 percent land disturbance, 34 percent stormwater, 13 percent wastewater and 0.6 percent other types.

Watershed improvements consist of 106 stream team sites in the watershed, three 319 Soil and Water Conservation and Nonpoint Source Grants, six Source Water Protection Projects and Grants, and 94 percent of the Soil and Water Cost Share practices were for sheet, rill and gully erosion management.

Opportunities

Community Involvement

- Through education, advocacy and hands-on projects, communities, groups and individuals can be involved in and promote watershed improvement activities. Some examples include, watershed education for schools, litter control, tree planting, water quality monitoring and storm drain stenciling.

Education and Outreach

- Technical assistance providers are available for training and assistance regarding several topics such as source water protection, municipal drinking water loss, water main leak detection, asset management, water conservation planning and implementation, and I/I (inflow and infiltration) reduction.
- Training is also available to livestock operations and landowners regarding the benefits of alternate watering sources for livestock, improvements to land application practices, best management practices and associated cost-share programs.

Financial Assistance

- **Clean Water and Drinking Water State Revolving Funds** are available to build or improve municipal wastewater and drinking water infrastructure and support agricultural and urban projects such as improvements to urban runoff, wet weather flow, stormwater and sewer overflow issues, water reuse and conservation and alternative treatment projects.
- **319 Nonpoint Source Funds** are available to assist organizations with implementation of on-the-ground practices that control, reduce or manage nonpoint source pollution such as riparian buffer strips, detention ponds, limitation of animal waste to stream and sinkholes.
- **Source Water Protection Grants** and **Well Plugging Grants** are available to public water systems to support safe well abandonment procedures and source water protection implementation and planning efforts.
- A full list of department funding sources is available at <http://dnr.mo.gov/financial.htm>

Lower Missouri - Crooked Watershed

The State of Our Missouri Waters – Current Conditions and Trends

What is a Watershed?

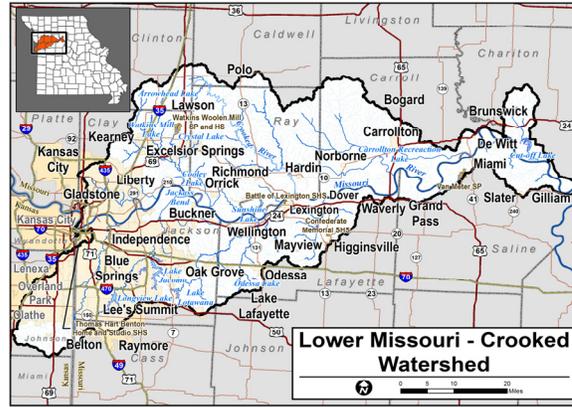
A watershed is an area of land defined by ridges, from which waters flow into a particular lake, river or wetland.

Basin Characteristics

- Drainage area of 2,698 mi²
- Includes portions of 11 counties in Missouri and 1 county in Kansas
- Part of the Missouri River system
- Population of 1.1 million
- The largest population resides in the Kansas City area of Jackson and Clay counties. There was steady growth in Cass (30 percent) and Clay (20 percent) counties from 2000 to 2010. Jackson, Johnson and Ray counties indicate moderate growth with Carroll, Chariton, Lafayette and Saline counties with no growth to a population decline expected to 2030.

Recreational Resources

There are six state parks managed by the Department of Natural Resources, Grand Pass Conservation Area in Saline County comprises 5,301 acres and is designated by Audubon. Missouri as an Important Bird Area for migratory birds and residential wildlife. Blue Springs Lake, Lake Jacomo and Longview Lake provide boating, camping and swimming.



Except in limited areas, where streams may incise Pennsylvanian aged rock, the surface of the basin is glacial till (sediments left by the glacier) between 8-32 feet. The loess deposits are deepest near the Missouri River. The depth of till is highly variable but is generally less than 100 feet in depth north of the Missouri and less than 50 feet in depth south of the Missouri. The till is predominantly clay with some rock and gravel intermixed with occasional sand lenses. Glacial sand and gravel may underlie the till. The glacial till deposits are underlain by cyclical (repetitive) deposits of shale, shaly limestone and sandstone and thin beds Pennsylvanian age coal beds. The clayey till and the underlying shales insure very little water infiltrates to the subsurface. Thus, almost all water movement in the basin is through the surface stream network and base flows to stream are very low during dry periods. Most of the water which does reach the subsurface will resurface locally when a stream valley incises the confining aquatard. The majority of the streams in the basin are gaining streams.

Land Use

The agricultural uses in the watershed are primarily located along the Missouri River corridor and radiating outward. This watershed is 1,727,417 acres and non-point source contributors are relevant to the overall health of the watershed. It should also be noted that the Kansas City area, in proximity to the Missouri River, Blue River, and Little Blue River, has a significant influence on stream conditions for the watershed. The areas of undeveloped land are primarily pasture and hay sources.

Water Resources

Surface Water

There are 25 lakes ranging in size from 55 to 1,003 acres. The watershed has 5,122 acres of lakes total. There are approximately 4,120 miles of streams in the Lower Missouri – Crooked watershed. Some of the larger streams are Missouri River, Blue River, Clear Creek, Crooked River, East Fork Crooked River, Fishing River, Indian Creek, Little Blue River, Sni-A-Bar Creek, Turkey Creek and Wakenda Creek.

Groundwater

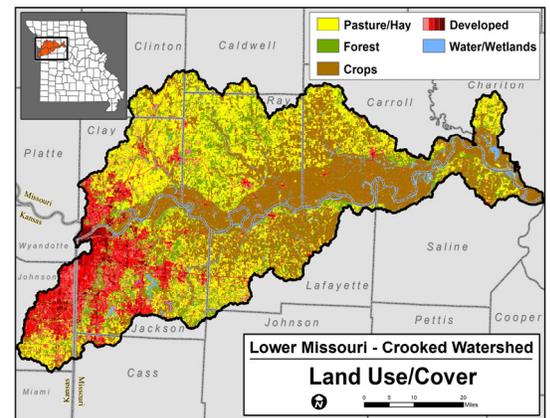
North of the Missouri River, there are no high-yield, potable bedrock aquifers available. Properly constructed wells producing from favorable locations in the drift-filled channels can produce several hundred gallons of water per minute, and are locally used for irrigation as well as public water supply. Alluvial deposits underlying the floodplains of the major rivers are a significant source of water for agriculture as well as public water supply. South of the Missouri River, there are two major aquifers that underlie this region, the St. Francois aquifer and the Ozark aquifer. The aquifer ranges in thickness from less than 200 feet to locally more than 700 feet thick, and averages about 500 feet in thickness. Most wells that are deep enough to produce from the St. Francois aquifer in this region also produce from the shallower and more prolific Ozark aquifer.

Springs

There are six mapped springs located in the watershed. All six are unnamed.

Geology/Hydrology

Except in limited areas, where streams may incise Pennsylvanian aged rock, the surface of the basin is glacial till (sediments left by the glacier) between 8-32 feet. The loess deposits are deepest near the Missouri River. The depth of till is highly variable but is generally less than 100 feet in depth north of the Missouri and less than 50 feet in depth south of the Missouri. The till is predominantly clay with some rock and gravel intermixed with occasional sand lenses. Glacial sand and gravel may underlie the till. The glacial till deposits are underlain by cyclical (repetitive) deposits of shale,

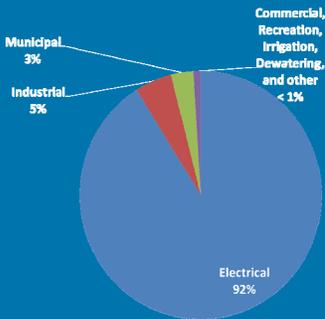


Lower Missouri - Crooked Watershed

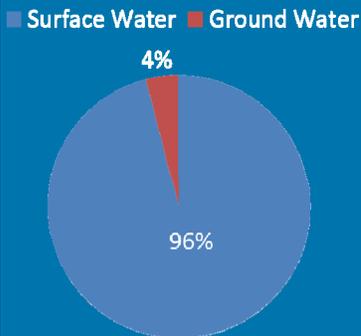
The State of Our Missouri Waters – Current Conditions and Trends

Climate and Water Availability

Estimated Annual Major Water Use by Category



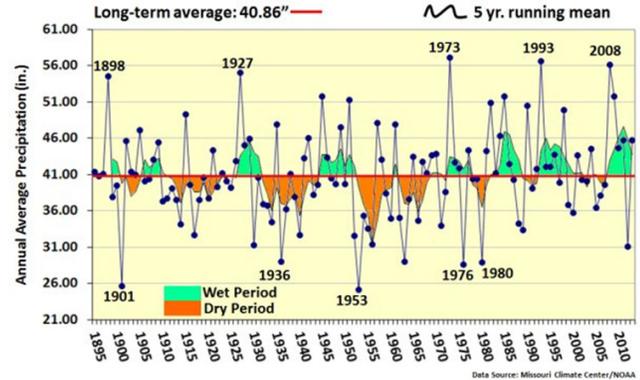
Estimated Annual Major Water Use by Source



Precipitation

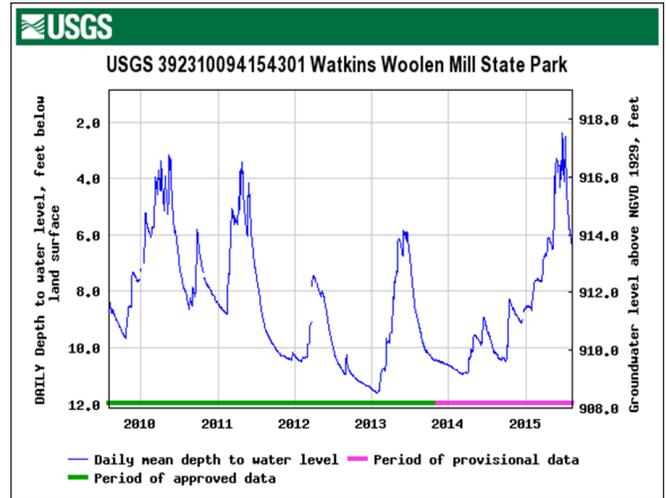
Annual precipitation totals reveals several wet periods have dominated since the early 1980s. This wet pattern has also been accompanied by an increasing trend of heavy precipitation events. Severe drought occurred during 2012, but this drought was brief compared to major multi-year droughts that occurred in the 1930s and 1950s. Tree ring analyses conducted in Missouri and historic observation data show periods of multi-year severe droughts in Missouri's history, indicating that extended dry periods are likely to occur in the future.

Missouri Annual Average Precipitation (1895-2013)



Groundwater Levels

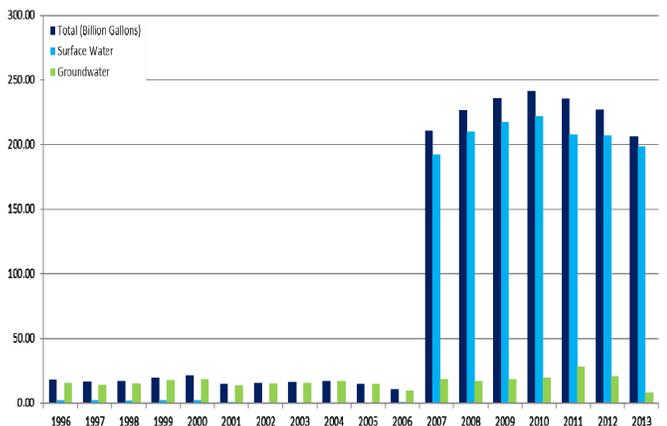
There are 5 groundwater monitoring wells in this watershed; Carrollton, Independence, Atherton, Watkins Woolen Mill State Park, and Van Meter State Park. The hydrograph represents the water levels at the Watkins Woolen Mill monitoring well. The graph highlights short periods of drought, such as the 2012 drought can cause groundwater to quickly change. The 2015 data highlights the rate of recovery of the water level from the pre-2012 levels. There are currently 26 stream gages operating in the watershed that measure the average stream flow. Three of these gages are located on the Missouri River.



Water Use Characteristics

A major water user is defined as the capacity to withdraw more than 70 GPM (gallons per minute) or 100,000 GPD (gallons per day). In 2013 there were 33 major users in the watershed with 133 wells and 17 surface water intakes. 198.4 billion gallons of water was used from surface water. Of that total, 91.6 percent was used by electrical industries.

Historical Water Use Lower Missouri - Crooked Watershed



Lower Missouri - Crooked Watershed

The State of Our Missouri Waters – Current Conditions and Trends

Protection of Our Natural Resources

The department exercises authority under Missouri's Clean Water Law to regulate point sources of pollution. When point sources are known or discovered, the department issues permits for these sources to limit the amount of certain water contaminants that may be discharged into the water body.

The department also has resources to help people proactively plan to protect water resources, such as:

- Source Water Protection Plans for drinking water sources
- Section 319 funding for watershed planning and projects
- Funding to plan for source water protection
- Soil and Water Conservation funding
- State Revolving Fund grants and loans for community drinking water and wastewater improvements

A full list of department funding sources is available at dnr.mo.gov/financial.htm

It is important to note that resources are limited and local involvement, in determining most critical and effective focus areas, is invaluable.

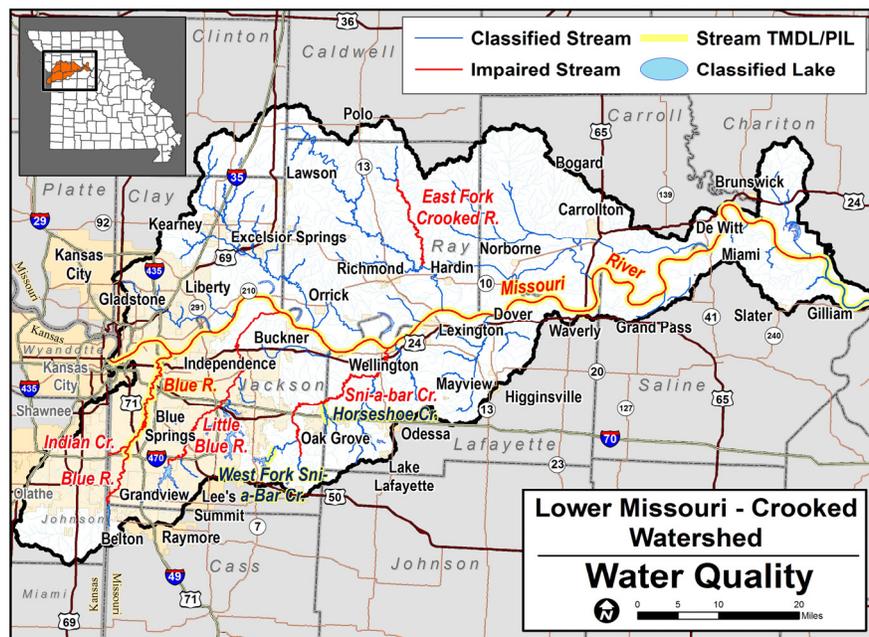


Watershed Protection

Water Quality Impairments

Section 303(d) of the federal Clean Water Act requires each state identify waters that do not meet water quality standards and for which adequate water pollution controls are not in place. These identified waters are considered impaired. Water quality standards protect beneficial uses of water such as whole body contact (e.g. swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife.

The following lakes and streams within the watershed are listed on the State's 2014 List of impaired waterways and are presented on the adjacent map: Blue River (Bacteria), Chaumiere Lake (Mercury in Fish Tissue), East Fork Crooked River (Low Dissolved Oxygen), Horseshoe Creek (Low Dissolved Oxygen), Indian Creek (Bacteria & Chloride) Little Blue River (Bacteria), Lake of the Woods (Mercury in Fish Tissue), Longview Lake (Mercury in Fish Tissue), Missouri River (Bacteria), Sni-a-bar Creek (Low Dissolved Oxygen). Impairments can be caused by known sources like point or nonpoint source pollution, or may be unknown; however, identifying activities near impaired water bodies can provide key information in determining the sources of contamination as well as developing solutions for impaired waters.



Section 303(d) of the federal Clean Water Act requires each state identify waters that do not meet water quality standards and for which adequate water pollution controls are not in place. These identified waters are considered impaired. Water quality standards protect beneficial uses of water such as whole body contact (e.g. swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife.

The department realizes that some impaired waters are also sources of drinking water and ensures that regulated facilities are permitted to treat these waters such that they are suitable for human consumption. As mentioned previously, the department also has regulatory authority over point sources; however, local voluntary action is needed to address nonpoint sources.

Lower Missouri - Crooked Watershed

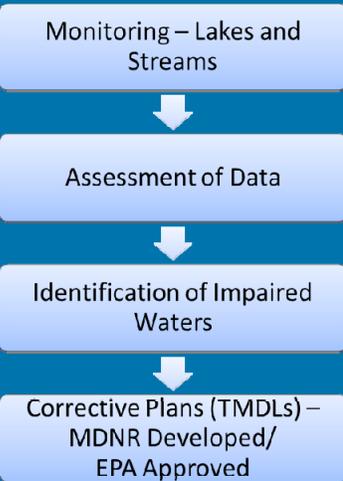
The State of Our Missouri Waters – Current Conditions and Trends

Watershed Protection

General Water Quality Criteria

A water body is considered impaired if it does not meet water quality standards that specifically protect its beneficial uses, such as drinking water, recreational uses and fish or other aquatic life health.

Missouri's Process to Improve Water Quality



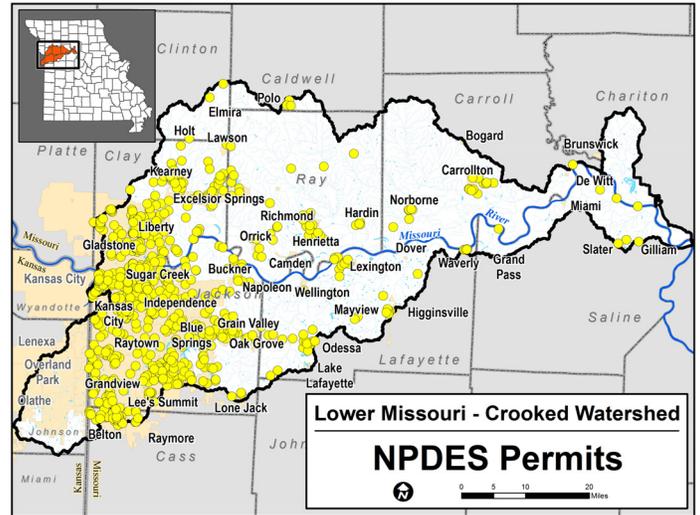
NPDES:

National Pollutant Discharge Elimination System. In Missouri, NPDES permits are also known as Missouri State Operating (MSOP) permits.

Total Maximum Daily Loads (TMDL)

A TMDL is a mathematical calculation of the maximum amount of a pollutant that a water body can absorb and still meet water quality standards. A TMDL study identifies the potential or suspected pollutant sources in the water and allocates the allowable pollutant load among these sources. It also includes an implementation plan to identify how the load will be reduced to a level that will protect water quality. In this watershed, two TMDLs and one permit-in-lieu of a TMDL have been written. The permit-in-lieu addresses a specific facility discharge to Horseshoe Creek and has been implemented with stricter permit limits and conditions. A chlordane TMDL was written for the Blue River and addresses legacy pollutant loads from this pesticide. This substance was banned in 1988 and reductions are expected to occur naturally. The Department of Health discontinued its fish advisories associated with this pollutant in 2001. The second TMDL was written for West Fork Sni-a-Bar Creek and addresses biochemical oxygen demand and suspended solids from a specific point source discharger in the watershed. Adherence to stricter permitting conditions is expected to result in attainment of water quality standards.

In addition, a TMDL has been completed for the entire length of the Missouri River bordering Missouri that addresses water quality impairments caused by chlordane and PCBs in fish tissue, a human health concern associated with fish consumption. This watershed drains to a segment of the Missouri River that is subject to this TMDL. Since these chemicals have been banned and are no longer manufactured, no specific implementation plans have been established, other than continued collection and proper disposal of existing chemicals. Pollutant reductions leading to improved water quality and attainment of beneficial uses are expected to occur naturally over time. More information about these various TMDLs can be found online at <http://dnr.mo.gov/env/wpp/tmdl/>.

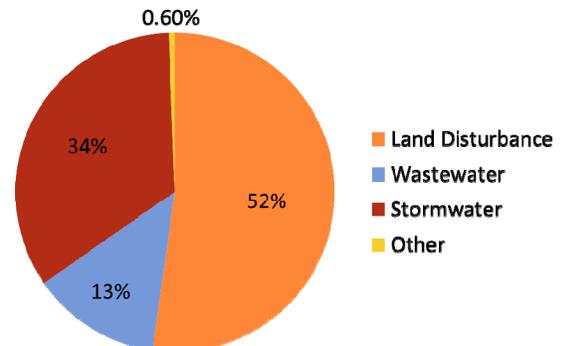


Regulated Point Sources

The department regulates point sources by issuing permits that prescribe conditions of operating the point discharge and limit the discharge of water contaminants. In addition, the department inspects regulated facilities and analyzes water samples to ensure the facilities are not polluting waters. It's also important that communities look to the future for watershed planning in order to maintain awareness of wastewater treatment types, their impacts and upcoming regulations.

The following graphics illustrate the type and distribution of permitted sites in the Lower Missouri Crooked watershed.

Distribution of Permit Types



Lower Missouri - Crooked Watershed

The State of Our Missouri Waters – Current Conditions and Trends

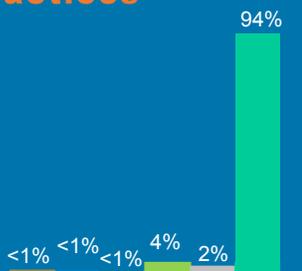
Local Watershed Improvements

Local Awareness

Is it safe to fish or swim in the nearby stream? Does the stream provide habitat suitable for fish? What does it cost to make this water potable? Will I have enough water during a drought?

Impacts to water quality and quantity are most critical to local communities; however, impacts are often not realized until a dire situation arises as a result of poor water quality or quantity. Local awareness and involvement can lead to pollution prevention and reduction, water supply sustainability and can give communities the upper hand in protecting, preserving and enhancing local water supplies for generations to come.

2014 Conservation Practices



- Animal Waste Management (0%)
- Cover Crops
- Grazing Management
- Irrigation Management
- Nutrient and Pest Management
- Sensitive Areas
- Sheet, Rill, and Gully Erosion
- Woodland Erosion (0%)

Missouri Stream Team and Volunteer Water Quality Monitoring

Missouri Stream Teams strive to gain and share knowledge regarding the state's stream systems and the problems and opportunities they face. The Missouri Stream Team Program is a partnership between the departments of Natural Resources and Conservation as well as the Conservation Federation of Missouri and the citizens of Missouri. Besides improving stream conditions, Stream Teams often provide useful data in targeting areas that should be monitored more closely for impairments. The Missouri Stream Team Watershed Coalition has compiled and reported monitoring data which demonstrates the importance of watershed protection, preservation and enhancement by local communities. (image from <http://mstwc.org/who-we-are/vision-mission-goals/>)



The Volunteer Water Quality Monitoring Program is one of the most popular activities of the Missouri Stream Team Program. Stream Team volunteer monitors have provided data from 106 sites.

Soil and Water Conservation and Nonpoint Source Grants (319 Grants)

Over the last five years, the department has provided several watershed project grants to local communities to improve water quality through reduction of nutrient and sediment loads and deposition, rehabilitation and removal of failing or neglected septic systems, watershed management planning, water quality monitoring, incentivized soil conservation practices, education/outreach efforts and other activities. These grant projects have included: 319-McCroskie Creek Watershed Project with the Carroll County Soil and Water Conservation District, 319-Kansas City Metropolitan Water Quality Initiative with the Mid America Regional Council, and 319-Big River Stewardship and Education Initiative with the Living Lands and Waters.

Source Water Protection Projects and Grants

This voluntary program is designed to assist public water systems and the communities they serve with developing local voluntary source water protection plans to protect their source of drinking water from existing or additional contamination sources. Participating public water systems include: Carroll Co. PWSD #1 (wells), Carrollton (wells), Hardin (wells), Higginsville (Higginsville South Lake and Missouri River), Independence (wells), Liberty, and Unity Village (two lakes) have received source water protection/wellhead protection grants.

Well Plugging Grants

As part of Source Water Protection, the department offers grants to plug abandoned wells. Inactive wells can act as a direct conduit for pollutants to enter our water sources. Safely closing these wells is another layer of protection for pollution prevention.

Soil and Water Conservation Cost Share Programs

Soil and Water Conservation Districts set goals for conservation issue concerns. These practices are funded and implemented to help districts meet their resource conservation goals, which conserves soil and improves water quality by reducing sedimentation in our rivers and streams. The chart on the left illustrates the number of practices implemented for each concern in the watershed from 2009 to 2014, relative to the total number of practices for this watershed. No irrigation management practices were implemented during this time. District funding requests for FY15 show that grazing management and sheet, rill and gully practices are most prevalent.

Lower Missouri - Crooked Watershed

The State of Our Missouri Waters

Contact Information for this Watershed

Missouri Department
of Natural Resources
Kansas City Region
Watershed Coordinator
Crew Schuster
500 NE Colbern Road
Lee's Summit, MO 64086
816-251-0798

Or visit the Web at
dnr.mo.gov/omw

Resources

Education and Outreach Resources include:

Missouri Department of Natural Resources' Our Missouri Waters dnr.mo.gov/omw

Missouri Department of Natural Resources Financial Assistance Opportunities
<http://dnr.mo.gov/pubs/financial-asst-brochure-2014.pdf>)

Natural Resources Conservation Service (NRCS) <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/>

Missouri Rural Water Association (MRWA) <http://www.moruralwater.org/training.php>;
<http://www.moruralwater.org/tools.php>; <http://www.moruralwater.org/dlcenter/>

Missouri Public Utilities Alliance (MPUA) <http://www.mpu.org/Training.php>; http://www.mpu.org/Untitled_Page_4.php

EPA Region 7 Environmental Finance Center (EFC) http://webs.wichita.edu/?u=HUGOWALL&p=/Centers_Research/Environmental_Finance_Center/

Funding Resources include:

Natural Resources Conservation Service (NRCS) <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/>

United States Department of Agriculture Rural Development (USDA-RD) <http://www.rurdev.usda.gov/ProgramsAndOpportunities.html>

Missouri Department of Economic Development (DED) <http://www.ded.mo.gov/BCS%20Programs/BCSProgramDetails.aspx?BCSProgramID=10>; <http://www.ded.mo.gov/Community/InfrastructureAssistance.aspx>

References

2010 Census data (<http://www.census.gov/>)

Center for Applied Research and Environmental Systems (<http://www.cares.missouri.edu/>)

Department of Natural Resources' Groundwater Level Observation Well Network Page (<http://dnr.mo.gov/env/wrc/groundwater/gwnetwork.htm>)

Department of Natural Resources' Missouri State Water Plan Series, Surface Water Resources of Missouri, 1995, Groundwater Resources of Missouri, 1996. (<http://dnr.mo.gov/env/wrc/statewaterplanMain.htm>)

Department of Natural Resources' Source Water Protection Program Page (<http://dnr.mo.gov/env/wpp/pdwb/swpp.htm>)

Department of Natural Resources' Major Water Users Page (<http://dnr.mo.gov/env/wrc/mwu-forms.htm>)

Missouri Stream Team Program Website, (<http://www.mostreamteam.org/aboutTeams.asp>)

Missouri Stream Team Watershed Coalition Website, (<http://mstwc.org/>)

Multi-Resolution Land Characteristics Consortium, 2011 and 2001 National Land Cover Database, (<http://www.mrlc.gov>)

Missouri Climate Center, (<http://climate.missouri.edu/modata.php>)

U.S. Army Corps of Engineers, Southwest Missouri Water Resource Study—Phase I. Sept. 2012 (http://tristatewater.org/?page_id=12)

Guinan, Pat, State Climatologist, MU Extension, Missouri Climate Center, (<http://climate.missouri.edu/modata.php>)