United States Department of Agriculture
Natural Resources Conservation Service

Lower Missouri - Crooked River Watershed

HUC # 10300101

RAPID WATERSHED ASSESSMENT

USDA NRCS
601 Business Loop 70 West
Parkade Center, Suite 250
Columbia, MO 65203

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A rapid watershed assessment (RWA) evaluates resource conditions and needs on an 8-digit hydrologic unit (HU) basis. The assessment identifies the primary resource concerns for the watershed being profiled and provides estimate as to where conservation investments would best address the concerns of landowners, conservation districts, stakeholders, and others. The RWA provides information on which to base decisions about conservation priorities, allocation of resources, and funding for implementation.

Introduction[1]

The Lower Missouri – Crooked River Sub-basin (HU 10300101) extends across portions of Caldwell, Carroll, Cass, Clay, Chariton, Clinton, Jackson, Lafayette, Johnson and Saline counties in west central Missouri, as well as two counties in east central Kansas. The part of the sub-basin in Missouri covers approximately 2,588 square miles (1,656,320 acres) or 94 percent of the entire sub-basin.

Straddling the Missouri River, the drainage area extends eastward from Kansas City on its western edge to Howard County in central Missouri. Here, the Missouri River alluvial plain drastically narrows as the river begins its eastern traverse across the northern fringes of the Ozark Highlands to the Mississippi River just north of St. Louis, Missouri.

The northern third of the sub-basin is moderately broad to gently rolling dissected plains with local relief decreasing away from the rugged, loess capped hills along the Missouri River alluvial plain. Compared to the Grand River sub-basin to the north, there is less glacial till and existing deposits thin rapidly from east to west. Land use transitions from predominantly cool-season pastures on the west side to a mix of cultivated crops and pastureland covering the eastern portion.

Figure 1. Location of the Lower Missouri - Crooked River Sub-basin in Missouri and in relationship to the Upper Midwest Region.

The central third of the sub-basin consists of the alluvial plain and channel of the Missouri River covered with fine textured, poorly drained soils. The narrow western end of this alluvial plain, originally heavily forested with scattered wetland prairies, is now a mix of urban development and cropland. The alluvial plain broadens extensively from south-central Ray County to the confluence of the Missouri and Grand Rivers. Bounded by low bluffs, these broad bottoms, once covered with wet prairies and marshland, are now levied and intensively row cropped. The eastern portion of the alluvial plain is narrower and the historic mix of wet prairies and bottomland forests has given way to cropland and several large public wetland areas.

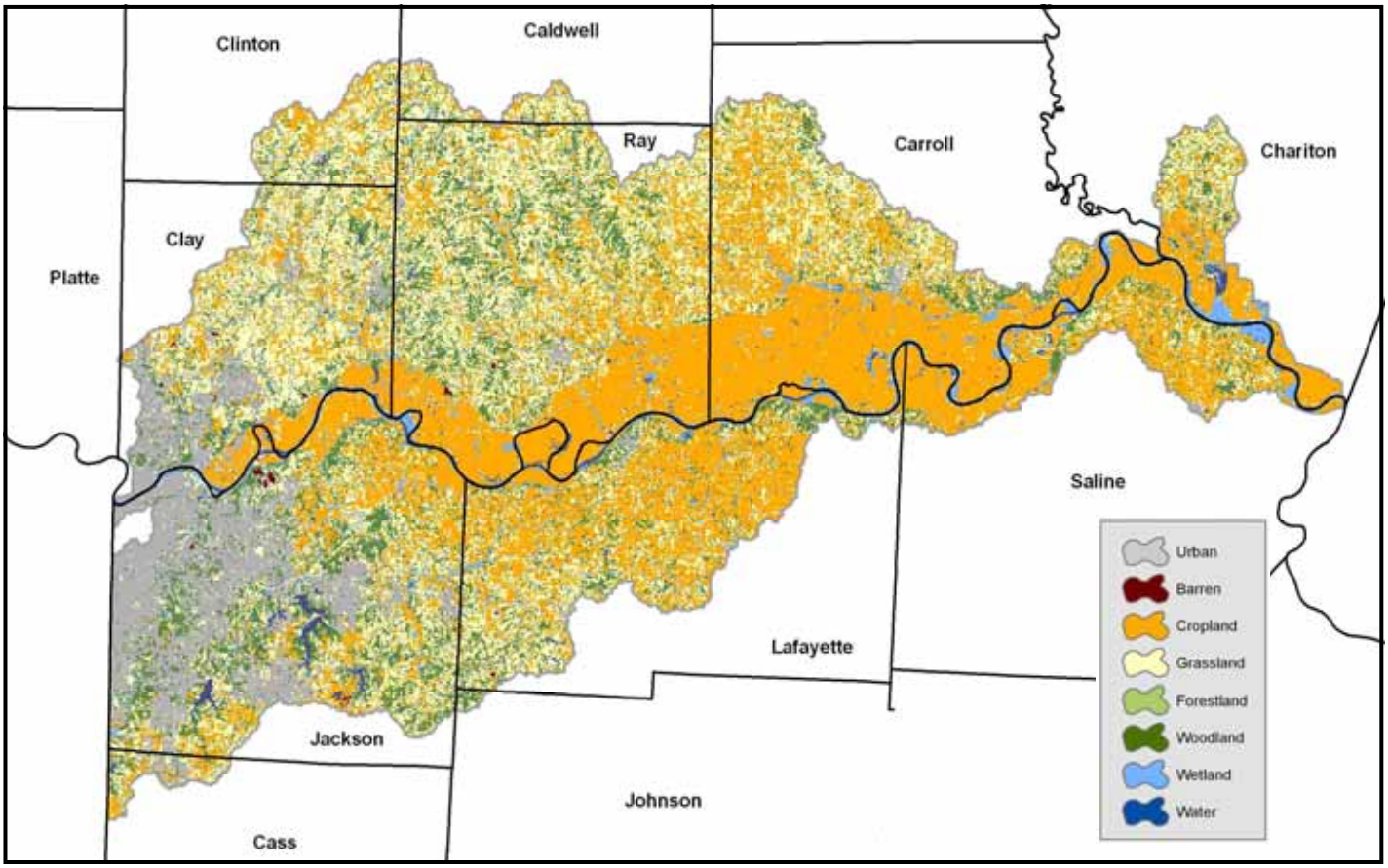
The southern third of the sub-basin is situated between the Missouri River and the Blackwater River drainage. From the narrow strip of steep sloped, loess covered hills on its northern edge, with local relief exceeding 200 feet, the topography flattens out into a minimally dissected loess covered plain with broad shallow valleys and local relief averaging less than 75 feet. The pre-European settlement prairies once dominating the landscape are now predominantly cropland.

Although the Kansas City metropolitan area forms the gateway to the sub-basin at its upper end, the watershed is still predominantly rural in character. Cultivated cropland accounts for 41 percent of the sub-basin's land area. Soybeans lead in crop acreage followed by corn. Forage crops are predominantly cool-season pastures and hayland covering 24 percent of the sub-basin. Forest land, much of it second growth, covers 13 percent of the sub-basin. Fourteen percent of the sub-basin's area is developed. Cattle, hogs and horses dominate livestock production.

Physical Description

A. Land Use/ Land Cover and Percent of Sub-Basin in Each County

Figure 2



Land Use/ Land Cover NRI[2]	Urban	Cultivated cropland	Conservation Reserve Program	Non-cultivated cropland	Pastureland	Forest land	Minor land cover/uses	Water	Federal land cover/use not recorded
1982 Acres, % of Area	187,700 11%	760,200 46%	0 0%	68,800 4%	364,500 22%	190,100 11%	38,100 2.3%	36,500 2.2 %	10,700 0.6%
1987 Acres, % of Area	205,600 12%	755,000 46%	12,000 1%	58,000 4%	341,800 21%	198,100 12%	36,900 2.2%	40,000 2.4%	9,200 0.6%
1992 Acres, % of Area	216,200 13%	690,100 42%	43,300 3%	77,800 5%	343,300 21%	198,000 12%	39,400 2.4%	40,400 2.4%	8,100 0.5%
1997 Acres, % of Area	235,900 14%	674,900 41%	41,800 3%	92,300 6%	318,000 19%	208,500 13%	35,900 2.2%	40,500 2.4%	8,800 0.5%
Total Gain or Loss from 1982 to 1997 Acres, % of Area	**48,200 26%**	**(85,300) -11%**	**41,800 N.A.**	**23,500 34%**	**(46,500) -13%**	**18,400 10%**	**(2,200) -6%**	**4,000 11%**	**(1,900) -0.18%**

B. Grassland[2]

	Hayland (acres)			Pastureland a(cres)			Other Farmland (acres
Year	Grass	Legume	Legume-Grass	Grass	Legume	Grass-Forbes-Legume Mix	CRP
1997	94,000	900	10,600	249,500	-	77,000	41,800

C. Crop History[2]

	Close Grown Crops (acres)			Row Crops (acres)				General (acres)	
Year	Oats	Wheat	All Other	Corn	Sorghum	Soybeans	Double Cropped	Cultivated	Non-Cultivated
1982	5,000	161,500	2,700	167,500	17,800	369,800	58,800	760,200	68,800
1987		89,100		142,200	11,900	428,000	10,600	755,000	58,000
1992		112,300		139,700	16,800	373,000	36,600	690,100	77,800
1997	4,800	66,500		205,100	3,800	351,400	4,900	674,900	92,300

D. Public Land[3]

About 25,611 acres or 1.6% of the sub-basin are in public ownership. These public lands include 20 conservation areas, 6 river accesses, 2 state parks and 3 units of the Big Muddy National Wildlife Refuge. The region falls well below the state average of 6.7% public ownership but is typical of sub-basins that are not in the Ozark Highlands.

Public Land Ownership (acres)								
	City of Excelsior Springs	Jackson Co. Parks and Recreation	Kansas City Parks and Recreation	Missouri Department of Conservation	Missouri Department of Natural Resources	National Park Service	US Fish and Wildlife Service	Other
Total Acres	16.4	21.9	85.9	12,149.7	2,644.1	3.0	10,113.8	317.0

E. Soil Capability

Land Capability[2]

Land Capability is a classification system used to identify the erosion potential of farmland. For over forty years the USDA has used land capability classification as a planning tool in laying out conservation measures and practices to farm without serious deterioration from erosion or other causes. The current system includes eight classes of land designated by Roman numerals I through VIII. The first four classes are arable land--suitable for cropland--in which the limitations and the need for conservation measures and management increase from I through IV. The remaining four classes, V through VIII, are not to be used for cropland, but may have uses for pasture, range, woodland, grazing, wildlife, recreation, and aesthetic purposes.

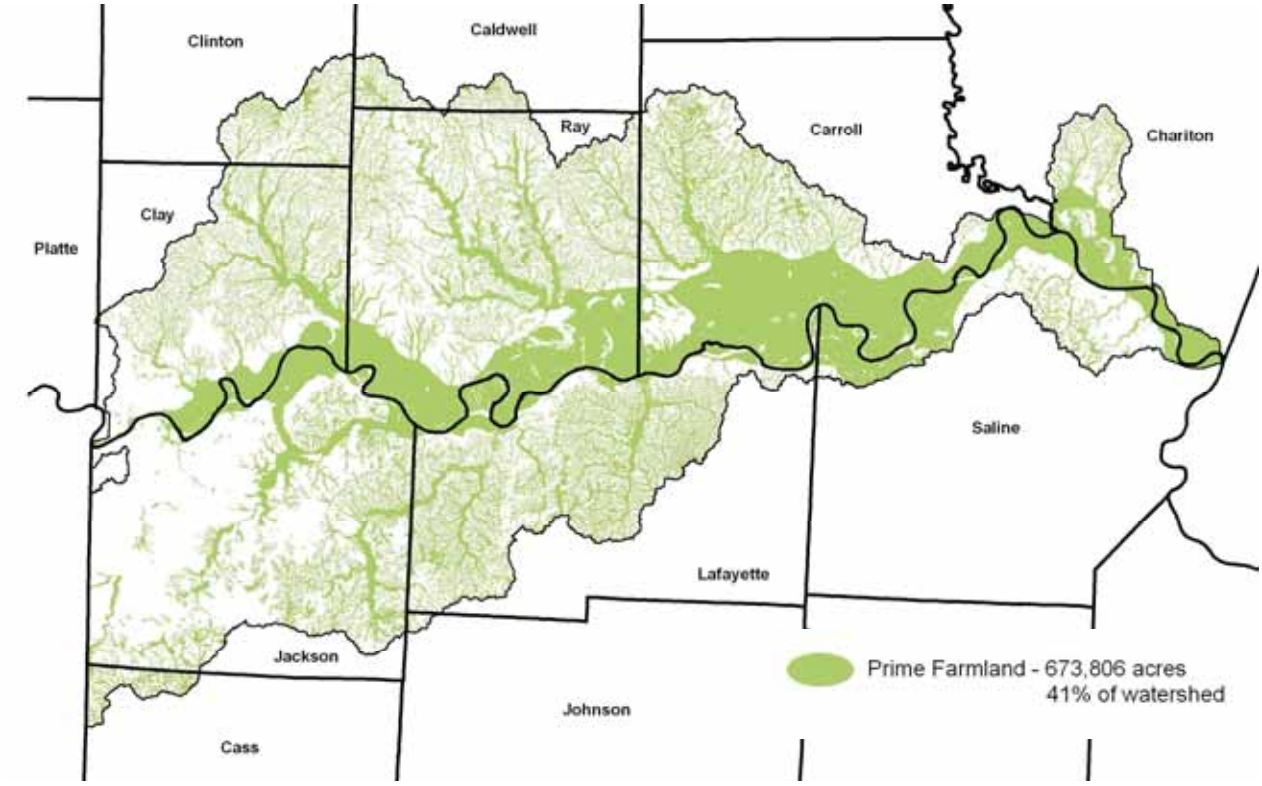
Figure 3

Land Capability Class	Cultivated cropland (acres, % of area)	Non-cultivated cropland (acres, % of area)	Pastureland (acres, % of area)
I - slight limitations	50,800, 8%	600, 1%	4,700, 1%
II - moderate limitations	373,300, 55%	28,000, 30%	77,600, 24%
III - severe limitations	231,700, 34%	54,000, 59%	173,600, 55%
IV - very severe limitations	13,900, 2%	6,300, 7%	37,600, 12%
V - no erosion hazard, but other limitations	-	-	1,100
VI - severe limitations, unsuited for cultivation, limited to pasture, range, forest	2,600, 0%	3,400, 4%	15,700, 5%
VII - very severe limitations, unsuited for cultivation, limited to grazing, forest, wildlife	2,600, 0%	-	7,700, 2%
VIII - misc. areas have limitations, limited to recreation, wildlife and water supply	-	-	-
Total	**674,900 acres**	**92,300 acres**	**318,000 acres**

Prime Farmland[4]

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Figure 4. Prime Farmland in the Lower Missouri-Crooked River



Prime Farmland[2] **Change in Acres from 1982 to 1997**	
1982	715,000 acres
1997	698,500 acres
Difference	**(16,500) acres**

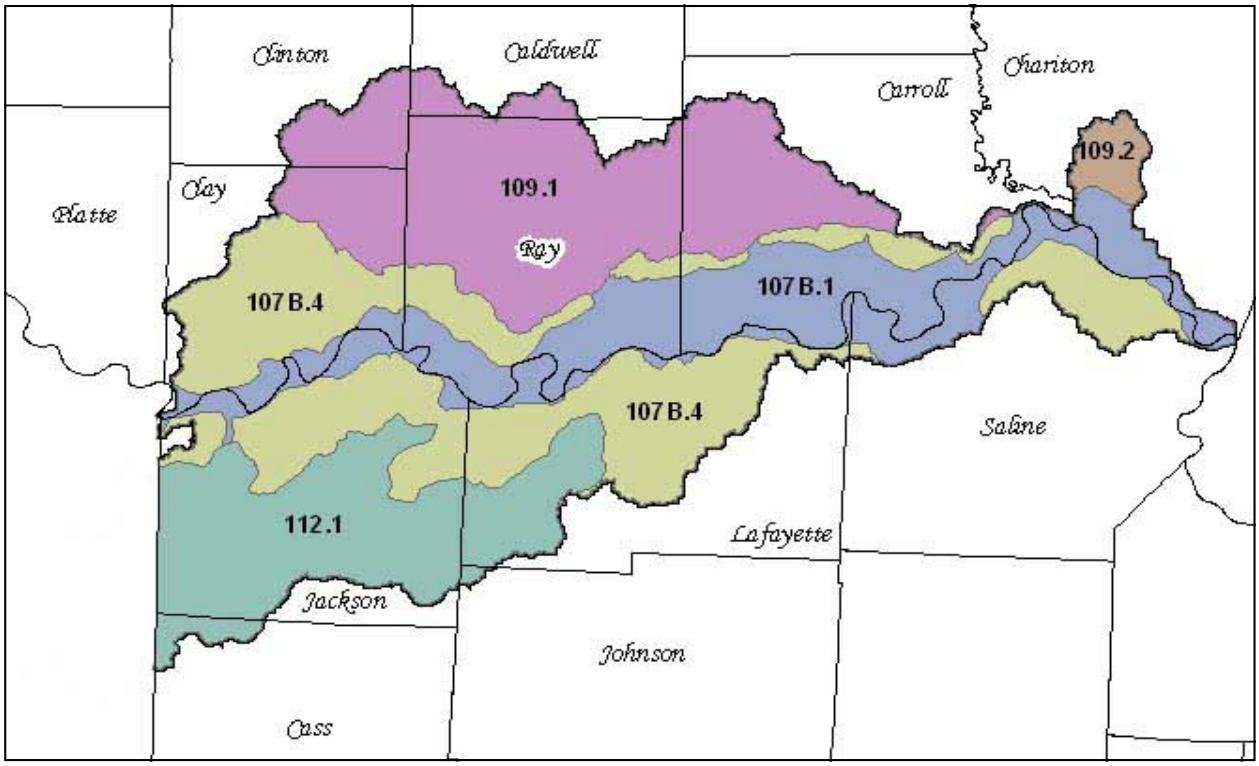
F. Common Resource Areas[6]

NRCS has divided the Nation into ecological type land regions called Major Land Resource Areas (MLRA). MLRAs are defined by their agricultural potential and soils capabilities and provide a spatial framework for addressing national and regional agricultural issues. A Common Resource Area (CRA) is a geographic and ecologic subdivision of an MLRA within which there are similar resource concerns and treatment requirements.

Each Missouri CRA is a grouping of Land Type Associations (LTA) taken directly from the state's ecological classification system (ECS). Missouri's LTAs are primarily differentiated on the basis of local climate, landforms and topography, geologic parent materials, soil types and potential vegetation.

The Lower Missouri – Crooked River Sub-basin occupies portions of MLRA 107B, MLRA 109 and MLRA 112.

Figure 5. Common Resource Areas in the Lower Missouri-Crooked River Sub-basin



107B.1 – Missouri River Alluvial Land

The Missouri River Alluvial Land CRA consists of the nearly level to gently sloping bottomland and channel of the Missouri River and the Lower Grand River. Native vegetation was largely wet prairie and marshes, with narrow bands and isolated pockets of bottomland forest. The Missouri River channel, which formerly meandered, has been stabilized, narrowed and confined by levees. The major land use is cropland with corn and soybeans being the major crop. Resource concerns are wind erosion, water management and water quality.

107B.4 – Missouri Loess Hills

The Missouri Loess Hills CRA is distinguished by a thick loess mantle (10-25 feet) and loess soils. It is a hilly region characterized by broad, rounded ridges, moderate slopes, broad stream valleys and a local relief of 100-150 feet. Bedrock and glacial till are exposed in the deeper valleys. Most of the CRA is farmed, but substantial tracts in the breaks along the Missouri River are thickly wooded.

109.1 – Grand River Hills

The Grand River Hills CRA is gently undulating to steep, dominantly pre-Illinoisan glacial till with a thin cover of loess. Native vegetation was prairie and timber, spatially associated with the pattern of ridges and valleys. The less sloping areas are in cropland, hayland and pasture. Corn and soybeans are the major cash crops. Pastures and woodlands dominate on the more sloping lands. Resource concerns are water erosion, nutrient management, pasture and woodland management and water quality.

109.2 – Chariton River Hills

The Chariton River Hills CRA is gently sloping to hilly formed mostly in glacial till with a thin covering of loess with broad alluvial plains. Native vegetation was a mosaic of upland and wet prairies, savannas and timbered slopes. The less sloping areas are in cropland, hayland and pasture. Corn and soybeans are the major cash crops. Pastures and woodlands dominate on the more sloping lands. Resource concerns are water erosion, nutrient management, pasture and woodland management and water quality.

112.1 – Scarped Osage Plains

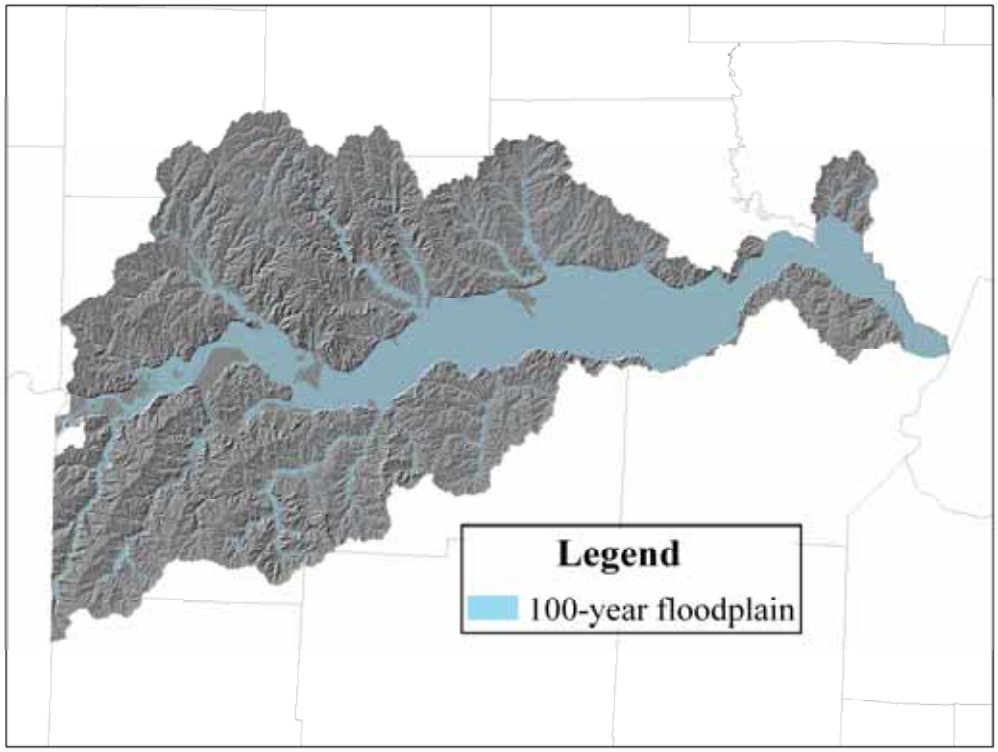
The Scarped Osage Plains CRA is a smooth plain interrupted by low, ragged escarpments trending southwest-northeast in which limestone bedrock is regularly exposed. Local relief reaches 150 feet in the escarpment zones but elsewhere averages less than 100 feet. Valley bottoms are exceptionally broad for the size of the streams. Geologic parent materials are mainly thin-bedded Pennsylvanian limestones and shales. Pre-settlement vegetation was mostly prairie, with belts of scattered timber along limestone scarps and valleys. Most of the land is farmed, both pasture and cropland. The Kansas City metropolitan area exerts urbanization pressure on the land use in the northwest.

G. Streams

Floodplains[7]

The Federal Emergency Management Agency (FEMA) maps areas of flood vulnerability. In the subbasin, 432,838 acres (27%) fall within the 100-year return period flood areas. This constitutes a hydrologic event having a one percent chance of occurring in any given year. Therm “100-year floodplain” is often misinterpreted to mean that this frequency of flooding only occurs every 100 years.

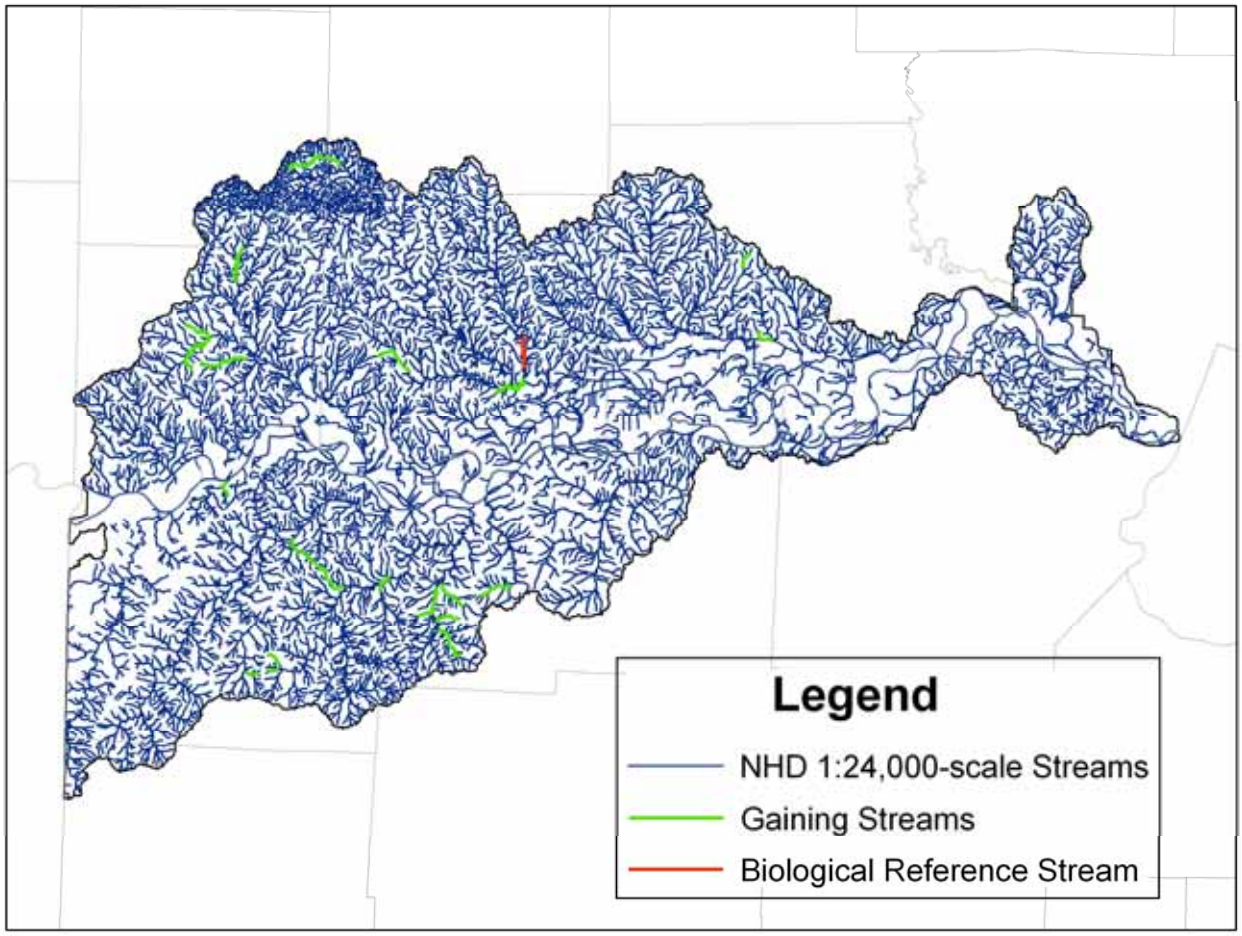
Figure 6



National Hydrography Dataset (NHD) with Gaining Streams and Biological Reference Streams [8]

High-resolution (1:24,000-scale) streams from the National Hydrography Dataset total 6,072 miles of intermittent and perennial streams in this sub-basin. Seventy-eight (78) miles of streams are considered gaining streams and there are no designated losing streams. Stream segments are classified 'gaining' or 'losing' by the Missouri Department of Natural Resources (MoDNR), Division of Geology and Land Survey (DGLS). The classification depicts sections of streams which are either losing water flow to the subsurface or gaining water flow from the subsurface, based on change in flow rate over a set distance. MoDNR also designates biological reference streams for watersheds. Biological reference streams are segments of streams that represent the best stream conditions to support aquatic life for a given area. A 4-mile stretch of East Fork Crooked River is the biological reference stream in this sub-basin.

Figure 7



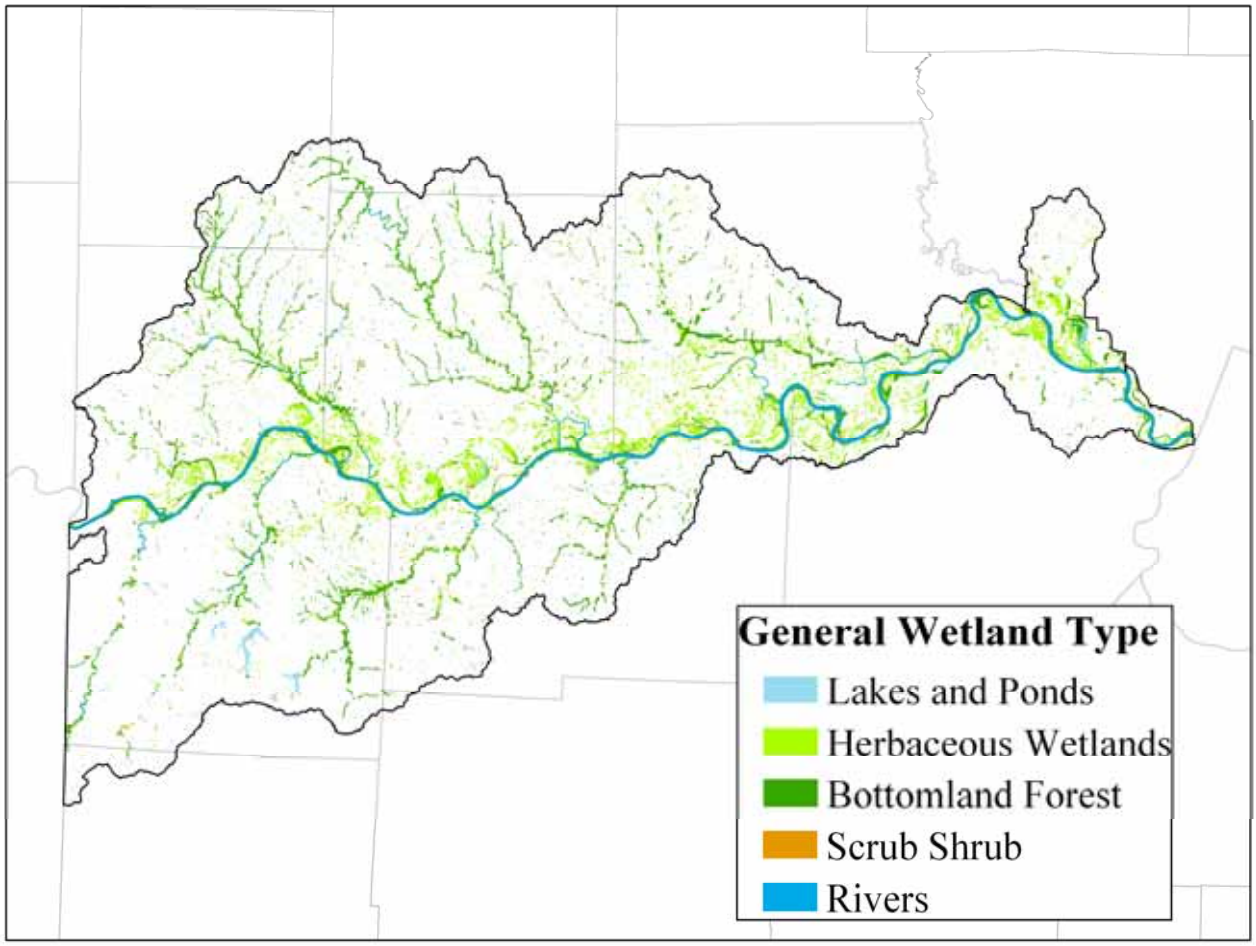
H. Wetlands[9]

Wetlands consist of land surface areas that are flooded or saturated by surface or ground water often enough to support plant and animal lifeforms that are adapted for life in wet environments.

The National Wetland Inventory delineated wetlands from early 1980s aerial photography and classified the wetlands using a wetland classification scheme developed by Cowardin, et al. The inventory identifies 88,521 acres of various wetland types within the Lower Missouri - Crooked River Sub-basin.

General Wetland Type	Acres	Percent of Sub-basin
Lakes and Ponds	16,369	1%
Herbaceous Wetlands	24,064	1.5%
Bottomland Forests	27,994	1.7%
Scrub Shrub	1,187	0.07
Rivers	18,907	1.2%
Total	**88,521 acres**	**5.47%**

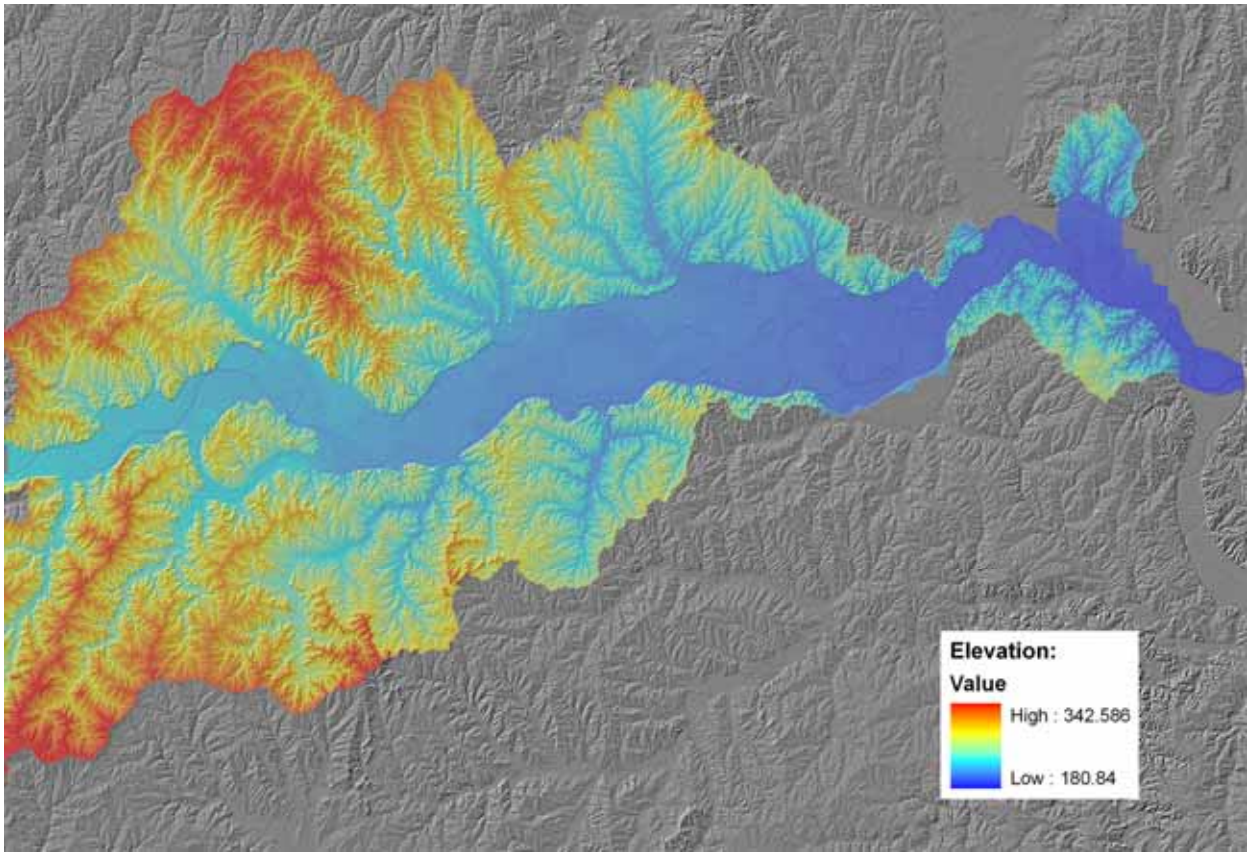
Figure 8



I. Relief Map[10,11]

This shaded relief map of the sub-basin depicts elevation above sea level. The shaded relief and elevation values are derived from digital elevation models generated from United States Geological Survey 7.5 minute elevation contours. The sub-basin's local relief varies from less then 10 feet on the Missouri River alluvial plain to over 200 feet in the rugged hills bordering the entire length of the Missouri River's course across the sub-basin. To the south of the Missouri River, the steep slopes of the river hills give way to broadly flat to gently rolling plains averaging less than 75 feet in local relief. To the north of the Missouri River, the river hills topography transitions to a gently rolling plain with local relief ranging from 80 to 150 feet.

Figure 9

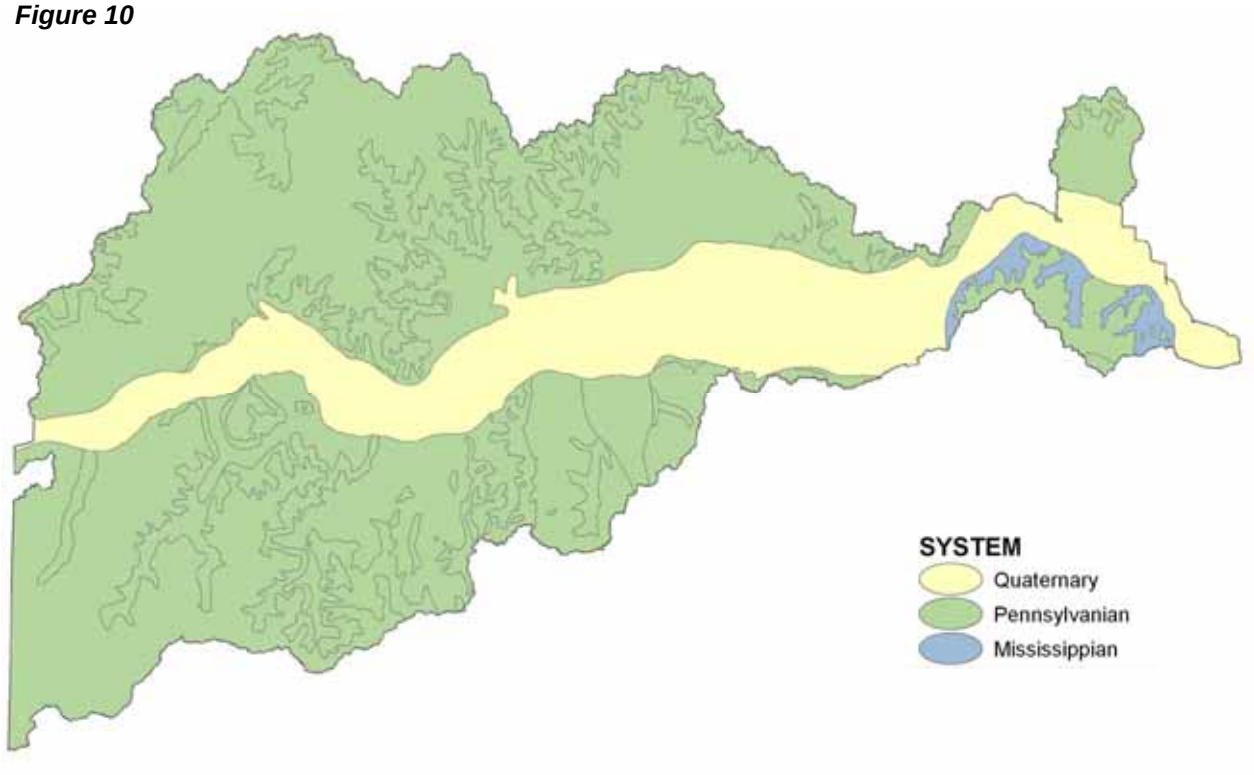


J. Geology[12,13]

Geology Map

This bedrock geology map is derived from the Geologic Map of Missouri. The Lower Missouri-Crooked River sub-basin, like much of western and northern Missouri, is dominated by Pennsylvanian-age bedrock formations dipping northwestward, away from the Precambrian and Ordovician formations dominating the Ozarks. A much younger, quaternary-age, alluvial formation defines the Missouri River floodplain across the middle of the sub-basin.

Figure 10



Bedrock units in the Lower Missouri-Crooked River sub-basin can be further divided into the following sub-systems and groups in descending order:

<u>Pennsylvanian Sub-System</u>

- Lansing group – Consists of alternating beds of limestone and shale. A channel- fill sandstone is sometimes present in the upper portion of the group.
- Kansas City group – Consists of alternating beds of limestone and shale. Occasional beds of sandstone and thin coal beds can be present.
- Pleasanton group – Consists predominantly of clastic materials which have formed sandstones and shales. Thin beds of coal and conglomerate are sometimes present.
- Marmaton group – Consists of a succession of shales, limestones, sandstones, clays, and coal beds.
- Cherokee group – Consists predominantly of shale with minor amounts of limestone and sandstone. This group contains most of the mineable coal beds in Missouri.

Mississippian Sub-System (Osagean Series) – Consists mostly of cherty limestones.

General bedrock geology for areas of the sub-basin contained in each county, except Cass and Johnson as the areas are so small, are as follows:

- **Clinton County –** Bedrock units are of Pennsylvanian-age and belong to Lansing and the Kansas City groups.
- **Clay County –** Bedrock units are primarily Pennsylvanian-age and belong to the Lansing and Kansas City groups. Small areas of Pleasanton group bedrock underlie the southeast corner of this sub-basin area.
- **Jackson County –** Bedrock units are predominantly Kansas City and Pleasanton group rocks. The northeast part of Jackson County and along the eastern border with Lafayette County is underlain by the Pennsylvanian-age Marmaton group.
- **Caldwell County –** Bedrock units are mostly of the Kansas City group with small areas of Pedee-Lansing bedrock in the southwest corner of the county.
- **Ray County –** Bedrock is predominantly of the Kansas City and Pleasanton groups, except northeast of the Missouri River floodplain where bedrock units of the Marmaton group dominate.
- **Lafayette County –** Bedrock units are primarily of the Marmaton group with lesser amounts of Kansas City and Pleasanton group rocks underlying the higher elevations. A narrow band of Pennsylvanian-age channel sandstone underlies an area that trends north and south from Higginsville. A small area of Pennsylvanian-age bedrock of the Cherokee group underlies the northeast corner of the county.
- **Carroll County –** Bedrock units in the southern part of the county and north of the Missouri River floodplain are predominantly Marmaton group rocks with lesser amounts of Kansas City and Pleasanton units to the northwest. Small amounts of Cherokee group bedrock underlie the southeast portion of the county.
- **Saline County –** South of the Missouri River floodplain bedrock consists mostly of Cherokee group units and Mississippian-age limestone.
- **Chariton County –** Bedrock units in this sub-basin area that lie north of the Missouri River floodplain consist of Marmaton group rocks to the north and Cherokee group units to the south.

Karst features[14]

Karst topography is generally formed over carbonate bedrock such as limestone and dolomite by dissolving or solution. It is often characterized by sinkholes, caves, underground drainage, and losing streams. This sub-basin is not a highly-developed karst region, especially in comparison to other parts of the state of Missouri. Six unnamed springs are located in the watershed, with flows less than ten gallons per minute or unmeasured flow. Two sinkholes and eight caves are documented in the area. One dye tracing effort by Missouri Department of Natural Resources (MoDNR) Division of Geology and Land Survey (DGLS) established a flow path of about 0.5 mile between a small tributary of Crooked River and a spring in the north central part of the sub-basin. As noted in section XX,

Resource Concerns

Resource concerns are issues related to the natural environment. Natural resources include soil, water, air, plants, animals, and humans. Missouri Natural Resources Conservation Service identified resource concerns that affect the Lower Missouri -Crooked River Watershed.

Figure 11

Resource Concerns/Issues by Land Use

Soil, Water, Air, Plant, Animal, plus Human (SWAPA+H) Concerns	Specific Resource	Pasture/Grass	Cropland	CRP	Forestland	Urban	Floodplain	Water
Soil Erosion	27% of all cropland eroding at levels above "T"		X					
	Erosion on streambanks and streambeds	X	X		X	X	X	
	Erosion and runoff from construction sites					X		
	Erosion from ephemeral gullies		X					
	Erosion from classical gullies	X	X		X	X		
Sedimentation	Damages to waterbodies, increased flooding						X	X
Prime Farmland	16,500 acres lost between 1982 and 1997	X	X		X		X	
Soil Quality	Degradation of soil quality		X					
Water Quality	Cultivated cropland primary nonpoint source of pollutants		X					X
	Certain waterbodies are not meeting water quality standards							X
	260 leaking tanks in the sub-basin							X
Floodplains	Over 400,000 acres fall within the 100-year flood area						X	
Riparian Corridors	Certain riparian zones unprotected or vulnerable		X			X	X	

Soil Erosion

- Streambank, streambed, and classical gully erosion occurs on pasture/grassland, cropland, forestland, and urban areas. However, due to a lack of reliable data at the sub-basin level, the degree and amount of soil loss from these sources is not known.
- Classical gully erosion occurs on pasture/grassland, cropland, forestland, and urban areas. No sub-basin level data are available to determine the degree and extent.
- Ephemeral gully erosion is occurring primarily on cropland eroding at levels above the tolerable limit ("T"). No sub-basin level data are available to determine the degree and extent.
- An estimated 27 percent (207,144 acres) of all cropland is eroding at levels above "T".
- The estimated USLE soil loss on highly erodible, cultivated cropland (eroding above "T") is 13.2 tons/ acre/year.
- Erosion and runoff is occurring from construction sites primarily found in and near urban areas.

Sedimentation

- Excessive sedimentation can reduce the useful life of ponds, lakes, reservoirs, and wetlands and can increase the severity and frequency of flooding by reducing the water carrying capacity of streams and rivers.

Prime Farmland

- The majority of the prime farmland (16,500 acres) lost between 1982 and 1997 is believed to be in the western one-third of the sub-basin where growth of the metropolitan Kansas City area is interacting with surrounding agricultural areas. Refer to the Population Interaction Zones for Agriculture (PIZA) map on page ???

Soil Quality

- Excessive soil erosion is a primary contributor to soil quality degradation. This limits the productivity and sustainability of the soil resource.

Water Quality

- Highly erodible and cultivated croplands with USLE soil losses above tolerable limits (“T”) are a primary non-point source of sediment, nitrogen, and phosphorus pollutants that enter the stream system.
- Twelve waterbodies within the sub-basin appear on the 303(d) list and are not meeting water quality standards. Pollutants listed include chlordane, mercury, ammonia, polychlorinated biphenyl (PCB), volatile suspended solids (VSS), biochemical oxygen demand (BOD), and fecal coliform. Refer to Water Quality section on page ???
- An estimated 260 leaking tanks have been identified within the sub-basin and are concentrated primarily in the Kansas City metropolitan area. Refer to Water Quality section on page ???

Floodplains

- An estimated 432,838 acres fall within the 100-year return period flood area. This can result in damages to crops, pastures, and other resources, as well as damages to roads, bridges, and buildings.

Riparian Corridors

- The data suggest that about one-half of the riparian corridors, primarily in cropland and urban areas, are unprotected or vulnerable. Protected riparian corridors can act as filters to trap nutrients, sediment, and other pollutants.

A. Soils

The upland soils of this sub-basin formed in loess (wind blown sediments) on the ridge tops and upper side slopes and in variable thicknesses of loess over glacial till (materials deposited by glacial ice) on lower steeper side slopes. Soils on these upland settings are predominately very deep and range from well drained to somewhat poorly drained depending upon gradient and shape of the slope.

Soils on the loess bluffs adjacent to major stream valleys formed under forest or savanna vegetation and have relatively thin silt loam surface layers over silty clay loam subsoils. Other deep loess soils on broad uplands formed under prairie vegetation and have thick, dark, silt loam surface layers with silty clay loam subsoils.

Soils formed in glacial till or in varying thicknesses of loess over glacial till are more prevalent with distance from the Missouri River valley. Soils in most of this area of the sub-basin formed under prairie vegetation and have thick dark surface layers.

Floodplain soils of the Missouri River and its tributaries formed in alluvial sediments and are very deep. These floodplain soils are extremely variable in texture and range from clayey soils in low slack water areas to sandy soils adjacent to the stream channel.

B. Soil Erosion[15]

The objectives of this section are to profile cropland erosion rates and identify cropland areas within the Lower Missouri-Crooked River sub-basin that would benefit the most from the application of conservation practices to limit sediment loss.

"**The production practices and inputs used by agriculture can result in a number of pollutants entering water resources, including sediment, nutrients, pathogens, pesticides and salts." (USDA-Economic Research Service).**

"Sediment is the largest contaminant of surface water in the United States by weight and volume (Koltun et al., 1997) and the second leading pollution problem in rivers and streams and third leading problem in lakes" (USEPA, 2002).

Sediment losses from soil erosion on cropland, streambanks and streambeds and runoff from construction sites and developed land are an ongoing resource concern throughout the Lower Missouri-Crooked River sub-basin. Cultivated cropland is the primary nonpoint source of sediment loss in this heavily cropped sub-basin and accounts for 41 percent of the sub-basin's total surface area**.** In sub-basins like the Lower Missouri-Crooked River throughout the Upper Midwest Region, the acres most in need of conservation treatment are those with waterborne sediment, nitrogen and phosphorus losses.

The consequences of excessive soil erosion are well known. Waterborne sediments are inextricably linked to degraded water quality through turbidity and loss of fertilizers and pesticides attached to soil particles. Suspended sediments degrade aquatic habitats, increase water treatment costs and marginalize water recreation. Sedimentation reduces the useful life of ponds, lakes and reservoirs; increases the probability and severity of flooding; and clogs drainage networks. Excessive soil erosion is a primary contributor to soil quality degradation, limiting the productivity and sustainability of the soil.

This assessment concentrates on sheet and rill erosion on cropland for which there are scientifically based soil erosion estimates for the entire sub-basin. This focus does not suggest that sedimentation related to urban stormwater runoff, stream bank erosion, classical gully erosion and ephemeral gully erosion on cropland is not significant in volume or impact. However, there is a lack of reliable data at the sub-basin level for these other sources of sediment. The erosion rate data have been extracted from the 1997 National Resources Inventory (NRI). Erosion rates and their relationship to "T" values are reported in tons/acre/year for cultivated cropland, non-cultivated cropland, and corn and soybeans on highly erodible and non-highly erodible land. Also included are erosion rates and their relationship to "T" values for pastureland.

Universal Soil Loss Equation (USLE) Cropland Erosion Rates in Tons/Acre/Year[2]

USLE - This table reports estimated soil loss rates from the 1997 NRI based on the Universal Soil Loss Equation (USLE). USLE estimates average annual sheet and rill soil movement down a uniform slope using rainfall energy as the erosive force acting on the soil. Soil characteristics and slope for the fields in which the NRI sample points fall or those portions of the fields surrounding the points that would be considered in conservation planning are used in the NRI USLE calculations.

"T" FACTOR – This is the maximum rate of annual soil erosion that will still permit crop productivity to be sustained economically and indefinitely.

HEL – Highly erodible land (HEL) is land that has an erodiblity index (EI) value of 8 or more. The EI index provides a numerical expression of the potential for a soil to erode, considering the physical and chemical properties of the soil and climatic conditions where it occurs. The higher the index value, the greater the investment needed to maintain the sustainability of the soil if intensively cropped.

Figure 12

USLE Cropland Erosion Rates Tons/Acre/Year[2]

CROPLAND CATEGORY	CULTIVATED CROPLAND	NON-CULTIVATED CROPLAND
HIGHLY ERODIBLE LAND (HEL)		
HEL Eroding at or below "T"	2.9	0.81
HEL Eroding above "T"	13.2	13.3
All HEL	12	1.1
NON-HIGHLY ERODIBLE LAND (Non-HEL)		
Non-HEL Eroding at or below "T"	2.2	0.23
Non-HEL Eroding above "T"	5.3	0
All Non-HEL	2.4	0.23
ALL CROPLAND		
All Land Eroding at or below "T"	2.2	0.71
All Land Eroding above "T"	12	13.3
All Land	5.6	0.92

Cropland Erosion in Relationship to "T"[2]

This table reports acres and percentages of cultivated cropland, non-cultivated cropland and all cropland by HEL and "T" categories for the sub-basin.

Cultivated Cropland

CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	23,600	12%	3%	1%
Highly Erodible Cropland above "T"	174,600	88%	23%	11%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**198,200**	**100%**	**26%**	**12%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	447,200	94%	58%	28%
Non-Highly Erodible Cropland above "T"	29,500	6%	4%	2%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**476,700**	**100%**	**62%**	**30%**
GRAND TOTALS	**674,900**	**100%**	**88%**	**42%**

Non-Cultivated Cropland

CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	74,400	98%	10%	5%
Highly Erodible Cropland above "T"	1,600	2%	<1%	<1%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**76,000**	**100%**	**10%**	**5%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	16,300	100%	2%	1%
Non-Highly Erodible Cropland above "T"	0	0%	0%	0%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**16,300**	**100%**	**2%**	**1%**
GRAND TOTALS	**92,300**	**100%**	**12%**	**6%**

All Cropland

CROPLAND CATEGORY	Total Acres	% of Cropland Category	% of all Cropland	% of Sub-basin
HEL				
Highly Erodible Cropland at or below "T"	98,000	36%	13%	6%
Highly Erodible Cropland above "T"	176,200	64%	23%	11%
TOTALS FOR HIGHLY ERODIBLE CROPLAND	**274,200**	**100%**	**36%**	**17%**
NON-HEL				
Non-Highly Erodible Cropland at or below "T"	463,500	94%	60%	28%
Non-Highly Erodible Cropland above "T"	29,500	6%	4%	2%
TOTALS FOR NON-HIGHLY ERODIBLE CROPLAND	**493,000**	**100%**	**64%**	**30%**
GRAND TOTALS	**767,200**	**100%**	**100%**	**47%**

Corn and Soybean Erosion Profiles[2]

These tables report USLE rates and acres by HEL, "T" and conservation practices for corn and soybeans (tons/acre/year).

All Corn and Soybean Acres

	All Corn Acres	USLE - Corn Acres	All Soybean Acres	USLE - Soybean Acres
All Acres	205,100	4.71	351,400	5.68
All Contoured acres	65,500	5.96	99.300	6.64
All Contoured and Terraced Acres	45,700	6.2	52,400	6.41
All Contoured Acres, Not Terraced	19,100	5.37	46,900	6.65
All Non-Contoured Acres	140,100	4.12	252,100	5.30
All Non-Contoured and Terraced Acres	2,600	10.6	4,400	17.01
All Non-Contoured, Not Terraced Acres	137,500	3.2	247,700	5.09

HEL Corn and Soybean Acres

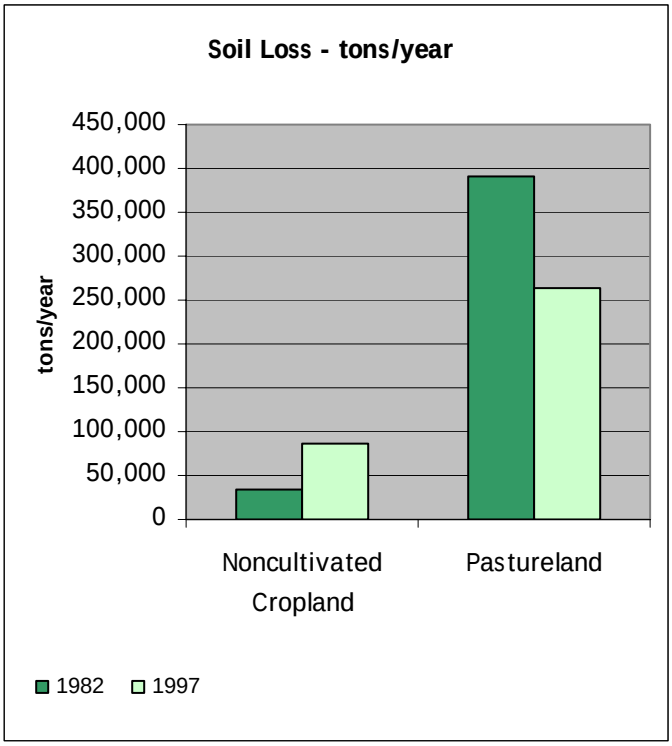
	All HEL Corn Acres	USLE - HEL Corn Acres	All HEL Soybean Acres	USLE - HEL Soybean Acres
All Acres	42,300	12.92	104,100	12.98
All Contoured acres	27,100	10.77	59,000	9.55
All Contoured and Terraced Acres	17,100	12.17	31,500	9.07
All Contoured Acres, Not Terraced	10,000	8.37	27,500	10.09
All Non-Contoured Acres	15,200	16.76	45,400	17.45
All Non-Contoured and Terraced Acres	1,300	19.00	4,400	17.01
All Non-Contoured, Not Terraced Acres	13,900	16.55	41,000	17.49

Pastureland Erosion

This table reports USLE rates and acres in relationship to "T" for pastureland (tons/acre/year).

	Pastureland Acres	USLE Rate
All Pastureland	318,000	0.83
Pastureland Eroding at or Below "T"	315,400	0.82
Pastureland Eroding Above "T"	2,600	4.5

USLE Soil Loss Rates (tons/year)[2]



Noncultivated Cropland

1982 45,000 tons per acre

1997 75,00 tons per acre

Pastureland

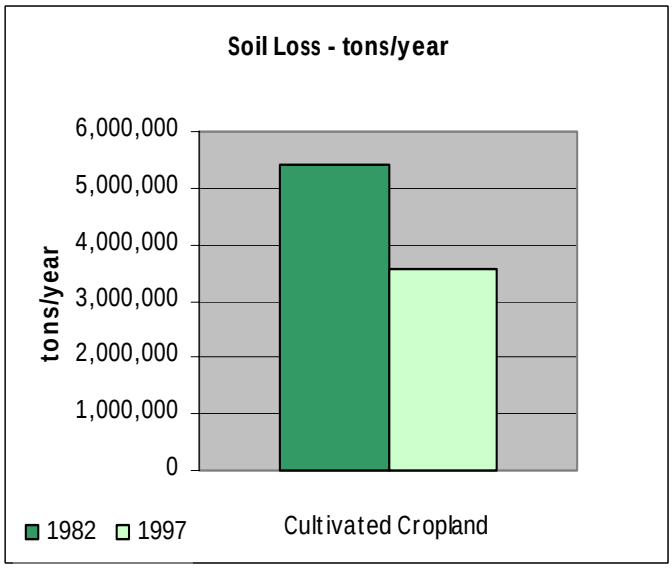
1982 395,000 tons per acre

1997 255,000 tons per acre

Cultivated Cropland

1982 5,.5 million tons per acre

1997 3.3 million tons per acre

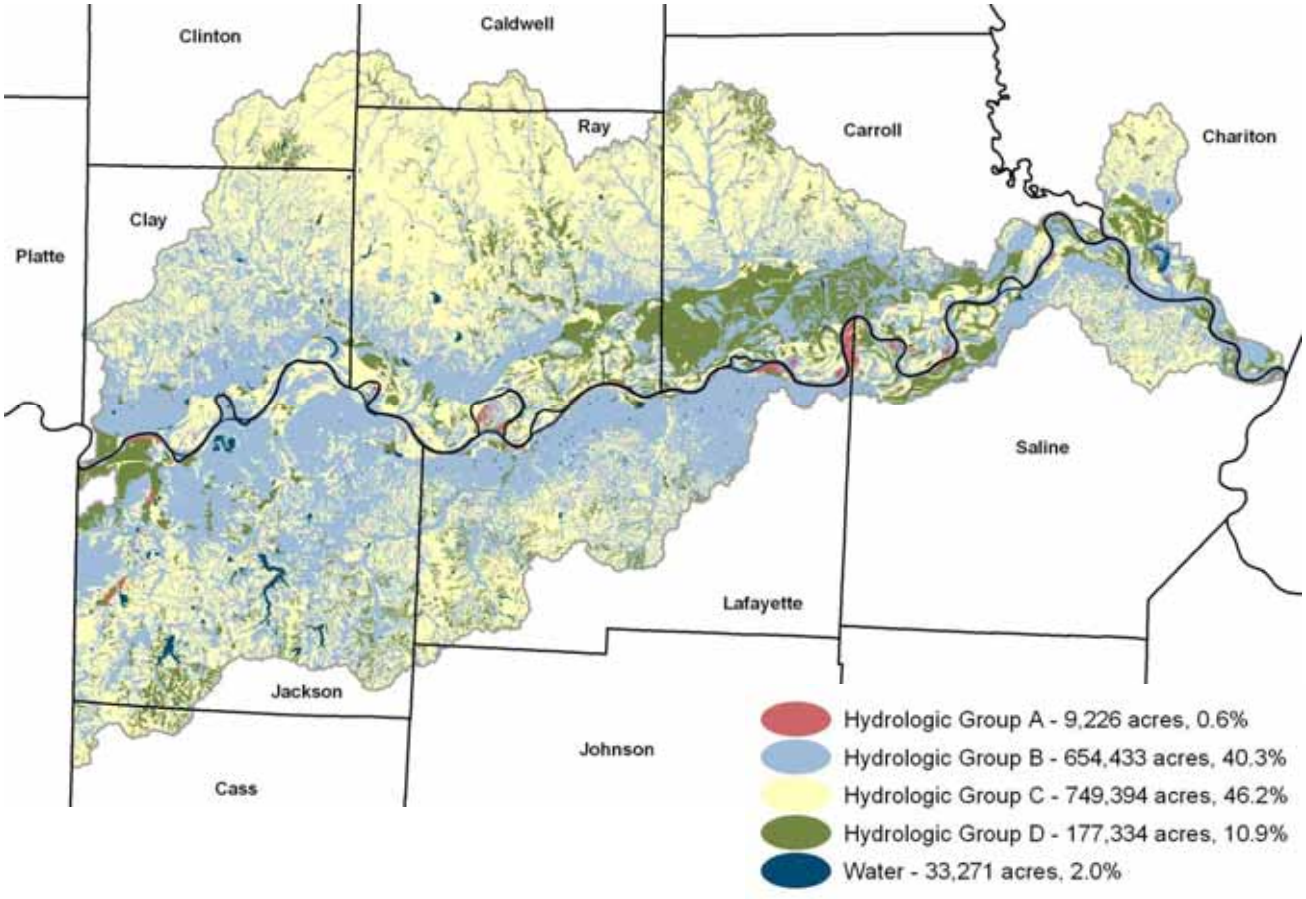


Hydrologic Soil Groups[5]

In addition to the sub-basin-wide NRI erosion estimates, a spatial assessment of erosion potential was implemented using SSURGO soils data and land cover. The acres most in need of conservation practices (acres with the highest potential for sediment loss, if cropped) have been targeted based on a major finding from model simulations of soil loss outcomes reported by the NRI-Conservation Effects Assessment Project (CEAP), (NRCS, 2006): ***Hydrologic soil group and soil texture account for a large part of the variability in the loss of sediment, nitrogen and phosphorus from field to field.*** Based on average per acre sediment loss rates by hydrologic soil groups and soil texture groups reported in the CEAP study, each hydrologic soil group was divided into three classes of sediment loss potential: (1) higher average, (2) moderate average and (3) lower average.

The amount of sediment loss from sheet and rill erosion is determined by the amount of precipitation, tillage practices, soil characteristics and the presence or absence of conservation practices and can vary considerably from field to field. A significant portion of this variability can be accounted for by hydrologic soil groups (HSG) and soil texture differences within the hydrologic groups. This map shows the spatial distribution of hydrologic soil groups A,B,C and D.

Figure 13. Hydrologic Groups Lower Missouri—Crooked River Sub-basin



Sediment Loss Potential on Hydrologic Soil Group A (if used for cropland)

The lowest sediment losses can be expected on these well-drained soils with high infiltration rates. They represent a very small percentage of a sub-basin and a small percentage of cropland acres. The lower average loss rate category is defined using the moderately coarse and coarse texture groups.

Sediment Loss Potential on Hydrologic Soil Group B (if used for cropland)

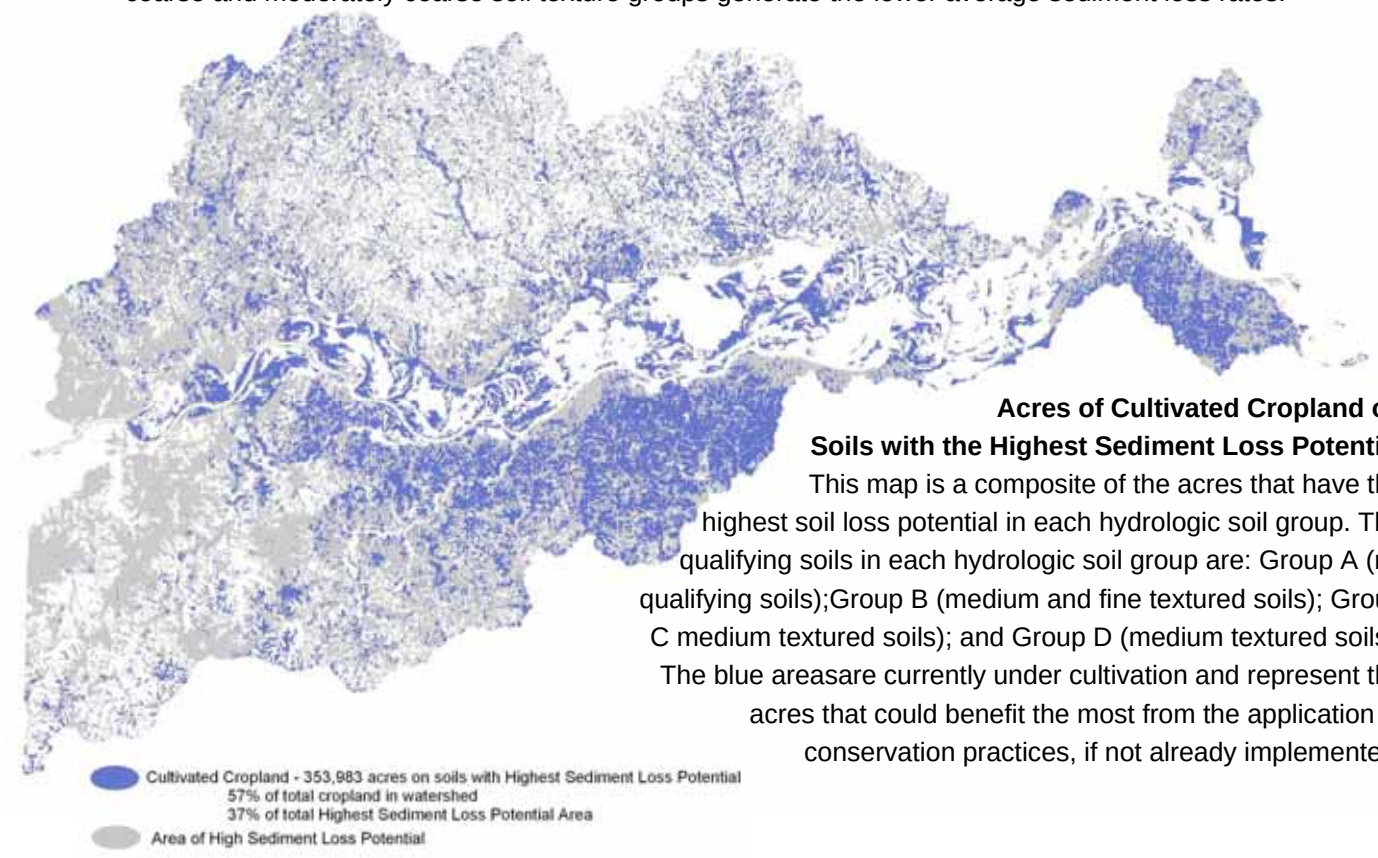
Acreages for this hydrologic soil group are typically high with a large number of cropland acres. Acres with the highest potential for sediment loss are defined by medium and fine soil texture groups. Soils with a medium average sediment loss potential are represented by moderately coarse and moderately fine textured soils. Coarse textured soils in hydrologic soil group B dominate the areas with the lowest average sediment loss rate potential. Average soil loss rates for all texture groups will tend to be at or below the average for the sub-basin.

Sediment Loss Potential on Hydrologic Soil Group C (if used for cropland)

This is the largest hydrologic soil group in the sub-basin with a large cropland acreage. Higher average sediment loss rates are reflected in the medium texture soil group. The moderate average sediment loss rate category is made up of the coarse and moderately coarse and fine and moderately fine soil texture groups. Average soil loss rates for all the texture groups will tend to exceed the average for the sub-basin.

Sediment Loss Potential on Hydrologic Soil Group D (if used for cropland)

This is the second smallest hydrologic soil group in the sub-basin but it is dominated by cropland. The higher average sediment loss rates are on the medium textured soils and the moderate average sediment loss rates are produced by the fine and moderately fine soil texture groups. The coarse and moderately coarse soil texture groups generate the lower average sediment loss rates.



Acres of Cultivated Cropland on Soils with the Highest Sediment Loss Potential

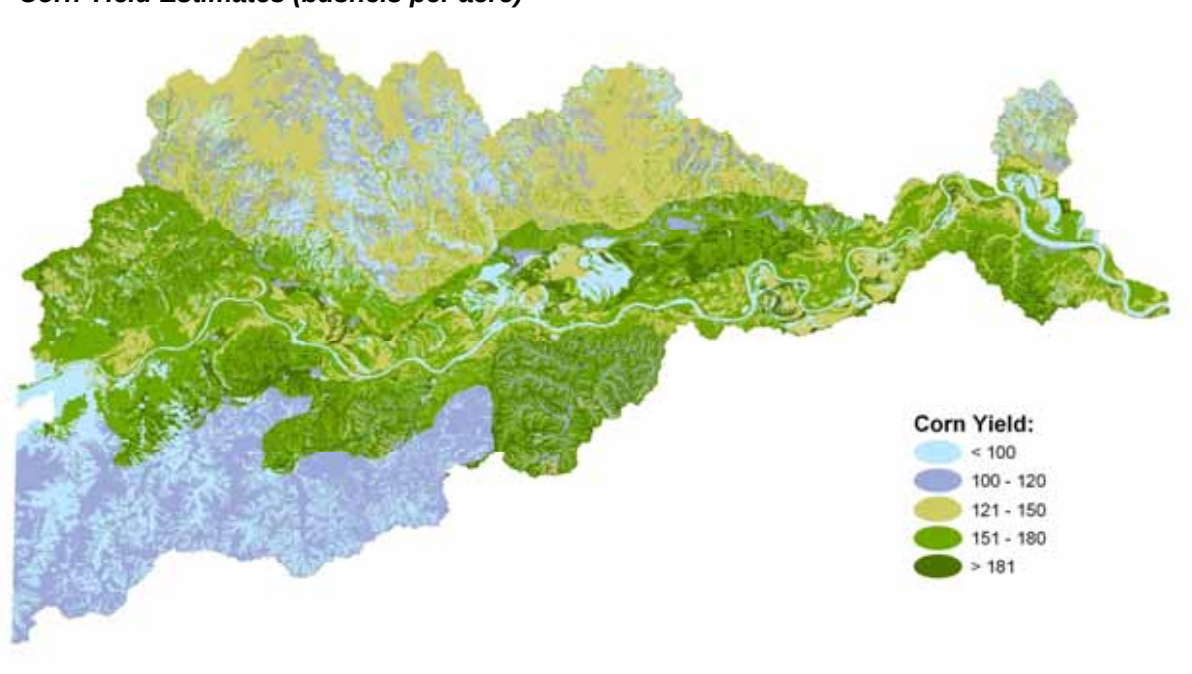
This map is a composite of the acres that have the highest soil loss potential in each hydrologic soil group. The qualifying soils in each hydrologic soil group are: Group A (no qualifying soils);Group B (medium and fine textured soils); Group C medium textured soils); and Group D (medium textured soils). The blue areasare currently under cultivation and represent the acres that could benefit the most from the application of conservation practices, if not already implemented.

Soil Productivity[5]

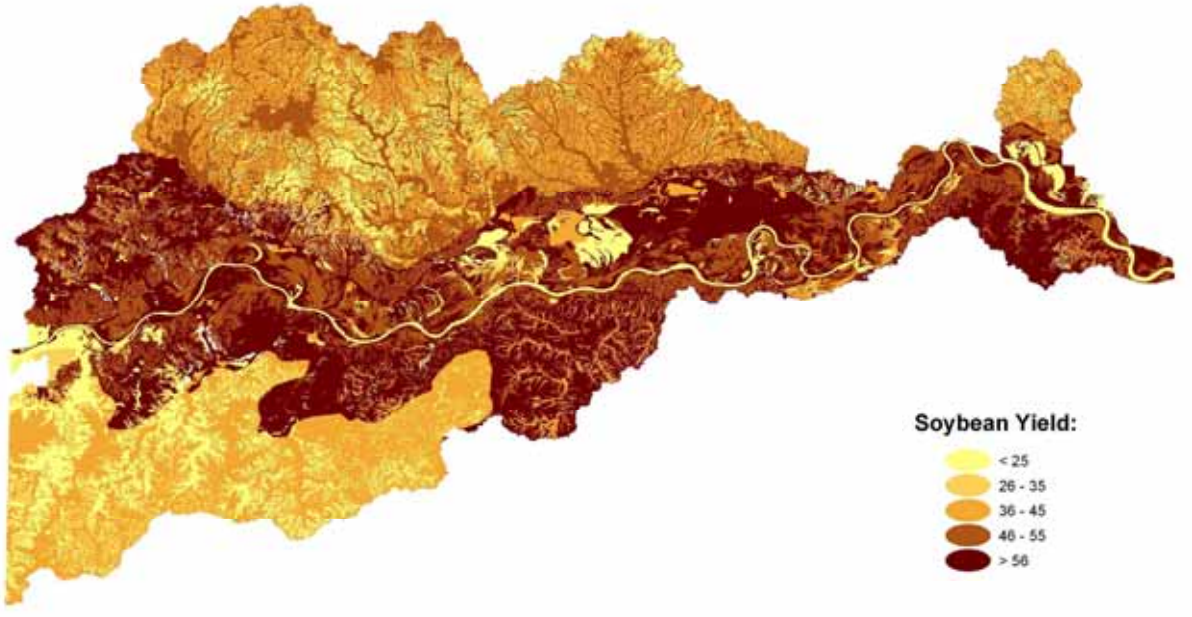
Yield estimates were developed using Missouri's Productivity Index (PI). The PI is a method developed by soil scientists that "automatically" evaluates specific soil properties directly related to plant growth. The soil properties used are a record of many years of soil survey data stored in USDA's National Soils Information System (NASIS) . The properties include: nutrient- supplying power (Organic matter, cation exchange capacity and pH), root penetration (depth to barriers, retarding layers, etc.), wetness effects (depth to seasonal high water table), available water capacity, surface restrictions (rocks, clayey, etc.), flooding restrictions (frequency), phase restrictions (gullied, channeled), slope restrictions and climate.

Figure 14

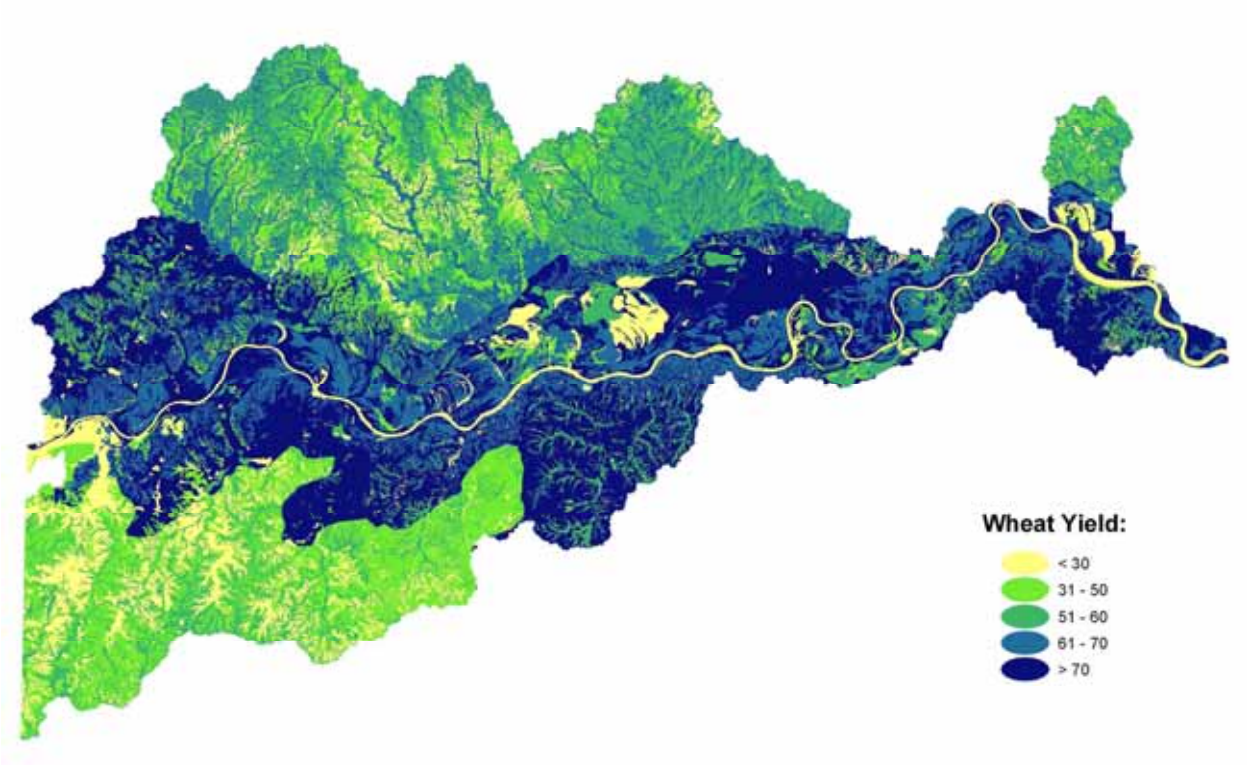
Corn Yield Estimates (bushels per acre)



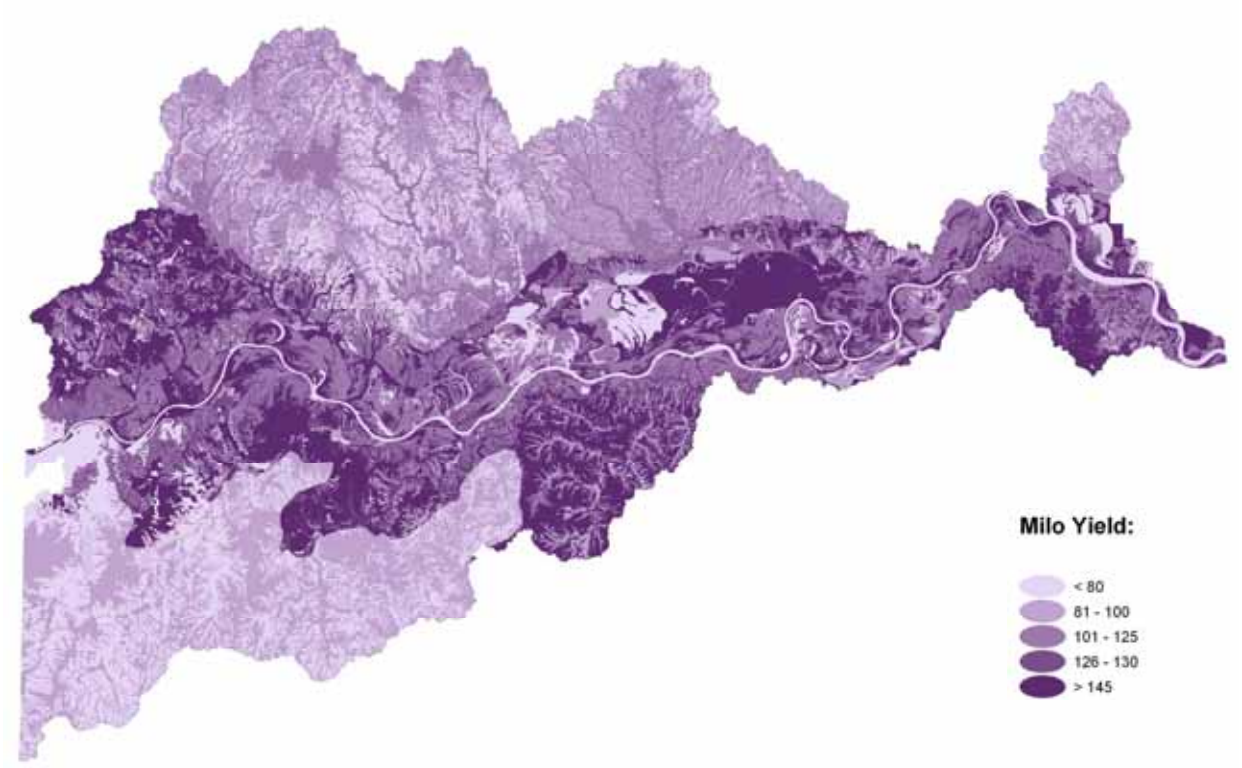
Soybean Yield Estimates (bushels per acre)



Wheat Yield Estimates (bushels per acre)



Grain SorghumYield Estimates (bushels per acre)



C. Water Quality

303d Listed Waters[16]

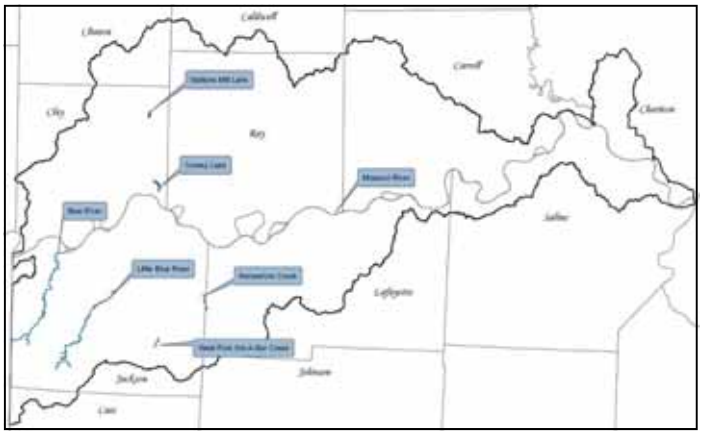
Section 303(d) of the federal Clean Water Act requires that each state identify waters that are not meeting water quality standards and for which adequate water pollution controls have not been required. Water quality standards protect such beneficial uses of water as whole body contact (such as swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife. The 303(d) list helps state and federal agencies keep track of waters that are impaired but not addressed by normal water pollution control programs.

Figure 15

Water Body, ID Number, County	Size	Pollutant	Source	Impaired Use(s)	Beneficial Use(s)*	Priority
Blue River, 417, Jackson	4 miles	Chlordane	Urban NPS	Fish Consumption	1, 2, 3	Low
Blue River, 418, Jackson	9 miles	Chlordane	Urban NPS	Fish Consumption	1, 2, 3, 4	Low
Blue River, 419, Jackson	9 miles	Chlordane	Urban NPS	Fish Consumption	1, 2, 3, 4, 5	Low
Blue River, 421, Jackson	2 miles	Chlordane	Urban NPS	Fish Consumption	1, 2, 3, 4	Low
Cooley Lake, 7090, Clay	300 acres	Mercury	Atmospheric	Fish Consumption		Medium
Horseshoe Creek, 3413, Jackson, Lafayette	3 miles	BOD, Ammonia	2 Lagoons, Oak Grove	Protection of Warm Water Aquatic Life	1, 2, 3	High
Little Blue River, 423,	22 miles	Mercury	Atmospheric	Fish Consumption		Medium
Longview Reservoir, 7097,	930 acres	Mercury	Atmospheric	Fish Consumption		Medium
Missouri River, 356	125 miles	Chlordane	Point and Non-	Fish Consumption	1, 2, 3, 5,	Medium
Missouri River, 701	129 miles	Chlordane	Point and Non-	Fish Consumption	1, 2, 3, 5,	Medium
West Fork of the Sni-a-Bar Creek, 400, Jackson	2 miles	BOD, VSS	Lagoon, Lake Lotawana	Protection of Warm Water Aquatic Life	1, 2, 3	High
Watkins Mill Lake, 7087, Clay	126 acres	Fecal Coliform	Unknown	Whole Body Contact (swimming)	1, 2, 3, 4, 5	Medium

*** Beneficial Uses:**

1 Livestock and Wildlife Watering
2 Protection of Warm Water Aquatic Life
3 Human Health associated with Fish Consumption
4 Boating and Canoeing
5 Whole Body Contact (swimming)
6 Secondary Contact Reaction
7 Irrigation
8 Drinking Water Supply
9 Industrial

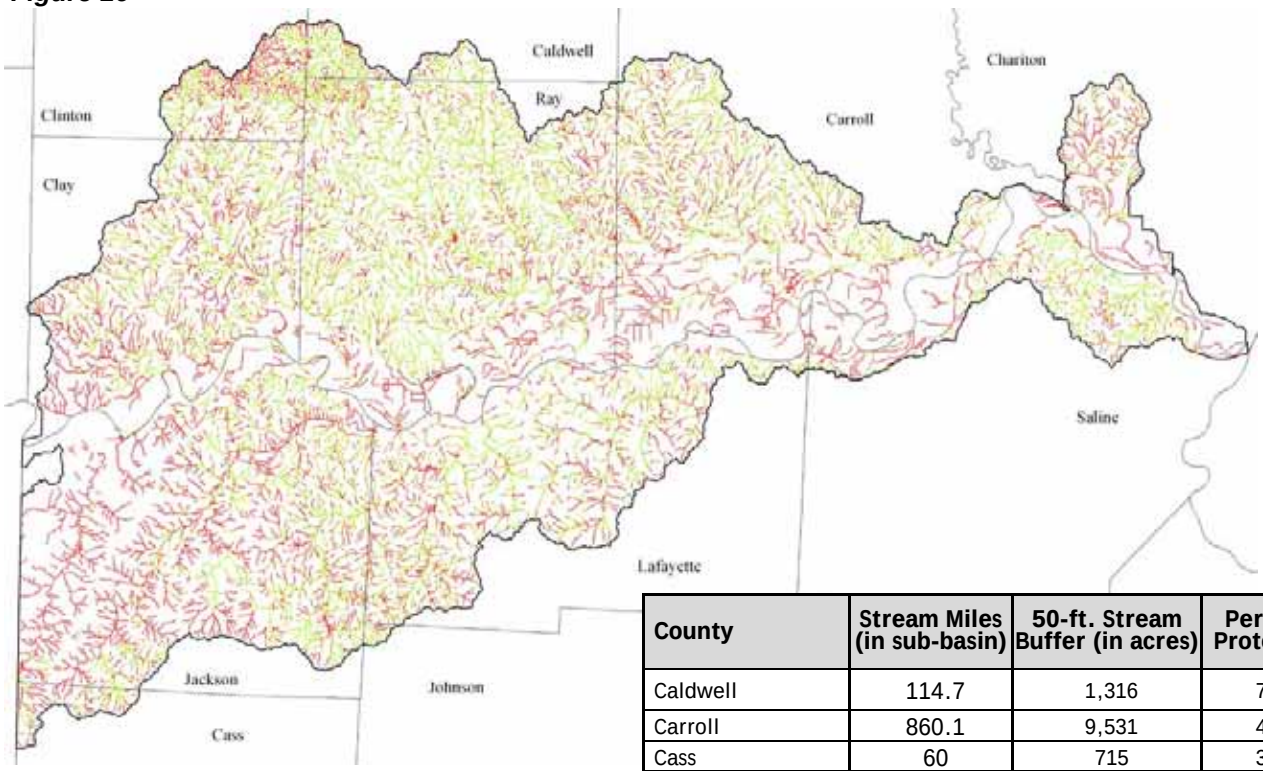


Riparian Corridor Condition[8,17]

The condition of the riparian zone adjacent to streams has a critical impact on water quality. Permanent and deeply-rooted streambank vegetation slows run-off of nutrients and pollutants, and reduces sedimentation and solar heating. NRCS riparian practice standards specify 50-feet buffers along first and second order streams and 100-feet for third order and higher streams.

The 1:24,000 National Hydrologic Dataset (NHD) stream network is the highest resolution stream representation available consistently for the State. Stream order is not an attribute of these data; therefore, the streams were all buffered by 50-feet to give the most conservative representation of riparian condition. Buffered streams were used to subset the common land unit (CLU) data, land parcel data developed and maintained by the Farm Service Agency. The land cover attribute in the CLU data was used to characterize the vegetative condition of the buffers. Cropland (which includes pasture and hayland), urban, mined and barren cover types were considered "unprotected" or "vulnerable" riparian conditions, while forestland, rangeland and water were considered "protected". Results are presented by county and sub-basin in the table and map below.

Figure 16



County	Stream Miles (in sub-basin)	50-ft. Stream Buffer (in acres)	Percent Protected
Caldwell	114.7	1,316	71%
Carroll	860.1	9,531	45%
Cass	60	715	39%
Clay	778	9155	46%
Clinton	276.1	3,274	47%
Chariton	171.9	1,927	31%
Jackson	1219.6	14344	35%
Johnson	10.3	120	65%
Lafayette	787	9029	56%
Ray	1460.0	16,664	62%
Saline	335.5	4177	45%
Total in Sub-basin	**6073.7**	**70252**	**49%**

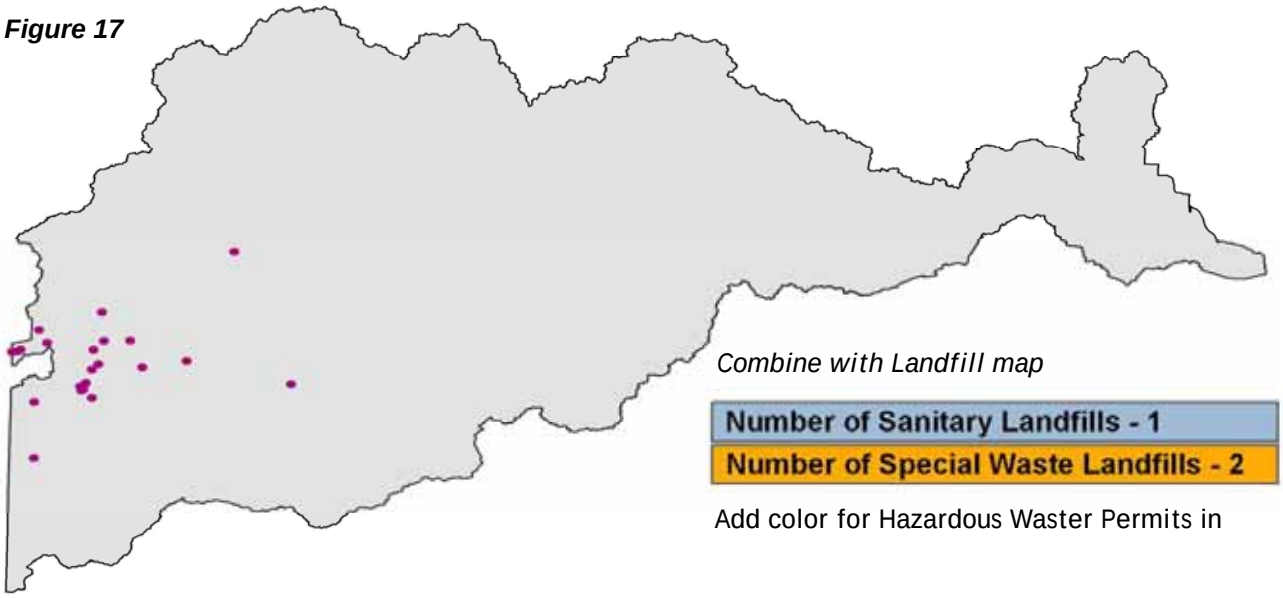
Landfills[19]

There is one sanitary landfill near XXXX. There are also two special waste landfills near xxxx and xxx. The map below shows the permitted active landfill sites in the sub-basin.

Sites with Hazardous Waste Permits[20]

Sites with hazardous waste permits are permitted to treat, store or dispose of hazardous waste or are facilities that are certified for resource recovery. There are 23 sites in the Lower Missouri-Crooked River sub-basin shown on the map below

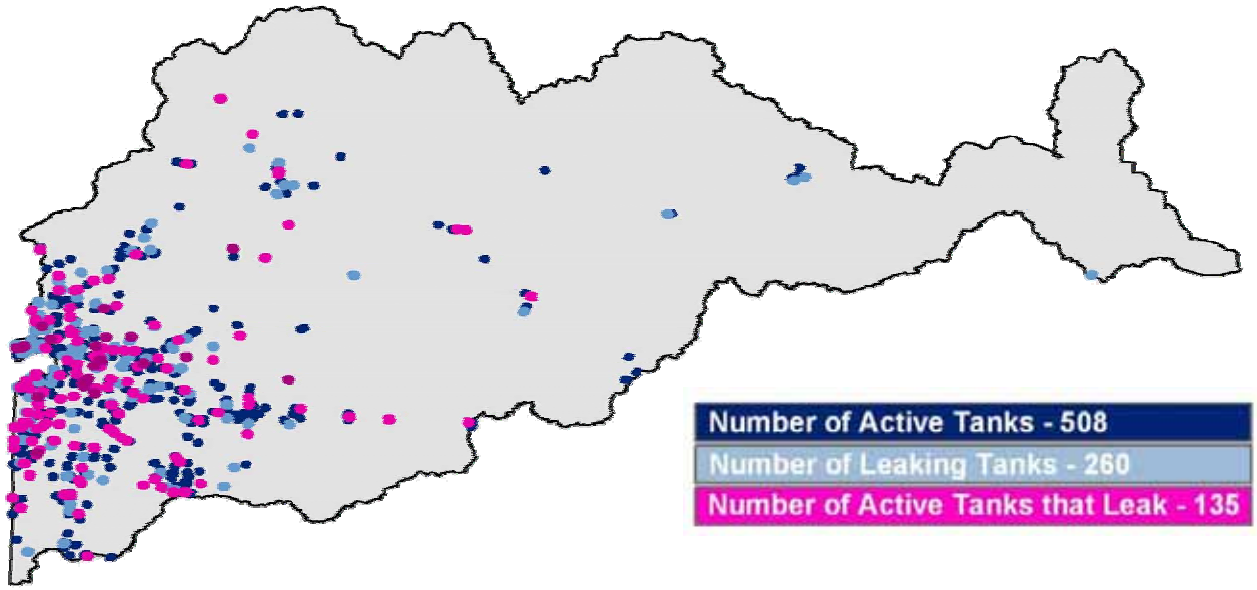
Figure 17



Underground Tanks[21,22]

Registered active underground tanks and locations of leaking underground tanks where clean-up activities are on-going. There are 508 active underground tanks, 135 of which are leaking. There are also 260 total tanks that are leaking in the sub-basin.

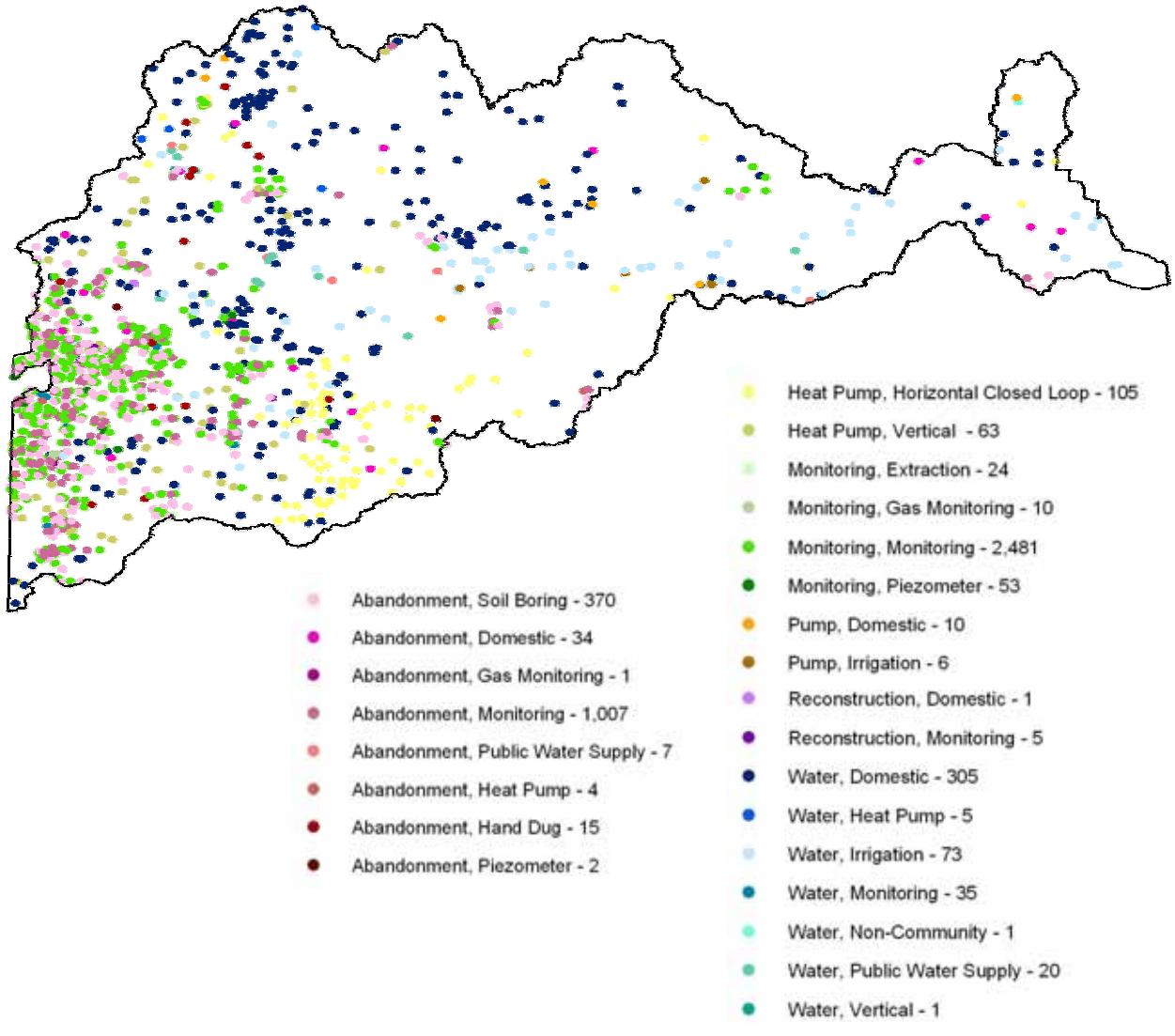
Figure 18



Wells[8]

The Missouri Well Driller's Law (Section 256.600-256.640 RSMo.) established minimum construction standards and state certification requirements of wells constructed after October, 1987. The law was created to protect Missouri groundwater from contamination due to improperly constructed wells. Contaminated groundwater exposes Missourians of all ages to serious health risks that can result from water borne diseases such as typhoid fever, dysentery, cholera, hepatitis and giardiasis. The law is administered through the Department of Natural Resources.

Figure 19



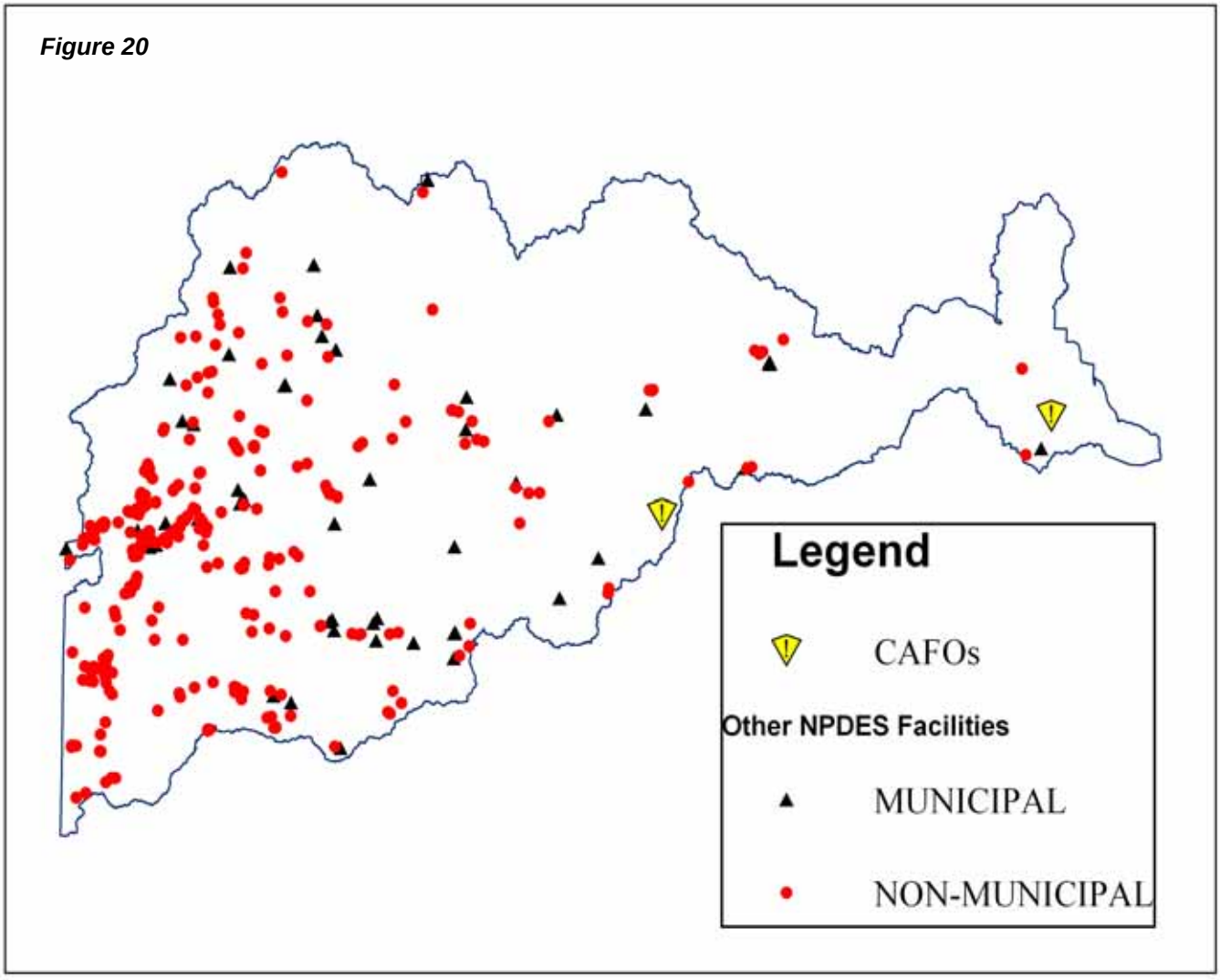
Waste Water Treatment Facilities and Concentrated Animal Feeding Operations[23]

Two swine finishing concentrated animal feeding operations (CAFOs) are documented in the Missouri National Pollutant Discharge Eliminations System (NPDES) Facilities database in this sub-basin. The NPDES is a point data set depicting outfall locations of waste water facilities requiring and holding Missouri NPDES operating permits.

An animal feeding operation is defined as a CAFO if it has more than 7000 animal units confined in an area with less than 50% vegetation ground cover. Smaller animal unit operations may be designated a CAFO if they discharge directly into waters of the state or have past history of discharge violations. The animal unit is a unit of measurement to compare waste produced by various animal types, using one beef feeder as a reference.

In addition to CAFOs, the NPDES identifies 408 municipal and non-municipal permitted waste water treatment facilities. A majority are for treatment of sewage sludge.

Figure 20



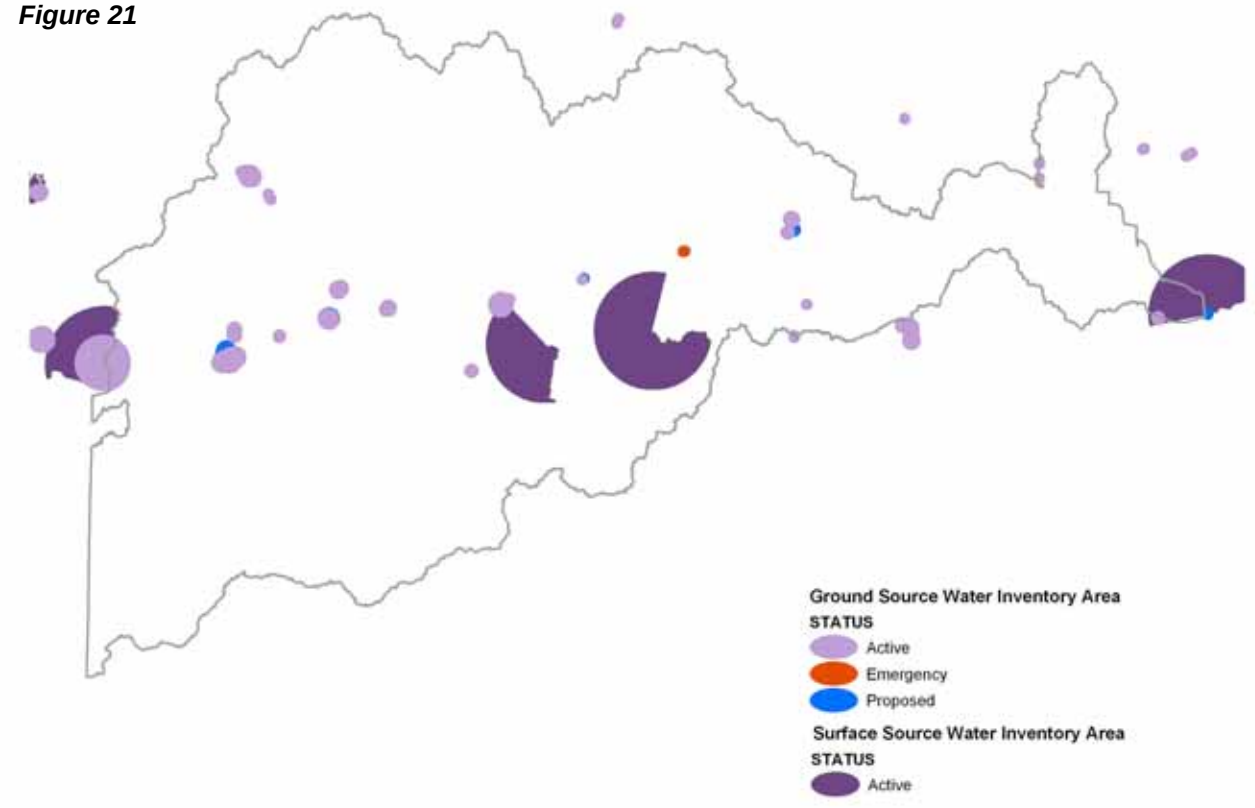
D. Water Quantity

Public Water Supply [24,25,26,27]

Missouri's 5.8 million residents draw their water supplies from ground and surface sources that vary tremendously in both quality and quantity. These variations are, to a large extent, controlled by geology and land use. North of the Missouri River, herbicides and sediment are a primary concerns in surface water sources and well sources contend with heavy mineralization, nitrates and pesticides. In the Ozark Highlands, ground water, the primary water supply source, is vulnerable to aquifer degradation from contaminated surface runoff and leachates through highly permeable soils and bedrock. Missouri's alluvial aquifers supply large quantities of high quality water, primarily to population centers located near the larger rivers and the Mississippi Embayment covering most of the southeastern corner of the state. Shallow wells are vulnerable to nitrate and pesticide contamination and the deeper wells in highly urbanized areas are at risk from a wide variety of chemical pollutants.

This map shows the surface and ground source water areas that have been inventoried for potential sources of drinking water contamination compiled by MDNR. Detailed information is available for individual public drinking supply systems and the spatial distribution of other drinking water supply features (wells, intakes, tanks, treatment plants, pumping stations, springs and lakes) from MDNR. The 2006 Missouri Water Quality Report provides current water quality assessments and summarizes water quality issues around the state. The 2007 Census of Missouri Public Water Systems is a comprehensive description of city, water district, subdivision and non-community water systems including type of treatment processes and chemical analyses of community water systems. The 2005 Missouri Water Supply Study provides detailed technical hydrologic and water resource engineering data for drought planning for 34 community water systems in North and West Central Missouri.

Figure 21



E. Forestry

Missouri is one of America's great forested states, ranking seventh of the 20 northeastern states in the amount of forest land. Forests cover about a third of the state - forests containing some of the finest oak, walnut, pine, and red cedar found anywhere.

Forests are Missouri's greatest renewable resource, providing many economic, environmental and social benefits. They protect hillsides from erosion, keeping streams and rivers clean. They filter the air, soften the extremes of the weather, and add beauty to cities and towns. Much of Missouri's recreation and tourism industry is centered in the forested regions of the state. And forests are a diverse resource of plants, animals, birds, and other life forms.

Annual growth of forests far exceeds the amount harvested, ensuring ample forests for future generations. Forest Products are also important to Missouri. Statewide, nearly 2,500 firms are involved in logging and wood products manufacturing. Harvesting and processing trees into wood products gives thousands of people jobs and contributes about $3 billion each year to Missouri's economy.

Federal, state, and local governments own only 15 percent of the forest land in Missouri, or about 2 million acres. Private landowners control 85 percent of the forest land in Missouri. Part of the challenge of forestry is helping private landowners apply management practices to create and maintain the kind of forest that meets their needs.

The following tables for this watershed are based on data compiled from The Forest Inventory and Analysis (FIA) Program of the U.S. Department of Agriculture (USDA) Forest Service. Information from USDA-Forest Service, National Forest Inventory and Analysis Database, 2005 is available at http://www.fia.fs.fed.us/tools-data/default.asp.

Area of Forestland by Ownership in Sub-Basin

Private	164,919 acres
Federal	8671 acres
State	12474 acres
County and municipal	15811 acres
Other	0 acres
Total	201,874 acres

Area of Forestland by Stocking Class in Sub-Basin

Overstocked	4512 acres
Fully stocked	38,160 acres
Medium stocked	72,378 acres
Poorly stocked	61,248 acres
Non-stocked	25,474 acres

F. Threatened and Endangered Species[28]

The Missouri Natural Heritage Database stores locations, population status and habitat information about species and communities of conservation concern. The database is a collection of over 18,000 records on 800 species and communities. The table below was generated from a subset of the Heritage Database, restricted to Federally threatened or endangered and state endangered species recorded in the sub-basin. The subset was spatially generalized with buffers around species records that relate to the species' mobility. While Heritage data can not prove absence of a species in an area, it is the best collection available of known locations of sensitive species and is used to assess potential impacts of various land management activities in a region.

Figure 23

Species Common Name	Scientific Name	Threatened, Endangered, or Candidate	Federal or State Listing
Amphibians			
Yellow Mud Turtle	Kinosternon flavescens flavescens	Endangered	State
Bats			
Indiana Bat	Myotis sodalis	Threatened/ Endangered	Federal/ State
Birds			
American Bittern	Botaurus lentiginosus	Endangered	State
Bald Eagle	Haliaeetus leucocephalus	Threatened/ Endangered	Federal/ State
Barn Owl	Tyto alba	Endangered	State
Greater Prairie Chicken	Tympanchus cupido	Endangered	State
King Rail	Rallus elegans	Endangered	State
Northern Harrier	Circus cyaneus	Endangered	State
Peregrine Falcon	Falco peregrinus	Endangered	State
Fish			
Topeka Shiner	Notropis Topeka	Endangered	State
Mammals			
Plains Spotted Skunk	Spilogale putorius interrupta	Endangered	State

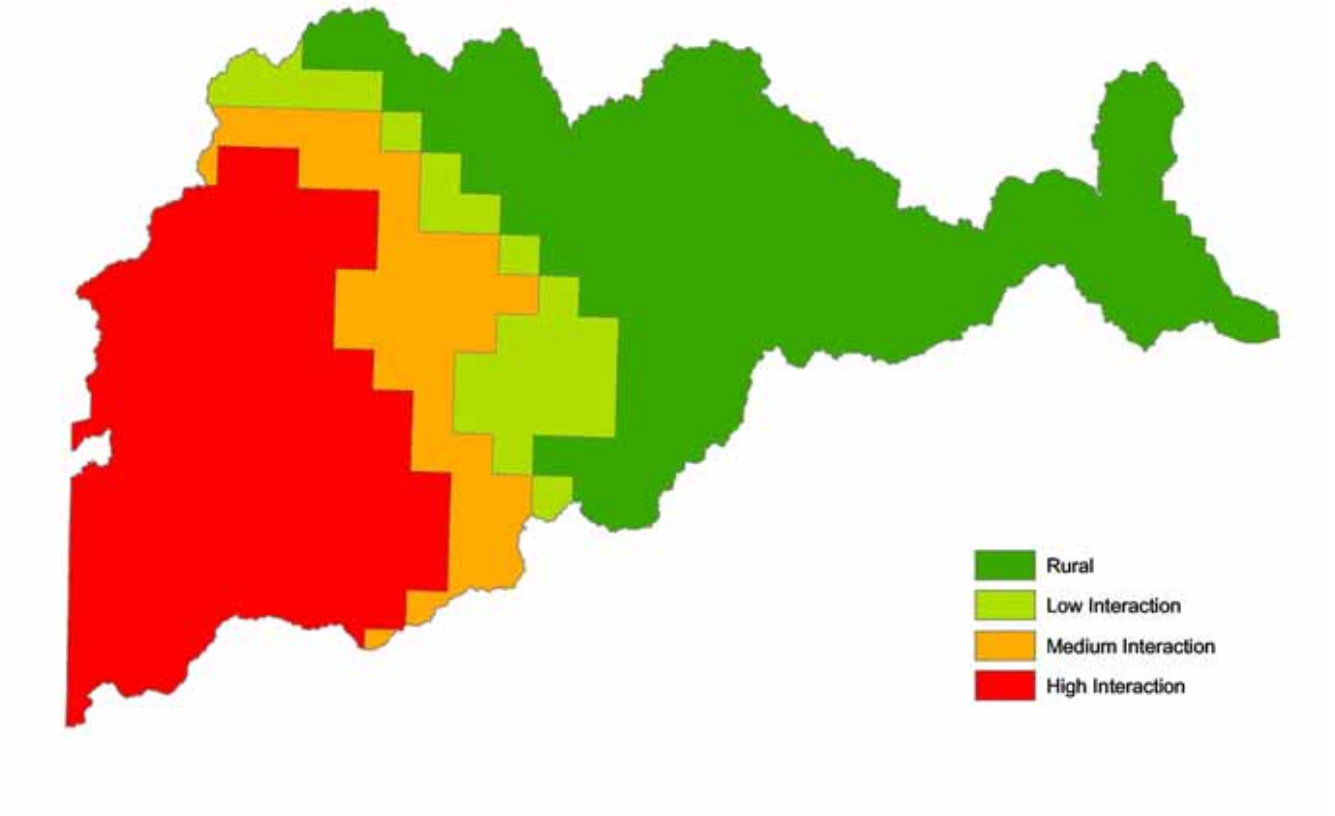
Census and Social Data

A. Population Interaction Zones for Agriculture (PIZA)[29]

USDA's Economic Research Service (ERS) has developed a number of methods for measuring urban-related population interactions with agricultural/rural land at the county and sub-county level. PIZA is based on a population interaction index value (PII) assigned to each cell in a 5-kilometer grid surface across the contiguous 48 States. The PII value is generated based on the interaction between population density (derived from 2000 Census population block data) and distance to agricultural land using a "gravity" model. The index values increase as population increases and/or as distance from agricultural land to nearby population decreases. The PII values are then thresholded into two zones: a rural zone that accounts for population that supports a commercial farming industry; and a zone that indicates potential interaction between urban-related population and agricultural production activities (population interaction zone).

Grid cells assigned to the population interaction zone are further thresholded into zones representing increasingly higher levels of population interaction: rural (little or no urban-related population interaction); low; medium; and high population interaction. Although the "high" zone cells will probably often correlate well with developed land, "population interaction" is not synonymous with urban development. The underlying premise of the map below is that agriculture operates under changing sets of economic and social conditions as one moves across the urban/rural fringe.

Figure 23a



B. Census Bureau[30]

Block group-level GIS data files from the 2000 Census were used to illustrate population, population change, income, and the agricultural cohort for the sub-basin. County block group spatial files were merged and clipped by the sub-basin boundary. The percent of the block group falling in the watershed was calculated, and population figures were prorated by this value. Although this technique erroneously assumes even distribution of the population, it is a more accurate population count for the sub-basin than including the entire block group population.

Figure 23b. 1990 Population - Total population in the sub-basin in 1990 was estimated at 794,992.

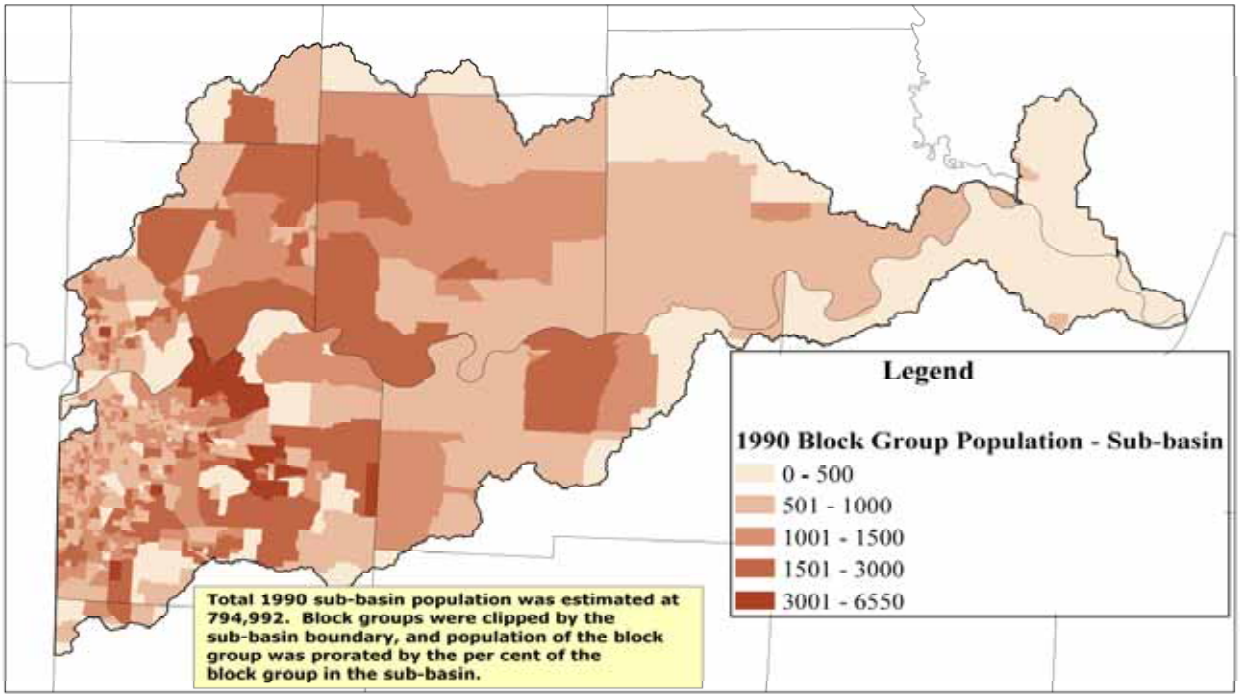
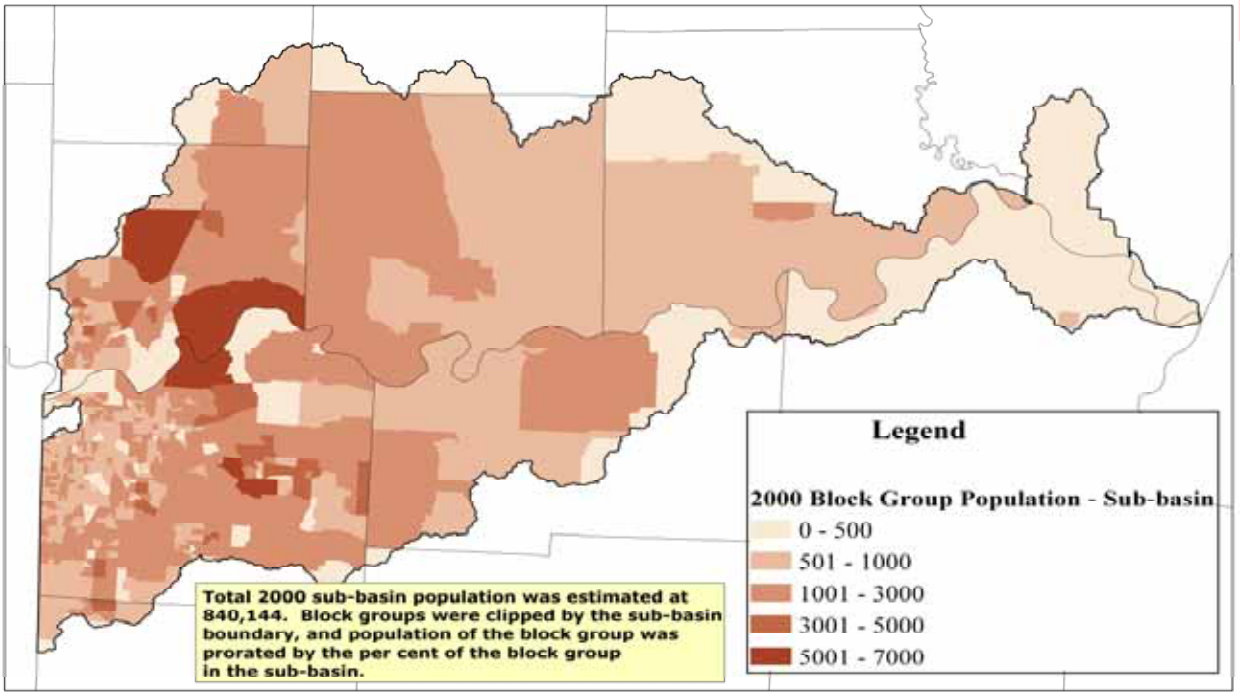


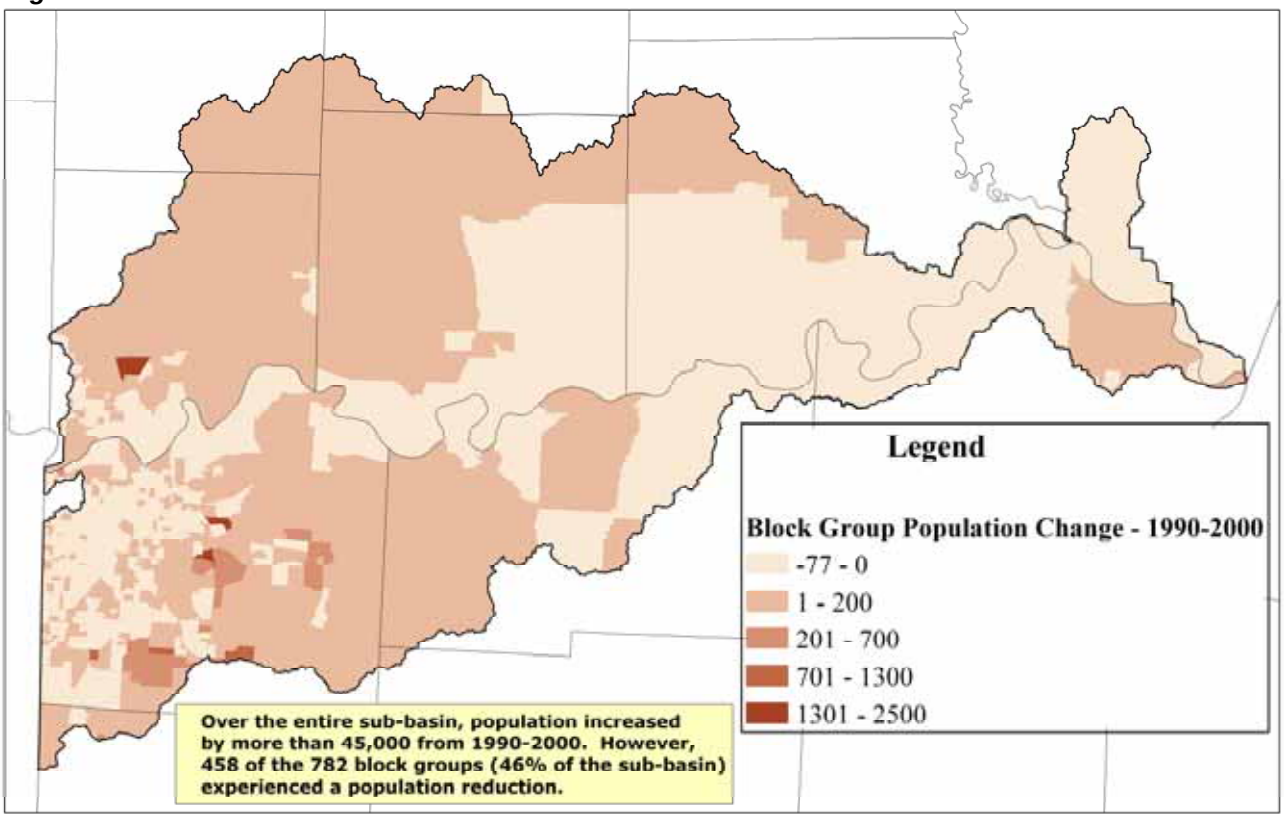
Figure 23c. 2000 Population Total population in the sub-basin in 1990 was estimated at 840,144.



Change in Population

Total population in the sub-basin increased by more than 45,000 from 1990-2000. However, 458 of the 782 block groups (46% pf the sub-basin) experienced a population reduction.

Figure 23d



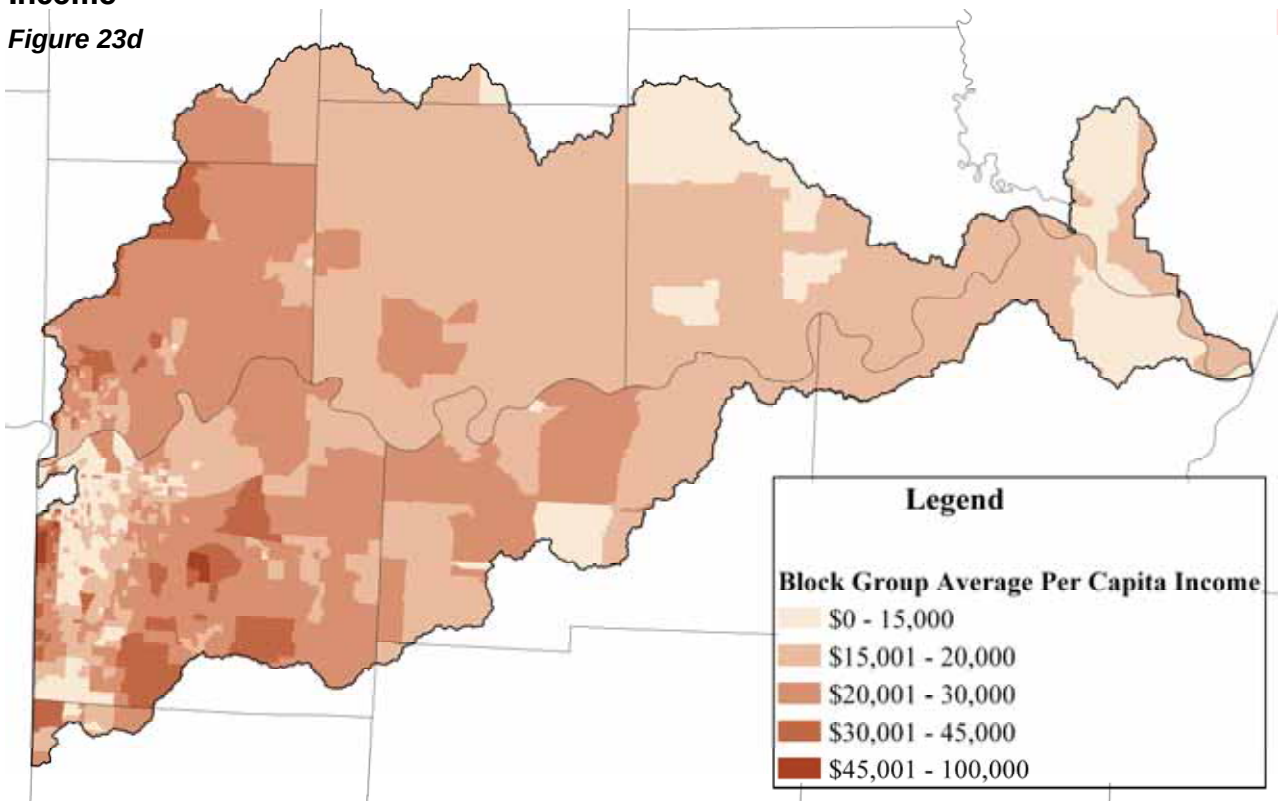
Limited Resource Producer Factor[31]

The Factor equals the number of farms in the county multiplied by the percentage of the county's population below the poverty level and then divided by 1,000.

County	Limited Resource Producer Factor
Caldwell	11
Carroll	15
Cass	9
Chariton	13
Clay	4
Clinton	8
Jackson	10
Johnson	27
Platte	4
Ray	8
Saline	12

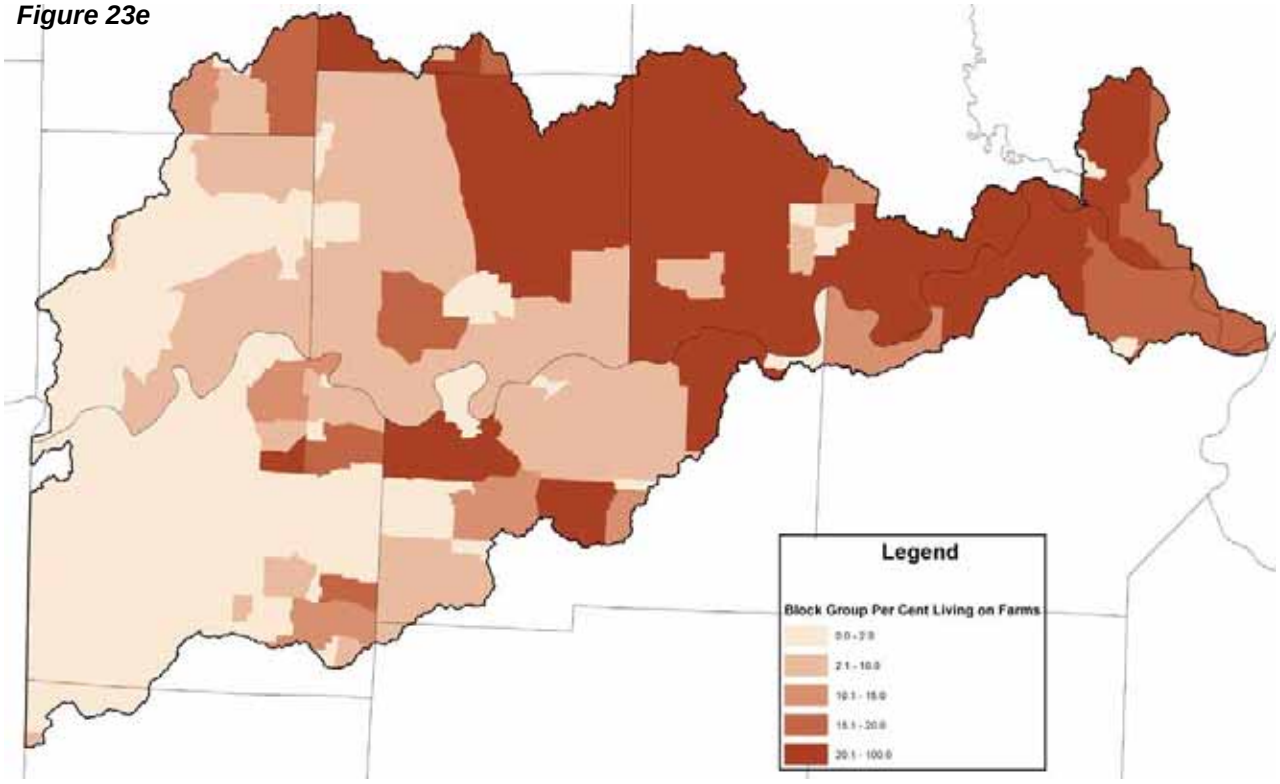
Income

Figure 23d



Farms

Figure 23e



B. Agricultural Census[32]

The data shown in the table are based on countywide information. Only those counties that are 50 percent or more within the Lower Missouri - Crooked River sub-basin are represented in the table. It is believed that the countywide data are fairly representative of the sub-basin portion for each of these counties: Carroll, Clay, Jackson, Lafayette, and Ray.

Data for Caldwell, Cass, Chariton, Cass, Johnson, and Saline counties are not shown. It is believed that countywide data for the sub-basin portions of these counties would have no reliable significance.

Animal data is for grazing livestock only.

Figure 24

COUNTY SUMMARY HIGHLIGHTS, 2002					
	Carroll	**Clay**	**Jackson**	**Lafayette**	**Ray**
Farms	1,081	683	807	1,286	1,231
Land in Farms	417,080 acres	128,118 acres	145,454 acres	363,186 acres	292,067 acres
Cattle	42,790	26,416	16,149	40,408	36,053
Sheep	167	210	372	685	308
Horses & Ponies	680	1,484	2,139	1,112	1,361
Goats	61	194	91	431	282
Cropland Used only for Pasture or Grazing	32,832 acres	16,018 acres	10,760 acres	25,913 acres	33,101 acres
Woodland pastured	8,639 acres	3,368 acres	3,449 acres	9,366 acres	12,497 acres
Permanent Pastureland and Rangeland	33,614 acres	35,377 acres	24,457 acres	33,099 acres	41,124 acres
Pastureland, All Types	75,085 acres	54,763 acres	38,666 acres	68,378 acres	86,722 acres
Percent Pastureland to All Land in Farms	18%	42.7%	26.6%	18.8%	29.7%
Sum of All Grazing Livestock	43,698	28,304	18,751	42,636	38,004
Pastureland per Animal	1.7 acres	1.9 acres	2.1 acres	1.6 acres	2.3 acres

Status of Resources

A. PRS[33]

NRCS' Performance Results System (PRS) is a consolidated reporting system of conservation activities. The following tables summarize conservation systems and practices planned and applied in the sub-basin for the designated time periods. PRS data, in conjunction with other information, are used to assess the current state of the resources in the sub-basin and past efforts to address resource concerns.

FY = Fiscal Year

PRS Data	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Average per Year
Total Acres Conservation Systems Applied	7,344	43,996	32,428	29,972	26,761	Not reported by Hydrologic Unit (HU)	27,207	30,349	28,778

Figure 25. Conservation Practices Applied

Summary Conservation Practices (PRS Number)	FY 04	FY 05	FY 06
Comprehensive Nutrient Management Plan (100)			1
Conservation Cover (327)	3,766 acres	4,317 acres	2,495 acres
Conservation Crop Rotation (328)	10,338 acres	13,540 acres	15,144 acres
Contour Buffer Strips (332)	161 acres		
Contour Farming (330)	5,521acres	5,839 acres	5,893 acres
Cover Crop (340)		90 acres	
Critical Area Planting (342)	42 acres	199 acres	40 acres
Dike (356)	2,378 feet	330 feet	
Diversion (362)	5,430 feet	12,785 feet	8,057 feet
Early Successional Habitat Development/Management (647)			104 acres
Fence (382)	2,375 feet	3,190 feet	4,371 feet
Field Border (386)		6,821 feet	61,965 feet
Filter Strip (393)	93 acres	208 acres	62 acres
Forage Harvest Management (511)	1,241 acres	3,430 acres	3,635 acres
Forest Site Preparation (490)	88 acres	244 acres	
Grade Stabilization Structure (410)	24	33	32
Grassed Waterway (412)	28 acres	82 acres	58 acres
Mulching (484)	7 acres	55 acres	11 acres
Nutrient Management (590)	1,762 acres	4,202 acres	9,147 acres
Pasture and Hay Planting (512)	296 acres	1,892 acres	848 acres

Conservation Practices Applied (continued)

Summary Conservation Practices	FY 04	FY 05	FY 06
Pest Management (595)	3,643 acres	4,201 acres	7,323 acres
Pipeline (516)	250 feet	1,270 feet	
Pond (378)		1	1
Prescribed Burning (338)		30 acres	
Prescribed Grazing (528)	38 acres	244 acres	736 acres
Prescribed Grazing (528A)	3,386 acres	692 acres	210 acres
Residue and Tillage Management, Mulch Till (345)			400 acres
Residue and Tillage Management, No-Till/Strip Till/ Direct Seed (329)			2,220 acres
Residue Management, Mulch Till (329B)	1,169 acres	2,230 acres	1,866 acres
Residue Management, No-Till/Strip Till (329A)	5,139 acres	8,003 acres	5,490 acres
Residue Management, Seasonal (344)	10,744 acres	138 acres	1,806 acres
Restoration and Management of Declining Habitats (643)		78 acres	
Restoration and Management of Natural Ecosystems (766)			54 acres
Riparian Forest Buffer (391)	150 acres	210 acres	60 acres
Sediment Basin (350)			1
Shallow Water Management for Wildlife (646)	10 acres	11 acres	
Spring Development (574)	1		
Structure for Water Control (587)	1		
Subsurface Drain (606)	13,736 feet	23,755 feet	32,519 feet
Terrace (600)	303,006	277,307	428,595
Tree/Shrub Establishment (612)	86 acres	244 acres	68 acres
Tree/Shrub Site Preparation (490)			52 acres
Underground Outlet (620)	68,267 feet	95,596 feet	157,492 feet
Upland Wildlife Habitat Management (645)	4,777 acres	3,731 acres	1,474 acres
Use Exclusion (472)	5,112 acres	2,825 acres	2,210 acres
Waste Utilization (633)			42
Water and Sediment Control Basin (638)	5	1	
Watering Facility (614)	2	5	
Well Decommissioning (351)			3
Wetland Creation (658)	10 acres		
Wetland Restoration (657)	1,453 acres	1,128 acres	114 acres
Wetland Wildlife Habitat Management (644)	754 acres	82 acres	

B. Watershed Projects

In addition to the conservation activities itemized for individual land units, watershed programs and Farm Bill easements contribute to the current state of resources. Past and current activities within this sub-basin are summarized in the tables below.

Figure 40

319 Project Name[35]	**Status**
KC Clean Streams & Clean Water Celebration	Closed
Kansas City Metropolitan Water Quality Initiative	Active
MARC-Groundwater Protection	Closed
McCroskie Creek Watershed Project	Active
T.R.U.E. BLUE: Clean Water Celebration	Closed
True Blue	Closed
Turkey Creek Watershed Protection Project	Active
Urban Conservation Education and Information (Discovery Center, Kansas City)	Active

PL-566 Project Name[36]	**Acres**	**Status**
Little Sni-A-Bar	25,069	Completed
Tabo Creek	84,588	Completed
Wellington-Napoleon	23,632	Completed
Williams Creek	15,240	Completed
Willow-Cravens Creek	34,142	Operational

AgNPS SALT Project Name[37]	**Status**
McCroskie Creek	In-Progress
Turkey Creek	Completed

< Map of projects to go here >

C. Farm Bill Program Lands[38]

In addition to the conservation activities itemized for individual land units, watershed programs and Farm Bill easements contribute to the current state of resources. Past and current activities within this sub-basin are summarized in the table below.

Program	Number of Acres	Number of Contracts or Easements
Conservation Reserve Program (CRP)	55,754	1,535 contracts
Wetland Reserve Program (WRP)	11,248	101 easements

D. Conservation Opportunity Areas[39]

The Missouri Department of Conservation joined with resource partners to take an "all conservation" approach via a framework referred to as Conservation Opportunity Areas (COAs). COAs identify the best places where partners can combine technology, expertise and resources for all conservation, with such focused efforts providing enhanced results. Various future funding opportunities for resource projects will give priority to work addressing the conservation goals within COAs.

Stakeholder groups have been formed and resource profiles developed for thirty-three of the highest priority COAs in Missouri. The Lower Missouri—Crooked River sub-basin contains the majority of a 300,000-acres COA called Wakenda Bottoms, a bottomland forest, wetland complex with excellent restoration potential.

E. Environmental Protection Agency Priority Watersheds[40]

This is the first set of "priority" watersheds identified by the Environmental Protection Agency (EPA), Missouri Department of Natural Resources (MDNR), University Extension, Natural Resources Conservation Service (NRCS) and other stakeholders; approved by the Missouri Clean Water Commission; and made part of MDNR's targeted request for 319 grant proposals in FY 2007. The prioritization process paid particular attention to those watersheds where there is a reasonably high potential to accomplish measurable water quality improvements in a relatively short time.

Figure 27

Change map to show both COAs and EPAPWs

References

1. Nigh, T. A., and Schroeder, W. A. (2002). Atlas of Missouri Ecoregions. Missouri Department of Conservation

   United States Department of Agriculture, Natural Resources Conservation Service (2006). “Land Resource Regions and Major Land Resource Areas of the United

2. USDA, Natural Resources Conservation Service. National Resources Inventory Database, 1997. For more information: http://www.nrcs.usda.gov/technical/NRI/

3. Missouri Resource Assessment Partnership (MoRAP). Missouri Public Lands, 2003. For more information: http://www.cerc.usgs.gov/morap/

4. United States Department of Agriculture (1993). Soil Survey Manual, USDA Handbook No. 18, Soil Survey Division Staff, October.

5. USDA-Natural Resources Conservation Service. Soil Survey Geographic Database (SSURGO), 2007. Available for download at: http://soildatamart.nrcs.usda.gov/

6. USDA-Natural Resources Conservation Service. Common Resource Area (CRA) Map. For more information: http://efotg.nrcs.usda.gov/treemenuFS.aspx select Section I; D. Maps; Common Resource Areas.

7. U. S. Department of Homeland Security, Federal Emergency Management Agency (FEMA). Digital Q3 Flood Insurance Rate Maps. Available for download at: http://www.msdis.missouri.edu/ For more information: http://www.fema.gov/hazard/map/q3.shtm When FEMA Q3 data unavailable, soil attribute frequency of flooding used. See reference 11.

8. U. S. Geological Survey. National Hydrography Dataset (NHD) high resolution (1:24,000-scale) geodatabase. For more information and to download: http://nhd.usgs.gov/data.html

9. U.S. Fish and Wildlife Service. National Wetlands Inventory, 1994. For more information: http://wetlandsfws.er.usgs.gov/NWI/index.html

   Cowardin, Lewis M., Virginia Carter, Francis C. Golet and Edward T. LaRoe (1979). Classification of Wetlands and Deepwater Habitats of the United States”, U.S. Fish and Wildlife Service OBS-79. For more information: http://www.fws.gov/nwi/Pubs_Reports/Class_Manual/class_titlepg.htm

10. Missouri Resource Assessment Partnership (MoRAP). 30 meter Digital Elevation Model (DEM) of Missouri. For more information: http://www.cerc.usgs.gov/morap/

11. Center for Agricultural, Resource and Environmental Systems (CARES), University of Missouri—Columbia. 10 meter Hillshade of Missouri, 2005. Available for download at: http://cares.missouri.edu/projects/hypso.html Also available via CARES Map Room: http://maproom.missouri.edu/

12. Missouri Department of Natural Resources, Division of Geology and Land Survey. Geologic Map of Missouri, 1979 (digitized by CARES, 1998). Available for download at: http://www.msdis.missouri.edu/datasearch/ThemeList.jsp

13. Missouri Department of Natural Resources, Division of Geology and Land Survey. *The Stratigraphic Succession in Missouri*, Thomas L. Thompson, Volume 40 - Revised, 1995.

14. Missouri Department of Natural Resources, Division of Geology and Land Survey, Geological Survey Program. Maps of sinkholes, springs, cave density, dye tracings and losing streams. Available for download at: http://www.msdis.missouri.edu/ For more information: http://www.dnr.mo.gov/env/wrc/springsandcaves.htm

15. Soil Erosion:
Koltun, G.F., M. N. Landers, K.M. Nolan, and R. S. Parker (1997). "Sediment transport and geomorphology issues in the Water Resources Division." Proceedings of the U.S. Geological Survey Sediment Workshop, Feb. 4-7, Reston, VA. and Harpers Ferry, WV. U.S. Geological Survey, Reston, VA.

Potter, S.R., S. Andrews, J.D. Atwood, R.L. Kellogg, J. Lemunyon, L. Norfleet, D. Oman (2006). "Model simulation of soil loss, nutrient loss, and change in soil organic carbon associated with crop production," USDA, Natural Resources Conservation Service, Conservation Effects Assessment Project (CEAP), June.

Ribaudo, M.O., and Johannson, R. (2006), "Water quality? Impacts of agriculture," Chapter 2.2 in Agricultural Resources and Environmental Indicators, 2006 Edition, K. Weibe and N Gollehon (eds), USDA, ERS, Economic Information Bulletin (EBI-16), July.

16. Missouri Department of Natural Resources. Missouri 303(d) List, 2002. For more information: http://www.dnr.mo.gov/env/wpp/waterquality/303d/index.html Available for download at http://www.msdis.missouri.edu/

17. U. S. Department of Agriculture, Farm Services Agency. Common Land Units (CLU), 2007. (sensitive data—not available for download).

18. Missouri Department of Natural Resources, Division of Environmental Quality, Wellhead Protection Section. Certified Wells, 2006. For more information: http://www.dnr.mo.gov/env/wpp

19. Missouri Department of Natural Resources, Air and Land Protection Division, Solid Waste Management Program. Landfills, 2004. Available for download at http://www.msdis.missouri.edu/ For more information: http://www.dnr.mo.gov/env/swmp/facilities/permittedfacilities.htm

20. Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waste Program, Permits Section. Hazardous Waste Program Permits, 2004. Available for download at http://www.msdis.missouri.edu/ For more information: http://www.dnr.mo.gov/env/hwp

21. Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waster Program, Tanks Section. Active Tanks, 2004. Available for download at http://www.msdis.missouri.edu/ For more information: http://www.dnr.mo.gov/env/hwp/tanks/tanks.htm

22. Missouri Department of Natural Resources, Air and Land Protection Division, Hazardous Waste Program, Tanks Section. Remediation Sites, 2004. Available for download at http://www.msdis.missouri.edu/ For more information: http://www.dnr.mo.gov/env/hwp/tanks/tanks.htm

23. Missouri Department of Natural Resources, Environmental Quality Division, Water Protection Program. Missouri National Pollutant Discharge Elimination System Facilities, Water Quality Information System. Available for download at: http://www.msdis.missouri.edu/. For more NPDES information: http://cfpub.epa.gov/npdes and http://www.dnr.mo.gov/env/wpp/index.html

24. Missouri Department of Natural Resources, Division of Environmental Quality. "2007 Census of Missouri Public Water Systems", Water Protection Program, Public Drinking Water Branch, Census of Public Drinking Water Supply Systems, 2007. Available at: http://www.dnr.mo.gov/env/wpp/census.htm

25. University of Missouri—Columbia, Center for Agricultural, Resource and Environmental Systems. "Source Water Inventory Project", 2004. Available at: http://drinkingwater.missouri.edu/swip/index.html

26. Edwards, J., Chen, S., McIntosh, S. (2005) "Missouri Water Supply Study—2005", Missouri Department of Natural Resources, Office of the Director, Water Resources Center. Available at: http://www.dnr.mo.gov/env/wrc/drought/RESOPreports.htm

27. Missouri Department of Natural Resources, Division of Environmental Quality (2006). "2006 Missouri Water Quality Report", Water Pollution Control Branch, Missouri Water Quality Reports. For more information: http://www.dnr.mo.gov/env/wpp/waterquality/305B/index.html

28. Missouri Department of Conservation. Heritage database, 2005. For more information: http://mdc.mo.gov/nathis/heritage/

29. Luboski, R. (2005). "A Population Interaction Index (PII)", In United States Department of Agriculture, Economic Research Service, Briefing Room, Land Use, Value and Management: Measuring Interactions Between Urban Populations and Agricultural Production, Measures of Population Interaction, June. For more information: http://www.ers.usda.gov/Briefing/Landuse/measuringurbanchapter.htm

30. U.S. Department of Commerce, Bureau of the Census. 2000 Block Group geography and summary file 3 (SF3) tabular attributes. Available for download at: http://www.msdis.missouri.edu/. For more information: http://mcdc.missouri.edu/census2000/

31. U.S. Census Bureau, Census of Population and Housing. Demographic Profile, 2000. *Factor = number of farms in the county multiplied by the percentage of the county's population below the poverty level and then divided by 1,000.*

32. Census of Agriculture Missouri: Released June 3, 2004, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture, 2002.

33. USDA-Natural Resources Conservation Service. Performance Results System (PRS), 2004-2006 reports. For more information http:/ias.sc.egov.usda.gov , reports tab.

34. Missouri Department of Natural Resources, Environmental Quality Division, Water Protection Program. Section 319 Non-Source Point (NPS) Implementation Program Map. For more information: http://www.dnr.mo.gov/env/wpp/nps/319nps-statewide-map.htm

35. U.S. Department of Agriculture, Natural Resources Conservation Service. PL-566 program. For

more information: http://www.mo.nrcs.usda.gov/programs/pl566/pl_566.html

36. Missouri Department of Natural Resources, Water Resources Division, Soil and Water Conservation Program. Special Area Land Treatment (SALT) Program map. For more information: http://www.dnr.mo.gov/env/swcp/Services/swcpsalt.htm

37. U.S. Department of Agriculture, Natural Resources Conservation Service. Wetlands Reserve Program (WRP), Grassland Reserve Program (GRP) and Farm and Ranch Land Protection Program (FRPP) and Conservation Reserve Program (CRP), 2007. (sensitive data—not available for download).
For more information on WRP: http://www.mo.nrcs.usda.gov/programs/wrp/wrp.html
For more information on GRP: http://www.mo.nrcs.usda.gov/programs/grp/grp.html
For more information on FRPP: http://www.mo.nrcs.usda.gov/programs/frpp/fpp.html
For more information on CRP: http://www.mo.nrcs.usda.gov/programs/CRP/crp_index.html

38. Missouri Department of Conservation, Wildlife Division. Comprehensive Wildlife Strategy Conservation Opportunity Areas map. For more information: http://mdc.mo.gov/nathis/cws/coa/

39. Missouri Department of Natural Resources, Division of Environmental Quality, Water Protection Program (2006).

40. U.S. Environmental Protection Agency (2002). National Water Quality Inventory: 2000 Report to Congress. EPA841-R-02-001. Office of Water, August.

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