LITTLE SAC RIVER WATERSHED MANAGEMENT PLAN

WATERSHED COMMITTEE OF THE OZARKS
&
GREENE COUNTY SOIL AND WATER CONSERVATION DISTRICT

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Summary

Introducing the project

Disclaimer

*The Little Sac Watershed Management Plan is a non-regulatory document. It portrays the watershed and its water quality, what actions are presently being done to maintain water quality, and what actions are needed to improve water quality. All best management practices suggested to stakeholders are purely voluntary in their implementation. If there is a desire to see the water quality improve in the Little Sac River watershed, it is the residents in the watershed that hold that responsibility. This includes city, county, public and private properties within the watershed. Our water can only be as clean as we make our watershed.

*This plan is intended to be ever-changing and dynamic, just as the river and its watershed. One set of plans made at this time may not meet the challenges that arise in the future. If major changes are seen in the watershed or seen in the water quality of the Little Sac River then the plan should be addressed as deemed necessary to compensate for the water quality in the watershed. Otherwise, it should be re-visited every 5-8 years to evaluate the effectiveness of the management measures, and the perception of the public on the water quality.

*Also included in the plan are 9 critical elements. These 9 critical elements are identified by the EPA and MODNR to be essential to a successful watershed management plan. Comments and concerns were recorded from initial stakeholder meeting within the watershed and then adapted to the 9 critical elements that are required. This approach then satisfies both regulatory purposes and public concerns about the watershed. The 9 elements also act as a framework for the plan. Outlining who, what, where, when, why and how much management measures intended to improve water quality will cost.

Mission Statement and Purpose

To help stakeholders identify water quality concerns and to develop a collective vision of protection and restoration of the watershed using a long range management plan.

A Watershed Management Plan for the Little Sac River watershed (HUC 10290106060) is necessary to guide stakeholders within the watershed as they seek to improve the Little Sac River water quality. The Watershed Committee of the Ozarks and Greene County believe that creating a watershed management plan for the Little Sac River watershed will help to protect and improve water quality in Fellows, McDaniel, and Stockton lakes (important drinking water resources) by identifying pollutant sources, identifying better management practices to be implemented, setting reachable goals and developing a timeline for implementation. A management plan would also help our current monitoring program to determine success of implemented projects/programs.

Development of a watershed management plan will increase the success of future projects, address issues related to the current TMDL for the Little Sac River, help to better determine where efforts should be focused, and fulfill specific grant application requirements for securing future funding.

The current TMDL (Total Mass Daily Load) for the Little Sac River focuses on the bacteria levels present within the river. To follow the approved TMDL, the majority of the management measures in the watershed plan are focused on reducing the bateria/E.coli present in the river. The management measures also address other water quality issues such as education, stormwater runoff and nutrients.

Our mission for this plan is to help stakeholders of the watershed improve water quality with a watershed plan. To do that we have kept this document to the point and as concise as possible to help stakeholders understand and utilize this plan for future implementation in the watershed.

History of Watershed Committee

The Watershed Committee of the Ozarks began 24 years ago, the Chair of the Board of Public Utilities, N. L. "Mac" McCartney, sent a memo to Springfield Mayor Harry Strawn. The memo began: "With your concurrence, I have appointed an ad hoc task force to develop a program for the protection of surface and subsurface watersheds which supply Springfield and the surrounding area with drinking water." It was a prophetic statement and a visionary approach. Development was encroaching into the drinking watersheds and officials worried about whether public policies and programs would effectively protect our precious drinking water supplies.

In November 1983, the Task Force issued its report and recommendations, many of which are pertinent and instructive even today. One recommendation centered on the need for a permanent body whose primary purpose would be oversight and protection of public drinking water sources. From this recommendation, the Watershed Management Coordinating Committee was established. In 1989, the organization became a non-profit corporation and changed its name to Watershed Committee of the Ozarks. The Committee adopted a six-member board, comprised of three citizen appointees representing the respective sponsors and three at-large positions.

"The mission of the Watershed Committee of the Ozarks is to preserve and improve the water supplies of Springfield and Greene County through education and effective management of the region's watersheds"

History of Greene County SWCD

Soil and Water Conservation District: In the 1930s, Americans realized how devastating soil erosion could be, as the Dust Bowl swept across the nation relocating an estimated 300 million tons of soil. Legislation began to take shape to better manage and conserve our nation's soil.

A one-tenth-of-one-percent parks, soils and water sales tax was passed by Missouri voters in 1984 to fund state parks and soil and water conservation efforts. It is estimated that more than 148 million tons of soil have been saved since the start of the sales tax, but millions of tons of soil still wash away every year on cultivated cropland in Missouri. The majority of this tax has been used to assist agricultural landowners through voluntary programs that are developed by the Soil and Water Districts Commission. The agricultural nonpoint source special area land treatment program provides funding for five to seven year projects that focus on decreasing sediments, pesticides and nutrients from entering waterways. By promoting good farming techniques that help keep soil on the fields and our waters clean, each soil and water conservation district is conserving the productivity of our working lands.

History within the Little Sac Watershed

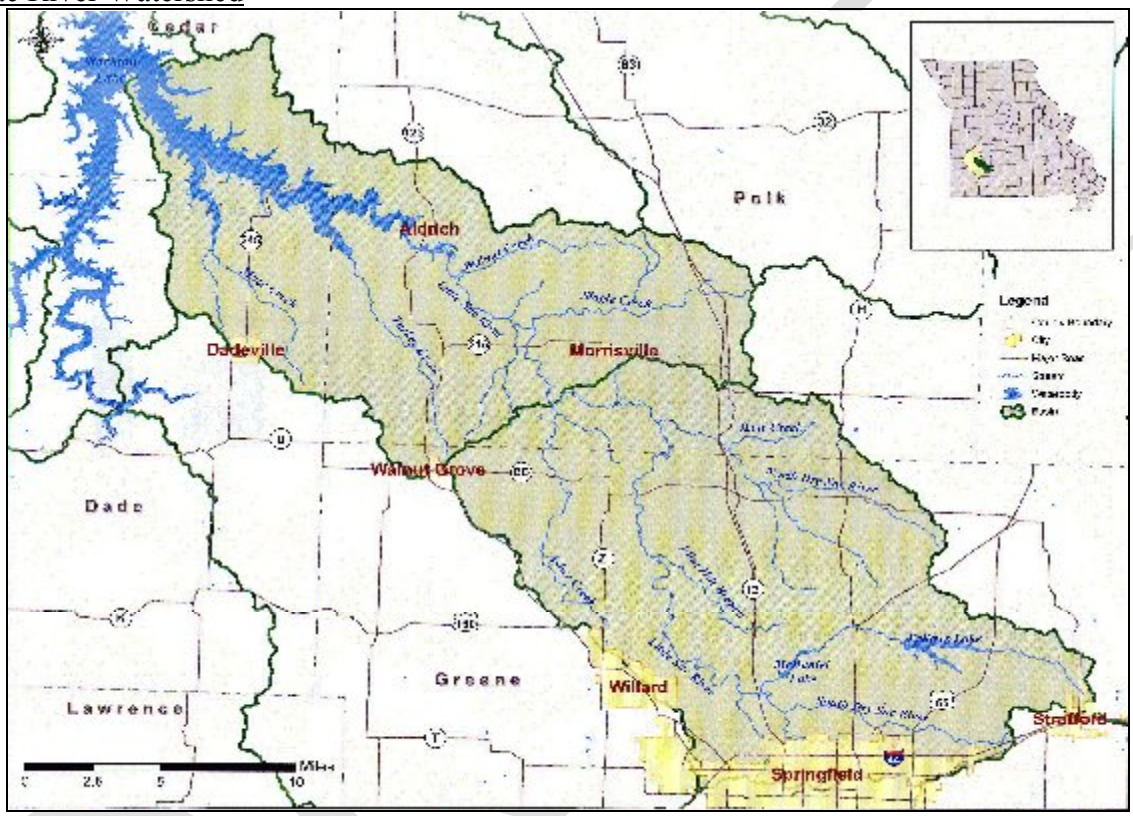
Both the Watershed committee of the Ozarks and the Greene County SWCD has helped to implement past management measures in the Little Sac Watershed. During the Little Sac Restoration Project (2001-2005), a past 319 project in the Little Sac Watershed, WCO utilized the SWCD, NECS, and MDC professionals to aid in the installation of conservation practices on landowners in the watershed.
They completed: 5 Riparian Restoration Sites, 5 Management Intensive Grazing Systems, 6 Alternative watering systems, 1 Animal Waste Containment System.

A list on page 37 lists other research, water quality data, and project that have been completed in the watershed to date.

Introduction of the Little Sac River Watershed

The Little Sac River begins at the north edge of Springfield and Strafford to form Fellows and McDaniel Lakes. On its journey north into Stockton Lake, the Little Sac's 41.5 mile channel gains flow through springs and its major tributaries; Slagle Creek, North Dry Sac, South Dry Sac, Asher Creek. The 390 square mile watershed encompasses the towns of Willard, Walnut Grove, and Morrisville. This watershed has a diverse land use that changes from very urbanized/high density population in the upper, southern part of the watershed to rural agricultural land use in the middle two-thirds, and recreational areas surrounding Stockton Lake.

Little Sac River Watershed



Soils, Climate and Geologic Characteristics

The Little Sac watershed originates in Eldon-Pembroke, Peridge-Wilderness-Goss-Pembroke, and Needleye-Viraton-Wilderness soil associations. It then flows through Peridge-Wilderness-Goss-Pembroke soils. The lower reach flows through Hartville-Ashton-Cedargap-Nolin bottomland soils until it is inundated by Stockton Reservoir. Two impoundments near the headwaters of the Little Sac watershed (Fellows Lake and McDaniel Lake) cause a rapid descent to Hartville-Ashton-Cedargap-Nolin bottomland soils. In general, the soils are moderately deep to very deep, moderately well drained to well drained, and medium to fine textured.

The watershed is characterized by a temperate climate with warm, humid summers and cool, wet winters. The National Oceanic and Atmospheric Administration (NOAA) operate a climatological station at the Springfield-Branson Regional Airport, which is in the northwestern part of the city of Springfield. The average temperature range as measured at the airport is 67 to 90 °F (degrees Fahrenheit) during the summer and 20 to 42 °F during the winter. The average annual precipitation is between 40 and 42 in. (inches) of rainfall and 17 in. of snowfall in Springfield. The annual runoff from precipitation ranges from 8-10 inches.

Elevations in the watershed range from 270 m (885 ft) at the watershed outlet to 455 m (1490 ft) at the southeastern boundary. The major part of the watershed consists of rolling plains. On the east side, broad upland

areas divide the Little Sac watershed from the Pomme de Terre watershed.

Hydrologic Setting

The Ozarks, including the lower Little Sac River watershed, are well known for their karst geology characterized by numerous sinkholes, caves, bedrock fractures and streams. The karst developments that are typical of the Springfield plateau aquifer are mostly located south and east of the Little Sac River Watershed.

Two aquifers lie under the Little Sac River Watershed. The Ozark aquifer is a high-yielding, deep confined aquifer of generally very good quality. It provides for municipal, agricultural, and industrial water. The Springfield plateau aquifer is an unconfined shallow aquifer located about 200 ft below the ground surface that is recharged by precipitation. The aquifer is generally of good quality and was a water supply resource until the mid-1950s. Since then, the contamination of the aquifer around Springfield and other places has prompted stricter regulations for wells. Most of the domestic water is now pumped from the deep Ozark aquifer but the Springfield plateau aquifer still provides agricultural and industrial water.

Land Use

The Little Sac River Watershed is located in the Ozark Border Area, Major Land Resource Area (MLRA) 116B. This area is part of the northeast and central farming forest region. The Ozark Border MLRA is comprised of approximately 35 % forest, 25 % pasture mainly of introduced grasses and legumes, and 40 % cropland. Feed grains and hay are the main crops. Summer droughts and steep slopes limit the use of the land for crop production. Shallow wells, small creeks, or springs are often used for livestock needs. Deep wells supply drinking water and water for high volume uses. This area supports oak-hickory forests. The grassland supports a combination of introduced and native tall-prairie grasses consisting mainly of indian grass, little bluestem, big bluestem, and switch grass. Introduced grasses include fescue, annual crab grasses, and Kentucky bluegrass. The pastures are mostly in fescue grass over-seeded with red clover.

The watershed consists mostly of grassland (67 %) and forests (30 %). The grassland designation includes hay, pasture, and land enrolled in the Conservation Reserve Program (CRP). Hay and CRP land, which are sometimes considered cropland, behave more like grassland in terms of runoff, erosion, and nutrient loads and have been left in this class. Urban areas are found in 2.4% of the watershed. This is the north part of Springfield. A high contamination potential is due to the high urban population density and the amount of impervious surfaces. Springfield is about 25% impervious on average draining to this watershed. New developments have been required to use extended detention basins with approx 40 hours of retention time as well as grass buffer strips and grass channels since the Water Quality Protection Policy passed in 1999.

The Little Sac River, from a canoer's eye view

The upper part of the Little Sac River starts near Strafford. If flows through Fellows and McDaniel lakes before meeting up with the South Dry Sac. This is where the river begins to hold enough water to float a canoe. Shortly after the confluence of the Dry Sac River the Little Sac receives the effluent of the North West Waste Water Treatment Plant. For this reason the stream gets looked down upon. There are plenty of great features to the Little Sac that outweigh the fact that treated effluent is released into the stream. If not for this Watershed Management Plan we would we would not have gained a more intimate and pleasant understanding of the Little Sac that we now enjoy.

The Little Sac is a different type of stream than most. It is fighting for its identity. It is stuck halfway between the clear Ozarks water and the turbid northern waters. This is very evident when floating the stream. The upper half reveals more characteristics of the Ozark streams, with large gravel, cobble and boulders. The lower section is more typical of a north central Missouri stream, turbid, large woody debris and mud. Same stream yet the end looks nothing like the beginning.

This stream is just as scenic as it nearby cousins, Pomme de Terre and the Niangua. It has its share of bluffs, rock ledges, small waterfalls, fast shoots of white water and yes it has fish too. The Little Sac has an abundance of common carp, a variety of sunfish, and bass mixed in on the rocky areas. The lower Little Sac River has the influence of Stockton Lake, so many species come to spawn in the river, such as white bass, walley, and catfish.

Though carp may not the best fish to put on the table they are a very wary fish to approach and are very strong fighters once caught. They are a challenge to any angler looking for a great sporting opportunity.

There is also plenty of wildlife present in the water. Native mussels, mayflies, red ear sliders, northern water snakes, great blue herons, yellow crowned night herons, green herons, barred owls, white tail deer, beavers, otters, mink, wood ducks, and many other water loving wildlife live on the banks of the Little Sac.

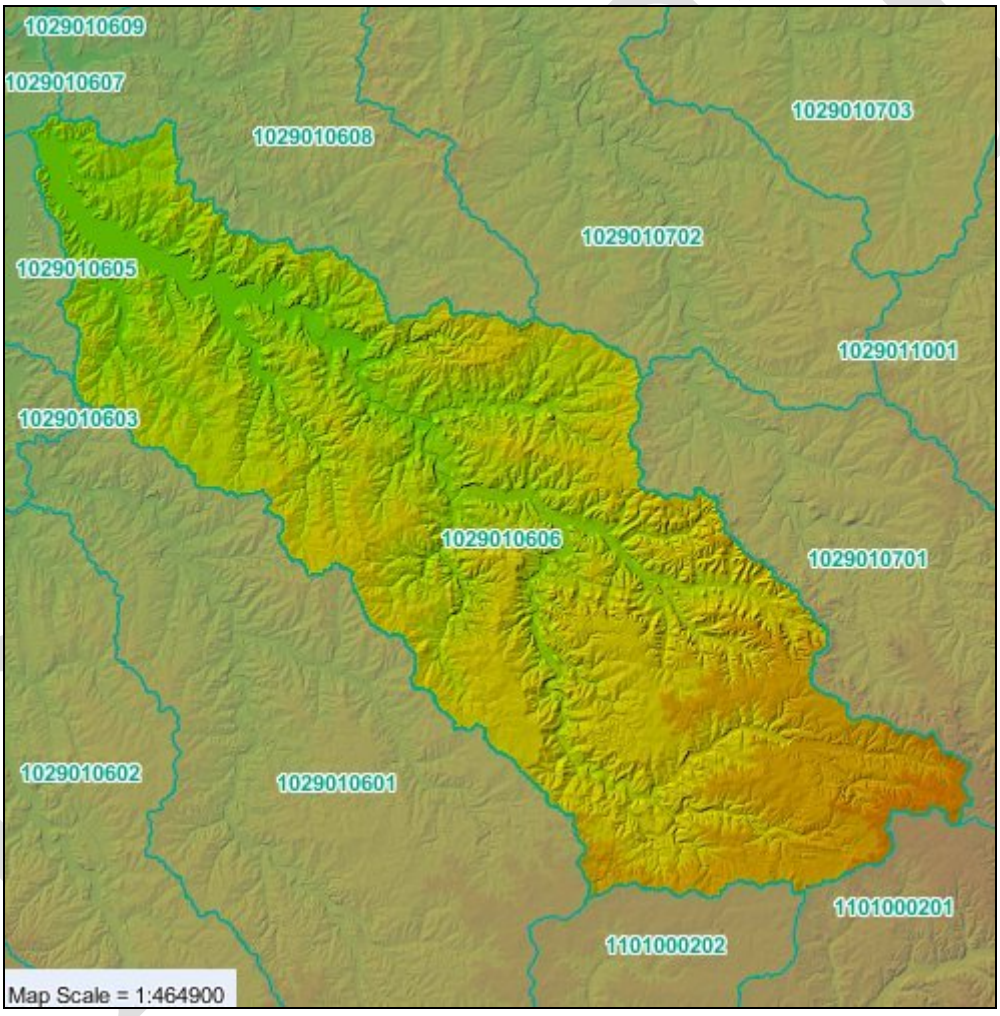
So just because the Little Sac receives the effluent from a treatment plant don't right it off, it is a great place to go and enjoy the wildlife and the scenery of the Ozarks.

Describing the Little Sac River Watershed (Maps)

Relief Map

Little Sac River (1029010606)

Minimum Elevation	780.5 ft
Maximum Elevation	1515.3 ft
Mean Elevation	1102.9 ft



Land Slope

Little Sac River (1029010606)

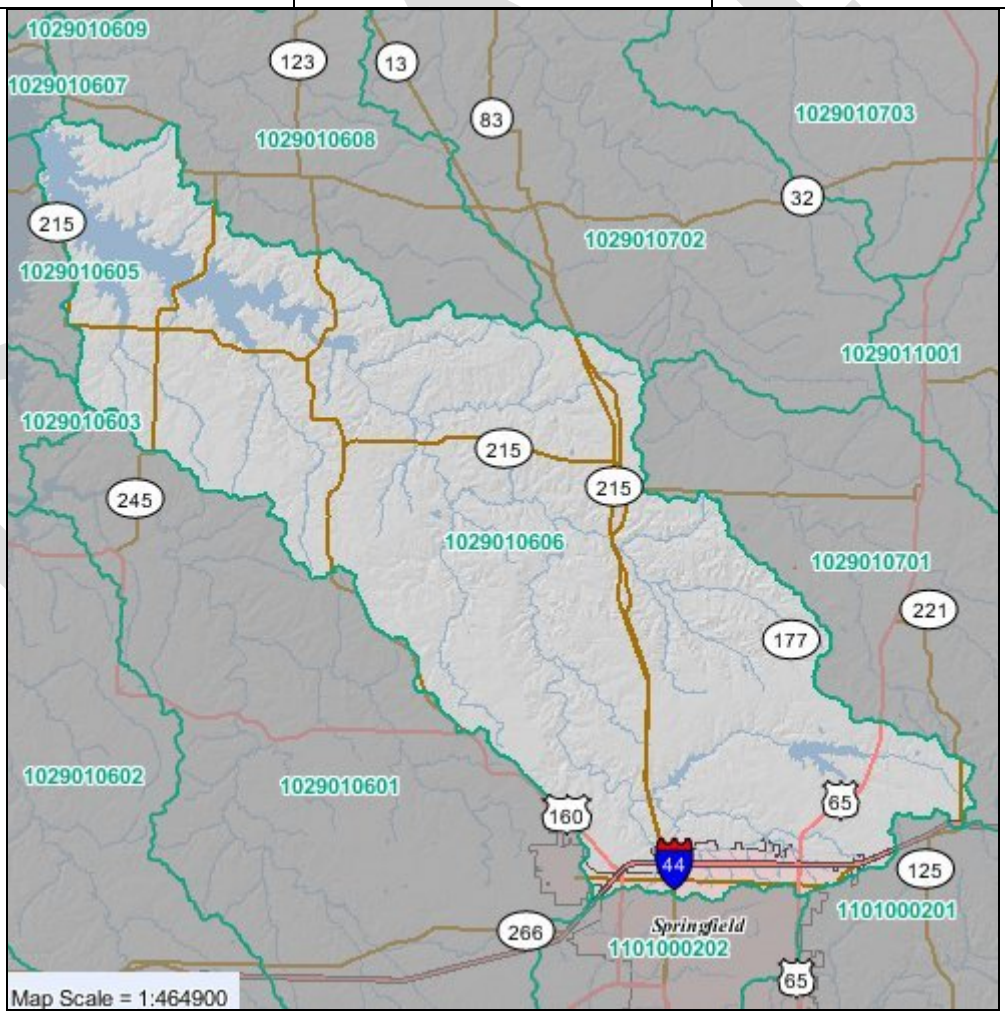
Slope Category	Acres	Percent
0 - 3%	70,959	26.12%
3 - 6%	75,743	27.88%
6 - 10%	62,807	23.12%
10-15%	37,973	13.98%
> 15%	24,157	8.89%
Total:	271,639	100.00%

Streams

Little Sac River (1029010606)

Stream Name (top 5)	Miles
Sac River	67.34
Little Sac River	55.12
Asher Creek	14.02
North Dry Sac River	13.94
Slagle Creek	10.77

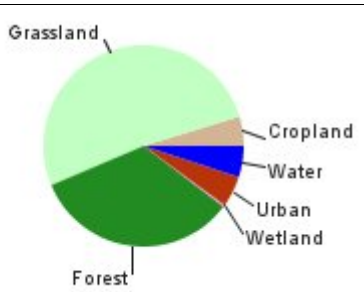
Stream Type	Miles	Percent
Perennial	150.50	16.16%
Intermittent	510.61	54.83%
Undesignated	158.92	17.06%
Other	111.29	11.95%
Total	931.33	100%

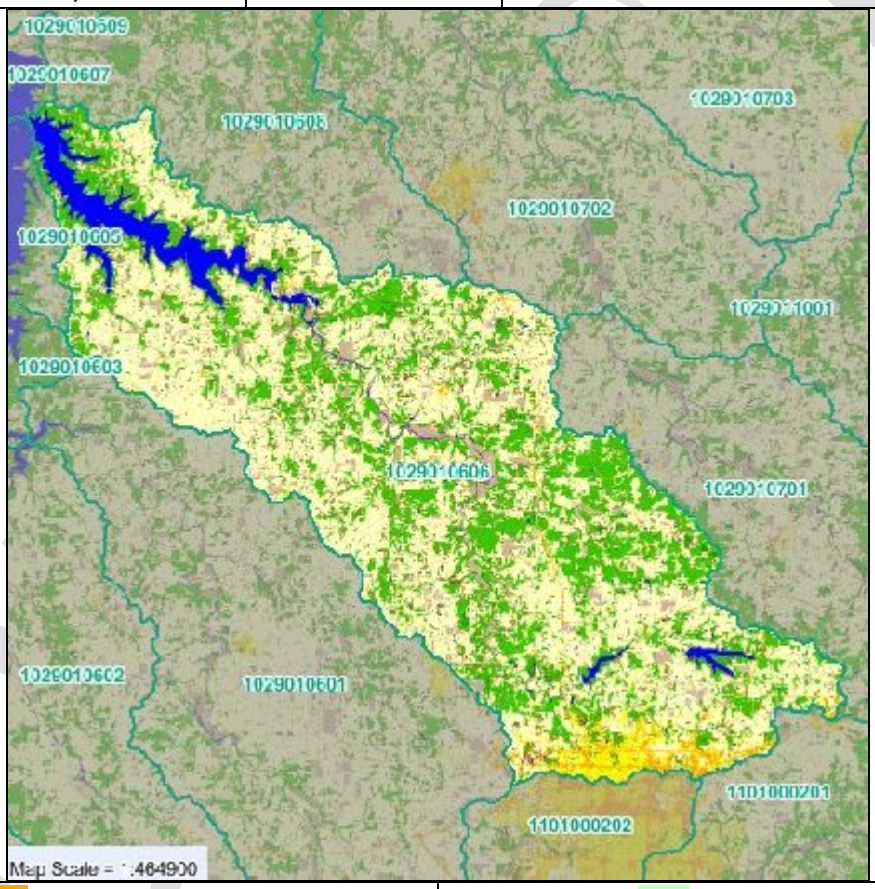


Land Use/Land Cover

Little Sac River (1029010606)

LandCover	Acres	Percent
Cropland	12,973.63	4.78%
Grassland	140,274.00	51.64%
Forest	90,776.69	33.42%
Wetland	819.52	0.30%
Urban	13,665.05	5.03%
Water	13,124.19	4.83%



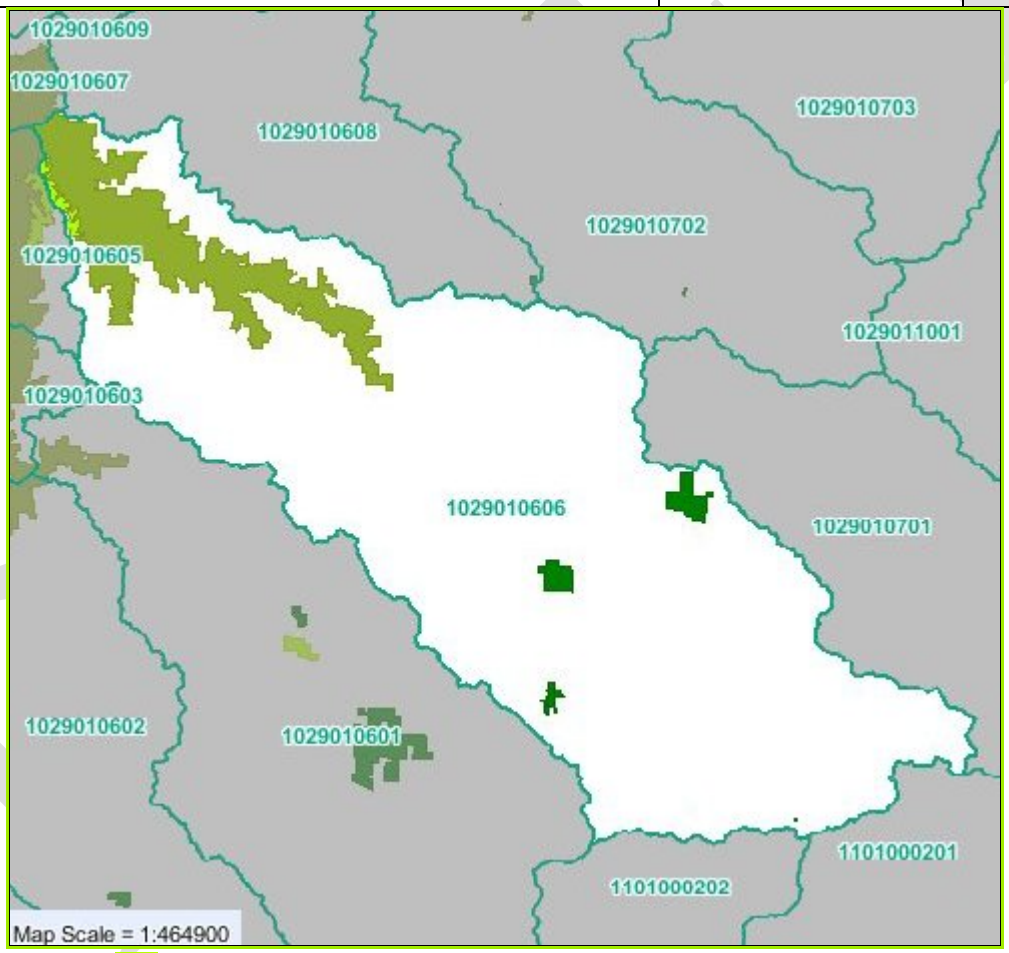


Impervious	Mixed Forest
High Density Urban	Deciduous Woody/Herbaceous
Low Density Urban	Evergreen Woody/Herbaceous
Cropland	Woody-Dominated Wetland
Grassland	Herbaceous-Dominated Wetland
Deciduous Forest	Open Water
Evergreen Forest	Barren or Sparsely Vegetated

Public Lands

Little Sac River (1029010606)

	Acres	% of HU
Total: » list all	31,710.9	11.67%
BONA GLADE DNA	17.6	0.01%
LITTLE SAC WOODS CA	771.1	0.28%
OZARK EMPIRE FAIR FACILITY	0.3	0.00%
PLEASANT HOPE CA	1,110	0.41%
ROCKY BARRENS CA	275.1	0.10%

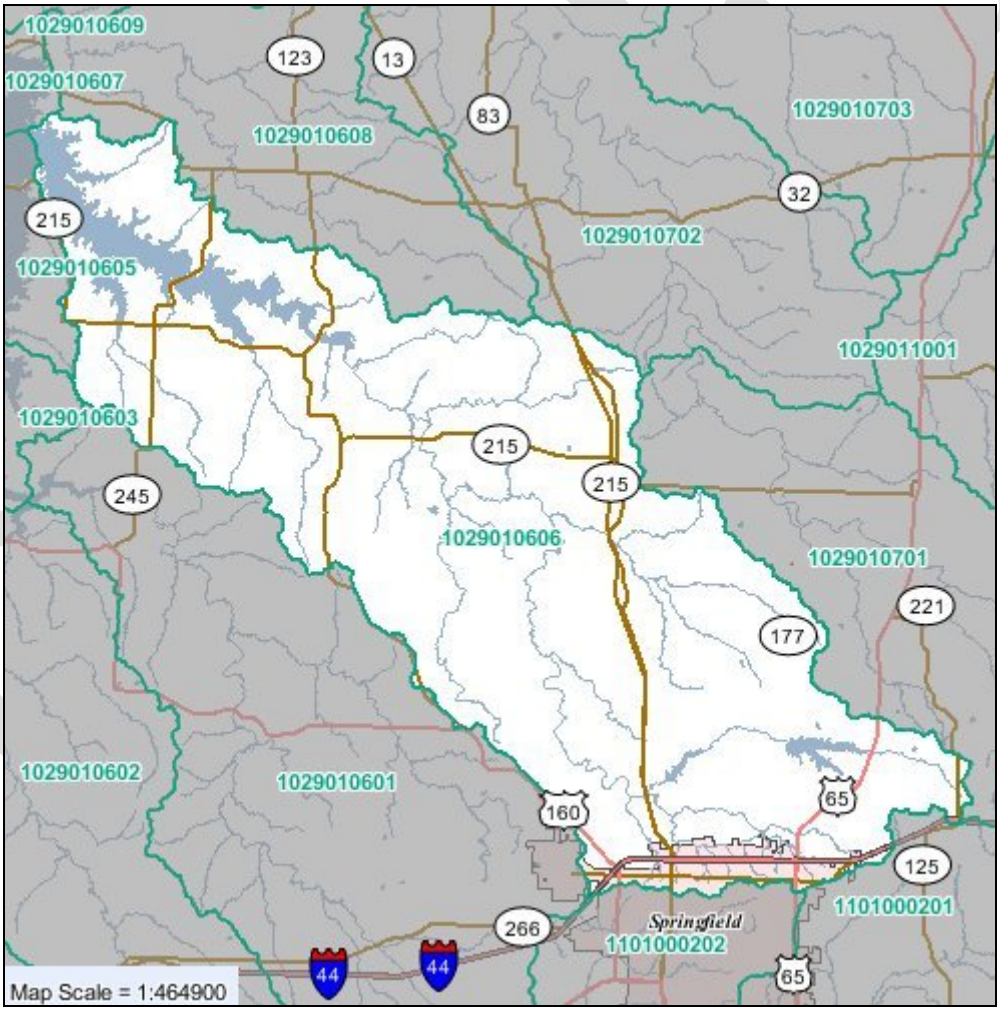


Missouri Department of Natural Resources
Missouri Department of Conservation
U.S. Corps of Engineers
U.S. Forest Service
U.S. Fish & Wildlife Service
National Park Service

Crop Acres by Crop Type

Little Sac River (1029010606)

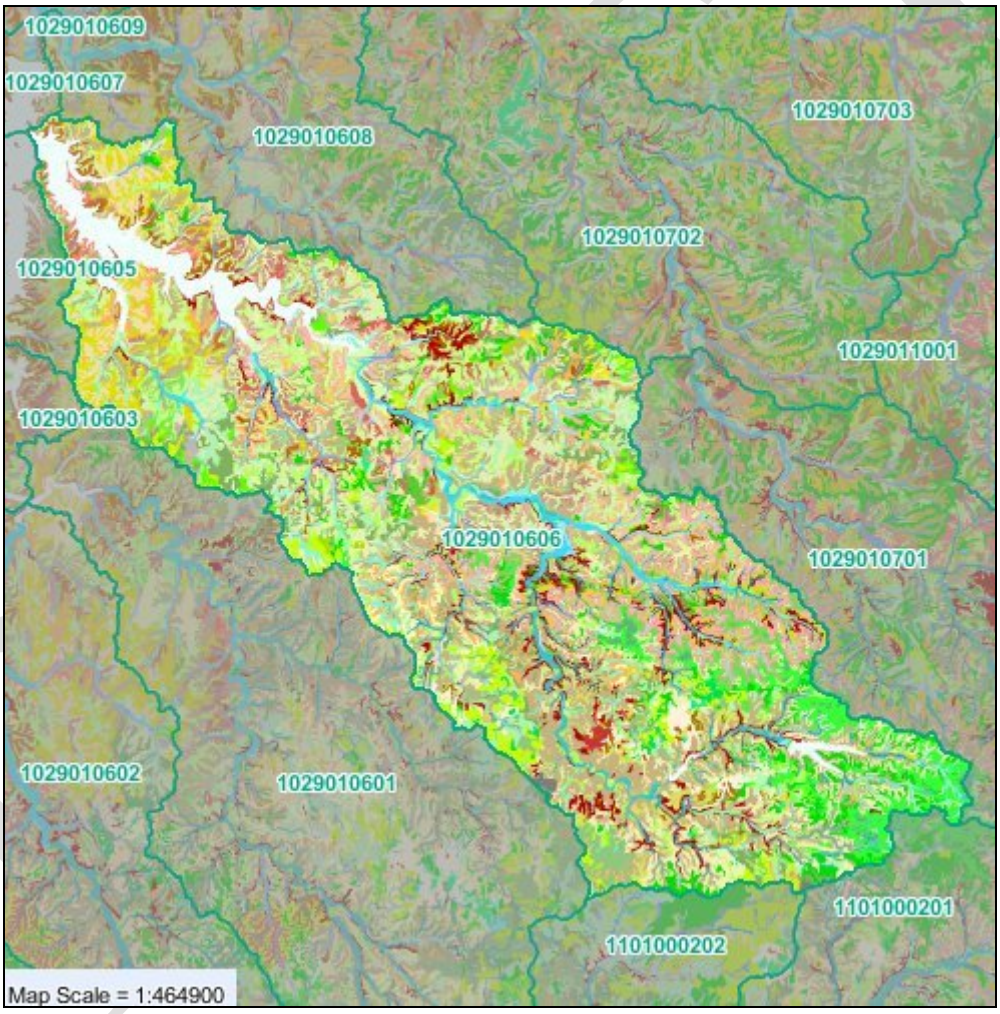
Crop Type	Acres	Percent
Corn, grain	1,205.1	0.44%
Corn silage	165.9	0.06%
Soybean	3,590.4	1.32%
Sorghum	569.7	0.21%
Wheat	1,582.6	0.58%
Oats	101.5	0.04%
Rice	0	0%
Cotton	0	0%
Tobacco	8.1	0%



Soils

Little Sac River (1029010606)

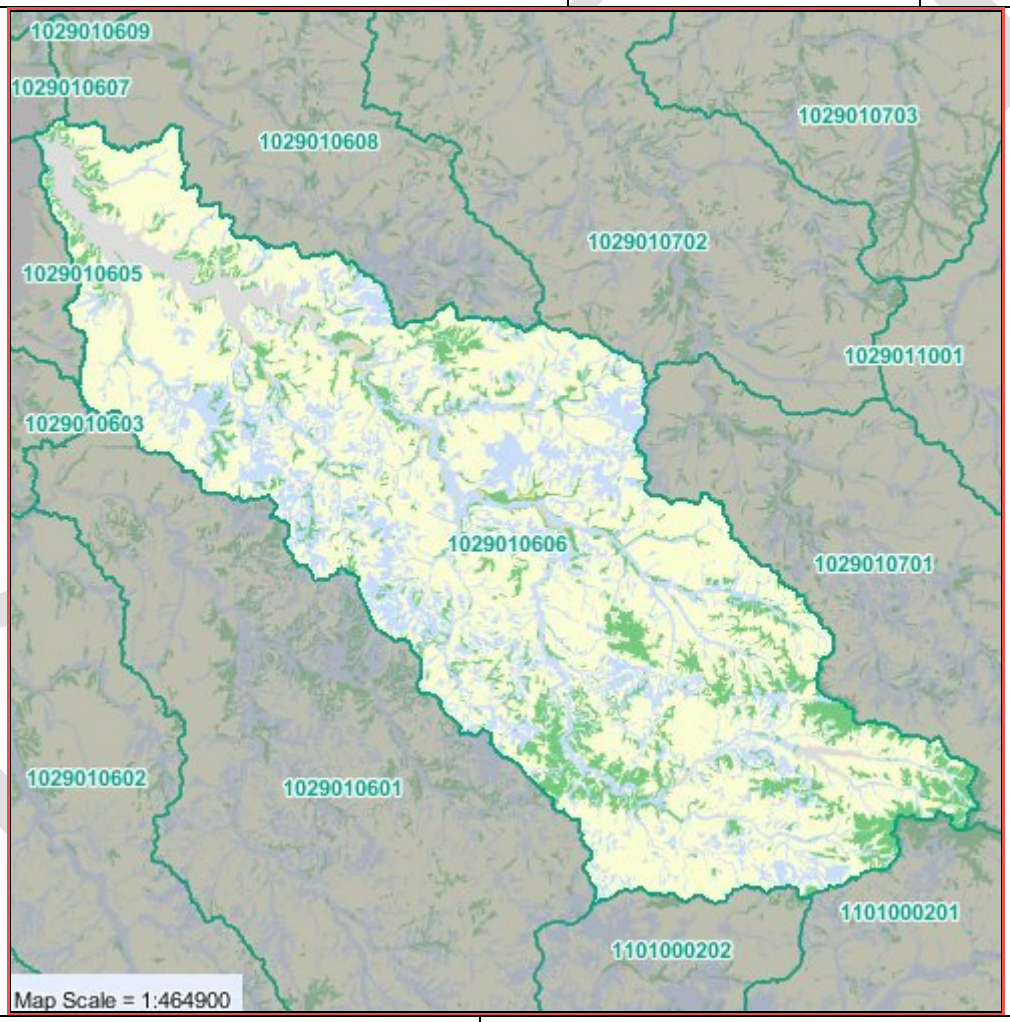
Map Unit Name (top 5) » list all soils	Percent
Goss gravelly silt loam, 8 to 15 percent slopes	15.26%
Goss gravelly silt loam, 3 to 8 percent slopes	5.42%
Alsup silt loam, 15 to 35 percent slopes, very stony	4.88%
Wilderness gravelly silt loam, 3 to 8 percent slopes	4.81%
Water	4.11%



Hydrologic Soil Groups

Little Sac River (1029010606)

Group Type	Acres	Percent
A	0	0.00%
B	59,942.58	22.07%
B/D	0	0.00%
C	165,600.22	60.96%
C/D	699.54	0.26%
D	33,633.78	12.38%
Not Rated	11,762.22	4.33%



A: High Infiltration Rate
B: Moderate Infiltration Rate
B/D: Combination of Group B and D
C/D: Combination of Group C and D
D: Very Slow Infiltration Rate
Not Rated
C: Slow Infiltration Rate

Highly Erodible Lands

Little Sac River (1029010606)

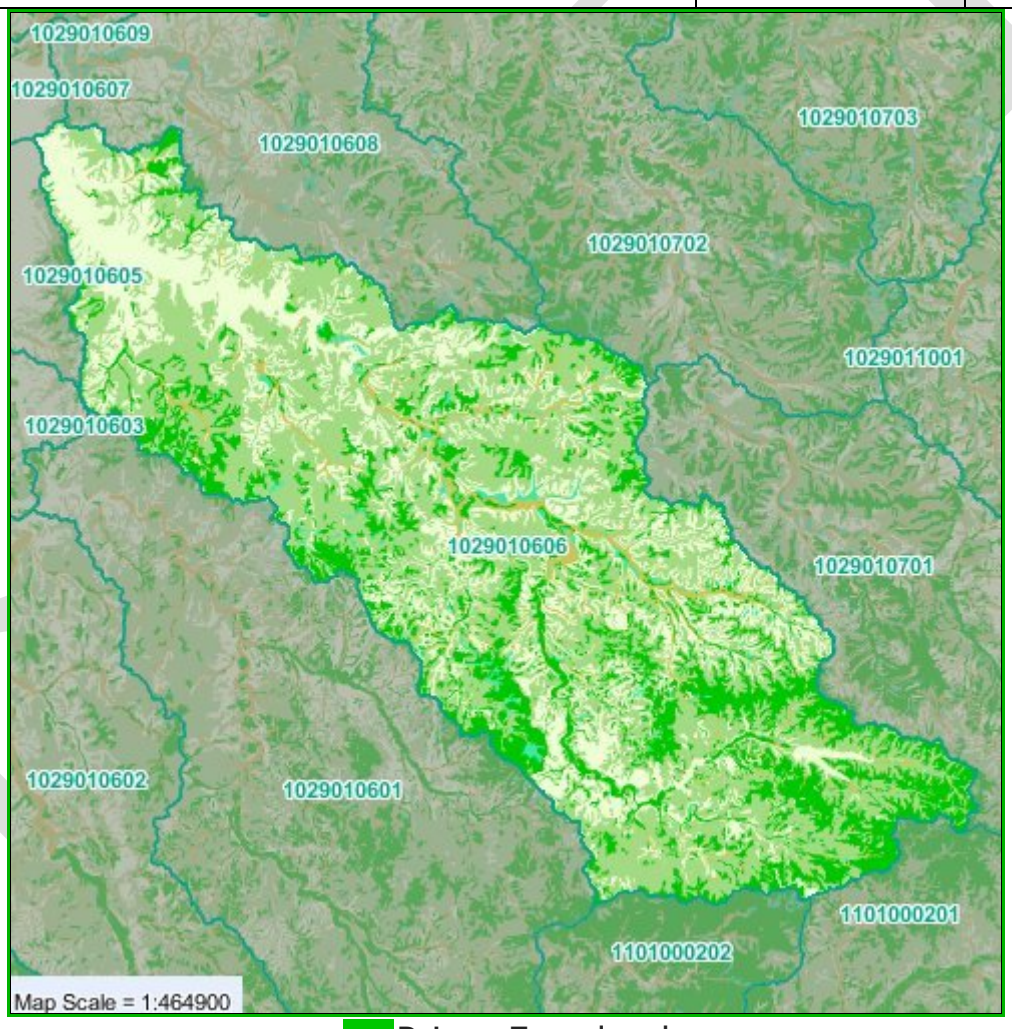
Type	Acres	Percent
Highly Erodible	146,542.39	53.95%
Potentially Highly Erodible	82,711.67	30.45%
Not Highly Erodible	30,622.06	11.27%
Not Rated	11,761.88	4.33%

Highly Erodible Land
Potentially Highly Erodible Land
Not Highly Erodible Land
Not Rated

Prime Farmland

Little Sac River (1029010606)

Type	Acres	Percent
Prime Farmland	57,318.32	21.10%
Prime Farmland if Drained	3,563.25	1.31%
Prime Farmland with Limitation	8,160.82	3.00%
Farmland of Statewide Importance	135,878.67	50.02%
Not Prime Farmland	66,717.28	24.56%

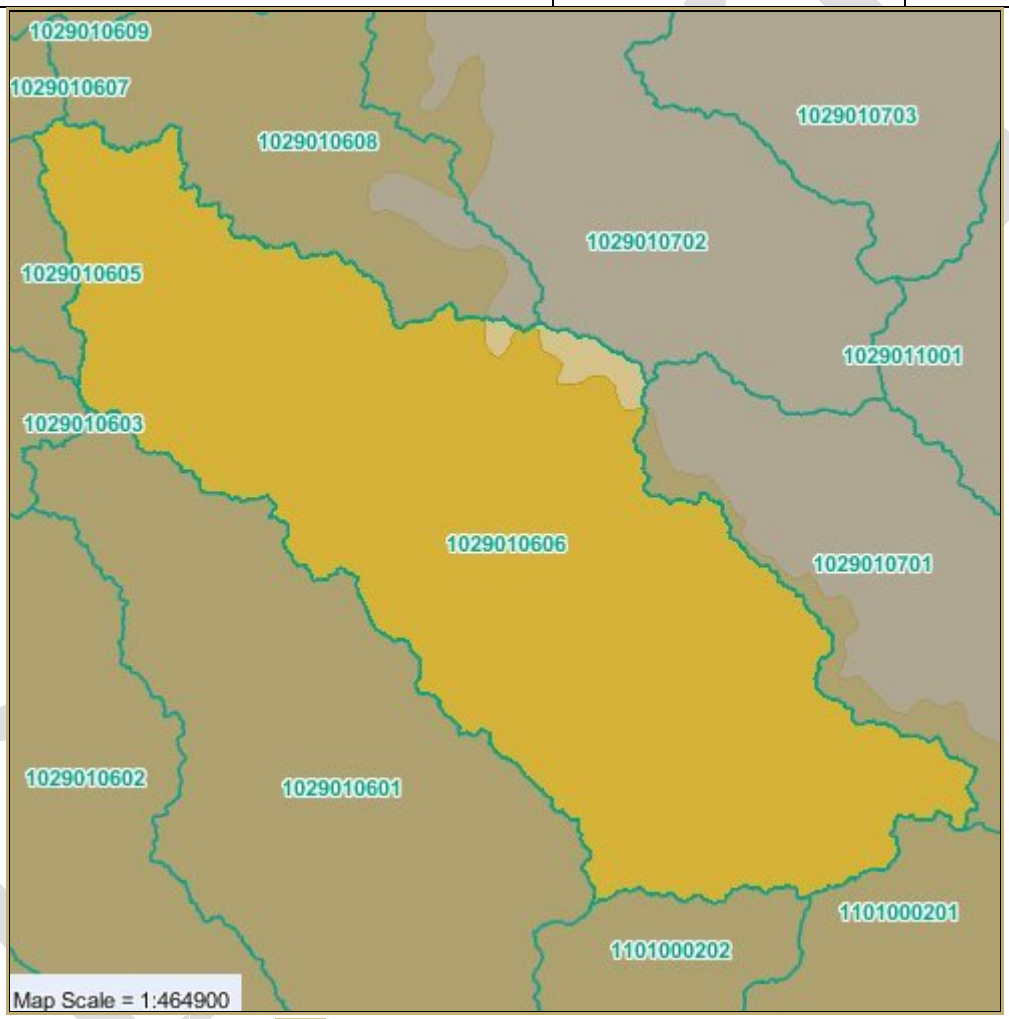


Prime Farmland
Prime Farmland if Drained
Prime Farmland with Limitations
Farmland of Statewide Importance
Not Prime Farmland

Major Land Resource Areas

Little Sac River (1029010606)

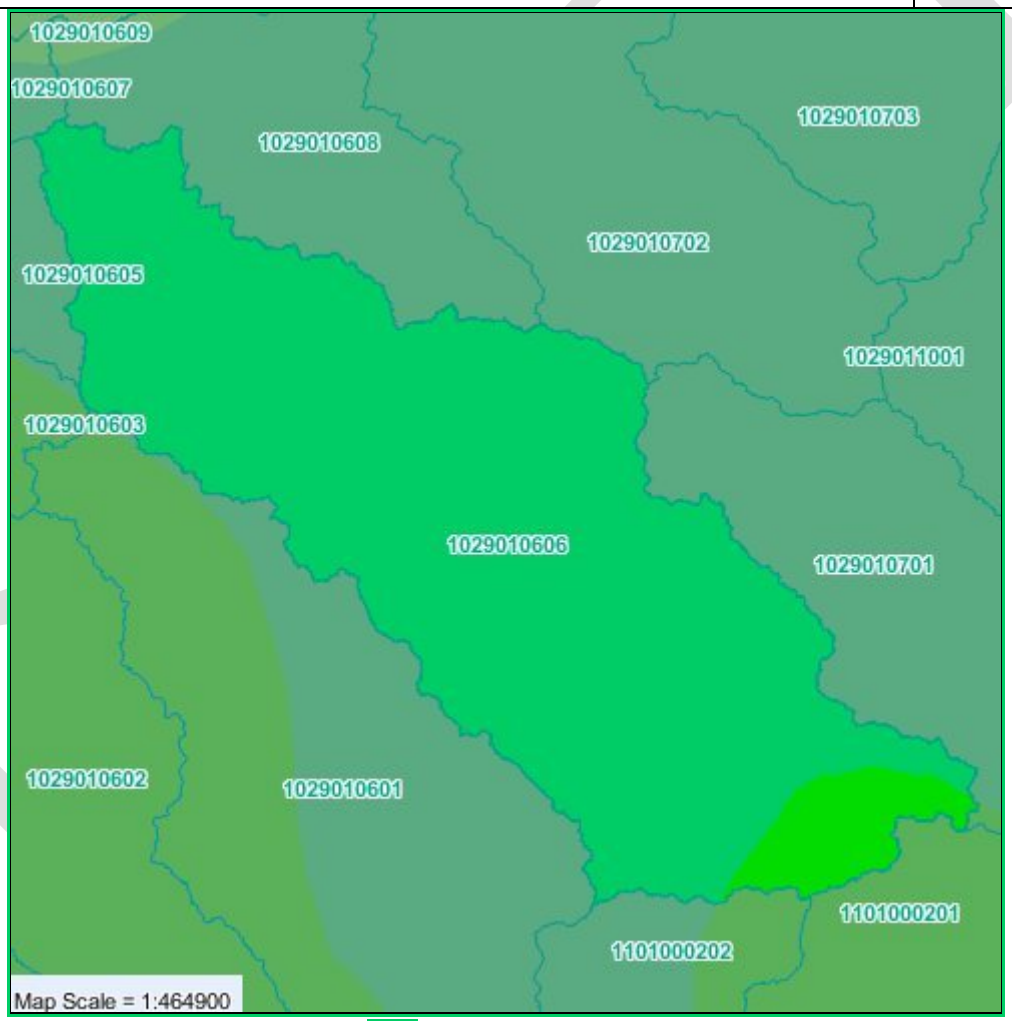
Type	Acres	Percent
N116A	4,924.80	1.81%
N116B	266,713.54	98.19%



N116A: Ozark Highland
N116B: Ozark Border

Precipitation (1961-1990)
Little Sac River (1029010606)

Minimum Annual (in.):	42.26
Maximum Annual (in.):	43.09
Average Annual (in.):	42.81

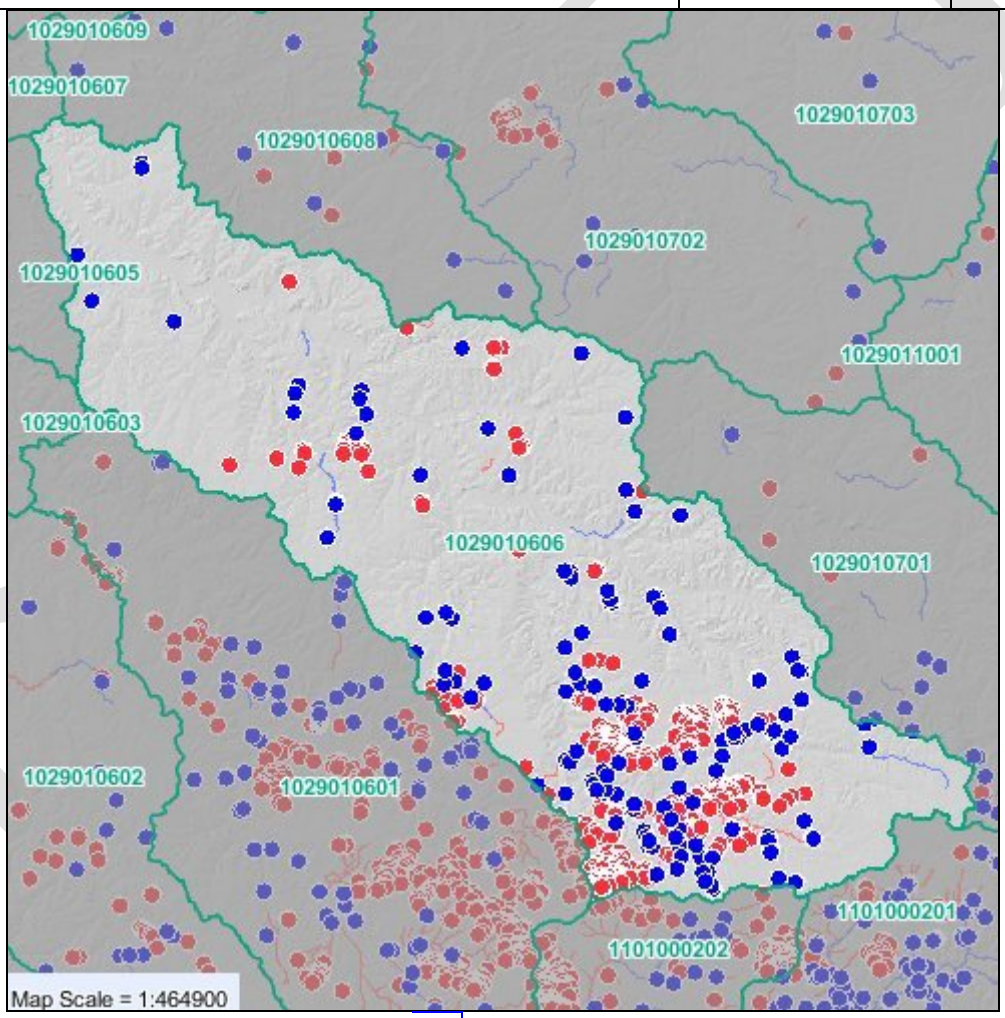


42-43 inches
43-44 inches

Karst Features

Little Sac River (1029010606)

	Numbers	Miles
Gaining streams:	5	14.11
Losing streams:	13	18.25
Sinkholes:	1,555	
Springs:	142	



Springs
Sinkholes
Sink Areas
Gaining Stream
Losing Stream

CAFOs

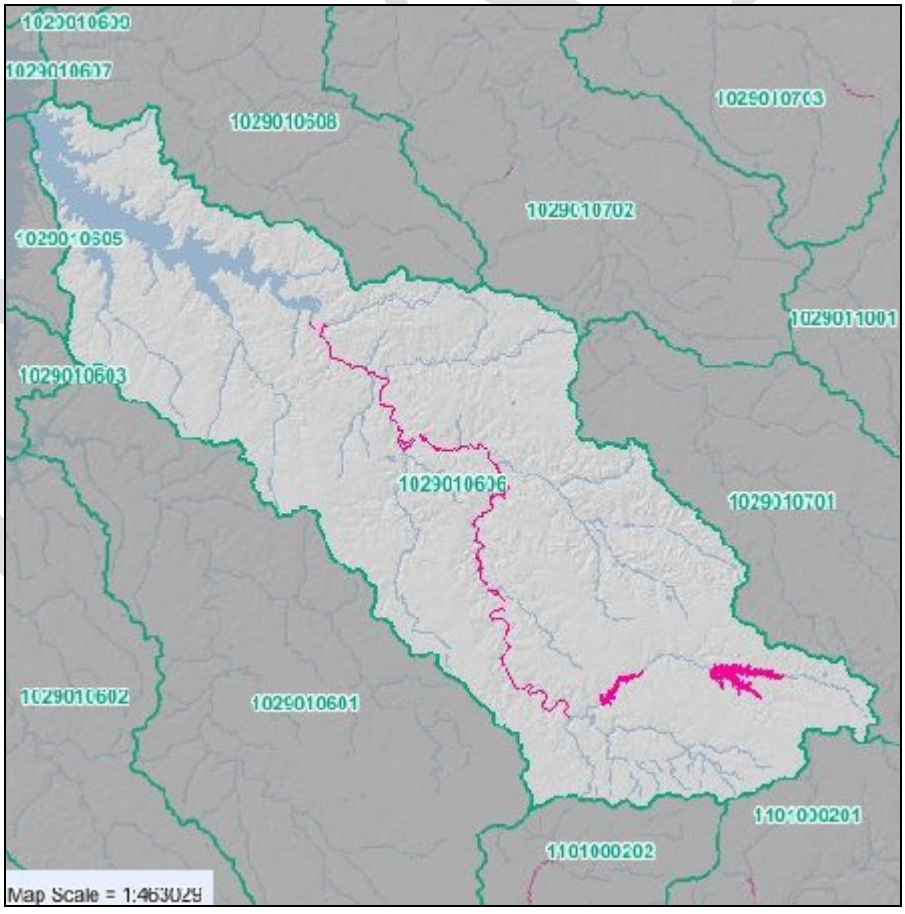
Little Sac River (1029010606)

Facilities:	0
Outfalls:	0
Animal Units:	0
Animal Type:	
Facility Class:	

303(d) Listed Lakes and Streams

Little Sac River (1029010606)

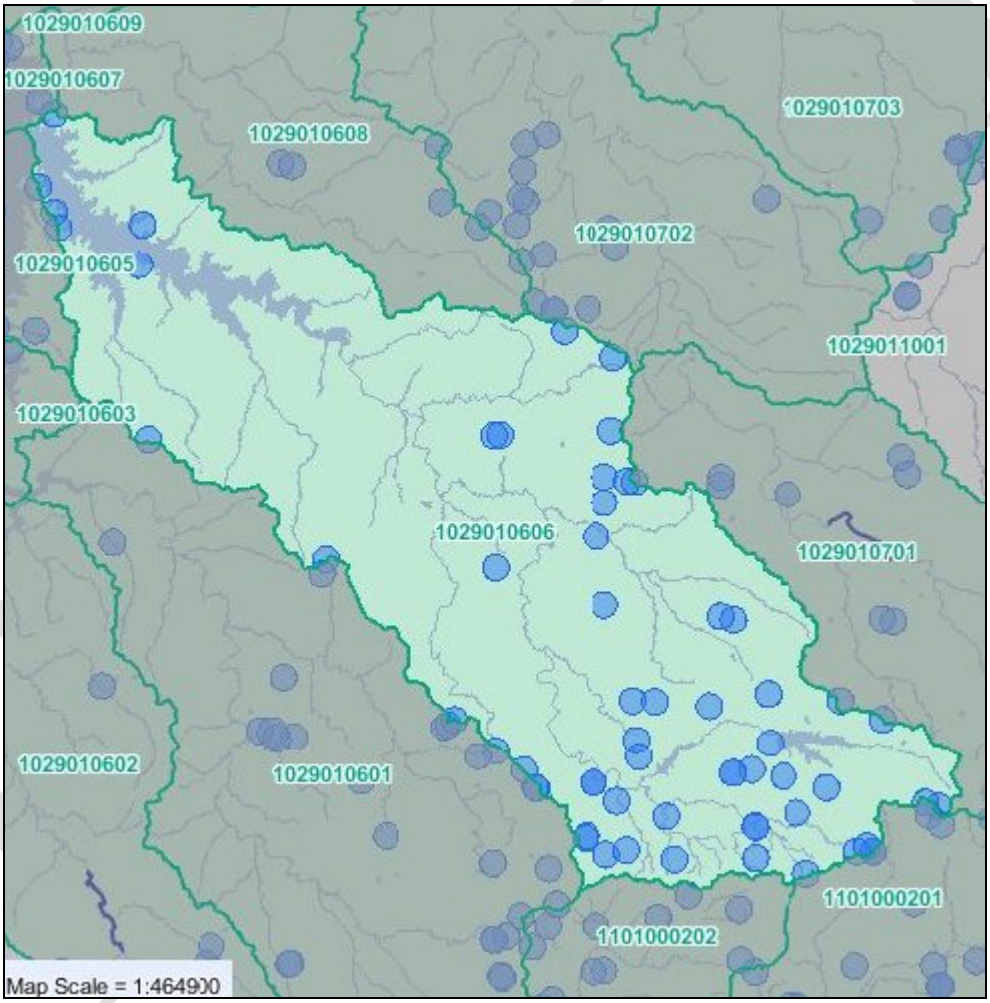
Total Water Bodies: » list all	3
Total Pollutants:	3
Water Body 1:	L. Sac River
Pollutants:	Fecal Coliform
Source:	Point and nonpoint sources
Source Type:	Point and Nonpoint
Priority:	M
TMDL Name:	Little Sac River, Polk County
TMDL Approved:	Aug. 09, 2006
Water Body 2:	Fellows Lake
Pollutants:	Mercury, Nutrients
Source:	Atmospheric Deposition
Source Type:	Nonpoint
Priority:	M
TMDL Name:	none



Protected Water

Little Sac River (1029010606)

Outstanding National Resource Waters:	0
Outstanding State Resource Waters:	0
Bioreference Waters:	0
Source Water Protection Areas:	25,946.71 acres
% of HU in SWPA:	9.55%

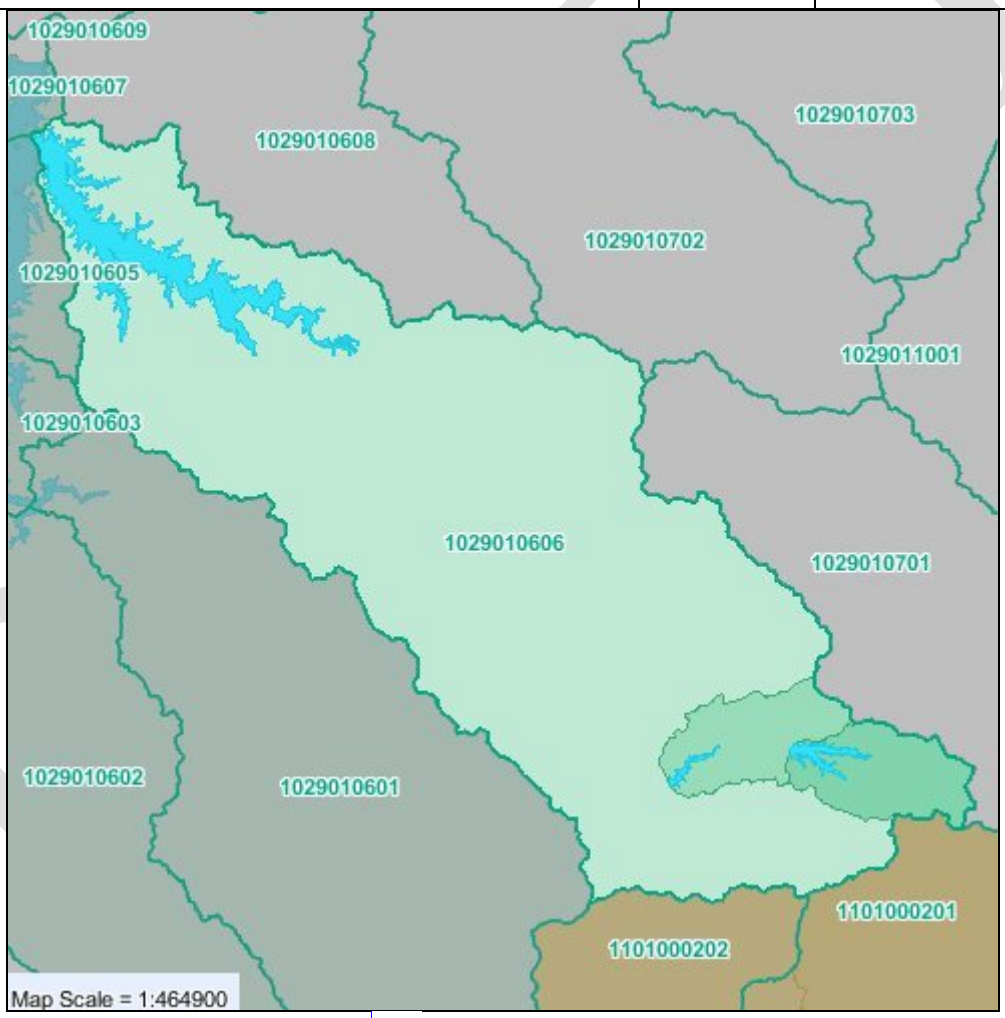


Bioreference Water
Outstanding National Resource Water
Outstanding State Resource Water
Public Drinking Water Watershed
Source Water Protection Area (SWPA)

Drinking Water Intakes

Little Sac River (1029010606)

Intakes	Number	Persons Served
Total:	4	134,313
Community:		134,313
Transient Noncommunity:		0
Non-transient Noncommunity:		0

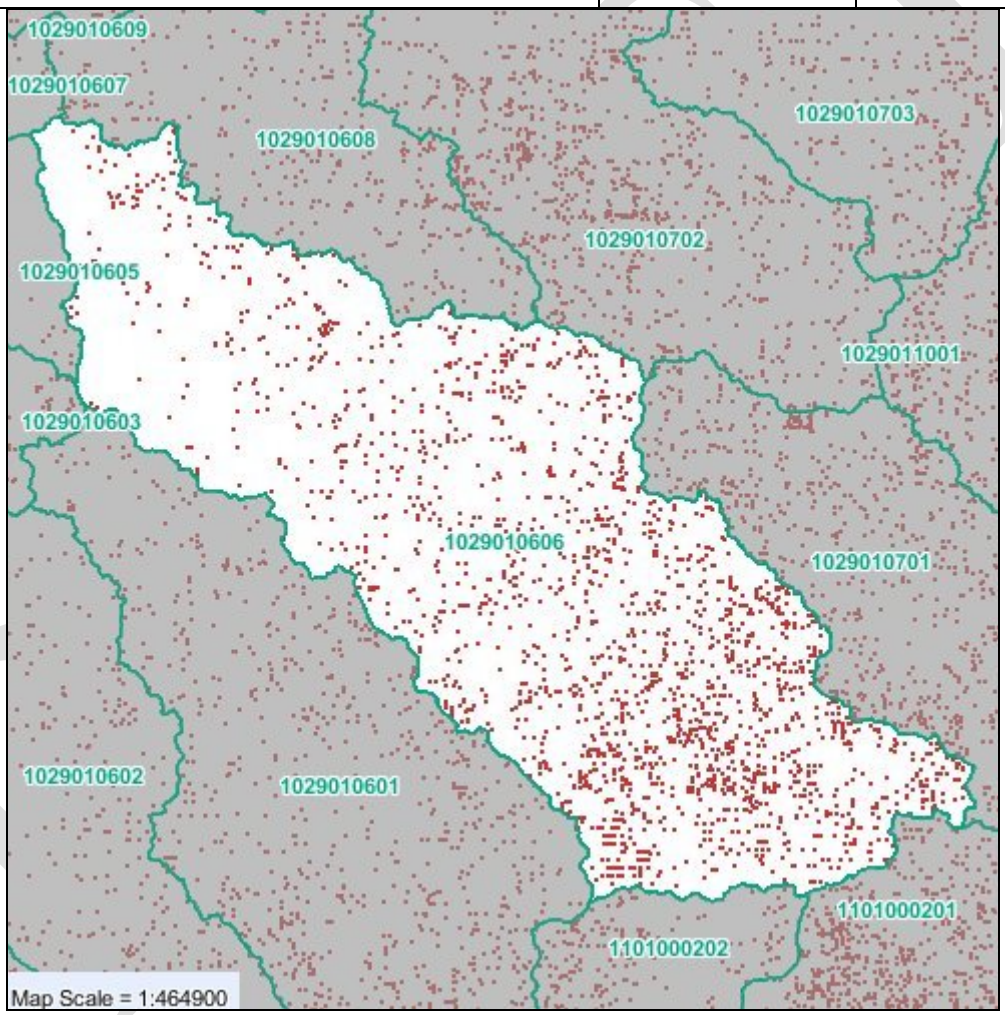


River Intake
Lake Intake
River Drainage Basins
Lake Drainage Basin
Public Water Supply Lakes

Drinking Water Wells

Little Sac River (1029010606)

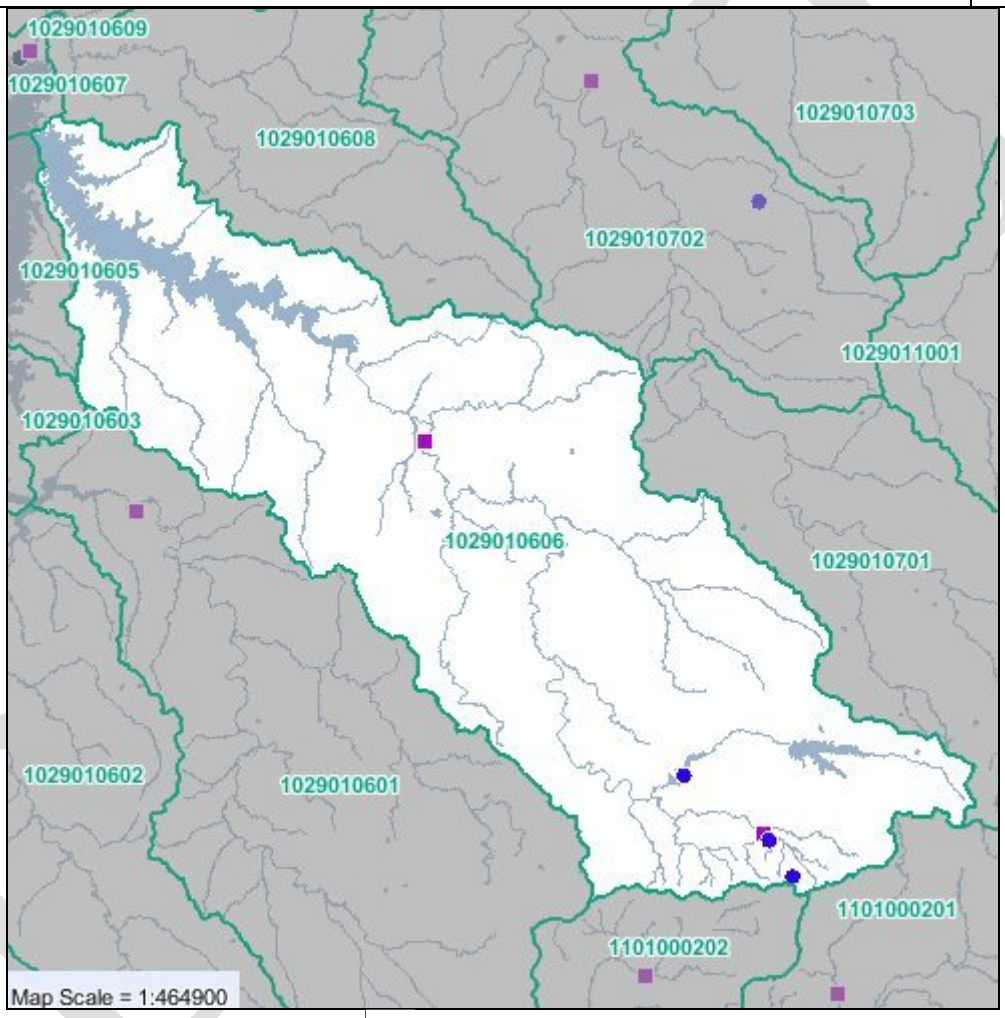
Wells	Number	Persons Served
Total:	2,125	
Private:	2,080	*no data*
Public (Active):	45	21,659
Community:	16	17,913
Transient Noncommunity:	14	1,675
Non-transient Noncommunity:	7	2,071



Private Wells
Public - Community Wells
Public - Transient Noncommunity Wells
Public - Non-transient Noncommunity Wells
Public - Not designated

USGS NWIS Sites
Little Sac River (1029010606)

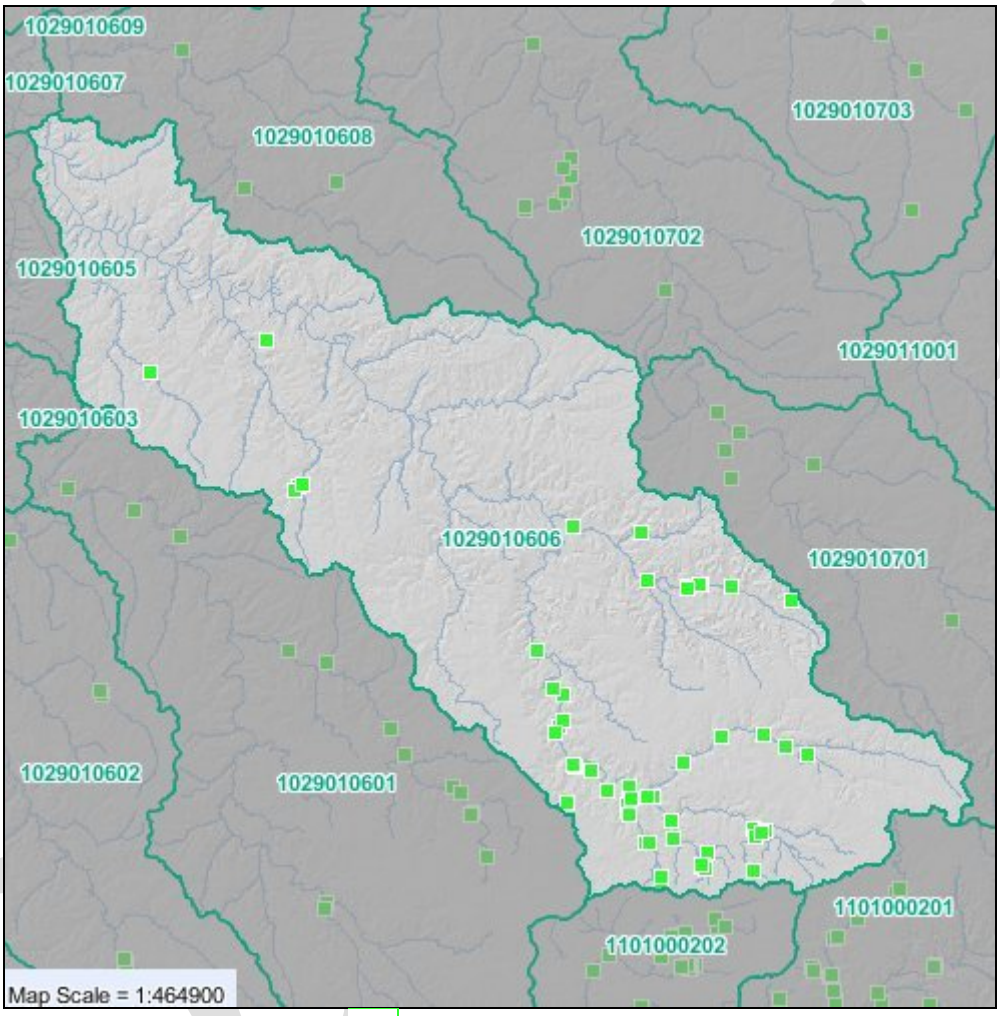
Total Sites:	6
Stream Sites:	2
Groundwater Sites:	4
Other Sites:	0



Stream Sites
Groundwater Sites
Other Sites

Local Initiatives
Little Sac River (1029010606)

Stream Teams:	59



Stream Teams

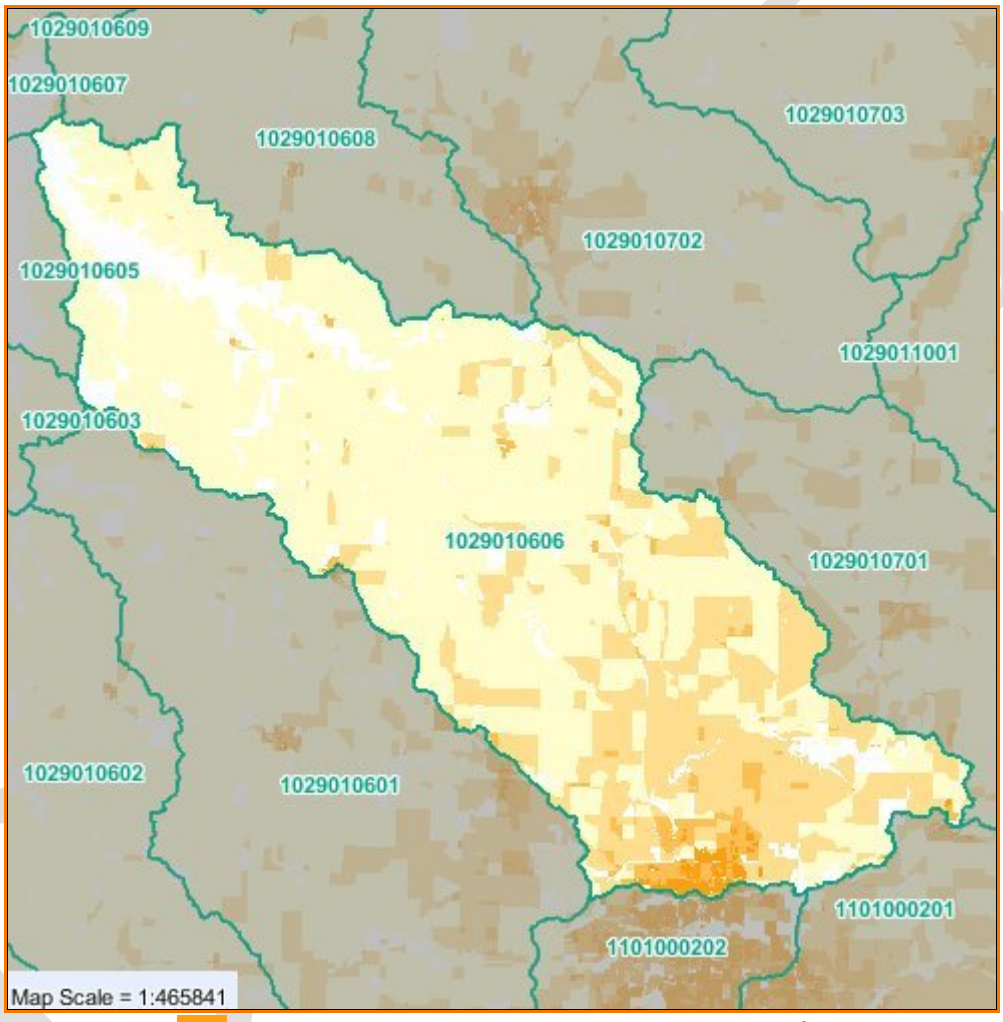
Census Data **Little Sac River (1029010606)**

Total Population:	40,489	
Persons/Sq Mile:	95.40	
Age 0-4:	2,361	6.02%
Age 5-17:	6,943	17.71%
Age 18-64:	24,400	62.25%
Age 65 and up:	5,493	14.01%
College Degree:	4,784	18.78%
Some College:	5,820	22.85%
High School Only:	9,665	37.94%
No High School:	5,203	20.43%
Households:	15,245	
Average Household Income:	$40,803.44	

% of Income from Public Assistance:	3.74%

Census Data

Little Sac River (1029010606)



2,500 or More Persons Per Sq Mile
250 - 2,499.99 Persons Per Sq Mile
50 - 249.99 Persons Per Sq Mile
Less than 50 Persons Per Sq Mile
No population

Missouri Watershed Profiles

DATA SOURCES

8-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

10-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

12-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), Version 14, 2006.

14-Digit Hydrologic Unit Boundaries: USDA Natural Resources Conservation Service (NRCS), 2000.

303(d) Listed Lakes and Streams: Missouri Department of Natural Resources, 2004 (2002 303(d) list).

Average Annual Precipitation: PRISM (Parameter-elevation Regressions on Independent Slopes Model) dataset for 1961-1990, Oregon State University.

Census Data: 2000 U.S. Census Data.

Cities and Towns: 2000 U.S. Census Tiger Boundary File.

Common Resource Areas: USDA Natural Resources Conservation Service (NRCS), 2006.

Confined Animal Feeding Operations (CAFOs): Missouri Department of Natural Resources, 2006.

County Boundaries: 1:24,000, Lincoln University Geographic Information System and Remote Sensing (GIS/RS) Laboratory, July 1997.

Crop Acres by Crop Type: NASS County crop estimates, average acres 2000-2004.

Highly Erodible Lands: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007.

Highways and Roads: Missouri Department of Transportation (MoDOT), 2005. U.S. Census Tiger Boundary Files, 2000.

Hydrologic Soil Groups: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007.

Land Ownership: MoDNR, 2006, MDC, 2006, USFS, 2005, MoRAP, 2000.

Land Slope: 10-Meter Digital Elevation Model, CARES, 2004.

Land Use/Land Cover: Missouri Resource Assessment Partnership (MoRAP), 2005.

Losing/Gaining Streams: Missouri Department of Natural Resources, DGLS, 2006.

Major Land Resource Areas: USDA Natural Resources Conservation Service (NRCS), 2006.

National Wetland Inventory: U.S. Fish and Wildlife Service, 10/1981 to present.

Outstanding National Resource Waters: CARES mapping of 10 CSR 20-7 Table D watershed, 2003.

Outstanding State Resource Waters: CARES mapping of 10 CSR 20-7 Table D watershed, 2004.

Prime Farmland: USDA Natural Resources Conservation Service, SSURGO data (NASIS attributes), 2007

Private Wells: Missouri Department of Natural Resources, 2006.

Public Drinking Water Watersheds: Missouri Department of Natural Resources, 2003 (CARES update 2007).

Public Drinking Water Wells: Missouri Department of Natural Resources, 2007. MoDNR 2007 Census of Missouri Public Water Systems.

Relief Map: 10-Meter shaded relief, CARES, 2004.

Sinkholes: Missouri Department of Natural Resources, 2006.

Sink Areas: Missouri Department of Natural Resources, 2006.

Source Water Areas: Missouri Department of Natural Resources, 2007.

Springs: Missouri Department of Natural Resources, 2006.

Streams and Lakes: U.S. Geological Survey (USGS) National Hydrologic Dataset, 2005.

Stream Teams: Missouri Department of Conservation, 2007.

USGS NWIS Sites: USGS National Water Information System (NWIS), 2007.

Eroding Banks on the Little Sac River, between FR 125 and Hwy O

ESTABLISHING BENCHMARKS

List of Existing Water Quality Information and Data

The Little Sac River Watershed is one of the sources for the public drinking water of the City of Springfield. This watershed is a high priority to maintain and this has led to copious amounts of data and research. As of July 29, 2009, this is the current list of water quality research in the watershed. It will be updated as needed when new or undiscovered data or research is revealed.

Little Sac Water Quality Data

1. WCO – WQM Field Data, 2003-2008
2. Stream Team - Biological/Visual/Chemical, 1995-2006
3. Waste Water Treatment Plant- Online Graphs of Effluent, 2004-06
4. City of Springfield – 2002-2007 Storm water data (Pea Ridge and S. Dry Sac)
5. MODNR – L. Sac (CU, USGS, MDNR, SPFDPW, FAPRI) 1984-2006
6. Data Gap (Sac River) – (MDNR, CU, WCO, SPW, USGS, FAPRI)

Little Sac Watershed Related Reports

1. Sac River Data Gap Analysis – March 2008,
2. Little Sac River TMDL - FAPRI June 2006
3. Little Sac Watershed Restoration Project Final Report – WCO, Nov 2005
4. Little Sac River Watershed Bact. Source Tracking – FAPRI-UMC, May 2005
5. Water Quality in the Little Sac River near Springfield – USGS 1999-2001
6. Watershed Restoration Action Strategy (WRAS) – 2000
7. Identification of sources of nutrients and fecal coliform bacterial contamination in the Little Sac River, Greene and Polk Counties, Missouri – USGS, MDNR, WCO, 1999
8. Fellows-McDaniel Lakes Watershed Protection Project – WCO, 1998
9. Water Quality in the Ozark Plateau – 1992-95, USGS
10. Sac River Watershed Inventory and Assessment – MDC Online

Thesis Work in the Little Sac

1. Priority Assessment of Low Water Stream Crossings Within the Range of the Niangua Darter – MDC, USFWS 2008
2. Channel Geomorphology and Restoration Guidelines for Springfield Plateau Streams, South Dry Sac Watershed, Southwest Missouri – John M. Horton, May 2003
3. Complementary population dynamics of exotic and native Daphnia in North American reservoir communities – MSU 2006
4. Competition between native and exotic Daphnia – MSU 2001
5. Invasibility of a reservoir to exotic Daphnia lumholtzi: experimental assessment of diet selection and life history responses to cyanobacteria – MSU 2003

6. The Effects of Landfill Leachate on the Behavior, Feeding Rate, and Growth Rate of the Freshwater Prosobranch Snail. – MSU 1992
7. The Central Stoneroller, *Campostoma anomalum*, as an Indicator of Heavy Metal Contamination Using Otolith Age and Growth Analysis. – MSU 1996
8. Effects of the Exotic Cladoceran *Daphnia lumhltzi* (SARS) on the Growth Rate and Prey Selection of Bluegill Sunfish (Lepomis Machochirus Rafinsque) – MSU 1998
9. Competition between native and exotic *Daphnia* – MSU 1998
10. Blue-green algae and the seasonal succession of *Daphnia* – MSU 2001

Impairments (303d list)

The Little Sac River had a 27 mile reach listed on the MDNR's 303(d)list for E. Coli in 1998 and 2002. The sources of the impairment are both point and non-point. The Little Sac River TMDL listed the point source to be attributed to Springfield's North West Waste Water Treatment Plant. Since the reprot the treatment plant has under gone major renovation and when the Little Sac River Watershed TMDL was approved in 2006, the NW WWTP began disinfecting the effluent water year-round. Now the main contribution of impairment is from non-point sources with in the watershed. These sources will be addressed in the "nine critical elements" of this watershed management plan.

Nine Critical Elements

1. Identify Causes and Sources of Impairment (upper watershed)

*Since the Little Sac watershed is very large, and has both urban and rural areas, it was decided that the area should be divided into upper and lower watershed plans. The upper (southern half) Little Sac Watershed's (HUC #10290106050) nine elements will be address first in this plan. The lower watershed (northern half) will be completed at a later date. Also contained in this plan will be separate "Nine Elements" for the sub-basins for Fellows and McDaniel Lake and the Fulbright Spring.
*It is important to note that this plan is ever-changing and dynamic, just as the river and its watershed. One set of plans made at this time may not meet the challenges that arise in the future. If major changes are seen in the watershed or seen in the water quality of the Little Sac River then the plan should be modified as deemed necessary to reflect the water quality changes in the watershed. Otherwise, the plan should be re-visited every 5-8 years to evaluate the effectiveness of the management measures and adapted to meet stakeholder concerns.

Sources of Impairment

The Little Sac River was designated "impaired" in 1998 and has remained on the list until 2002 due to E. coli concentrations that exceed the water quality standard for whole body contact set by the Missouri Department of Natural Resources. The Little Sac River Watershed Fecal Coliform Total Mass Daily Load (TMDL) was approved by MODNR in June 2006. This allowed the Little Sac to be removed from the "impaired" list. A list of potential sources of impairment was derived by the TMDL stakeholder committee. The TMDL stakeholder committee listed livestock, horses, septic tanks, wildlife, permitted facilities, and storm runoff from urban areas as potential sources of bacteria. DNA source tracking was conducted by FAPRI to examine these sources and modeling was used to estimate the loading percentages of the Little Sac River. This was conducted at 2 monitoring locations according to the FAPRI study.

This is a section from that study:

> "DNA analyses of these samples showed that the hosts of these bacteria colonies include the following sources present in the watershed: cattle, sewage, geese, and horses. At Farm Road 129, 15% of the bacteria were attributed to geese, 16% to sewage, 9% to cattle, 7% to horses, and 2% to septic. At Farm Road 215, 27% of the bacteria were attributed to geese, 13% to sewage, 14% to cattle, 10% to horses, and 2% to septic. However, more than half (51%) of the fecal coliform at Farm Road 129 and 34% at Road 215 could not be identified with our database. Only 3% of the bacteria identified as coming from sewage can be attributed to the Northwest WWTP treated effluent, implying that there are other sources of sewage."
>
> "At base flow, the loadings potentially come from contamination of the springs or from direct input to streams (illegal discharges, cattle in streams, wildlife). While there are some data about these springs, the information is not as thorough as would be needed to build an accurate model of the watershed hydrology."

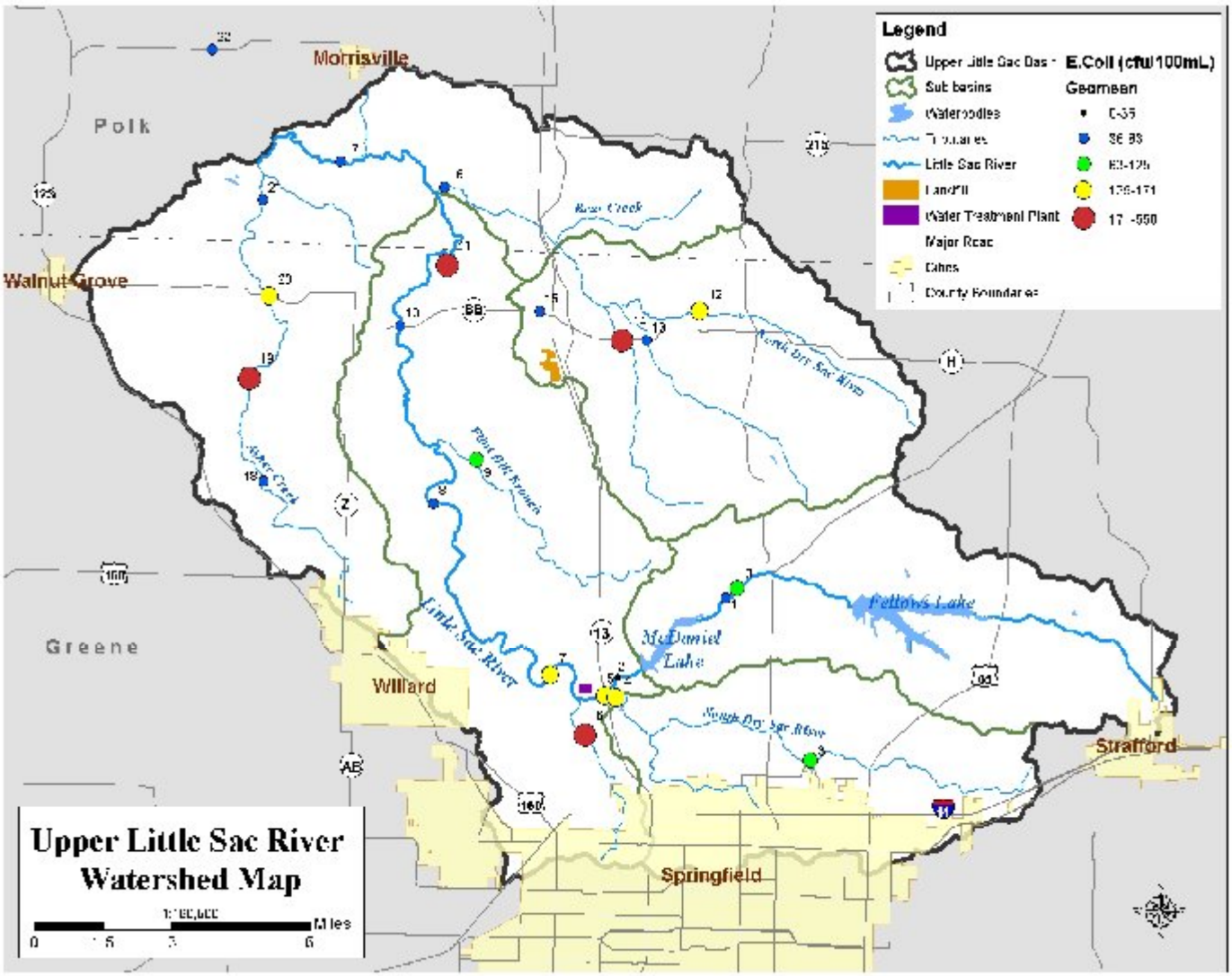
The Little Sac River crosses under Farm Road 129 and Hwy 215 bridges. This is where the water was sampled to base the 2006 Little Sac TMDL. The TMDL attempted to locate the physical sources of the impairment. These two sites were used to base the TMDL. They are on opposite sides of the Little Sac Watershed. This is good for a broad look at the contaminants but does not allow for identifying specific areas of bacteria contamination.

March of 2008, the Southwest Missouri Water Quality Improvement Project funded the completion of the Sac River Basin Water Quality Data Gap Analysis. This project was aimed to compile and analyze all

existing water quality data for the Sac River Basin. One analysis completed was mapping of the highest geomeans of E. coli (cfu/100mL) throughout the watershed.

Source of Impairment Map "Areas of Concern"

Map shows the geomean of the E. coli levels in the Little Sac watershed. - Sac River Data Gap Analysis.



The current E. coli data shows where the "hot-spots" of contamination are within the upper watershed. These hot spots and their watershed are potential "areas of concern" and could be good locations where new management efforts and further research might focus.

Sample Site Locations for the Sac R. Data Gap Analysis with in the Little Sac River Watershed

ID	Site Description	latitude	longitude	Geomean
0	L. Sac R. at FR 68	37.318900	-93.276800	98
1	L.Sac R. at FR 159	37.315900	-93.281200	70
2	L. Sac R. nr. Springfield	37.291710	-93.324080	36
3	South Dry Sac at Valley Water Mill	37.266440	-93.247690	83
4	South Dry Sac River bl. Springfield	37.285600	-93.324630	134
5	Little Sac River-State Hwy 13	37.286217	-93.329083	141
6	Spring Branch	37.274210	-93.336860	171
7	L. Sac R. 1 mi.bl. Spfd NW WWTP at FR 125 ***	37.292500	-93.350700	133
8	Little Sac River-FR 54	37.344518	-93.396995	60
9	Flint Hill Branch- FR 117	37.357783	-93.380250	125
10	L. Sac R. ab. Walnut Grove, Hwy BB	37.398660	-93.410470	65
11	Tributary of Little Sac River-N FR 115	37.417444	-93.392069	366
12	North Dry Sac River- FR 163	37.403666	-93.291942	139
13	Sims Branch- State Hwy CC	37.394727	-93.312847	62
14	King Br. at CC	37.394900	-93.322700	365
15	Trib. to trib. to N. Dry Sac R. at BB	37.403300	-93.355400	78
16	North Dry Sac River at Sod Farm	37.441150	-93.393250	60
17	Little Sac River- 111th Rd	37.448750	-93.434583	62
18	Asher Creek- W FR 52	37.351149	-93.464624	46
19	Asher Creek- N FR 81	37.382700	-93.470217	406
20	Asher Creek- State Hwy BB	37.407763	-93.462541	167
21	Asher Creek nr. mouth	37.436990	-93.465200	82
22	Little Sac River nr. Morrisville	37.482860	-93.485650	57

*** The only sample site used in 2006 TMDL for the upper Little Sac River Watershed.

Quantified Pollutant Load Attributed to Each Source

The Little Sac Watershed TMDL gives quantified load percentages for each source during different flow conditions at both FR 129 and RD 215. It is interesting to note that over 50% of the load is unknown at FR215

Table 18. Average predicted daily loadings at FR129, by source

	Actua Northwest WTTP	Urban runoff	Cattle	other Unknown	Goose	Springs	Total
Base load (%)	9.86E+09 (3%)	0.00	0.00	0.00	0.00	2.97E+11 (97%)	3.07E+11 (100%)
Surface load (%)	0.00	1.34E+11 (6%)	3.01E+11 (14%)	1.28 E+12 (61%)	3.71E+11 (18%)	0.00	2.09E+12 (100%)
Total load (%)	9.86E+09 (0%)	1.34E+11 (6%)	3.01E+11 (13%)	1.28E+12 (54%)	3.71E+11 (15%)	2.97E+11 (12%)	2.39E+12 (100%)

Table 19. Average predicted daily loadings at RD215, by source

	Actua Northwest WTTP	Urban runoff	Cattle	other Unknown	Goose	Springs	Total
Base load (%)	3.45E+09 (2%)	0.00	0.00	0.00	0.00	1.54E+11 (98%)	1.57E+11 (100%)
Surface load (%)	0.00	8.46E+10 (2%)	5.43E+11 (14%)	2.53E+12 (66%)	6.59E+11 (17%)	0.00	3.82E+12 (100%)
Total loac (%)	3.45E+09 (0%)	8.46E+10 (2%)	5.43E+11 (14%)	2.53E+12 (64%)	6.59E+11 (17%)	1.54E+11 (4%)	3.98E+12 (100%)

Table 20. Average measured load fraction in each host class during the 2004 recreation season

	Sewage	Septic	Cattle	Horses	Goose	Unknown	Total
FR 129	12%	2%	9%	10%	16%	52%	100%
RD 215	9%	2%	18%	12%	31%	27%	100%

*NOTE: The Northwest Waste Water Treatment Plant now disinfects all year long. According to the TMDL then, 21% of the E. coli load is already removed from the watershed with the upgrade to the treatment plant.

Data Sources

- Missouri Department of Natural Resources, Little Sac River Watershed Fecal Coliform TMDL, June 2006.
- Environmental Resources Coalition, Southwest Missouri Water Quality Improvement Project Sac River Basin Water Quality Gap Analysis, March 2008.

Load Reduction Goal

The Little Sac Watershed TMDL concluded through their research and monitoring of two sample sites that the load reduction goals would be as following:

> "A TMDL for each site was determined based on the simulated flows and the water quality standard of 200 colonies/100 ml. Model results show that the average daily load at FR129 needs to be reduced by 70% to 90% in order to meet the whole body contact fecal coliform criteria throughout all flow conditions."

These percentages are based on two sampling sites in the watershed. 52% of the loading a farm road 129 is unknown. Does this suggest that more research is needed to isolate the influences of bacteria into the stream? The TMDL suggested that springs are the main contributor to bacterial loading during base flow. If this correct, the springs' recharge areas near the bacteria "hot-spots" should be investigated for potential pollution sources. DNA studies and dye traces should be performed in the recharge areas of springs near these "hot-spots" to determine the loading sources. Then these sources can be addressed according to the management practices proposed within this watershed plan.

2. Expected Load Reductions

Load Reductions Needed to Achieve Environmental Goals

In order to achieve the Little Sac Watershed TMDL goal of whole body contact criteria the Little Sac River TMDL recommended a nearly 70% to 90% reduction in E. coli levels.

	Base flows (more than 83% of total flow is base flow)		Medium flows (base flow is less than 83% but more than 53% of total flow)		Extreme flows (base flow is less than 53% of total flow)	
Location	FR 129	RD 215	FR 129	RD 215	FR 129	RD 215
Load capacity (colonies/day)	1.90E+11	4.38E+11	2.54E+11	5.09E+11	1.34E+12	3.17E+12
MOS (colonies/day)	1.14E+10	2.73E+10	2.02E+10	4.79E+10	1.06E+11	5.62E+11
Waste load allocation (colonies/day)	9.47E+10	9.47E+10	9.47E+10	9.47E+10	9.47E+10	9.47E+10
Load allocation (colonies/day)	8.36E+10	3.16E+11	1.40E+11	3.66E+11	1.14E+12	2.51E+12
Current load from data (colonies/day)	NA	2.48E+11	NA	5.78E+11	NA	2.94E+12
Current load from model (colonies/day)	5.09E+11	6.76E+11	2.03E+12	2.20E+12	9.42E+12	1.16E+13
Reduction (colonies/day)	3.31E+11	[0; 2.65E+11][a]	1.80E+12	[1.17E+11; 1.73E+12][a]	8.19E+12	[3.30E+11; 9.04E+12][a]
Reduction (%)	65%	[0; 39%][a]	88%	[20%;79%][a]	87%	[11%;78%][a]

Desired Load Reduction Quantified for Each Source of Impairment

The non-point sources listed as potential contributors to the impairment of the Little Sac river are described in the TMDL and a load reduction is given for each to meet water quality standards.

> "The reduction of the springs' bacterial contamination is considered here because it has been determined that they are responsible for more than 97% of the load at FR129 at base flow. This determination is based on the data that is currently available. As additional springs monitoring data better characterize their water quality, this will be updated.
> A 30% reduction of the goose population is a starting point for the purpose of estimating what it would do on the general bacteria levels in the watershed. A publication by the Missouri Conservation Commission gives details about giant Canada geese and the methods used to control their numbers (MDC, 2002). Canada goose control activities include habitat modification, exclusion, harassment, chemical repellents, and lethal control.
> Reductions of urban runoff fecal coliform loadings to the stream can be attained with detention basins or with edge-of-impervious-area vegetation buffer strips. The 50% reduction is also a starting point for the purpose of estimating what it would do on the stream bacteria concentrations. As mentioned earlier, several efforts are already directed at encouraging enhanced urban designs that minimize urban runoff." -TMDL

% Violation of WQS[a] criterion			Reduction in Fecal coliform loadings to the stream (%)				
Scenario ID	30-day Geomean 200 col/100ml	Single sample 400 col/100ml	Springs	Geese	Urban runoff	Cattle & horses	Septics
Baseline	99%	54%	0%	0%	0%	0%	0%
1	44%	28%	85%	0%	0%	0%	0%
2	42%	27%	85%	30%	0%	0%	0%
3	41%	27%	85%	30%	50%	0%	0%

* If the main source of contamination is springs, then further research is needed to isolate those springs and correct the problem. DNA source tracking, dye traces, and further water quality monitoring could be possible avenues to isolate the issues.

Load Reduction in the Little Sac Watershed Plan will not be using a total stream load approach. The management measures each have their own load reduction based on past research of the capabilities of that particular type of BMP. This is a small number to estimate using research than a number estimating the entire load for a stream. It seems that this will be a more accurate method of estimating load reductions.

Eroding Bank on the Little Sac River that needs bank stabilization

Estimated Load Reduction for Each Management Measure (Element 3)

Urban Watershed Area

Management Measure	Pollutants Addressed	Estimated Load Reduction @ Each BMP Location
Zoo Storm water BMPs	sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Doling Park Lake Improvements	Sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Storm water inspections of industrial/high risk operations	Heavy metals, sediment	HeavMtl-Site Dependant Sediment-50%
Regional Detention Basins	Sediment	Sed-50%
City of Springfield & Greene County Water quality requirements for new developments & significant redevelopments	Dependent on BMP type	Variable
City of Springfield & Greene County Land Disturbance/ Site Grading Permit Programs	Sediment	50%-70%
Public education and outreach programs	Nutrients, pesticides, household chemicals, sediment, runoff volume	Variable on BMP and Funding
Flood Plain Development Planning Program	Nutrients, Bacteria, Sediment	Sed-50%/Bact-75%/Nutr-25%
Water Quality Protection of Wells, Springs, Sinkholes, Caves	Nutrients, Bacteria, Sediment	Sed-50%/Bact-75%/Nutr-25%

Rural Watershed Area

Management Measure	Pollutants Addressed	Estimated Load Reduction @ Each BMP Location
Education & Outreach (Onsite Waste Water Training Facility & Watershed Center)	sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Springs Source Tracking Research	Sediment, bacteria, nutrients	Sed-50%/Bact-75%/Nutr-25%
Septic Remediation/Install/Repair/Maintenance	Heavy metals, oil, sediment, phosphorus, others	
Riparian Habitat Improvement	Sediment, Bacteria, Nutrients, Run-off volume, Temp.	Sed-50%/Bact-75%/Nutr-25%
Nutrient Management	Dependent on BMP type	
Sheet/Rill Erosion Prevention	Sediment, nutrients, bacteria	Sed-50%/Bact-75%/Nutr-25%
Forage Management	Nutrients, sediment, bacteria	Sed-50%/Bact-75%/Nutr-25%
Flood Plain Development Planning Program	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%
Water Quality Protection for Wells, Sinkholes, caves,	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%
Low-Impact Development Test Site @ Legacy Trails	Bacteria, Sediment, Nutrients	Sed-50%/Bact-75%/Nutr-25%

3. Proposed Management Measures

Springfield uses ground and surface water for its drinking water sources. This comes from different sub-watersheds and each watershed has different characteristics and each watershed should also have different management strategies to address and maintain the quality/quantity of drinking water in the area. There is also a highly urban to rural transition within the watershed that should be considered when planning management measures. With the combination of these issues this plan will be divided into the Urban and Rural areas within the Little Sac River watershed. Each of these areas will be addressed with specific sets of management measures that will address issues common to the urban and rural settings.

Critical/Priority Areas Maps

Identify Critical/Priority areas

The "Critical Priority Areas" are the areas within the watershed with the highest geomean levels of E.coli in the watershed. These areas need funding for research to locate the specific sources of contamination. The TMDL suggests springs to be the major contributor of bacteria loading. In these critical areas the research should focus on the spring recharge areas to investigate where this E.coli is originating with DNA source tracking. These areas should also be the focal point to begin the implementation of the management measures proposed in this watershed plan.

(one map for each priority area also look at the source water protection areas)

Drinking water source protection????

INSERT MAPS HERE- data layers:springs, spring recharge, faults, karst, towns, homes, septic info?...

Urban Watershed Area Management Measures

Management Measure	Responsible Party	Size/Quantity	Date: Start/End	Pollutants Addressed
Zoo Storm water BMPs	City of Springfield Storm Water Services	Approx. 500 feet of lakeshore stabilization and BMPs for approx. 1.5 acres of animal exhibits	Summer 2009 – Summer 2010	Runoff volume, sediment, bacteria, nutrients
Doling Park Lake Improvements	City of Springfield Storm Water Services	Approx. 500 feet of lakeshore stabilization; waterfowl deterrent measures; 400 feet of channel improvements	2010	Sediment, bacteria, nutrients
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	Avg. 5 inspections annually	Ongoing	Heavy metals, oil, sediment, others
Regional Detention Basins	Private developers	10 basins	Ongoing property acquisition as available	Sediment
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Per development/ redevelopment	Ongoing	Dependent on BMP type
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	Per land disturbance site	Ongoing	Sediment
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	-20 presentations, 15 community events, 5,000 handouts, various other projects annually - SSWS -40,000 reached by - WCO	Ongoing	Nutrients, pesticides, household chemicals, sediment, runoff volume
Flood Plain Development Planning Program	Greene County Resource Management	Per Proposed Development	Ongoing	Nutrient, Sediment, Bacteria
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	Site Dependant	Ongoing	Nutrients, Bacteria, Sediment, Pesticides

Rural Watershed Area Management Measures

Management Measure	Responsible Party	Size/Quantity	Date: Start/End	Pollutants Addressed
Education & Outreach	WCO	-40,000 reached by - WCO	Ongoing	Nutrients, pesticides, household chemicals, sediment, runoff volume
Springs Source Tracking Research	Interested Party	1 graduate research project at the 4 areas of critical priority	When Funded	Bacteria
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	Funding Dependant	When Funded	Bacteria, phosphorus
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	5 acres/year	Start 2010	Sediment, bacteria, nutrients
Nutrient Management	Greene County SWCD	50 acres/year	Start 2010	Nutrients
Sheet/Rill Erosion Prevention	Greene County SWCD	40 acres/year	Start 2010	Nutrients, bacteria, sediment
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management / Other	Per Qualified Applicant	Ongoing	Nutrients, Bacteria
Forage Management	Greene County SWCD	200 acres/year	Start 2010	Nutrients, bacteria, sediment, runoff volume
Flood Plain Development Planning Program	Greene County Resource Management	Per Planned Development	Ongoing	Nutrients, Sediment, Bacteria
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	Per Instance	Ongoing	Nutrients, Sediment, Bacteria

Other Possible Landowner/Homeowner/Business Owner Management Measures

Management Measure	Responsible Party	Pollutants Addressed
Water Conservation/ Pollution Prevention -Rain Barrel -Low Flow -Less Irrigation -Native Landscaping -Rain Gardens -Recycle House Hold Chemicals -Pick up your pet's waste (urban areas) -Don't dump in storm drains -Do Not Litter (we all live down stream) -Green Roof -Pervious Pavement	Home Owners/Landowners/Business Owners (Urban and Rural)	Run-off Volume, water usage demand, bacteria, nutrients, chemical

These measures are effective practices that can be utilized by the land, home or small business owners in the watershed. With widespread implementation they can help and maintain the water quality and quantity in the Little Sac River. The numbers of these measures in the watershed is undetermined and it is unknown what amount of a load reduction they would have in the Little Sac River.

Process to Evaluate Effectiveness of Management Measures

Continued routine water sampling for E. coli will be used to monitor the effectiveness of the management measures that effect water quality directly. (See element 9 monitoring component) There is also the possibility for further surveys within the watershed, either mailed or online, to monitor the public opinion of the water quality in the Little Sac Watershed.

4. Technical and Financial Assistance Needs

Urban Watershed Area

Management Measure	Responsible Party	Cost Estimate of Planning & Implementation per measure	Funding Sources /Cost Share
Zoo Storm water BMPs	City of Springfield Storm Water Services	$750,000	Greene County Parks/Waterways Sales Tax
Doling Park Lake Improvements	City of Springfield Storm Water Services	$1 Million	Greene County Parks/Waterways Sales Tax
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	$1,000 annually	General Fund
Regional Detention Basins	Private developers	$100,000 annually $1 Million Total	Payment n lieu of detention funds and future storm water bond issues
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Dependant of BMP	Private Developers
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	Dependant of Site	Private Developers
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	$60,000 Annually	Various City Funds
Flood Plain Development Planning Program	Greene County Resource Management	$50,000 Annually	Various

Rural Watershed Area

Management Measure	Responsible Party	Cost Estimate of Planning & Implementation per measure	Funding Sources (Fed, State, County, City, Private)
Education & Outreach	WCO	$50,000/year	WCO
Springs Source Tracking Research	Interested Party	$100,000/year	Unknown
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	$5,000-15,000/site	Greene County SWCD/Grants
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	$15,000 per 5 acres/year	Greene County SWCD/Grants
Nutrient Management	Greene County SWCD	$1,500 per 50 acres/year	Greene County SWCD/Grants
Sheet/Rill Erosion Prevention	Greene County SWCD	$70 per 40 acres/year	Greene County SWCD/Grants
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	Up to $15,000/site	Greene County
Forage Management	Greene County SWCD	$250 per 200 acres/year	Greene County SWCD/Grants
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management and SWCD	$4,000/site	Greene County

5. Information, Education, and Public Participation

Information/education component that will enhance public understanding and participation in selecting, designing, and implementing the NPS management measures to be implemented.

Stakeholder Outreach

The watershed committee and Greene County NRCS have outreached to watershed stakeholders through mailings, phone calls, personal visits, newspaper articles, Newsletters (WCO), Monthly Meetings (WCO), as well as a web page specifically for the Little Sac WMP.

Identify Stakeholders

Stakeholder Committee:

Technical Committee:

Public Meetings Held

Stakeholder Meetings Dates	Technical Meetings Dates
June 24th 2008	July 22nd 2008
September 22nd 2008	April 14th 2009
July 22nd 2009	July 22nd 2009
August 11th 2009	August 11th 2009

Educational Outreach Materials for WMP & Future Management Measures

E&O for Little Sac WMP	**E&O for Future Management Measures**
Brochure – L. Sac WMP	Watershed Center-40,000 people reached in 2008
Web Site- www.watershedcenter.com	Web Site- www.watershedcenter.com
L. Sac WMP Stakeholder Folders	Low-Impact Development Site @ Legacy Trails
Field Days July 2008 & 2009	Onsite Waste Water Training Facility
Spring Forage Conference 2008 & 2009	
Horse Fest	
Watershed Center-40,000 people reached in 2008	
Farm Fest	
Newspaper Ad for Stakeholder Meeting	

6/7. Implementation Time Line

Urban Watershed Area

Management Measure	Responsible Party	Dates and Expected Accomplishments	Interim Milestones	Milestones
Zoo Storm water BMPs	City of Springfield Storm Water Services	START Summer 2009 – END Summer 2010	Summer 2008	N/A
Doling Park Lake Improvements	City of Springfield Storm Water Services	START/END 2010	N/A	N/A
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	Ongoing	Ongoing	Ongoing
Regional Detention Basins	Private developers	Ongoing property acquisition when available	Ongoing	Ongoing
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	Ongoing	Ongoing	Ongoing
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	START December 2008 - ongoing	Ongoing	Ongoing
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	Ongoing	Ongoing	Ongoing
Flood Plain Development Planning Program	Greene County Resource Management	Ongoing	Ongoing	Ongoing
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	Ongoing	Ongoing	Ongoing

Rural Watershed Area

Management Measure	Responsible Party	Dates and Expected Accomplishments	Interim Milestones	Milestones
Education & Outreach	WCO	Ongoing	Ongoing	Ongoing
Springs Source Tracking Research	Interested Party	Awaiting Funding Opportunity	NA	NA
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	Awaiting Funding Opportunity	NA	NA
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	Start 2010	Ongoing	Ongoing
Nutrient Management	Greene County SWCD	Start 2010	Ongoing	Ongoing
Sheet/Rill Erosion Prevention	Greene County SWCD	Start 2010	Ongoing	Ongoing
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	Awaiting Funding	NA	NA
Forage Management	Greene County SWCD	Start 2010	Ongoing	Ongoing
Flood Plain Development Planning Program	Greene County Resource Management	Ongoing	Ongoing	Ongoing
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	Ongoing	Ongoing	Ongoing

8. Load Reduction Evaluation Criteria

Urban Watershed Area

Management Measure	Responsible Party	Progress Indicators	Evaluation Criteria	Threshold Criteria to Change Plan When…or E. coli levels don't decrease in 5-8yrs
Zoo Storm water BMPs	City of Springfield Storm Water Services	BMP Completion	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Doling Park Lake Improvements	City of Springfield Storm Water Services	Completion	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Storm water inspections of industrial/high risk operations	City of Springfield Storm Water Services	# Inspections	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Regional Detention Basins	Private developers	# Basins	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water quality requirements for new developments & significant redevelopments	City of Springfield Storm Water Services & Greene County Resource Management	#Developments	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Land Disturbance/ Site Grading Permit Program	City of Springfield Storm Water Services/ Greene County Resource Management	# permits	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Public education and outreach programs	City of Springfield Storm Water Services, Watershed Committee of the Ozarks	#'s Reached	Surveys	5yr survey for stakeholders w/in Watershed
Flood Plain Development Planning Program	Greene County Resource Management	# flood plain plans	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water Protection for Well, Sinkholes, Caves & Springs	Greene County Resource Management	#'s of sites	WQM Data	5yrs Re-evaluation of water quality in Little Sac River

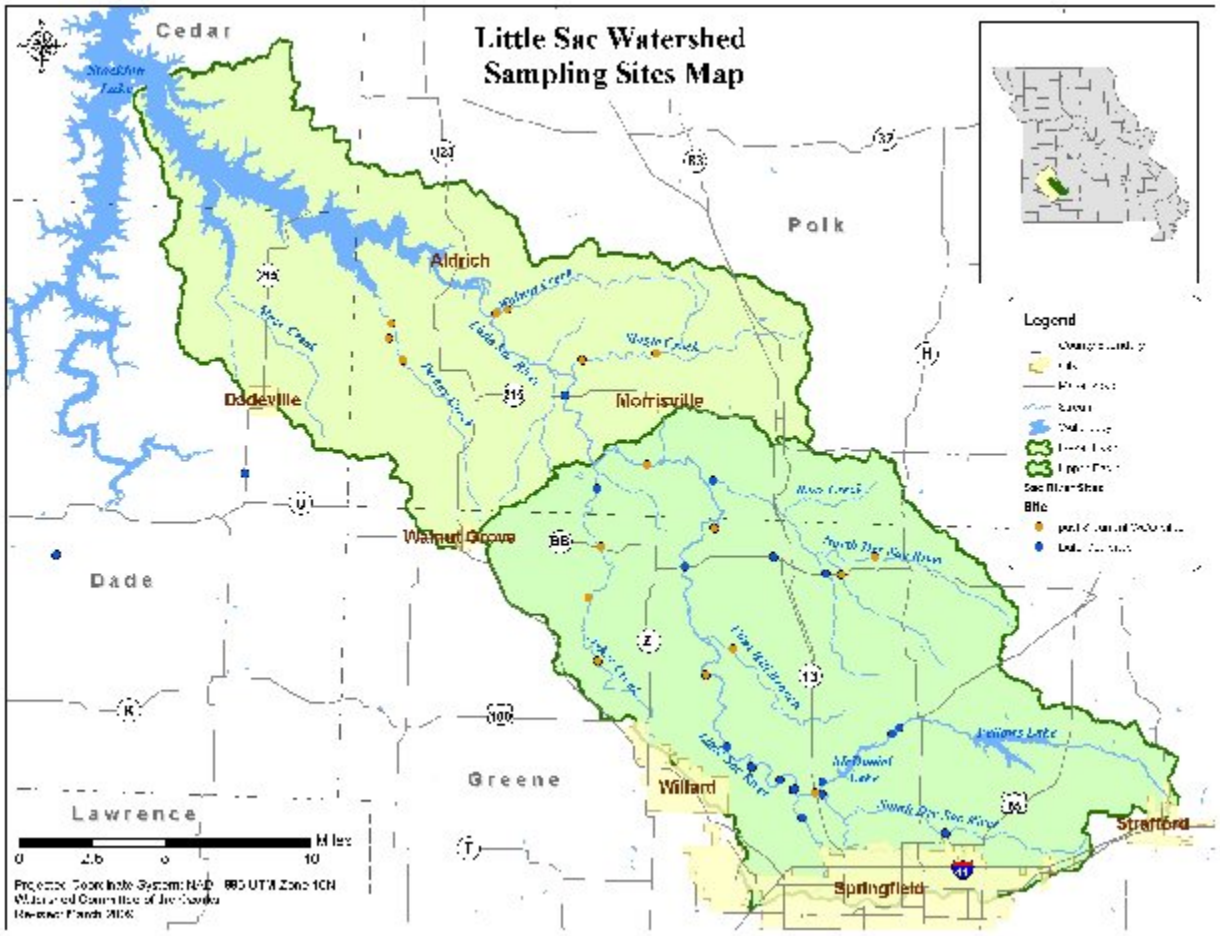
Rural Watershed Area

Management Measure	Responsible Party	Progress Indicators	Evaluation Criteria	Threshold Criteria to Change Plan When…or E. coli levels don't decrease in 5-8yrs
Education & Outreach	WCO	# People Reached	Surveys	…E&O results show >60% involvement in watershed efforts by landowners
Springs Source Tracking Research	Interested Party	# Springs	WQM Data	N/A
Little Sac Watershed Septic Remediation Project	WCO/Greene County SWCD/Grant Recipients	# Sites	WQM Data	…80% compromised systems are replaced along riparian or karst areas
Riparian Habitat Improvement	WCO/Greene County SWCD/Grant Recipients	# Miles/Acres	WQM Data	All Critical Riparian areas are remediated
Nutrient Management	Greene County SWCD	# Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Sheet/Rill Erosion Prevention	Greene County SWCD	# Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
On-Site Waste Water System Install/Repair/Maintenance	Greene County Resource Management	#Systems	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Forage Management	Greene County SWCD	#Farms/Acres	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Flood Plain Development Planning Program	Greene County Resource Management	# Plans	WQM Data	5yrs Re-evaluation of water quality in Little Sac River
Water Quality Protection for Wells, Sinkholes, Caves, Springs	Greene County Resource Management	# Sites	WQM Data	5yrs Re-evaluation of water quality in Little Sac River

9. Monitoring Component

Number of Monitoring Sites

The Watershed Committee of the Ozarks currently monitors 18 sites within the Little Sac Watershed. Each site is sampled for: Temp, Cond., pH, DO, Nutrients N & P, and E. Coli/Total Coliform.



Sampling Frequency

Each Site is sampled monthly unless high water conditions are prevailing at the time. Only base flow water levels are sampled by WCO. (Stacey could you add details to sampling here?)

Measures to Monitor for Evaluation Criteria Element 8

Measures to monitor will be E. coli. The Little Sac was listed on the 303(d) list for this.

*make sampling more efficient/ between different organizations

Summary

Written Last…

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