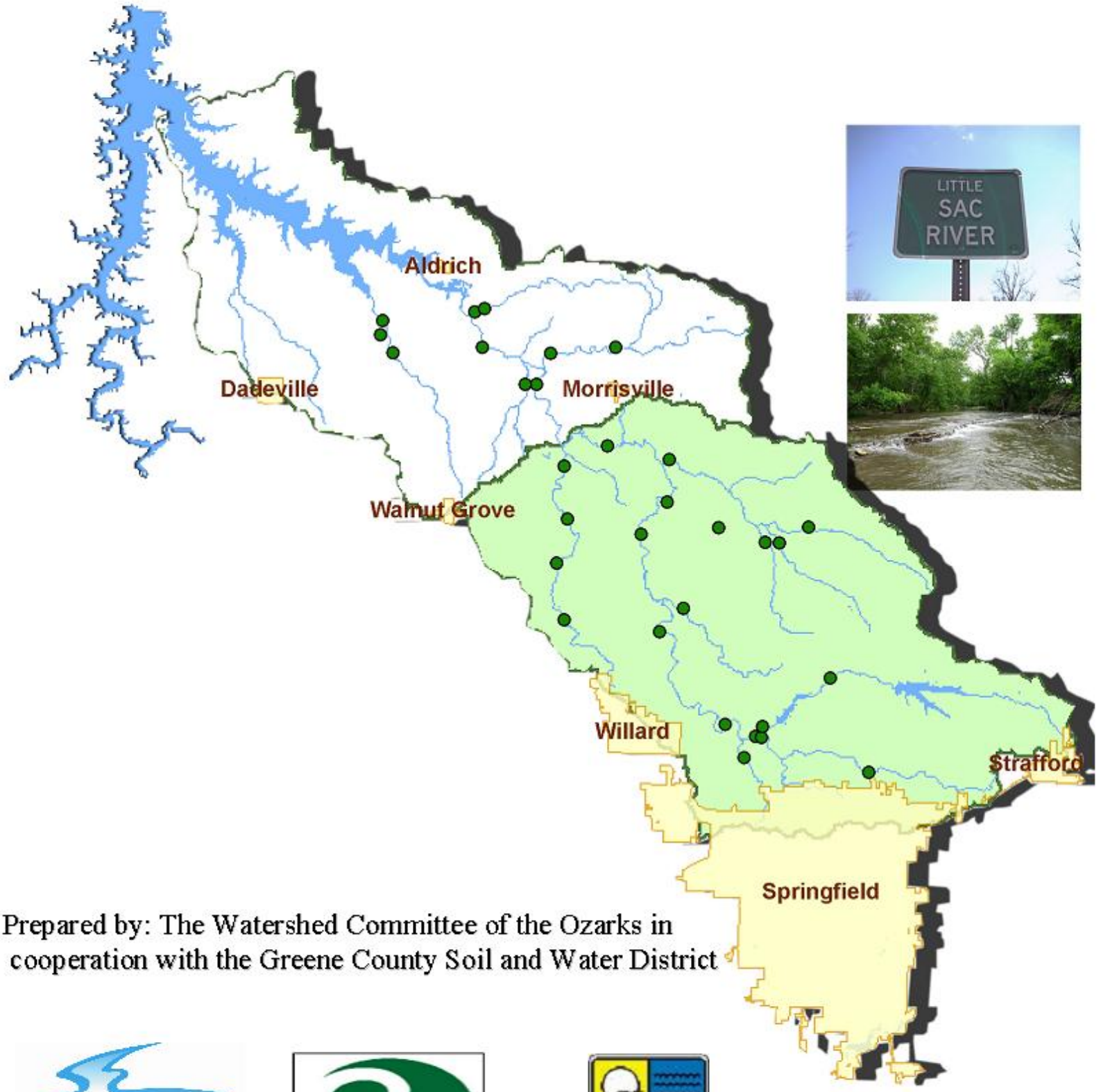
# Little Sac River Watershed Management Plan









Prepared by: The Watershed Committee of the Ozarks in cooperation with the Greene County Soil and Water District

WATERSHED CENTER

The Greene County Soil and Water Conservation District

Missouri Department of Natural Resources

"U.S. EPA Region 7, through the Missouri Department of Natural Resources, has provided partial funding for this project under Section 319 of the Clean Water Act."

***Watershed Committee of the***

***Ozarks***

***320 N. Main***

***Springfield, MO 65807***

***417-866-1127***

***417-866-1918(fax)***

***www.watershedcommittee.org***

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**Disclaimer**

*The Little Sac Watershed Management Plan has been written as clearly and concisely as possible to help stakeholders understand and utilize this plan to make future management decisions in the watershed. It is a non-regulatory document. It portrays the watershed and its water quality, actions that are presently being taken to maintain water quality, and what actions that 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 have the ability to improve water quality. This includes city, county, public and private properties within the watershed. The water can only be as clean as people keep the 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 occur in the watershed or in the water quality of the Little Sac River, then the plan should be revised as deemed necessary to compensate for changing conditions. 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 within the watershed.

*Also included in the plan are 9 critical elements as suggested by the EPA. 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 meetings within the watershed and then adapted to the 9 critical elements. This approach satisfies both regulatory purposes and public concerns about the watershed. The 9 elements also act as a framework for the plan.

*For any questions, comments, or concerns about this plan or the Little Sac River Watershed contact the Watershed Committee of Committee of the Ozarks. 417-866-1127 or visit www.watershedcenter.org

## EPA's Nine Critical Elements to a Watershed Plan

1. Identify Causes and Sources of Impairment
    - Sources of Impairment
    - Source of Impairment Map "Areas of Concern"
    - Sample Site Locations for the Sac R. Data Gap Analysis w/n the Little Sac River Watershed
    - Quantified Pollutant Load Attributed to Each Source
    - Load Reduction Goal

2. Expected Load Reductions
    - Load Reductions Needed to Achieve Environmental Goals
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    - Estimated Load Reduction for Each Management Measure (Element 3)
        - Urban Watershed Area
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    - Urban Watershed Area
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    - Rural Watershed Area

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    - Sampling Frequency
    - Measures to Monitor for Evaluation Criteria Element 8

# Introducing the project

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 10290106050) is necessary to guide stakeholders within the watershed as they seek to improve the water quality of the Little Sac River. This plan is first addressing the upper or southern portion of the Little Sac watershed (HUC 10290106050). In the future, the lower/northern portion of the watershed (HUC 10290106060) will be addressed. The Watershed Committee of the Ozarks and Greene County Soil and Water Conservation District believe that creating a watershed management plan for the Little Sac River watershed will help to protect and improve water quality in the rivers and streams as well as in Fellows, McDaniel, and Stockton lakes, by identifying pollutant sources, identifying better management practices to be implemented, setting reachable and reasonable goals, and developing a timeline for implementation. A management plan would also help current and future monitoring evaluation programs to determine success of implemented projects/programs.

Development of a watershed management plan will increase the success of future projects and address issues related to the current TMDL for the Little Sac River. This plan will help determine where efforts should be focused, and fulfill specific grant application requirements for securing future funding and potential cost-share funds for implementation of best management practices.

The current TMDL (http://www.fapri.missouri.edu/outreach/publications/2006/FAPRI_UMC_Report_11_06.pdf) (Total Maximum Daily Load) for the Little Sac River focuses on the bacteria levels 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, storm water runoff, nutrients and sediment.

History of Watershed Committee

The Watershed Committee of the Ozarks began 25 years ago when Springfield Mayor Harry Strawn, sent a memo to the Chair of the Board of Public Utilities, N. L. "Mac" McCartney. 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 Watershed Committee of the Ozarks (WCO) 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 (SWCD): 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 (SALT) 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 WCO the Greene County SWCD 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, NRCS, and MDC professionals to aid in the installation of conservation practices with landowners in the watershed.

The project completed: 5 Riparian Restoration Sites, 5 Management Intensive Grazing Systems, 6 Alternative watering systems, and 1 Animal Waste Containment System.

See page 37 for other research, water quality data, and projects that have been completed in the watershed to date.

There are two demonstration farms that are available for tours and educational field days; the Fellows-McDaniel Lake Demo and the Jerome Rader Farm. Jerome Rader from Willard participated in a cost share project with WCO that allowed him to fence out cattle on his section of Asher Creek and obtain alternative watering systems. For more info on this project contact the Watershed Committee of the Ozarks.

# Overview 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 and 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. The three lakes (Stockton, Fellows, McDaniel) are public drinking water sources for Springfield and Greene County residents. The lakes also provide recreation, fishing, and hunting opportunities for thousands of users annually.

Little Sac River Watershed


**Figure 1**

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 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 in the southern portion, more urban and suburban portions 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 from near the surface down to 200 to 300 feet and is recharged by precipitation. The shallow aquifer was generally of fairly good quality and was a major drinking water supply resource until the mid-1950s. Karst geologic conditions in the Springfield area make the shallow aquifer vulnerable to contamination. Contamination of this aquifer has prompted stricter regulations for wells, which now require this aquifer to be "cased out" and wells are drilled into the deeper aquifers. 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 comprise of 2.4% of the watershed. A high contamination potential exist due to the high urban population density and the amount of impervious surfaces. Estimates have been made indicating that the most urbanized portion of this watershed has about 25% imperviousness.

## Historic Issues in the Little Sac Watershed

Historically, there have been concerns among the downstream landowners, primarily agricultural producers, that the real water quality impairments in the Little Sac arise from the urban area at the top of the watershed-primarily the Springfield Landfill and the Northwest Wastewater Treatment Plant. Below are descriptions of the efforts of the City of Springfield to protect and preserve the water quality of the Little Sac River.

### Northwest Wastewater Treatment Plant

The City of Springfield is committed to the protection of water quality of the Little Sac River as evidenced by recent investments in improvements at their Northwest Wastewater Treatment Plant. In 2008, $21,279,000 was spent on improvements to increase the peak flow capacity of the plant from 12.0 million gallons/day to 22 million gallons/day while treating an average daily flow of 6 million gallons/day. It is expected that the expansion will meet the needs of the ever-growing area estimated through the year 2020. In addition, facilities for the treatment/removal of phosphorus and nitrates were added – a voluntary measure on the part of the City. No regulations currently exist or are in process to designate the Little Sac River as an area to be covered by more strict nutrient management regulations. The plant has also begun year-round disinfection utilizing UV equipment which provides the benefit of higher quality effluent without the use of chlorine. To learn more about the Northwest Wastewater Treatment Plant visit:
http://www.springfieldmo.gov/egov/publicworks/sanitary/nw_plant.html

### Springfield Sanitary Landfill

Solid Waste Management Division staff continue to make improvements to the storm water management and compliance practices used at the Springfield Sanitary Landfill (SSLF). The SSLF staff are continuously re-vegetating disturbed soil and using other storm water management practices to reduce erosion and prevent suspended solids from leaving the property. The storm water is regularly monitored and reported to ensure compliance with all applicable state and federal regulations. To learn more visit:
http://www.springfieldmo.gov/recycling/landfill.html

### Springfield Storm Water Services

The City of Springfield Storm Water Services division has committed many actions toward maintaining and improving the water quality of the Little Sac River. Current improvement projects in the Little Sac watershed area within the City include: 1) Dickerson Park Zoo—Best Management Practices (BMPs) to address runoff from animal exhibits and stabilize lake bank erosion. 2) Doling Park—Lake improvements to address bank erosion and water quality. 3)Regional Detention Basin Plan/Implementation—Projects to control flooding, reduce erosion and improve water quality

Urban Stream Monitoring: Monitoring is conducted to characterize effects of storm water runoff on area streams throughout the city. In the Little Sac watershed, monitoring data has been collected on Pea Ridge Creek at Farm Road 102 since 2002 and monitoring will be expanded in Fall 2008 to include South Dry Sac at FR171 and Spring Branch at Norton Road.

Storm Water Design Criteria: To protect the City's drinking water source, water quality requirements have been in place since 1999 for all new developments in the South Dry Sac watershed. Recent revisions to the design criteria expand water quality requirements city-wide, and include significant redevelopments such as the North Town Mall Wal-Mart Supercenter, which is located in the Little Sac watershed. Designs emphasize natural channel protection, "green" engineering, and low-impact development.

Industrial and "High Risk" Runoff: The City conducts storm water monitoring and inspections of industries

and other "high-risk" facilities for pollution prevention.

Land Disturbance Program: In Fall 2008, the City will be implementing a land disturbance permit program for erosion and sediment control on sites 1 acre or larger, including storm water pollution prevention plan review, inspection, and enforcement.

Public Education/Outreach: The City, in partnership with Watershed Committee of the Ozarks, James River Basin Partnership, and others, is continually expanding its public education/outreach efforts through a variety of programs and projects including:

Show-Me Yards & Neighborhoods (environmentally-friendly yard care) —Began in 2000; Homeowners/professionals workshops planned for Jan-Feb 2009.

Rain Garden Demonstration Projects—Four projects completed totaling 8 gardens. Rain Barrel Rebate Program—Over 500 barrels sold to Greene County residents since Jan 2007; increased program goals and media campaign planned for 2009.

Storm Drain Manhole Cover Design Contest— Winning design with "Upstream Starts Here, Protect Our Waterways" now standard for all new storm drain manhole covers.

"What Goes Down Does Comes Around" education campaign in 2007 with billboards, bus wraps, movie theatre ads, radio PSAs. Print pieces continue to be distributed. For more information visit: www.springfieldmo.gov/stormwater

**Figure 2 Below Greene County Farm Road 125**

## The Little Sac River, A River-level View

The upper part of the Little Sac River starts near Strafford. It 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 Northwest Wastewater Treatment Plant NWWTP. This discharge has raised concerns in the past about downstream water quality and conditions. However, the river below this discharge point remains relatively healthy and has some outstanding natural attributes. The development of this management plan allows us to gain a more intimate understanding of these attributes, as well as provide a means for future water quality improvements throughout the watershed.

The Little Sac is a different type of stream than most. It is fighting for its identity. Its unique location places it halfway between the clear waters of the Ozarks and the turbid waters of western and north Missouri. The upper half is more characterized by with coarse gravel, cobble, and boulders. The lower section is characterized by turbid water, large woody debris, and mud. Same stream, yet the end looks nothing like the beginning.

**Figure 3 Between Highway O and Hackney Bridge**

**Figure 4 Below Hackney Bridge**

This stream is just as scenic as its nearby cousins, Pomme de Terre and the Niangua. It has its share of bluffs, rock ledges, small waterfalls, fast chutes 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 is influenced by Stockton Lake, many species swim up the river to spawn, such as white bass, walleye, and catfish.

**Figure 5** Longear Sunfish

**Figure 6** Spring White Bass Season

**Figure 7** Carp fishing on fly rod

Though carp may not be the best fish to put on the dinner table, they are a wary fish to approach and are 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.

**Figure 8 Little Sac River Native Mussels**

**Figure 9 Ephemeroptera Mayfly**

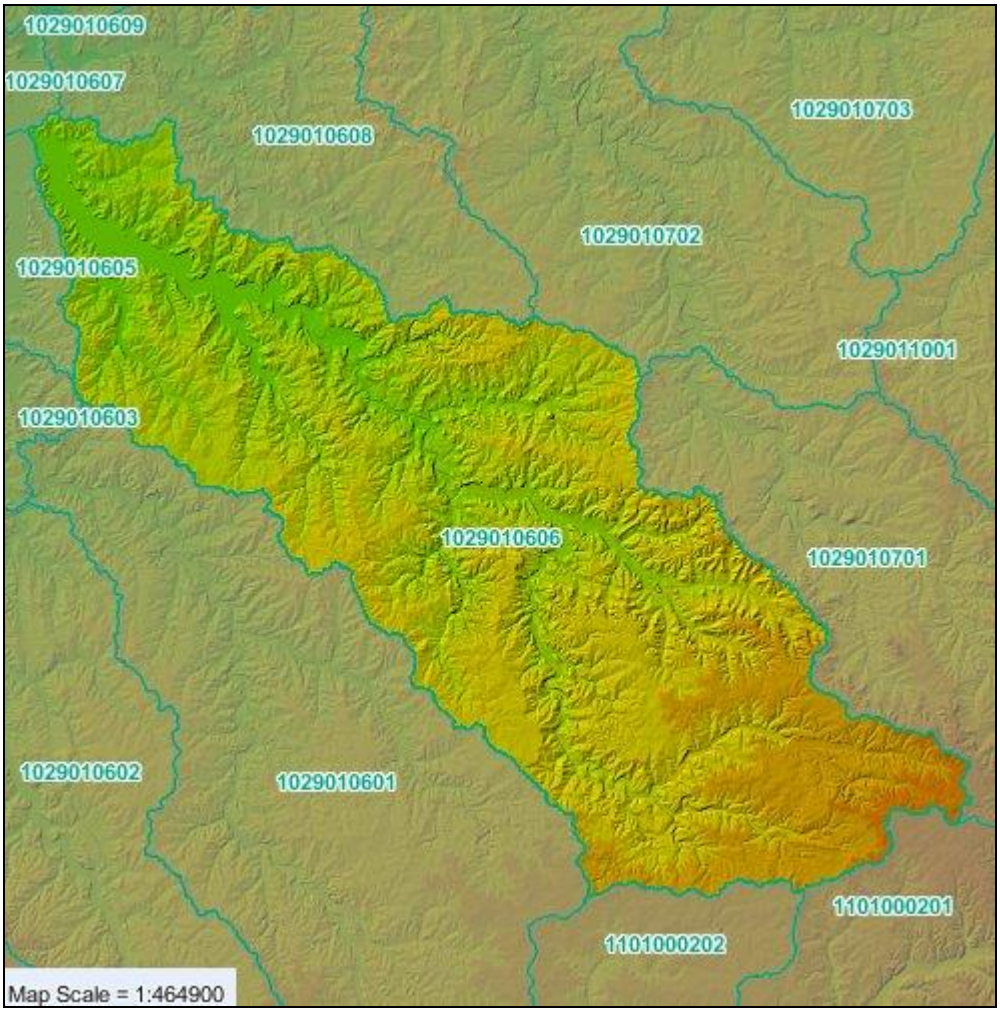
Even though the Little Sac receives the effluent from a wastewater treatment plant, and is a partially an urban stream, one shouldn't write it off. It is a great place to go to enjoy wildlife and the characteristic scenery of the Ozarks.

**Figure 10 Little Sac River between Farm Road 44 Bridge and Highway BB**

## Describing the Little Sac River Watershed with Maps

Each of he following maps are being used for a general description of the watershed. They describe the physical features of the land area, give general information, and help in illustrating the watershed. They were produced by free mapping software online at http://www.cares.missouri.edu/. If interested in a close proximity map that shows greater detail, one may go to this site and create maps showing any or all the information in the following maps.
(These maps provide general physiographic information at the 10 HUC watershed code)

# Relief Map
## Little Sac River (1029010606)




**Elevation in Feet**

**High** (1,515.3)

**Low** (1,102.9)

# 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% |


**Steep Slope** (>15%)

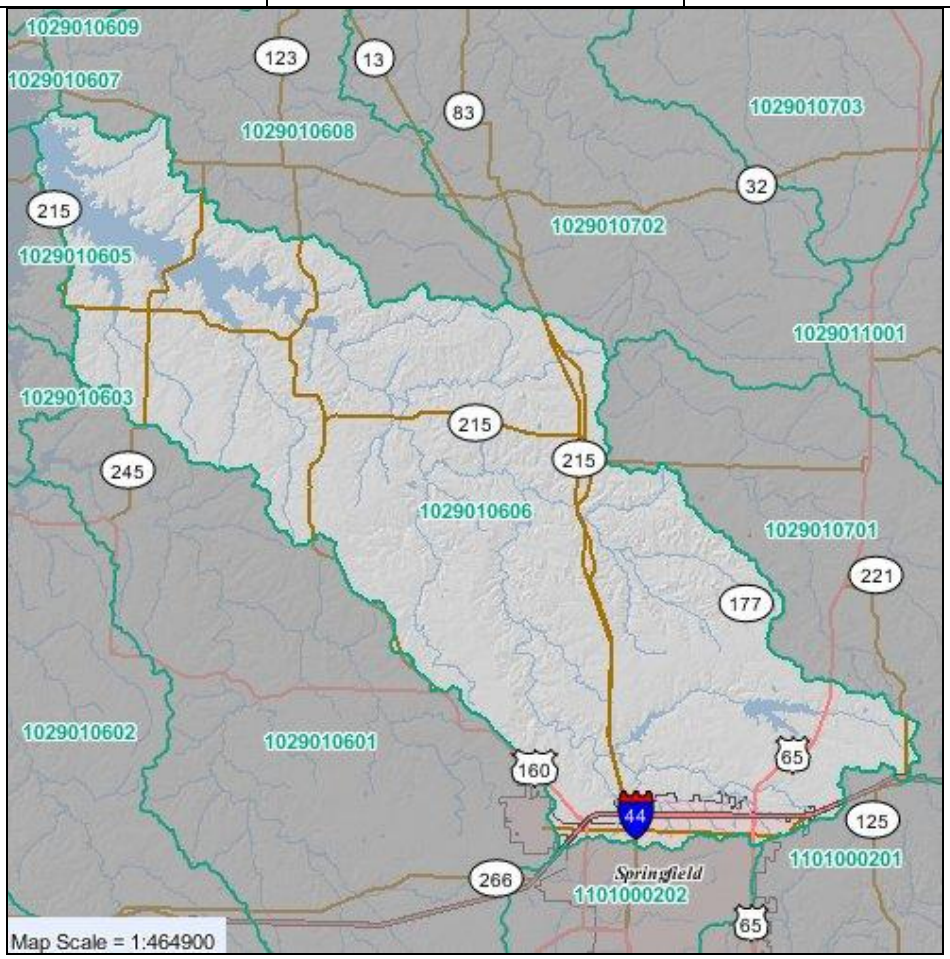
**Little to No Slope** (0-3%)

# 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% |

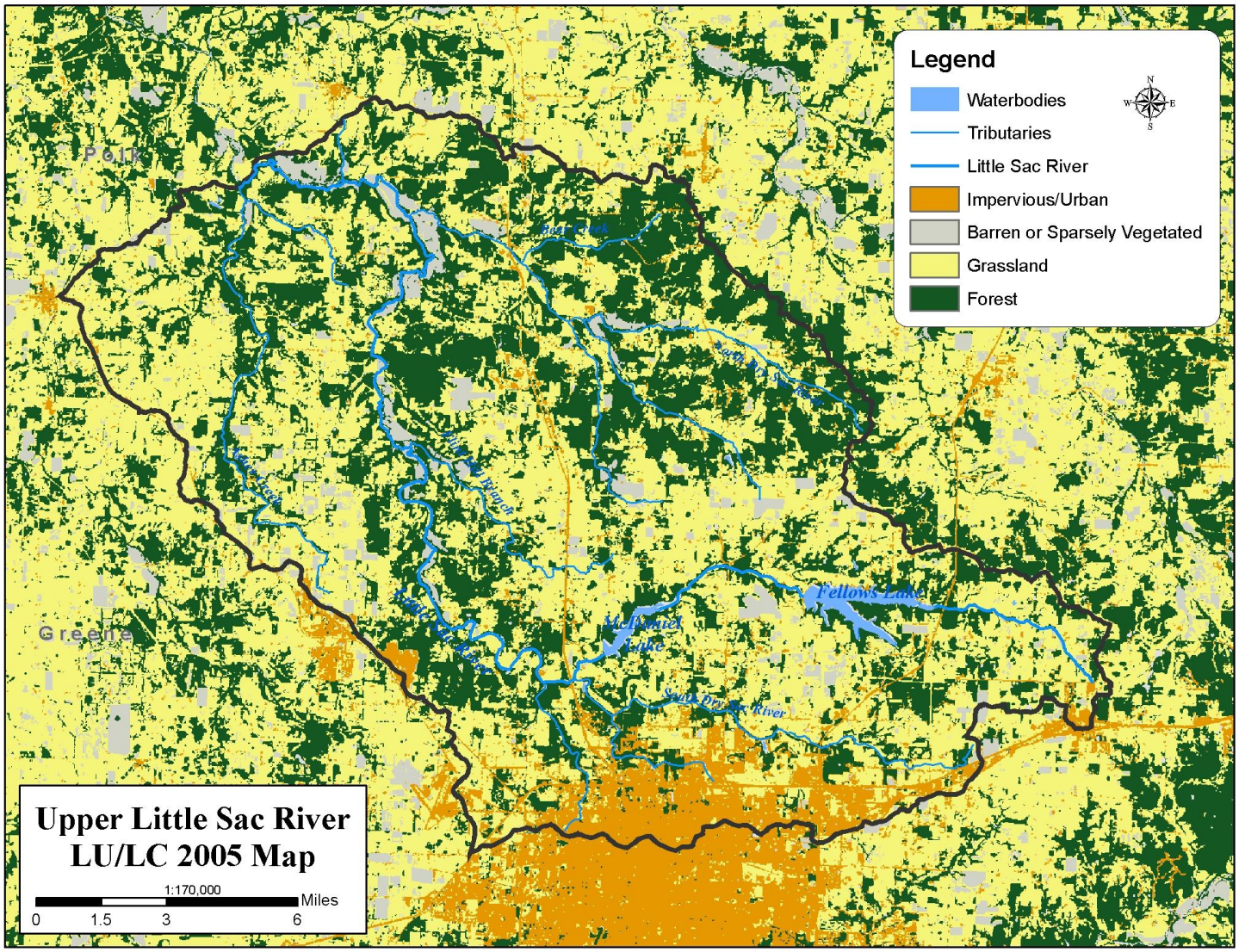



**Rivers, Streams, Lakes**

# Land Use/Land Cover

## Upper Little Sac River

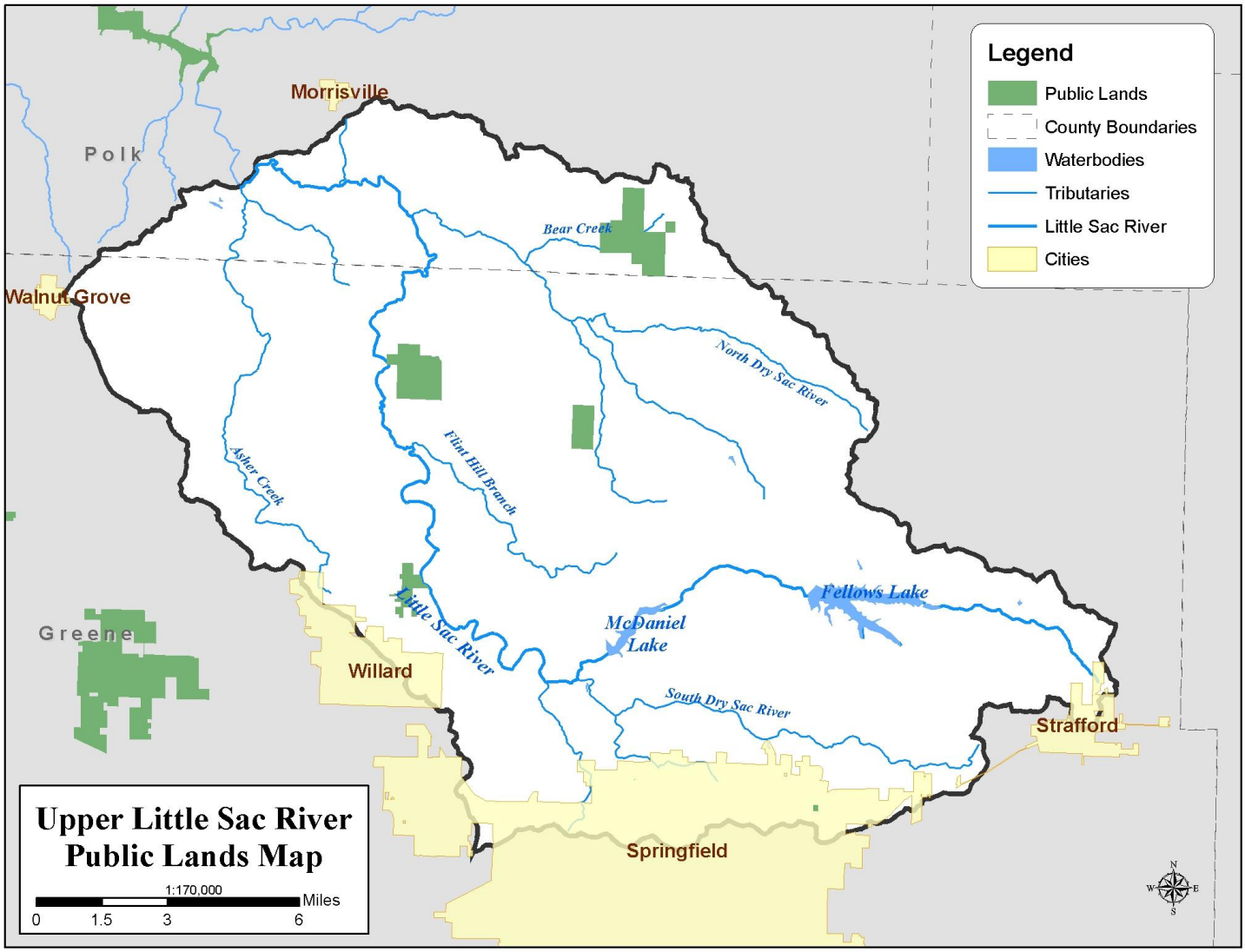
| Land Cover | Acres | Percent |
|---|---|---|
| Cropland | 12,974 | (4.78%) |
| Grassland | 140,274 | (51.64%) |
| Forest | 90,777 | (33.42%) |
| Wetland | 819.52 | (.30%) |
| Urban | 13,665.05 | (5.03%) |
| Water | 13,124.19 | (4.83%) |



# Public Lands

## Upper Little Sac River

| | 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% |



# Crop Acres by Crop Type

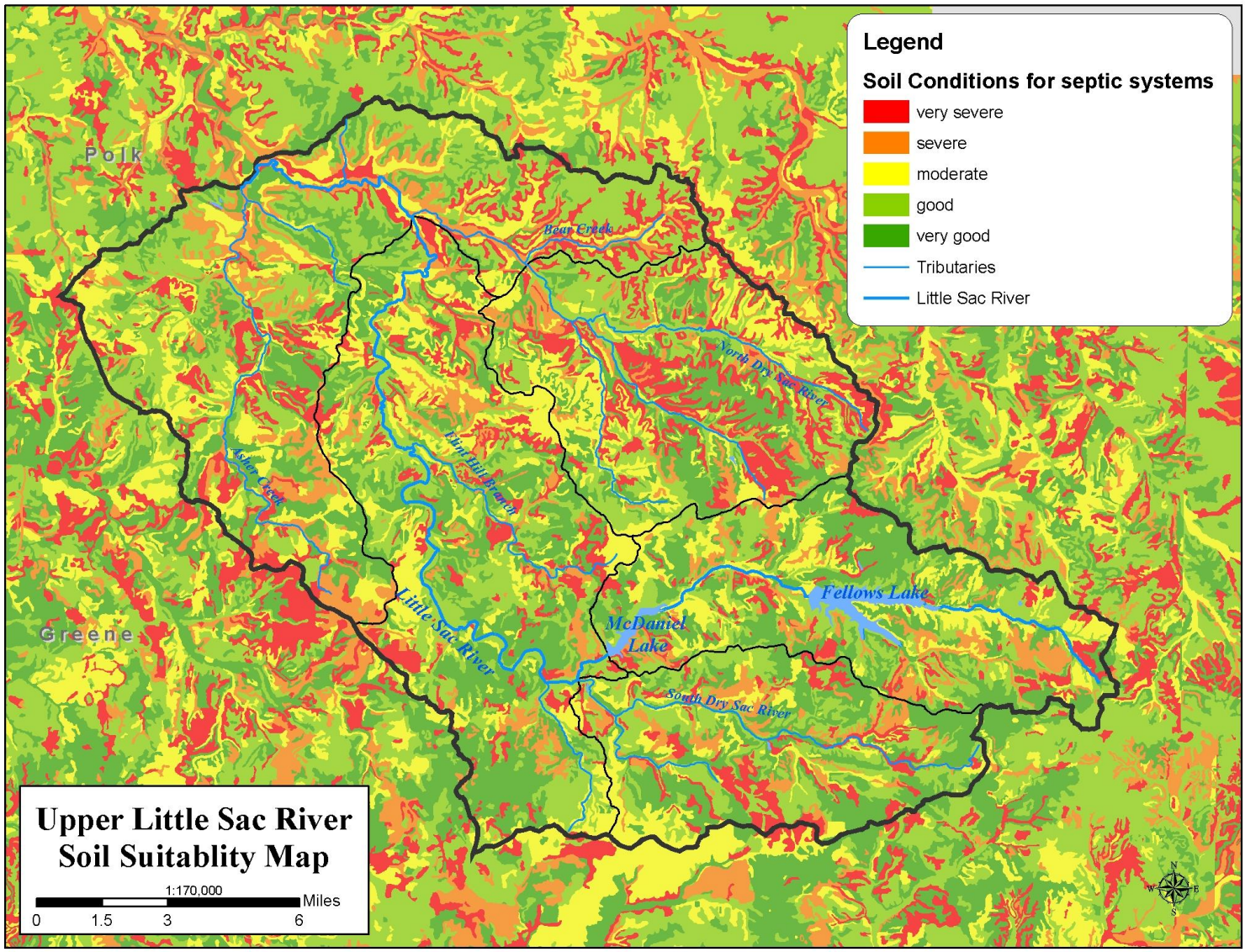
## Little Sac River (1029010606)

| 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)

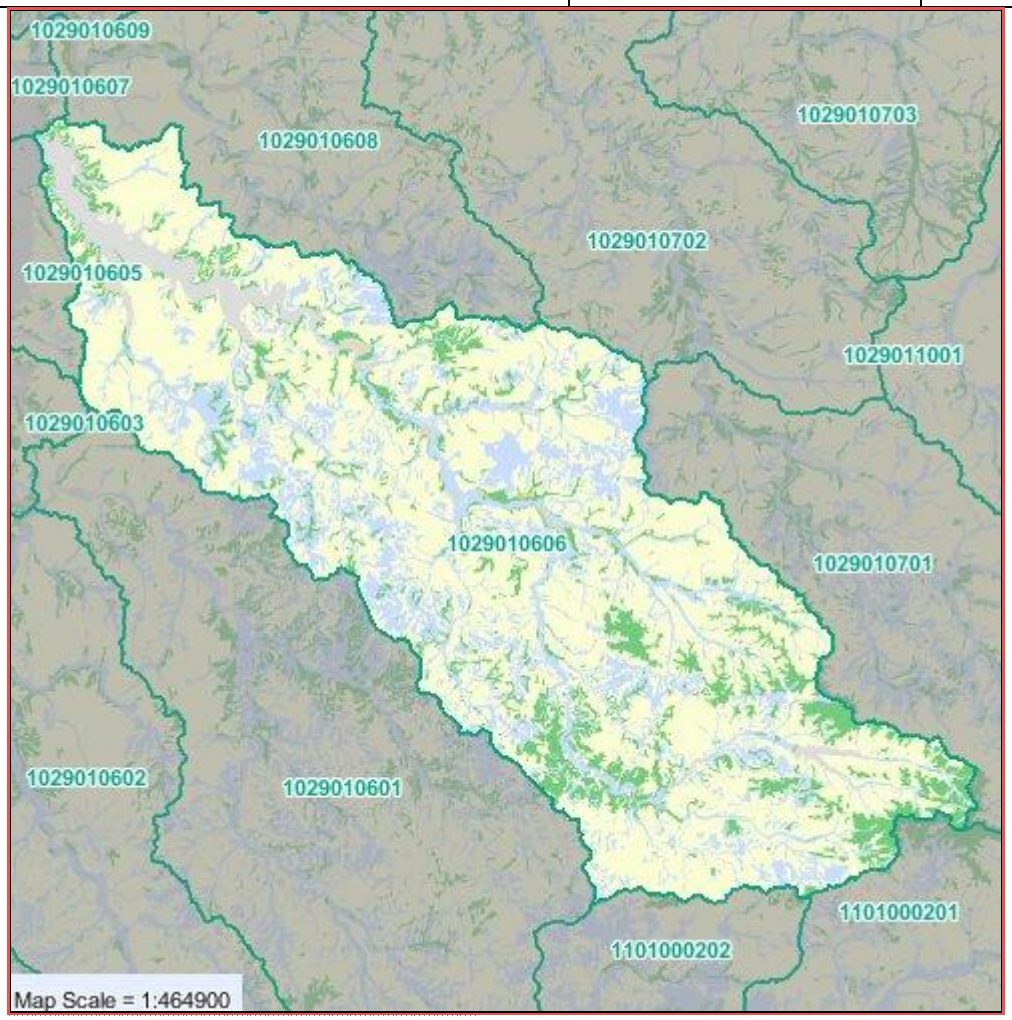
| Unit Name | Percent |
|---|---|
| Goss gravelly silt loam, 8 to 15 percent slopes | 15.26% |
| Goss gravelly silt loam, 3 to 8 percent slopes | 5.42% |
| Alsup silt loam, 15 to 35 percent slopes, very stony | 4.88% |
| Wilderness gravelly silt loam, 3 to 8 percent slopes | 4.81% |
| Water | 4.11% |



# 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% |

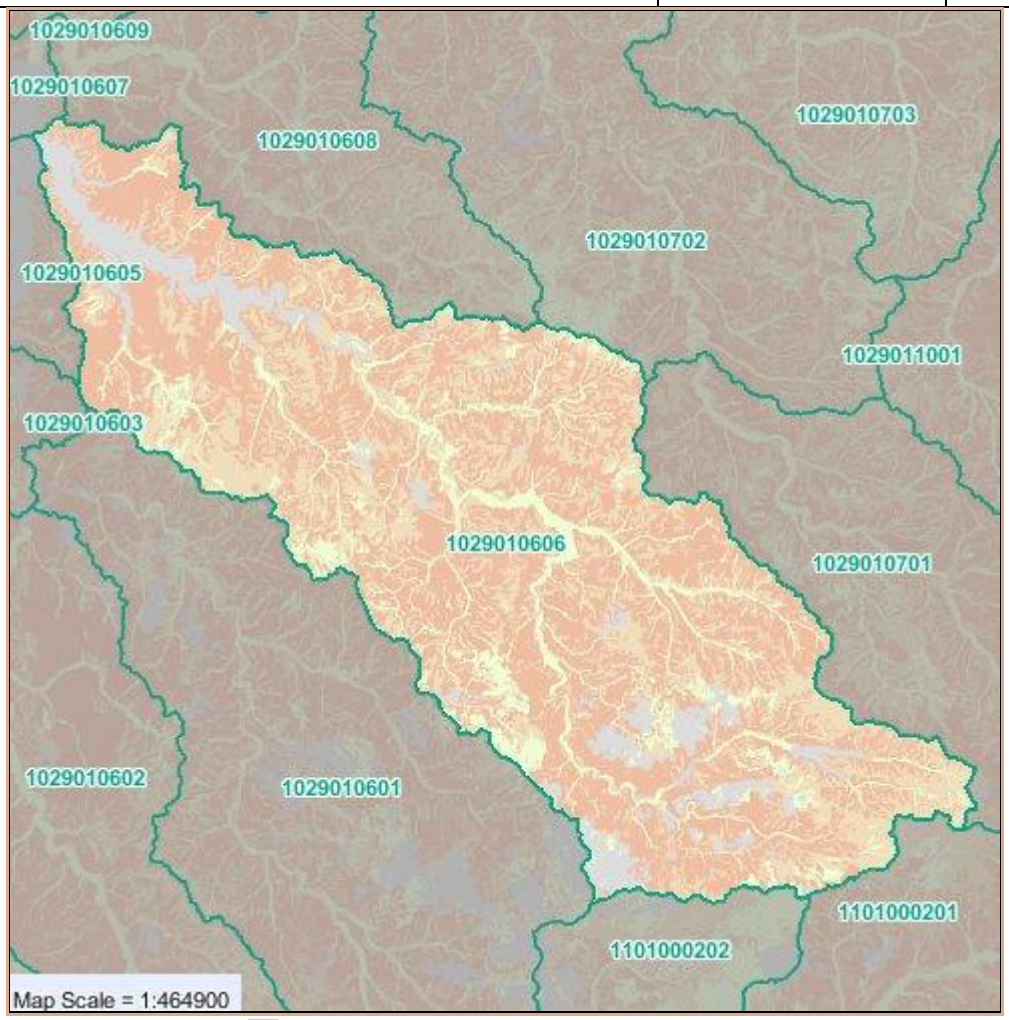



- High Infiltration Rate
- Moderate Infiltration Rate
- Combination of Group B and D
- Combination of Group C and D
- Very Slow Infiltration Rate
- Not Rated
- Slow Infiltration Rate

# 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% |

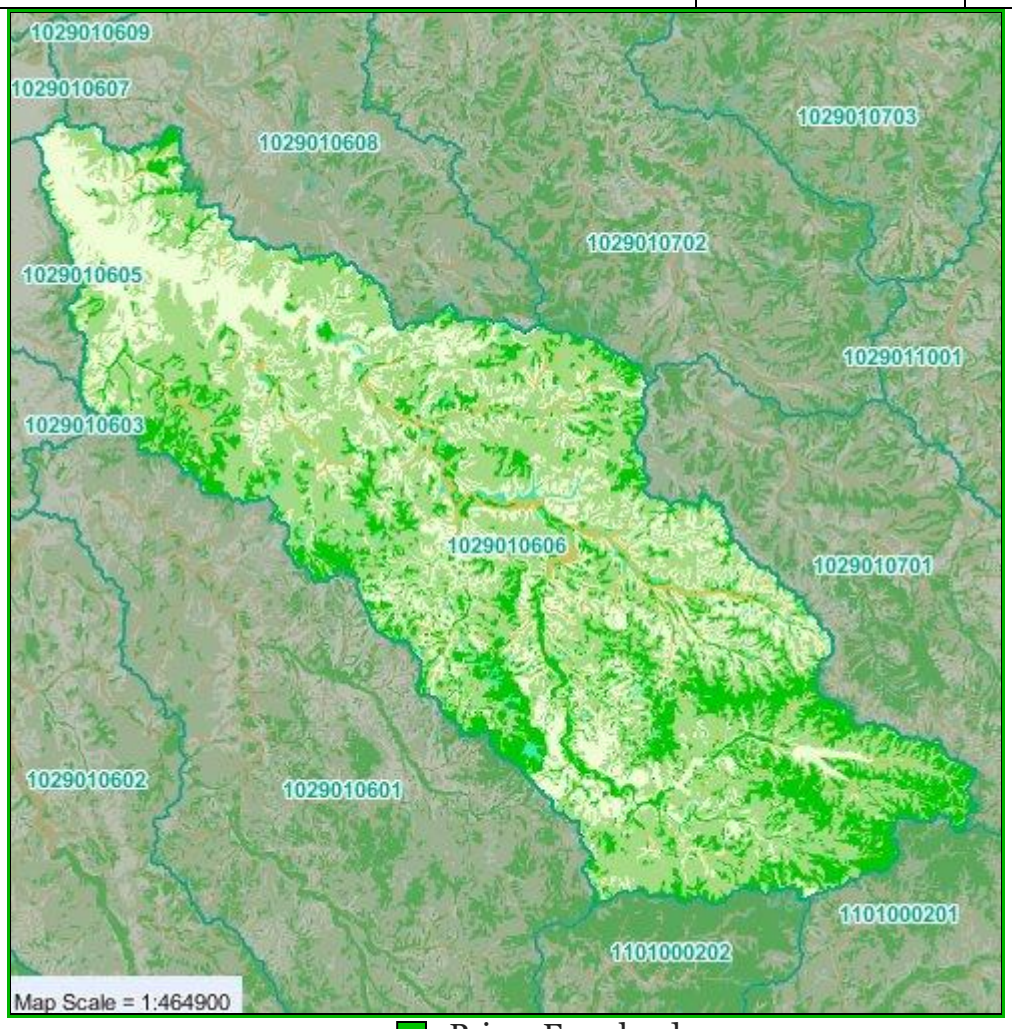



- Highly Erodible Land
- Potentially Highly Erodible Land
- Not Highly Erodible Land
- Not Rated

# Prime Farmland

## Little Sac River (1029010606)

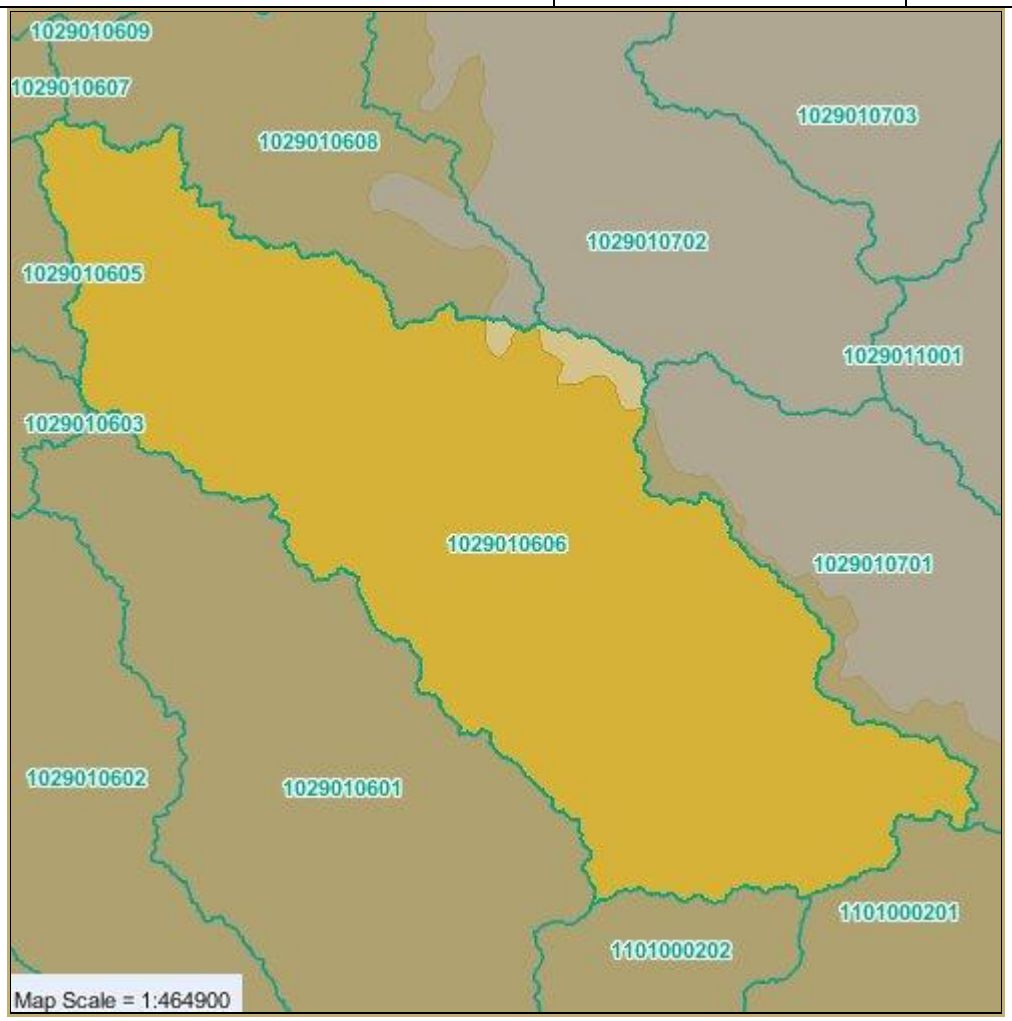
| Type | Acres | Percent |
|---|---|---|
| Prime Farmland | 57,318.32 | 21.10% |
| Prime Farmland if Drained | 3,563.25 | 1.31% |
| Prime Farmland with Limitation | 8,160.82 | 3.00% |
| Farmland of Statewide Importance | 135,878.67 | 50.02% |
| Not Prime Farmland | 66,717.28 | 24.56% |




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

## Little Sac River (1029010606)

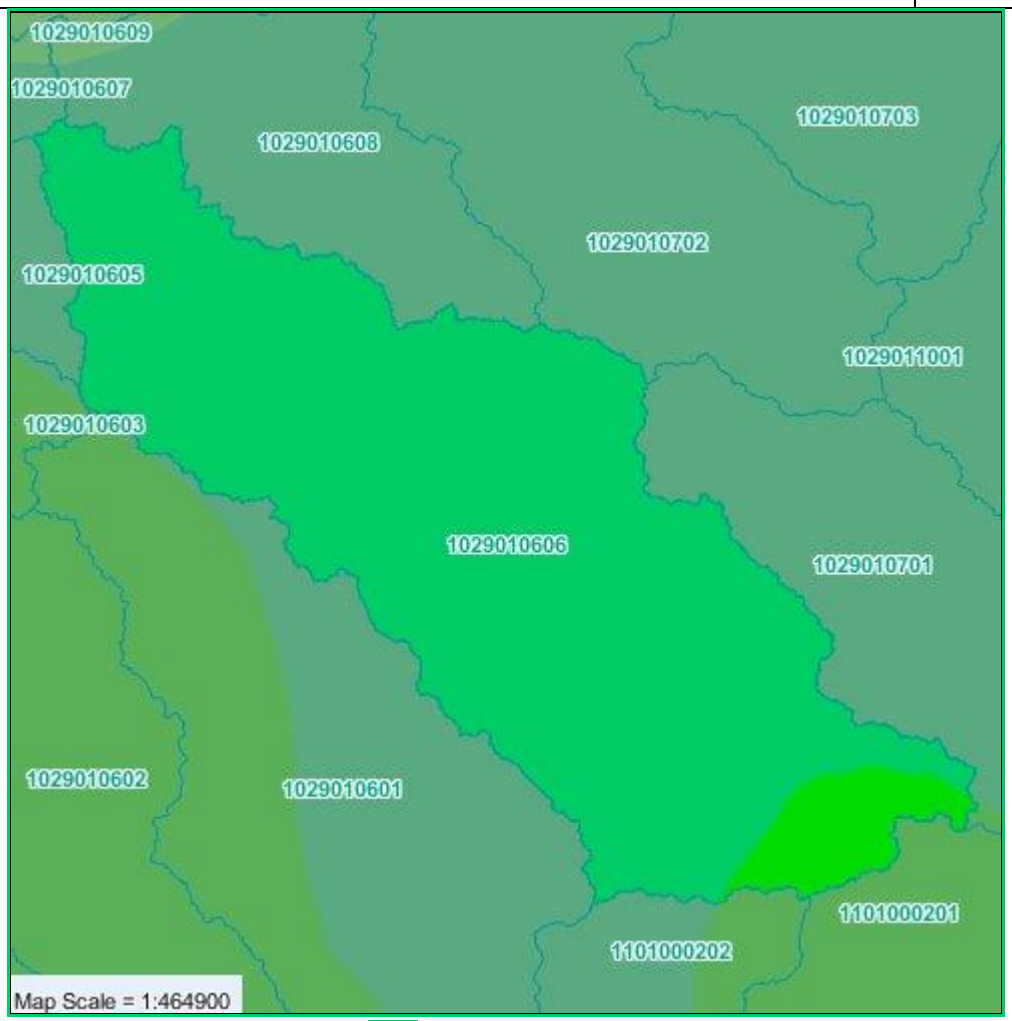
| Type | Acres | Percent |
|---|---|---|
| N116A | 4,924.80 | 1.81% |
| N116B | 266,713.54 | 98.19% |




N116A: Ozark Highland
N116B: Springfield Plain

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

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

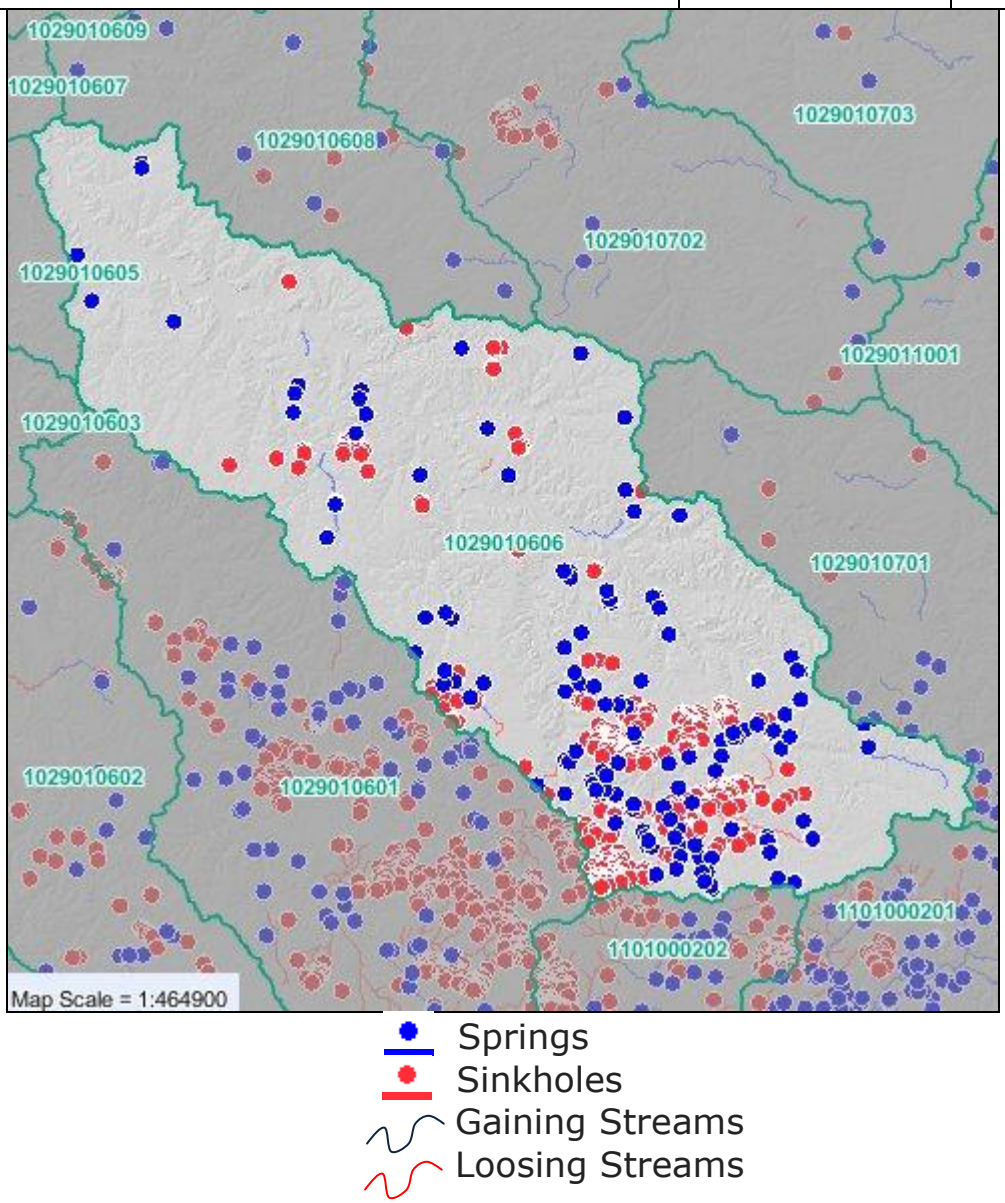



42-43 inches
43-44 inches

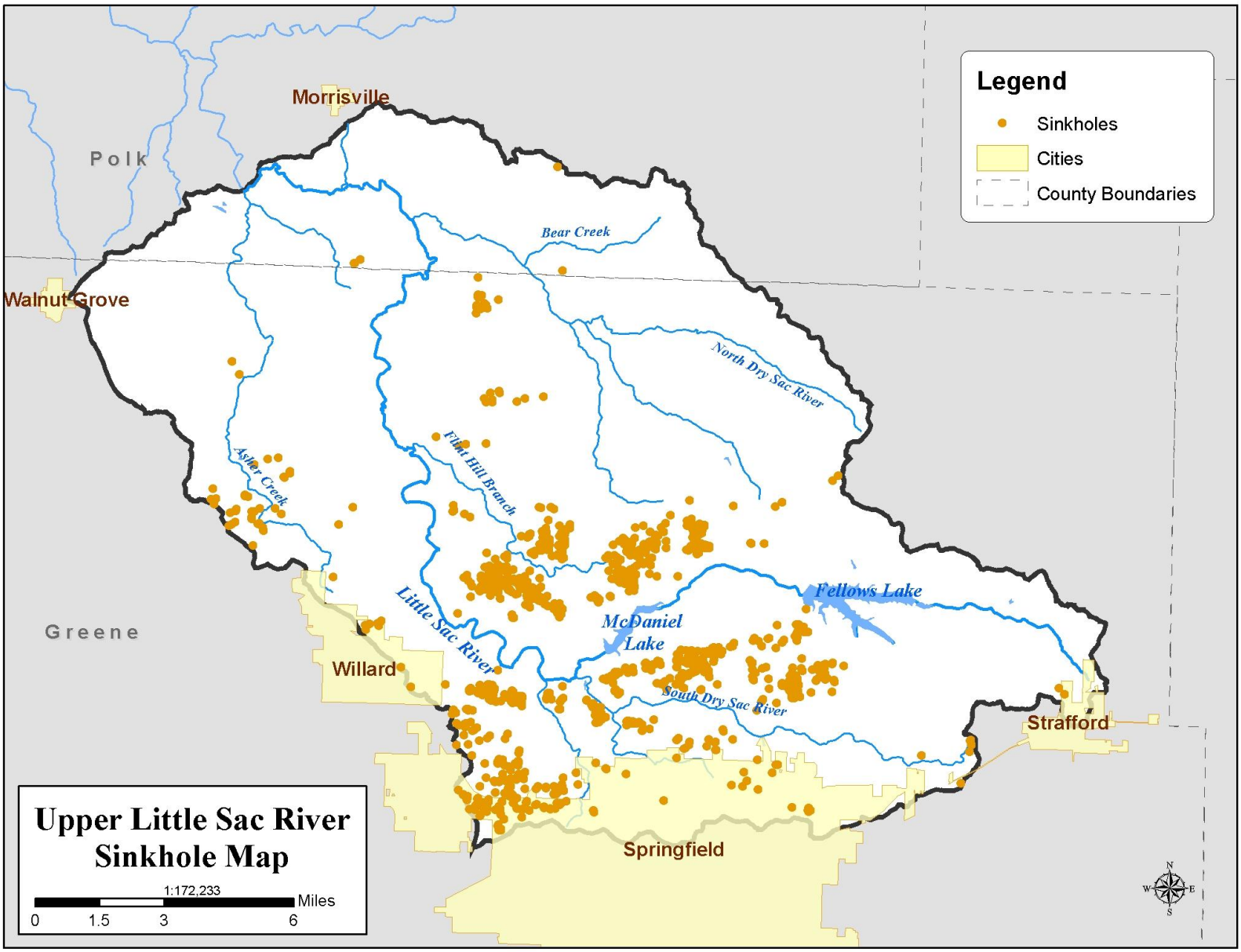
# Karst Features

## Little Sac River (1029010606)

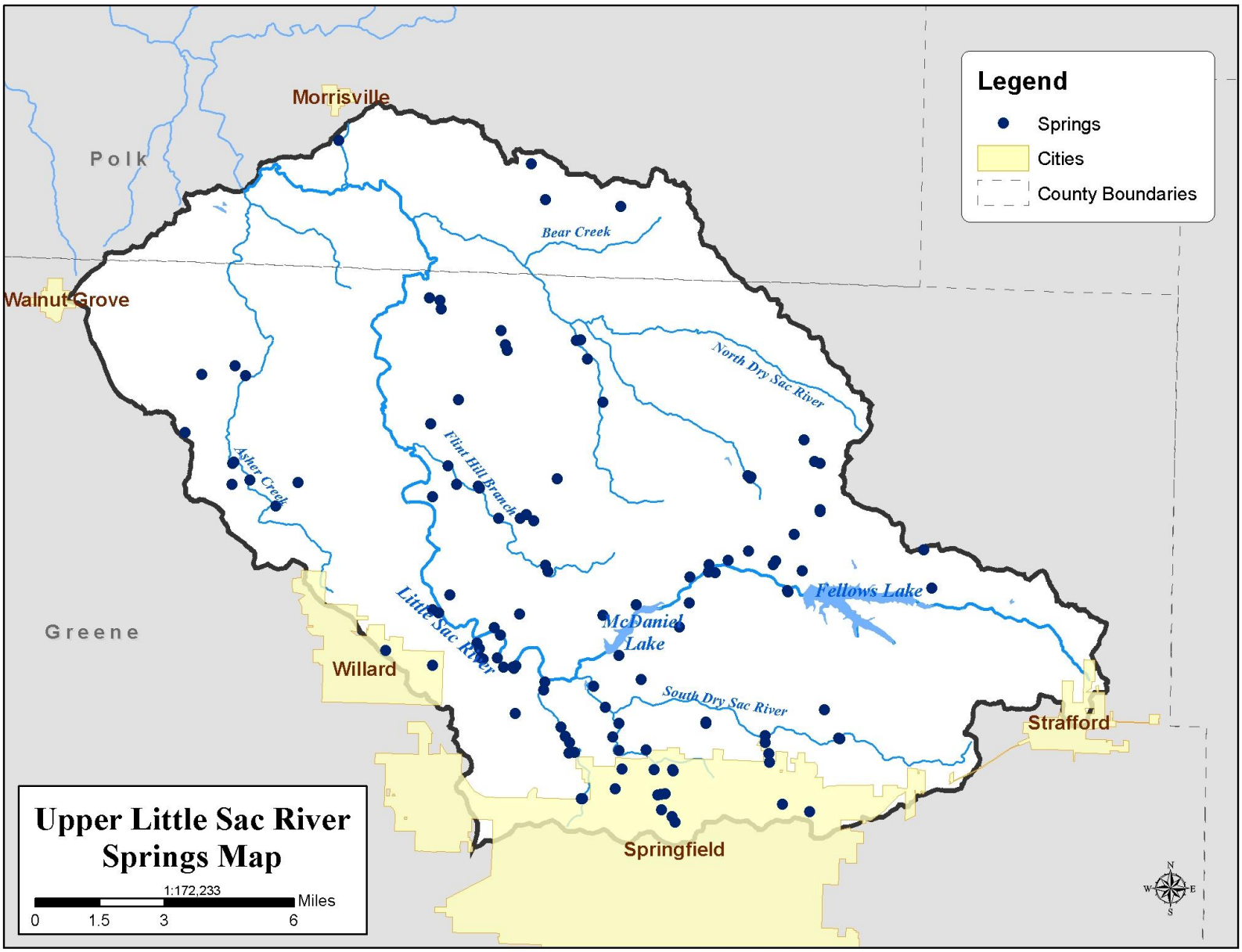
| | Numbers | Miles |
|---|---|---|
| Gaining streams: | 5 | 14.11 |
| Losing streams: | 13 | 18.25 |
| Sinkholes: | 1,555 | |
| Springs: | 142 | |



# Karst Features cont'd



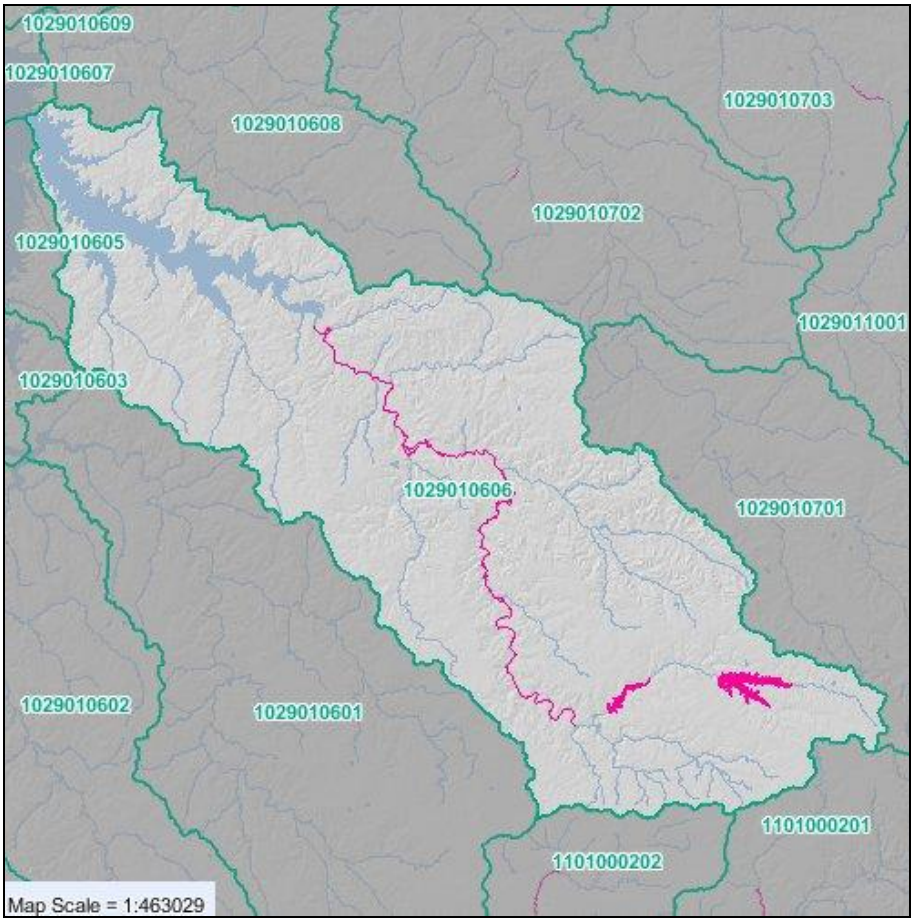
# Karst Features cont'd



# 303(d) Listed Lakes and Streams

## Little Sac River (1029010606)

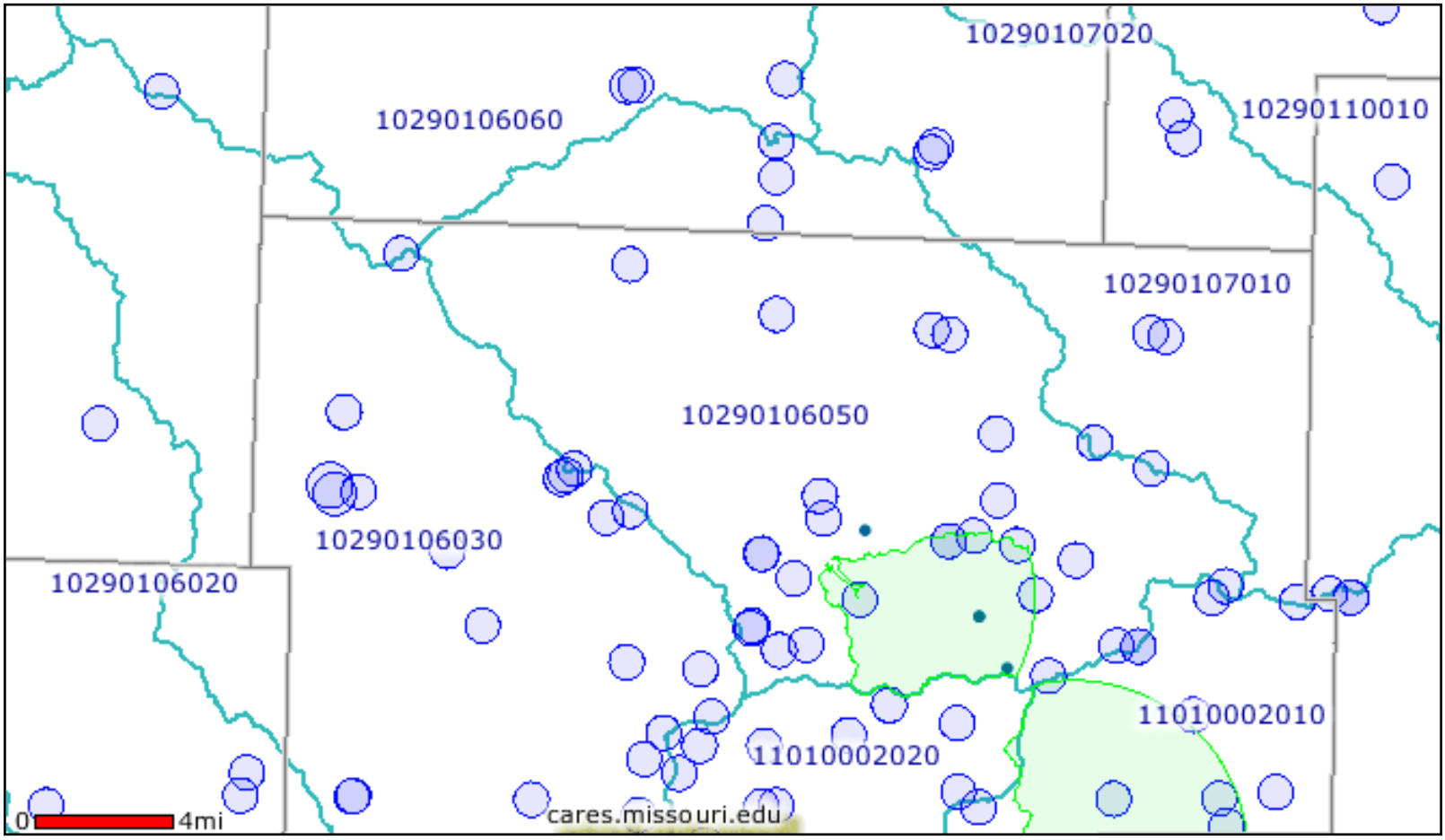
| | |
|---|---|
| Total Water Bodies:<br>» list all | 3 |
| Total Pollutants: | 3 |
| Water Body 1: | L. Sac River |
| Pollutants: | Fecal Coliform |
| Source: | Point and nonpoint sources |
| Source Type: | Point and Nonpoint |
| Priority: | M |
| TMDL Name: | Little Sac River, Polk County |
| TMDL 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 Inventory

## 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% |




Surface Source Water Inventory Areas

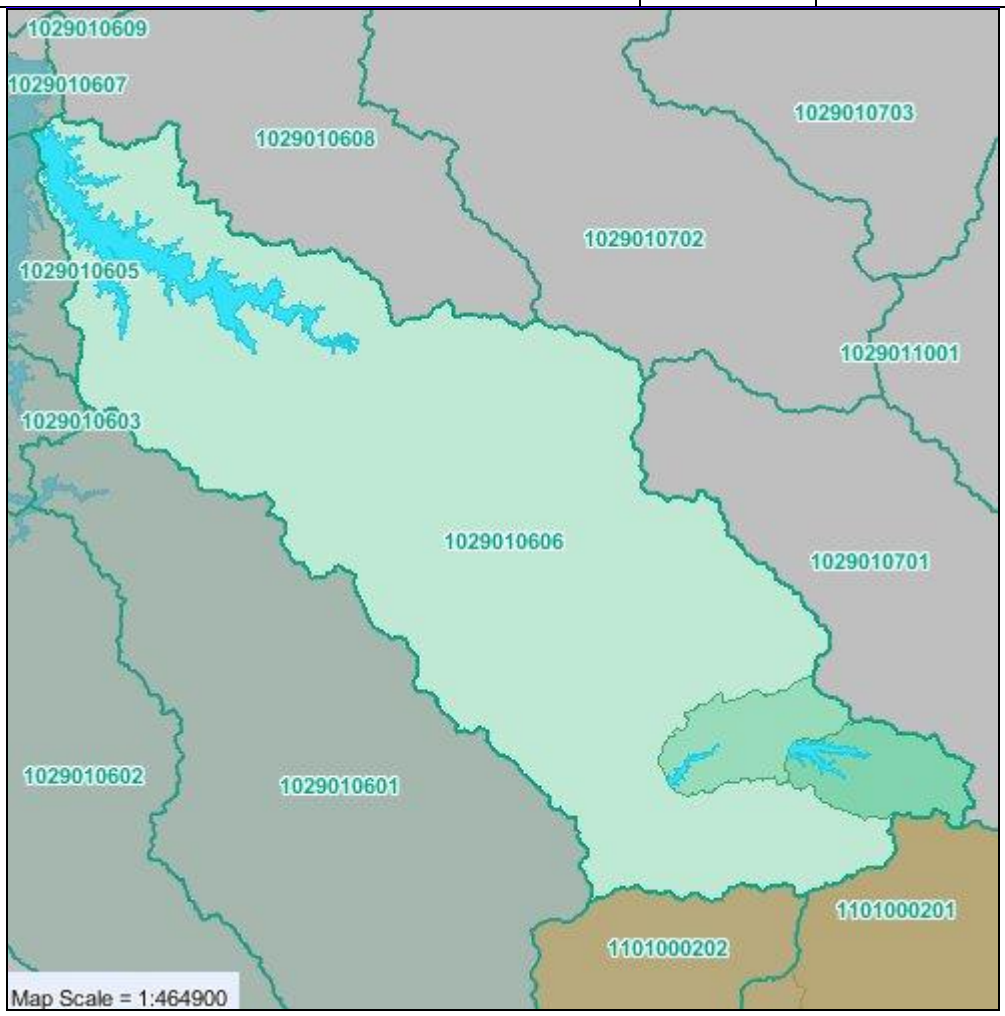
Ground Water Observation Wells

Ground Source Water Inventory Areas

# 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 |

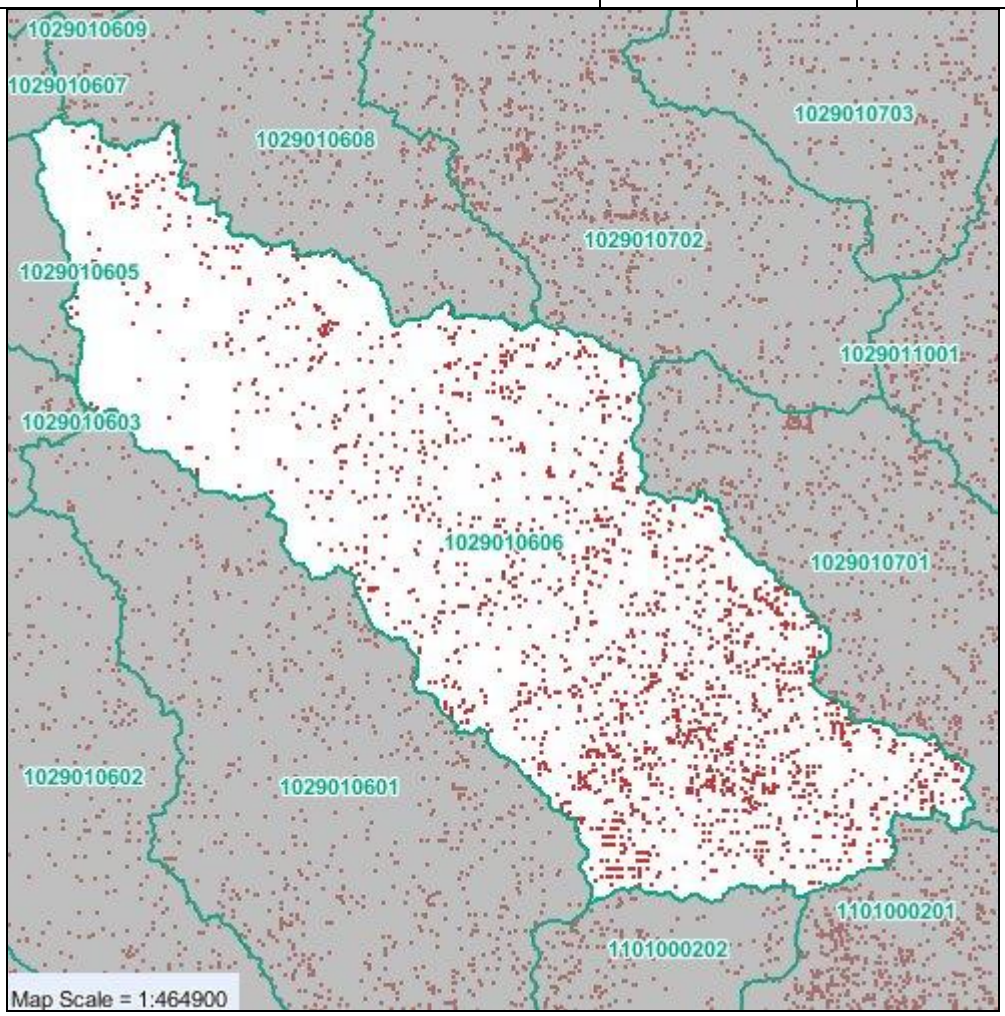



Lake Drainage Basin
Public Water Supply Lakes

# 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 |

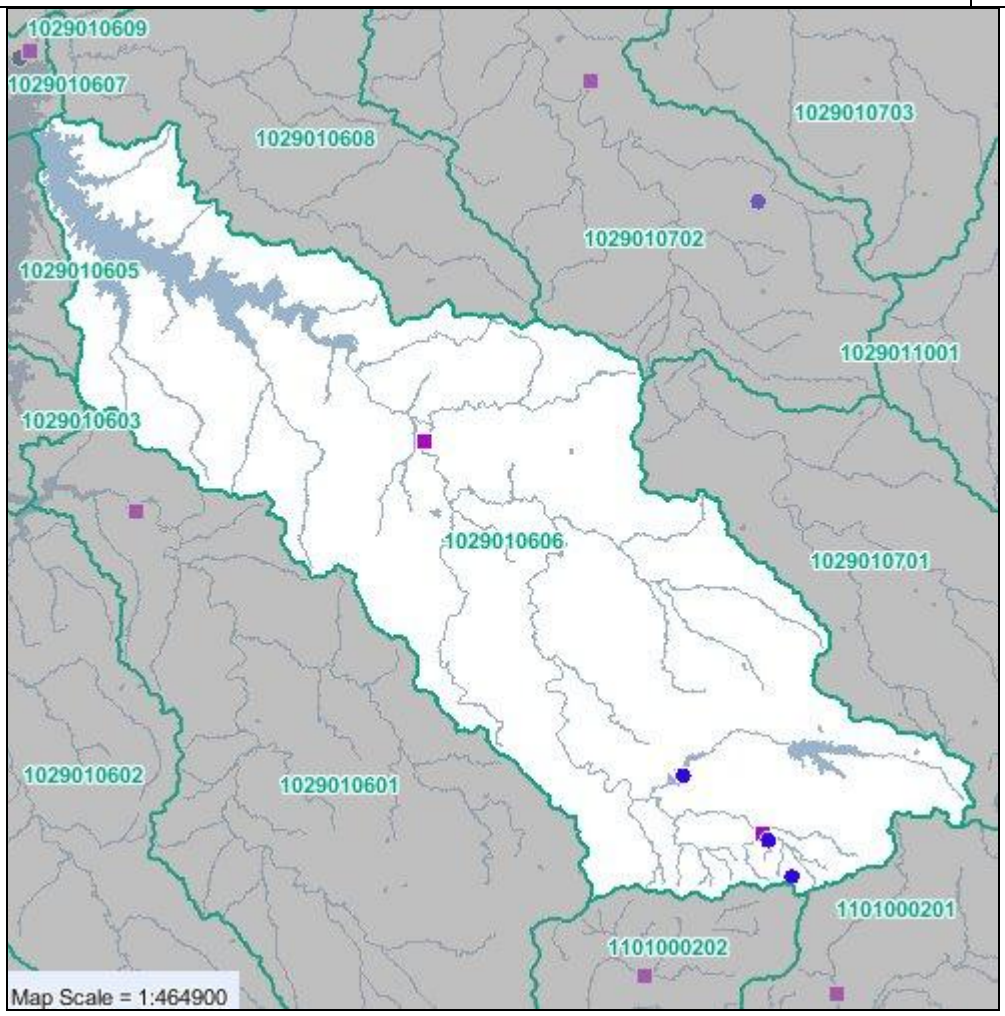



- Private Wells
- Public - Community Well
- Public - Transient Noncommunity Wells
- Public - Non-transient Noncommunity Well
- Public - Not designated

# USGS NWIS Sites

## Little Sac River (1029010606)

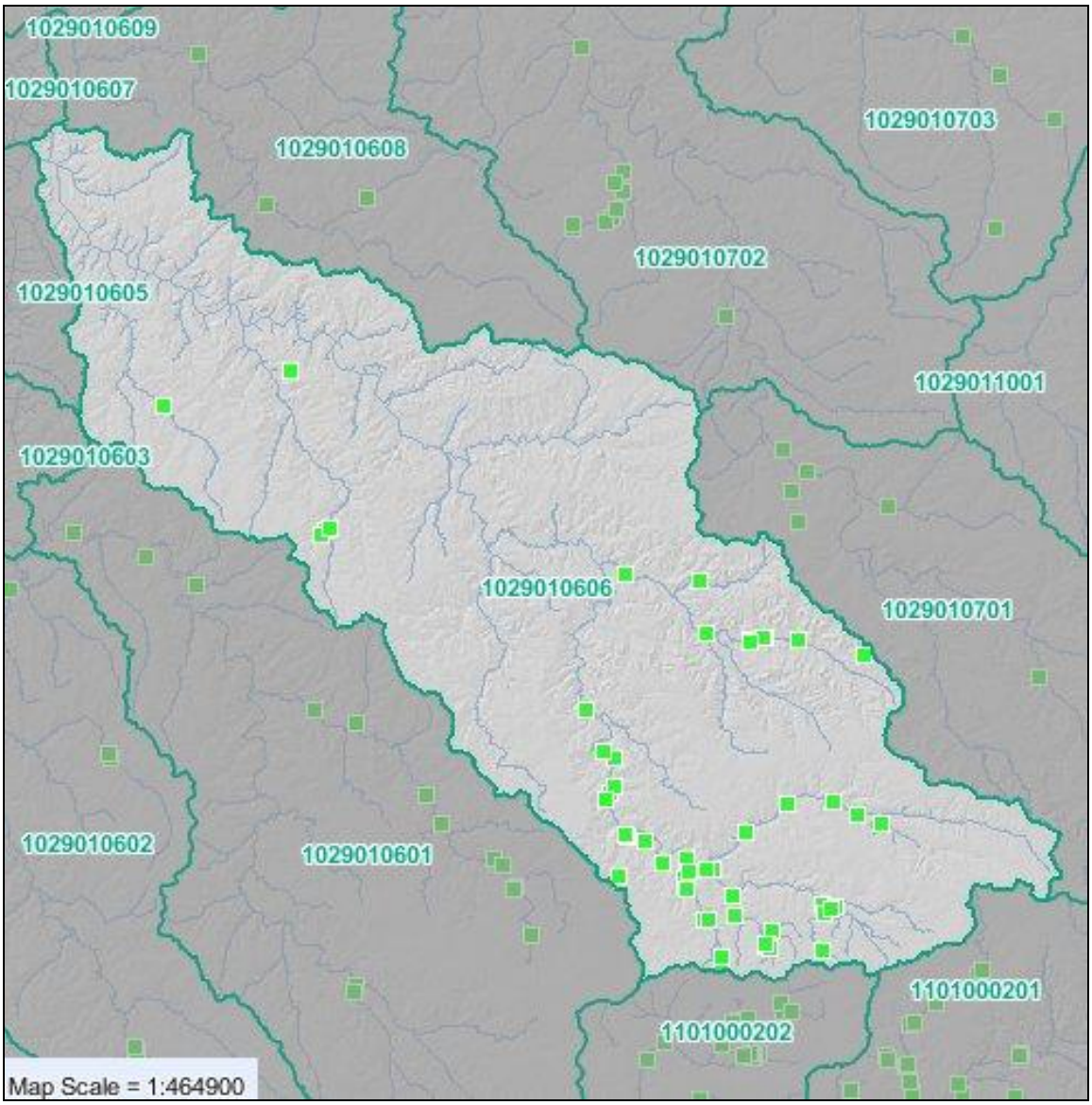
| | |
|---|---|
| Total Sites: | 6 |
| Stream Sites: | 2 |
| Groundwater Sites: | 4 |
| Other Sites: | 0 |




Stream Sites
Groundwater Sites
Other Sites

# Local Initiatives
## Little Sac River (1029010606)

| | |
|---|---|
| Stream Teams: | 59 |




Stream Teams

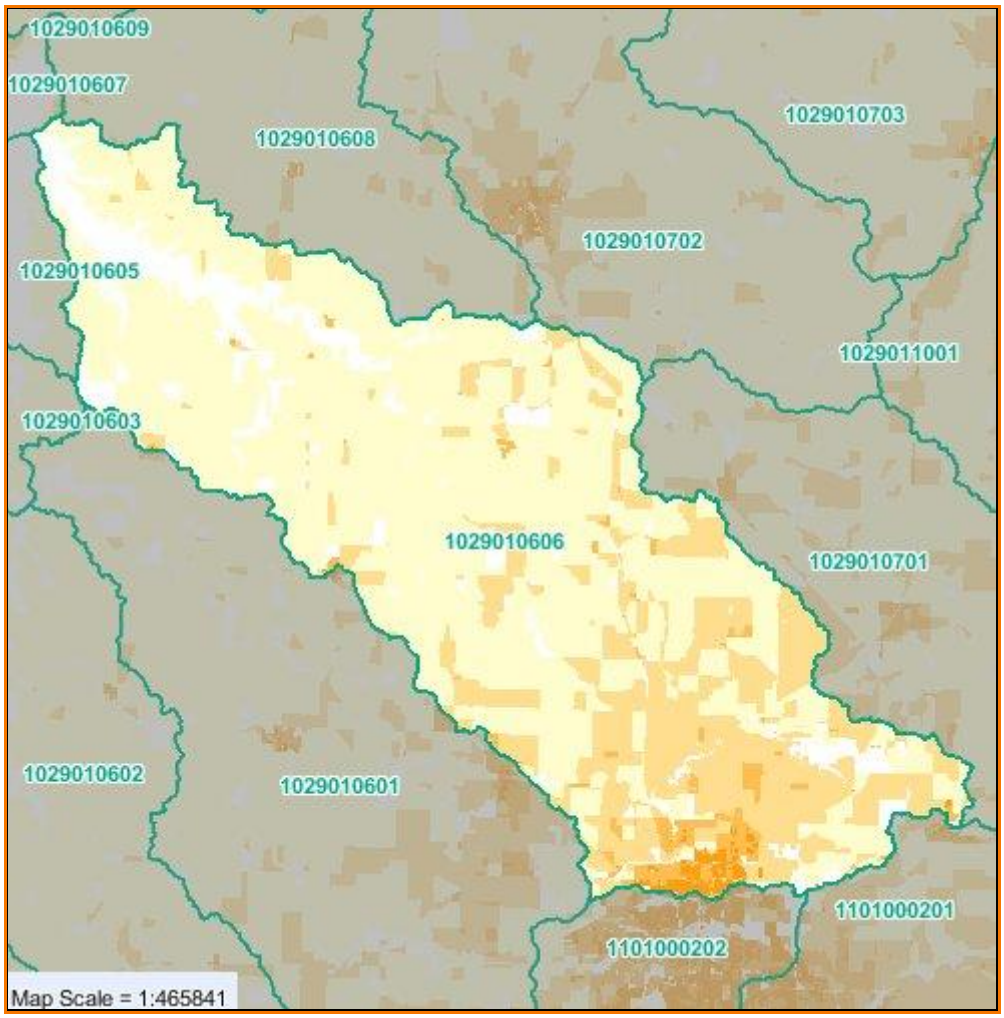
# Census Data **Little Sac River (1029010606)**

| | | |
|---|---|---|
| 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.

**Figure 11 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 the primary source of the public drinking water for the City of Springfield. Since this watershed provides drinking water, water quality is a priority. For this reason, many studies have been completed relative to water quality. As of August 31, 2009, this is the current list of known 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 Analysis (Sac River) – (MDNR, CU, WCO, SPW, USGS, FAPRI)

Little Sac Watershed Related Reports

1. Sac River Data Gap Analysis – March 2008 – Summary Statement - Mapped all the waterquality data for the Sac and Little Sac Rivers. They found that *E.coli* exceeded safe levels in 2 of the 6 monitoring stations. Formation of a monitoring network, standardized sampling, and central database of water quality data were the recommendations of this project.
2. Little Sac River TMDL - FAPRI June 2006- Summary Statement – Bacterial source tracking data showed that the highest loads came from unknown sources, geese, and human. Base flow loading is suggested to be from springs. Suggestions are to monitor springs further, address the contamination of the springs, and address storm waters issues in the urban areas.
3. Little Sac Watershed Restoration Project Final Report – WCO, Nov 2005 – Summary Statement – Shows data of stream monitoring on the Little Sac and discusses BMP cost share projects that took place during this 319 grant project.
4. Little Sac River Watershed Bacteria Source Tracking – FAPRI-UMC, May 2005 – Summary Statement – Water quality data showing that two sites on the Little Sac River did not meet the whole body contact water quality criteria during the sampling period. Found that significant differences between base flow and storm flow bacteria loading occurred.
5. Water Quality in the Little Sac River near Springfield – USGS 1999-2001 – Summary Statement – Study on the bacteria in the Little Sac River. Compares the upstream of the Norwest Wastewater Treatment Plant to below the treatment plant.

6. Watershed Restoration Action Strategy (WRAS) – 2000 – Summary Statement - Very similar to this WMP. Gives general descriptions of the watershed, water quality concerns, and strategies to address the concerns. It also outlines the implementation and funding needs of the strategies.
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 – Summary Statement – A study to ID contaminates in the Little Sac River.
8. Fellows-McDaniel Lakes Watershed Protection Project – WCO, 1998 – Summary Statement – A 319 grant Project that implemented BMPs, education, and monitoring in the Little Sac River Watershed.
9. Water Quality in the Ozark Plateau – 1992-95, USGS - Summary Statement – A broad look at water quality and issues facing Ozark streams. Includes information on bacteria, nutrients, riparian, chemical, sediment, and fish data of Ozark streams.
10. Drinking Water & Urbanization: Water Issues in the Fulbright Spring Recharge Area, SMSU Dept. of Geology and Planning. 1999 – Summary Statement – An Assessment of the baseline conditions in the Fulbright Spring recharge area.
11. Sac River Watershed Inventory and Assessment – MDC Online – General description of the Sac River Watershed. Includes geography, wildlife, and aquatics.

<u>Thesis Work in the Little Sac</u>

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. (see 303d listed lakes and stream map on page 29) The sources of the impairment are both point and nonpoint. The Little Sac River TMDL listed the point source is the City of Springfield's Northwest Wastewater Treatment Plant. Since the TMDL report, the treatment plant has undergone major renovation and when the Little Sac River Watershed TMDL was approved in 2006, the NW WTP has begun disinfecting the effluent water year-round. Now the main contribution of impairment is presumably from non-point sources in the watershed. These sources will be addressed in the "nine critical elements" section of this watershed management plan.

**Figure 12 A Few Miles Above Hwy BB**

# 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 or southern half of the Little Sac Watershed's (HUC #10290106050) nine elements will be addressed first in this plan. The lower watershed (HUC 10290106060) or northern half will be completed at a later date. Also contained in this plan will be the "Nine Critical 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 any changes. 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 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 Maximum Daily Load (TMDL) was approved by MODNR in June 2006. A list of potential sources of impairment was derived by the TMDL stakeholder committee and 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 UMC and evaluated 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.

Below is a section from the FAPRI TMDL 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 samples were collected for the 2006 Little Sac TMDL. They are on opposite ends of the Little Sac River Watershed. This is good for a broad look at the contaminants, but having sample sites at opposite ends of a long river segment does not allow for identifying specific areas of contamination with high bacteria loads.

In March of 2008, the Southwest Missouri Water Quality Improvement Project funded the completion of the Sac River Basin Water Quality Data Gap Analysis. Below is the Executive Summary of that project.

"Rapid growth and expansion in southwest Missouri are threatening the water resources this region's population, agriculture, and tourism industry so heavily depend upon. In response to this threat, several watershed groups in southwest Missouri collaborated to secure federal funding for water protection efforts in this region. As a result of this effort, the Environmental Resources Coalition (ERC) received a U.S. Environmental Protection Agency (EPA) grant to develop and manage the Southwest Missouri Water Quality Improvement Project (WQIP), a mult-year, multi-stakeholder effort to address water quality issues in this region. WQIP has initially been tasked with assembling, evaluating, and interpreting existing water quality for several major basins in southwest Missouri. The Sac River Basin is the subject of this report.

The Sac River Basin is 1,969 square miles and includes the north edge of the Springfield area along its southern boundary. Major tributaries of the Sac River include Turnback, Sons, Horse, Cedar, Coon, Turkey, Brush and Bear Creeks, and the Little Sac River. Water quality regulatory concerns in the basin include a bacteria total maximum daily load on the Little Sac River, the impairment of Stockton Branch for volatile suspended solids, and the impairment of Brush Creek for low dissolved oxygen.

Water quality data from the Sac River Basin were compiled from multiple collection entities including the Missouri Department of Natural Resources, U.S. Army Corps of Engineers – Kansas City District, City Utilities of Springfield, City of Springfield Public Works, Food and Agricultural Policy Research Institute at the University of Missouri, Murphy Family Farms, and the U.S. Geological Survey. The data were analyzed with relation to total phosphorus, total nitrogen, nitrate plus nitrite as nitrogen, sestonic chlorophyll a, Escherichia coli (E. coli) and fecal coliform. Phosphorus and nitrogen levels were notably elevated in the Sac River above Walnut Grove and in Brush and Turnback Creeks. Significant levels of nitrogen were also observed in the Horse Creek watershed where there is a large concentration of swine operations. Fecal coliform geometric means exceeded Missouri's water quality criterion at two of six stations on the Little Sac River; however, E. coli geometric means did not exceed criterion.

Based on a data gap analysis of the existing water quality data in the Sac River Basin, several recommendations were made for WQIP. Formation of a monitoring coordinating board could benefit all the stakeholder entities in WQIP by standardizing sampling designs, quality assurance programs, metadata requirements, and by developing a centralized database to facilitate the sharing of water quality data. Current and historical water quality data are insufficient to address the goals of WQIP; therefore, a new comprehensive water quality monitoring network needs to be designed. Further data analysis and potential special storm water studies are also recommended to better understand non-point source loading issues. WQIP stakeholders are encouraged to participate in the development of regional stream nutrient criteria through stakeholder involvement and further water quality studies. Finally, efforts should be made to incorporate additional existing water quality data into the WQIP database that were not populated at the time of the database's creation."

Source of Impairment Map "Areas of Concern"

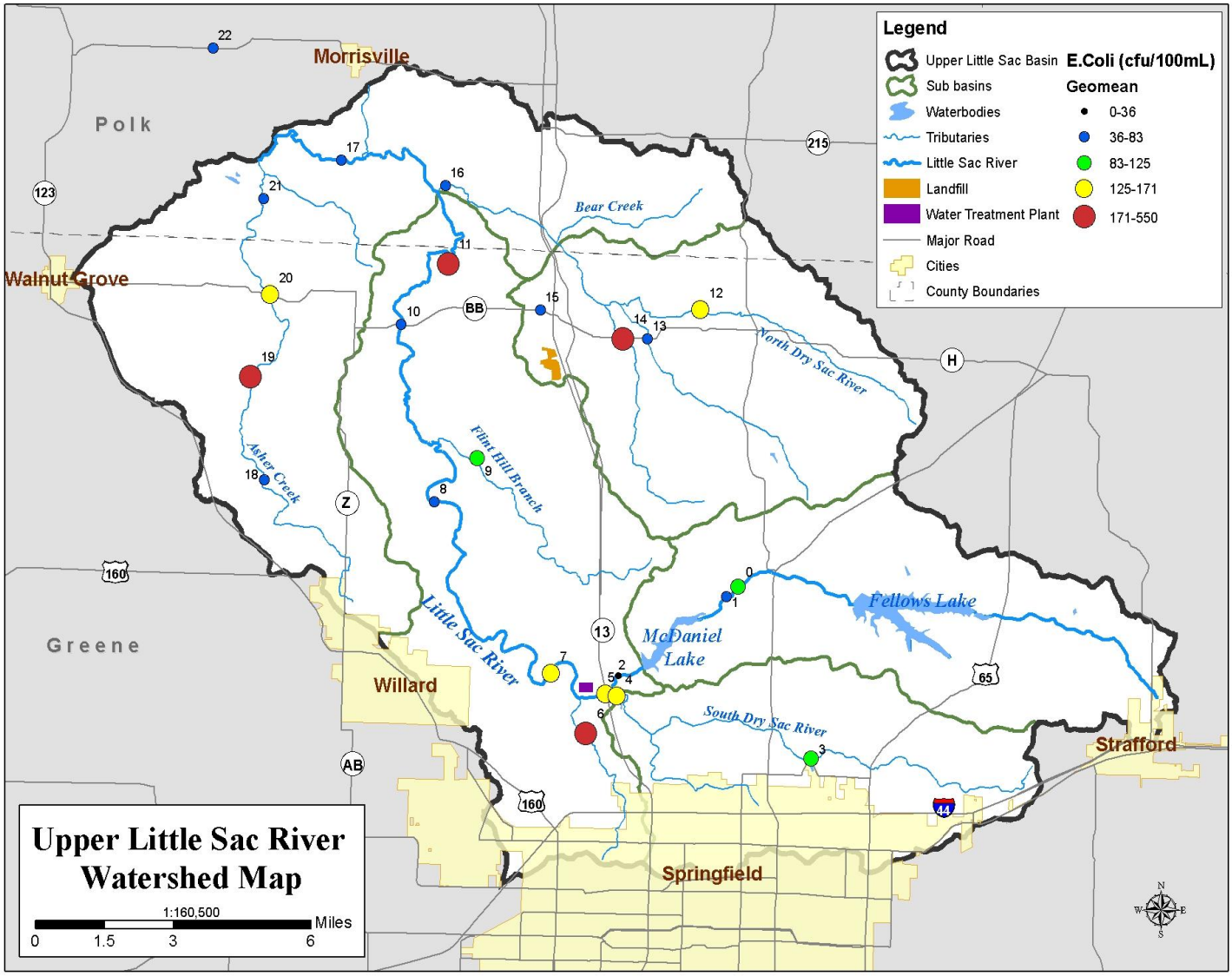



**Figure 13 This map shows the average E. coli levels in the Little Sac watershed-Sac River Data Gap Analysis**

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 would be good locations where new management efforts and further research could focus.

The location description of the sample sites are listed on the following page.

Sample Site Locations for the Sac R. Data Gap Analysis map on previous page

| ID | Site Description |
|---|---|
| 0 | L. Sac R. at Farm Road 68 |
| 1 | L. Sac R. at Farm Road 159 |
| 2 | L. Sac R. near. Springfield |
| 3 | South Dry Sac at Valley Water Mill |
| 4 | South Dry Sac River below. Springfield |
| 5 | Little Sac River-State Hwy 13 |
| 6 | Spring Branch |
| 7 | L. Sac R. 1 mile below Springfield North West Waste Water Treatment Plant at Farm Road 125 *** |
| 8 | Little Sac River-Farm Road 54 |
| 9 | Flint Hill Branch- Farm Road 117 |
| 10 | L. Sac R. above. Walnut Grove, Hwy BB |
| 11 | Tributary of Little Sac River Farm Road 115 |
| 12 | North Dry Sac River- Farm Road 163 |
| 13 | Sims Branch- State Hwy CC |
| 14 | King Branch. at CC |
| 15 | Tributary to tributary. to North Dry Sac River at BB |
| 16 | North Dry Sac River at Sod Farm |
| 17 | Little Sac River- 111th Rd |
| 18 | Asher Creek- West Farm Road 52 |
| 19 | Asher Creek- N Farm Road 81 |
| 20 | Asher Creek- State Hwy BB |
| 21 | Asher Creek near L. Sac R. Confluence |
| 22 | Little Sac River near Morrisville |

**Table 1**

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

Quantified Pollutant Load Attributed to Each Source of Impairment

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 relevant to note that over 50% of the load is unknown at FR215. Below is a table from the TMDL describing the average daily loads.

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

| | Actual 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

| | Actual 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 load (%) | 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% |

**Fig. 14**

*NOTE: The Northwest Wastewater Treatment Plant currently disinfects effluent all year long. For more info on the NWTP visit this website. http://www.springfieldmo.gov/egov/publicworks/sanitary/nw_plant.html

Remaining Load

According to the TMDL then, 12% of the *E. coli* load at Farm Road 129 could already be removed from the watershed with the upgrade to the treatment plant. There is 37% of the identified and 52% unknown daily *E.coli* loading remaining in the watershed.

Load Reduction Goal

The Little Sac Watershed TMDL lists the following as load reduction goals for the Little Sac River:

> "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 with 52% of the loading at Farm Road 129 unknown. This might indicate the need for further research to isolate the actual sources of bacteria into the stream. The TMDL further suggested that springs are the main contributor to bacterial loading during base flow. Based on the findings the springs' recharge areas near 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 better determine the loading sources. Once identified, these source locations can be addressed according to the management practices proposed within this watershed plan.

**Figure 14 Above County Road 44**

## 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 at the sample locations.

| | 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] |

**Table 2**

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. (See above figure). The text below, from the TMDL describes the bacterial loading in the Little Sac.

> "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."

| % 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% |

**Table 3**

* The TMDL found that the main source of contamination in the river is coming from springs, and that further research is needed to identify contaminated springs and their pollutants. DNA source tracking, dye traces, and further water quality monitoring are possible avenues to isolate these issues.

Load Reduction estimates in the Little Sac Watershed Management Plan are not based on a total stream load approach. Each management measure has its own load reduction based on past research that calculated the capabilities of a particular type of BMP.

**Figure 15** Eroding Bank on the Little Sac River in need of bank stabilization work

Estimated Load Reduction for Each Management Measure (Element 3)

It is difficult to accurately estimate the number of BMP's to meet the 80% load reduction suggested by the FAPRI report. Due to the variable nature of rivers and their watersheds it is estimate to the number of BMPs needed. Under optimal conditions these BMP's would be able to reduce 75% of the bacterial loading from each single BMP implemented. The latest data (FAPRI 2006, TMDL) suggests that loading is from springs in the upper watershed, urban contamination during storm events, and animal waste. If this is so, then 100% of those sources should be located and have BMP's installed, resulting in the estimated 75% load reduction to the entire stream; based on the efficiency of the BMP. Therefore, to find the number of BMP's to be implemented for reducing the bacterial load in the stream, the number of contamination sites must first be identified. This will give the number of BMP's.

**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 | Heavy Metal-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% |

**Table 4**

The load reduction estimates for the Urban Watershed Area were obtained from the National Pollutant Removal Performance Database of 2007, the International Stormwater Best Management Practices (BMP) database [1999-2008], and the Natural Resource Conservation Service (NRCS). This research was used to assign a percentage of bacteria, sediment, and nutrients that were removed from the water when leaving a single BMP compared to when it entered. The different data percentages were averaged and listed in the table for each measure.

**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% |
| Specific Contamination Source & Springs Source Tracking Research | Sediment, bacteria, nutrients | Load not effected, only identified for future BMP Implementation |
| Septic Remediation/Install/Repair/Maintenance | Bacteria, Nutrients | Bact-75% Nutr-75% |
| Riparian Habitat Improvement | Sediment, Bacteria, Nutrients, Run-off volume, Temp. | Sed-50%/Bact-75%/Nutr-25% |
| Nutrient Management | Nutrients | Up to 50% Nutrients |
| 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% |

**Table 5**

The load reduction estimates for the Rural Watershed Area were obtained from the National Pollutant Removal Performance Database of 2007, the International Stormwater Best Management Practices (BMP) database [1999-2008], and the Natural Resource Conservation Service (NRCS). This research was used to assign a percentage of bacteria, sediment, and nutrients that were removed from the water when leaving a single BMP compared to when it entered. The different data percentages were averaged and listed in the table for each measure.

## 3. Proposed Management Measures

Springfield uses ground and surface water for its drinking water sources. This drinking water comes from different sub-watersheds. Each sub-watershed has different characteristics and requires different management strategies to address and maintain the quality and quantity of drinking water in the area. Within the Little Sac watershed the highly urban area in Springfield transitions into the rural agricultural area to the north. In this transition zone, urban sprawl is occurring and needs proper conservation and growth management practices. For these reasons, the management measures of the plan will be divided into the Urban and Rural areas.

### Critical/Priority Areas Maps

Identify Critical/Priority areas

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

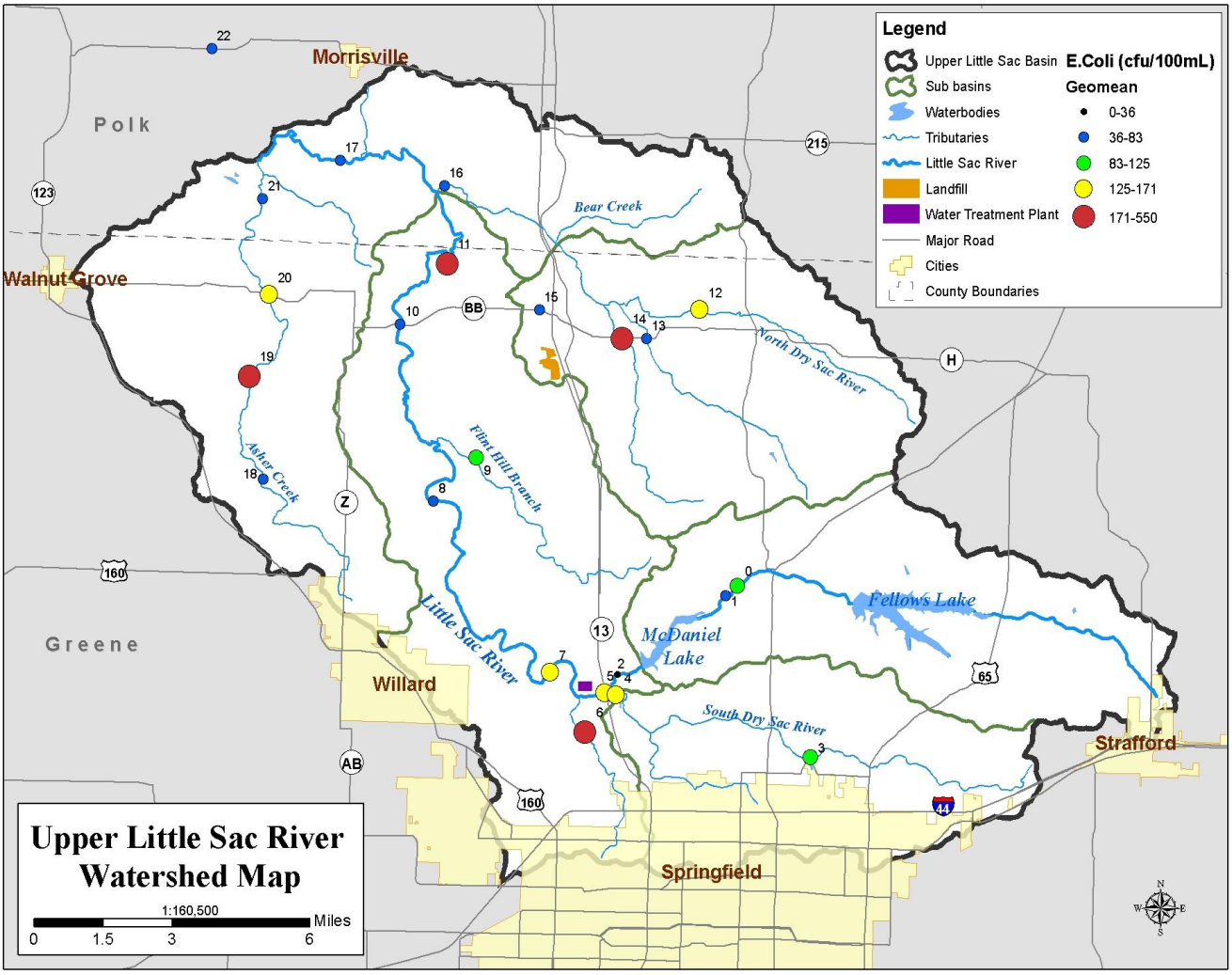



**Figure 16**

## Critical Priority Area "Location Maps"

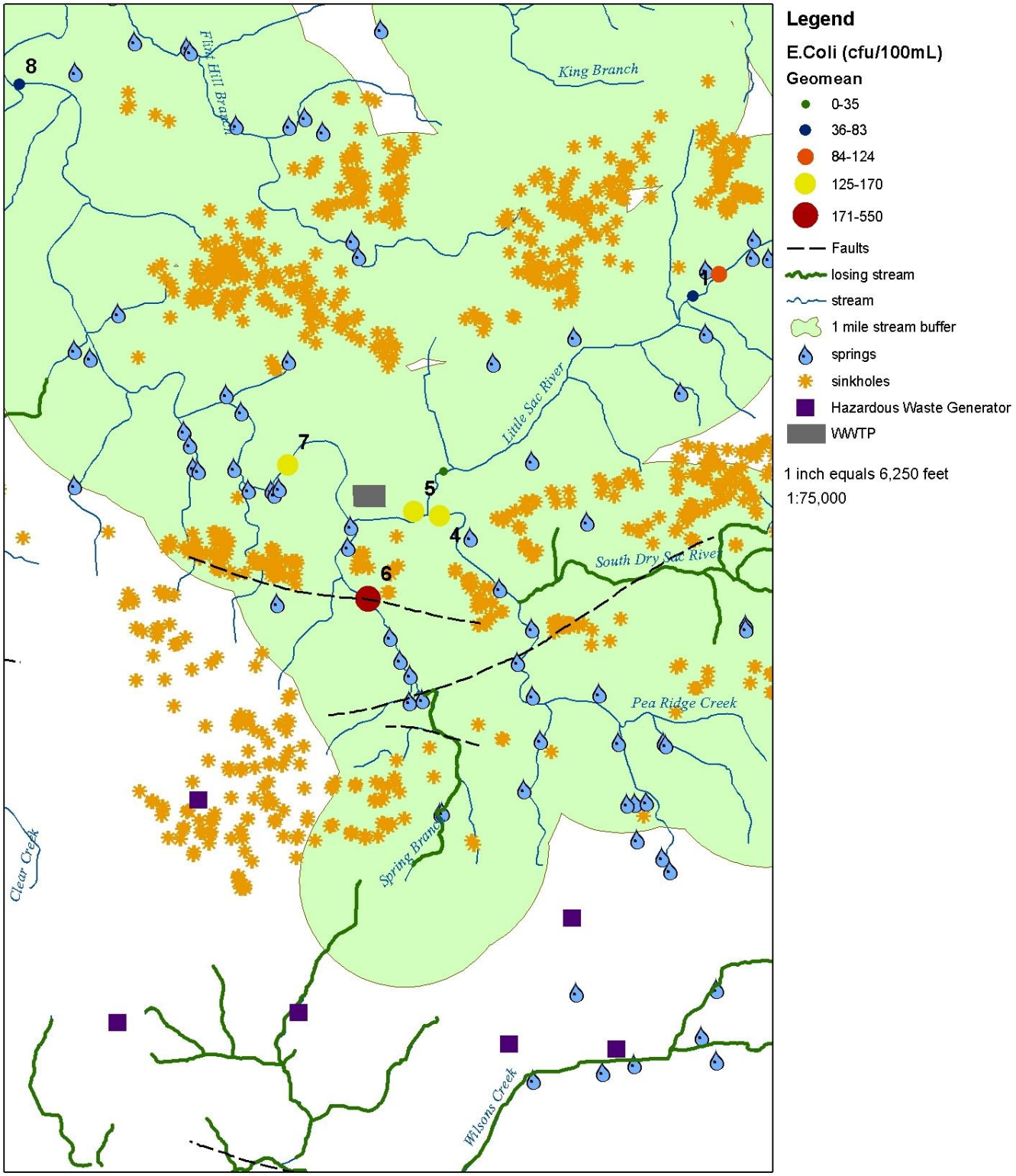



**Figure 17** Critical Priority Area Map of sample site #6 on Spring Branch a tributary to the South Dry Sac

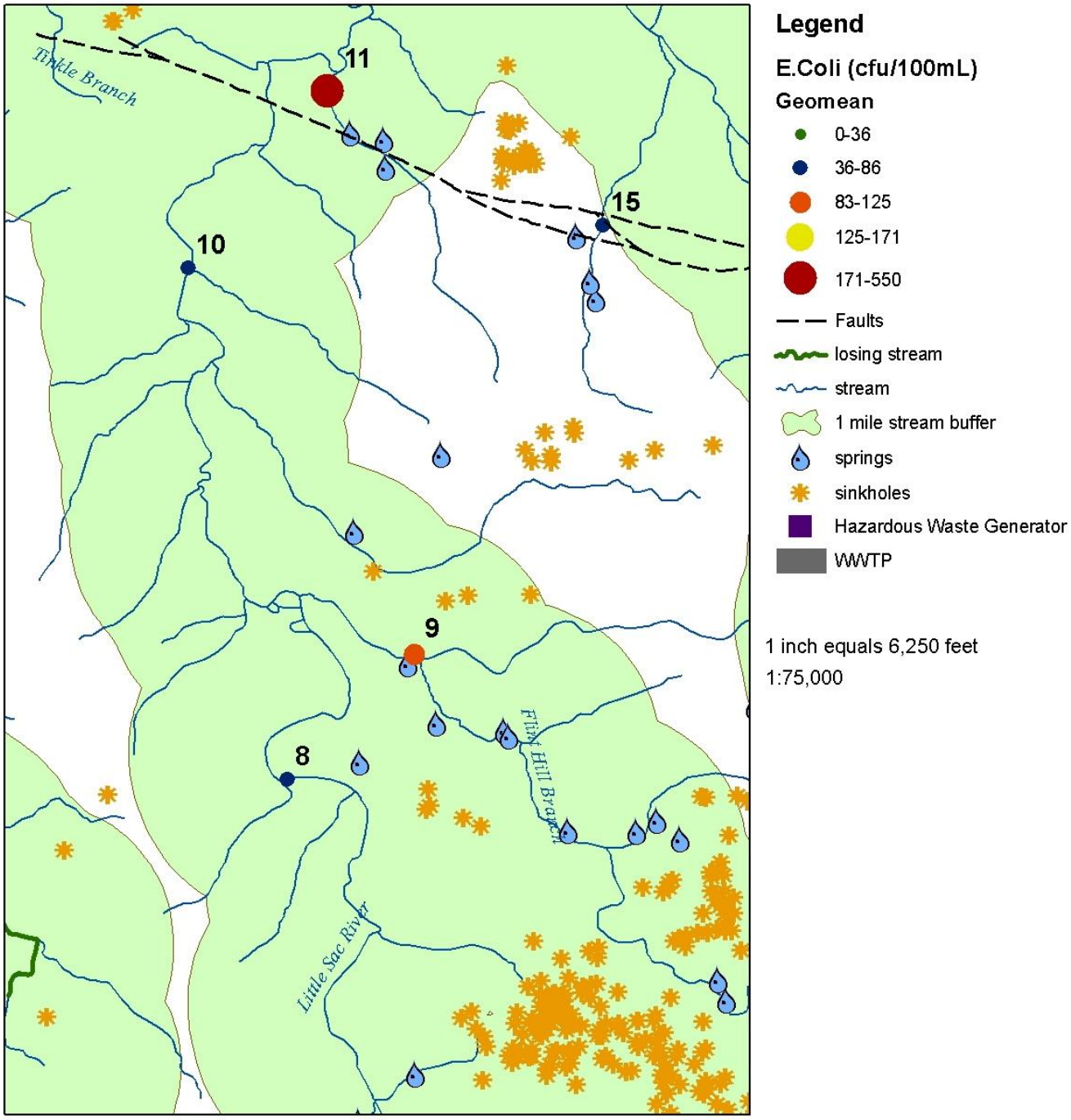



**Figure 18** Critical Priority Area Map of Sample Site #11 on Unnamed Tributary of Little Sac River

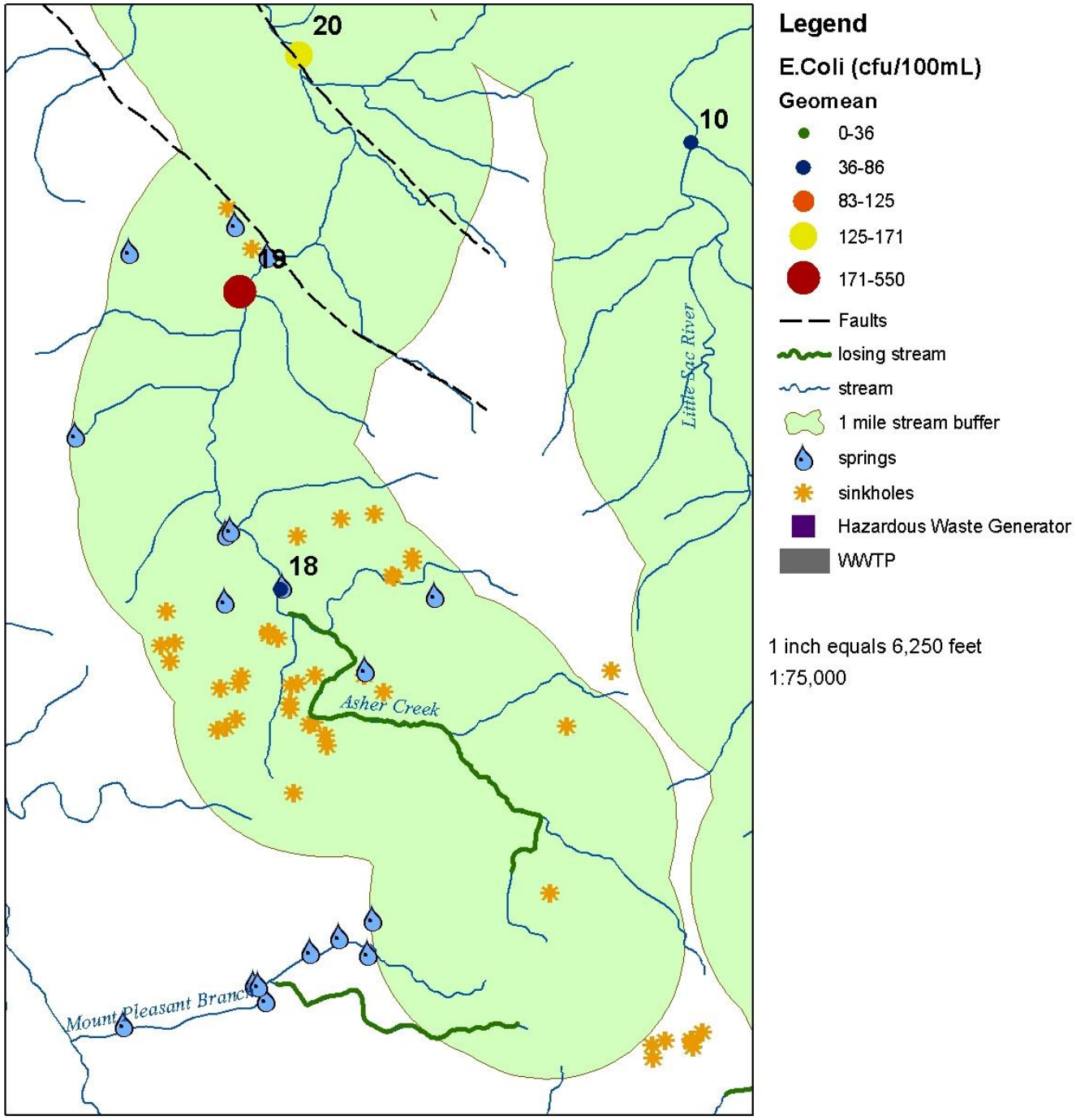



**Figure 19** Critical Priority Area Sample Site #19 on Asher Creek

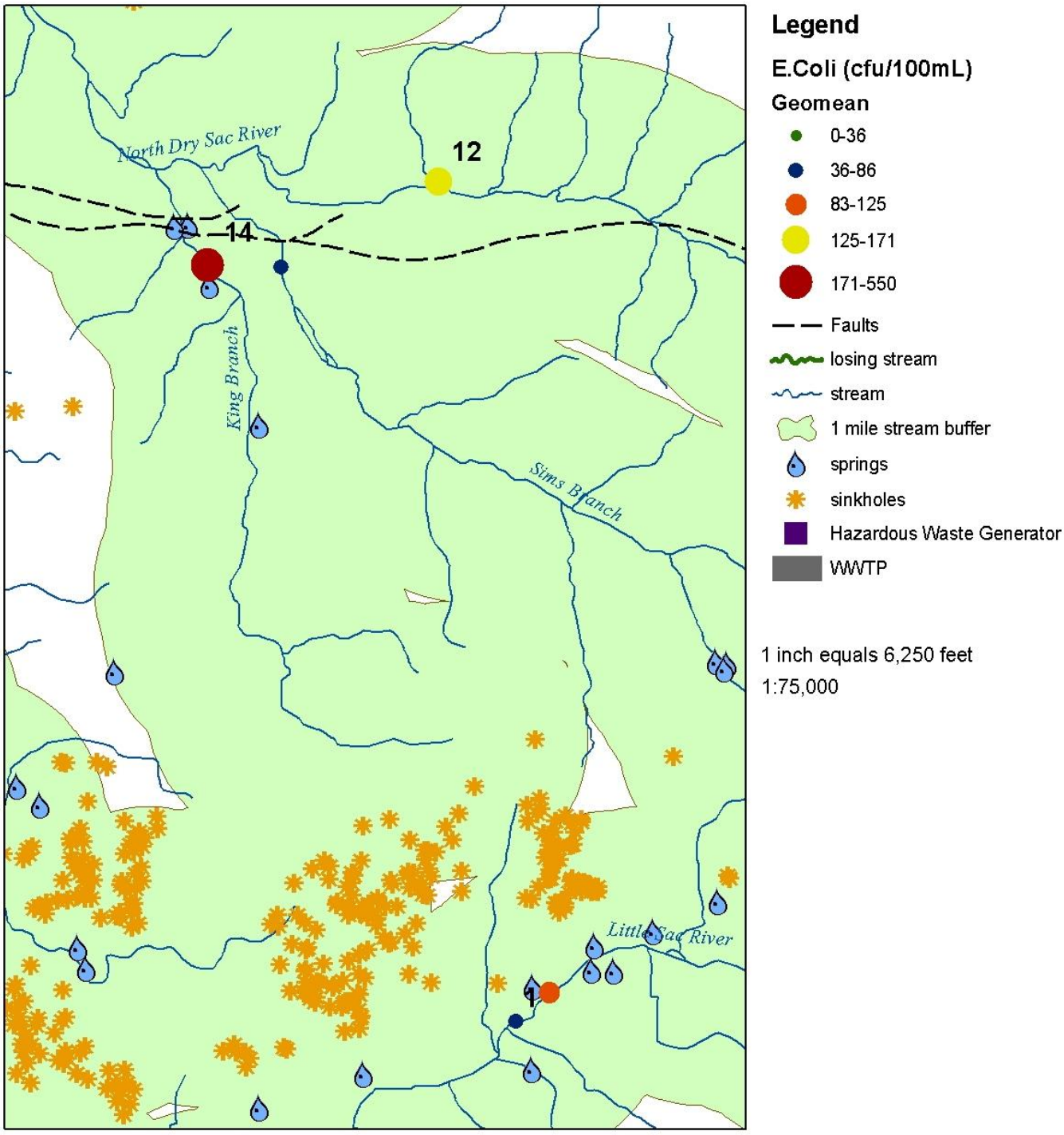



**Figure 20** Critical Priority Area Sample Site #14 on Kings Branch

Critical Areas of eroded banks on the Little Sac

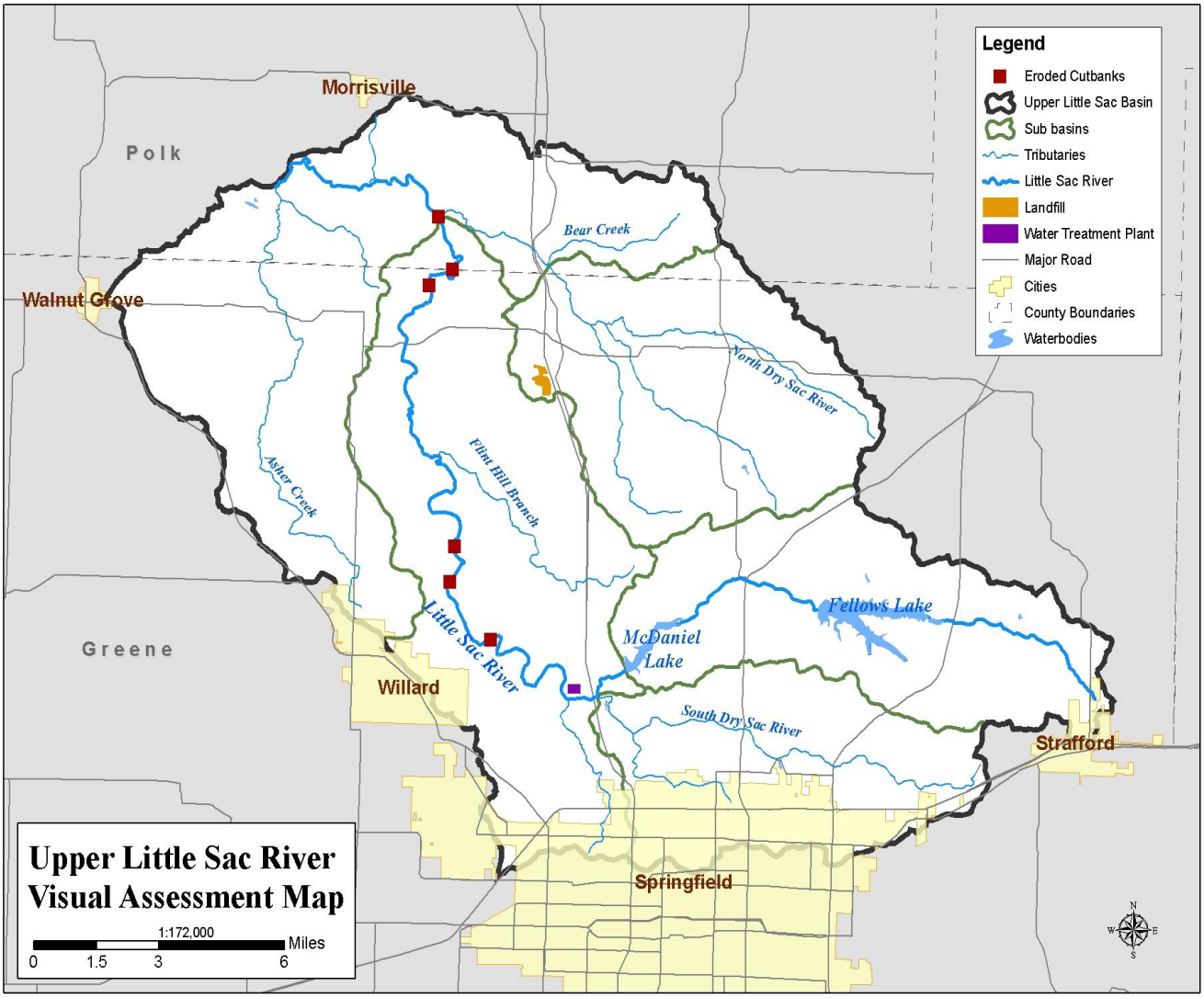



**Figure 21 Sites located on this map are from the Visual Assessment in June of 2009. Each location is of an eroded bank that needs more assessment and attention. They were marked with a GPS unit from the river.**

**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 | City of Springfield Storm Water Services | 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 see element #5 | 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 |

**Table 6**

The Urban Watershed Area Management Measures Table above displays what best management measures (BMPs) currently implemented or planned for implementation in the Little Sac Watershed.

**Rural Watershed Area Management Measures**

| Management Measure | Responsible Party | Size/Quantity | Date: Start/End | Pollutants Addressed |
|---|---|---|---|---|
| Education & Outreach | WCO | See element #5 | Ongoing | Nutrients, pesticides, household chemicals, sediment, runoff volume |
| Specific Contamination Source & 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- Wells, Sinkholes, Caves, Springs | Greene County Resource Management | Per Instance | Ongoing | Nutrients, Sediment, Bacteria |

**Table 7**

The Rural Watershed Area Management Measures Table above displays what best management measures (BMPs) currently implemented or planned for implementation in the Little Sac Watershed.

**Other Possible Landowner/Homeowner/Business Owner Management Measures**

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

**Table 8**

These measures are effective practices that can be utilized by the landowner, homeowner or small business owner in the watershed. With widespread implementation, they can help maintain 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 load reduction they could affect in the Little Sac River. For more information, visit the www.watershedcenter.org.

Process to Evaluate Effectiveness of Management Measures

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, mailed or online, to monitor public opinion of 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 | City of Springfield Storm Water Services | $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(cost is City's cost for administration; actual BMP cost paid for by developer per City standards) | City of Springfield Storm Water Services & Greene County Resource Management | $46,000 | Private Developers/City Funds |
| Land Disturbance Permit Program/ Site Grading Permit Program (Cost is City's cost for administering permit) | City of Springfield Storm Water Services/ Greene County Resource Management | $106,000 | Private Developers/City Funds |
| Public education and outreach programs | City of Springfield Storm Water Services, Watershed Committee of the Ozarks | $60,000 Annually(city cost only) | Various City Funds |
| Flood Plain Development Planning Program | Greene County Resource Management | $50,000 Annually | Various |

**Table 9**

This Urban table above displays how the management measures are currently being paid for or which ones need funding before implementation. The majority of the BMP's in this table would receive some level of funding through the City of Springfield or Greene County.

**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 |

**Table 10**

This Rural table above displays how the management measures are currently being paid for, or which ones need funding before implementation. There is a special need for funding to further the research in the watershed to locate the sources of *E. coli* in the springs during base flow, as well as Outreach and Education projects.

## 4. Information, Education, and Public Participation

Stakeholder Outreach

The Watershed Committee and Greene County NRCS have communicated with watershed stakeholders by mail, phone, personal visits, newspaper articles, Newsletters (WCO), Monthly Meetings (WCO), the web page specifically for the Little Sac WMP. http://www.watershedcommittee.org/wordpress/?cat=2&paged=2

Stakeholder Participation

*Stakeholder Committee Participants:* Cheryll Willis, Joan & Hunter Highfill, James Farrell, Jack Sneed, Jerome Rader, David Rhodes, J. M. Crighton, Roland Alexander, Joan Collins, Neil Fassnight, Kathy Wimberly, Todd Wagner, Michael Bowers, Wayne Fortner, Larry H. Jones, C. W. Link, Harold & Darlene Bensch, Chad Wosley, Nancy Tucker, Paul Sloan, Amy Strickland.

*Technical Committee Participants:* Jon Williams Greene County Resource Management, Vanessa Brandon Greene County Resource Management, Tucker Fredrickson Missouri Department of Natural Resources, Charles Parrot City of Springfield Public Works, Randy Lyman City of Springfield Public Works, Scott Foley City of Springfield Public Works, Erik Roberts City of Springfield Public Works, John Havel Missouri State University, Ray Gumucio City Utilities, David Ballou City Utilities, Janet Hicks Springfield Greene County Health Department, Eric Morris Greene County Soil and Water Conservation District, Will Rhodes Greene County Soil and Water Conservation District, Roddy Rogers City Utilities, Barbara Lucks City of Springfield Public Works Solid Waste, Stacey Armstrong, Watershed Committee of the Ozarks, Mike Crocker, Springfield Dickerson Park Zoo, Carrie Lamb City of Springfield Storm Water Services, Teresa Carroll Drury University, Michael Bowers, Greene County Resource Management, Dede Vest USDA-NRCS, Ed Malter City of Springfield, Todd Wagner City of Springfield Storm Water Services.

Dates of 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 |

**Table 11**

This list of Stakeholder concerns is not in any particular order. The numbers next to the concerns are only to identify each concern in the tables on the following pages.

**Stakeholder Concerns from Meeting #1 June 24th 2008**
**(Not Prioritized)**

1. Concern: Bacteria & Nutrients
   Cause:
   - Zoo runoff
   - Treatment plant effluent
   - Animal waste land application
   - Human waste/ treatment plant
   - Fertilizer/pesticides use by urbanites
   - Improper septic system maintenance/installation $$
   - Karst/Abandoned wells
   - Too many people

2. Concern: Water pollution-chemicals
   Cause:
   - Karst/Abandoned wells
   - Trash dumping
   - Parking lot runoff
   - Roads street runoff
   - Waste dumping/paint
   - Too many people

3. Concern: Water Clarity and sedimentation
   Cause:
   - Stream Bank erosion
   - Algae growth
   - Too many people

4. Concern: public is unaware of personal impact on water quality
   Cause:
   - Lack of education
   - Lack of concern

5. Concern: Additional storm water runoff
   Cause:
   - Development
   - Unrestricted Growth
   - Too many people

## How the WMP Addresses the Stakeholder Concerns with the Proposed Management Measures

The next tables show how the management practices in this plan meet the stakeholder concerns. Each concern was given a number. This number does not reflect the priority of the concern. It is only used to identify the concerns on the following tables.

### Urban Watershed Area Management Measures

| Management Measure | Responsible Party | Size/Quantity | Date: Start/End | Pollutants Addressed | Stakeholder Concerns 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 | #1, 3, 5 |
| 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 | #1, 3, 5 |
| Storm water inspections of industrial/high risk operations | City of Springfield Storm Water Services | Avg. 5 inspections annually | Ongoing | Heavy metals, oil, sediment, others | #1, 2, 5 |
| Regional Detention Basins | Private developers | 10 basins | Ongoing property acquisition as available | Sediment, Bacteria, Nutrients | #1, 2, 3, 5 |
| 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 (bacteria, nutrients, metals, sediment) | #1, 2, 3, 5 |
| Land Disturbance/ Site Grading Permit Program | City of Springfield Storm Water Services/ Greene County Resource Management | Per land disturbance site | Ongoing | Sediment | #1, 2, 3, 5 |
| 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 | Ongoing | Nutrients, pesticides, household chemicals, sediment, runoff volume | #1, 2, 3, 4, 5 |
| Flood Plain Development Planning Program | Greene County Resource Management | Per Proposed Development | Ongoing | Nutrient, Sediment, Bacteria | #1, 2, 3, 5 |
| Water Protection for Well, Sinkholes, Caves & Springs | Greene County Resource Management | Site Dependant | Ongoing | Nutrients, Bacteria, Sediment, Pesticides | #1, 2 |

**Table 12**

The urban management measures meet one or many of the concerns of the stakeholders in the watershed. The public education and outreach programs of the Watershed Committee and the City of Springfield meet all concerns, to some extent of the stakeholders. All of the management measures address the bacteria or *E. coli* concern.

**Rural Watershed Area Management Measures**

| Management Measure | Responsible Party | Size/Quantity | Date: Start/End | Pollutants Addressed | Stakeholder Concerns addressed |
|---|---|---|---|---|---|
| Education & Outreach | WCO | -40,000 reached by - WCO | Ongoing | Nutrients, pesticides, household chemicals, sediment, runoff volume | #4 |
| Specific Contamination Source & Springs Source Tracking Research | Interested Party | 1 graduate research project at the 4 areas of critical priority | When Funded | Bacteria | #1 |
| Little Sac Watershed Septic Remediation Project | WCO/Greene County SWCD/Grant Recipients | Funding Dependant | When Funded | Bacteria, phosphorus | #1, 2 |
| Riparian Habitat Improvement | WCO/Greene County SWCD/Grant Recipients | 5 acres/year | Start 2010 | Sediment, bacteria, nutrients | #1, 3 |
| Nutrient Management | Greene County SWCD | 50 acres/year | Start 2010 | Nutrients | #1 |
| Sheet/Rill Erosion Prevention | Greene County SWCD | 40 acres/year | Start 2010 | Nutrients, bacteria, sediment | #1, 3 |
| On-Site Waste Water System Install/Repair/Maintenance | Greene County Resource Management / Other | Per Qualified Applicant | Ongoing | Nutrients, Bacteria | #1, 3 |
| Forage Management | Greene County SWCD | 200 acres/year | Start 2010 | Nutrients, bacteria, sediment, runoff volume | #1, 3 |
| Flood Plain Development Planning Program | Greene County Resource Management | Per Planned Development | Ongoing | Nutrients, Sediment, Bacteria | #1, 2, 3, |
| Water Quality Protection for Wells, Sinkholes, Caves, Springs | Greene County Resource Management | Per Instance | Ongoing | Nutrients, Sediment, Bacteria | #1, 2, 3, 4 |

**Table 13**

Education and Outreach Materials for the Watershed Management Plan

- Brochure – L. Sac WMP
- Web Site- www.watershedcenter.com
- L. Sac WMP Stakeholder Folders
- Field Days July 2008 & 2009
- Spring Forage Conference 2008 & 2009
- Horse Fest
- Watershed Center-40,000 people reached in 2008
- Farm Fest
- Newspaper Ad for Stakeholder Meeting

Education and Outreach of Best Management Practices

| Watershed Committee's Education Programs | Pollutants Addressed | Implementation | Yr 2008 #'s Reached w/ Program |
|---|---|---|---|
| The Watershed Center | ALL | Complete 2010 | NA |
| Web Site- www.watershedcenter.com | ALL | Ongoing | 10,000 hits |
| Low-Impact Development Site @ Legacy Trails | Bact/Nutr/Sed/Others | Ongoing | Undetermined |
| Onsite Waste Water Training Facility | Bact/Nutrients | Ongoing | 250 |
| Stormwater Demonstration | Bact/Nutr/Sed/Others | Ongoing | Undetemined |
| Publications (see website for lists) | ALL | Ongoing | |
| Septic Installer Training w/ Greene County | Bact/Nutrients | Ongoing | 4 professional train groups |
| Stormwater Education w/ City of Springfield | Bact/Nutr/Sed/Others | Ongoing | 6,500 |
| Stormwater Design Criteria Review | Bact/Nutr/Sed/Others | Ongoing | NA |
| Watershed Festivals | Non-point | Ongoing | 500 |
| Basic Watershed Education | ALL | Ongoing | 6,000 |
| Watershed Center Learning Stations and Interpretative Signage | ALL | Ongoing | 5,000 |
| Apply for 319 Grants- L. Sac Watershed | Bact/Nutr/Sed/Others | Future Plan-2011 | NA |
| Pet Waste Education | Bacteria/E.coli | Future Plan-2011 | NA |
| Rainwater Harvesting | ALL | Future Plan-2011 | NA |

**Table 14**

The table above shows the Watershed Committee of the Ozarks' education programs within the watershed. As can be seen from this list, the WCO conducts a great deal of education in the Little Sac Watershed. The Watershed Center will be completed next year and will feature many Best Management Practices on site to allow people to visit and learn how they function. For more info visit: www.watershedcenter.org.

## 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 |

**Table 15**

The Implementation and timeline tables for the urban and rural areas show that most of the measures are either an ongoing program or one that needs funding before it can be started.

**Rural Watershed Area**

| Management Measure | Responsible Party | Dates and Expected Accomplishments | Interim Milestones | Milestones |
|---|---|---|---|---|
| Education & Outreach | WCO | Ongoing | Ongoing | Ongoing |
| Specific Contamination Source & 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 |

**Table 16**

The Rural Measures have more programs starting up in 2010 than the urban areas. It also has fewer measures in place due to funding constraints.

## 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 |

**Table 17**

The Load Reduction Evaluation table shows how each measure will be evaluated to determine success. Each measure will have unique indicators that mark its progress and success. The threshold criteria timeframe for analyzing the water quality data is 5-8 years. At that time it will be decided whether the Little Sac Watershed Management Plan or TMDL needs to be modified. Evaluating the success of the Little Sac WMP will require analyzing years of water quality data, which will take a great deal of time. Significant levels of funding will be needed to employ one or several people to perform this work. The Watershed Committee of the Ozarks may or may not be in a financial situation to carry out this task. As future funding becomes available, the WCO may be in the position to complete the work.

**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 |
| Specific Contamination Source & 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 |

**Table 18**

The Load Reduction Evaluation table show how each measure will be evaluated to determine its success. Each measure will have unique indicators that mark its progress and success. The threshold criteria timeframe for analyzing the water quality data is 5-8 years. At that time it will be decided whether the Little Sac Watershed Management Plan or TMDL needs to be modified. Evaluating the success of the Little Sac WMP will require analyzing years of water quality data, which will take a great deal of time. Significant levels of funding will be needed to employ one or several people to perform this work. The Watershed Committee of the Ozarks may or may not be in a financial situation to carry out this task. As future funding becomes available, the WCO may be in the position to complete the work.

## 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.

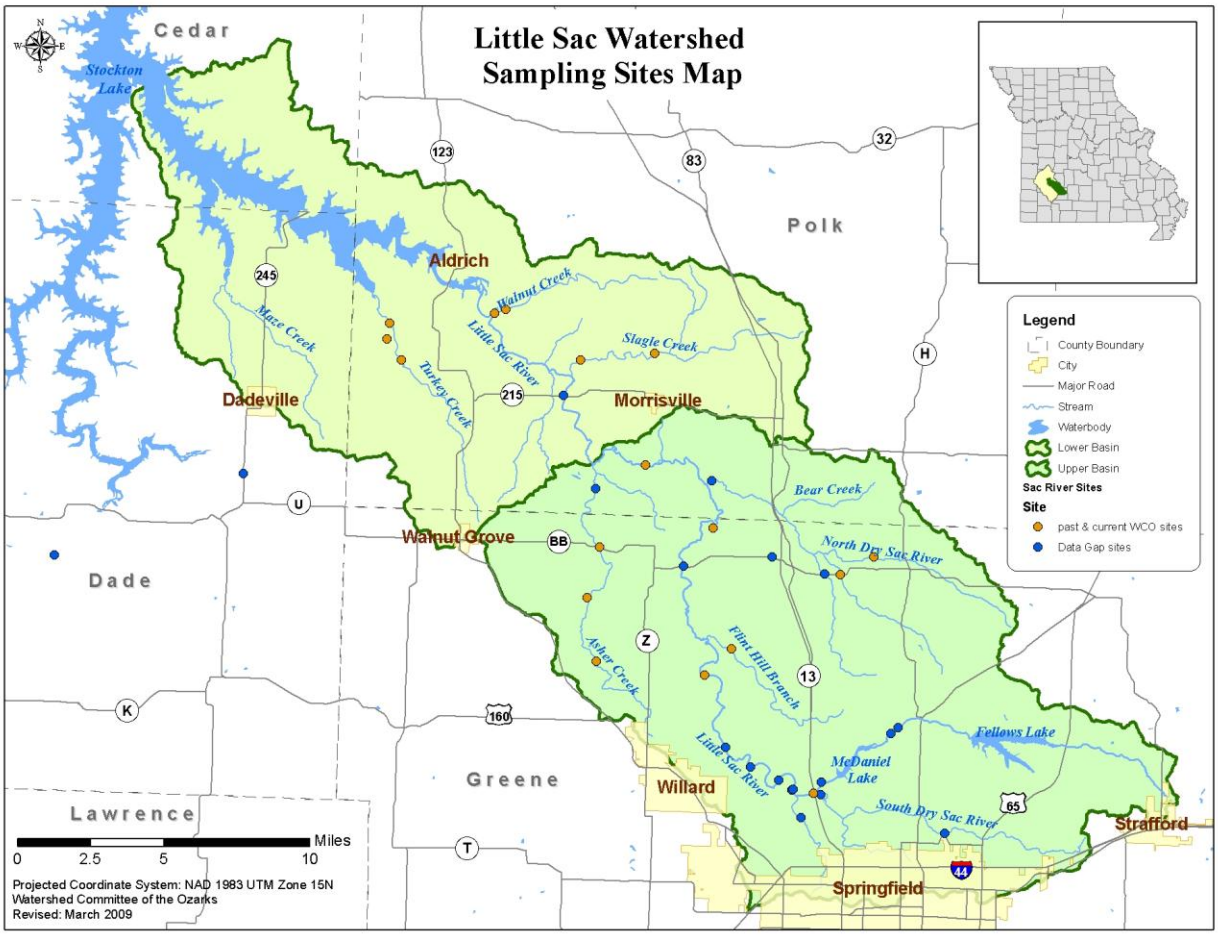



**Figure 22**

Sampling Frequency

When funding and staff are available, the Watershed Committee of the Ozarks collects bacteria, nutrients, and water quality data at 18 sites throughout the watershed each month. Data collected is used to determine a baseline and screen for excessively high levels. At the time of this writing, monthly sampling has been put on hold due to funding cuts. The Watershed Committee does continue to partner with Springfield-Greene County Health department to sample bacteria levels at local swimming locations during the summer months and participates in the Adopt-A-Spring program. Other entities currently collect samples in this watershed include the City of Springfield Storm Water Services, NW Treatment Plant, NW Sanitary Landfill and City Utilities. Further cooperation and coordination should take place in the watershed to establish a uniform sampling effort that is both comprehensive and efficient.

Watershed Committee will also continue its yearly visual survey of river condition in early June. This will include Missouri Stream Team macroinvertebrate sampling at remote locations, riparian cover observations and overall appearance of the stream in comparison to the 2009 survey.

Measures to Monitor for Evaluation Criteria Element 8

The Little Sac was listed on the 303(d) list for fecal coliform in 1998-2002. The measures will be monitored for a reduction in *E. coli* and fecal coliform.

## Summary

The Little Sac River Watershed Management Plan is necessary to guide stakeholders within the watershed as they seek to improve the water quality of the Little Sac River. The Watershed Committee of the Ozarks and Greene County Soil and Water Conservation District 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 by identifying pollutant sources, identifying better management practices to be implemented, setting reachable and reasonable goals, and by developing a timeline for implementation. A management plan would also help current and future monitoring programs to determine success of implemented projects or programs.

There are nine critical elements identified by the EPA and MODNR to be essential to a successful watershed management plan. Comments and concerns were recorded from initial stakeholder meetings within the watershed and then modeled after the nine critical elements. The plan is then able to satisfy both regulatory purposes and public concerns about the watershed.

The current TMDL (Total Maximum Daily Load) (http://www.fapri.missouri.edu/outreach/publications/2006/FAPRI_UMC_Report_11_06.pdf) for the Little Sac River found that the bacteria levels within the river were at unsafe levels. The TMDL set a limit that the bacteria load in the stream must not exceed in order to follow the MODNR approved TMDL. The majority of the management measures in the watershed plan are then focused on reducing the bacteria and E.coli present. The management measures used to reduce bacteria also address other water quality issues such as education, storm water runoff, nutrients and sediment, but the main focus in the plan was the bacteria loading in the stream.

This watershed has very diverse land uses. The watershed has urban and farmland influences that create a unique set of issues and require a diverse set of solutions to maintain water quality and quantity. The main issue in the watershed identified by the TMDL was bacteria, but the stakeholders within the watershed listed many other issues that raised their concern. Storm water, septic systems, nutrients, chemicals, spring contamination, and education were main categories of issues brought up by stakeholders in the watershed.

Matching best management practices to concerns help address the bacteria contamination as well as remediate problems with sediment, nutrients, and chemical pollution in the watershed. The urban and rural areas of the watershed need a wide gamut of management practices. A few specific issues pertain only to certain areas of the watershed. Storm water management and proper septic remediation/installation programs are unique to different parts of the watershed. The urban and rural areas also share similarities. Outreach and education, water quality monitoring and research, and the protection of karst features are necessary in the entire watershed.

Water quality was shown to be important to the stakeholders of the Little Sac, but it takes funding to improve water quality. Management measures, outreach and education programs, and further monitoring and research all need additional funding sources. Cost share incentives will help the private landowner.

Without proper research to pinpoint areas of concern, and cost effective education and outreach the cost of BMPs could likely deter residents from improving their land. Proper water quality monitoring and research can pinpoint areas of concern. Then, by strategically installing BMPs in the most vital areas, the efficiency of the BMPs will increase and be more effective in improving water quality. Outreach and education can also help

in promoting proper land management and water management practices to stakeholders. Paired education and good cost share incentive programs could improve the water quality in the Little Sac watershed.

The Little Sac River is a stream vital to the health of the community. With the proper watershed planning and future financial support through grants, agencies, governments, non-profits, and community support, water quality in the Little Sac River Watershed can be maintained and improved.

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