Spring River Nonpoint Source Watershed Plan

Draft Plan

The Spring River Nonpoint Source Watershed Plan is possible through United States Environmental Protection Agency Clean Water Act, Section 319, grant funds administered by the Missouri Department of Natural Resources.

September 22, 2015

ACKNOWLEDGEMENTS

The Environmental Protection Agency Region 7, through the Missouri Department of Natural Resources, has provided partial funding for this project under Section 319 of the Clean Water Act. Contract Agreement #: AOC13380100

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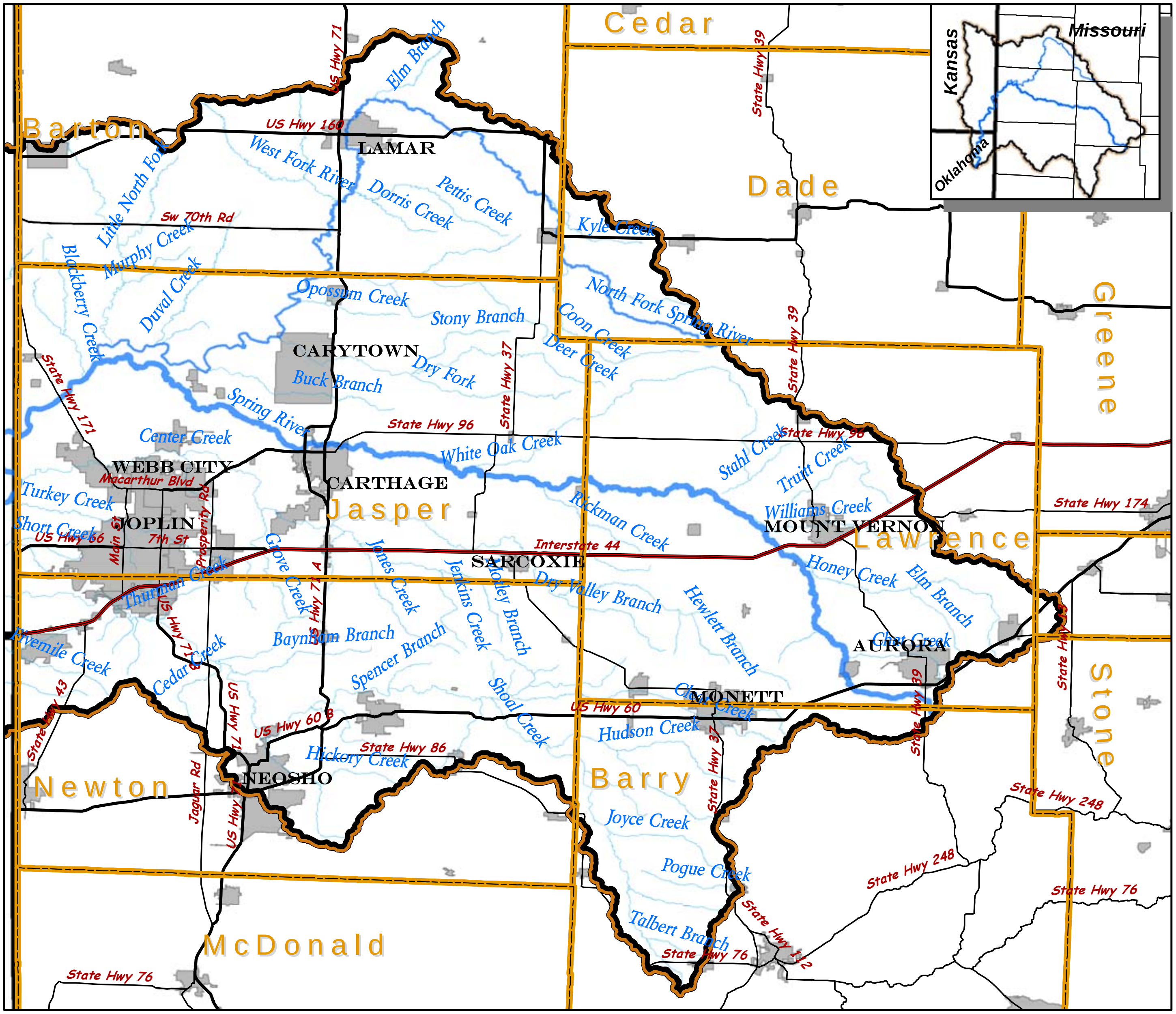


Figure 1. The Spring River Watershed.

The Spring River Watershed extends into Kansas and Oklahoma. For purposes of this report, when the Spring River Watershed is referenced, it will only encompass the Missouri portion of the entire watershed.

Glossary of Terms

Best Management Practices (BMP): Environmental protection practices used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities.

Biological Oxygen Demand (BOD): Measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements.

Biota: Plant and animal life of a particular region.

Chlorophyll a: Common pigment found in algae and other aquatic plants that is used in photosynthesis

Dissolved Oxygen (DO): Amount of oxygen dissolved in water.

***E. coli* bacteria (*E. coli*):** Bacteria normally found in gastrointestinal tracts of animals. Some strains cause diarrheal diseases. Used as an indicator of potential fecal contamination.

Eutrophication (E): Excess of mineral and organic nutrients that promote a proliferation of plant life in lakes and ponds.

Fecal coliform bacteria: Bacteria that originate in the intestines of all warm-blooded animals. Used as an indicator of potential fecal contamination.

Municipal Water System: Water system that serves at least 25 people or has more than 15 service connections.

National Pollutant Discharge Elimination System (NPDES) Permit: Required by Federal law for all point source discharges into waters.

Nitrates: Final product of ammonia's biochemical oxidation. Primary source of nitrogen for plants. Originates from manure and fertilizers.

Nitrogen(N or TN): Element that is essential for plants and animals. TN or total nitrogen is a chemical measurement of all nitrogen forms in a water sample.

Nonpoint Sources (NPS): Sources of pollutants from a disperse area, such as urban areas or agricultural areas

Nutrients: Nitrogen and phosphorus in water source.

Phosphorus (P or TP): Element in water that, in excess, can lead to increased biological activity in water. TP or total phosphorus is a chemical measurement of all phosphorus forms in a water sample.

Point Sources (PS): Pollutants originating from a single localized source, such as industrial sites, sewerage systems, and confined animal facilities

Riparian Zone: Margin of vegetation within approximately 100 feet of waterway.

Sedimentation: Deposition of slit, clay or sand in slow moving waters.

Secchi Disk: Circular plate 10-12" in diameter with alternating black and white quarters used to measure water clarity by measuring the depth at which it can be seen.

Stakeholders: Organization of watershed residents, landowners, farmers, ranchers, agency personnel and all persons with an interest in water quality.

Total Maximum Daily Load (TMDL): Maximum amount of pollutant that a specific body of water can receive without violating the surface water-quality standards. Meeting the goals of a TMDL will result in attainment of the designated uses of the water body.

Total Suspended Solids (TSS): Measure of the suspended organic and inorganic solids in water. Used as an indicator of sediment or silt.

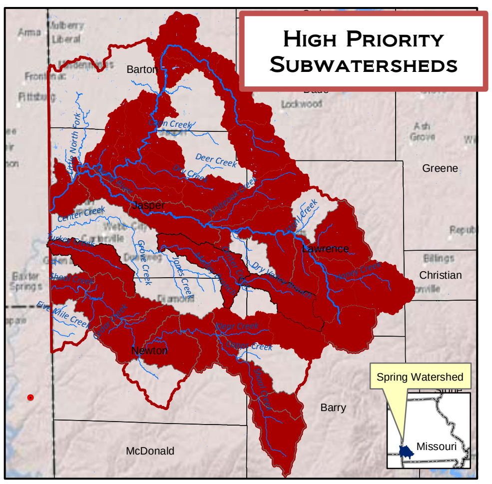
Water Quality Standard (WQS): Mandated in the Clean Water Act. Defines goals for a water body by designating its uses, setting criteria to protect those uses and establishing provisions to protect waterbodies from pollutants.

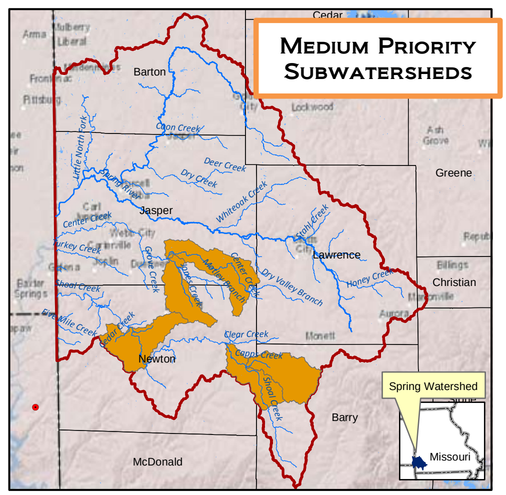
Executive Summary

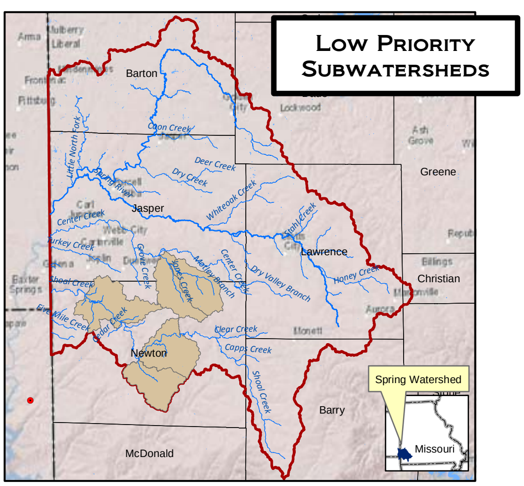
The objective of this Nonpoint Source Watershed Plan is to directly address:

- the sediment impairment in the North Fork Spring River Subwatershed
- the bacteria impairments in the Baynham Branch, Capps Creek, Center Creek, Dry Fork, Hickory Creek, Honey Creek, Jenkins Creek, Jones Creek, North Fork Spring River, Shoal Creek, Slater Branch, Spring River, Thurman Creek, Truitt Creek, Turkey Creek, White Oak Creek, and Williams Creek Subwatersheds
- and the nutrient impairments in Clear Creek and North Fork Spring River Subwatersheds

Targeting certain watersheds was determined by the use of SWAT modeling. (See page 58) Subwatersheds are divided into High, Medium and Low Priority for Implementation of Conservation Practices.







Best Management Practices to address sediment and bacteria impairments (see page 66) were chosen by the watershed stakeholders and were determined to be:

- Cropland Best Management Practices

    - No-Till
    - Cover Crops
    - Nutrient Management
    - Conservation Crop Rotation
    - Grassed Waterways
    - Terraces
    - Vegetative Buffers
    - Water Retention Structures
- Livestock Best Management Practices
    - Off Stream Watering Systems
    - Rotational Grazing
    - Relocate Pasture Feeding Sites
    - Grazing Management Plans
    - Relocate Feeding Pens
    - Fence off Streams and Ponds
    - Vegetative Filter Strip
- Streambank Best Management Practices
    - Streambank Stabilization
- Septic System Best Management Practices
    - Replace or Repair Failing Septic Systems
- Urban Best Management Practices
    - Bioswales
    - Vegetative Buffers
    - Permanent Vegetative Buffers

The required sediment load reduction is 2,737 tons. If all the Best Management Practices are implemented and installed, the sediment load reduction will be met in 11 years. The required phosphorus load reduction is 230,758 pounds. If all the Best Management Practices are implemented and installed, the phosphorus load reduction will be met in 20 years.

1. Introduction

A Purpose

The purpose of this Nonpoint Source Watershed Plan for the Spring River Watershed is to outline a plan of goals and actions for the surface waters of the watershed. Watershed restoration is needed for surface waters that do not meet Missouri water quality standards, and for areas of the watershed that need improvement in habitat, land management, or other attributes. Watershed protection is needed for surface waters that currently meet water quality standards, but are in need of protection from future degradation.

The process of developing a watershed plan involves local communities and governmental agencies working together toward the common goal of a healthy environment. Local participants or stakeholders provide valuable grass roots leadership, responsibility and management of resources in the process. They have the most "at stake" in ensuring the water quality existing on their land is protected. Agencies bring science-based information, communication, and technical and financial assistance to the table. Together, several steps can be taken towards watershed restoration and protection. These steps involve building awareness and education, engaging local leadership, monitoring and evaluation of watershed conditions, in addition to assessment, planning, and implementation of the process at the local level. Ultimate objectives for the watershed at the end of the process are to provide a sustainable water source for drinking and domestic use while preserving food, fiber, timber and industrial production. Other crucial objectives are to maintain recreational opportunities and biodiversity while protecting the environment from flooding, and negative effects of urbanization and industrial production. The ultimate endpoint is to restore impaired waters to conditions that meet water quality standards. This process will be "locally led and driven" in conjunction with government agencies in order to better the environment for everyone.

B Scope of the Watershed Plan

This Watershed Plan is intended to serve as an overall strategy to guide watershed restoration and protection efforts by individuals, local, state, and federal agencies and organizations. At the end of the process, the stakeholders will have the capability, capacity and confidence to make decisions that will restore and protect the water quality and watershed conditions of the Spring River Watershed. This watershed strategy is intended to be a living, fluid plan. Adjustments and alterations may be needed in order to be current with the watershed needs. In Sections 8 and 9 of this plan, water quality conditions will be discussed and possible plan updates will be reviewed.

C History of the Watershed Planning Process

Numerous watershed projects have been conducted in the Spring River Watershed. The funding for these projects has primarily been from Environmental Protection Agency (EPA) Section 319 funds.[1] 319 funding is dedicated to be awarded to states from the Clean Water Act. Section 319 is for nonpoint source programs to deal with impaired waters within the state. Usually these funds are used for local pollution control projects in impaired waters. These funds are distributed through Missouri Department of Natural Resources (MoDNR).

The Spring River Watershed has had nine 319 funded watershed projects in the last 15 years. These projects include areas of the watershed such as: the Upper Reach of Spring River, Shoal Creek, Barton County waters, Carthage, and Joplin, as well as watershed wide programs. Some of the issues addressed have been: nutrient management plans, redistribution of poultry litter, on-site wastewater treatment system repair and replacement or pumping, stream sampling and assessments, and watershed awareness and education. A full list of projects can be found in the Appendix, page 425.

Through a contract agreement with the MoDNR, Kansas State University Research and Extension (KSRE) has assisted with the development of a watershed plan that meets the guidelines of the EPA Nine Key Elements Watershed Plan with the use of 319 funds. These guidelines that are commonly referred to as "9 Elements" are as follows:

1. Identify and quantify causes and sources of the impairments in the watershed,
2. Estimate expected pollutant load reductions,
3. Identify Best Management Practices (BMPs) needed to achieve pollutant load reductions and critical areas where BMPs will be implemented,
4. Estimate needed technical and financial resources,
5. Provide an information, education and public participation component,
6. Include schedule for implementing NPS measures,
7. Identify and describe interim measurable milestones for implementation,
8. Establish criteria to determine if pollutant load reductions and targets are being achieved, and
9. Provide a monitoring component to evaluate effectiveness of the implementation over time.

KSRE has provided calibrated modeling data, economic data, identification and location of installation of BMPs, costs of implementing all BMPs in the watershed and pollutant load reductions anticipated by BMP implementation. The information provided in this watershed plan will meet the criteria in an EPA 9 Key Element Watershed Plan.

In 2013 and 2014, Spring River Watershed stakeholders have met in different locations throughout the watershed. The stakeholders have consisted of a wide range of participants, including landowners, agricultural producers, city and town staff members, state elected officials and agency personnel. The charge of the stakeholder meetings was to contribute to the development of a watershed plan.

D Watershed Plan Goals

The goals of the Spring River watershed plan are to:

- Restore impaired surface waters impacted by nonpoint source pollution,
- Guide future implementation of voluntary conservation practices funded by Missouri's nonpoint source pollution program (319), and
- Provide direction for multiple agencies and programs working to address water quality issues in the Spring River Watershed.

The objectives of the Spring River watershed plan are to:

- Reduce pollution loading into waterbodies that are designated as impaired through either the state's 303(d) list or through the establishment of TMDLs;
- Achieve applicable water quality standards for all impaired waterbodies in 20 years from the implementation of this plan; and
- Restore and maintain designated uses for impaired waterbodies.

The goals and objectives of this plan will be achieved primarily through the implementation of conservation practices in designated priority areas. The implemented practices that will be outlined in this Watershed Plan are voluntary and are not intended to be used for regulation of farmers, ranchers or landowners.

E Point and Nonpoint Source Pollution

Point source pollution is defined as a stationary location from which pollutants are discharged. An example of point source pollution is direct, concentrated discharge such as sewage effluent discharging from a pipe or ditch into a water body. Point sources of pollution require a National Pollutant Discharge Elimination System (NPDES) Permit, a permit required by Federal law for all point sources discharge pipes that discharge into U.S. waters. Authorized by the 1972 Clean Water Act, NPDES is a permit program that controls water pollution by regulating the type and amounts of pollutants that can be discharged into the waters of the United States. The NPDES Section of this watershed plan describes and lists NPDES sites found in the Spring River Watershed. For additional information, contact MoDNR. [2]

Nonpoint source (NPS) pollution is defined as pollution discharged other than through a pipe or ditch over a wide land area, originating from different sources, which enters water bodies through runoff or snowmelt and deposits pollutants into ground or surface waters. Within the Spring River Watershed, the primary NPS pollution issues are related to runoff from agricultural lands as well as non-confined animal grazing. **This watershed plan will only address impairments related to NPS pollution.**

2. Watershed Setting

A Watershed Geographic Boundaries

WHAT IS A WATERSHED?

A watershed is an area of land that catches precipitation and funnels it to a particular creek, stream, and river and so on, until the water drains into an ocean. A watershed has distinct elevation boundaries that do not follow political "lines" such as county, state and international borders. Watersheds come in all shapes and sizes, with some only covering an area of a few acres while others are thousands of square miles across.

The Spring River Watershed is located in Southwest Missouri. Its geographic scope contains portions of Barton, Dade, Jasper, Lawrence, Newton and Barry counties. There are small portions of the watershed in Christian County. It drains the Spring River, the North Fork Spring River and all tributaries feeding into these rivers.

Elevation determines the watershed boundaries. The upper boundary of the Spring River Watershed has an elevation of 526 meters (1,725 feet) and the lowest point of the watershed has an elevation of 69 meters (226 feet) above sea level. See Figure 2 below.

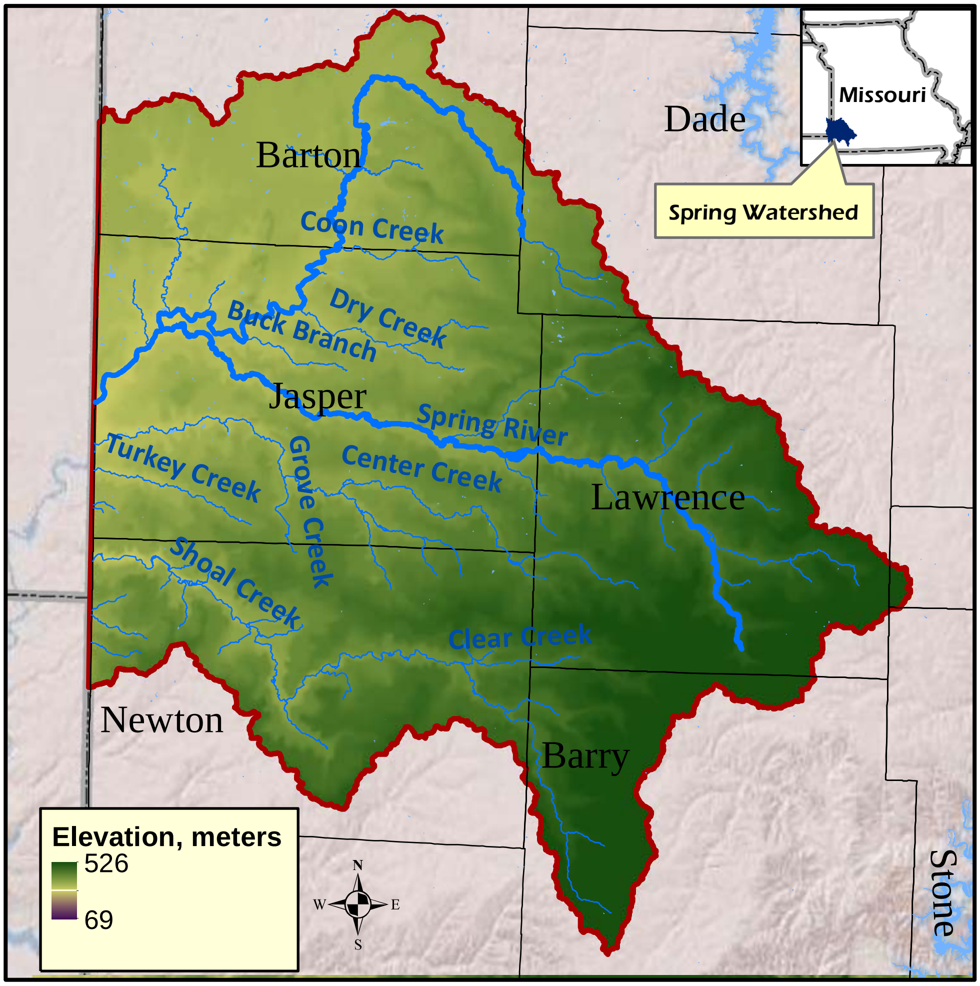


Figure 2. Elevation of the Spring River Watershed.

The Spring River Watershed extends into Kansas. For the purposes of this plan, only the portion of the Spring Watershed that lies in Missouri will be discussed. Kansas has developed a watershed plan for its portion of the Spring Watershed. [3]

B What is a HUC?

HUC is an acronym for Hydrologic Unit Codes. HUCs are an identification system for watersheds. Each watershed has a HUC number in addition to a common name. As watersheds become smaller, the HUC number will become larger. A commonly used HUC size is the HUC 8 code. The Spring River Watershed is HUC 8 code 11070207. The first 2 numbers in the HUC refer to the drainage region, the second 2 digits refer to the drainage subregion, the third 2 digits refer to the accounting unit and the fourth set of digits is the cataloging unit. For example:

<u>11</u>070207 = Region drainage of the Arkansas, White and Red River Basins which includes all of Oklahoma and parts of Arkansas, Colorado, Kansas, Louisiana, Missouri, New Mexico, and Texas. (Area = 245,500 sq. miles) See Figure 3

11**<u>07</u>**0207 = Includes the Neosho and Verdigris River Basins in Arkansas, Kansas, Missouri and Oklahoma. (Area = 20,500 sq. miles) There are five major watershed basins that eventually drain into the Gulf of Mexico. See Figure 4.

1107**<u>02</u>**07 = Includes the Neosho River Basin in Arkansas, Kansas, Missouri and Oklahoma. (Area = 12,400 sq. miles) See Figure 5.

110702**<u>07</u>** = Includes the drainage of the Spring River in Kansas, Missouri and Oklahoma. (Area = 2,500 sq. miles)

Figure 3. Major US Watershed Basins that Drain into the Gulf of Mexico

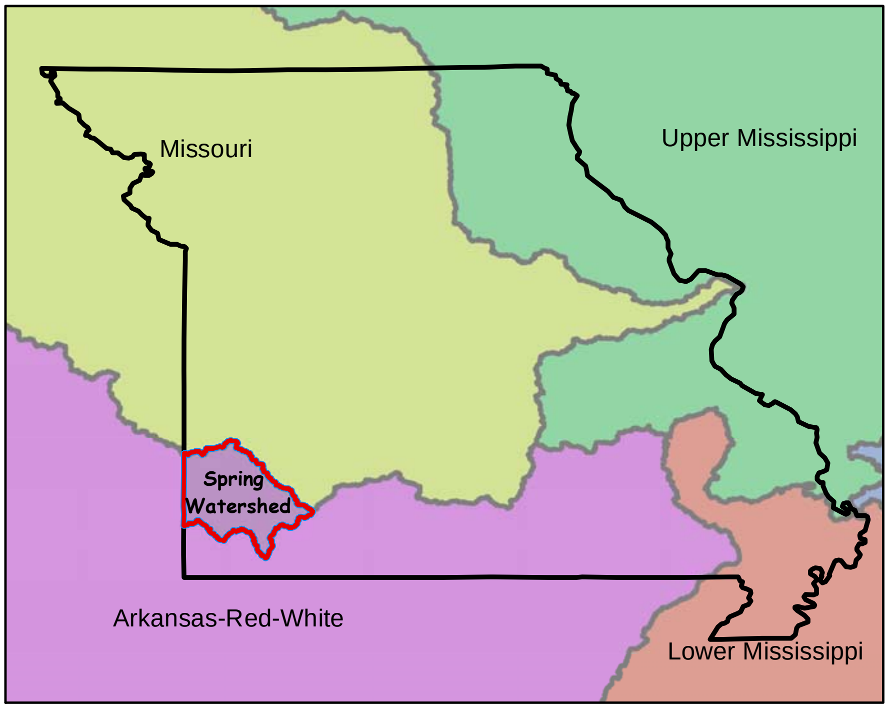


Figure 4. Spring Watershed Location in Missouri and in the Arkansas-Red-White Watershed Basin HUC 4.

Within the state of Missouri, there are 12 watershed basins with a HUC 6 code. Spring River is located in the Neosho River Basin.

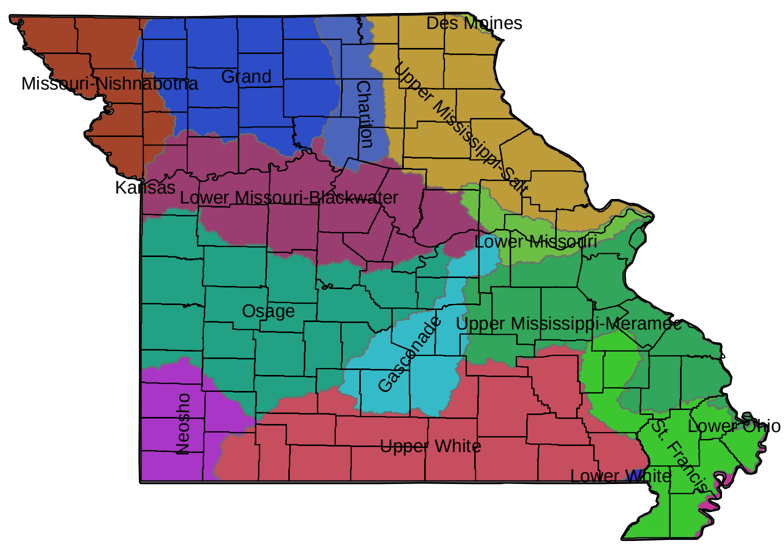


Figure 5. Major HUC 6 River Basins in Missouri.

As a watershed becomes geographically smaller, the HUC code becomes larger. HUC 8s are further divided into HUC 10s. There are ten HUC 10 watersheds in the Spring River Watershed. Additional sub division of HUC 10s creates HUC 12 watersheds. The Spring River Watershed is divided into fifty-six HUC 12s. A complete listing of the HUC 10s and 12s and their encompassed waterbodies is included in the Appendix.

In this Watershed Plan, the term "HUC 12" will be repeatedly used. This refers to the sub watersheds that have a HUC 12 code number. The identifying shortened HUC 12 code number that will be referenced in this watershed plan will be the last 3 digits of the HUC 12 number. For example, for the HUC 12 number 110702070206, the number mentioned in the plan will be 206.

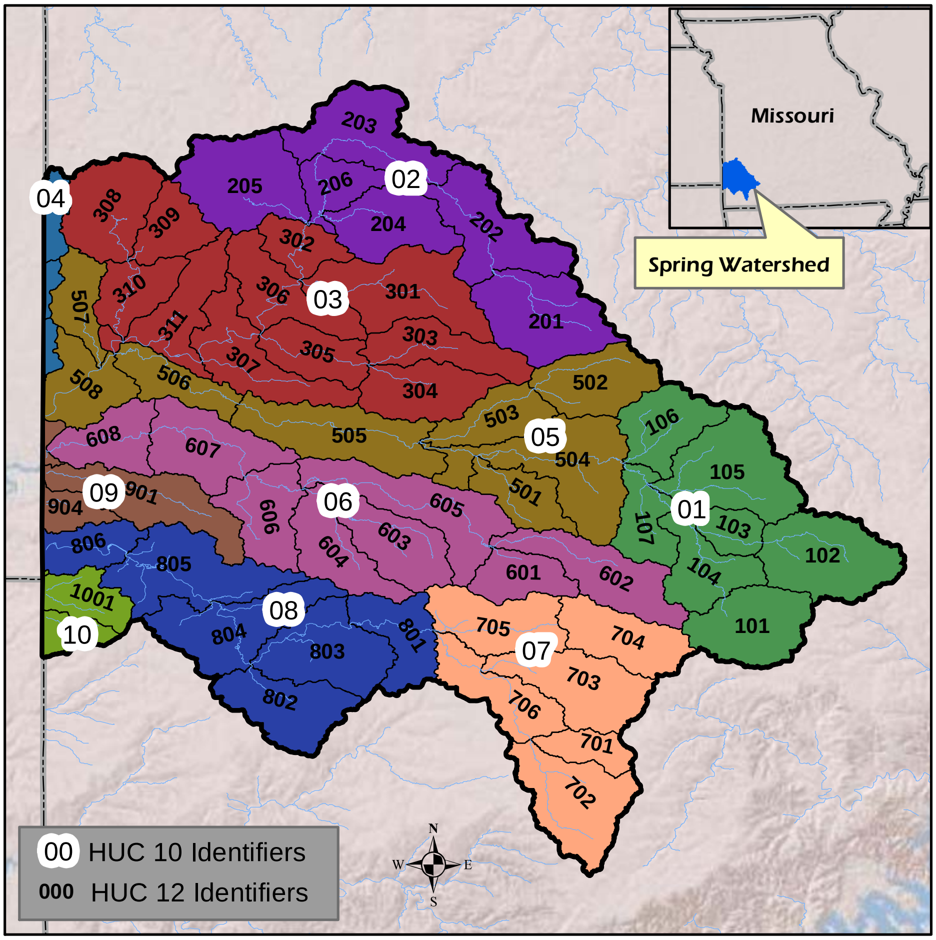


Figure 6. HUC 10 and HUC 12 Watersheds in the Spring River Watershed.

C Why is the Spring River Watershed Important to Grand Lake?

Grand Lake O' the Cherokees, located in northeast Oklahoma, was impounded in 1940. It contains 46,500 surface acres and is a major recreational reservoir. Three major rivers flow into Grand Lake:

- the Spring River from Missouri,
- the Neosho River from Kansas, and

- the Elk River from Missouri.

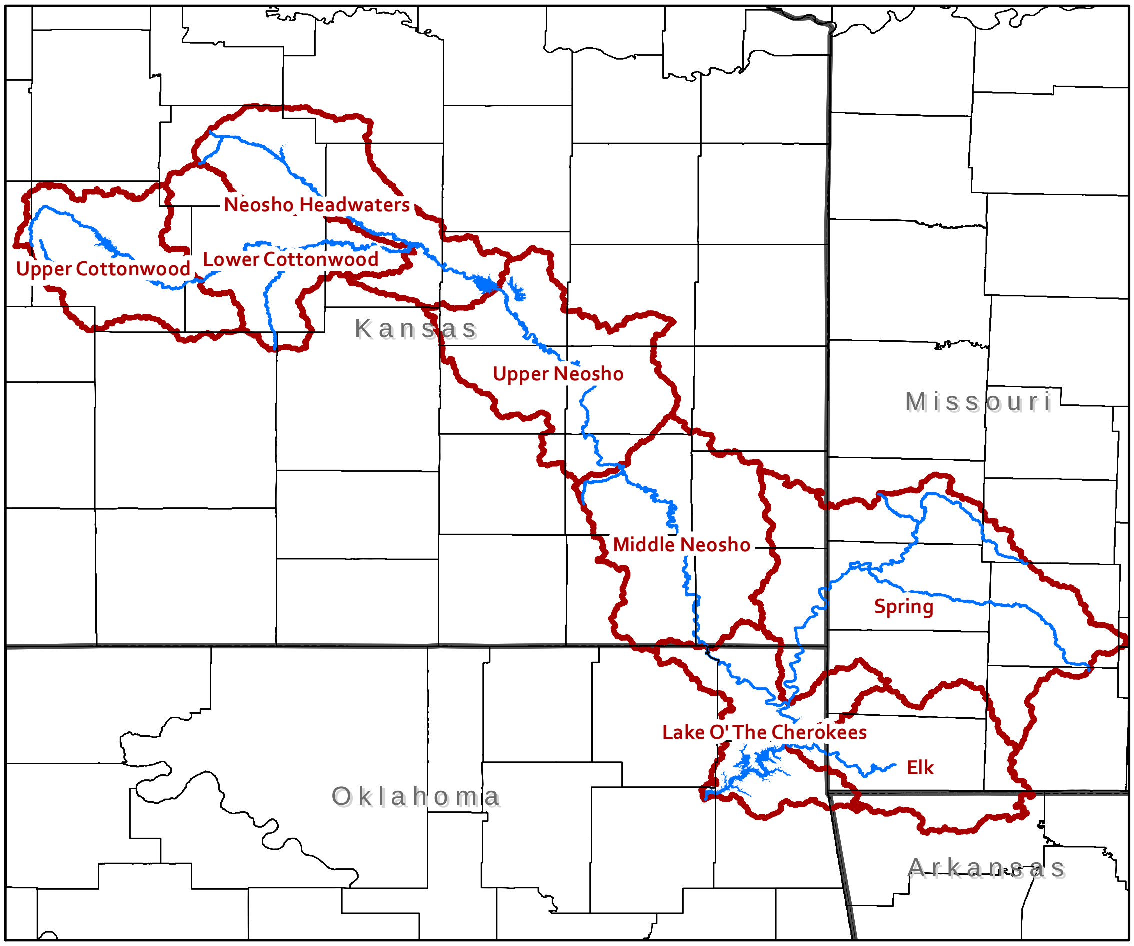


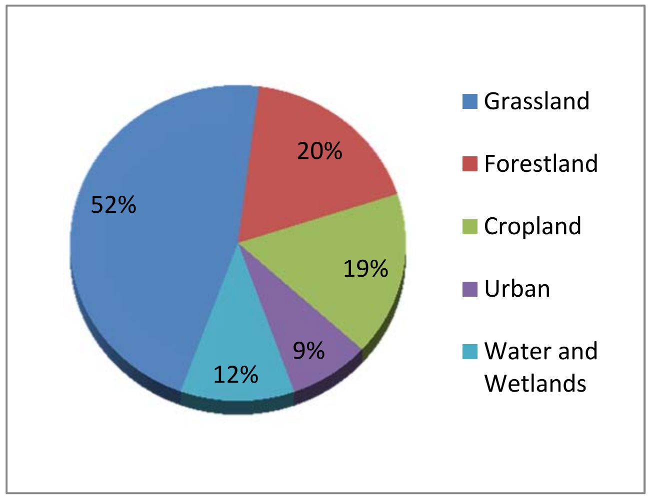
Figure 7. Drainage Area of the HUC 8s that Flow into Grand Lake O' the Cherokees.

Grand Lake O' the Cherokees (commonly referred to as Grand Lake) is a surface water supply to many communities in the area. It is also a major recreational economic resource for Oklahoma. The Spring River Watershed delivers approximately 32 percent of the inflow into Grand Lake. Nutrients are a major impairment in Grand Lake. An excess of nutrients can cause algal blooms in the lake and low levels of dissolved oxygen. Both of these incidents will negatively impact aquatic life, resulting in drinking water taste and odor problems, in addition to restrictions in fishing and swimming. According to the Grand Lake Watershed Alliance Foundation (GLWAF), the Neosho River basin can contribute nutrients, sediment and bacteria into Grand Lake, Spring River may contribute to the nutrient and bacteria levels, but also carries heavy metals from abandoned mining areas, and Elk River is similar to the Neosho River in that it can contribute nutrients, bacteria and sediment. Therefore, the water quality of Grand Lake depends on the water quality of the rivers entering it.

Grand Lake is expected to receive Total Maximum Daily Loads, TMDLs, in the near future. (TMDLs will be discussed later in this report and is located in the section beginning on Page 44 of this report.) When this happens, the Spring River could receive a significant portion of the pollutant load. When the TMDL is issued, the stakeholders in the Spring River Watershed will need to reevaluate the BMPs and pollutant load reductions that are outlined later in this plan for needed corrections and alterations.

D Land Cover/Land Use

The Spring River Watershed encompasses 1,453,440 acres. According to watershed modeling, cropland is the primary land use in the northern third of the watershed, whereas, grasslands are the primary land use in the southern portion of the watershed. Cropland is typically located along creeks and streams. Properly functioning riparian buffers are essential between cropland and streams to prevent overland flow of pollutants. These buffers can be grassed or forested. A healthy riparian area decreases erosion, slows runoff from crop fields and reduces pollutants from overland runoff. Forested land (including riparian buffers) is interspersed throughout the entire watershed.



The primary urban area is Joplin, a city of approximately 50,000 residents. Understanding of the distribution of land use activities is significant since each land use type tends to contribute to different pollutants in the watershed. In the Spring River Watershed, sediment, nutrients and bacteria are primary agricultural impairments. These can be a result of cropland and livestock land use and will be discussed on Page 42 of this watershed plan.

Table 1. Soil and Water Assessment Tool (SWAT) Modeling Generated Land Use in the Spring River Watershed.

Landuse	Percentage of Watershed	Acres in Watershed
Grassland	51.55	749,248
Forestland	19.93	289,671
Cropland	18.64	270,921
Urban	8.66	125,868
Water and Wetlands	1.22	17,732

Landuse	Percentage of Watershed	Acres in Watershed
Total	**100.00**	**1,453,440**

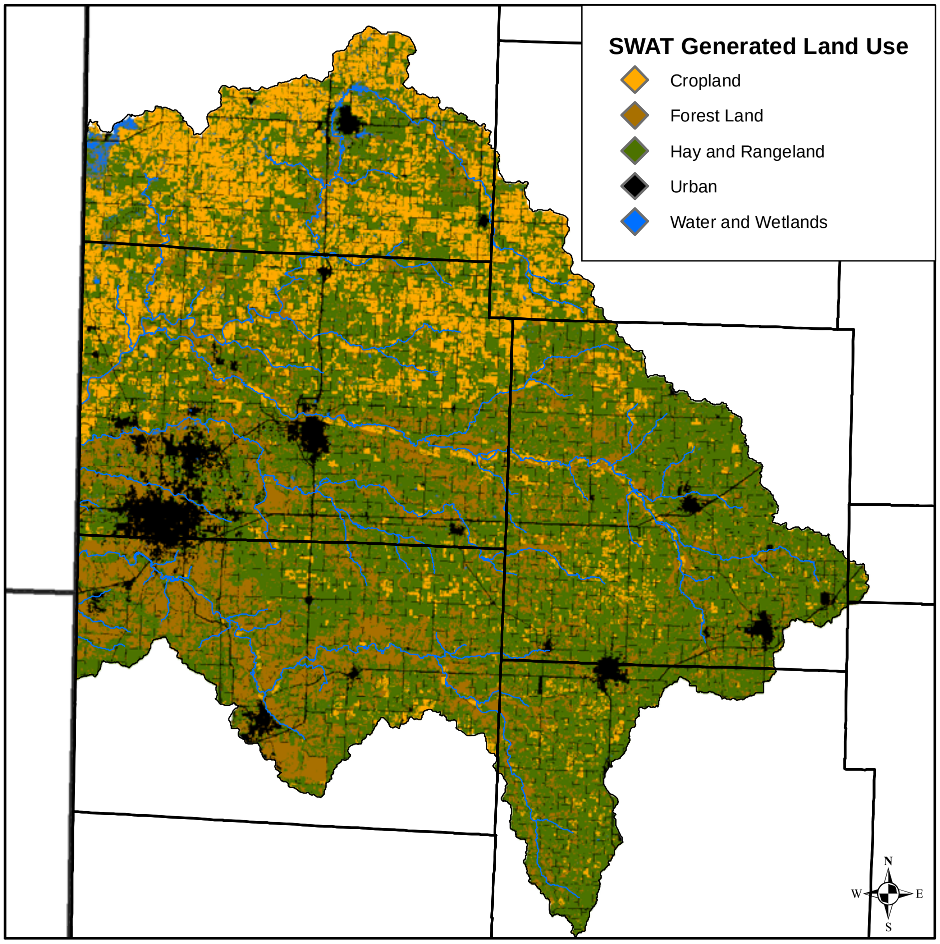


Figure 8. Soil and Water Assessment Tool (SWAT) Modeling Generated Land Use in the Spring River Watershed.

E Designated Uses Designation

Surface water quality standards are developed and used as a measure of exactly how water resources can support their "designated uses". State water quality standards must be reviewed every three years. Designated uses are the desirable uses or purposes that streams or lakes should be able to support. When the water quality of a stream or lake is determined to be at or above the minimum water quality standard established for the designated use of that water body, the designated use of the water body is said to be supported. However, when the water quality of a stream or lake falls below the water quality standards for the water body, the designated use of the water body is not supported and the stream or lake is said to be impaired. Designated uses for waterbodies are issued by MoDNR. [4]

Table 2. Definitions of Designated Uses. [5]

Designated Uses	Description
Irrigation	Application of water to cropland or directly to plants that may be used for human or livestock consumption. Occasional supplemental irrigation, rather than continuous irrigation, is assumed.
Livestock and wildlife watering	Maintenance of conditions to support health in livestock and wildlife.
Cold water habitat	Waters in which naturally-occurring water quality and habitat conditions allow the maintenance of a naturally-reproducing or stocked trout fishery and other naturally-reproducing populations of recreationally-important fish species.
Cool water habitat	Waters in which naturally-occurring water quality and habitat conditions allow the maintenance of a sensitive, high-quality sport fishery (including smallmouth bass and rock bass) and other naturally-reproducing populations of recreationally-important fish species.
Warm water habitat	Waters in which naturally-occurring water quality and habitat conditions allow the maintenance of a wide variety of warm-water biota, including naturally-reproducing populations of recreationally-important fish species.
Human health protection	Criteria to protect this use are based on the assumption of an average amount of fish consumed on a long-term basis. Protection of this use includes compliance with Food and Drug Administration (FDA) limits for fish tissue.
Whole body contact recreation	Activities in which there is direct human contact with the raw surface water to the point of complete body submergence. The raw water may be ingested accidentally and certain sensitive body organs, such as the eyes, ears, and the nose, will be exposed to the water. Although the water may be ingested accidentally, it is not intended to be used as a potable supply unless acceptable treatment is applied. Water so designated is intended to be used for swimming, water skiing, or skin diving.
Whole body contact Category A	This category applies to those water segments that have been established by the property owner as public swimming areas allowing full and free access by the public for swimming purposes and waters with existing whole body contact recreational use(s). Examples of this category include, but are not limited to, public swimming beaches and property where whole body contact recreational activity is open to and accessible by the public through law or written permission of the landowner.
Whole body contact Category B	This category applies to waters designated for whole body contact recreation not contained within category A.
Secondary contact recreation	Uses include fishing, wading, commercial and recreational boating, any limited contact incidental to shoreline activities, and activities in which users do not swim or float in the water. These recreational activities may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal. Assignment of this use does not grant an individual the right to trespass when a land is not open to and accessible by the public through law or written permission of the landowner.
Drinking water supply	Maintenance of a raw water supply which will yield potable water after treatment by public water treatment facilities
Industrial water supply	Water to support various industrial uses; since quality needs will vary by industry, no specific criteria are set in these standards.

Table 3. Designated Uses Designations for the Waterbodies in the Spring River Watershed. [6] **See Appendix for a more detailed list.**

Water Body ID	Water Body	Classified *	County	Warm Water Habitat	Cold Water Habitat	Cool Water Habitat	Drinking Water Supply	Industrial Water Supply	Irrigation	Livestock and Wildlife Water Supply	Secondary Contact Recreation	Whole Body Contact Category A	Whole Body Contact Category B
3159	Spring R.	P	Jasper	X		X		X	X	X	X	X	
3160	Spring R.	P	Jasper	X		X		X	X	X	X	X	
3161	Trib. to Spring R.	C	Jasper	X						X			X
3162	Cave Spring Br.	C	Jasper	X						X			X
3163	Dry Hollow	C	Lawrence	X						X			
3164	Spring R.	P	Lawrence	X	X			X	X	X	X	X	
3165	Spring R.	P	Lawrence	X						X	X	X	
3166	Browning Hollow	C	Lawrence	X						X			X
3167	Spring R.	C	Lawrence	X						X			X
3168	Chat Cr.	C	Lawrence	X						X	X		X
3168	Chat Cr.	C	Lawrence	X						X	X		X
3169	Honey Cr.	P	Lawrence	X						X			X
3170	Honey Cr.	C	Lawrence	X						X			X
3171	Williams Cr.	P	Lawrence	X	X					X		X	
3172	Williams Cr.	P	Lawrence	X						X		X	
3173	Williams Cr.	C	Lawrence	X						X			X
3174	Truitt Cr.	P	Lawrence	X						X			X
3175	Truitt Cr.	C	Lawrence	X						X			
3176	Stahl Cr.	P	Lawrence	X						X			X
3177	Trib. to Stahl Cr.	C	Lawrence	X						X			X
3178	Dry Fk.	C	Lawrence	X						X			X
3179	Trib. to Spring R.	C	Lawrence	X						X			X
3180	Trib. to Spring R.	C	Lawrence	X						X			X
3181	Trib. to Spring R.	P	Lawrence	X						X			X
3182	White Oak Cr.	C	Jasper	X					X	X		X	
3183	Trib. to White Oak Cr.	C	Lawrence	X						X			X
3184	Blackberry Cr.	C	Jasper	X						X			X
3185	Pond Cr.	C	Jasper	X						X			X
3186	N. Fk. Spring R.	P	Jasper	X						X	X		X
3187	Buck Br.	C	Jasper	X						X			X
3188	N. Fk. Spring R.	C	Jasper	X						X	X		X
3189	Dry Fk.	C	Jasper	X						X		X	
3190	Opossum Cr.	C	Jasper	X						X			X

Water Body ID	Water Body	Classified *	County	Warm Water Habitat	Cold Water Habitat	Cool Water Habitat	Drinking Water Supply	Industrial Water Supply	Irrigation	Livestock and Wildlife Water Supply	Secondary Contact Recreation	Whole Body Contact Category A	Whole Body Contact Category B
3191	Coon Cr.	C	Barton	X						X			X
3192	L. Coon Cr.	C	Barton	X						X			X
3193	Pettis Cr.	C	Barton	X						X			X
3194	Coon Cr.	C	Dade	X						X			X
3195	Kyle Cr.	C	Barton	X						X			X
3196	Trib. to N. Fk. Spring R.	C	Barton	X						X			X
3197	Dicks Fk.	C	Barton	X						X			X
3198	West Fk.	C	Barton	X						X			X
3199	Duval Cr.	C	Jasper	X						X			X
3200	L. N. Fork	C	Jasper	X					X	X			X
3201	Trib. to L. N. Fk. Spring R.	C	Barton	X						X			X
3202	Glendale Fk.	C	Barton	X						X	X		
3203	Center Cr.	P	Jasper	X		X		X	X	X	X	X	
3204	Grove Cr.	P	Jasper	X						X			X
3205	Jones Cr.	P	Jasper	X		X				X		X	
3206	Fidelity Br..	P	Jasper	X						X			X
3207	Jenkins Cr.	P	Jasper	X						X		X	
3208	Jenkins Cr.	C	Jasper	X						X		X	
3209	Trib. to Jenkins Cr.	C	Jasper	X						X			X
3210	Center Cr.	P	Jasper	X				X	X	X	X	X	
3212	Dry Valley Br.	P	Newton	X						X			X
3214	Center Cr.	P	Newton	X	X			X	X	X	X	X	
3215	Center Cr.	P	Lawrence	X						X		X	
3216	Turkey Cr.	P	Jasper	X						X			X
3217	Turkey Cr.	P	Jasper	X						X		X	
3218	Warren Br.	P	Newton	X						X			X
3219	Warren Br.	C	Newton	X						X			X
3220	Fivemile Cr.	P	Newton	X					X	X			X
3221	Rock Br.	P	Newton	X						X			X
3222	Shoal Cr.	P	Newton	X		X	X	X	X	X	X	X	
3223	Jacobs Br.	P	Newton	X						X			X
3224	Beef Br.	P	Newton	X						X			X
3225	Cedar Cr.	P	Newton	X						X			X
3226	Hickory Cr.	P	Newton	X						X		X	
3227	Elm Spring Br.	C	Newton	X						X			X

Water Body ID	Water Body	Classified *	County	Warm Water Habitat	Cold Water Habitat	Cool Water Habitat	Drinking Water Supply	Industrial Water Supply	Irrigation	Livestock and Wildlife Water Supply	Secondary Contact Recreation	Whole Body Contact Category A	Whole Body Contact Category B
3228	Newtonia Br.	P	Newton	X						X			X
3229	Shoal Cr.	P	Newton	X	X				X	X	X	X	
3230	Shoal Cr.	P	Newton	X		X			X	X	X	X	
3231	Shoal Cr.	C	Barry	X						X			X
3232	Pogue Cr.	C	Barry	X						X			X
3233	Joyce Cr.	C	Barry	X						X			X
3234	Capps Cr.	P	Newton	X	X				X	X	X	X	
3235	Trib. to Capps Cr.	P	Newton	X						X			X
3236	S. Fk. Capps Cr.	C	Barry	X						X	X		X
3236	S. Fk. Capps Cr.	C	Barry	X						X	X		X
3237	Hudson Cr.	C	Barry	X						X	X		X
3238	Clear Cr.	P	Newton	X						X			X
3239	Clear Cr.	C	Lawrence	X						X			X
3240	Baynham Br.	P	Newton	X						X			X
3241	Carver Br.	P	Newton	X						X		X	
3243	Thurman Cr.	P	Newton	X						X			X
3244	Silver Cr.	P	Newton	X						X			X
3810	Douger Br.	C	Lawrence	X						X			
						Lakes							
Water Body ID	**Water Body**	**Classified ***	**County**	**Warm Water Habitat**	**Cold Water Habitat**	**Cool Water Habitat**	**Drinking Water Supply**	**Industrial Water Supply**	**Irrigation**	**Livestock and Wildlife Water Supply**	**Secondary Contact Recreation**	**Whole Body Contact Category A**	**Whole Body Contact Category B**
	Oscie Ora Acres		Jasper	X					X	X	X		X
	Kellogg Lake		Jasper	X					X	X	X	X	
	Lamar City Lake		Barton	X			X		X	X	X		X

Table 4. Classified Use Definition.

***Classified waters**	C – Streams that may cease flow in dry periods but maintain permanent pools which support aquatic life. P – Streams that maintain permanent flow even in drought periods.

F Outstanding National Resource Waters

The Outstanding National Resource Waters provision of the Clean Water Act protects our nation's most treasured water bodies. This provision states that when high quality waters constitute an outstanding national resource, the water quality shall be maintained and protected. The designation is important because it provides the maximum amount of protection to water quality under the Clean Water Act. There are no Outstanding National Resource Waters in this watershed.

G Rainfall and Runoff

Rainfall rates and duration will affect sediment and nutrient runoff during high rainfall events. The Spring River Watershed averages 50 inches of rainfall yearly.

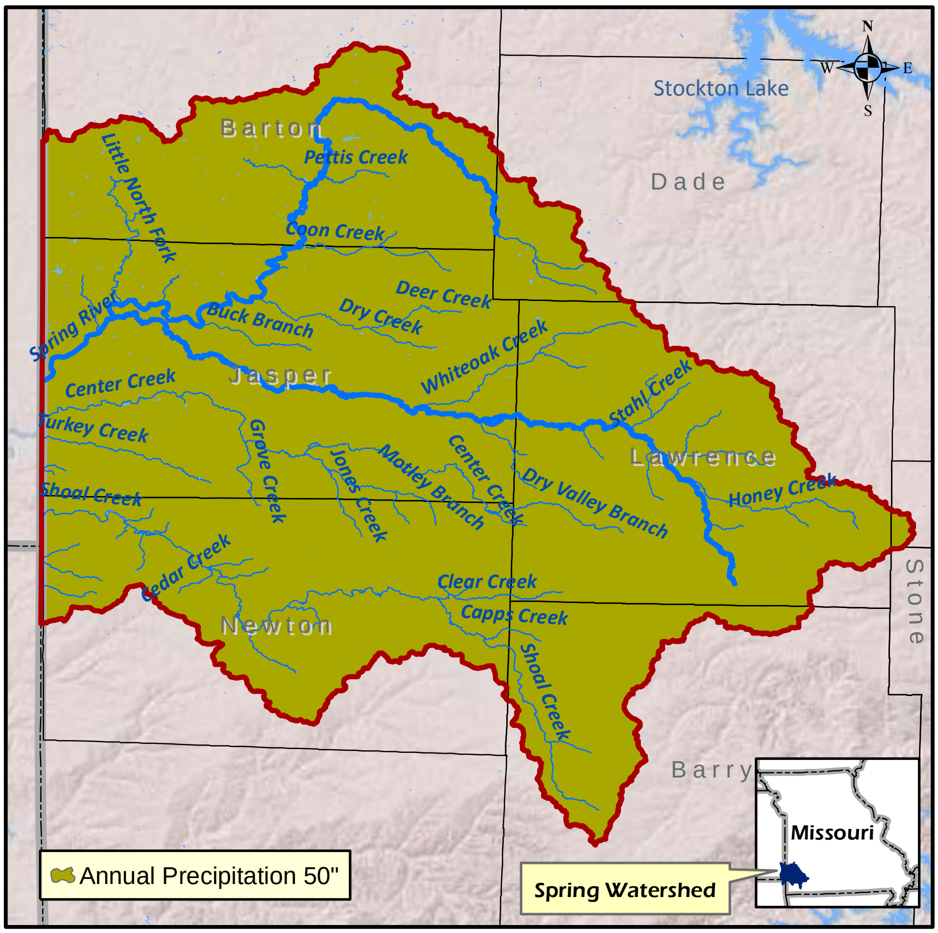


Figure 9. Average Annual Precipitation in the Spring River Watershed.

Most high intensity rainfall events in this watershed will occur in late spring and early fall.

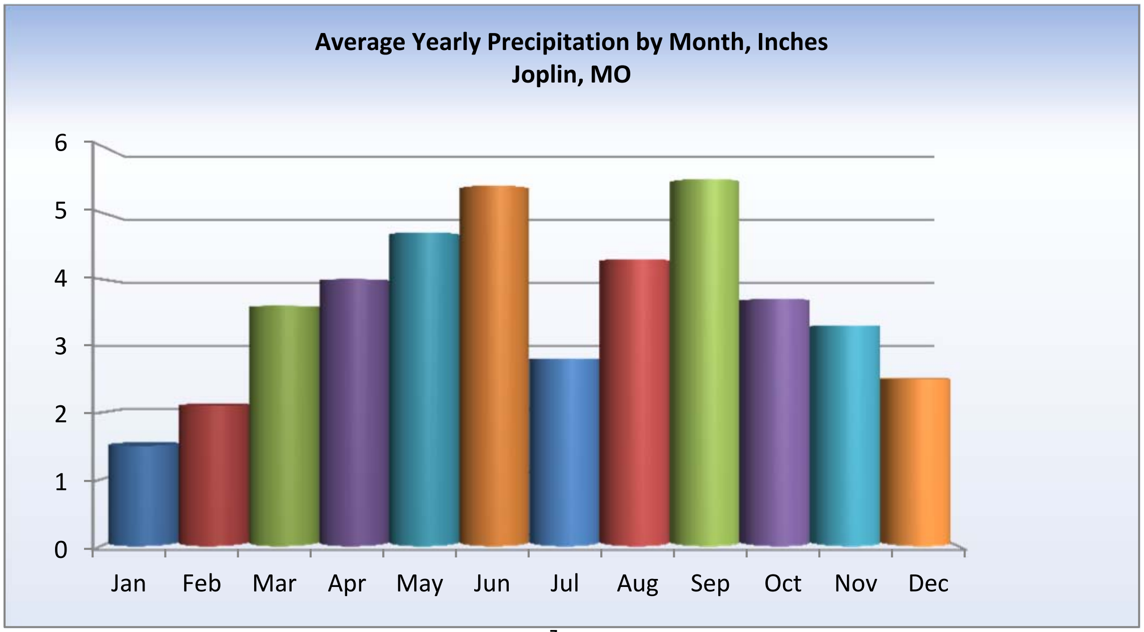


Figure 10. Average Monthly Precipitation, Joplin MO. [7]

Late spring is the period when crop ground is either bare or crop biomass is small and grassland biomass is short. Both of these conditions allow for maximum runoff since there isn't sufficient biomass to protect topsoil or slow runoff. Heavy rainfall events at this time can lead to sediment or pollutants entering the waterways via overland runoff. Therefore, as a management strategy, it is important to utilize conservation tillage practices, maintain adequate grassland cover and preserve a healthy riparian buffer.

H Population and Wastewater Systems

Newton County is the only county in the watershed that has had an increase in population from 2010 to 2013. All other counties have seen a decrease in population. Newton County contains portions of the city of Joplin. Rural population changes and density are important since single family wastewater systems, and their effectiveness, must be considered a source of pollutants in the watershed.

Table 5. Population in the Counties of the Spring River Watershed. [8]

County	Population in 2013	Percent Population Change from 2010 to 2013	Persons per Square Mile	Size, Square Miles
Newton	58,845	1.3	93	624
Barry	35,572	-0.1	45	778
Jasper	116,398	-0.9	183	638

County	Population in 2013	Percent Population Change from 2010 to 2013	Persons per Square Mile	Size, Square Miles
Barton	12,275	-1.0	21	591
Lawrence	38,185	-1.2	63	611
Missouri	6,044,171	0.9	87	68,741

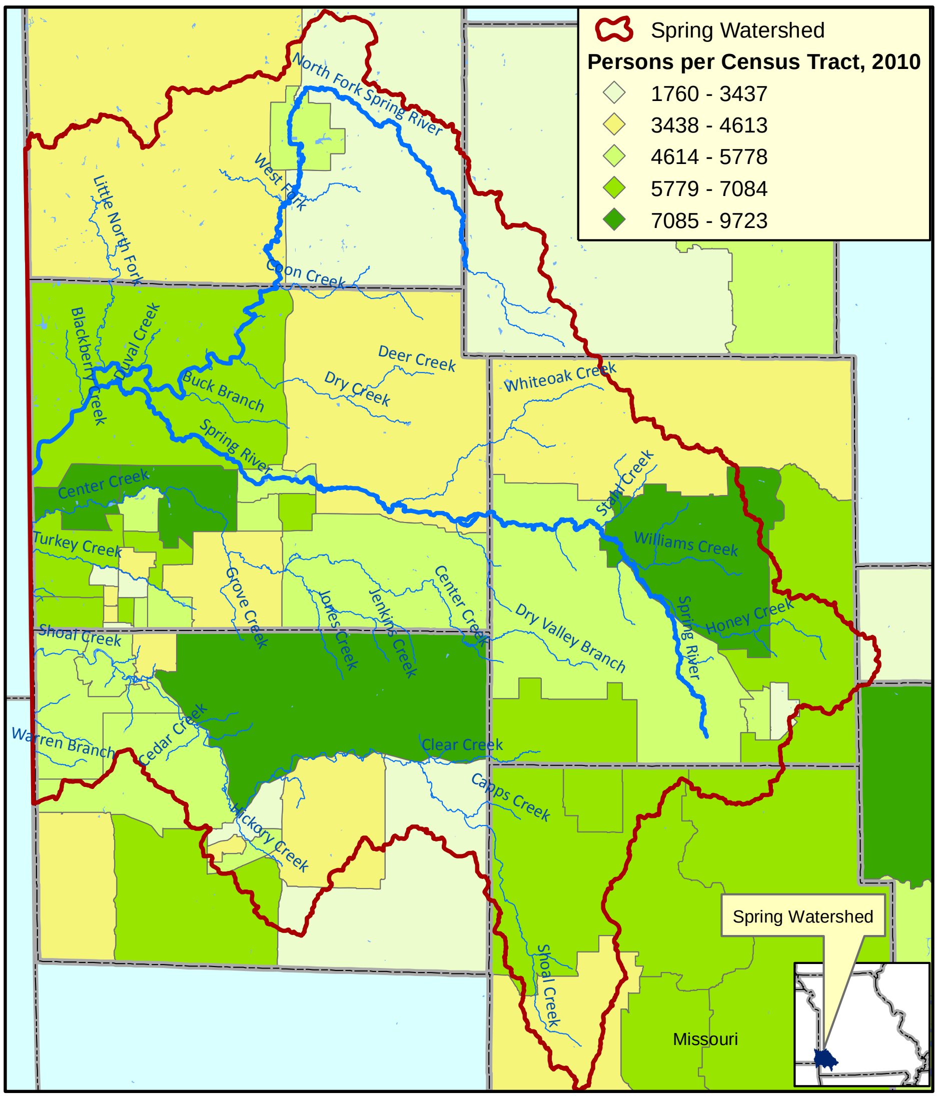


Figure 11. Persons per Census Tract, 2010.

The number of on-site wastewater treatment systems is directly tied to population, particularly in rural areas that do not have access to municipal wastewater treatment facilities. Failing, improperly installed or a lack of an on-site wastewater system can contribute bacteria or nutrients to the watershed through leakage or drainage of untreated sewage. Hundreds of on-site wastewater systems may exist in this watershed and the functional condition of these systems is generally unknown. EPA estimated the failure rate of on-site wastewater treatment systems is between 30 to 50 percent in Missouri.[9] Even though this is a significant number of failing systems, according to the land use data rural development is still small compared to livestock land use. These sites will be addressed in the implementation plan for this watershed and through the Missouri Nutrient Reduction Strategy[10].

I Aquifers

An aquifer is a rock or sediment unit in which the pore space is saturated and is sufficiently permeable to transmit water to wells and springs in useful or economic quantities. There are three aquifers underlying the Spring River Watershed:

- The Ozark Aquifer underlies the majority of the geographic region of the watershed.- The Ozark Aquifer extends from southeastern Kansas and eastern Oklahoma east to St. Louis and south into Arkansas. It is mainly comprised of limestone and dolomite. Historically, water from this aquifer is very hard.
- There is a minor aquifer or confining unit in the northwest portion of the watershed. A confining unit is a rock or sediment unit with permeability so low that water hardly moves though the unit.
- The Alluvial Aquifer, or alluvial deposits, is a part of and connected to a river system and consists of sediments deposited by rivers in the stream valleys. All of the major rivers and streams in the Spring River Watershed have alluvial aquifers that lie along and below the water body.

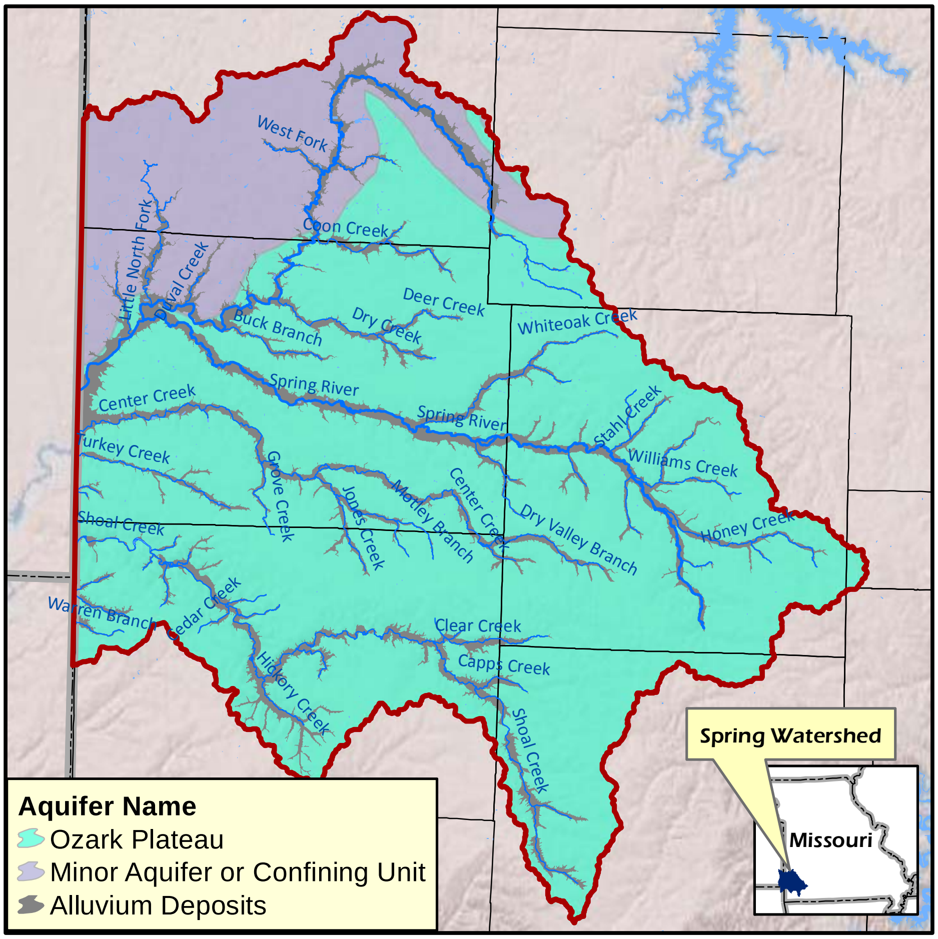


Figure 12. Aquifers in the Spring River Watershed. [11]

Depth to the aquifers ranges from 20 to 240 feet.

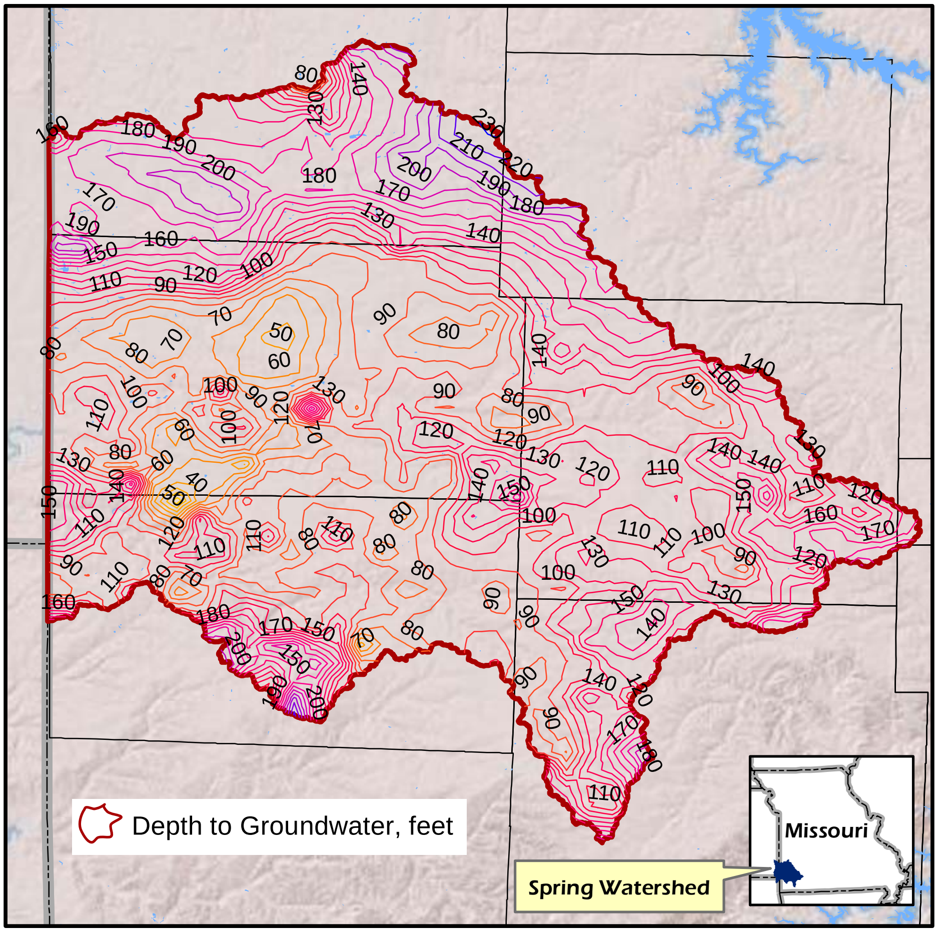


Figure 13. Depth to Groundwater, feet, in the Spring River Watershed. [8]

J Public Water Supplies

A Public Water Supply (PWS) that derives its water from a surface water source can be affected by sediment – either in difficulty at the intake in accessing the water or in treatment of the water prior to consumption. Nutrients and bacteria will also affect surface water sources causing excess cost in treatment prior to public consumption. There are only three surface water intakes for PWS in the watershed. Lamar City Lake has one and there are two intakes located on Shoal Creek. There are 340 PWS groundwater wells for providing a public drinking source. These wells are primarily located in the Ozark Plateau aquifer. Six watershed districts are located in the watershed in Barton, Jasper, Newton and Barry counties.

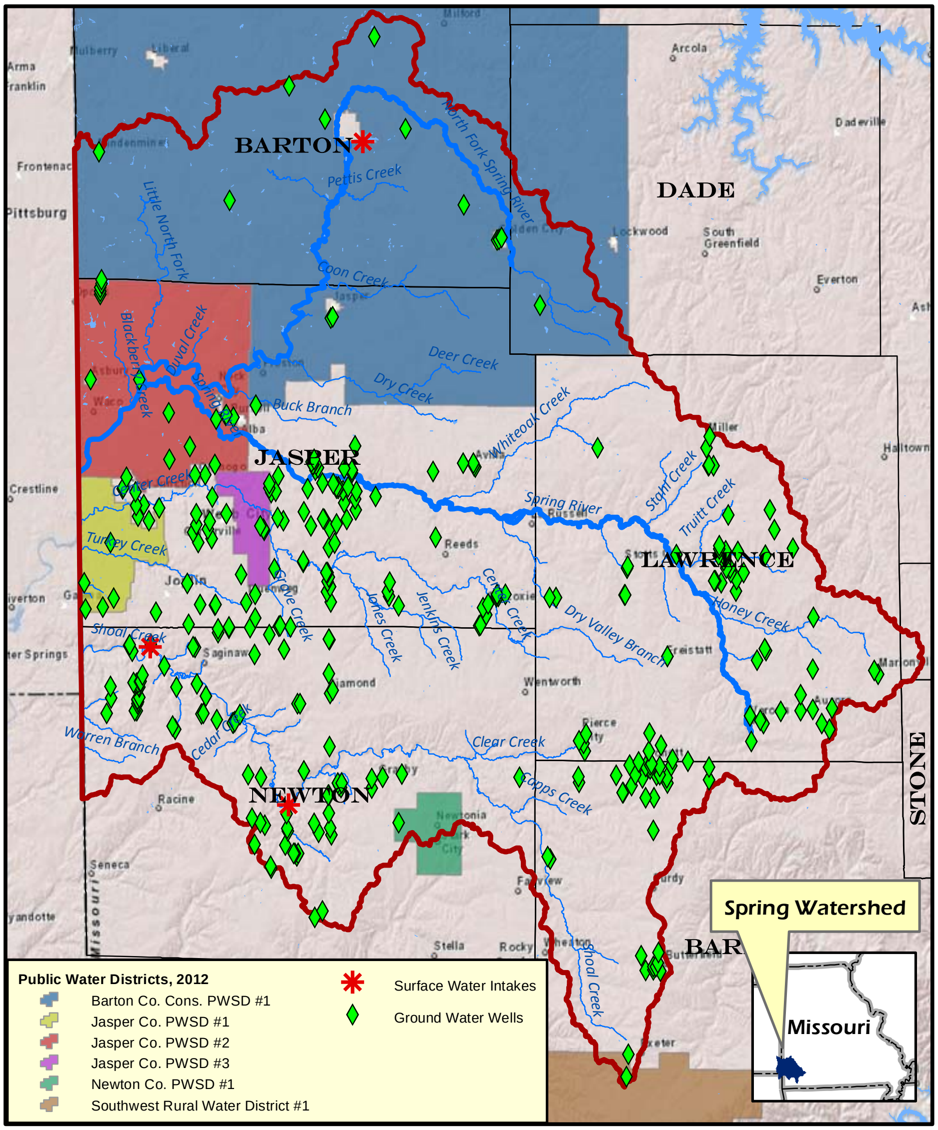


Figure 14. Public Water Supply Intakes and Public Water Districts in the Spring River Watershed. [12]

K National Pollutant Discharge Elimination System (NPDES)

Wastewater treatment facilities are permitted and regulated through MoDNR. [13] They are considered point sources of pollutants. (This watershed plan does not address point source pollution. Possible pollutant contributions from point sources are addressed in the TMDLs of the watershed. However, it is important to mention point sources in the discussion of possible pollutants in the watershed.) NPDES permits specify the maximum allowable amount of pollutants to be discharged into surface waters. Having theses point sources located on streams or rivers could impact water quality in the waterways. For example, municipal waste water can contain suspended solids, biological pollutants that reduce oxygen in the water column, inorganic compounds or bacteria. Wastewater will be treated to remove solids and organic materials, disinfected to kill bacteria and viruses, and discharged to surface water. Permitted discharges that may contribute bacterial pollutants like *E. Coli* (for example, wastewater treatment and some stormwater discharges), have permit conditions such as bacteria (*E. Coli*) limits that are protective of the receiving stream designated use. Treatment of municipal waste water is similar across the country. Industrial point sources can contribute toxic chemicals or heavy metals. Treatment of industrial waste water is specific to the industry and pollutant discharged.

NPDES sites are included in the map below.

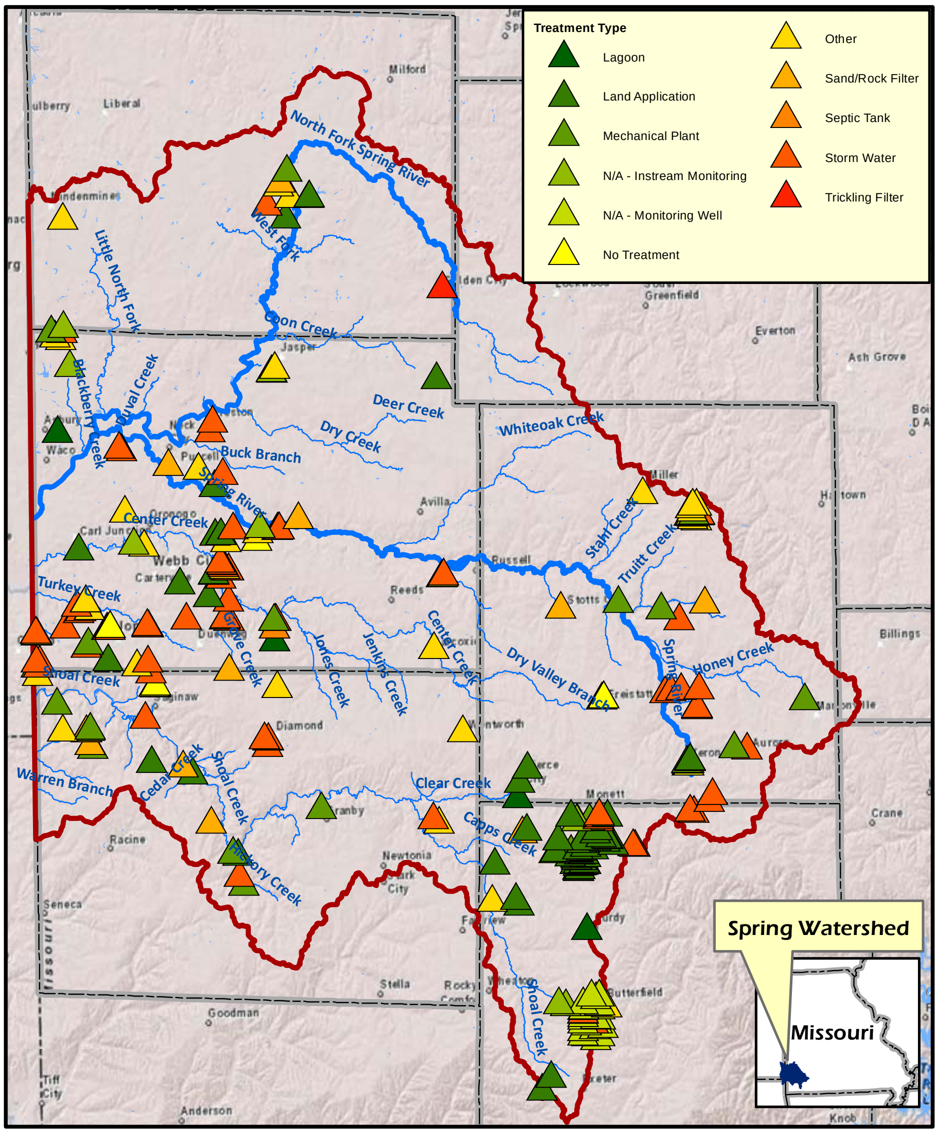


Figure 15. NPDES sites in the Spring River Watershed. [14]

L Concentrated Animal Livestock Operations

Animal feeding operations (AFOs) with greater than 300 animal units must register with MoDNR.[15] Concentrated animal feeding operations (CAFOs), those with more than 999 animal units, must be permitted with EPA. An animal unit or AU is an equal standard for all animals based on size and manure production. For example: 1 AU=one animal weighing 1,000 pounds. The watershed contains numerous AFOs. Number of and location of AFOs is important in nutrient reduction because of the manure that is generated and must be disposed of by the AFOs. Most farmers haul manure to cropland and incorporate it to be used as fertilizer for their crops. However, due to hauling costs, fields close to the AFO tend to receive more manure over the course of time than fields that are at a more distant location. These close fields will have a higher concentration of soil phosphorus and therefore, a higher incidence of erosion runoff potential not only as ortho phosphate, but also as phosphorus that is attached to soil particles. Therefore, prevention of erosion is an important component of phosphorus reduction in surface water. Grazing density is also important in reducing phosphorus runoff. In pastures and rangeland, the possibility exists of livestock loafing in streams and ponds and directly depositing manure into the waterways. Also, over grazing pasture and rangeland can cause greater rates of erosion and nutrient runoff from manure. The south and southeast portions of the Spring River Watershed have the highest grazing density.

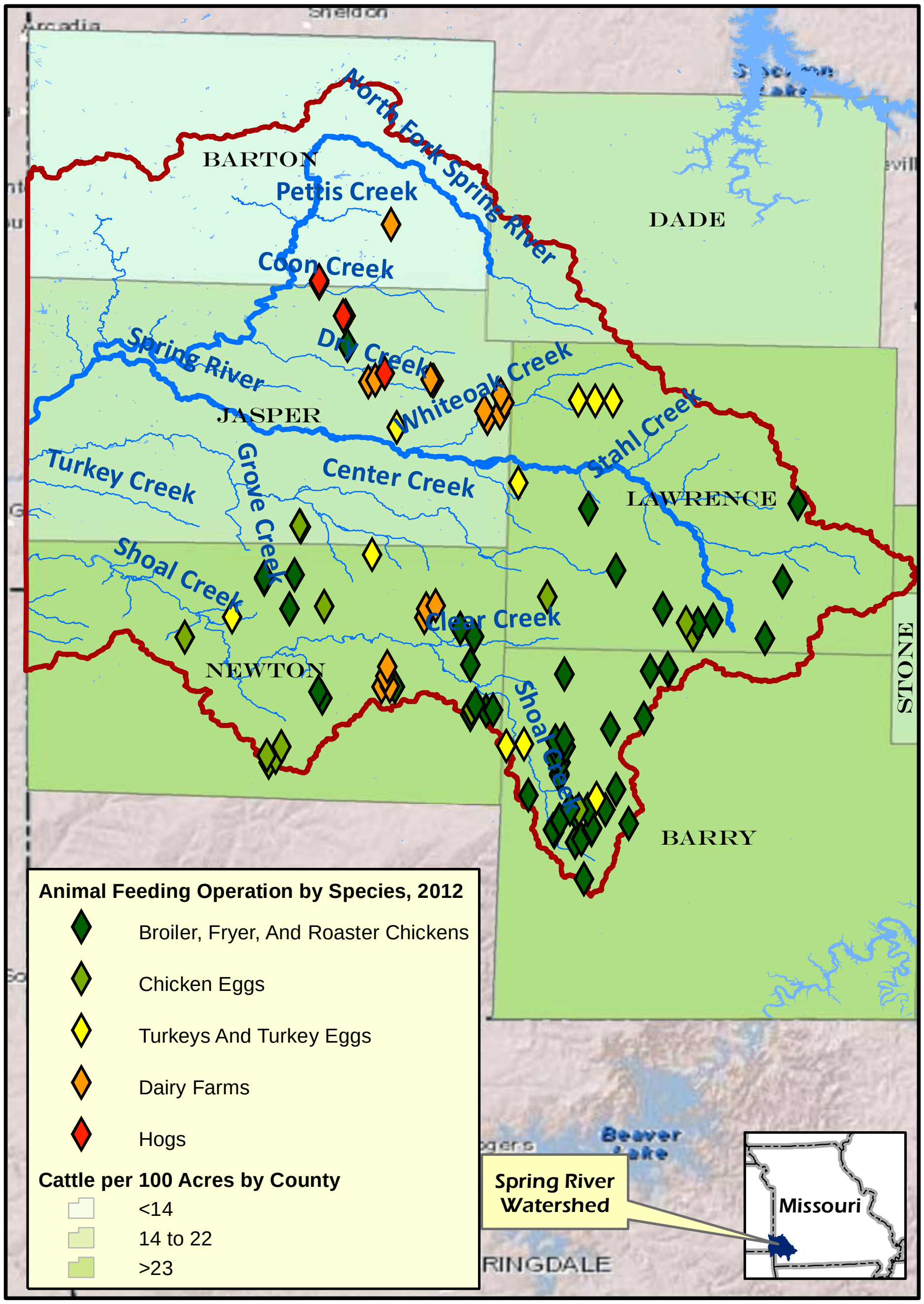


Figure 16. Spring River Watershed Animal Feeding Operations. [16]

3. Watershed Conditions

A Water Quality Monitoring Sites [17]

Several monitoring stations are located throughout the Spring River watershed. A majority of the sampling efforts focus on bacteria monitoring. As of 2011, samples have been routinely collected by the Jasper County Health Department (JCHD), Lawrence County Health Department (LCHD), Newton County Health Department (NCHD), Missouri Department of Natural Resources (MoDNR), and the U.S. Geological Survey (USGS). Tables 283, 284, 285, 286, and 287, located in the Appendix provide a list of organizations and locations of monitoring sites involved with collecting water quality data in the Spring River watershed since 2011. A map of all the monitoring locations is provided in Figure 17. Other historical water quality information may also be available for the watershed, but the information provided in the Appendix is the most recent data that has been consistently collected over the 2011-2013 timeframe.

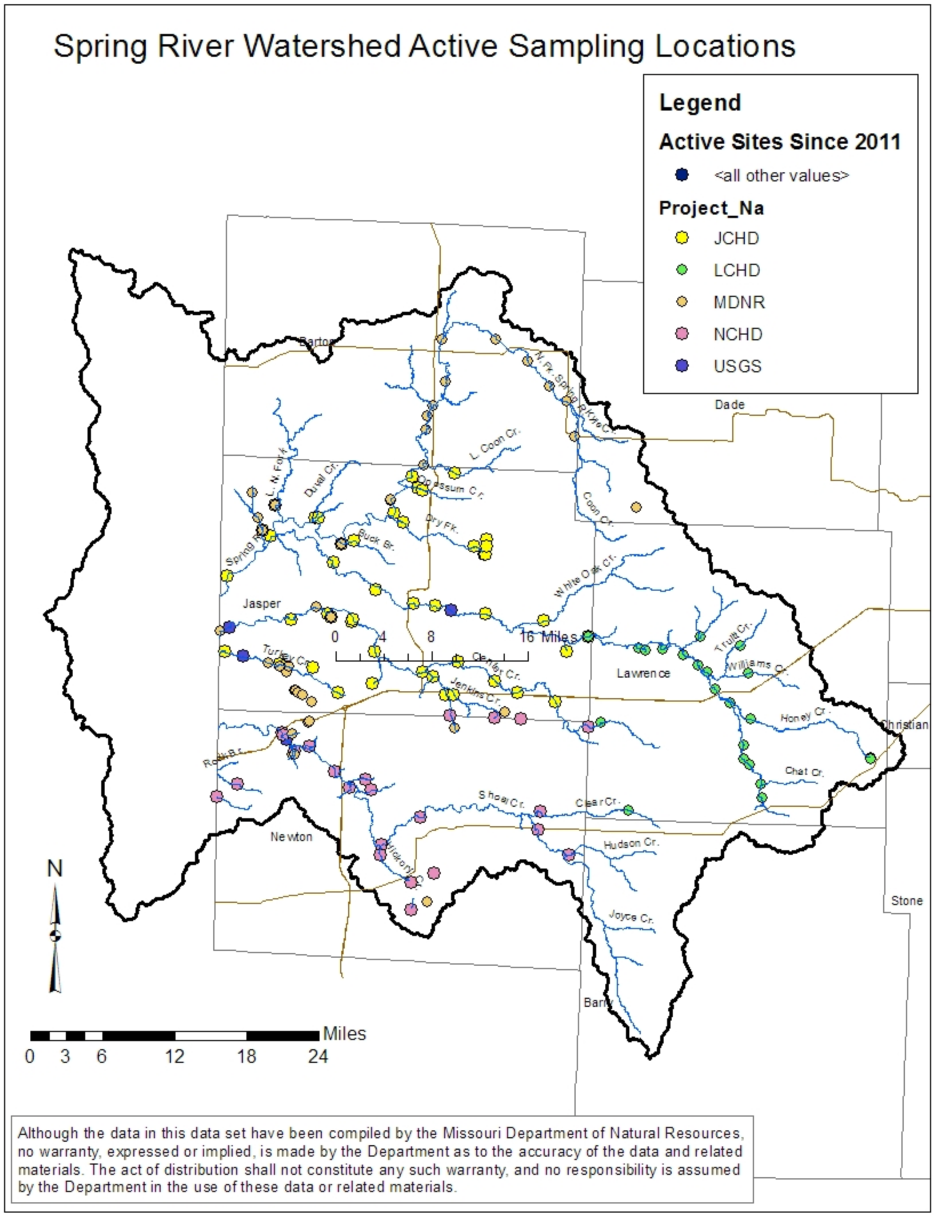


Figure 17. Monitoring Sites in the Spring River Watershed. [17]

The following water quality parameters are currently monitored by federal, state, and local organizations. The MoDNR will continue to monitor sites to evaluate water quality for the Spring River watershed for both point and nonpoint sources, and will continue to support the USGS ambient monitoring site as funding allows. The duration of the county health departments monitoring efforts are unknown at this time. All available data collected by the organizations will also be used to conduct Section 303(d) water quality assessments.

- Jasper County Health Department (Sampling frequency: weekly)
  - *E. coli*

- Lawrence County Health Department (Sampling frequency: weekly during recreational season, less frequent during other months)
    - *E. coli*
- Newton County Health Department (Sampling frequency: two times per month
    - *E. coli*
- Missouri Department of Natural Resources (Sampling frequency: twice per month)
    - Temperature, Dissolved Oxygen, pH, Specific Conductivity
    - Chlorophyll a
    - Chloride, Sulfate, Calcium, Magnesium
    - Dissolved Metals (nickel, zinc, lead, cupper, cadmium, barium, aluminum)
    - *E. coli*
    - Nutrients (ammonia, nitrate, TKN, total phosphorus, total nitrogen)
    - Total Suspended Solids
    - Turbidity
    - Stream flow
- USGS (Sampling frequency: monthly)
    - Temperature, Dissolved Oxygen, pH, Specific Conductivity,
    - Chloride, Calcium, Hardness, Bicarbonate, Potassium, Sodium, Sulfate
    - Dissolved Metals (aluminum, arsenic, barium, cadmium, copper, iron, magnesium, manganese, lead, selenium, strontium, zinc)
    - Total Metals (aluminum, cadmium, mercury, zinc)
    - Total Dissolved Solids, Total suspended solids
    - *E. coli*, Fecal Coliform
    - Nutrients (ammonia, nitrate, phosphate, TKN, total nitrogen, lead, total phosphorus)
    - Stream flow

The location of water quality monitoring sites, water quality parameters, number and types of conservation management practices implemented will be used to track water quality improvements in the Spring River Watershed and sub-watersheds. Long-term water quality trends will be used to evaluate watershed improvements in accordance with the implementation schedule and stated water quality milestones. To determine if mid- and long-term water quality milestones are being achieved, sub-watershed data will be reviewed more frequently (e.g. two to five-year schedule or when sufficient information has been obtained that allows for an accurate representation of current watershed conditions) to determine if scheduled implementation in critical areas can be linked to changes in water quality.

B Water Quality Impairments

A Total Maximum Daily Load (TMDL) calculation sets the maximum amount of pollutant that a specific body of water can receive without exceeding the surface water quality standards. TMDLs are written to achieve water quality standards and restore waters so that they meet their designated uses. TMDLs provide a tool to target and reduce point and nonpoint pollution sources. TMDLs established by Missouri may be done on a watershed basis and may use a pollutant-by-pollutant approach or a biomonitoring approach or both as appropriate. TMDL establishment means a draft TMDL has been completed, there has been public notice and comment on the TMDL, there has been consideration of the public comment, any necessary revisions to the TMDL have been made, and the TMDL has been submitted and approved by EPA. The desired outcome of the TMDL process is indicated, using the current situation as the baseline. Deviations from the water quality standards will be documented. The TMDL will state its objective in meeting the appropriate water quality standard by quantifying the degree of pollution reduction expected over time. Interim objectives, outlined in a separate implementation plan, will also be defined for midpoints in the implementation process. In summary, TMDLs provide a tool to target and reduce point and nonpoint pollution sources.

What is a Total Maximum Daily Load (TMDL)?

Every state assigns designated uses for each water body. These uses provide for:

- healthy aquatic life,
- safe contact recreation (swimming and boating),
- safe drinking water,
- safe food procurement, and
- adequate ground, irrigation, industrial, and livestock water usage.

Not meeting these uses indicates a failure to meet the Missouri ***Water Quality Standard*** (WQS). When this happens, a ***TMDL*** is developed. TMDL is a regulatory term derived from the US Clean Water Act. The TMDL will set a maximum amount of pollutant that can be discharged into a water body while still providing for its designated uses. It is an assessment tool that helps to identify pollutant impairments and determine the amount of pollutant in the water.

As part of the Clean Water Act, a 303(d) list of impaired waters is developed biennially and submitted in the Section 305(b) Report by MoDNR to EPA. [18] To be included on the 303(d) list, samples taken during the MoDNR monitoring program must show that water quality standards are not being met. This in turn means that beneficial or designated uses are not met.

The TMDLs in the Spring River Watershed are discussed in the following sections.

1) Sediment Impairments in the Spring River Watershed

The North Fork of the Spring River has a 2006 TMDL for Sediment due to agricultural nonpoint sources in the water. [19] Sediment in the waters of the North Fork Spring River poses a threat to warm water aquatic life and causes degradation to the aquatic habitat. Erosion and soil loss can originate from streambank loss and sloughing of the sides of rivers and streams and from sheet and rill erosion from cropping and pasture systems. Therefore, reducing erosion is necessary for accomplishing a reduction in sediment. At the time of this publication, streambank erosion sites have not been identified through assessment. This will be included in the implementation plan for this watershed.

Activities performed on the land affects sediment that is transported downstream. Physical components of the terrain are important in sediment movement. Causes of erosion can be:

- Slope of the land and soil type with a propensity to generate runoff.
- Streambank erosion and sloughing of the sides of the river and stream bank. A lack of riparian cover can cause washing on the banks of streams or rivers and enhance erosion.
- Cropland that does not have conservation practices will have a greater amount of sediment runoff than those fields with waterways or buffer strips in addition to practicing no-till or conservation tillage.
- Livestock overgrazing may be a factor in erosion originating in pastures.
- Silt that is present in the stream from past activities and is gradually moving downstream with each high intensity rainfall event.

Activities performed on the land affects sediment that is transported downstream. Agricultural BMPs that will help reduce sediment deposition in waterways are (in no particular order, many other BMPs exist):

- No-till
- Minimum tillage
- Vegetative buffers and riparian areas
- Grassed waterways
- Grassed terraces
- Wetland creation
- Establishing permanent vegetative cover
- Rotational grazing
- Farming on the contour
- Conservation crop rotation

BMPs that have been selected by the stakeholders to mitigate erosion in the Spring River Watershed based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness are (BMP descriptions are included on page 67):

- Establish cover crops
- Develop nutrient management plans
- Conservation crop rotation
- Grassed waterways
- Terraces
- Vegetative buffers
- Water retention structures

Table 6. Sediment Impairments in the Spring River Watershed.

Year*	Water Body Name**	Pollutant	County Upstream/ Downstream	Impaired Use
2006	North Fork Spring River	Sediment	Dade, Barton, Jasper	Warm Aquatic Life

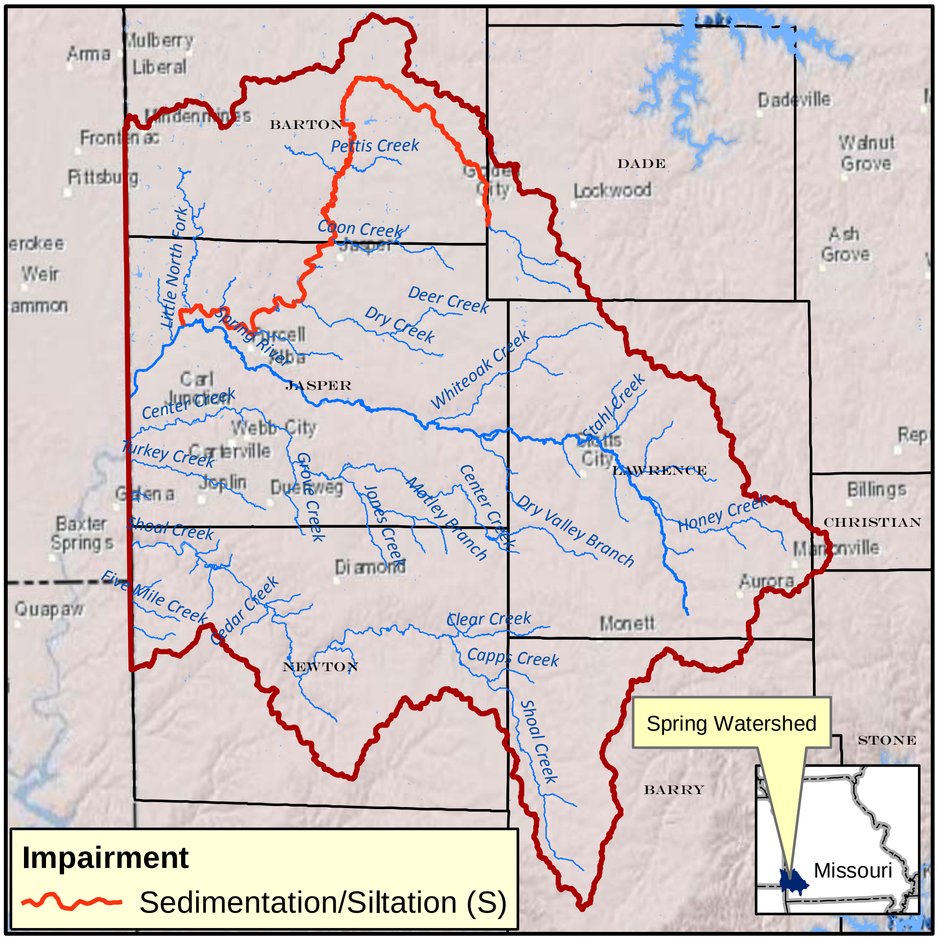


Figure 18. Sediment TMDL (North Fork Spring River) in the Spring River Watershed.

2) Bacteria Impairments in the Spring River Watershed

Bacteria are used as an indicator of contamination and are a broad spectrum of species which includes *E. coli* bacteria. [20] While bacteria are present in the digestive tract of all warm blooded animals including humans and animals (domestic and wild), its presence in water indicates that the water has been in contact with human or animal waste. Although bacteria may not be harmful, their presence in water indicates that fecal material is present, and that disease organisms such as *E. coli*, giardia, or others may also be found in the water. Generally speaking, the higher the level of bacteria, the greater the level of fecal contamination of the water, and the greater the likelihood of pathogenic organisms being present. The term bacteria and *E. coli* are being used interchangeably in this report; however, the current and proposed bacteria TMDLs in this watershed are specifically for *E. coli* because the water quality criterion to protect the state's recreational uses is based on *E. coli*.

Presence of *E. coli* in waterways can originate from runoff from livestock production areas, close proximity of any mammals to water sources, failing on-site wastewater treatment systems and manure application to agricultural fields. *E. coli* can originate in both rural and urban areas. It can be caused by both point and nonpoint sources. It must be noted that not all bacteria can be attributed to livestock. Wildlife has a contribution to bacteria loads and failing on-site wastewater treatment systems can be a source of bacteria from humans. However, according to land use data, livestock is the major contributor of bacteria in this watershed.

The livestock BMPs that the watershed stakeholders have chosen that are related to bacteria runoff are(BMP descriptions are included on page 68):

- Off-stream watering systems
- Rotational grazing
- Relocate pasture feeding sites
- Grazing management plans
- Relocate feeding pens
- Fence off streams and ponds
- Vegetative filter strips

On-site wastewater treatment systems can be a factor in bacteria present in the watershed. BMPs selected by the stakeholders for on-site wastewater treatment systems are:

- Repair
- Replacement

In addressing bacteria in this watershed plan, phosphorus (P) will be tracked as a surrogate for bacteria.[21] Since bacteria have an unpredictable lifespan that differs with environmental conditions, acquiring reliable laboratory results are difficult and expensive. This NPS watershed plan is primarily addressing bacteria from livestock and it is known that an animal unit will excrete an average of 0.0987 pounds of P daily.[22] Literature from several university studies was reviewed to determine the P output for beef cattle. A wide range of values exist for beef cattle P output in the literature. Two studies were deemed to be of significant value: These studies were from the University of Minnesota (UM) and Washington State University (WSU). The WSU journal article refers to the ASAE Manure Production and Characteristics Manual for its P value, which is a highly referenced manual. The determined P value was 0.097 pounds per beef cow. After adjusting this value to AU, the value is 0.0882 pounds P/day. The UM article concludes a P output of 0.25 pounds per day/AU of P_2O_5. This converts to 0.1092 pounds of actual P. Averaging these two studies concludes with a P value of 0.0987 pounds P/AU/day. This was determined to be the value to be utilized in the calculations of BMP efficiency and thus needed installed BMPs in the watershed. Therefore, if the amount of phosphorus (assumed to be from manure) in the waterbodies is reduced after implementation of livestock BMPs, it will be assumed that bacteria will be decreased also. This relationship gives the Watershed Plan a definitive goal for load reduction of phosphorus as a replacement for bacteria.

Table 7. Bacteria Impairments in the Spring River Watershed.[23]

Year	Water Body Name**	Pollutant	County Upstream/ Downstream	Impaired Use
2012	Baynham Br.	Escherichia coli	Newton	Whole Body Contact B

Year	Water Body Name**	Pollutant	County Upstream/ Downstream	Impaired Use
2006	Capps Cr.	Escherichia coli	Barry	Whole Body Contact A
2008	Center Cr.	Escherichia coli	Newton/Jasper	Whole Body Contact A
2010	Center Cr.	Escherichia coli	Lawrence/Newton	Whole Body Contact A
2008	Dry Fork	Escherichia coli	Jasper	Whole Body Contact B
2006	Hickory Cr.	Escherichia coli	Newton	Whole Body Contact A
2010	Honey Cr.	Escherichia coli	Lawrence	Whole Body Contact B
2012	Jenkins Cr.	Escherichia coli	Newton/Jasper	Whole Body Contact A
2012	Jones Cr.	Escherichia coli	Newton/Jasper	Whole Body Contact A
2008	North Fk. Spring R.	Escherichia coli	Barton	Whole Body Contact B
2008	North Fk. Spring R.	Escherichia coli	Dade/Jasper	Whole Body Contact B
2008	Shoal Cr.	Escherichia coli	Newton	Whole Body Contact A
2014	Slater Br	Escherichia coli	Jasper	Whole Body Contact B
2006	Spring R.	Escherichia coli	Lawrence/Jasper	Whole Body Contact A
2010	Spring R.	Escherichia coli	Lawrence	Whole Body Contact A
2012	Thurman Cr.	Escherichia coli	Newton	Whole Body Contact B
2012	Truitt Cr	Escherichia coli	Lawrence	Whole Body Contact B
2006	Turkey Cr.	Escherichia coli	Jasper	Whole Body Contact A
2008	Turkey Cr.	Escherichia coli	Jasper	Whole Body Contact B
2010	White Oak Cr.	Escherichia coli	Lawrence/Jasper	Whole Body Contact A
2010	Williams Cr.	Escherichia coli	Lawrence	Whole Body Contact A
2010	Williams Cr.	Escherichia coli	Lawrence	Whole Body Contact A

- Whole Body Contact A= Waters that have been established by the property owner as public swimming areas welcoming access by the public for swimming purposes and waters with documented existing whole body contact recreational use(s) by the public. Examples of this category include, but are not limited to: public swimming beaches and property where whole body contact recreational activity is open to and accessible by the public through law or written permission of the landowner.
- Whole Body Contact B= Waters designated for whole body contact recreation not contained within category A.

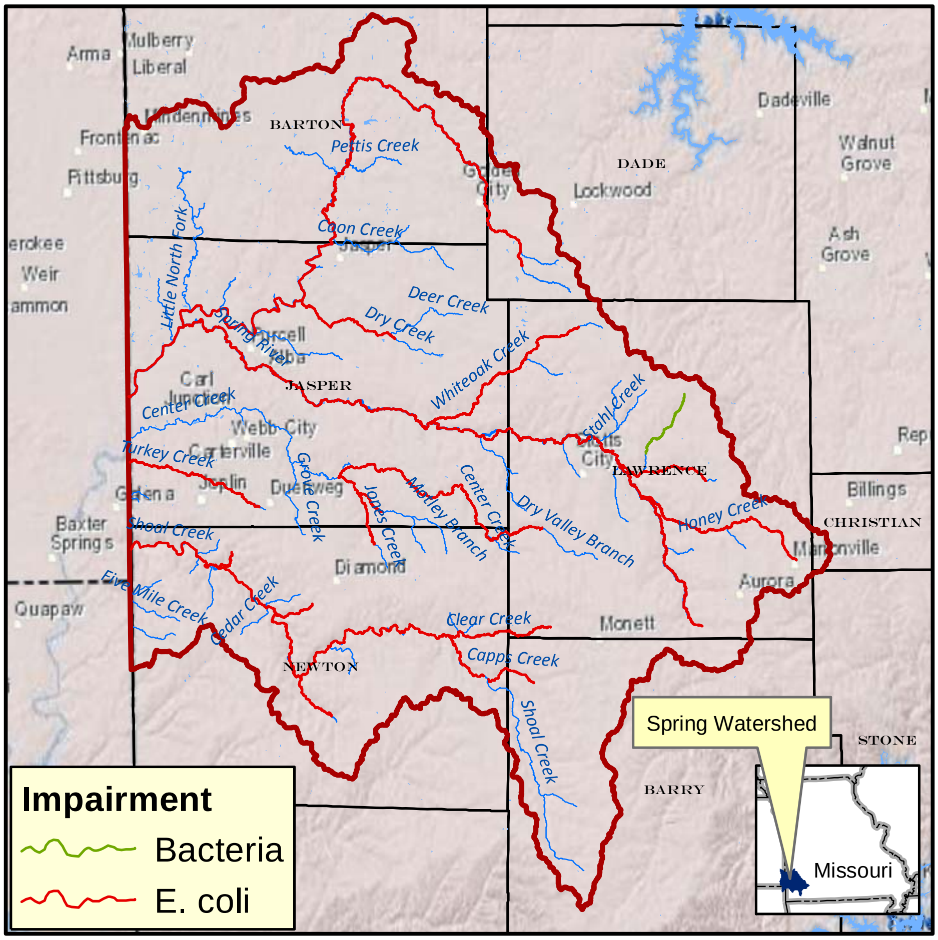


Figure 19. Bacteria Impairments in the Spring River Watershed.

3) Nutrient Impairments in the Watershed

When excess nutrients, primarily nitrogen and phosphorus, occur in a water body, it can create optimum conditions that are favorable for algal blooms and plant growth. Currently Missouri is developing water quality standards for nutrients (e.g. nitrogen or phosphorus). Streams have been assessed against other narrative or numeric criteria and listed impaired for nutrient enrichment. In the Spring River Watershed, phosphorus is identified as the primary pollutant causing nutrient related impairments. Excess nutrients create a proliferation of algae and the subsequent decomposition depletes available dissolved oxygen in the water profile. This lack of oxygen is devastating for aquatic species and can lead to fish kills. Desirable criteria for a healthy water profile includes dissolved oxygen (DO) rates greater than 5 milligrams per liter and biological oxygen demand (BOD) less than 3.5 milligrams per liter. BOD is a measure of the amount of oxygen removed in water from biodegradable organic matter. It can be used to indicate organic pollution levels. The pH of the water is another indicator of excess organic matter. Desirable pH levels are between 6.5 and 8.5. Higher rates can be caused by excess nitrogen and phosphorus.

An excess in nutrients can be caused by any land practice that will contribute nitrogen or phosphorus in surface waters. Examples are (but not limited to):

- Fertilizer runoff from agricultural and urban lands
- Manure runoff from domestic livestock and wildlife in close proximity to streams and rivers
- Failing on-site wastewater treatment systems, and
- Phosphorus recycling from lake or stream sediment

Activities performed on the land affects nutrient loading in the streams and lakes of the watershed. Land use in this watershed is primarily agricultural related; therefore, agricultural BMPs are necessary for reducing nitrogen and phosphorus. Some examples of nitrogen and phosphorus BMPs include:

- Soil sampling and appropriate fertilizer recommendations
- Minimum and continuous no-till farming practices
- Filter and buffer strips installed along waterways
- Reduce contact to streams from domestic livestock, and
- Develop nutrient management plans for manure management

BMPs that have been selected by the Spring River Watershed stakeholders are based on acceptability by the landowners, cost effectiveness and pollutant load reduction effectiveness. The BMPs from cropland that are related to nutrient runoff are:

- Establish cover crops
- Develop nutrient management plans
- Conservation crop rotation
- Grassed waterways
- Terraces
- Vegetative buffers, and
- Water retention structures

The selected BMPs from livestock sources that are related to nutrient runoff are:

- Off-stream watering systems
- Rotational grazing
- Relocate pasture feeding sites
- Grazing management plans
- Relocate feeding pens
- Fence off streams and ponds, and
- Vegetative filter strips

All livestock BMPs aimed at reducing nutrients in this watershed will have an indirect positive effect on bacteria as well.

Urban activities can also have an effect on nutrient runoff. BMPs selected by the stakeholders for urban BMPs related to nutrients are:

- Bioswales

- Stream buffers, and
- Permanent vegetation

Septic systems can be a factor in nutrients in the watershed. BMPs selected by the stakeholders for on-site wastewater treatment systems are:

- Repair
- Replacement

Table 8. Nutrient Impairments in the Spring River Watershed. [23]

Year	Water Body Name**	Pollutant	County Upstream/ Downstream	Impaired Use
2002	Clear Cr	Dissolved Oxygen	Barry/Lawrence	Aquatic Life
2002	Clear Cr	Nutrient/Eutrophication Biological Indicators	Barry/Lawrence	Aquatic Life
2006	North Fk. Spring R.	Ammonia, Total	Dade/Jasper	Aquatic Life
2006	North Fk. Spring R.	Dissolved Oxygen	Dade/Jasper	Aquatic Life
2006	Lamar Lake	Nutrients	Barton	Drinking Water Supply

Table 9. Nutrient Impaired Streams Delisted in the Spring River Watershed.

Year	Water Body Name**	Pollutant	Delisting Reason	Delisting Comment
2014	Dry Fk	Aquatic Macroinvertebrate Bioassessments	Status Unknown	Stream too small to be assessed

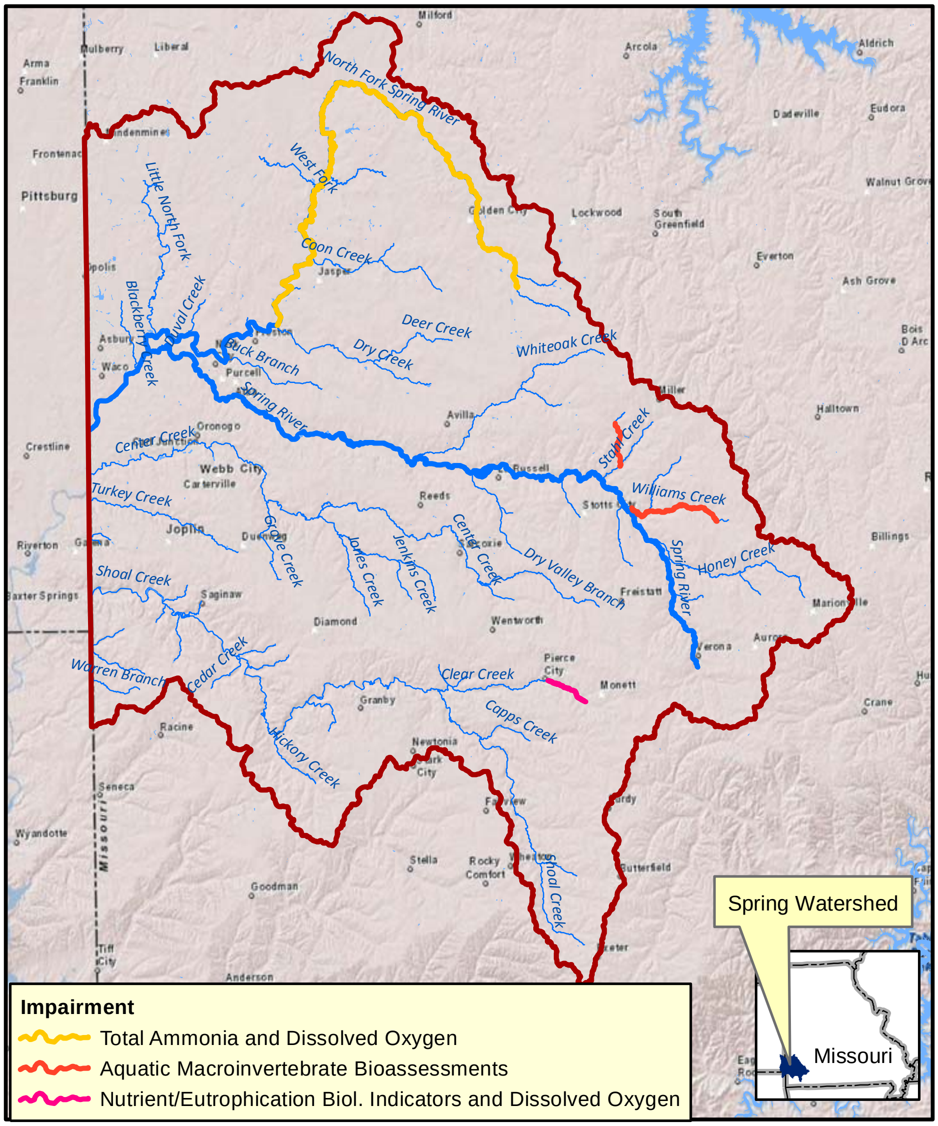


Figure 20. Nutrient Impairments in the Spring River Watershed.

4) Heavy Metal Impairments in the Watershed

The local physiography and geology of the Spring River watershed has provided metal ores that brought notable wealth to the area for more than 100 years. Lead and zinc were the primary minerals harvested and the conclusion of lead and zinc mining occurred in the 1960s. [24] Mining wastes have been identified as sources of metal contamination in surface waters and sediments. TMDLs for sulfate, lead, cadmium and zinc are located primarily in Jasper County along Center Creek and Turkey Creek and in Newton County on Shoal Creek. In addition to lead and zinc mining in the southern portion of the watershed, the northern portion of the watershed has sustained substantial impact from coal mining. The region is scarred by sinkholes, acid mine drainage, and chat piles; all of which create an environment that is filled with contaminated soil, sediment and water. As a result of this contamination many of the streams in the area are classified as impaired for heavy metals. These contaminants are being addressed by the EPA Superfund Program and the US Department of the Interior Natural Resources Damage Assessment and Restoration Program (NRDAR). [25] A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people. The EPA Superfund Program is working to remediate mining waste sites by removing mining wastes from the environment. The NRDAR program will address restoration of habitat and biotic communities impacted by the contamination. Remediation activity by the EPA has been occurring through the Superfund program for more than 20 years.

The Department of the Interior and the MoDNR released the Springfield Plateau Regional Restoration Plan in 2012. This plan outlines the restoration objectives for dealing with the legacy of mining activities in the region. In most of the areas affected by mine waste, the primary concern is zinc. Cadmium and lead are also present in lesser concentrations. Data collected by EPA suggests that contamination from these substances has caused degradation of the aquatic environment resulting in severe impacts to aquatic life. Several streams have been directly impacted, most notably Center Creek and Shoal Creek. Nonpoint source runoff and erosion from upland areas are an issue in some places as well. Current and future efforts to restore the area include the establishment of native prairie on some of the land remediated by the EPA, protecting existing native prairie remnants throughout the watershed, and restoring riparian buffers and wetlands along streams. Continued assessment of injuries to natural resources is ongoing and will be used to design and implement projects to restore the condition of the injured resources. To facilitate local involvement in the projects, developments in the NRDAR program will be considered in future iterations of the community-based watershed planning process for lower Shoal Creek.

Even though heavy metals are a prominent issue in the Spring River Watershed, this Watershed Plan will not address heavy metals directly. However, all installed BMPs for NPS pollution can have a direct, positive impact on heavy metal impairments as well.

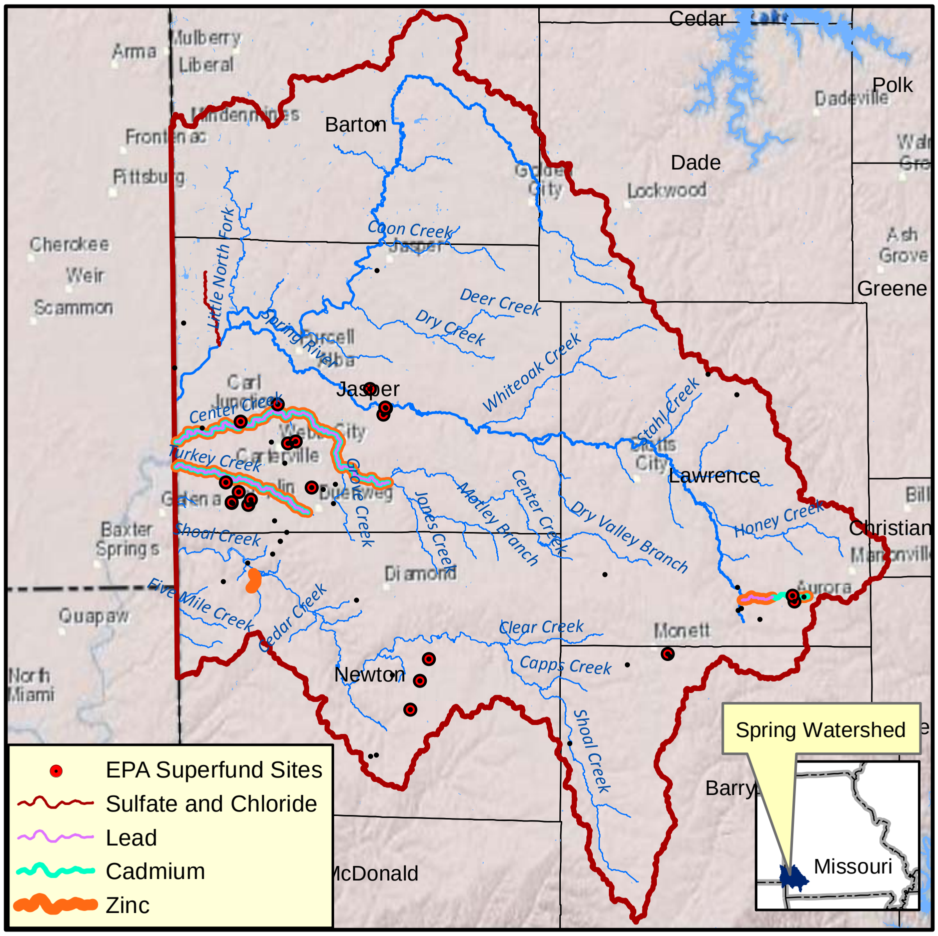


Figure 21. Metal TMDLs and Superfund Sites in the Spring River Watershed.

Table 10. Metal Impairments in the Spring River Watershed. [23]

Year*	Water Body Name**	Pollutant	County Upstream/ Downstream	Impaired Use
2014	Bens Br.	Cd, Pb, Zn	Jasper	General
2006	Blackberry Cr	Cl, TDS	Jasper	Aquatic Life
2006	Center Cr.	Cd, Pb	Jasper	Aquatic Life
2014	Jacobs Br	Zn, Pb, Cd	Newton	Aquatic Life
2014	Shoal Cr Trib	Cd, Zn	Jasper	General
2006	Turkey Cr Trib..	Cd, Pb, Zn	Jasper	General
2006	Turkey Cr.	Cd, Zn, Pb	Jasper	Aquatic Life

Table 11. Metal Impairments Delisted in the Spring River Watershed.

Year*	Water Body Name**	Pollutant	Delisting Reason	Delisting Comment
2014	Turkey Cr	Lead	WQS attained	Reassessed based on geomean vs. arithmetic mean

4. Critical Areas, Targeted Areas, and Load Reduction Methodology

A Critical Areas

In the Spring River Watershed, “Critical Areas” have been identified as areas that need to be protected or restored, such as areas that have TMDLs, emerging pollutant threats, on the 303d list or contain a public water supply. Critical areas are defined by EPA as geographic areas that are critical to implement management practices in order to achieve load reductions. Three areas have been identified as Critical Areas in this watershed:

1. Sub watersheds that have been identified by modeling as a potential source of pollutants,
2. Sub watersheds with TMDLs and those sub watersheds that are listed on the 303(d) list, and
3. Sub watersheds that contain lakes that are public water supplies and/or provide public recreation.

B Targeted Areas

In every watershed, there are specific locations that contribute a greater pollutant load due to soil type, proximity to a stream and land use practices. By focusing BMPs in these areas; pollutants can be reduced at a more efficient rate. Identifying smaller fields as specific target points within the greater targeted areas is not realistic. Landowner cooperation is essential in this process and “pinpointing” specific problematic fields and pastures would alienate farmers and ranchers, leading to a lack of collaboration. Through research at the University of Wisconsin, it has been shown that there is a “bigger bang for the buck” with streamlining BMP placement in contrast to a “shotgun” approach of applying BMPs in a random nature throughout the watershed. [26] These areas are referred to as Targeted Areas.

Targeted Areas are those specific areas in the Critical Areas that require BMP placement in order to meet load reductions. The Targeted Areas that have been identified in this watershed are:

1. Cropland areas targeted for sediment and nutrient runoff,
2. Livestock areas targeted for nutrients and *E. coli* bacteria runoff, and
3. Impaired areas targeted for bacteria runoff.

There is significant overlap in these targeted areas which is to the benefit of water quality in that applying BMPs for one pollutant will also positively affect other pollutants. Detailed discussion of each Targeted Area follows in the next sections of this report.

C Methodology for Determining Targeted Areas

The Soil and Water Assessment Tool (SWAT) was used as an assessment tool by Kansas State University Department of Biological and Agricultural Engineering to estimate annual average pollutant loadings such as nutrients and sediment coming from the land into the stream. At the end of simulation runs the average annual loads are calculated for each sub watershed. Some areas have higher average annual loads than the others. Based on experience and technical knowledge, the areas or sub watershed with the top 20 to 30 percent of the highest loads among all areas within the watershed are selected as targeted areas for cropland and livestock BMPs implementation.

The SWAT model was developed by United States Department of Agriculture-Agricultural Research Service (USDA-ARS) from numerous equations and relationships that have evolved from years of runoff and erosion research in combination with other models used to estimate pollutant loads from animal feedlots, fertilizer and agrochemical applications, etc. The SWAT model has been tested for a wide range of regions, conditions, practices, and time scales. Evaluation of monthly and annual streamflow and pollutant outputs indicate SWAT functioned well in a wide range of watersheds. The model directly accounts for many types of common agricultural conservation practices, including terraces and small ponds; management practices, including fertilizer applications; and common landscape features, including grass waterways. The model incorporates various grazing management practices by specifying amount of manure applied to the pasture or grassland, grazing periods, and amount of biomass consumed or trampled daily by the livestock. Septic systems, NPDES discharges, and other point-sources are considered as combined point-sources and applied to inlets of sub watersheds. These features made SWAT a good tool for assessing rural watersheds in Missouri.

The SWAT model is a physically based, deterministic, continuous, watershed-scale simulation model developed by the USDA-ARS. ArcGIS interface of ArcSWAT version 9.2 was used. It uses spatially distributed data on topography, soils, land cover, land management, and weather to predict water, sediment, nutrient, and pesticide yields. A modeled watershed is divided spatially into sub watersheds using digital elevation data according to the drainage area specified by the user. Sub watersheds are modeled as having non-uniform slope, uniform climatic conditions determined from the nearest weather station, and they are further subdivided into lumped, non-spatial hydrologic response units (HRUs) consisting of all areas within the sub watershed having similar soil, land use, and slope characteristics. The use of HRUs allows slope, soil, and land-use heterogeneity to be simulated within each sub watershed, but ignores pollutant attenuation between the source area and stream and limits spatial representation of wetlands, buffers, and other BMPs within a sub watershed.

The model includes subbasin, reservoir, and channel routing components.

1. The subbasin component simulates runoff and erosion processes, soil and water movement, evapotranspiration, crop growth and yield, soil nutrient and carbon cycling, and pesticide and bacteria degradation and transport. It allows simulation of a wide array of agricultural structures and practices, including tillage, fertilizer and manure application, subsurface drainage, irrigation, ponds and wetlands, and edge-of-field buffers. Sediment yield is estimated for each subbasin with the Modified Universal Soil Loss Equation (MUSLE). The hydrology model supplies estimates of runoff volume and peak runoff rates. The crop management factor is evaluated as a function of above ground biomass, residue on the surface, and the minimum C factor for the crop that is the crop provided in the database.
2. The reservoir component detains water, sediments, and pollutants, and degrades nutrients, pesticides and bacteria during detention. This component was not used during the simulations.
3. The channel component routes flows, settles and entrains sediment, and degrades nutrients, pesticides and bacteria during transport. SWAT produces daily results for every sub watershed outlet, each of which can be summed to provide daily, monthly, and annual load estimates. The sediment deposition component is based on fall velocity, and the sediment degradation component is based on Bagnold's stream power concepts. Bed degradation is adjusted by the USLE soil erodibility and cover factors of the channel and the floodplain. This component was utilized in the simulations but not used in determining the critical areas.

Data for the Spring River Watershed SWAT model were collected from a variety of reliable online and printed data sources and knowledgeable agency personnel within the watershed. Input data and their online sources are:

1. 30 meters DEM (USGS National Elevation Dataset)
2. 30m NLCD 2001 Land Cover data layer (USDA-NRCS)
3. STATSGO soil dataset (USDA-NRCS)
4. NCDC NOAA daily weather data (NOAA National Climatic Data Center)
5. Point sources
6. Septic tanks (US Census)
7. Crop rotations (local knowledge)
8. Grazing management practices (local knowledge)

The Spring River Watershed (in both Kansas and Missouri) was delineated into 61 sub watersheds and 351 catchments using the spatial analyst toolbox in ArcGIS. The area of the watershed that is located in Missouri contains 54 sub watersheds that represent HUC-12 watersheds and 281 catchments. During the delineation process, a river network was created, and each sub watershed contained a single stream segment. Sub watersheds size and stream length varied throughout the watershed. This approach is standard for delineation of the SWAT modeling. Water from all fields within each sub watershed drains into a stream and then routes along the stream network to watershed outlet.

The SWAT model uses a concept of Hydrologic Response Units (HRU), areas of homogeneous soil type, land use, and slope. HRUs can be spatially connected or disconnected within a sub watershed. Within each HRU, hydrologic and water-quality balances are calculated independently, and output variables, such as, surface runoff depth, subsurface flow, nutrient loads, etc., are calculated daily. These output daily variables from all HRUs are combined within a sub watershed and applied to the inlet of the corresponding segment of river flow for further routing. For calculation of annual average characteristics in each HRU or sub watershed, daily values are summed over the entire simulation period and yearly means are calculated.

In addition to sub watersheds, each sub watershed was also divided into catchments of the size of 100 acres to 2,000 acres using the described above delineation procedure. Catchment size was highly affected by topographic features with high slope areas having smaller size catchments, and flat areas resulting with larger catchment areas. The smallest number of catchments in a sub watershed was two, and the highest was 16. All HRUs within each catchment were collected, and daily HRU outputs were combined using an area-weighted averaging approach. As a result of this approach, annual average loads of all pollutants coming off the fields were calculated for each catchment, sorted, and ordered. Catchments with the highest values were selected for targeted BMP implementation.

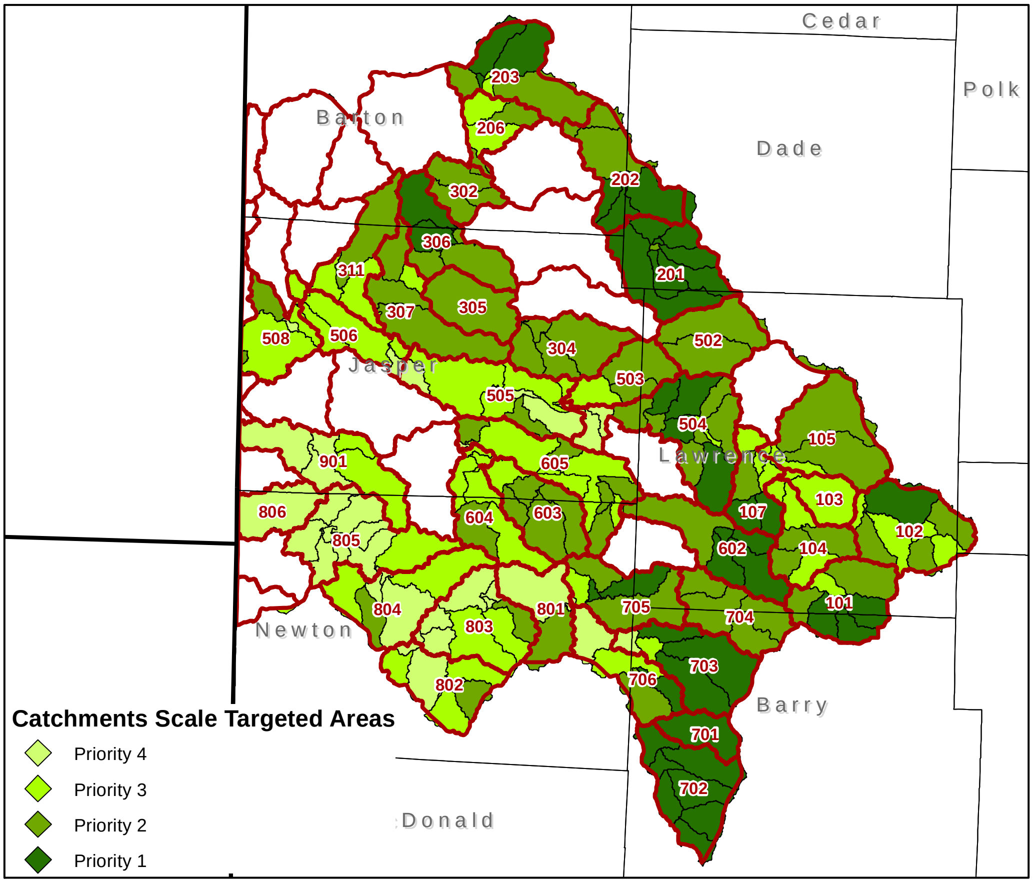


Figure 22. Spring River Watershed Catchment Scale Targeted Areas

Catchment scale areas were prioritized into four groups for pollutant potential. Priority 1 catchment targeted areas, as seen in Figure 22, are the areas which have the potential to generate a higher amount of pollutants. Therefore, these areas are in greater need of BMP implementation in order to protect and restore the waters in the catchment and downstream. Priority catchment targeted areas 2 through 4 have decreasing potential for pollutant generation. They are shown in the increasing lighter colors in Figure 22.

All sediment, phosphorus and nitrogen SWAT generated maps for each sub watershed in the Spring River Watershed are provided in the Appendix.

D Prioritization of Impaired Sub Watersheds for Plan Implementation

After the catchments were prioritized, the impaired sub watersheds were then additionally categorized as High, Moderate or Low Priority for **implementation**. These priorities will be important when deciding quantity and location of implementing BMPs in the watershed since available financial funding is most always a limiting factor. High Priority sub watersheds will be addressed first, then the Moderate Priority sub watersheds, and lastly the Low Priority sub watersheds.

The High Priority sub watersheds were determined by the locations of existing or planned TMDLs in the Spring River Watershed. The High priority sub watersheds are listed below.

Table 12. High Priority Sub Watersheds for Plan Implementation in the Spring River Watershed.

Impaired Water Body	HUC 12	NPS Impairments	Reason for Priority Ranking	Plan Implementation Priority
North Fork Spring River (includes 311 Slater Branch)	201	Dissolved Oxygen Bacteria Sediment (TSS)	Existing or planned TMDLs and/or public water supplies	High
	202			
	203			
	206			
	302			
	306			
	307			
	311			
	506			
Lamar Lake	206	Nutrients		
Dry Fork	304	Bacteria		
	305			
	306			
Spring River (includes 105 Truitt and Williams Creeks)	101	Bacteria		
	104			
	105			
	107			
	503			
	504			
	505			
	506			
	508			
Center Creek	602	Bacteria		
	605			
Turkey Creek	901	Bacteria		
Shoal, Pogue, and Joyce Creeks	701	Bacteria		
	702			
	706			
	801			
	803			
	804			
	805			
	806			
Clear Creek	704	Bacteria		
	705			
	706			

Impaired Water Body	HUC 12	NPS Impairments	Reason for Priority Ranking	Plan Implementation Priority
White Oak Creek	502	Bacteria		
	503			
Honey Creek	102	Bacteria		
	103			
	104			

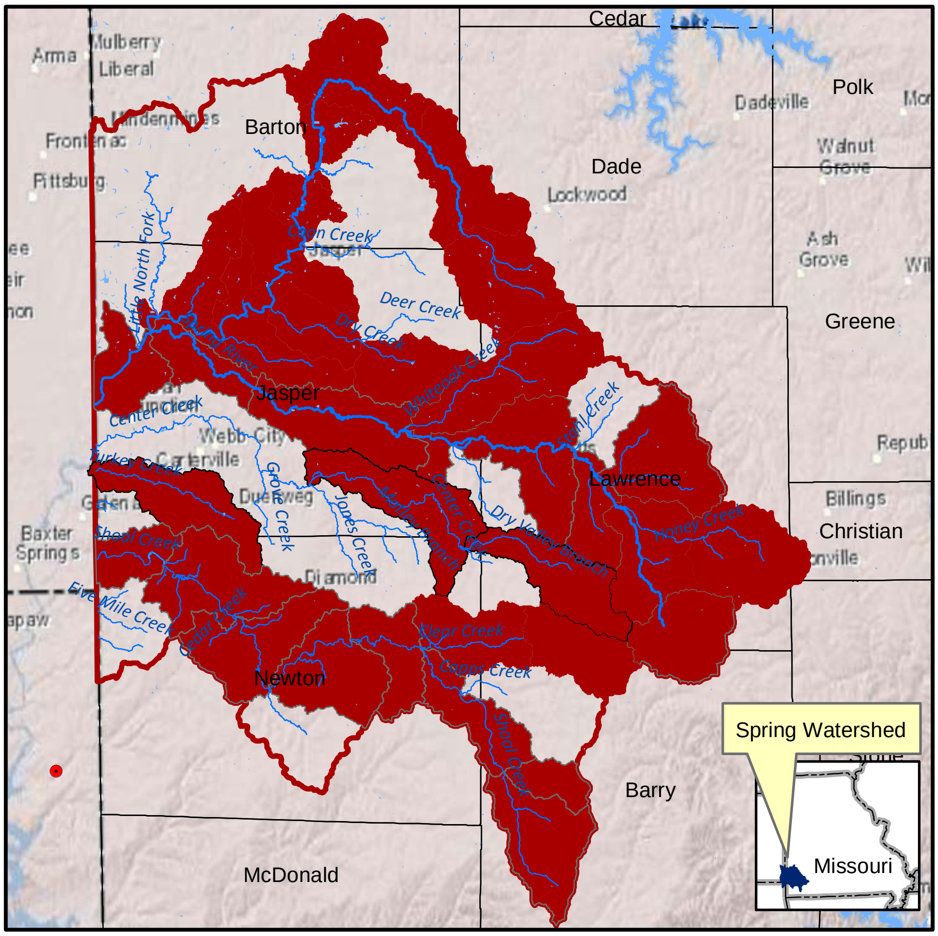


Figure 23. High Priority Sub Watersheds in the Spring River Watershed.

After the High Priority sub watersheds were removed, the required reduction needed from the actual bacteria count to attain the standard bacteria count in the Whole Body Contact designation of designated uses was used to evaluate the rest of the sub watersheds. There was a natural break in the list of sub watersheds separating the Moderate and Low Priority rankings. The Moderate and Low priority sub watersheds are listed below.

Table 13. Moderate Priority Sub Watersheds for Plan Implementation in the Spring River Watershed.

Impaired Water Body	HUC 12	NPS Impairments	WBC Designation	Actual (counts per ml)	Standard (counts per ml)	Required Reduction	Plan Implemen-tation Priority
Jones Creek	604	Bacteria (no TMDLs)	A	229	126	45%	Moderate
	605						
Baynham Branch	804		B	439	206	53%	
Capps Creek	703		A	324	126	61%	
	706						

WBC = Whole Body contact designated use (A or B)
Actual = Geometric mean of water quality samples
Standard = Water quality standard for WBC designated use (A=126 or B=206)
Required Reduction = Percentage difference between actual and standard.

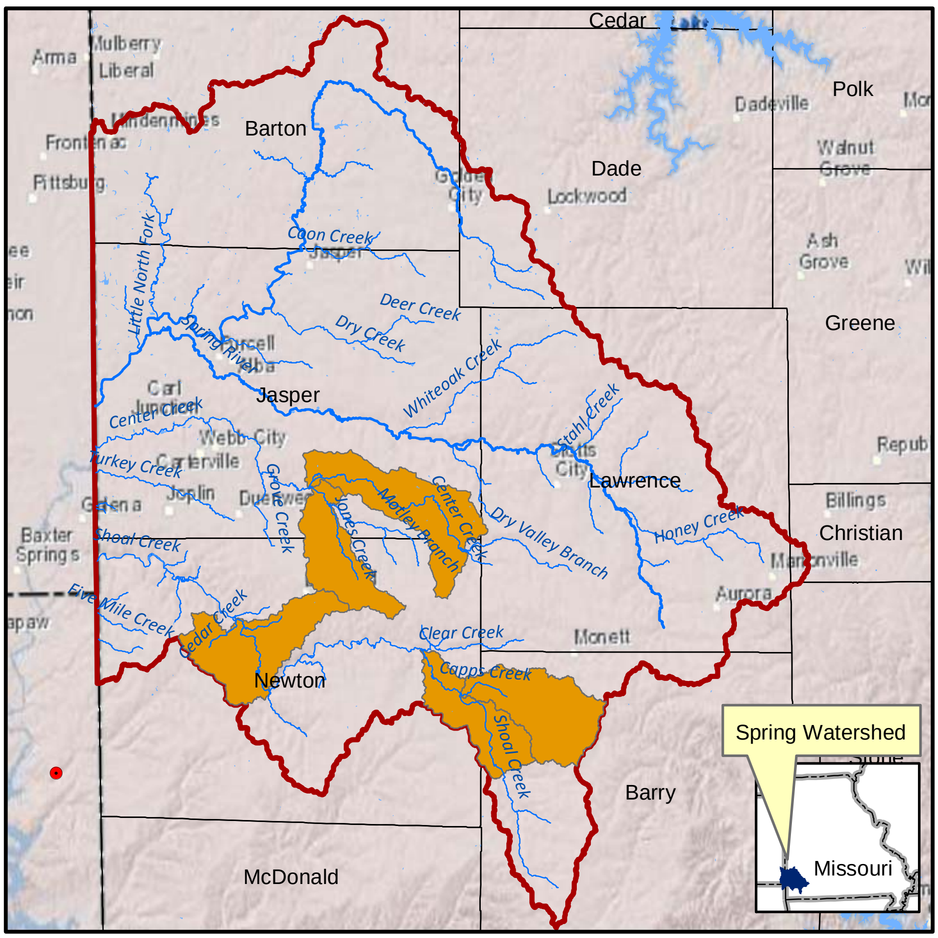


Figure 24. Targeted Moderate Priority Sub Watersheds in the Spring River Watershed.

Table 14. Low Priority Sub Watersheds for Plan Implementation in the Spring River Watershed.

Impaired Water Body	HUC 12	NPS Impairments	WBC Designation	Actual (counts per ml)	Standard (counts per ml)	Required Reduction	Plan Implementation Priority
Hickory Creek	802	Bacteria (no TMDLs)	A	136	126	7%	Low
	803						
Jenkins Creek	603		A	127	126	1%	
	604						
Thurman Creek	805		B	259	206	20%	

WBC = Whole Body contact designated use (A or B)
Actual = Geometric mean of water quality samples
Standard = Water quality standard for WBC designated use (A=126 or B=206)
Required Reduction = Percentage difference between actual and standard.

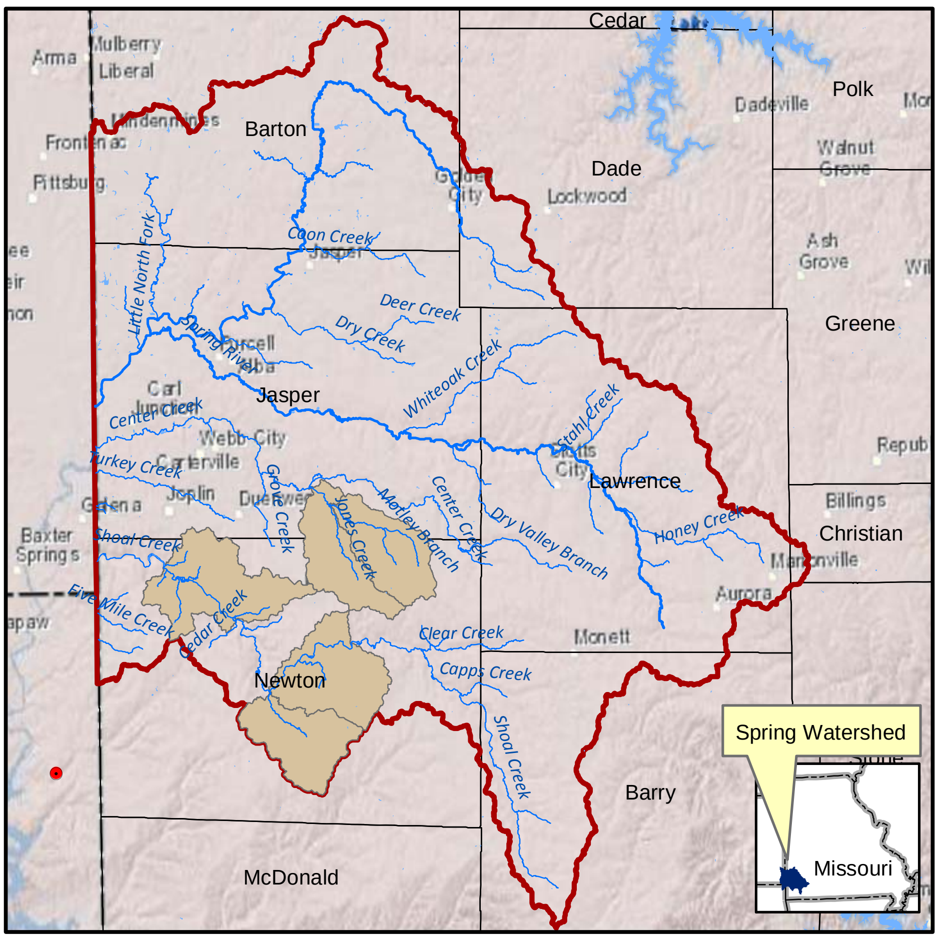


Figure 25. Targeted Low Priority Water Bodies in the Spring River Watershed

5. Best Management Practices

In this report, the term BMP (Best Management Practice) will be used frequently. A BMP is defined as an environmental protection practice used to control pollutants, such as sediment or nutrients, from common agricultural or urban land use activities. Common agricultural BMPs are buffer strips, terraces, grassed waterways, utilizing no-till or minimum tillage, conservation crop rotation and nutrient management plans. Common livestock BMPs are alternative watering supply, relocation of feeding sites, developing a nutrient management plan and vegetative buffers. Common urban BMPs are bioswales, permanent vegetation, vegetative buffers, stream buffers and rain gardens. Common BMPs for on-site wastewater treatment systems include restoration, replacement and pump out.

Many BMPs that are installed to address a certain pollutant will have an indirect positive effect on other pollutants. And many areas that are targeted for one pollutant will also be targeted for a second pollutant as shown in the table below.

Table 15. Overlapping Targeted Areas for Sediment, Nutrients, Bacteria and Impairments. The X indicates an impairment in the watershed.

Targeted Areas	Sediment	Nutrients	Bacteria	Existing or Planned TMDLs
High Priority Waterbodies				
North Fork Spring River	X	X	X	X
Lamar Lake		X		X
Dry Fork			X	X
Spring River			X	X
Center Creek			X	X
Turkey Creek			X	X
Shoal, Pogue, and Joyce Creeks			X	X
Clear Creek			X	X
White Oak Creek			X	X
Honey Creek			X	X
Moderate Priority Waterbodies				
Jones Creek			X	
Baynham Branch			X	
Capps Creek			X	
Low Priority Waterbodies				
Hickory Creek			X	
Jenkins Creek			X	
Thurman Creek			X	

The targeted areas for BMP implementation were selected by analyzing bacteria impairments. A presentation of common BMPs to reduce sediment, phosphorus and bacteria runoff was given to the watershed stakeholders. Producers and landowners within these areas as well as local agency personnel familiar with these areas then discussed which BMPs were needed in the area. The top cropland, livestock, streambank, urban and on-site wastewater treatment system BMPs were selected by need, cost-effectiveness, and producer acceptability. Adoption rate goals were set for the next 20 years based on their overall need and what can be feasibly adopted.

A Agricultural BMPs

The stakeholders have chosen eight agricultural BMPs to utilize to address pollutant issues in the watershed. They were chosen by the watershed stakeholders to be the most cost effective and have adaptive acceptance by landowners in the watershed. Agricultural BMPs can be divided into cropland BMPs and livestock BMPs. Cropland BMPs are aimed at preventing sediment and nutrients (primarily fertilizer and applied manure) from leaving the field in runoff. Livestock BMPs are directed at reducing the time that livestock are allowed access to streams and lakes. Maintenance of BMPs is required.

The agricultural BMPs that have been selected by the stakeholders are as follows:

1) Cropland BMPs [27]

- **No-Till**: No-till is a management system in which chemicals may be used for weed control and seedbed preparation. The soil surface is never disturbed except for planting or drilling operations in a 100 percent no-till system. It is assumed to have a 75 percent erosion reduction efficiency, and a 40 percent Phosphorus reduction efficiency.
- **Cover Crops**: Cover crops are areas of grass, small grain, legumes or combination of these that are planted for nutrient management and surface erosion reduction. Cover and green manure crops are grown on cropland and are often grown after the primary production crop is harvested. Generally the cover crop is plowed under or chemically desiccated to accommodate the primary crop production on the site. It is assumed to have a 10 percent erosion reduction and a 15 percent phosphorus reduction efficiency.
- **Nutrient Management**: Nutrient management is managing the amount, source, placement, form and timing of the application of nutrients and soil amendments. It involves utilizing intensive soil testing. It is assumed to have a 25 percent erosion reduction and 25 percent phosphorus reduction efficiency.
- **Conservation Crop Rotation**: Conservation crop rotation is growing various crops on the same piece of land in a planned rotation. High residue crops (corn) with low residue crops (wheat, soybeans) are common rotations. This prevents low residue crops grown in succession from encouraging erosion. It is assumed a 25 percent erosion reduction efficiency and a 25 percent Phosphorus reduction efficiency
- **Grassed Waterways**: A grassed waterway is a grassed strip which is used as an outlet to prevent silt and gully formation. It can also be used as outlets for water from terraces. On average, one acre of waterway will treat ten acres of cropland. It is assumed that there will be a 40 percent erosion reduction efficiency and a 40 percent Phosphorus reduction efficiency.
- **Terraces**: Terraces are an earth embankment and/or channel constructed across the slope of the field to intercept runoff water and trap soil. It is one of the oldest and most common

BMPs. It is assumed to have a 30 percent erosion reduction efficiency and a 30 percent Phosphorus reduction efficiency

- **Vegetative Buffers**: Vegetative buffers are an area of crop fields maintained in permanent vegetation to help reduce nutrient and sediment loss from agricultural fields, improve runoff water quality, and provide habitat for wildlife. On average, one acre buffer treats 15 acres of cropland. It is assumed to have a 50 percent erosion reduction efficiency and a 50 percent Phosphorus reduction efficiency
- **Water Retention Structure**: A water retention structure may include a sediment basin that is a water impoundment made by constructing an earthen dam. It may include grade stabilization structures that control runoff and prevent gully erosion. It traps sediment and nutrients from leaving edge of field and provides a source of water. It is assumed to have a 50 percent soil erosion, nitrogen, and phosphorus reduction efficiency.

2) Livestock BMPs

- **Off Stream Watering Systems**:   An off stream watering system is a watering system that is away from the stream or pond. This restricts livestock from entering the stream or body of water. Studies have shown that cattle will drink from tank over a stream or pond 80 percent of the time. In a 10 to25 year lifespan of the system, average phosphorus reduction is 30 to 98 percent with greater efficiencies for limited stream access.
- **Rotational Grazing**:   Rotational grazing is rotating livestock within a pasture to spread manure more uniformly and allow grass to regenerate. It may involve significant cross fencing and additional watering sites. It is assumed to have a 25 to 75 percent phosphorus reduction.
- **Relocate Pasture Feeding Sites**:   Relocating a pasture feeding site is to move the feeding site in a pasture away from a stream, waterway, or body of water to increase the filtration and waste removal (e.g. move bale feeders away from stream). It is assumed to have a average phosphorus reduction of 25 to 80 percent.
- **Grazing Management Plans**:   Grazing management plans are designed to avoid over grazing of pastures and improved grazing distribution. It is assumed to have an average phosphorus reduction of 20 to 30 percent.
- **Relocate Feeding Pens**: Relocation of feeding pens involves moving feedlots or feeding pens away from a stream, waterway, or body of water to increase filtration and waste removal of manure. It is assumed to have an average phosphorus reduction of 30 to 80 percent.
- **Fence off Streams and Ponds**:   Fencing off streams and ponds is designed to prevent livestock from entering the water body. Therefore, they cannot directly deposit manure in the waterway. It commonly has a 25 year life expectancy. It is assumed to have a 95 to 100 percent phosphorus reduction.
- **Vegetative Filter Strip**: A vegetative filter strip is a vegetated area that receives runoff during rainfall from an animal feeding operation. It often requires a land area equal to or greater than the drainage area (needs to be as large as the feedlot). Over a 10 year lifespan, the filter strip will require periodic mowing or haying. It is assumed to have an average phosphorus reduction of 50 percent.

B Streambank BMPs

Streambank erosion and failure will be addressed by implementing stabilization projects. Streambank stabilization involves using vegetative or structural methods to stop or reduce the erosion and degradation of stream banks, particularly on outer banks of stream curves. Methods may include bank reshaping; armoring streambanks with rock, fiber material, or vegetation; installing rock or concrete protection at the toe of the bank; construction of rock vanes and weirs within the channel to direct the flow away from the bank; or by using structures to slow the flow of the water on the outer edges of the channel. Stabilizing the streambank benefits the adjacent land by stopping erosion that has been undercut by the stream. At the time of this publication, there is no assessment of streambank conditions, but streambank failure and erosion is well known to be a source of sediment. Assessments will be conducted as part of the implementation plan for the Spring River Watershed.

C Septic System BMPs

Failing on-site wastewater treatment systems can leak bacteria or phosphorus into surface and ground water. Other issues with a malfunctioning on-site wastewater treatment system are noxious odors, perennial wet spots and marshy areas. Although failing septic systems are an issue in all watersheds, the load reductions obtained by replacement of a failing system are not as efficient as other BMPs. Therefore, this plan does not address large numbers of failing septic systems. Any failing systems that are replaced in addition to the number of systems targeted in this plan will contribute to the overall load reduction needed. At the time of this publication, there is no assessment of failing septic systems. Clustered systems or those that are located geographically close to a water body will be important to address in the implementation of BMPs.

The on-site wastewater treatment system BMPs that are chosen for this watershed are as follows:

- **Replace:** A total replacement of an on-site wastewater treatment system
- **Repair:** Repair of an existing but malfunctioning on-site wastewater treatment tank, failing drainage fields or waste lagoon systems

D Urban BMPs

Urban sprawl can negatively influence physical habitats supporting aquatic life. The eventual channelization of most urban streams results in aquatic habitats incapable of supporting the full range of fish and wildlife indigenous to this region. Stormwater runoff from impervious surfaces such as paved areas and rooftops can lead to powerful flooding events, scouring stream bottoms and effectively eliminating the habitat required by some native aquatic species. In addition, with increased growth occurring throughout the watershed, the demand for drinking water continues to increase. Water quality and quantity are important issues for the residents and community leaders. Urban BMP implementation is a developing issue. Many times it involves retrofitting old waterways and can be very site specific and expensive. No cities in the watershed identified any specific site or practice for this plan. However, larger cities have stormwater plans in place in order to deal with water runoff issues.

In many instances, negative effects of urban development on the state's streams, lakes, and wetlands could be reduced through careful planning and adherence to recognized BMPs and established surface water quality standards.

The urban BMPs that are chosen for this watershed are as follows:

- **Bioswale:** A bioswale or vegetated swale is a form of bioretention filled with deep rooted native plants that will slow and filter stormwater. Common locations are parking lots, roadsides, and highway medians. It is assumed to have a 50 percent erosion reduction efficiency and a 50 percent Phosphorus reduction efficiency
- **Stream Buffers:** Vegetative buffers are an area maintained in permanent vegetation to help reduce nutrient and sediment loss from urban areas and improve runoff water quality. It is assumed to have a 50 percent erosion reduction efficiency and a 50 percent Phosphorus reduction efficiency
- **Permanent Vegetation:** Establishing permanent vegetation in areas that are at risk of erosion and runoff. It is assumed to have a 95 percent erosion reduction efficiency and a 95 percent Phosphorus reduction efficiency

6. Action Plan for the Spring River Watershed

The watershed stakeholders have selected specific BMPs that they have determined will be acceptable to agricultural producers, landowners, city and town officials, and urban residents in the watershed. Numerous BMPs were presented to the stakeholders in meetings throughout the watershed. The stakeholders voted on which BMPs they thought would be acceptable to producers and landowners – this system determined the BMPs that were selected for cropland and livestock. Specific acreages or projects that need to be implemented to meet pollutant load reductions have been determined through economic analysis, surveys of local agency staff, and approved by the stakeholders. Number of acres or projects were determined the agriculture economist in order to meet the TMDL or the goal of impairment reduction.

SWAT modeling confirmed the quantity of acres that are in need of treatment for each agricultural BMP. Acres treated are calculated by multiplying the adoption rate by the cropland acreage. [27] Cropland BMPs can be applied on the same land. For instance, grassed buffers, no-till and cover crops could all be applied on the same acreage and each category would receive credit for that BMP. Treated acres are considered to be the amount of acreage controlled or "treated" by the BMP. They are not the actual size of the BMP. Livestock projects are determined by the needed phosphorus reduction to meet the bacteria reduction goal. Nitrogen reductions are calculated as a constant ratio with phosphorus reductions. The duration of this plan is 20 years as determined by the time required to meet the phosphorus reduction goal that is being used as a tracking surrogate for bacteria reduction. The sediment reduction goal for North Fork Spring River will be met in 11 years. Below are the tables with acreages, load reductions and implementation rates for installed BMPs in the entire Spring River Watershed. Evaluation of the progress in water quality will be discussed in a later chapter of this watershed plan.

Individual action plans for each sub watershed are provided in later chapters of this watershed plan.

Table 16. BMPs and Acres or Projects Needed to Reduce Nutrient and Sediment Contribution in the Spring River Watershed for the Life of the Watershed Plan (20 Years). Table is an aggregate of all BMPs. Individual sub watershed tables are included further in this plan.

Protection Measures	Best Management Practices and Other Actions	Treated Acres Needed to be Implemented
Prevention of nutrient and sediment contribution from cropland	1. No-Till	16,973 acres
	2. Cover Crops	16,973 acres
	3. Nutrient Management	16,919 acres
	4. Conservation Crop Rotation	16,919 acres
	5. Grassed Waterways	16,919 acres
	6. Terraces	16,919 acres
	7. Vegetative Buffers	16,919 acres
	8. Water Retention Structure	16,919 acres
Protection Measures	**Best Management Practices and Other Actions**	**Projects Needed to be Implemented**
Prevention of phosphorus contribution from livestock	1. Off Stream Watering Systems	197 in 20 years
	2. Rotational Grazing	200 in 20 years
	3. Relocate Pasture Feeding Sites	78 in 20 years
	4. Grazing Management Plans	98 in 20 years
	5. Relocate Feeding Pens	27 in 20 years
	6. Fence off Streams and Ponds	43 in 20 years
	7. Vegetative Filter Strip	38 in 20 years
Protection Measures	**Best Management Practices and Other Actions**	**Projects Needed to be Implemented**
Prevention of nutrient and sediment contribution from streambank degradation	Streambank Stabilization	1.136 miles in 20 years
Protection Measures	**Best Management Practices and Other Actions**	**Projects Needed to be Implemented**
Prevention of nutrient contribution from failing on-site wastewater treatment **systems**	Repair or Replace Failing Septic Systems	57 systems in 20 years

Protection Measures	Best Management Practices and Other Actions	Projects Needed to be Implemented
Prevention of sediment and nutrient contribution from urban areas	1. Bioswale	48 projects in 20 years
	2. Stream Buffer	48 projects in 20 years
	3. Permanent Vegetation	48 projects in 20 years

The required phosphorus reduction in the watershed over 20 years is 230,758 pounds. Implementing these BMPs will have an estimated phosphorus load reduction over the life of the plan (20 years) of 239,432 pounds. This will result in 104 percent of the required phosphorus reduction.

The required sediment load reduction to achieve the TMDL in the North Fork Spring River sub watershed is 2,737 tons. Implementing these BMPs will have an estimated sediment load reduction in 11 years of 2,977 tons. Over the life of the plan, the sediment load reduction will be 5,413 tons or 198 percent of the required reduction.

A BMP Adoption Rates in the Spring River Watershed

Table 17. Cropland BMP Adoption Rates for the Spring River Watershed.

Total Annual Adoption (treated acres), Cropland BMPs									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	846	846	846	846	846	846	846	846	6,768
2	846	846	846	846	846	846	846	846	6,768
3	846	846	846	846	846	846	846	846	6,768
4	846	846	846	846	846	846	846	846	6,768
5	846	846	846	846	846	846	846	846	6,768
6	846	846	846	846	846	846	846	846	6,768
7	846	846	846	846	846	846	846	846	6,768

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
8	846	846	846	846	846	846	846	846	6,768
9	846	846	846	846	846	846	846	846	6,768
10	846	846	846	846	846	846	846	846	6,768
11	846	846	846	846	846	846	846	846	6,768
12	846	846	846	846	846	846	846	846	6,768
13	846	846	846	846	846	846	846	846	6,768
14	846	846	846	846	846	846	846	846	6,768
15	846	846	846	846	846	846	846	846	6,768
16	846	846	846	846	846	846	846	846	6,768
17	846	846	846	846	846	846	846	846	6,768
18	846	846	846	846	846	846	846	846	6,768
19	846	846	846	846	846	846	846	846	6,768
20	846	846	846	846	846	846	846	846	6,768

Table 18. Livestock BMP Adoption Rates for the Spring River Watershed.

Spring River Livestock BMP Adoption by Water Body								
Water Body	Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Adoption (over 20 years)
Total	197	200	78	99	29	45	40	688

Table 19. Streambank BMP Adoption Rates for the Spring River Watershed.

Year	Streambank Stabilization (feet)
1	300
2	300
3	300
4	300
5	300
6	300
7	300
8	300
9	300
10	300
11	300
12	300
13	300

Year	Streambank Stabilization (feet)
14	300
15	300
16	300
17	300
18	300
19	300
20	300
Total	**6,000**

Table 20. Septic System BMP Adoption Rates for the Spring River Watershed.

Year	Failing Systems Addressed
1	3
2	3
3	3
4	3
5	3
6	3
7	3
8	3
9	3
10	3
11	3
12	3
13	3
14	3
15	3
16	3
17	3
18	2
19	2
20	2

Table 21. Urban BMP Adoption Rates in the Spring River Watershed.

Spring River Watershed Total Urban BMP Adoption				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Total Adoption**
1	9	0	0	9
2	0	9	2	11
3	2	0	7	9
4	0	2	2	4

Year	Bioswale	Stream Buffers	Permanent Vegetation	Total Adoption
5	2	0	0	2
6	7	2	2	11
7	2	7	0	9
8	0	2	9	11
9	2	0	0	2
10	0	2	2	4
11	9	0	0	9
12	0	2	2	4
13	2	7	0	9
14	0	2	9	11
15	2	0	0	2
16	7	2	2	11
17	2	7	0	9
18	0	2	9	11
19	2	0	0	2
20	0	2	2	4

B Sediment Load Reductions for Implemented BMPs in the Spring River Watershed

Table 22. Cropland Sediment Load Reduction in the Spring River Watershed.

Total Annual Soil Erosion Reduction, Cropland BMPs (tons)									
Year	No-Till	Cover Crops	Nutrient Management Plan	Conservation Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	497	66	166	166	265	199	331	331	2,020
2	994	132	331	331	530	397	662	662	4,040
3	1,490	199	497	497	795	596	994	994	6,061
4	1,987	265	662	662	1,060	795	1,325	1,325	8,081
5	2,484	331	828	828	1,325	994	1,656	1,656	10,101
6	2,981	397	994	994	1,590	1,192	1,987	1,987	12,121
7	3,477	464	1,159	1,159	1,855	1,391	2,318	2,318	14,141
8	3,974	530	1,325	1,325	2,120	1,590	2,649	2,649	16,162
9	4,471	596	1,490	1,490	2,384	1,788	2,981	2,981	18,182
10	4,968	662	1,656	1,656	2,649	1,987	3,312	3,312	20,202
11	5,464	729	1,821	1,821	2,914	2,186	3,643	3,643	22,222
12	5,961	795	1,987	1,987	3,179	2,384	3,974	3,974	24,242
13	6,458	861	2,153	2,153	3,444	2,583	4,305	4,305	26,263

Year	No-Till	Cover Crops	Nutrient Management Plan	Conservation Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
14	6,955	927	2,318	2,318	3,709	2,782	4,637	4,637	28,283
15	7,452	994	2,484	2,484	3,974	2,981	4,968	4,968	30,303
16	7,948	1,060	2,649	2,649	4,239	3,179	5,299	5,299	32,323
17	8,445	1,126	2,815	2,815	4,504	3,378	5,630	5,630	34,343
18	8,942	1,192	2,981	2,981	4,769	3,577	5,961	5,961	36,364
19	9,439	1,258	3,146	3,146	5,034	3,775	6,292	6,292	38,384
20	9,935	1,325	3,312	3,312	5,299	3,974	6,624	6,624	40,404

Table 23. Streambank Sediment Load Reduction in the Spring River Watershed.

Year	Streambank Stabilization (feet)	Soil Load Reduction (tons)	Cumulative Erosion Reduction (tons)
1	300	600	600
2	300	600	1,200
3	300	600	1,800
4	300	600	2,400
5	300	600	3,000
6	300	600	3,600
7	300	600	4,200
8	300	600	4,800
9	300	600	5,400
10	300	600	6,000
11	300	600	6,600
12	300	600	7,200
13	300	600	7,800
14	300	600	8,400
15	300	600	9,000
16	300	600	9,600
17	300	600	10,200
18	300	600	10,800
19	300	600	11,400
20	300	600	12,000

Table 24. Urban Sediment Load Reduction in the Spring River Watershed.

Spring River Watershed Total Urban BMP Sediment Reduction Rates (tons)				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Cumulative Load Reduction
1	9.23	0.00	0.00	9.23

Year	Bioswale	Stream Buffers	Permanent Vegetation	Cumulative Load Reduction
2	9.23	13.84	0.21	23.27
3	11.28	13.84	0.92	26.04
4	11.28	16.91	1.13	29.32
5	13.33	16.91	1.13	31.37
6	20.50	19.99	1.33	41.82
7	22.55	30.75	1.33	54.63
8	22.55	33.83	2.26	58.63
9	24.60	33.83	2.26	60.68
10	24.60	36.90	2.46	63.96
11	33.83	36.90	2.46	73.19
12	33.83	39.98	2.67	76.47
13	35.88	50.74	2.67	89.28
14	35.88	53.81	3.59	93.28
15	37.93	53.81	3.59	95.33
16	45.10	56.89	3.79	105.78
17	47.15	67.65	3.79	118.59
18	47.15	70.73	4.72	122.59
19	49.20	70.73	4.72	124.64
20	49.20	73.80	4.92	127.92

Table 25. Sediment Load Reduction in the Spring River Watershed by Category.

Spring River Sediment Reduction		
Best Management Practice Category	**Total Load Reduction (tons)**	**% of Sediment Reduction**
Cropland	40,404	76.9%
Streambank	12,000	22.8%
Urban	127	0.3%
Total	**52,531**	**100%**

C Phosphorus Load Reductions for Implemented BMPs in the Spring River Watershed

Table 26. Cropland Phosphorus Load Reduction in the Spring River Watershed.

Total Annual Phosphorus Reduction, Cropland BMPs (lbs)									
Year	**No-Till**	**Cover Crops**	**Nutrient Management Plan**	**Conservation Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	1,312	492	820	820	1,312	984	1,640	1,640	9,021

Year	No-Till	Cover Crops	Nutrient Management Plan	Conservation Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
2	2,613	980	1,633	1,633	2,613	1,959	3,266	3,266	17,962
3	3,925	1,472	2,453	2,453	3,925	2,944	4,906	4,906	26,982
4	5,237	1,964	3,273	3,273	5,237	3,928	6,546	6,546	36,003
5	6,549	2,456	4,093	4,093	6,549	4,912	8,186	8,186	45,024
6	7,861	2,948	4,913	4,913	7,861	5,896	9,826	9,826	54,044
7	9,173	3,440	5,733	5,733	9,173	6,880	11,466	11,466	63,065
8	10,485	3,932	6,553	6,553	10,485	7,864	13,107	13,107	72,086
9	11,797	4,424	7,373	7,373	11,797	8,848	14,747	14,747	81,107
10	13,109	4,916	8,193	8,193	13,109	9,832	16,387	16,387	90,127
11	14,422	5,408	9,013	9,013	14,422	10,816	18,027	18,027	99,148
12	15,734	5,900	9,834	9,834	15,734	11,800	19,667	19,667	108,169
13	17,046	6,392	10,654	10,654	17,046	12,784	21,307	21,307	117,189
14	18,358	6,884	11,474	11,474	18,358	13,768	22,947	22,947	126,210
15	19,670	7,376	12,294	12,294	19,670	14,752	24,587	24,587	135,231
16	20,982	7,868	13,114	13,114	20,982	15,737	26,228	26,228	144,252
17	22,294	8,360	13,934	13,934	22,294	16,721	27,868	27,868	153,272
18	23,606	8,852	14,754	14,754	23,606	17,705	29,508	29,508	162,293
19	24,918	9,344	15,574	15,574	24,918	18,689	31,148	31,148	171,314
20	26,230	9,836	16,394	16,394	26,230	19,673	32,788	32,788	180,334

Table 27. Livestock Phosphorus Load Reduction in the Spring Watershed.

Phosphorus Load Reduction in Pounds (after all livestock BMPs are installed)								
Water Body	Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Management Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
Total	**20,680**	**94,999**	**37,050**	**37,620**	**25,761**	**5,557**	**17,766**	**239,432**

Table 28. Streambank Phosphorus Load Reductions in the Spring River Watershed.

Year	Streambank Stabilization (feet)	P Reduction (lbs)	Cumulative P Load Reduction (lbs)
1	300	36	36
2	300	36	72
3	300	36	108
4	300	36	144

Year	Streambank Stabilization (feet)	P Reduction (lbs)	Cumulative P Load Reduction (lbs)
5	300	36	180
6	300	36	216
7	300	36	252
8	300	36	288
9	300	36	324
10	300	36	360
11	300	36	396
12	300	36	432
13	300	36	468
14	300	36	504
15	300	36	540
16	300	36	576
17	300	36	612
18	300	36	648
19	300	36	684
20	300	36	720

Table 29. Septic System Phosphorus Load Reductions in the Spring River Watershed.

Year	Failing Systems Addressed	Phosphorus Load Reduction (lbs)	Cumulative Phosphorus Load Reduction (lbs)
1	3	930	930
2	3	930	1,861
3	3	930	2,791
4	3	930	3,721
5	3	930	4,652
6	3	930	5,582
7	3	930	6,512
8	3	930	7,442
9	3	930	8,373
10	3	930	9,303
11	3	930	10,233
12	3	930	11,164
13	3	930	12,094
14	3	930	13,024
15	3	930	13,955
16	3	930	14,885
17	3	930	15,815
18	2	620	16,435

Year	Failing Systems Addressed	Phosphorus Load Reduction (lbs)	Cumulative Phosphorus Load Reduction (lbs)
19	2	620	17,056
20	2	620	17,676

NOTE: Assuming that 25% of all failing on-site wastewater treatment tanks are addressed

Table 30. Urban Phosphorus Load Reduction in the Spring River Watershed.

Spring River Watershed Total Urban BMP Phosphorus Reduction Rates (pounds)				
Year	**Bioswale**	**Vegetative Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	67.5	0	0	68
2	67.5	101.25	2.85	172
3	82.5	101.25	12.825	197
4	82.5	123.75	15.675	222
5	97.5	123.75	15.675	237
6	150	146.25	18.525	315
7	165	225	18.525	409
8	165	247.5	31.35	444
9	180	247.5	31.35	459
10	180	270	34.2	484
11	247.5	270	34.2	552
12	247.5	292.5	37.05	577
13	262.5	371.25	37.05	671
14	262.5	393.75	49.875	706
15	277.5	393.75	49.875	721
16	330	416.25	52.725	799
17	345	495	52.725	893
18	345	517.5	65.55	928
19	360	517.5	65.55	943
20	360	540	68.4	968

Table 31. Phosphorus Load Reduction in the Spring River Watershed by Category.

Spring River Phosphorus Reduction		
Best Management Practice Category	**Total Load Reduction (lbs)**	**% of Phosphorus Reduction**
Livestock	239,432	54.5%
Cropland	180,334	41.1%
Septic	17,676	4.0%
Urban	968	0.2%
Streambank	720	0.2%
Total	**439,130**	**100%**

D Nitrogen Load Reductions for Implemented BMPs in the Spring River Watershed

Table 32. Cropland Nitrogen Load Reduction in the Spring Watershed.

Total Annual Nitrogen Reduction, Cropland BMPs (lbs)									
Year	No-Till	Cover Crops	Nutrient Management Plan	Conservation Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	2,386	1,432	2,386	2,386	3,818	2,864	2,386	4,773	22,432
2	4,750	2,850	4,750	4,750	7,599	5,700	4,750	9,499	44,647
3	7,136	4,282	7,136	7,136	11,418	8,563	7,136	14,272	67,079
4	9,522	5,713	9,522	9,522	15,236	11,427	9,522	19,045	89,511
5	11,909	7,145	11,909	11,909	19,054	14,291	11,909	23,818	111,944
6	14,295	8,577	14,295	14,295	22,872	17,154	14,295	28,591	134,376
7	16,682	10,009	16,682	16,682	26,691	20,018	16,682	33,363	156,808
8	19,068	11,441	19,068	19,068	30,509	22,882	19,068	38,136	179,240
9	21,454	12,873	21,454	21,454	34,327	25,745	21,454	42,909	201,672
10	23,841	14,305	23,841	23,841	38,145	28,609	23,841	47,682	224,104
11	26,227	15,736	26,227	26,227	41,964	31,473	26,227	52,455	246,537
12	28,614	17,168	28,614	28,614	45,782	34,336	28,614	57,227	268,969
13	31,000	18,600	31,000	31,000	49,600	37,200	31,000	62,000	291,401
14	33,387	20,032	33,387	33,387	53,418	40,064	33,387	66,773	313,833
15	35,773	21,464	35,773	35,773	57,237	42,927	35,773	71,546	336,265
16	38,159	22,896	38,159	38,159	61,055	45,791	38,159	76,319	358,697
17	40,546	24,327	40,546	40,546	64,873	48,655	40,546	81,091	381,130
18	42,932	25,759	42,932	42,932	68,691	51,519	42,932	85,864	403,562
19	45,319	27,191	45,319	45,319	72,510	54,382	45,319	90,637	425,994
20	47,705	28,623	47,705	47,705	76,328	57,246	47,705	95,410	448,426

Table 33. Livestock Nitrogen Load Reduction in the Spring Watershed.

Nitrogen Load Reduction in Pounds (after all livestock BMPs are installed)								
Water Body	Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Management Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
Total	38,950	178,930	69,783	70,856	48,520	10,467	33,462	450,970

Table 34. Urban Nitrogen Load Reduction in the Spring River Watershed.

Spring River Watershed Total Urban BMP Nitrogen Reduction Rates (pounds)				
Year	**Bioswale**	**Vegetative Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	526.5	0	0	527
2	526.5	789.75	33.345	1,350
3	702	789.75	100.035	1,592
4	702	1053	133.38	1,888
5	877.5	1053	133.38	2,064
6	1228.5	1316.25	166.725	2,711
7	1404	1842.75	166.725	3,413
8	1404	2106	266.76	3,777
9	1579.5	2106	266.76	3,952
10	1579.5	2369.25	300.105	4,249
11	2106	2369.25	300.105	4,775
12	2106	2632.5	333.45	5,072
13	2281.5	3159	333.45	5,774
14	2281.5	3422.25	433.485	6,137
15	2457	3422.25	433.485	6,313
16	2808	3685.5	466.83	6,960
17	2983.5	4212	466.83	7,662
18	2983.5	4475.25	566.865	8,026
19	3159	4475.25	566.865	8,201
20	3159	4738.5	600.21	8,498

Table 35. Nitrogen Load Reduction in the Spring River Watershed by Category.

Spring River Nitrogen Reduction		
Best Management Practice Category	**Total Load Reduction (lbs)**	**% of Nitrogen Reduction**
Livestock	450,970	49.7%
Cropland	448,426	49.4%
Urban	8,498	0.9%
Total	**907,894**	**100%**

E Reductions Obtained through Past BMP Implementation

Watershed residents expressed an interest in BMP effectiveness and reductions from those BMPs that have already been implemented in the watershed. MoDNR provided a list of BMPs implemented in the watershed from 2008 to 2013. After calculations were conducted, it was estimated that 69,303 pounds of phosphorus had been removed from the watershed by implementing livestock BMPs. Cropland BMPs provided an estimated reduction of 187,633 tons of suspended solids, an additional 910,753 pounds of phosphorus and 193,900 pounds of nitrogen.

F Information and Education and Technical Assistance Needed to Support BMP Implementation

Surveying and discussion of citizen understanding of both watershed issues and practices to mitigate watershed issues was performed during MoDNR's Our Missouri Waters watershed summit and during the stakeholder meetings specific to the Nonpoint Source Management Plan. Local watershed citizens were polled on their understanding of Spring River watershed issues, what issues they felt should be given priority, and to what extent they would like to be involved in actions to address issues. During stakeholder meetings specific to the Nonpoint Source Management Plan, participants discussed even more specifically the types of Best Management Practices they were familiar with and the extent to which they felt the practices would be effectively utilized by other local citizens.

The successful implementation of the BMPs outlined in this plan will require information and education activities and technical assistance. Information and education activities and technical assistance services are categorized by BMPs.

Table 36. Information and Education and Technical Assistance Needed to Support BMP Implementation.

BMP Type	Information/Education Activities	Technical Assistance Services	Service Providers
Agricultural: Cropland			
No-Till **Cover Crops** **Nutrient Management Plan** **Conservation Crop Rotation** **Grassed Waterway** **Terraces** **Vegetative buffers** **Water Retention Structure**	Demonstration projects Tours/field days highlighting successful projects Workshops, informational meetings *Existing activities: no additional cost*	Technical design of projects BMP maintenance training *Existing services: no additional cost*	NRCS SWCDs MDC MoDNR MU Extension
BMP Type	Information/Education Activities	Technical Assistance Services	Service Providers
Agricultural: Livestock			
Off-Stream Watering Systems **Rotational Grazing** **Relocation of Pasture Feeding Sites** **Grazing Management Plan** **Relocation of feedlots and feeding pens** **Fencing Off Streams** **Vegetative Filter Strips**	Demonstration projects Tours/field days highlighting successful projects Workshops, informational meetings *Existing activities: no additional cost*	Technical design of projects One-on-one assistance for livestock producers to identify pollution potential of operations and to identify potential BMP projects *Existing services: no additional cost*	NRCS SWCDs MDC MoDNR MU Extension

BMP Type	Information/Education Activities	Technical Assistance Services	Service Providers
Urban			
Bioswale **Stream Buffers** **Permanent Vegetation**	Demonstration projects, workshops/ training, conferences targeting local government elected officials and staff *New activities: $50,000*	Implementation standards, design specifications, codes and ordinances for use by local governments *New services: $50,000*	MoDNR Harry S. Truman Coordinating Council Professional Associations
Streambanks			
Streambank Restoration/Stabilization	General outreach targeting landowners with streambanks *Existing activities: no additional cost*	Assessment to identify and prioritize eroding streambanks *New services: $100,000* Engineering and design for specific projects *New services: $100,000*	MDC MoDNR SWCDs NRCS
Septic Systems			
Repair/Replacement of Failing Systems	General outreach to homeowners with on-site wastewater treatment systems *Existing activities: no additional cost*	One-on-one assistance in identifying status of systems and design for repair/replacement *Existing services: no additional cost*	County Health Departments

1) Evaluation of Information and Education Activities

All service providers conducting information and education activities will be required to include an evaluation component in their project proposals and Project Implementation Plans. The evaluation methods will vary based on the activity.

At a minimum, all information and education projects must include participant learning objectives as the basis for the overall evaluation. Depending on the scope of the project, development of a basic logic model identifying long-term, medium-term, and short-term behavior changes or other outcomes that are expected to result from the activity may be required.

Specific evaluation tools or methods may include (but are not limited to):

- Feedback forms allowing participants to provide rankings of the content, presenters, useful of information, etc.
- Pre and post surveys to determine amount of knowledge gained, anticipated behavior changes, need for further learning, etc.

- Follow up interviews (one-on-one contacts, phone calls, e-mails) with selected participants to gather more in-depth input regarding the effectiveness of the activity.

All service providers will be required to submit a brief written evaluation of their information and education activity, summarizing how successful the activity was in achieving the learning objectives, and how the activity contributed to achieving the long-term watershed goals and/or objectives for pollutant load reductions.

7. Costs of Implementing BMPs and Possible Funding Sources

Prices below reflect current prices (2014) for implementation and also include technical assistance costs such as NRCS planning and engineering design in the case of streambank stabilization. All BMPs will be applied in the targeted areas.

BMP costs were reviewed and feedback was provided from Missouri NRCS, University of Missouri Extension and MoDNR. Feedback was accounted for in the costs used for BMPs.

A Costs of Implementing BMPs

Summarized Derivation of Cropland BMP Cost Estimates

No-Till: A fair price was determined to entice a producer to adopt no-till. The price would be a net present value of $78 per acre upfront assuming the NRCS discount rate of 4.75%.
Cover Crops: A fair price to entice a producer to adopt planting cover crops would be $40 per acre.
Nutrient Management Plans: A fair price was determined to entice a producer to adopt nutrient management plans. The price would be a net present value of $78 per acre upfront assuming the NRCS discount rate of 4.75%.
Conservation Crop Rotation: A fair price was determined to entice a producer to adopt conservation crop rotation. The price would be a net present value of $40 per acre upfront assuming the NRCS discount rate of 4.75 %.
Grassed Waterway: $1,600 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and updated costs of brome grass seeding.
Terraces: In consulting with numerous conservation districts it was determined that the average cost of building a terrace at the time of this watershed plan is $1.25 per foot.
Vegetative Buffer Strips: The cost of $1,000 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and cost estimates from the KSU Vegetative Buffer Tool.
Water Retention Structure: A retention structure cost of approximately $5,000 will treat 40 acres at $125 per treated acre.

Table 37. Cropland Total BMP Costs in the Spring River Watershed.

Total Annual Cost of Cropland BMPs, 3% Inflation									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	$65,722	$32,992	$65,984	$32,992	$135,352	$105,744	$56,397	$105,744	$600,925
2	$67,693	$33,982	$67,964	$33,982	$139,412	$108,916	$58,088	$108,916	$618,953
3	$69,724	$35,001	$70,002	$35,001	$143,595	$112,183	$59,831	$112,183	$637,522
4	$71,816	$36,051	$72,103	$36,051	$147,903	$115,549	$61,626	$115,549	$656,647
5	$73,970	$37,133	$74,266	$37,133	$152,340	$119,015	$63,475	$119,015	$676,347

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
6	$76,190	$38,247	$76,494	$38,247	$156,910	$122,586	$65,379	$122,586	$696,637
7	$78,475	$39,394	$78,788	$39,394	$161,617	$126,263	$67,340	$126,263	$717,536
8	$80,829	$40,576	$81,152	$40,576	$166,466	$130,051	$69,361	$130,051	$739,063
9	$83,254	$41,793	$83,587	$41,793	$171,460	$133,953	$71,442	$133,953	$761,234
10	$85,752	$43,047	$86,094	$43,047	$176,603	$137,971	$73,585	$137,971	$784,071
11	$88,325	$44,339	$88,677	$44,339	$181,902	$142,111	$75,792	$142,111	$807,594
12	$90,974	$45,669	$91,337	$45,669	$187,359	$146,374	$78,066	$146,374	$831,821
13	$93,704	$47,039	$94,077	$47,039	$192,979	$150,765	$80,408	$150,765	$856,776
14	$96,515	$48,450	$96,900	$48,450	$198,769	$155,288	$82,820	$155,288	$882,479
15	$99,410	$49,903	$99,807	$49,903	$204,732	$159,947	$85,305	$159,947	$908,954
16	$102,392	$51,400	$102,801	$51,400	$210,874	$164,745	$87,864	$164,745	$936,222
17	$105,464	$52,942	$105,885	$52,942	$217,200	$169,687	$90,500	$169,687	$964,309
18	$108,628	$54,531	$109,062	$54,531	$223,716	$174,778	$93,215	$174,778	$993,238
19	$111,887	$56,167	$112,333	$56,167	$230,427	$180,021	$96,011	$180,021	$1,023,035
20	$115,244	$57,852	$115,703	$57,852	$237,340	$185,422	$98,892	$185,422	$1,053,726
Total									**$16,147,093**

Summarized Derivation of Livestock BMP Cost Estimates

Off-Stream Watering System: The average cost of installing an alternative watering system is $4,000. This amount was estimated from detailed average cost estimates. Treats 70 animal units.

Rotational Grazing: The average cost of implementing a rotational grazing system is $7,000. This was estimated from detailed average cost estimates. More complex systems that require significant cross fencing and buried water lines will come with a much higher price. Treats 70 animal units.

Relocated Pasture Feeding Site: The average cost of moving a pasture feeding site of $3,000 was estimated using the cost of building ¼ mile of fence, a permeable surface, and labor. Treats 70 animal units.

Grazing Management Plans: $2,000 is the average price needed to persuade a livestock producer to adopt a grazing management plan. This amount is an average and is dependent on the size of the acreage. Treats 70 animal units.

Relocated Feeding Pens: Relocating feeding pens is highly variable in price, average of $12,000 per unit. Treats 100 animal units.

Fence off Streams and Ponds: The average cost of ½ mile of fence at $7,500 was determined by current fencing and labor prices, assuming the fence has a 20 year life, and value of future repairs. Treats 70 animal units.

Vegetative Filter Strip: The cost of $1,000 an acre was calculated assuming the average filter strip in the watershed will require four hours of bulldozer work at $125 an hour plus the cost of seeding one acre in permanent vegetation. Treats 100 animal units.

Table 38. Livestock Total BMP Costs in the Spring River Watershed.

Spring River Livestock BMP Cost								
Water Body	Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Cost (over 20 years)
Total	**$788,000**	**$1,400,000**	**$234,000**	**$198,000**	**$348,000**	**$337,500**	**$40,000**	**$3,345,500**

Summarized Derivation of Streambank BMP Cost Estimates *

Streambank Stabilization: The average cost of streambank stabilization is $91.55 per linear foot. However, prices are highly variable due to a wide range of site specific stabilization needs.

Table 39. Streambank Total BMP Costs in the Spring River Watershed.

Spring River Annual Streambank Cost		
Year	**Streambank Stabilization (feet)**	**Cost***
1	300	$27,465
2	300	$28,289
3	300	$29,138
4	300	$30,012
5	300	$30,912
6	300	$31,839
7	300	$32,795
8	300	$33,778
9	300	$34,792
10	300	$35,836
11	300	$36,911
12	300	$38,018
13	300	$39,159
14	300	$40,333
15	300	$41,543
16	300	$42,790
17	300	$44,073
18	300	$45,395
19	300	$46,757
20	300	$48,160
Total		**$737,995**
****$91.55 per linear foot, 3% Inflation***		

Summarized Derivation of Septic System BMP Cost Estimates *

Septic System Repair and Replacement: The average cost of on-site wastewater treatment system repair or replacement is $5,000 per system. However, prices are highly variable due to the level of repair or replacement needed.

Table 40. Septic System Total BMP Costs in the Spring River Watershed.

Spring River Annual Failing Septic System Repair Cost		
Year	**Failing Systems Addressed**	**Cost***
1	3	$15,000
2	3	$15,450
3	3	$15,914
4	3	$16,391
5	3	$16,883
6	3	$17,389
7	3	$17,911
8	3	$18,448
9	3	$19,002
10	3	$19,572
11	3	$20,159
12	3	$20,764
13	3	$21,386
14	3	$22,028
15	3	$22,689
16	3	$23,370
17	3	$24,071
18	2	$24,793
19	2	$25,536
20	2	$26,303
Total		**$403,056**
***	*$5,000*	

Summarized Derivation of Urban BMP Cost Estimates

Bioswale: The average cost of a bioswale is $21,780. However, prices are highly variable due to the size and level of complexity in the installation.
Stream Buffers: The cost of $1,000 per acre was arrived at using average cost of installation figures from the conservation districts within the watershed and cost estimates from the KSU Vegetative Buffer Tool. Projects are estimated to be one acre.
Permanent Vegetation: The cost of $150 an acre was calculated based on K-State Research and Extension estimates of the cost of planting and maintaining native grass. Urban permanent vegetation projects are estimated to be one acre.

Table 41. Urban Total BMP Costs in the Spring River Watershed.

Spring River Watershed Total Urban BMP Implementation Cost				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cost**
1	$196,020	$0	$0	$196,020
2	$0	$9,000	$300	$9,300
3	$43,560	$0	$1,050	$44,610
4	$0	$2,000	$300	$2,300
5	$43,560	$0	$0	$43,560
6	$152,460	$2,000	$300	$154,760
7	$43,560	$7,000	$0	$50,560
8	$0	$2,000	$1,350	$3,350
9	$43,560	$0	$0	$43,560
10	$0	$2,000	$300	$2,300
11	$196,020	$0	$0	$196,020
12	$0	$2,000	$300	$2,300
13	$43,560	$7,000	$0	$50,560
14	$0	$2,000	$1,350	$3,350
15	$43,560	$0	$0	$43,560
16	$152,460	$2,000	$300	$154,760
17	$43,560	$7,000	$0	$50,560
18	$0	$2,000	$1,350	$3,350
19	$43,560	$0	$0	$43,560
20	$0	$2,000	$300	$2,300
Total				**$1,100,640**

Summarized Derivation of I&E and Technical Assistance BMP Cost Estimates

I&E: The average cost of a tour, field day or workshop is estimated to be $2,500. This cost will cover a demonstration project, and tour or workshop expenses. However, prices can vary greatly.
Technical Assistance: Technical assistance can cover implantation standards, design specifications and assessments along with outreach on a one-on-one basis.

Table 42. Information and Education and Technical Assistance Total Costs in the Spring River Watershed.

Spring River Annual Information and Education, Technical Assistance		
Year	**Information and Education**	**Technical Assistance**
1	$2,500	$12,500
2	$2,500	$12,500
3	$2,500	$12,500
4	$2,500	$12,500
5	$2,500	$12,500
6	$2,500	$12,500
7	$2,500	$12,500
8	$2,500	$12,500
9	$2,500	$12,500
10	$2,500	$12,500
11	$2,500	$12,500
12	$2,500	$12,500
13	$2,500	$12,500
14	$2,500	$12,500
15	$2,500	$12,500
16	$2,500	$12,500
17	$2,500	$24,071
18	$2,500	$12,500
19	$2,500	$12,500
20	$2,500	$12,500
Total	**$50,000**	**$250,000**

Table 43. Total BMP Costs and Percentage by Category in the Spring River Watershed.

Spring River BMP Total Costs for 20 Years		
BMP Category	Total Cost for 20 Years	Percentage of Total Cost
Cropland	$16,147,093	73.3%
Livestock	$3,345,500	15.2%
Urban	$1,100,640	5.0
Streambank	$737,995	3.3%
Septic System	$403,056	1.8%

BMP Category	Total Cost for 20 Years	Percentage of Total Cost
Information and Education, and Technical Assistance	$300,000	1.4
Total	**$22,034,284**	**100%**

B Funding Sources

Funds can be derived from multiple sources**. It should be noted that EPA 319 funds will only be eligible in the watersheds with a TMDL designation or a High Priority Targeted watershed. After the water body meets water quality standards, it will no longer be eligible for EPA 319 funds.** Other funding sources are listed below.

Missouri Department of Natural Resources
Drinking Water Source Water Protection Grants
http://dnr.mo.gov/env/wpp/pdwb/swpp.htm

Grants are provided to community water systems to implement source water protection strategies or develop a source water plan. Available funds and maximum award amounts vary on a yearly basis.

Nonpoint Source Animal Waste Treatment Facility Loan Program
http://agriculture.mo.gov/abd/financial/awloanprg.php

Low-interest state revolving fund loans are available from Department of Natural Resources through the Missouri Agriculture and Small Business Development Authority (MASDBA) to small producers and farmers for design and construction of animal waste treatment facilities and application of best management practices. Applications are obtained from the MASDBA for 100 percent of eligible costs.

319 Nonpoint Source Project Grants
http://dnr.mo.gov/env/wpp/nps/index.html

Grants are available to public institutions of higher education, units of government and nonprofit organizations with 501(c) (3) status for the prevention, control or abatement of nonpoint source water pollution projects. Research or activities required under discharge permits are not eligible. Project length may be up to three years. Awards are made through a request for proposal. In addition, detailed letters of intent may be submitted at any time.

604(b) Water Quality Management Planning Grants

Grants are available to assist the state, regional public comprehensive planning organizations and interstate organizations to carry out water quality management planning. Funds are used to determine the nature and extent of point and nonpoint source pollution and to develop management plans to address them with an emphasis on a watershed approach.

Soil and Water Conservation Cost-Share Program
http://dnr.mo.gov/env/swcp/Service/swcp_cs.htm

The Soil and Water Cost-Share program provides partial funding to landowners for voluntarily implementing practices on agricultural land that prevent or control erosion and protect water quality. The program funds up to 75 percent of the state average cost for construction or implementation of a soil and water conservation practice. These efforts help protect the water resources of the state and the productive power of farmland. This program is funded by the parks, soils and water sales tax. The application is ongoing, and administered through local soil and water conservation districts.

USDA Natural Resources Conservation Service

Conservation Reserve Program

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=stelprdb1041269

The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. The program is funded through the Commodity Credit Corporation (CCC). CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, conservation planning and practice implementation.

Agricultural Conservation Easement Program

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.

Environmental Quality Incentives Program (EQIP)

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mo/programs/financial/eqip/

The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat. Interested parties may apply for EQIP at their local NRCS office located in the USDA Service Center.

Conservation Stewardship Program (CSP)

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

The Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.

US Environmental Protection Agency

Catalog of Federal Funding Sources for Watershed Protection

https://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1

The Catalog of Federal Funding Sources for Watershed Protection is a searchable database of financial assistance sources (grants, loans, cost-sharing) available to fund a variety of watershed protection projects.

Five Star Restoration Program

http://water.epa.gov/grants_funding/wetlands/restore/index.cfm

The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects.

Community Action for a Renewed Environment (CARE)

http://www.epa.gov/care/

CARE is a competitive grant program that offers an innovative way for a community to organize and take action to reduce toxic pollution in its local environment. Through CARE, a community creates a partnership that implements solutions to reduce releases of toxic pollutants and minimize people's exposure to them.

8. Evaluation of Watershed Plan Implementation and Water Quality Improvement

Progress in achieving the goals and objectives of this plan will be evaluated based on BMP implementation, load reductions, and monitoring improvement in water quality conditions. Improvement in water quality conditions will be determined by a statistically-significant reduction of pollutant concentrations in the water body such that progress in attaining water quality goals can be documented. The endpoint for comparison of improved water quality conditions will either be the TMDL for the water body, if established, or the appropriate water quality standards for the water body as assessed using the most recent approved 303(d) Listing Methodology Document.

- If all of the BMPs are implemented in the North Fork Spring watershed as outlined in this plan, it will take approximately 11 years to achieve the required pollution load reduction outlined in the TMDL for sediment. Water quality will be met when sediment load reductions result in attainment of impaired aquatic habitat designated uses within the watershed. Follow-up monitoring as critical area BMPs are implemented, and assessment of the impaired water bodies through future assessment cycles, will provide the framework for attainment determinations.
- If all of the BMPs are implemented in the North Fork Spring River, Dry Fork, Spring River, Center Creek, Turkey Creek, Shoal, Pogue and Joyce Creeks, Clear Creek, White Oak Creek, and Honey Creek watersheds as outlined in this plan, it will take approximately 20 years to achieve the needed load reductions for phosphorus. Because sources of nutrients (i.e., septic systems, livestock waste, and domestic wastewater treatment systems) are also sources of bacteria, BMPs targeted for nutrients are also expected to achieve concurrent reductions in bacteria. Monitoring will verify this. Water quality standards will be met when bacteria load reductions result in attainment of impaired recreational designated uses in these water bodies. Follow-up monitoring as critical area BMPs are implemented, and assessment of the impaired water bodies through future assessment cycles, will provide the framework for attainment determinations.
- If all of the BMPs are implemented in the Lamar Lake watershed as outlined in this plan, it will take approximately 18 years to achieve the required pollution load reduction outlined in the TMDL for total phosphorus. Water quality standards will be met when nutrient load reductions result in attainment of impaired aquatic habitat and drinking water supply designated uses.

The watershed plan will be reviewed every five years. Because significant changes to water quality are not typically achieved in short timeframes, the first five-year review will focus on evaluating progress in terms of BMP implementation and load reductions. Subsequent five-year reviews will include an evaluation of water quality changes against the original impaired water quality condition prior to implementation of BMPs, as well as the water quality condition of the previous five-year review. This analysis will allow measurement of progress toward

TMDL load reductions and attainment of water quality standards, while allowing for potential adjustment and reassessment of BMP type and location for implementation.

It is anticipated that decreases in both pollutant concentration and frequency of exceedance will occur as BMPs are implemented. Significant reduction of pollutant concentrations at low flow conditions should be experienced as discharge permits implement nutrient reductions and disinfection requirements. Reductions at low flow conditions should also be realized as failing septic systems are replaced with newer, more efficient systems.

As nonpoint source BMPS are implemented in areas contributing pollutant loading at higher flows, reductions are anticipated first in the mid- to upper-flow ranges of the flow and load duration curves found in established TMDLs or this document. Load reductions and attainment of water quality standards at highest flows will likely occur later in the implementation schedule as these flows occur less frequently, and BMP effectiveness tends to be less at extremely high flows.

Continuous monitoring and feedback from watershed interests will assist in deploying and prioritizing BMPs within the Spring River watershed. Feedback on water quality trends gained through public input and monitoring will allow watershed managers to adjust or refine BMP placement and priority to most efficiently and effectively meet water quality goals. Table 45 contains information on pollutant BMP implementation by review year for the Spring River watershed.

Table 44. Review Schedule for Pollutant and BMP Implementation.

Review Year	Sediment	Phosphorus	BMP Implementation
2019			X
2024	X	X	X
2029	X	X	X
2034	X	X	X

9. Interim Measurable Milestones

The five-year evaluations will be based on a comparison of actual achievements versus pre-determined milestones.

Milestones for BMP implementation will be determined by number of acres treated, practices installed, and load reductions at the end of five, ten and twenty years (short, medium, and long term). Formal information and education opportunities will be held at least once a year (e.g., a watershed summit), with additional events added as the opportunity and schedule allow (e.g, county commission meetings, soil and water commission meetings, etc).

Table 45. Short, Medium and Long Term Goals for Implementation of All BMPs.

		Cropland	Livestock	Streambank	Septic Systems	Urban	Information and Education
	Year	**acres**	**number of installed projects**	**feet**	**number of systems**	**number of installed projects**	**number of I&E activities**
Short Term	1	6,768	34	300	3	9	1
	2	6,768	35	300	3	11	1
	3	6,768	34	300	3	9	1
	4	6,768	35	300	3	4	1
	5	6,768	34	300	3	2	1
	Total	**33,840**	**172**	**1,500**	**15**	**35**	**5**
Medium Term	6	6,768	35	300	3	11	1
	7	6,768	34	300	3	9	1
	8	6,768	35	300	3	11	1
	9	6,768	34	300	3	2	1
	10	6,768	34	300	3	4	1
	Total	**67,680**	**344**	**3,000**	**30**	**72**	**10**
Long Term	11	6,768	35	300	3	9	1
	12	6,768	34	300	3	4	1
	13	6,768	35	300	3	9	1
	14	6,768	34	300	3	11	1
	15	6,768	34	300	3	2	1
	Total	**101,520**	**516**	**4,500**	**45**	**107**	**15**
	16	6,768	35	300	3	11	1
	17	6,768	34	300	3	9	1
	18	6,768	35	300	2	11	1

		Cropland	Livestock	Streambank	Septic Systems	Urban	Information and Education
	19	6,768	34	300	2	2	1
	20	6,768	34	300	2	4	1
	Year	**acres**	**number of installed projects**	**feet**	**number of systems**	**number of installed projects**	**number of I&E activities**
	Total	**135,360**	**688**	**6,000**	**57**	**144**	**20**

Milestones for water quality changes (improvement) will be determined through the state's water quality monitoring system. It is anticipated that attainment of improved water quality conditions will be met at lower flow regimes in the short and medium term, while improved water quality at higher flows will be achieved nearer the end of the implementation schedule.

The Spring River watersheds (North Fork Spring River, Dry Fork, Spring River, Center Creek, Turkey Creek, Shoal/Progue/Joyce Creeks, Clear Creek, White Oak Creek, and Honey Creek) will achieve bacteria reductions by implementing conservation practices. The load reductions for phosphorus identified earlier in the plan will be used a surrogate for estimating bacteria loads as bacteria load reductions will be concomitant with reductions in phosphorous due to similar sourcing. Livestock BMPs will meet the needed phosphorus reduction. Cropland, septic system, urban phosphorus reduction is considered to be an extra amount. Several sites within the Spring River watershed are monitored for bacteria by the local county health departments. Based upon the BMP implementation schedule for these sub-watersheds, seasonal, spatial and temporal analyses should be conducted in an effort to determine if baseflow bacterial load reductions are being achieved over time. Based on monitoring efforts, annual median concentrations of bacteria could indicate a downward trend within a five-year time frame at established monitoring stations in closest proximity to BMP implementation sites.

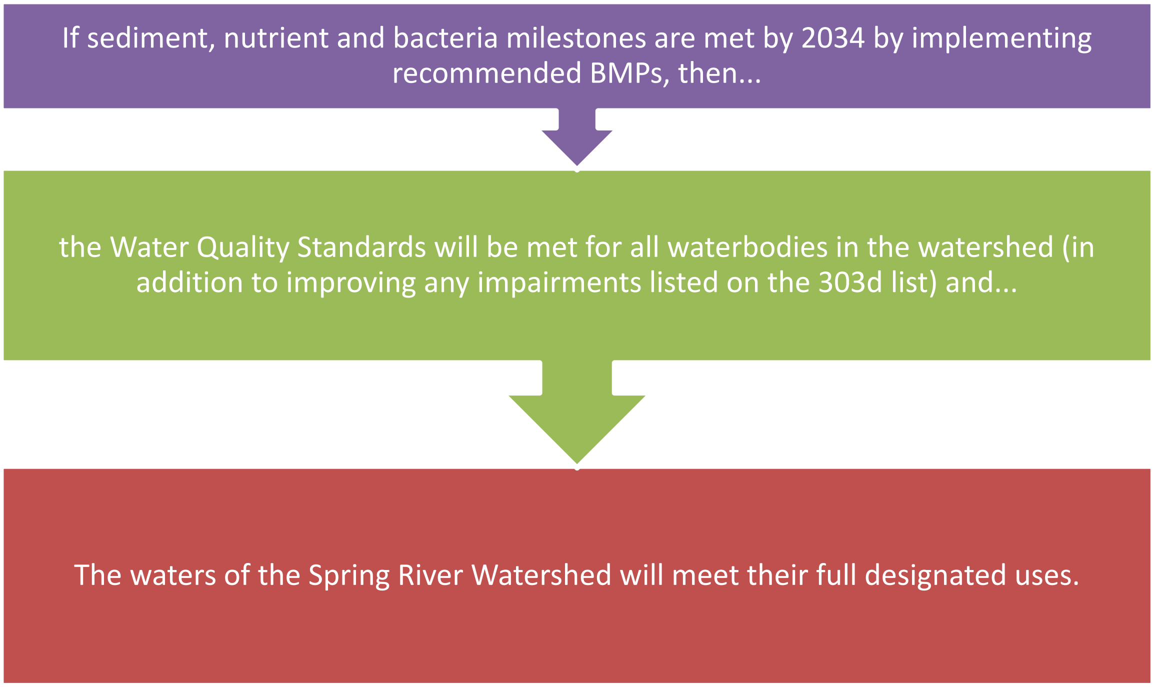
The North Fork Spring River watershed will address low dissolved oxygen and sediment loads by implementing conservation practices. Practices will be implemented to reduce soil erosion, phosphorus, and nitrogen. Currently, several water quality monitoring sites along the North Fork Spring River are monitored on at least a monthly basis. The data obtained from these sites can be used to track changes in total suspended solids and dissolved oxygen concentrations. Reductions in sediment and nutrient loading in the watershed will be accomplished through strategic placement of BMPs in critical source reduction areas. It is anticipated that exceedances of sediment and dissolved oxygen criteria will be reduced at low flows due to reduced pollutant input during these flows within the short and medium term (i.e., 10 years). Reductions at higher flows will likely take significantly longer and occur toward the end of the implementation schedule (i.e., 20 years or more). Seasonal, spatial and temporal analyses should also be conducted, but will be highly dependent upon BMP implementation. Flow-based trend analyses for sediment and nutrients should be conducted to determine if load reductions are being achieved over time. Based on monitoring efforts, the annual median concentrations could indicate a downward trend within a five to ten year timeframe at monitoring stations in closest proximity to the implementation sites.

Due to the size of the Spring River watershed, loading reductions seen at or near the watershed outlet may not be determined immediately through direct water quality measurement. This is due to various environmental conditions or anthropogenic changes that may occur within the watershed over the life of the watershed plan. In addition, bacterial load reductions may not be achieved or lag several years behind what may be documented sooner at the local or sub-watershed level.

Water quality data is routinely collected by various entities within the Spring River Watershed. Efforts to increase the quality and quantity of useable data will be explored during implementation of this plan through department monitoring, cooperative agreements and volunteer water quality monitors. Education and outreach opportunities will be used to inform watershed stakeholders of available water quality data, and to increase the scope of monitoring as opportunities arise (e.g., Cooperative Stream Investigation (CSI) monitoring). Much of this information is utilized by MDNR to determine if the water body is meeting the water quality criteria as stated in the state's water quality standards (10 CSR 20-7.031). [28] Under Section 303(d) of the Clean Water Act, states are to complete water quality assessments biennially. Information generated from the 303(d) listing process will be used to track progress and/or when an impaired water body is proposed for delisting.

Interim measurements for tracking short-term milestone progress will be obtained by tracking the frequency of in stream water quality thresholds (e.g. recreational bacterial exceedance counts), tracking land use changes, and continued sub-watershed or edge of field modeling etc. Statistical analysis of available water quality data will determine if statistically-significant decreases in pollutant concentrations and exceedances of water quality standards are correlated with implementation of BMPs in critical areas.

Specific chemical analysis, water quality, sediment, and bacteria milestones to track progress toward achieving the TMDLs will be provided by MoDNR.


If sediment, nutrient and bacteria milestones are met by 2034 by implementing recommended BMPs, then...
the Water Quality Standards will be met for all waterbodies in the watershed (in addition to improving any impairments listed on the 303d list) and...
The waters of the Spring River Watershed will meet their full designated uses.

10. Action Plan by Targeted Sub Watersheds

The Targeted Sub Watersheds are the geographic areas in the watershed that are most in need of conservation practices to reduce the pollution loads. Each sub watershed has been analyzed utilizing SWAT, a modeling program. SWAT has determined the areas that have the greatest potential to contribute sediment and nutrients from cropland. SWAT does not predict high potential livestock targeted areas. Therefore, the cropland targeted areas will be utilized for livestock targeting as well. Steambank BMPs and on-site wastewater treatment system BMPs are to be applied to the entire Spring Watershed so will not be addressed in this section of the Watershed Plan.

A North Fork Spring River Sub Watershed

The North Fork Spring River Sub Watershed has impairments of sediment, dissolved oxygen and bacteria. Therefore, it will be targeted for cropland, livestock and urban BMPs. It will be targeted for cropland BMPs to address the sediment TMDL and livestock BMPs to address the planned bacteria TMDL.

It has been calculated that the required sediment load reduction in this sub watershed is 2,737 tons of sediment to meet the TMDL goal. If all cropland BMPs are implemented in this watershed, 454 tons of sediment will be reduced each year. In addition to the sediment reduction from cropland, sediment from urban BMPs will contribute 1.03 tons towards meeting the TMDL goal. **This load reduction will be attained if all BMPs are implemented in the watershed.**

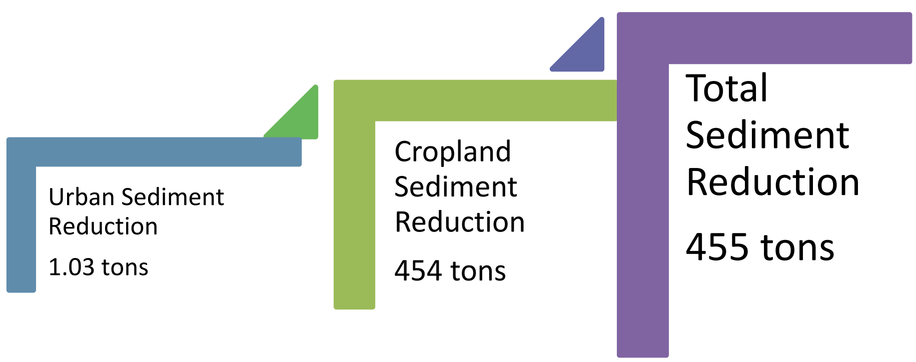


Figure 26 Annual Sediment Reduction by Category in North Fork Spring River Sub Watershed after All BMPs have been Implemented.

Since phosphorus is tied to manure and the needed bacteria reduction, it has been calculated that the phosphorus load reduction for control of bacteria in this sub watershed is 50,459 pounds of phosphorus over the 20 year life of the plan. If all livestock BMPs are implemented in this watershed, 2,621 pounds of phosphorus will be reduced each year. In addition to the phosphorus reduction that is connected to bacteria contribution, phosphorus from cropland BMPs and urban BMPs will contribute 1,175 pounds. **This load reduction will be attained if all BMPs are implemented in the watershed.**

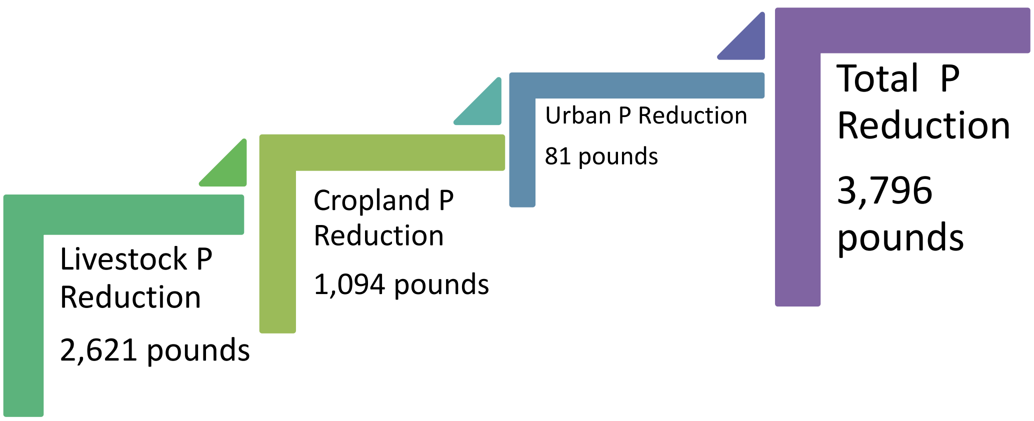


Figure 27. Annual Phosphorus Reduction by Category in North Fork Spring River Sub Watershed after All BMPs have been Implemented.

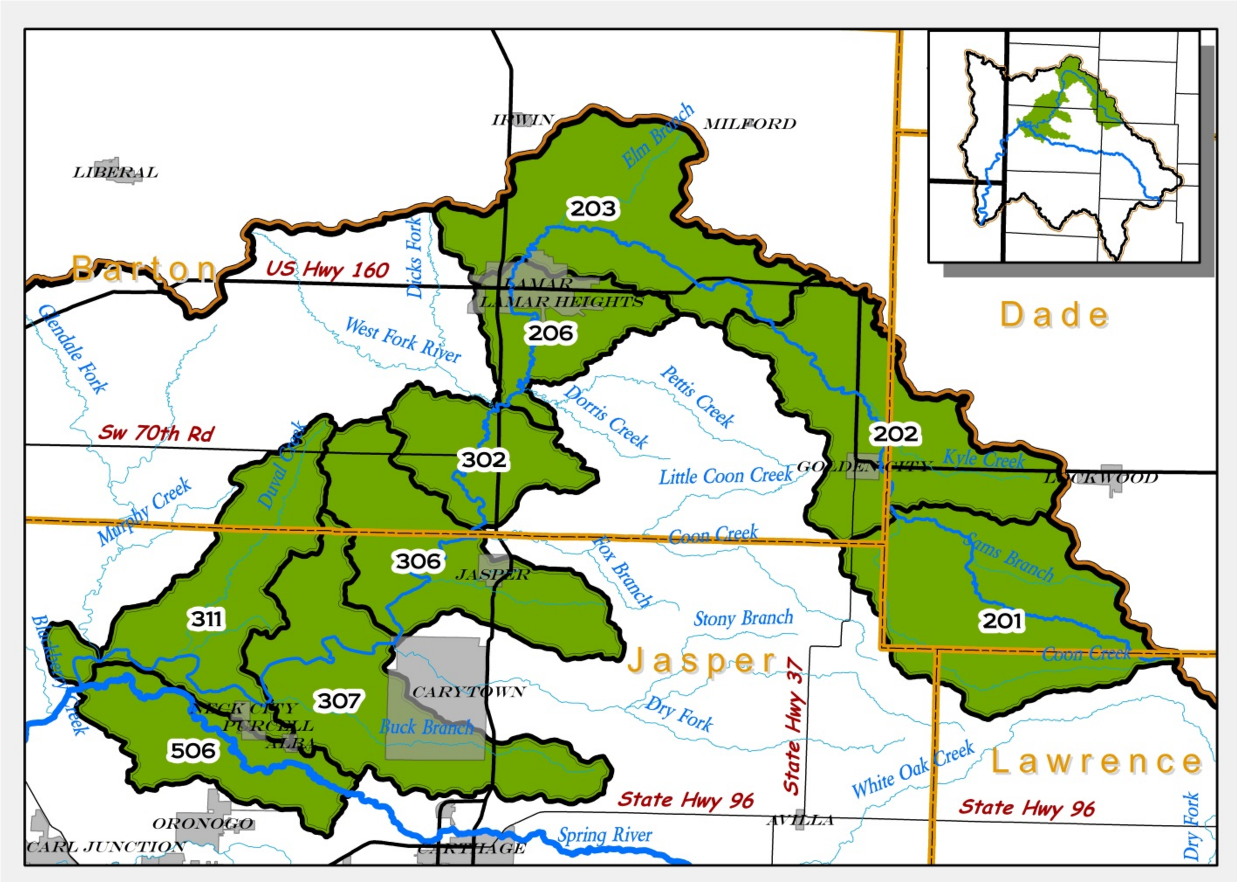


Figure 28. North Fork Spring River Sub Watershed

Table 46. SWAT Generated Land Use in North Fork Spring River Sub Watershed.

Land Use	Acres	Percentage of Land Use
Cropland	72,086	34%
Hay and Pasture	103,712	48%
Urban	12,713	6%
Woodland	23,846	11%
Water	2,480	1%
Total	214,838	100%

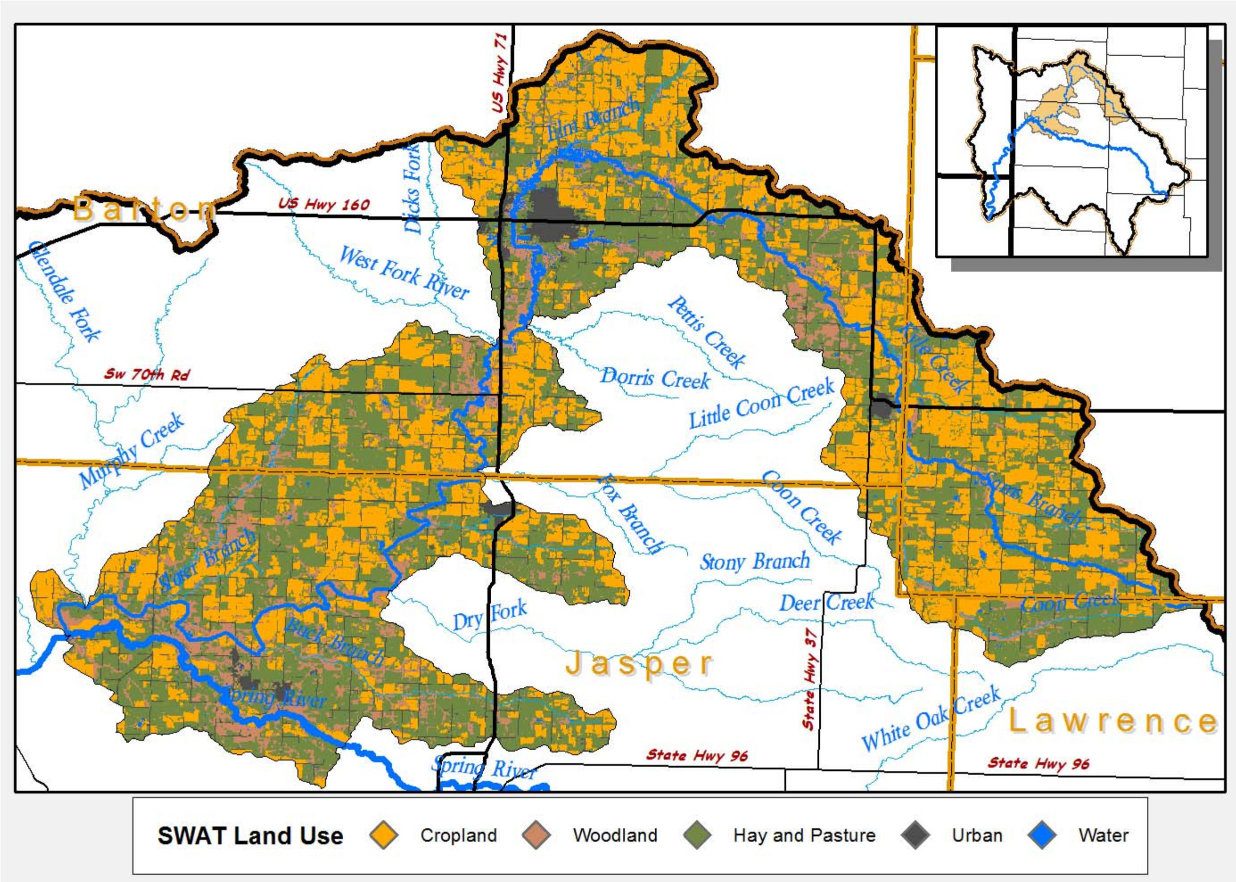


Figure 29. SWAT Generated Land Use in North Fork Spring Sub Watershed.

1) Targeted Priority Areas

The SWAT determined priority catchment areas in the North Fork Spring River Sub Watershed are located in HUC 12 numbers 201, 202, 203 and 306 as shown in the dark green color on the map below. These Priority 1 catchment areas will be the top priority for BMP placement for cropland and livestock BMPs. Urban BMPs will be placed in any urban area in the watershed.

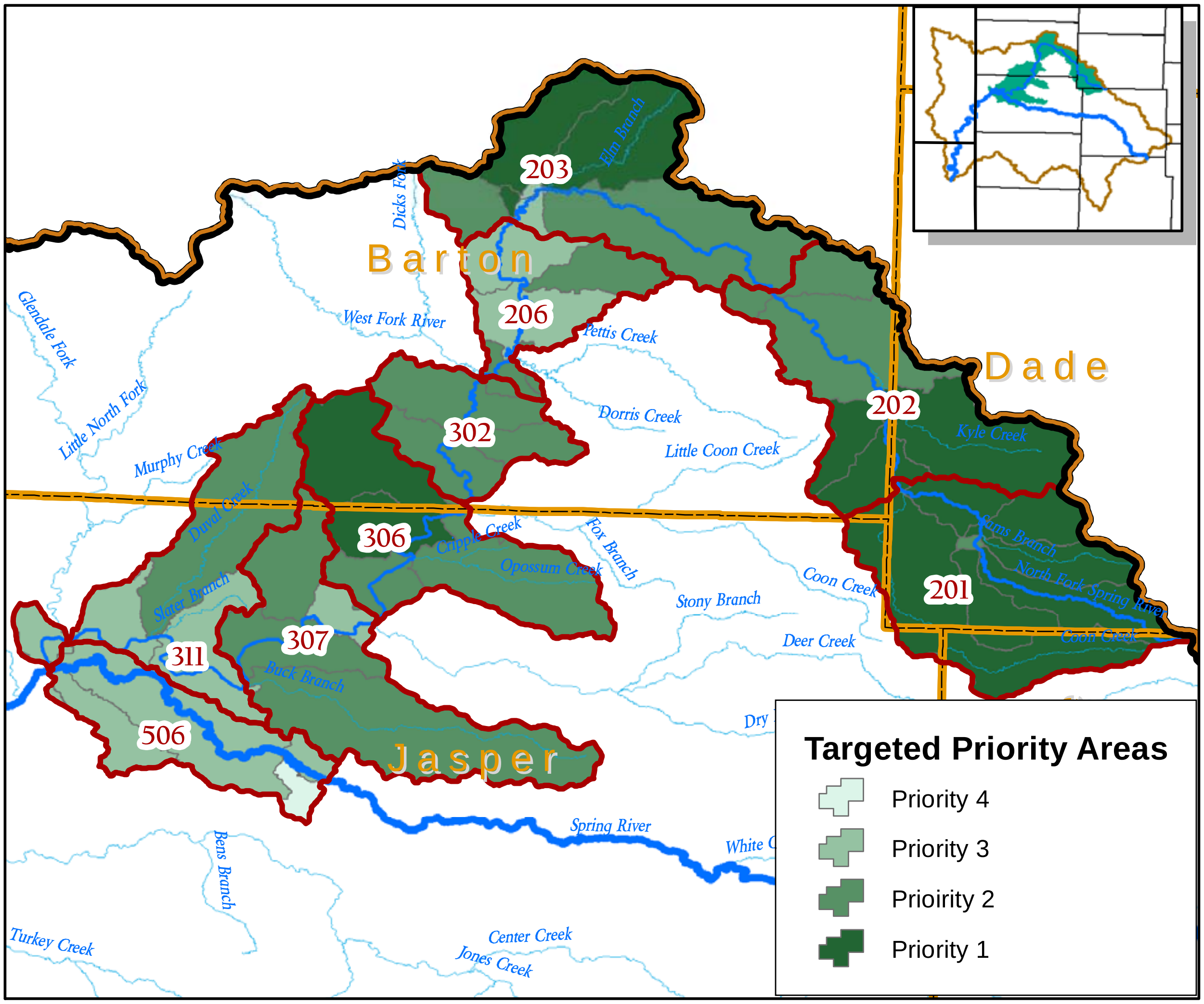


Figure 30. Targeted Priority Areas in the North Fork Spring River Sub Watershed

2) Adoption Rates for BMPs by Pollutant Source

Table 47. Cropland Annual BMP Adoption Rates in North Fork Spring River Sub Watershed. *

North Fork Spring River Annual Adoption (treated acres), Cropland BMPs									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	93	93	93	93	93	93	93	93	745
2	93	93	93	93	93	93	93	93	745
3	93	93	93	93	93	93	93	93	745
4	93	93	93	93	93	93	93	93	745
5	93	93	93	93	93	93	93	93	745
6	93	93	93	93	93	93	93	93	745
7	93	93	93	93	93	93	93	93	745

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
8	93	93	93	93	93	93	93	93	745
9	93	93	93	93	93	93	93	93	745
10	93	93	93	93	93	93	93	93	745
11	93	93	93	93	93	93	93	93	745
12	93	93	93	93	93	93	93	93	745
13	93	93	93	93	93	93	93	93	745
14	93	93	93	93	93	93	93	93	745
15	93	93	93	93	93	93	93	93	745
16	93	93	93	93	93	93	93	93	745
17	93	93	93	93	93	93	93	93	745
18	93	93	93	93	93	93	93	93	745
19	93	93	93	93	93	93	93	93	745
20	93	93	93	93	93	93	93	93	745

***Adoption rates by HUC 12 are provided in the Appendix.**

Table 48. Livestock BMP Adoption Rates in North Fork Spring River Sub Watershed.

Adoption Rates for Livestock BMPs, number							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Adoption (over 20 years)
50	50	20	20	4	8	4	156

Table 49. Urban BMP Adoption Rates in North Fork Spring River Sub Watershed.

North Fork Spring River Urban BMP Adoption				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Total Adoption
1	1			1
2		1		1
3			1	1
4				0
5				0
6	1			1
7		1		1
8			1	1
9				0
10				0
11	1			1
12				0

Year	Bioswale	Stream Buffers	Permanent Vegetation	Total Adoption
13		1		1
14			1	1
15				0
16	1			1
17		1		1
18			1	1
19				0
20				0

3) Pollutant Reduction

Table 50. Cropland BMP Annual Erosion Load Reductions in North Fork Spring River Sub Watershed. * Required sediment reduction is 2,737 tons. Reduction goal is met in Year 11.

North Fork Spring River Annual Soil Erosion Reduction										
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**	**% of Goal**
1	67	9	22	22	35	27	44	44	271	10%
2	133	18	44	44	71	53	89	89	541	20%
3	200	27	67	67	106	80	133	133	812	30%
4	266	35	89	89	142	106	177	177	1,083	40%
5	333	44	111	111	177	133	222	222	1,353	49%
6	399	53	133	133	213	160	266	266	1,624	59%
7	466	62	155	155	248	186	311	311	1,894	69%
8	532	71	177	177	284	213	355	355	2,165	79%
9	599	80	200	200	319	240	399	399	2,436	89%
10	665	89	222	222	355	266	444	444	2,706	99%
11	732	98	244	244	390	293	488	488	2,977	109%
12	799	106	266	266	426	319	532	532	3,248	119%
13	865	115	288	288	461	346	577	577	3,518	129%
14	932	124	311	311	497	373	621	621	3,789	138%
15	998	133	333	333	532	399	665	665	4,060	148%
16	1,065	142	355	355	568	426	710	710	4,330	158%
17	1,131	151	377	377	603	453	754	754	4,601	168%
18	1,198	160	399	399	639	479	799	799	4,871	178%
19	1,264	169	421	421	674	506	843	843	5,142	188%
20	1,331	177	444	444	710	532	887	887	5,413	198%

***Cropland erosion load reductions by HUC 12 can be found in the Appendix.**

Table 51. Cropland BMP Annual Phosphorus Load Reductions in North Fork Spring River Sub Watershed. *

North Fork Spring River Annual Phosphorus Reduction (lbs)									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	159	60	99	99	159	119	199	199	1,094
2	318	119	199	199	318	239	398	398	2,189
3	478	179	298	298	478	358	597	597	3,283
4	637	239	398	398	637	478	796	796	4,377
5	796	298	497	497	796	597	995	995	5,471
6	955	358	597	597	955	716	1,194	1,194	6,566
7	1,114	418	696	696	1,114	836	1,393	1,393	7,660
8	1,273	478	796	796	1,273	955	1,592	1,592	8,754
9	1,433	537	895	895	1,433	1,074	1,791	1,791	9,849
10	1,592	597	995	995	1,592	1,194	1,990	1,990	10,943
11	1,751	657	1,094	1,094	1,751	1,313	2,189	2,189	12,037
12	1,910	716	1,194	1,194	1,910	1,433	2,388	2,388	13,131
13	2,069	776	1,293	1,293	2,069	1,552	2,586	2,586	14,226
14	2,228	836	1,393	1,393	2,228	1,671	2,785	2,785	15,320
15	2,388	895	1,492	1,492	2,388	1,791	2,984	2,984	16,414
16	2,547	955	1,592	1,592	2,547	1,910	3,183	3,183	17,509
17	2,706	1,015	1,691	1,691	2,706	2,029	3,382	3,382	18,603
18	2,865	1,074	1,791	1,791	2,865	2,149	3,581	3,581	19,697
19	3,024	1,134	1,890	1,890	3,024	2,268	3,780	3,780	20,791
20	3,183	1,194	1,990	1,990	3,183	2,388	3,979	3,979	21,886

***Cropland phosphorus load reductions by HUC 12 can be found in the Appendix.**

Table 52. Cropland BMP Annual Nitrogen Load Reductions in North Fork Spring River Sub Watershed. *

North Fork Spring River Annual Nitrogen Reduction (lbs)									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	335	201	335	335	536	402	335	670	3,149
2	670	402	670	670	1,072	804	670	1,340	6,299
3	1,005	603	1,005	1,005	1,608	1,206	1,005	2,010	9,448
4	1,340	804	1,340	1,340	2,144	1,608	1,340	2,680	12,598
5	1,675	1,005	1,675	1,675	2,680	2,010	1,675	3,350	15,747
6	2,010	1,206	2,010	2,010	3,216	2,412	2,010	4,021	18,897
7	2,345	1,407	2,345	2,345	3,753	2,814	2,345	4,691	22,046
8	2,680	1,608	2,680	2,680	4,289	3,216	2,680	5,361	25,196
9	3,015	1,809	3,015	3,015	4,825	3,619	3,015	6,031	28,345

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
10	3,350	2,010	3,350	3,350	5,361	4,021	3,350	6,701	31,494
11	3,686	2,211	3,686	3,686	5,897	4,423	3,686	7,371	34,644
12	4,021	2,412	4,021	4,021	6,433	4,825	4,021	8,041	37,793
13	4,356	2,613	4,356	4,356	6,969	5,227	4,356	8,711	40,943
14	4,691	2,814	4,691	4,691	7,505	5,629	4,691	9,381	44,092
15	5,026	3,015	5,026	5,026	8,041	6,031	5,026	10,051	47,242
16	5,361	3,216	5,361	5,361	8,577	6,433	5,361	10,722	50,391
17	5,696	3,417	5,696	5,696	9,113	6,835	5,696	11,392	53,541
18	6,031	3,619	6,031	6,031	9,649	7,237	6,031	12,062	56,690
19	6,366	3,820	6,366	6,366	10,185	7,639	6,366	12,732	59,839
20	6,701	4,021	6,701	6,701	10,722	8,041	6,701	13,402	62,989

***Cropland nitrogen load reductions by HUC 12 can be found in the Appendix of this Watershed Plan.**

Table 53. Livestock Phosphorus Load Reduction in the North Fork Spring River Sub Watershed.

Phosphorus Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction (over 20 years)
5,249	**23,750**	**9,500**	**7,600**	**3,553**	**988**	**1,777**	**52,416**

Table 54. Livestock Nitrogen Load Reduction in the North Fork Spring River Sub Watershed.

Nitrogen Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction (over 20 years)
9,886	**44,733**	**17,893**	**14,314**	**6,692**	**1,861**	**3,346**	**98,725**

Table 55. Urban Sediment Load Reduction in the North Fork Spring River Sub Watershed.

North Fork Spring River Urban BMP Sediment Reduction Rates (tons)				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Cumulative Load Reduction
1	1.03	0.00	0.00	1.03
2	1.03	1.54	0.00	2.56
3	1.03	1.54	0.10	2.67
4	1.03	1.54	0.10	2.67
5	1.03	1.54	0.10	2.67
6	2.05	1.54	0.10	3.69
7	2.05	3.08	0.10	5.23

Year	Bioswale	Stream Buffers	Permanent Vegetation	Cumulative Load Reduction
8	2.05	3.08	0.21	5.33
9	2.05	3.08	0.21	5.33
10	2.05	3.08	0.21	5.33
11	3.08	3.08	0.21	6.36
12	3.08	3.08	0.21	6.36
13	3.08	4.61	0.21	7.89
14	3.08	4.61	0.31	8.00
15	3.08	4.61	0.31	8.00
16	4.10	4.61	0.31	9.02
17	4.10	6.15	0.31	10.56
18	4.10	6.15	0.41	10.66
19	4.10	6.15	0.41	10.66
20	4.10	6.15	0.41	10.66

Table 56. Urban Phosphorus Load reduction in the North Fork Spring River Sub Watershed.

North Fork Spring River Urban BMP Phosphorus Reduction Rates (pounds)				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	7.5	0	0	8
2	7.5	11.25	0	19
3	7.5	11.25	1.425	20
4	7.5	11.25	1.425	20
5	7.5	11.25	1.425	20
6	15	11.25	1.425	28
7	15	22.5	1.425	39
8	15	22.5	2.85	40
9	15	22.5	2.85	40
10	15	22.5	2.85	40
11	22.5	22.5	2.85	48
12	22.5	22.5	2.85	48
13	22.5	33.75	2.85	59
14	22.5	33.75	4.275	61
15	22.5	33.75	4.275	61
16	30	33.75	4.275	68
17	30	45	4.275	79
18	30	45	5.7	81
19	30	45	5.7	81
20	30	45	5.7	81

Table 57. Urban Nitrogen Load Reduction in the North Fork Spring River Sub Watershed.

North Fork Spring River Urban BMP Nitrogen Reduction Rates (pounds)				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	58.5	0	0	59
2	58.5	87.75	0	146
3	58.5	87.75	11.115	157
4	58.5	87.75	11.115	157
5	58.5	87.75	11.115	157
6	117	87.75	11.115	216
7	117	175.5	11.115	304
8	117	175.5	22.23	315
9	117	175.5	22.23	315
10	117	175.5	22.23	315
11	175.5	175.5	22.23	373
12	175.5	175.5	22.23	373
13	175.5	263.25	22.23	461
14	175.5	263.25	33.345	472
15	175.5	263.25	33.345	472
16	234	263.25	33.345	531
17	234	351	33.345	618
18	234	351	44.46	629
19	234	351	44.46	629
20	234	351	44.46	629

4) Costs of Implementing BMPs

Table 58. Cropland BMP Costs in the North Fork Spring River Sub Watershed. *

North Fork Spring River Total Annual Cost of Cropland BMPs, 3% Inflation									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	$7,234	$3,632	$7,263	$3,632	$14,899	$11,640	$6,208	$11,640	$66,148
2	$7,451	$3,741	$7,481	$3,741	$15,346	$11,989	$6,394	$11,989	$68,132
3	$7,675	$3,853	$7,706	$3,853	$15,806	$12,349	$6,586	$12,349	$70,176
4	$7,905	$3,968	$7,937	$3,968	$16,281	$12,719	$6,784	$12,719	$72,282
5	$8,142	$4,087	$8,175	$4,087	$16,769	$13,101	$6,987	$13,101	$74,450
6	$8,387	$4,210	$8,420	$4,210	$17,272	$13,494	$7,197	$13,494	$76,684
7	$8,638	$4,336	$8,673	$4,336	$17,790	$13,899	$7,413	$13,899	$78,984
8	$8,897	$4,466	$8,933	$4,466	$18,324	$14,316	$7,635	$14,316	$81,354
9	$9,164	$4,600	$9,201	$4,600	$18,874	$14,745	$7,864	$14,745	$83,794

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
10	$9,439	$4,738	$9,477	$4,738	$19,440	$15,187	$8,100	$15,187	$86,308
11	$9,722	$4,881	$9,761	$4,881	$20,023	$15,643	$8,343	$15,643	$88,897
12	$10,014	$5,027	$10,054	$5,027	$20,624	$16,112	$8,593	$16,112	$91,564
13	$10,315	$5,178	$10,356	$5,178	$21,243	$16,596	$8,851	$16,596	$94,311
14	$10,624	$5,333	$10,666	$5,333	$21,880	$17,094	$9,117	$17,094	$97,140
15	$10,943	$5,493	$10,986	$5,493	$22,536	$17,606	$9,390	$17,606	$100,055
16	$11,271	$5,658	$11,316	$5,658	$23,212	$18,135	$9,672	$18,135	$103,056
17	$11,609	$5,828	$11,655	$5,828	$23,909	$18,679	$9,962	$18,679	$106,148
18	$11,957	$6,003	$12,005	$6,003	$24,626	$19,239	$10,261	$19,239	$109,332
19	$12,316	$6,183	$12,365	$6,183	$25,365	$19,816	$10,569	$19,816	$112,612
20	$12,686	$6,368	$12,736	$6,368	$26,126	$20,411	$10,886	$20,411	$115,991

***Annual Costs by HUC 12 are provided in the Appendix.**

Table 59. Livestock BMP Costs in the North Fork Spring River Sub Watershed.

North Fork Spring River Livestock BMP Cost							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Cost (over 20 years)
$200,000	**$350,000**	**$60,000**	**$40,000**	**$48,000**	**$60,000**	**$4,000**	**$762,000**

Table 60. Urban BMP Costs in the North Fork Spring River Sub Watershed.

North Fork Spring River Urban BMP Implementation Cost				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Cost
1	$21,780	$0	$0	$21,780
2	$0	$1,000	$0	$1,000
3	$0	$0	$150	$150
4	$0	$0	$0	$0
5	$0	$0	$0	$0
6	$21,780	$0	$0	$21,780
7	$0	$1,000	$0	$1,000
8	$0	$0	$150	$150
9	$0	$0	$0	$0
10	$0	$0	$0	$0
11	$21,780	$0	$0	$21,780
12	$0	$0	$0	$0
13	$0	$1,000	$0	$1,000
14	$0	$0	$150	$150

Year	Bioswale	Stream Buffers	Permanent Vegetation	Cost
15	$0	$0	$0	$0
16	$21,780	$0	$0	$21,780
17	$0	$1,000	$0	$1,000
18	$0	$0	$150	$150
19	$0	$0	$0	$0
20	$0	$0	$0	$0

5) Totals by Category

Table 61. Sediment Load Reduction by Category in the North Fork Spring River Sub Watershed.

North Fork Spring River Total Sediment Reduction over the 20 Year Life of the Plan		
Best Management Practice Category	Total Sediment Reduction, tons	% of Total Reduction
Cropland	9,084	99.9%
Urban	11	0.1%
Total	**9,095**	**100.0%**

Table 62. Phosphorus Load Reduction by Category in the North Fork Spring River Sub Watershed.

North Fork Spring River Total Phosphorus Reduction over the 20 Year Life of the Plan		
Best Management Practice Category	Total Phosphorus Reduction, pounds	% of Total Reduction
Livestock	52,416	70.5%
Cropland	21,886	29.4%
Urban	81	0.1%
Total	**74,383**	**100.0%**

Table 63. North Fork Spring River Sub Watershed Total Cost by Category.

North Fork Spring River Total Cost over the 20 Year Life of the Plan		
Best Management Practice Category	Total Cost	% of Total Cost
Cropland	$1,777,418	67.6%
Livestock	$762,000	29.0%
Urban	$91,720	3.4%
Total	**$2,631,138**	**100.0%**

B Lamar Lake Sub Watershed

The Lamar Lake Sub Watershed is a public drinking water supply and therefore, is an important resource to be protected. It has a TMDL for total phosphorus. Therefore, it will be targeted for cropland BMPs. The Lamar Lake Watershed is located within the North Fork Spring River Sub Watershed. Livestock BMPs will be applied to the North Fork Spring River Sub Watershed so will not be addressed in this section. There are no urban areas in the watershed of the lake.

The required phosphorus load reduction in this sub watershed is 550 pounds per year. If all cropland BMPs are implemented in this watershed, 31 pounds of phosphorus will be reduced each year. The goal will be reached in year 18 of the plan. **This load reduction will be attained if all needed BMPs are implemented in the watershed.**

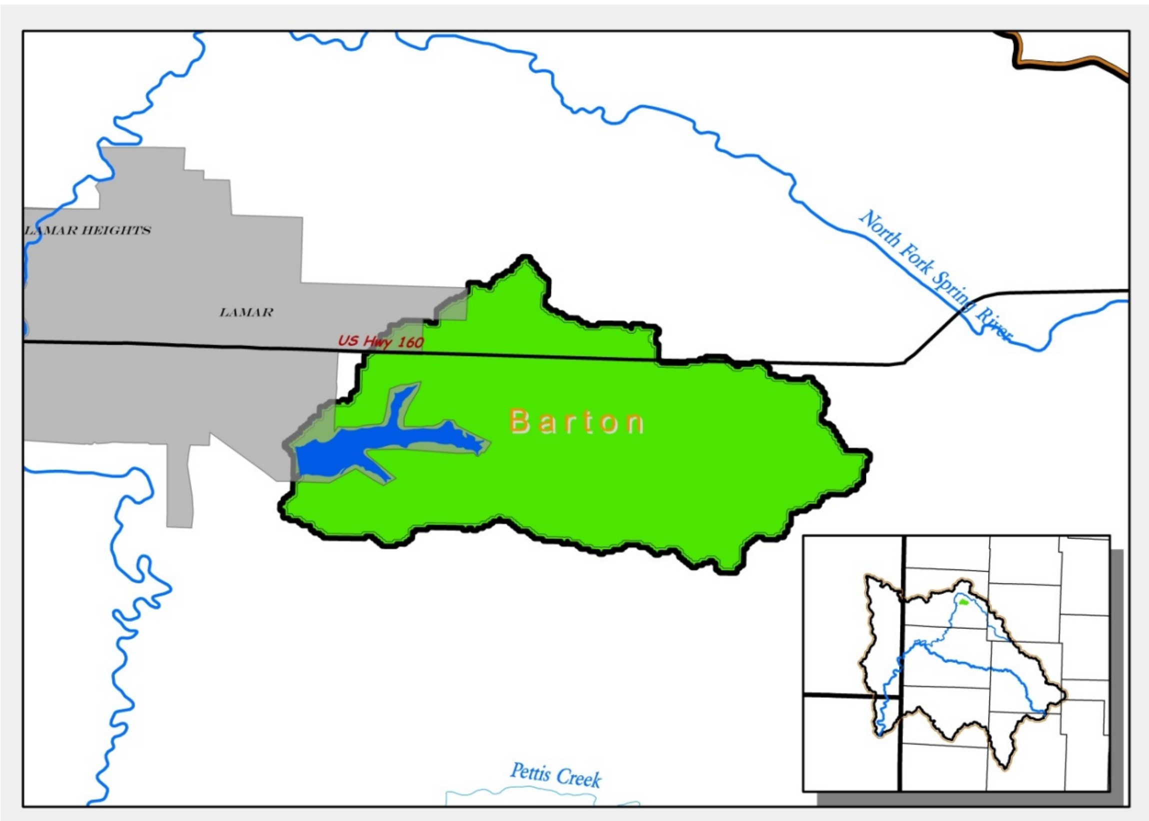


Figure 31. Lamar Lake Sub Watershed.

Table 64. SWAT Generated Land Use in Lamar Lake Sub Watershed.

Land Use	Acres	Percentage of Land Use
Cropland	218	6%
Hay and Pasture	2,313	67%
Urban	305	9%
Woodland	412	12%
Water	218	6%
Total	3,465	100%

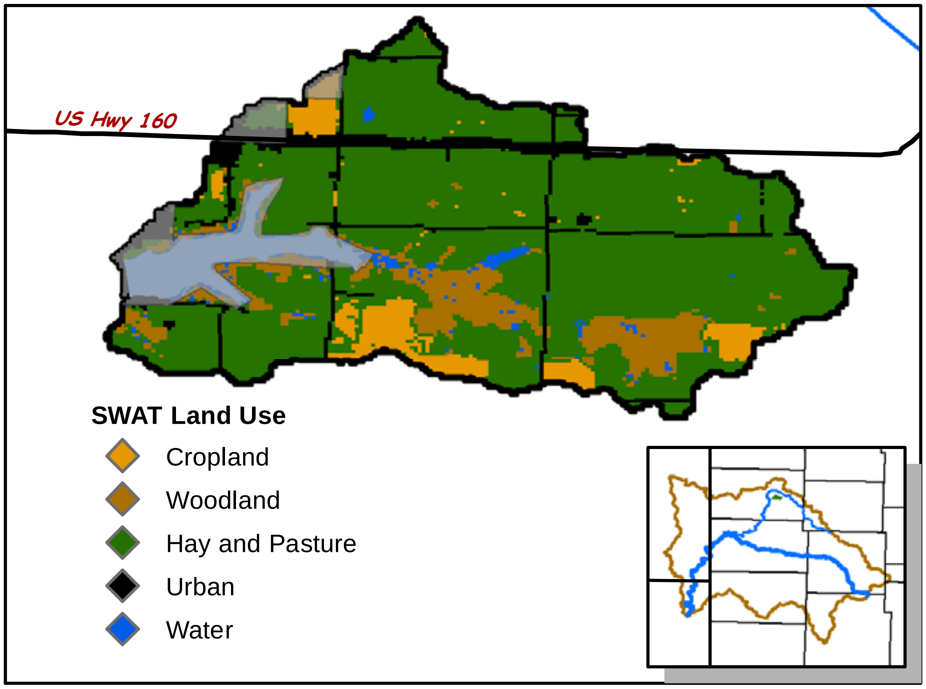


Figure 32. SWAT Generated Land use in Lamar Lake Sub Watershed.

Table 65. Cropland BMP Adoption Rates for the Lamar Lake Sub Watershed.

BMP Adoption Rates for Lamar Lake Sub Watershed, acres								
No-Till	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
108	108	54	54	54	54	54	54	540

Table 66. Cropland Erosion Load Reduction in the Lamar Lake Sub Watershed.

Cumulative Sediment Load Reductions	
Year	**Cropland BMPs (tons)**
1	29
2	58
3	87
4	116
5	145
6	174
7	203
8	232
9	261
10	290

Year	Cropland BMPs (tons)
11	319
12	348
13	377
14	406
15	435
16	464
17	493
18	522
19	551
20	580

Table 67. Cropland Annual Phosphorus Load Reduction in the Lamar Lake Sub Watershed. Required Annual TMDL Phosphorus Load Reduction is 550 pounds. This goal will be achieved in Year 18 of the plan.

Cumulative Phosphorus Load Reductions Meeting the Lamar Lake Nutrient TMDL		
Year	**Cropland BMPs (lbs/year)**	**Percent of TMDL**
1	31	6%
2	63	11%
3	94	17%
4	125	23%
5	157	29%
6	188	34%
7	220	40%
8	251	46%
9	282	51%
10	314	57%
11	345	63%
12	376	68%
13	408	74%
14	439	80%
15	470	86%
16	502	91%
17	533	97%
18	564	103%
19	596	108%
20	627	114%
TMDL:		**550**

Table 68. Cropland Nitrogen Load Reduction in the Lamar Lake Sub Watershed.

Cumulative Nitrogen Load Reductions for Cropland BMPs	
Year	**Cropland BMPs (lbs)**
1	80
2	159
3	239
4	318
5	398
6	477
7	557
8	636
9	716
10	795
11	875
12	954
13	1,034
14	1,113
15	1,193
16	1,272
17	1,352
18	1,431
19	1,511
20	1,590

Table 69. Annual Cost in the Lamar Lake Sub Watershed for Cropland BMP Implementation.

Year	Annual Cost
1	$2,234
2	$2,301
3	$2,370
4	$2,441
5	$2,514
6	$2,589
7	$2,667
8	$2,747
9	$2,829
10	$2,914
11	$3,002
12	$3,092
13	$3,184

Year	Annual Cost
14	$3,280
15	$3,378
16	$3,480
17	$3,584
18	$3,692
19	$3,802
20	$3,917

C Dry Fork Sub Watershed

The Dry Fork Sub Watershed has an impairment for bacteria. Therefore, it will be targeted for livestock BMPs. Cropland BMPs will also be addressed.

Since phosphorus is tied to manure, it has been calculated that the phosphorus load reduction for control of bacteria in this sub watershed is 13,518 pounds of phosphorus over the 20 year life of the plan. If all livestock BMPs are implemented in this watershed, 737 pounds of phosphorus will be reduced each year. In addition to the phosphorus reduction that is connected to bacteria contribution, phosphorus from cropland BMPs will contribute 1,106 pounds annually. **This load reduction will be attained if all BMPs are implemented in the watershed.** Since there are no major urban areas in this sub watershed, no urban BMPs will be assigned.

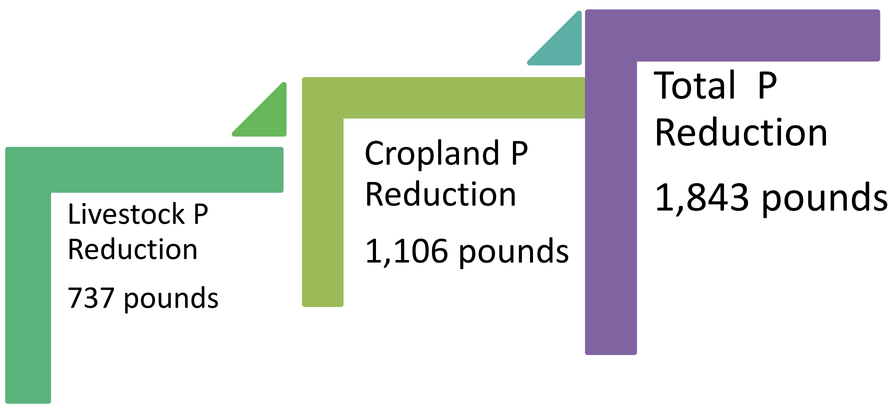


Figure 33. Annual Phosphorus Reduction by Category in Dry Fork Sub Watershed after All BMPs have been Implemented.

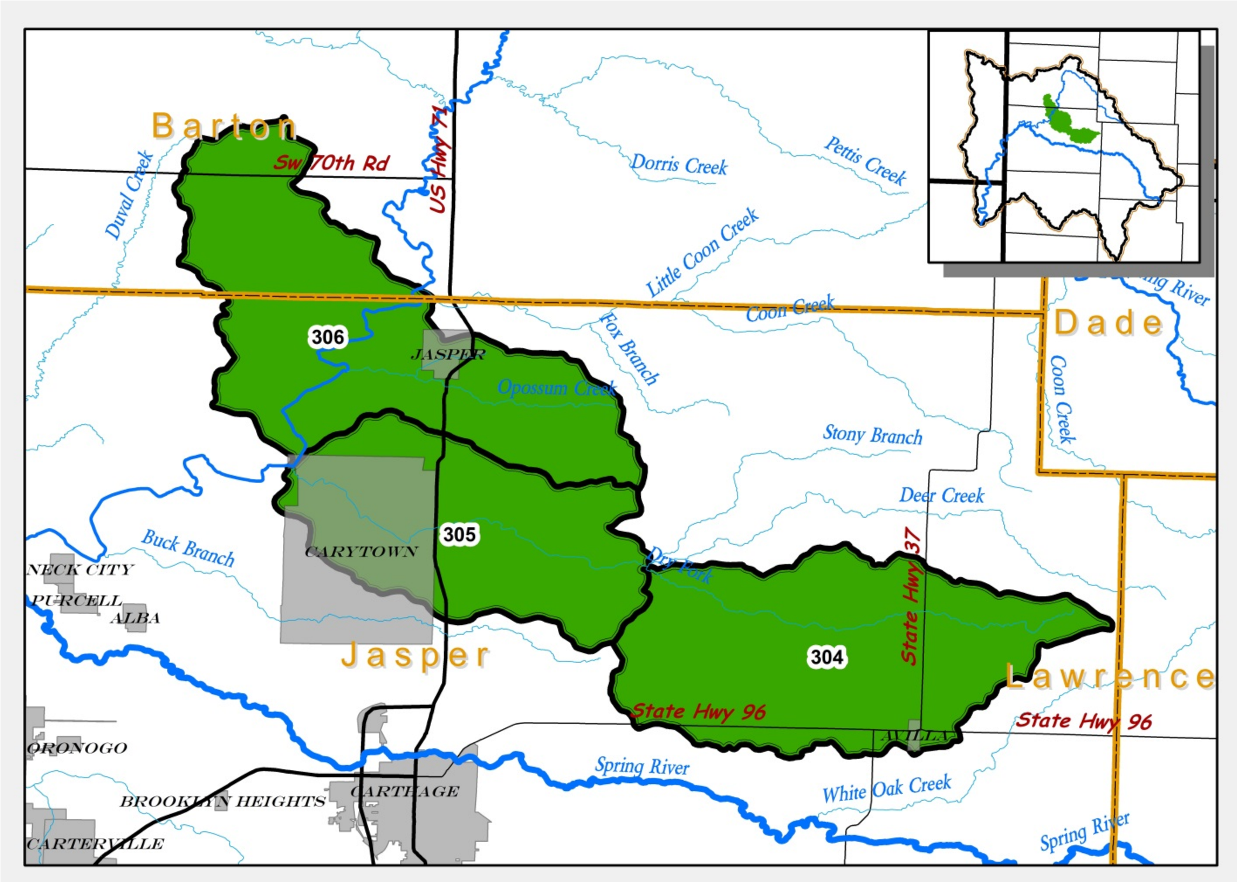


Figure 34. Dry Fork Sub Watershed.

Table 70. SWAT Generated Land Use in the Dry Creek Sub Watershed.

Land Use	Acres	Percentage of Land Use
Cropland	18,877	29%
Hay and Pasture	37,055	57%
Urban	3,255	5%
Woodland	5,240	8%
Water	258	0%
Total	64,685	100%

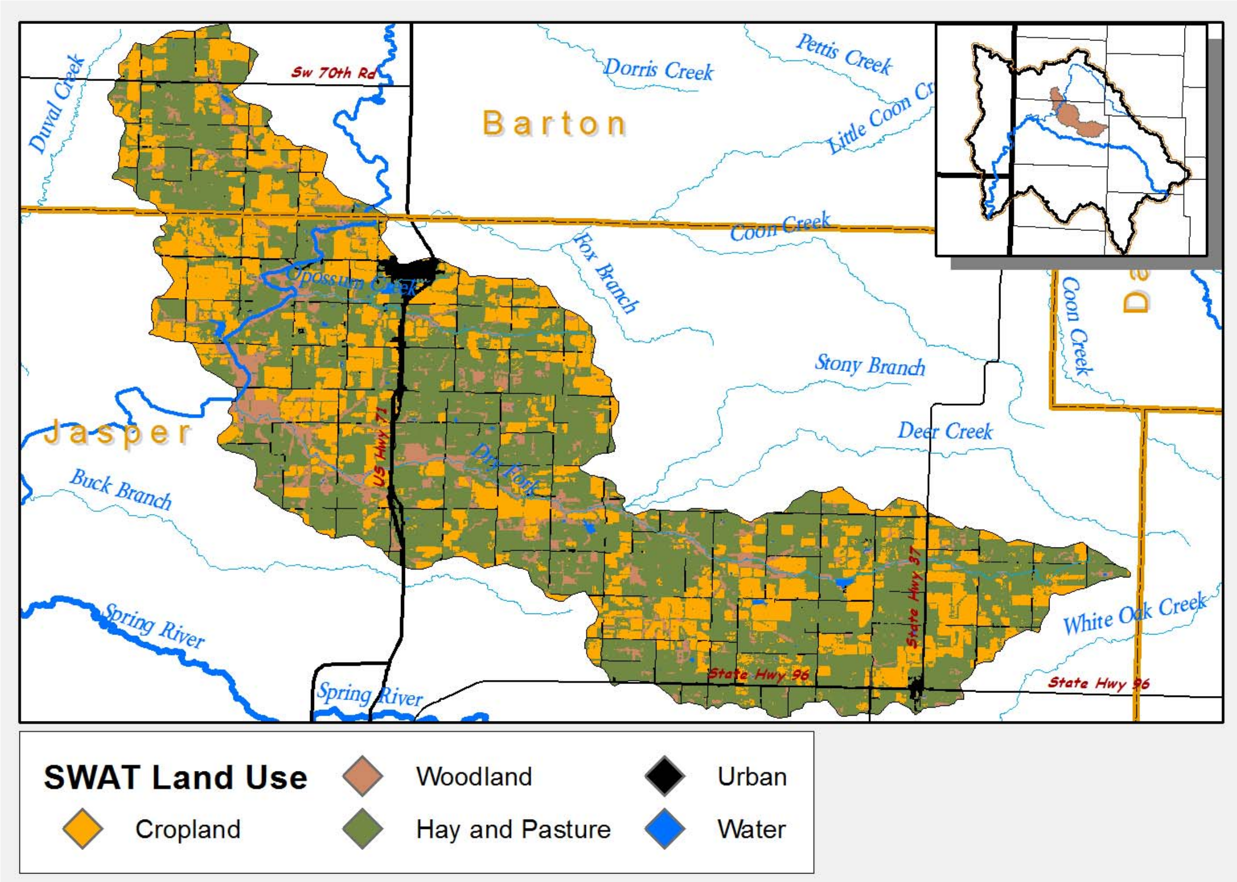


Figure 35. SWAT Generated Land Use in the Dry Fork Sub Watershed.

1) Targeted Priority Areas

The SWAT determined Priority 1 Targeted Area is contained in the northern portion of HUC 306 as shown in the dark green color on the map below. This Priority 1 catchment area will be the top priority for BMP placement for cropland and livestock BMPs.

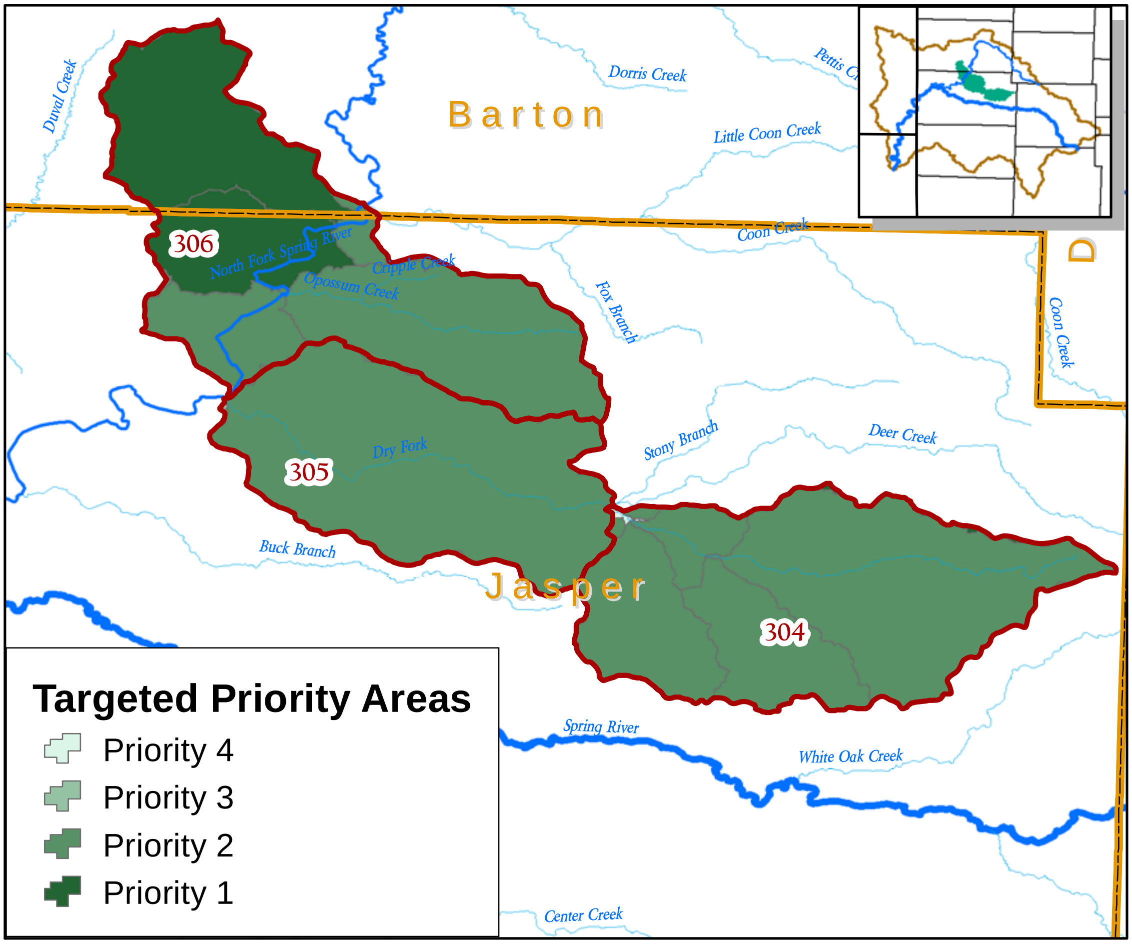


Figure 36. Targeted Priority Areas in Dry Fork Sub Watershed.

2) Adoption Rates for BMPs by Pollutant Source

Table 71. Cropland BMP Adoption Rates in Dry Fork Sub Watershed. *

Dry Fork Creek Annual Adoption (treated acres), Cropland BMPs									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	87	87	87	87	87	87	87	87	700
2	87	87	87	87	87	87	87	87	700
3	87	87	87	87	87	87	87	87	700
4	87	87	87	87	87	87	87	87	700
5	87	87	87	87	87	87	87	87	700
6	87	87	87	87	87	87	87	87	700
7	87	87	87	87	87	87	87	87	700
8	87	87	87	87	87	87	87	87	700
9	87	87	87	87	87	87	87	87	700

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
10	87	87	87	87	87	87	87	87	700
11	87	87	87	87	87	87	87	87	700
12	87	87	87	87	87	87	87	87	700
13	87	87	87	87	87	87	87	87	700
14	87	87	87	87	87	87	87	87	700
15	87	87	87	87	87	87	87	87	700
16	87	87	87	87	87	87	87	87	700
17	87	87	87	87	87	87	87	87	700
18	87	87	87	87	87	87	87	87	700
19	87	87	87	87	87	87	87	87	700
20	87	87	87	87	87	87	87	87	700

***Adoption rates by HUC 12 are provided in the Appendix.**

Table 72. Livestock BMP Adoption Rates in Dry Fork Sub Watershed.

Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Adoption (over 20 years)
8	8	5	5	2	4	8	**40**

3) Pollutant Load Reductions

Table 73. Cropland Erosion Load Reduction in the Dry Fork Sub Watershed.*

Dry Fork Creek Annual Soil Erosion Reduction									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	89	12	30	30	48	36	59	59	363
2	178	24	59	59	95	71	119	119	725
3	268	36	89	89	143	107	178	178	1,088
4	357	48	119	119	190	143	238	238	1,451
5	446	59	149	149	238	178	297	297	1,813
6	535	71	178	178	285	214	357	357	2,176
7	624	83	208	208	333	250	416	416	2,539
8	713	95	238	238	381	285	476	476	2,901
9	803	107	268	268	428	321	535	535	3,264
10	892	119	297	297	476	357	595	595	3,627
11	981	131	327	327	523	392	654	654	3,989
12	1,070	143	357	357	571	428	713	713	4,352

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
13	1,159	155	386	386	618	464	773	773	4,715
14	1,249	166	416	416	666	499	832	832	5,077
15	1,338	178	446	446	713	535	892	892	5,440
16	1,427	190	476	476	761	571	951	951	5,803
17	1,516	202	505	505	809	606	1,011	1,011	6,165
18	1,605	214	535	535	856	642	1,070	1,070	6,528
19	1,694	226	565	565	904	678	1,130	1,130	6,891
20	1,784	238	595	595	951	713	1,189	1,189	7,254

***Erosion load reductions by HUC 12 are provided in the Appendix.**

Table 74. Cropland Phosphorus Load Reduction in the Dry Fork Sub Watershed.*

Dry Fork Creek Annual Phosphorus Reduction (lbs)									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	161	60	101	101	161	121	201	201	1,106
2	322	121	201	201	322	241	402	402	2,213
3	483	181	302	302	483	362	604	604	3,319
4	644	241	402	402	644	483	805	805	4,426
5	805	302	503	503	805	604	1,006	1,006	5,532
6	966	362	604	604	966	724	1,207	1,207	6,639
7	1,127	422	704	704	1,127	845	1,408	1,408	7,745
8	1,288	483	805	805	1,288	966	1,609	1,609	8,852
9	1,448	543	905	905	1,448	1,086	1,811	1,811	9,958
10	1,609	604	1,006	1,006	1,609	1,207	2,012	2,012	11,065
11	1,770	664	1,106	1,106	1,770	1,328	2,213	2,213	12,171
12	1,931	724	1,207	1,207	1,931	1,448	2,414	2,414	13,278
13	2,092	785	1,308	1,308	2,092	1,569	2,615	2,615	14,384
14	2,253	845	1,408	1,408	2,253	1,690	2,816	2,816	15,491
15	2,414	905	1,509	1,509	2,414	1,811	3,018	3,018	16,597
16	2,575	966	1,609	1,609	2,575	1,931	3,219	3,219	17,704
17	2,736	1,026	1,710	1,710	2,736	2,052	3,420	3,420	18,810
18	2,897	1,086	1,811	1,811	2,897	2,173	3,621	3,621	19,917
19	3,058	1,147	1,911	1,911	3,058	2,293	3,822	3,822	21,023
20	3,219	1,207	2,012	2,012	3,219	2,414	4,024	4,024	22,130

***Phosphorus load reductions by HUC 12 are provided in the Appendix.**

Table 75. Cropland Nitrogen Load Reduction in the Dry Fork Sub Watershed.*

Dry Fork Creek Annual Nitrogen Reduction (lbs)									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	336	202	336	336	538	404	336	673	3,162
2	673	404	673	673	1,076	807	673	1,346	6,324
3	1,009	605	1,009	1,009	1,615	1,211	1,009	2,018	9,486
4	1,346	807	1,346	1,346	2,153	1,615	1,346	2,691	12,648
5	1,682	1,009	1,682	1,682	2,691	2,018	1,682	3,364	15,810
6	2,018	1,211	2,018	2,018	3,229	2,422	2,018	4,037	18,972
7	2,355	1,413	2,355	2,355	3,768	2,826	2,355	4,709	22,134
8	2,691	1,615	2,691	2,691	4,306	3,229	2,691	5,382	25,296
9	3,027	1,816	3,027	3,027	4,844	3,633	3,027	6,055	28,458
10	3,364	2,018	3,364	3,364	5,382	4,037	3,364	6,728	31,620
11	3,700	2,220	3,700	3,700	5,920	4,440	3,700	7,401	34,783
12	4,037	2,422	4,037	4,037	6,459	4,844	4,037	8,073	37,945
13	4,373	2,624	4,373	4,373	6,997	5,248	4,373	8,746	41,107
14	4,709	2,826	4,709	4,709	7,535	5,651	4,709	9,419	44,269
15	5,046	3,027	5,046	5,046	8,073	6,055	5,046	10,092	47,431
16	5,382	3,229	5,382	5,382	8,612	6,459	5,382	10,764	50,593
17	5,719	3,431	5,719	5,719	9,150	6,862	5,719	11,437	53,755
18	6,055	3,633	6,055	6,055	9,688	7,266	6,055	12,110	56,917
19	6,391	3,835	6,391	6,391	10,226	7,670	6,391	12,783	60,079
20	6,728	4,037	6,728	6,728	10,764	8,073	6,728	13,456	63,241

***Nitrogen load reductions by HUC 12 are provided in the Appendix.**

Table 76. Livestock Phosphorus Load Reduction in the North Fork Spring River Sub Watershed.

Phosphorus Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction (over 20 years)
840	3,800	2,375	1,900	1,777	494	3,553	14,738

Table 77. Livestock Nitrogen Load Reduction in the Dry Fork Sub Watershed.

Nitrogen Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction (over 20 years)
1,582	7,157	4,473	3,579	3,346	930	6,692	27,760

4) Costs of Implementing BMPs

Table 78. Cropland Costs of Implementing BMPs in the Dry Fork Sub Watershed.*

Dry Fork Creek Total Annual Cost of Cropland BMPs, 3% Inflation									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	$6,795	$3,411	$6,822	$3,411	$13,995	$10,933	$5,831	$10,933	$62,132
2	$6,999	$3,514	$7,027	$3,514	$14,414	$11,261	$6,006	$11,261	$63,996
3	$7,209	$3,619	$7,238	$3,619	$14,847	$11,599	$6,186	$11,599	$65,916
4	$7,425	$3,727	$7,455	$3,727	$15,292	$11,947	$6,372	$11,947	$67,893
5	$7,648	$3,839	$7,679	$3,839	$15,751	$12,305	$6,563	$12,305	$69,930
6	$7,878	$3,954	$7,909	$3,954	$16,224	$12,675	$6,760	$12,675	$72,028
7	$8,114	$4,073	$8,146	$4,073	$16,710	$13,055	$6,963	$13,055	$74,189
8	$8,357	$4,195	$8,391	$4,195	$17,212	$13,447	$7,171	$13,447	$76,415
9	$8,608	$4,321	$8,642	$4,321	$17,728	$13,850	$7,387	$13,850	$78,707
10	$8,866	$4,451	$8,902	$4,451	$18,260	$14,265	$7,608	$14,265	$81,068
11	$9,132	$4,584	$9,169	$4,584	$18,808	$14,693	$7,836	$14,693	$83,500
12	$9,406	$4,722	$9,444	$4,722	$19,372	$15,134	$8,072	$15,134	$86,005
13	$9,688	$4,864	$9,727	$4,864	$19,953	$15,588	$8,314	$15,588	$88,586
14	$9,979	$5,009	$10,019	$5,009	$20,552	$16,056	$8,563	$16,056	$91,243
15	$10,278	$5,160	$10,319	$5,160	$21,168	$16,538	$8,820	$16,538	$93,980
16	$10,587	$5,315	$10,629	$5,315	$21,803	$17,034	$9,085	$17,034	$96,800
17	$10,904	$5,474	$10,948	$5,474	$22,457	$17,545	$9,357	$17,545	$99,704
18	$11,231	$5,638	$11,276	$5,638	$23,131	$18,071	$9,638	$18,071	$102,695
19	$11,568	$5,807	$11,615	$5,807	$23,825	$18,613	$9,927	$18,613	$105,776
20	$11,915	$5,982	$11,963	$5,982	$24,540	$19,172	$10,225	$19,172	$108,949

***Costs by HUC 12 are provided in the Appendix.**

Table 79. Livestock Costs for Implementing BMPs in the Dry Fork Sub Watershed.

Dry Fork Livestock BMP Cost							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Cost (over 20 years)
$32,000	$56,000	$15,000	$10,000	$24,000	$30,000	$8,000	$175,000

5) Totals by Category

Table 80. Dry Fork Sub Watershed Total Phosphorus Load Reduction by Category.

Dry Fork Total Phosphorus Reduction over the 20 Year Life of the Plan		
Best Management Practice Category	Total Phosphorus Reduction, pounds	% of Total Cost
Cropland	22,130	60%
Livestock	14,738	40%
Total	**36,868**	**100%**

Table 81. Dry Fork Sub Watershed Total Cost by Category.

North Fork Spring River Total Cost over the 20 Year Life of the Plan		
Best Management Practice Category	Total Cost	% of Total Cost
Cropland	$1,669,513	91%
Livestock	$175,000	9%
Total	**$1,844,513**	**100%**

D Spring River Sub Watershed

The Spring River Sub Watershed has an impairment for bacteria. Therefore, it will be targeted for livestock BMPs to address the planned bacteria TMDL. Cropland BMPs will also be addressed. Urban BMPs will apply to this watershed to be implemented in any urban area, but with special consideration to Carthage, a town with a population of 12,668.

The Spring River Sub Watershed includes Truitt and Williams Creek sub watersheds in HUC 105.

Since phosphorus is tied to manure, it has been calculated that the phosphorus load reduction for control of bacteria in this sub watershed is 53,807 pounds of phosphorus over the 20 year life of the plan. If all livestock BMPs are implemented in this watershed, 2,693 pounds of phosphorus will be reduced each year. In addition to the phosphorus reduction that is connected to bacteria contribution, phosphorus from cropland BMPs and urban BMPs will contribute 2,076 pounds. **This load reduction will be attained if all BMPs are implemented in the watershed.**

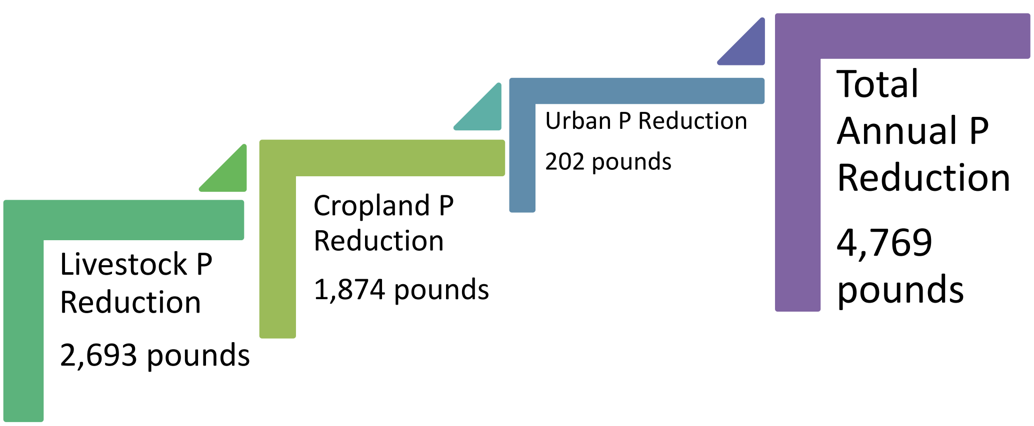


Figure 37. Annual Phosphorus Reduction by Category in Spring River Sub Watershed after All BMPs have been Implemented.

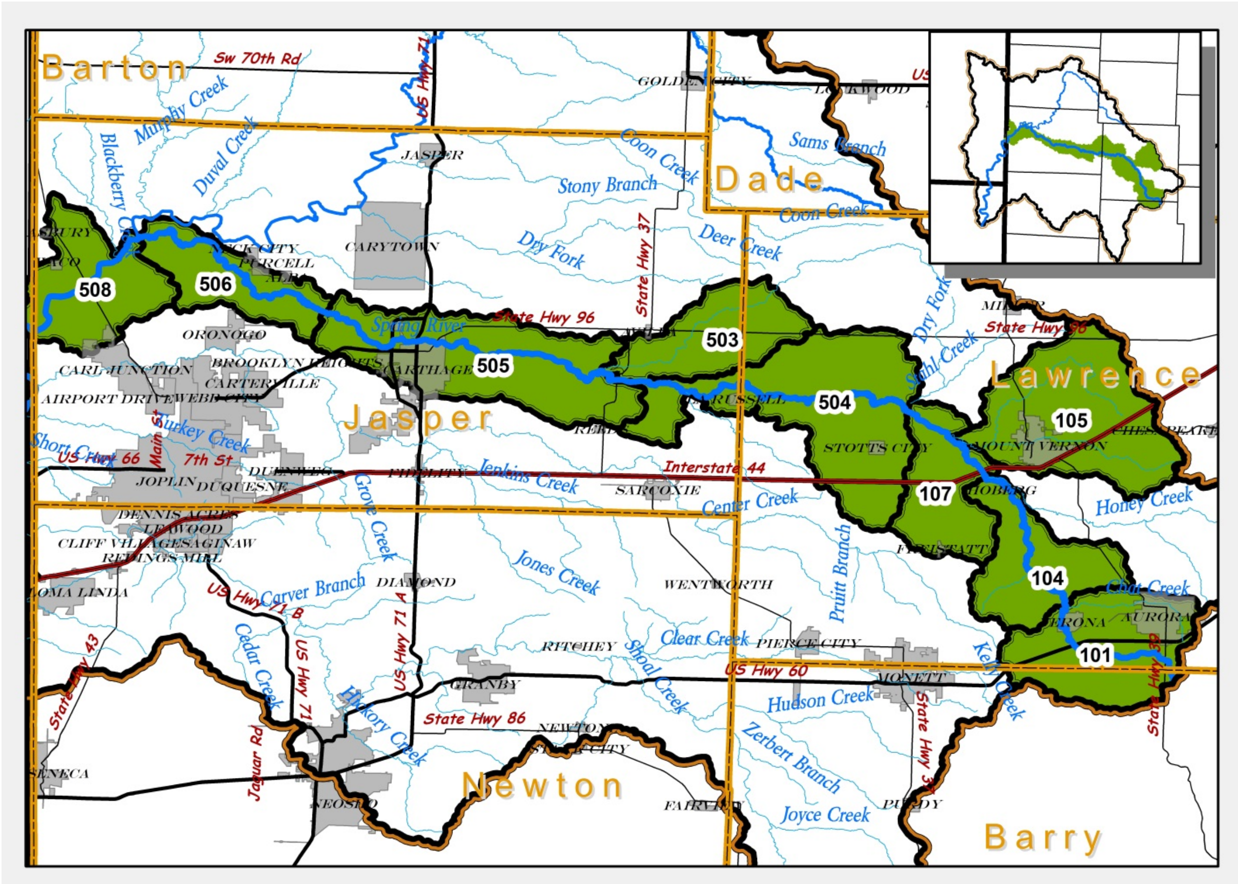


Figure 38. Spring River Sub Watershed.

Table 82. SWAT Generated Land Use in the Spring River Sub Watershed.

Land Use	Acres	Percentage of Landuse
Cropland	19,950	9%
Hay and Pasture	129,994	61%
Urban	19,243	9%
Woodland	43,442	20%
Water	652	0%
Total	213,281	100%

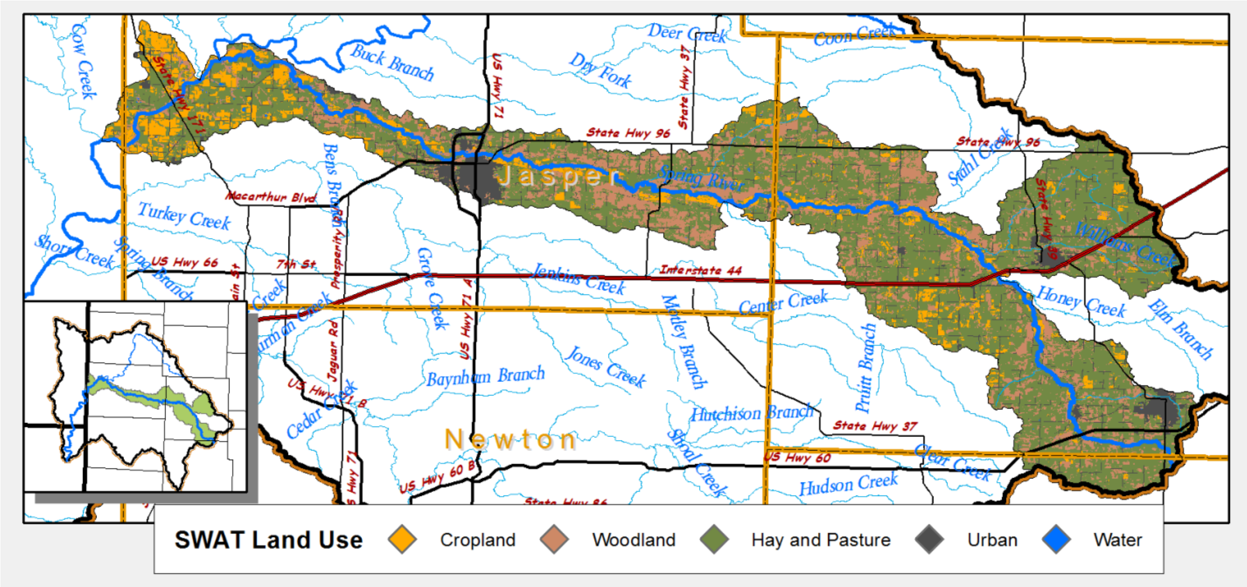


Figure 39. SWAT Generated Land Use in the Spring River Sub Watershed.

1) Targeted Priority Areas

The SWAT determined priority catchment areas in the North Fork Spring River Sub Watershed are located in HUC 12 numbers 101, 107, and 504 as shown in the dark green color on the map below. These Priority 1 catchment areas will be the top priority for BMP placement for cropland and livestock BMPs. Urban BMPs will be placed in any urban area in the watershed.

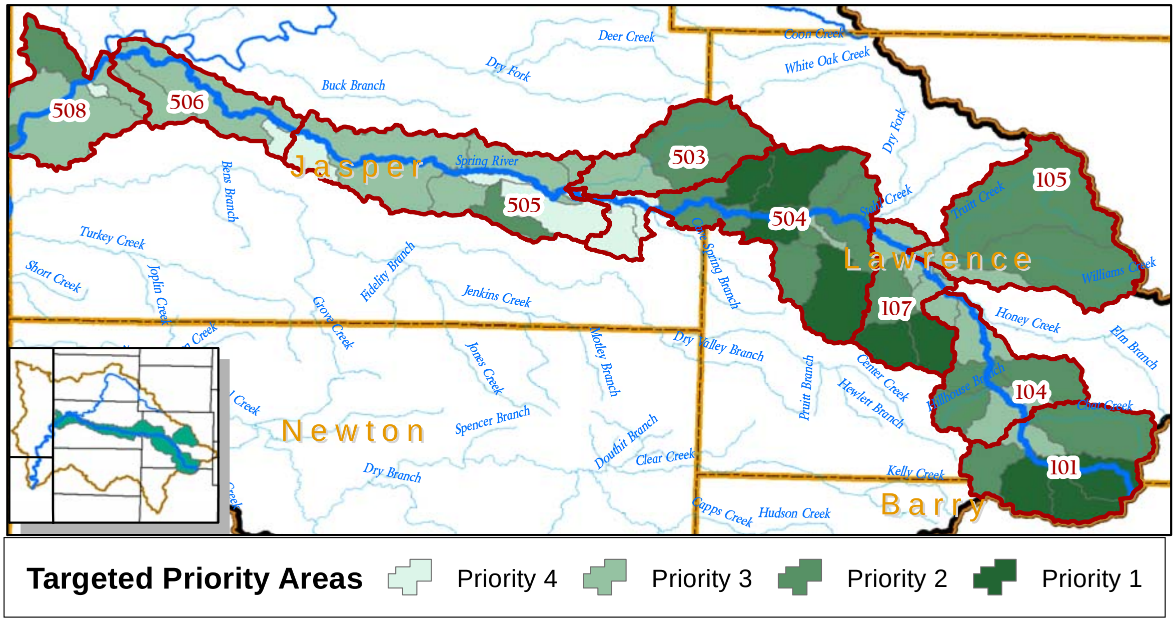


Figure 40. Targeted Priority Areas in the Spring River Sub Watershed.

2) Adoption Rates for BMPs by Pollutant Source

Table 83. Cropland BMP Adoption Rates in the Spring River Sub Watershed. *

Spring River Annual Adoption (treated acres), Cropland BMPs									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	157	157	157	157	157	157	157	157	1,253
2	157	157	157	157	157	157	157	157	1,253
3	157	157	157	157	157	157	157	157	1,253
4	157	157	157	157	157	157	157	157	1,253
5	157	157	157	157	157	157	157	157	1,253
6	157	157	157	157	157	157	157	157	1,253
7	157	157	157	157	157	157	157	157	1,253
8	157	157	157	157	157	157	157	157	1,253
9	157	157	157	157	157	157	157	157	1,253
10	157	157	157	157	157	157	157	157	1,253
11	157	157	157	157	157	157	157	157	1,253
12	157	157	157	157	157	157	157	157	1,253
13	157	157	157	157	157	157	157	157	1,253
14	157	157	157	157	157	157	157	157	1,253
15	157	157	157	157	157	157	157	157	1,253
16	157	157	157	157	157	157	157	157	1,253
17	157	157	157	157	157	157	157	157	1,253
18	157	157	157	157	157	157	157	157	1,253
19	157	157	157	157	157	157	157	157	1,253
20	157	157	157	157	157	157	157	157	1,253

***Adoption rates by HUC 12 are provided in the Appendix.**

Table 84. Livestock BMP Adoption Rates in the Spring River Sub Watershed.

Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Adoption (over 20 years)
45	45	15	30	6	10	6	157

Table 85. Urban BMP Adoption Rates in the Spring River Sub Watershed.

Spring River Urban BMP Adoption				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Total Adoption
1	1			1
2		1	1	2
3	1			1

Year	Bioswale	Stream Buffers	Permanent Vegetation	Total Adoption
4		1	1	2
5	1			1
6		1	1	2
7	1			1
8		1	1	2
9	1			1
10		1	1	2
11	1			1
12		1	1	2
13	1			1
14		1	1	2
15	1			1
16		1	1	2
17	1			1
18		1	1	2
19	1			1
20		1	1	2

3) Pollutant Load Reductions

Table 86. Cropland Erosion Reduction in the Spring River Sub Watershed. *

Spring River Annual Soil Erosion Reduction									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	67	9	22	22	35	27	44	44	271
2	133	18	44	44	71	53	89	89	541
3	200	27	67	67	106	80	133	133	812
4	266	35	89	89	142	106	177	177	1,083
5	333	44	111	111	177	133	222	222	1,353
6	399	53	133	133	213	160	266	266	1,624
7	466	62	155	155	248	186	311	311	1,894
8	532	71	177	177	284	213	355	355	2,165
9	599	80	200	200	319	240	399	399	2,436
10	665	89	222	222	355	266	444	444	2,706
11	732	98	244	244	390	293	488	488	2,977
12	799	106	266	266	426	319	532	532	3,248
13	865	115	288	288	461	346	577	577	3,518
14	932	124	311	311	497	373	621	621	3,789

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
15	998	133	333	333	532	399	665	665	4,060
16	1,065	142	355	355	568	426	710	710	4,330
17	1,131	151	377	377	603	453	754	754	4,601
18	1,198	160	399	399	639	479	799	799	4,871
19	1,264	169	421	421	674	506	843	843	5,142
20	1,331	177	444	444	710	532	887	887	5,413

***Erosion load reductions by HUC 12 are provided in the Appendix.**

Table 87. Cropland Phosphorus Load Reduction in the Spring River Sub Watershed. *

Spring River Annual Phosphorus Reduction (lbs)									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	273	102	170	170	273	204	341	341	1,874
2	533	200	333	333	533	400	667	667	3,667
3	806	302	504	504	806	604	1,007	1,007	5,541
4	1,078	404	674	674	1,078	809	1,348	1,348	7,415
5	1,351	507	844	844	1,351	1,013	1,689	1,689	9,288
6	1,624	609	1,015	1,015	1,624	1,218	2,029	2,029	11,162
7	1,896	711	1,185	1,185	1,896	1,422	2,370	2,370	13,035
8	2,169	813	1,355	1,355	2,169	1,626	2,711	2,711	14,909
9	2,441	915	1,526	1,526	2,441	1,831	3,051	3,051	16,783
10	2,714	1,018	1,696	1,696	2,714	2,035	3,392	3,392	18,656
11	2,986	1,120	1,866	1,866	2,986	2,240	3,733	3,733	20,530
12	3,259	1,222	2,037	2,037	3,259	2,444	4,073	4,073	22,403
13	3,531	1,324	2,207	2,207	3,531	2,648	4,414	4,414	24,277
14	3,804	1,426	2,377	2,377	3,804	2,853	4,755	4,755	26,151
15	4,076	1,529	2,548	2,548	4,076	3,057	5,095	5,095	28,024
16	4,349	1,631	2,718	2,718	4,349	3,262	5,436	5,436	29,898
17	4,621	1,733	2,888	2,888	4,621	3,466	5,777	5,777	31,771
18	4,894	1,835	3,059	3,059	4,894	3,670	6,117	6,117	33,645
19	5,166	1,937	3,229	3,229	5,166	3,875	6,458	6,458	35,519
20	5,439	2,040	3,399	3,399	5,439	4,079	6,799	6,799	37,392

***Phosphorus load reductions by HUC 12 are provided in the Appendix.**

Table 88. Cropland Nitrogen Load Reduction in the Spring River Sub Watershed. *

Spring River Annual Nitrogen Reduction (lbs)									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	456	273	456	456	729	547	456	912	4,284
2	888	533	888	888	1,421	1,066	888	1,777	8,351
3	1,344	806	1,344	1,344	2,151	1,613	1,344	2,688	12,635
4	1,800	1,080	1,800	1,800	2,880	2,160	1,800	3,600	16,919
5	2,256	1,353	2,256	2,256	3,609	2,707	2,256	4,511	21,203
6	2,711	1,627	2,711	2,711	4,338	3,254	2,711	5,423	25,487
7	3,167	1,900	3,167	3,167	5,067	3,801	3,167	6,334	29,772
8	3,623	2,174	3,623	3,623	5,797	4,348	3,623	7,246	34,056
9	4,079	2,447	4,079	4,079	6,526	4,894	4,079	8,157	38,340
10	4,534	2,721	4,534	4,534	7,255	5,441	4,534	9,069	42,624
11	4,990	2,994	4,990	4,990	7,984	5,988	4,990	9,980	46,908
12	5,446	3,268	5,446	5,446	8,714	6,535	5,446	10,892	51,192
13	5,902	3,541	5,902	5,902	9,443	7,082	5,902	11,803	55,476
14	6,357	3,814	6,357	6,357	10,172	7,629	6,357	12,715	59,760
15	6,813	4,088	6,813	6,813	10,901	8,176	6,813	13,626	64,045
16	7,269	4,361	7,269	7,269	11,630	8,723	7,269	14,538	68,329
17	7,725	4,635	7,725	7,725	12,360	9,270	7,725	15,450	72,613
18	8,181	4,908	8,181	8,181	13,089	9,817	8,181	16,361	76,897
19	8,636	5,182	8,636	8,636	13,818	10,364	8,636	17,273	81,181
20	9,092	5,455	9,092	9,092	14,547	10,910	9,092	18,184	85,465

***Nitrogen load reductions by HUC 12 are provided in the Appendix.**

Table 89. Livestock Phosphorus Load Reduction in the Spring River Sub Watershed.

Phosphorus Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
4,724	**21,375**	**7,125**	**11,400**	**5,330**	**1,235**	**2,665**	**53,853**

Table 90. Livestock Nitrogen Load Reduction in the Spring River Sub Watershed.

Nitrogen Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
8,897	**40,259**	**13,420**	**21,472**	**10,039**	**2,326**	**5,019**	**101,432**

Table 91. Urban Erosion Load Reduction in the Spring River Sub Watershed.

Spring River Urban BMP Sediment Reduction Rates (tons)				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	1.03	0.00	0.00	1.03
2	1.03	1.54	0.10	2.67
3	2.05	1.54	0.10	3.69
4	2.05	3.08	0.21	5.33
5	3.08	3.08	0.21	6.36
6	3.08	4.61	0.31	8.00
7	4.10	4.61	0.31	9.02
8	4.10	6.15	0.41	10.66
9	5.13	6.15	0.41	11.69
10	5.13	7.69	0.51	13.33
11	6.15	7.69	0.51	14.35
12	6.15	9.23	0.62	15.99
13	7.18	9.23	0.62	17.02
14	7.18	10.76	0.72	18.66
15	8.20	10.76	0.72	19.68
16	8.20	12.30	0.82	21.32
17	9.23	12.30	0.82	22.35
18	9.23	13.84	0.92	23.99
19	10.25	13.84	0.92	25.01
20	10.25	15.38	1.03	26.65

Table 92. Urban Phosphorus Load Reduction in the Spring River Sub Watershed.

Spring River Urban BMP Phosphorus Reduction Rates (pounds)				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	7.5	0	0	8
2	7.5	11.25	1.425	20
3	15	11.25	1.425	28
4	15	22.5	2.85	40
5	22.5	22.5	2.85	48
6	22.5	33.75	4.275	61
7	30	33.75	4.275	68
8	30	45	5.7	81
9	37.5	45	5.7	88
10	37.5	56.25	7.125	101
11	45	56.25	7.125	108
12	45	67.5	8.55	121
13	52.5	67.5	8.55	129
14	52.5	78.75	9.975	141

Year	Bioswale	Stream Buffers	Permanent Vegetation	Cumulative Load Reduction
15	60	78.75	9.975	149
16	60	90	11.4	161
17	67.5	90	11.4	169
18	67.5	101.25	12.825	182
19	75	101.25	12.825	189
20	75	112.5	14.25	202

Table 93. Urban Nitrogen Load Reduction in the Spring River Sub Watershed.

Spring River Urban BMP Nitrogen Reduction Rates (pounds)				
Year	**Bioswale**	**Stream Buffers**	**Permanent Vegetation**	**Cumulative Load Reduction**
1	58.5	0	0	59
2	58.5	87.75	11.115	157
3	117	87.75	11.115	216
4	117	175.5	22.23	315
5	175.5	175.5	22.23	373
6	175.5	263.25	33.345	472
7	234	263.25	33.345	531
8	234	351	44.46	629
9	292.5	351	44.46	688
10	292.5	438.75	55.575	787
11	351	438.75	55.575	845
12	351	526.5	66.69	944
13	409.5	526.5	66.69	1,003
14	409.5	614.25	77.805	1,102
15	468	614.25	77.805	1,160
16	468	702	88.92	1,259
17	526.5	702	88.92	1,317
18	526.5	789.75	100.035	1,416
19	585	789.75	100.035	1,475
20	585	877.5	111.15	1,574

4) Costs of Implementing BMPs

Table 94. Cropland BMP Costs in the Spring River Sub Watershed.*

Spring River Sub Watershed **Total Annual Cost of Cropland BMPs, 3% Inflation**									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	$12,171	$6,110	$12,220	$6,110	$25,067	$19,583	$10,444	$19,583	$111,289

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
2	$12,537	$6,293	$12,587	$6,293	$25,819	$20,171	$10,758	$20,171	$114,628
3	$12,913	$6,482	$12,964	$6,482	$26,593	$20,776	$11,080	$20,776	$118,066
4	$13,300	$6,677	$13,353	$6,677	$27,391	$21,399	$11,413	$21,399	$121,608
5	$13,699	$6,877	$13,754	$6,877	$28,213	$22,041	$11,755	$22,041	$125,257
6	$14,110	$7,083	$14,166	$7,083	$29,059	$22,702	$12,108	$22,702	$129,014
7	$14,533	$7,296	$14,591	$7,296	$29,931	$23,383	$12,471	$23,383	$132,885
8	$14,969	$7,515	$15,029	$7,515	$30,829	$24,085	$12,845	$24,085	$136,871
9	$15,418	$7,740	$15,480	$7,740	$31,754	$24,807	$13,231	$24,807	$140,977
10	$15,881	$7,972	$15,944	$7,972	$32,706	$25,552	$13,628	$25,552	$145,207
11	$16,357	$8,211	$16,423	$8,211	$33,687	$26,318	$14,036	$26,318	$149,563
12	$16,848	$8,458	$16,915	$8,458	$34,698	$27,108	$14,458	$27,108	$154,050
13	$17,353	$8,711	$17,423	$8,711	$35,739	$27,921	$14,891	$27,921	$158,671
14	$17,874	$8,973	$17,945	$8,973	$36,811	$28,759	$15,338	$28,759	$163,431
15	$18,410	$9,242	$18,484	$9,242	$37,915	$29,621	$15,798	$29,621	$168,334
16	$18,963	$9,519	$19,038	$9,519	$39,053	$30,510	$16,272	$30,510	$173,384
17	$19,532	$9,805	$19,609	$9,805	$40,225	$31,425	$16,760	$31,425	$178,586
18	$20,117	$10,099	$20,198	$10,099	$41,431	$32,368	$17,263	$32,368	$183,944
19	$20,721	$10,402	$20,804	$10,402	$42,674	$33,339	$17,781	$33,339	$189,462
20	$21,343	$10,714	$21,428	$10,714	$43,954	$34,339	$18,314	$34,339	$195,146

***Costs by HUC 12 are provided in the Appendix.**

Table 95. Livestock BMP Costs in the Spring River Sub Watershed.

Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Cost (over 20 years)
$180,000	$315,000	$45,000	$60,000	$72,000	$75,000	$6,000	$753,000

Table 96. Urban BMP Costs in the Spring River Sub Watershed.

Spring River Urban BMP Implementation Cost				
Year	Bioswale	Stream Buffers	Permanent Vegetation	Cost
1	$21,780	$0	$0	$21,780
2	$0	$1,000	$150	$1,150
3	$21,780	$0	$0	$21,780
4	$0	$1,000	$150	$1,150
5	$21,780	$0	$0	$21,780
6	$0	$1,000	$150	$1,150
7	$21,780	$0	$0	$21,780

Year	Bioswale	Stream Buffers	Permanent Vegetation	Cost
8	$0	$1,000	$150	$1,150
9	$21,780	$0	$0	$21,780
10	$0	$1,000	$150	$1,150
11	$21,780	$0	$0	$21,780
12	$0	$1,000	$150	$1,150
13	$21,780	$0	$0	$21,780
14	$0	$1,000	$150	$1,150
15	$21,780	$0	$0	$21,780
16	$0	$1,000	$150	$1,150
17	$21,780	$0	$0	$21,780
18	$0	$1,000	$150	$1,150
19	$21,780	$0	$0	$21,780
20	$0	$1,000	$150	$1,150

5) Total by Category

Table 97. Spring River Sub Watershed Total Phosphorus Load Reduction by Category.

Spring River Total Phosphorus Reduction over the 20 Year Life of the Plan		
Best Management Practice Category	Total Phosphorus Reduction, pounds	% of Total Cost
Cropland	37,392	40.9%
Livestock	53,853	58.9%
Urban	202	0.2
Total	**91,447**	**100.0%**

Table 98. Spring River Sub Watershed Total Cost by Category.

Spring River Total Cost over the 20 Year Life of the Plan		
Best Management Practice Category	Total Cost	% of Total Cost
Cropland	$2,990,373	75.3%
Livestock	$753,000	18.9%
Urban	$229,300	5.8
Total	**$3,972,673**	**100.0%**

E Center Creek Sub Watershed

The Center Creek Sub Watershed has an impairment for bacteria. Therefore, it will be targeted for livestock BMPs to address a needed bacteria TMDL. Cropland BMPs will also be addressed. Urban BMPs will not apply to this sub watershed since there are no significant urban areas contained in the sub watershed.

Since phosphorus is tied to manure, it has been calculated that the phosphorus load reduction for control of bacteria in this sub watershed is 10,679 pounds of phosphorus over the 20 year life of the plan. If all livestock BMPs are implemented in this watershed, 552 pounds of phosphorus will be reduced annually. In addition to the phosphorus reduction that is connected to bacteria contribution, phosphorus from cropland BMPs will contribute 616 pounds. **This load reduction will be attained if all BMPs are implemented in the watershed.**

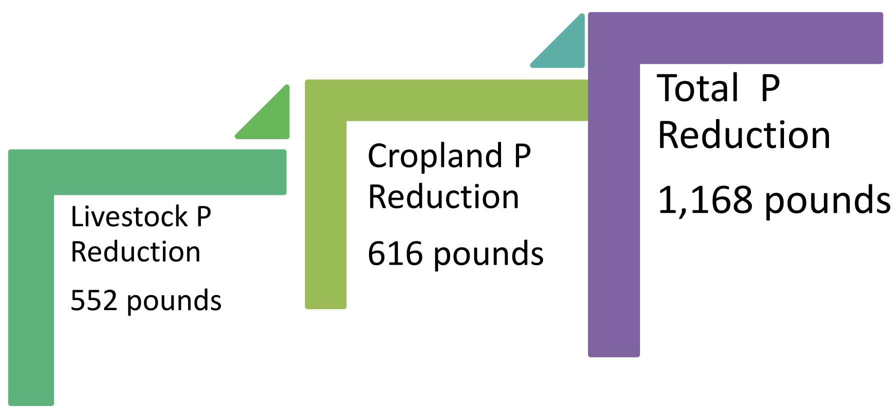


Figure 41. Annual Phosphorus Reduction by Category in Center Creek Sub Watershed after All BMPs have been Implemented.

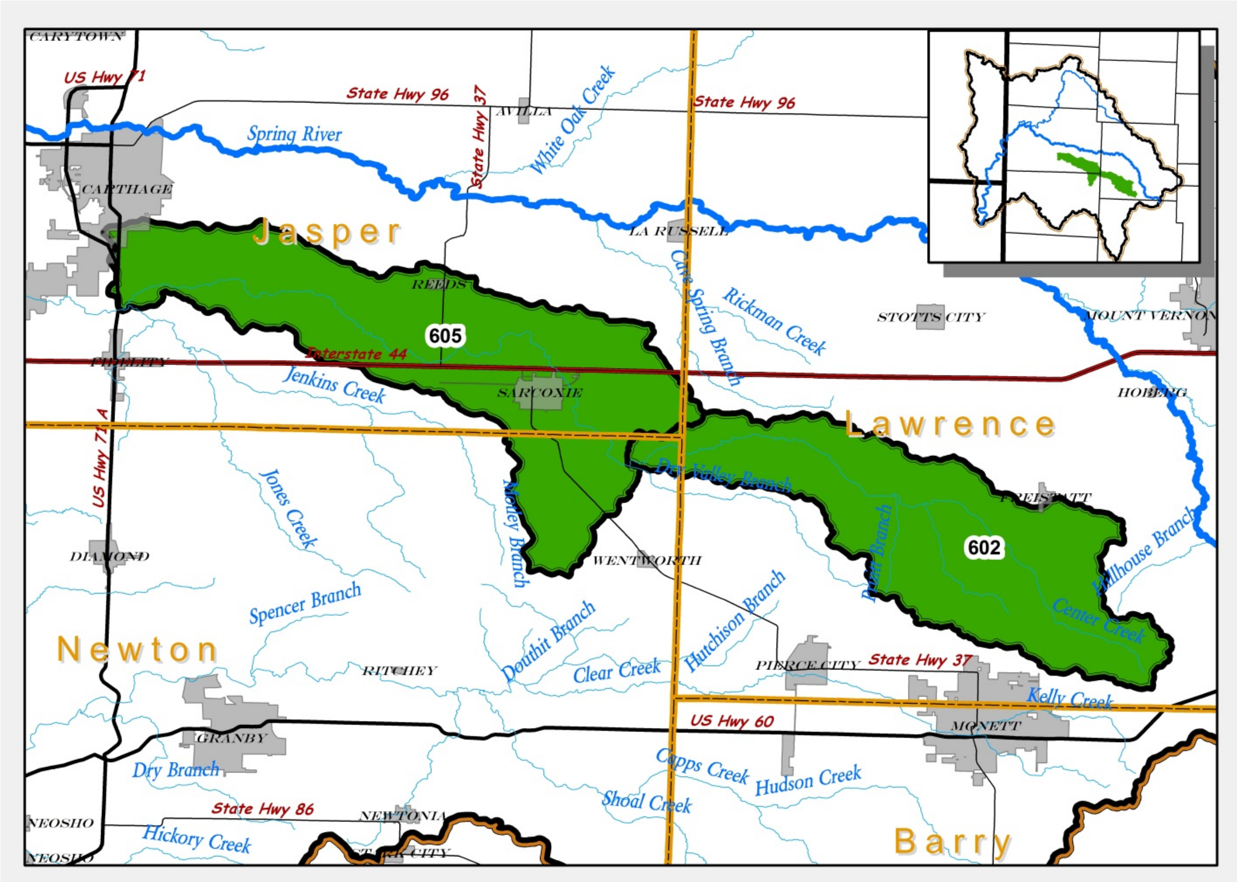


Figure 42. Center Creek Sub Watershed

Table 99. SWAT Generated Land Use in the Center Creek Sub Watershed.

Land Use	Acres	Percentage of Landuse
Cropland	5,219	8%
Hay and Pasture	39,953	64%
Urban	3,718	6%
Woodland	13,672	22%
Water	103	0%
Total	62,666	100%

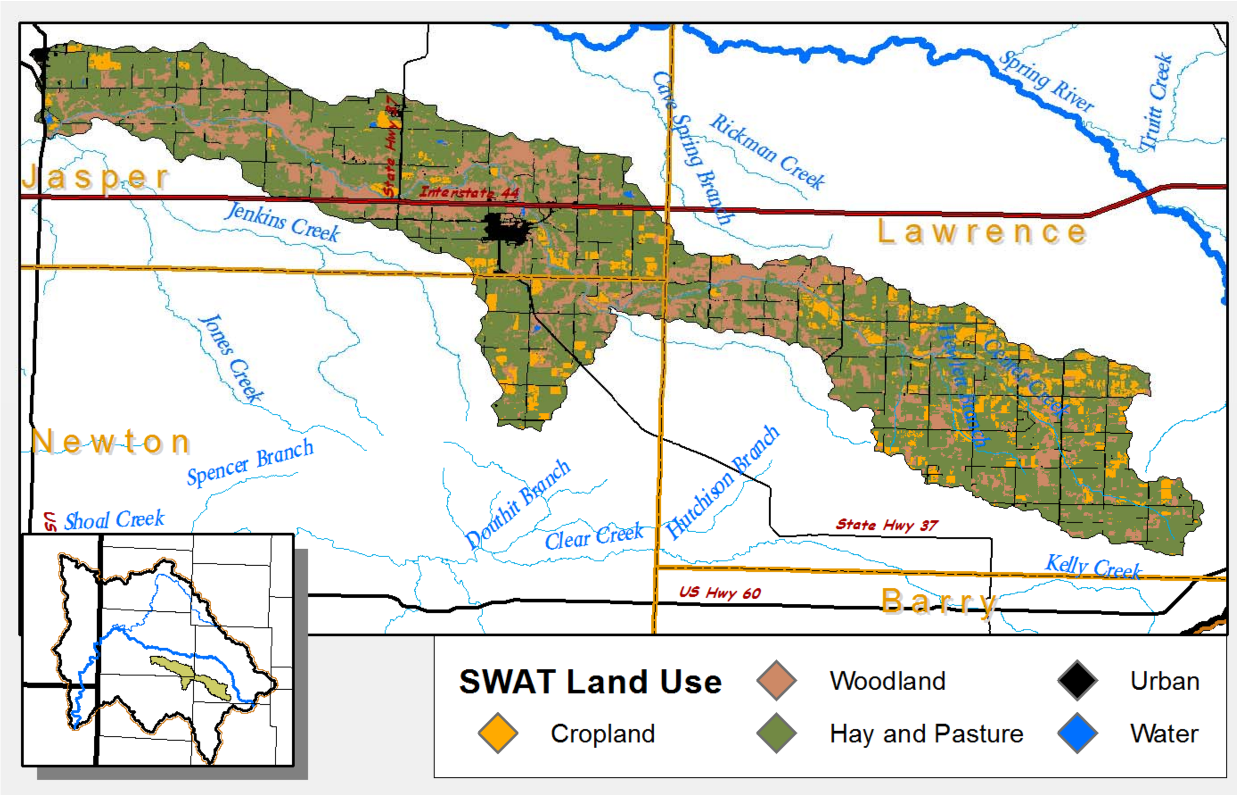


Figure 43. SWAT Generated Lnad Use for Center Creek Sub Watershed.

1) Targeted Priority Areas

The SWAT determined priority catchment area in the Center Creek Sub Watershed is located in HUC 12 numbers 602 as shown in the dark green color on the map below. This Priority 1 catchment area will be the top priority for BMP placement for cropland and livestock BMPs.

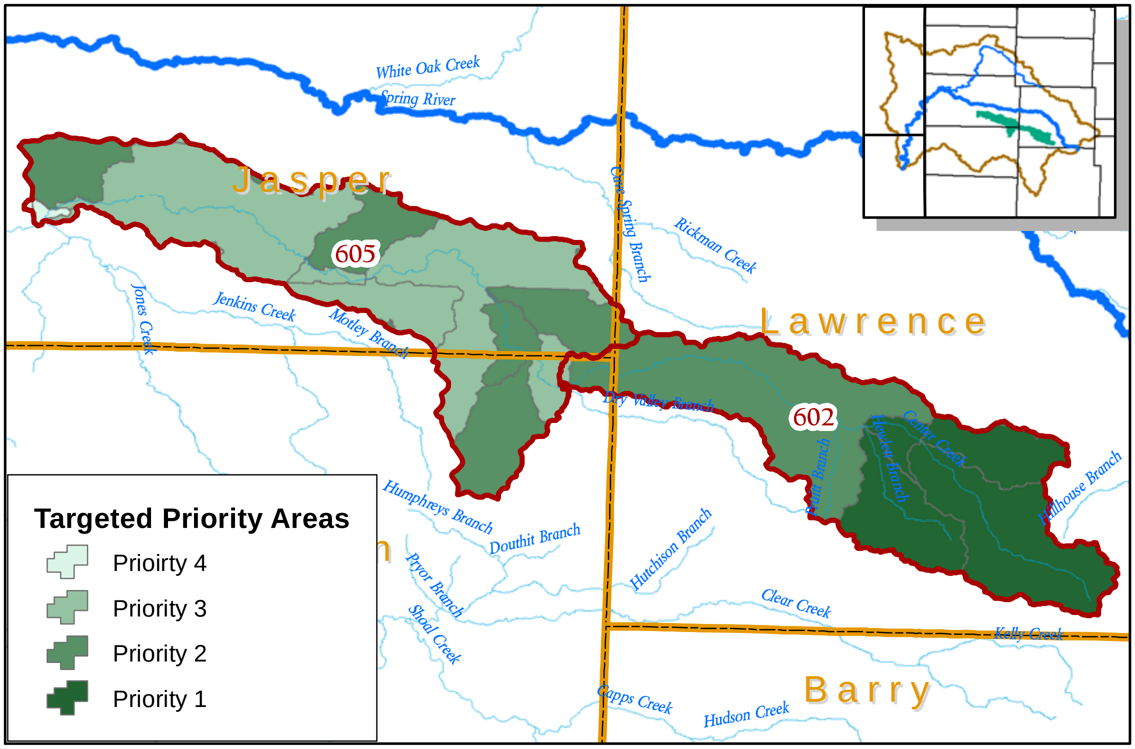


Figure 44. Targeted Priority Areas in Center Creek Sub Watershed.

2) Adoption Rates for BMPs

Table 100. Cropland BMP Adoption Rates in Center Creek Sub Watershed.

Center Creek Annual Adoption (treated acres), Cropland BMPs									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	46	46	46	46	46	46	46	46	371
2	46	46	46	46	46	46	46	46	371
3	46	46	46	46	46	46	46	46	371
4	46	46	46	46	46	46	46	46	371
5	46	46	46	46	46	46	46	46	371
6	46	46	46	46	46	46	46	46	371
7	46	46	46	46	46	46	46	46	371
8	46	46	46	46	46	46	46	46	371
9	46	46	46	46	46	46	46	46	371
10	46	46	46	46	46	46	46	46	371
11	46	46	46	46	46	46	46	46	371
12	46	46	46	46	46	46	46	46	371
13	46	46	46	46	46	46	46	46	371
14	46	46	46	46	46	46	46	46	371

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
15	46	46	46	46	46	46	46	46	371
16	46	46	46	46	46	46	46	46	371
17	46	46	46	46	46	46	46	46	371
18	46	46	46	46	46	46	46	46	371
19	46	46	46	46	46	46	46	46	371
20	46	46	46	46	46	46	46	46	371

Table 101. Livestock BMP Adoption Rates in the Center Creek Sub Watershed.

Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Adoption (over 20 years)
5	10	2	5	1	2	4	**29**

3) Pollutant Load Reductions

Table 102. Cropland Erosion Load Reduction in Center Creek Sub Watershed.

Center Creek Annual Soil Erosion Reduction, tons									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	34	5	11	11	18	14	23	23	138
2	68	9	23	23	36	27	45	45	276
3	102	14	34	34	54	41	68	68	414
4	136	18	45	45	72	54	90	90	552
5	170	23	57	57	90	68	113	113	690
6	204	27	68	68	109	81	136	136	828
7	238	32	79	79	127	95	158	158	966
8	271	36	90	90	145	109	181	181	1,104
9	305	41	102	102	163	122	204	204	1,242
10	339	45	113	113	181	136	226	226	1,380
11	373	50	124	124	199	149	249	249	1,518
12	407	54	136	136	217	163	271	271	1,656
13	441	59	147	147	235	176	294	294	1,794
14	475	63	158	158	253	190	317	317	1,932
15	509	68	170	170	271	204	339	339	2,070
16	543	72	181	181	290	217	362	362	2,208
17	577	77	192	192	308	231	385	385	2,346

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
18	611	81	204	204	326	244	407	407	2,484
19	645	86	215	215	344	258	430	430	2,622
20	679	90	226	226	362	271	452	452	2,760

Table 103. Cropland Phosphorus Load Reduction in Center Creek Sub Watershed.

Center Creek Annual Phosphorus Reduction (lbs)									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	90	34	56	56	90	67	112	112	616
2	179	67	112	112	179	134	224	224	1,233
3	269	101	168	168	269	202	336	336	1,849
4	359	134	224	224	359	269	448	448	2,466
5	448	168	280	280	448	336	560	560	3,082
6	538	202	336	336	538	403	672	672	3,698
7	628	235	392	392	628	471	784	784	4,315
8	717	269	448	448	717	538	897	897	4,931
9	807	303	504	504	807	605	1,009	1,009	5,548
10	897	336	560	560	897	672	1,121	1,121	6,164
11	986	370	616	616	986	740	1,233	1,233	6,780
12	1,076	403	672	672	1,076	807	1,345	1,345	7,397
13	1,166	437	728	728	1,166	874	1,457	1,457	8,013
14	1,255	471	784	784	1,255	941	1,569	1,569	8,629
15	1,345	504	841	841	1,345	1,009	1,681	1,681	9,246
16	1,435	538	897	897	1,435	1,076	1,793	1,793	9,862
17	1,524	572	953	953	1,524	1,143	1,905	1,905	10,479
18	1,614	605	1,009	1,009	1,614	1,210	2,017	2,017	11,095
19	1,703	639	1,065	1,065	1,703	1,278	2,129	2,129	11,711
20	1,793	672	1,121	1,121	1,793	1,345	2,241	2,241	12,328

Table 104. Cropland Nitrogen Load Reduction in Center Creek Sub Watershed.

Sub Watershed #602 Center Creek Annual Nitrogen Reduction (lbs)									
Year	**No-Till**	**Cover Crops**	**Nutrient Mgmt Plan**	**Cons Crop Rotation**	**Grassed Waterways**	**Terraces**	**Vegetative Buffers**	**Water Retention Structures**	**Total**
1	157	94	157	157	252	189	157	315	1,480
2	315	189	315	315	504	378	315	630	2,961
3	472	283	472	472	756	567	472	945	4,441

Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
4	630	378	630	630	1,008	756	630	1,260	5,922
5	787	472	787	787	1,260	945	787	1,575	7,402
6	945	567	945	945	1,512	1,134	945	1,890	8,883
7	1,102	661	1,102	1,102	1,764	1,323	1,102	2,205	10,363
8	1,260	756	1,260	1,260	2,016	1,512	1,260	2,520	11,843
9	1,417	850	1,417	1,417	2,268	1,701	1,417	2,835	13,324
10	1,575	945	1,575	1,575	2,520	1,890	1,575	3,150	14,804
11	1,732	1,039	1,732	1,732	2,772	2,079	1,732	3,465	16,285
12	1,890	1,134	1,890	1,890	3,024	2,268	1,890	3,780	17,765
13	2,047	1,228	2,047	2,047	3,276	2,457	2,047	4,095	19,246
14	2,205	1,323	2,205	2,205	3,528	2,646	2,205	4,410	20,726
15	2,362	1,417	2,362	2,362	3,780	2,835	2,362	4,725	22,206
16	2,520	1,512	2,520	2,520	4,032	3,024	2,520	5,040	23,687
17	2,677	1,606	2,677	2,677	4,284	3,213	2,677	5,355	25,167
18	2,835	1,701	2,835	2,835	4,536	3,402	2,835	5,670	26,648
19	2,992	1,795	2,992	2,992	4,788	3,591	2,992	5,985	28,128
20	3,150	1,890	3,150	3,150	5,040	3,780	3,150	6,300	29,609

Table 105. Livestock Phosphorus Load Reduction in the Center Creek Sub Watershed.

Phosphorus Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
525	4,750	950	1,900	888	247	1,777	**11,037**

Table 106. Livestock Nitrogen Load Reduction in the Center Creek Sub Watershed.

Nitrogen Load Reduction in Pounds (after all livestock BMPs are installed)							
Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Load Reduction
989	8,947	1,789	3,579	1,673	465	3,346	**20,788**

4) Costs of Implementing BMPs

Table 107. Cropland BMP Costs in the Center Creek Sub Watershed.

Sub Watershed #602 Center Creek Total Annual Cost of Cropland BMPs, 3% Inflation									
Year	No-Till	Cover Crops	Nutrient Mgmt Plan	Cons Crop Rotation	Grassed Waterways	Terraces	Vegetative Buffers	Water Retention Structures	Total
1	$3,600	$1,807	$3,614	$1,807	$7,414	$5,792	$3,089	$5,792	$32,915
2	$3,708	$1,861	$3,723	$1,861	$7,636	$5,966	$3,182	$5,966	$33,902
3	$3,819	$1,917	$3,834	$1,917	$7,865	$6,145	$3,277	$6,145	$34,919
4	$3,934	$1,975	$3,949	$1,975	$8,101	$6,329	$3,375	$6,329	$35,967
5	$4,052	$2,034	$4,068	$2,034	$8,344	$6,519	$3,477	$6,519	$37,046
6	$4,173	$2,095	$4,190	$2,095	$8,594	$6,714	$3,581	$6,714	$38,157
7	$4,298	$2,158	$4,315	$2,158	$8,852	$6,916	$3,688	$6,916	$39,302
8	$4,427	$2,222	$4,445	$2,222	$9,118	$7,123	$3,799	$7,123	$40,481
9	$4,560	$2,289	$4,578	$2,289	$9,391	$7,337	$3,913	$7,337	$41,695
10	$4,697	$2,358	$4,716	$2,358	$9,673	$7,557	$4,030	$7,557	$42,946
11	$4,838	$2,429	$4,857	$2,429	$9,963	$7,784	$4,151	$7,784	$44,234
12	$4,983	$2,501	$5,003	$2,501	$10,262	$8,017	$4,276	$8,017	$45,561
13	$5,132	$2,576	$5,153	$2,576	$10,570	$8,258	$4,404	$8,258	$46,928
14	$5,286	$2,654	$5,308	$2,654	$10,887	$8,506	$4,536	$8,506	$48,336
15	$5,445	$2,733	$5,467	$2,733	$11,214	$8,761	$4,672	$8,761	$49,786
16	$5,608	$2,815	$5,631	$2,815	$11,550	$9,024	$4,813	$9,024	$51,280
17	$5,777	$2,900	$5,800	$2,900	$11,897	$9,294	$4,957	$9,294	$52,818
18	$5,950	$2,987	$5,974	$2,987	$12,254	$9,573	$5,106	$9,573	$54,403
19	$6,128	$3,076	$6,153	$3,076	$12,621	$9,860	$5,259	$9,860	$56,035
20	$6,312	$3,169	$6,337	$3,169	$13,000	$10,156	$5,417	$10,156	$57,716

Table 108. Livestock BMP Costs in the Center Creek Sub Watershed.

Off-Stream Watering System	Rotational Grazing	Relocate Pasture Feeding Site	Grazing Mgmt Plans	Relocate Feeding Pens	Fence off Streams and Ponds	Vegetative Filter Strip	Total Cost (over 20 years)
$20,000	$70,000	$6,000	$10,000	$12,000	$15,000	$4,000	**$137,000**

5) Totals by Category

Table 109. Phosphorus Load Reduction by Category in the Center Creek Sub Watershed.

Spring River Total Phosphorus Reduction over the 20 Year Life of the Plan		
Best Management Practice Category	Total Phosphorus Reduction, pounds	% of Total Reduction
Cropland	12,328	53%
Livestock	11,037	47%
Total	**23,365**	**100%**

Table 110. Total Cost by Category in the Center Creek Sub Watershed.

Spring River Total Cost over the 20 Year Life of the Plan		
Best Management Practice Category	Total Cost	% of Total Cost
Cropland	$884,427	87%
Livestock	$137,000	13%
Total	**$1,021,427**	**100%**

F Turkey Creek Sub Watershed

The Turkey Creek Sub Watershed has an impairment for bacteria. Therefore, it will be targeted for livestock BMPs to address the needed bacteria TMDL. Cropland BMPs will also be addressed. Urban BMPs will apply to this watershed to be implemented in any urban area, but with special consideration to Joplin (population 45,504) and Webb City (population 9,812).

Since phosphorus is tied to manure, it has been calculated that the phosphorus load reduction for control of bacteria in this sub watershed is 4,986 pounds of phosphorus over the 20 year life of the plan. If all livestock BMPs are implemented in this watershed, 251 pounds of phosphorus will be reduced annually. In addition to the phosphorus reduction that is connected to bacteria contribution, phosphorus from cropland BMPs and urban BMPs will contribute 46 pounds. **This load reduction will be attained if all BMPs are implemented in the watershed.**

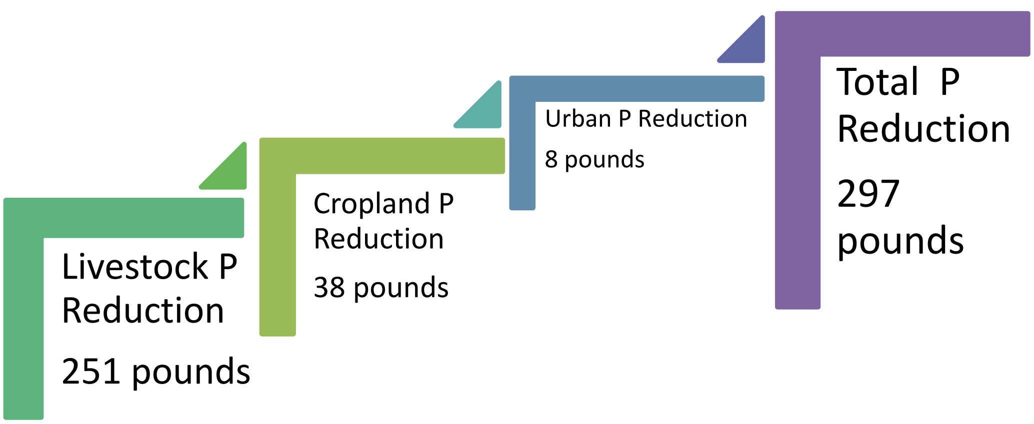


Figure 45. Annual Phosphorus Reduction by Category in Turkey Creek Sub Watershed after All BMPs have been Implemented.